THE CONNECTICUT VALLEY ELECTRIC TRANSMISSION RELIABILITY PROJECTS

APPLICATION TO THE

CONNECTICUT SITING COUNCIL

FOR CERTIFICATES OF ENVIRONMENTAL COMPATIBILITY AND PUBLIC NEED FOR

THE CONNECTICUT PORTION

OF THE GREATER SPRINGFIELD RELIABILITY PROJECT

AND FOR

THE MANCHESTER TO MEEKVILLE JUNCTION CIRCUIT SEPARATION PROJECT

BY

THE CONNECTICUT LIGHT & POWER COMPANY

VOLUME 1 of 11

OCTOBER 2008

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Appendices

An Appendix containing Confidential Critical Energy Infrastructure Information will be filed separately with the Siting Council. CL&P will seek a protective order restricting access to such information. It is anticipated that the Siting Council will provide a mechanism in the protective order for making the information available to interested parties and intervenors; and that copies of the information will be made available to interested parties and intervenors upon execution of a Non-Disclosure Agreement. The CEII Appendix will contain:

A. Supplement to Section F – Project Need: (This supplement provides detailed results of power-flow studies identifying specific weaknesses and vulnerabilities in the Bulk Power Supply system.)
B. Supplement to Section G –System Alternatives: Complete Chapter Six of Report of ICF Resources LLP: Assessment of Non-Transmission Alternatives to the NEEWS Transmission Projects: Greater Springfield Reliability Project, September 2008 (A copy of this report, with redactions to Chapter Six, is included in Vol. 5 of the Application. The full chapter reproduced in the CEII Appendix provides detailed results of power-flow studies identifying specific weaknesses and vulnerabilities in the Bulk Power Supply system.)

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EXECUTIVE SUMMARY

ES.1 THE GREATER SPRINGFIELD RELIABILITY PROJECT AND MANCHESTER TO MEEKVILLE JUNCTION CIRCUIT SEPARATION PROJECT: PUBLIC NEED AND OBJECTIVES

The Greater Springfield Reliability Project (GSRP) is a set of improvements to the electric transmission systems of The Connecticut Light and Power Company (CL&P) in Connecticut and the Western Massachusetts Electric Company (WMECO) in Massachusetts. CL&P and WMECO are wholly-owned subsidiaries of Northeast Utilities, as is their affiliate, Northeast Utilities Service Company (NUSCO). NUSCO provides services to CL&P and WMECO, including the transmission planning, design, and permitting work described in this document. These improvements are needed to provide safe, reliable, and economic transmission service throughout the Greater Springfield, Massachusetts geographic area and in north-central Connecticut, and to assure that these portions of the transmission grid will comply with mandatory federal and regional reliability standards. At the same time, the GSRP improvements will advance a comprehensive regional plan for improving electric transmission in New England, through extensive coordinated improvements in Connecticut, Massachusetts, and Rhode Island. This comprehensive plan is known as the New England East – West Solution (NEEWS).

The separate but related Manchester to Meekville Junction Circuit Separation Project (MMP), which involves the modification of approximately 2.2 miles of existing transmission lines in Manchester, Connecticut, is needed to reliably accommodate higher power flows on the north-central Connecticut transmission system.

For convenience, the GSRP and the MMP are sometimes referred to collectively as “The Connecticut Valley Electric Transmission Reliability Projects.”

ES.1.1 Improvements to the Electric System of Greater Springfield

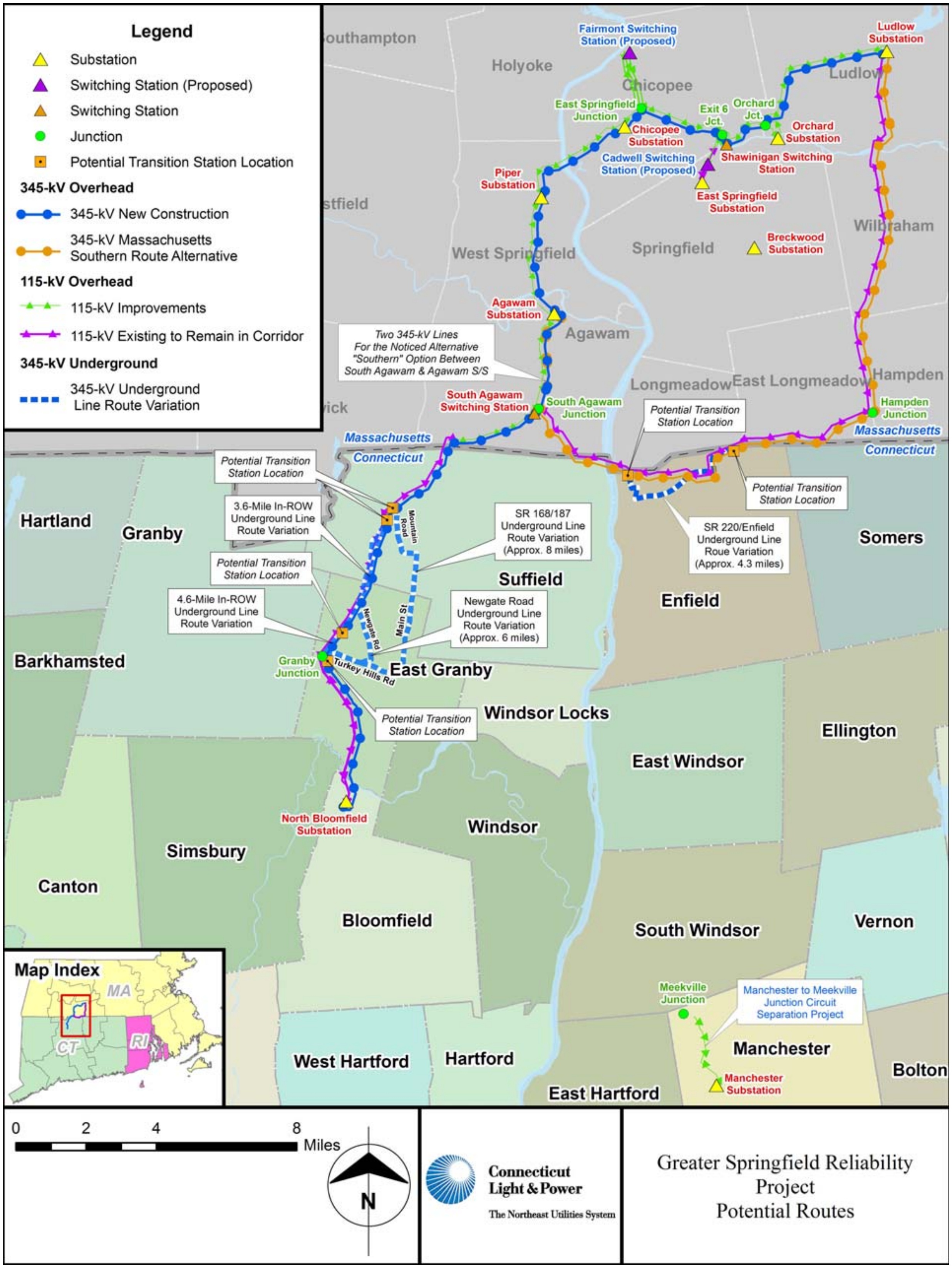
The existing transmission system serving the Greater Springfield geographical area is comprised largely of 115-kilovolt (kV) lines originally constructed from the 1940s through the early 1970s[1]. This system does not meet current mandatory national and regional reliability criteria. Under conditions existing today, the system can become overloaded during normal conditions with all lines in service. In the event of the unscheduled outage of a system element, such as a transmission line or generator, the system is subject to extensive overload and voltage problems. These problems limit the available power within the Greater Springfield geographical area and the transfers of power over the 345-kV interstate tie line between Massachusetts and Connecticut. The problems become increasingly worse every year as electric usage increases and will be further exacerbated as older generation plants are retired.

To alleviate these problems, CL&P and WMECO propose transmission system improvements in Connecticut and Massachusetts, both to the 115-kV system that transmits power to substations that serve local load, and to the 345-kV bulk-power supply system. The full scope of the proposed improvements, and of their potential route alternatives and variations, are illustrated in Figure ES-1. This filing seeks approval for the Connecticut portion of the proposed GSRP construction.

The Greater Springfield additions will, on their own, improve the reliability of the electric transmission systems of western Massachusetts and north-central Connecticut by eliminating extensive violations of reliability criteria, eliminating transfer constraints on the existing transmission system over which power is imported into Connecticut from western Massachusetts, and by completing a 345-kV loop that will supply the North Bloomfield Substation from two directions. These improvements will both increase the security of electric supply to Connecticut customers, and provide them with better access to lower cost, low-emission, and renewable remote power sources.

[1] Many of the towers supporting the 115-kV transmission line between the Agawam Substation in Massachusetts and the North Bloomfield Substation were constructed in the 1920s for a 69-kV line.

Figure ES-1: The Greater Springfield Reliability Project Potential Routes



ES.1.2 Contribution of the Greater Springfield Reliability Project and the Manchester to Meekville Junction Circuit Separation Project to the Overall New England East -West Solution

The New England East – West Solution (NEEWS) is a comprehensive long-term electric transmission construction plan that addresses multiple related electrical reliability issues in Connecticut, Massachusetts, and Rhode Island. The development and full scope of the NEEWS plan is described in Section G of this Application. The GSRP will work together with the other NEEWS projects to:

- Increase the transfer capacity between Connecticut and Massachusetts, and between Connecticut and Rhode Island, thus providing a needed reliability improvement and providing a platform for access to lower cost, low-emission, and renewable remote power sources;
- Relieve transmission bottlenecks between Massachusetts, Rhode Island, and eastern Connecticut, and the load center in southwest Connecticut;
- Increase the system's capacity to move power across Southern New England, from east to west; and
- Improve the reliability of the Rhode Island transmission system.

NEEWS involves improvements to portions of the interconnected bulk-power transmission system owned and operated by four separate regulated public utilities: CL&P, WMECO, Narragansett Electric Company, and The New England Power Company. The latter two companies are wholly-owned subsidiaries of National Grid USA, and are known as "National Grid".

ES.2 OVERVIEW OF THE GREATER SPRINGFIELD RELIABILITY PROJECT AND THE MANCHESTER TO MEEKVILLE JUNCTION CIRCUIT SEPARATION PROJECT

The GSRP includes: the construction of a new 345-kV line along approximately 35 miles of overhead line right-of-way (ROW), 23 miles in Massachusetts and 12 miles in Connecticut; the construction, reconstruction, and upgrade of 115-kV lines along approximately 27 miles of existing and new overhead line ROW in Massachusetts; and related substation improvements in both Massachusetts and Connecticut. In Connecticut, the required substation improvements associated with the new 345-kV line would consist of installing a 345-kV switchyard and a 345-kV to 115-kV, 600-Megavolt Ampere (MVA) autotransformer in the North Bloomfield Substation.

The separate but related MMP includes the separation of a 345-kV circuit and a 115-kV circuit between Manchester Substation and Meekville Junction, Manchester, Connecticut over a distance of approximately 2.2 miles.

ES.3 PROPOSED LOCATION OF THE GREATER SPRINGFIELD RELIABILITY PROJECT AND THE MANCHESTER TO MEEKVILLE JUNCTION CIRCUIT SEPARATION PROJECT FACILITIES

ES.3.1 Locations of Facilities

The location of the North Bloomfield Substation is:

Hoskins and Tariffville Roads, Bloomfield, Connecticut

The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route will not have a fixed address, but will be located along an existing ROW between the North Bloomfield Substation and the

Connecticut/Massachusetts state border, passing through portions of the Towns of Bloomfield, East Granby, and Suffield.

The reconstructed MMP line will not have a fixed address, but will be located within the Town of Manchester, along an existing ROW between the Manchester Substation and Meekville Junction.

ES.3.2 Overview of GSRP 345-kV Line Routes and Substation Facilities in Massachusetts and Connecticut

CL&P and WMECO propose to construct new 345-kV transmission lines to complete a 345-kV "loop" through north-central Connecticut and western Massachusetts. New lines would be built between WMECO's Ludlow Substation in Ludlow, Massachusetts and its Agawam Substation in Agawam, Massachusetts, and between the Agawam Substation and CL&P's North Bloomfield Substation in Bloomfield, Connecticut. The new lines would form a loop back to Ludlow Substation in combination with an existing 345-kV line from North Bloomfield Substation to CL&P's Barbour Hill Substation[2] to Ludlow Substation. CL&P will construct and own the portion of new line between North Bloomfield Substation and the Connecticut/Massachusetts state border in Suffield. The new North Bloomfield to Agawam 345-kV line will functionally replace the two existing 115-kV circuits which share common transmission structures that presently connect the Springfield area to the North Bloomfield Substation. The northern section of the two 115-kV circuits between the South Agawam Switching Station and the North Bloomfield Substation will be bundled together to form a single 115-kV circuit segment between the Connecticut/Massachusetts state border and Granby Junction. At Granby Junction in East Granby, Connecticut the line will be reconnected to another 115-kV line to serve local load in western Massachusetts. The capacity of the 345-kV line will be much greater than that provided by the existing

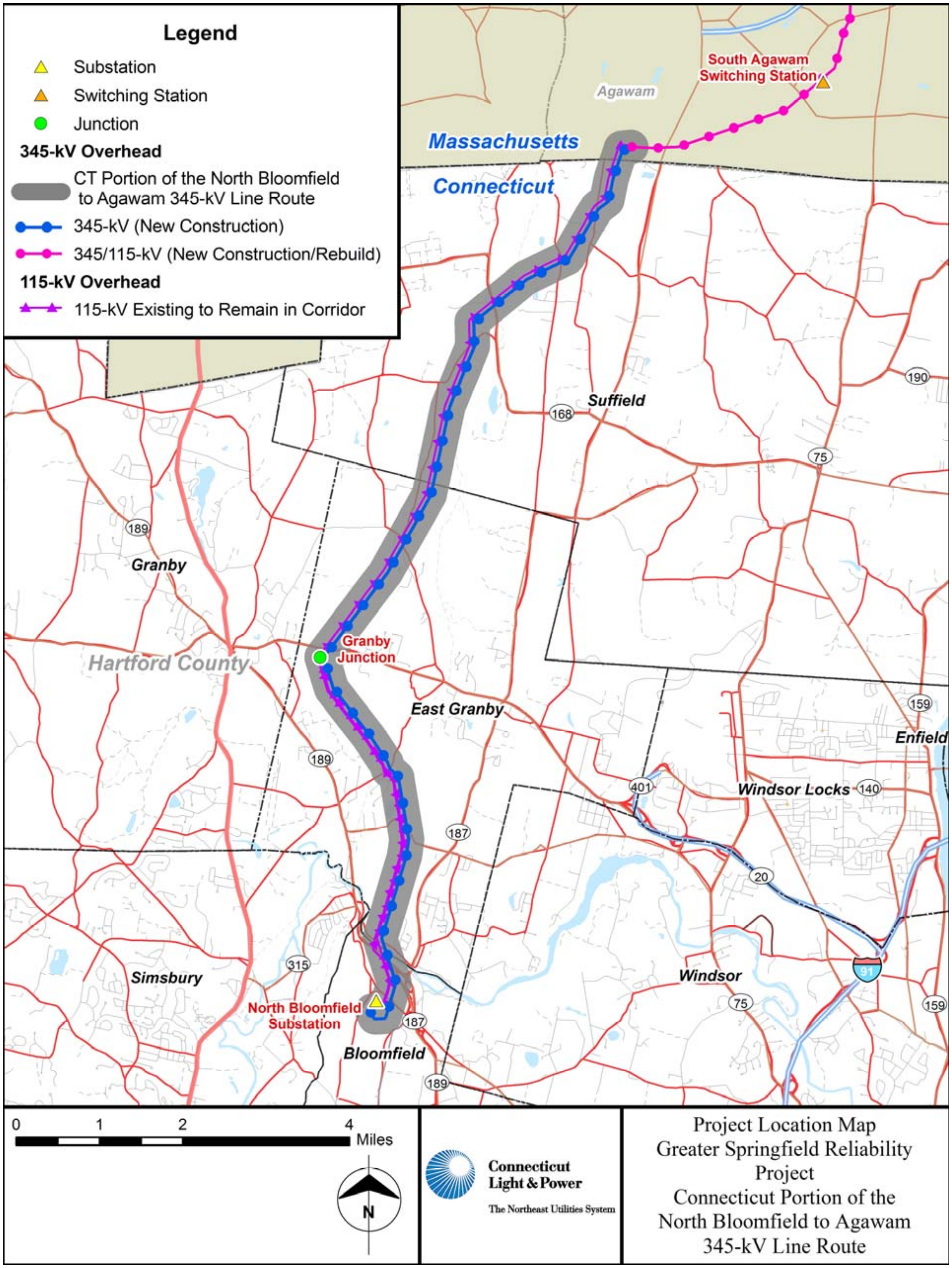
[2] Although this line was originally not connected to the Barbour Hill Substation, modifications to the substation and line that connect the line into the substation were completed in June 2008.

double-circuit 115-kV lines and will solve the reliability needs of both Springfield and the Greater Springfield area, including parts of north-central Connecticut.

ES.3.3 Description of Connecticut Segment of Proposed GSRP 345-kV Line Route and Substation

The new 345-kV line between CL&P's North Bloomfield Substation and WMECO's Agawam Substation in Agawam, Massachusetts will be approximately 18 miles long. Approximately 12 miles of that length would be in Connecticut. From the North Bloomfield Substation, the new line would proceed northerly, traversing the municipalities of Bloomfield, East Granby, and Suffield to the Connecticut/Massachusetts state border. The line would be built predominantly within the boundaries of an existing CL&P overhead transmission line ROW, next to existing 115-kV transmission lines. Figure ES-2 illustrates the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

Figure ES-2: Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

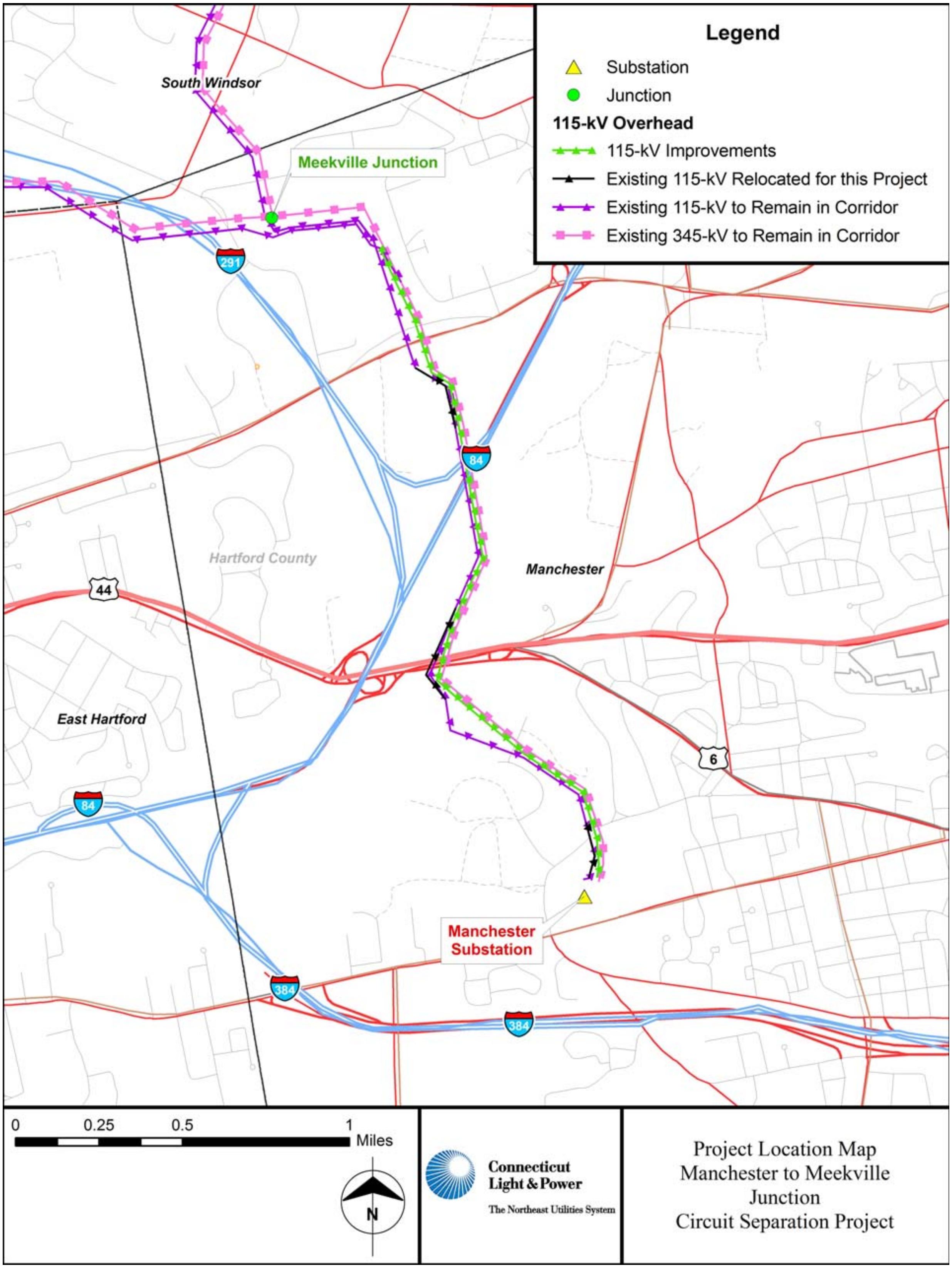


ES.3.4 Overview of the Manchester to Meekville Junction Circuit Separation Project

The MMP consists of the reconstruction of a section of one existing 115-kV transmission circuit along 2.2 miles of ROW in Manchester, Connecticut, between Manchester Substation, and Meekville Junction. Presently, a 345-kV circuit and a 115-kV circuit are supported on a common line of structures over this distance. The 115-kV circuit would be reconstructed on a new line of structures, and the 345-kV line would be left in place on the existing structures, so that each circuit would then be supported by a separate line of structures.

Figure ES-3 illustrates the MMP Line Route.

Figure ES-3: Manchester to Meekville Junction Circuit Separation Project



ES.4 NON-TRANSMISSION SYSTEM ALTERNATIVES

In some cases, electric reliability needs can be met by means other than improvements to the transmission system. For instance, where the reliability problem is simply a lack of sufficient generation resources to reliably serve the load in a defined area, it may be possible to meet the reliability need through building new generation in the area, reducing demand in the area, increasing the capacity of the transmission system to import power into the area, or through some combination of these strategies. In such a case, the determination of the optimum strategy for addressing the need requires an evaluation of the relative cost effectiveness of each solution strategy. However, as demonstrated by power-flow studies performed by ICF Resources, LLP (ICF), the only practical means of resolving the many reliability criteria violations on the Greater Springfield and north-central Connecticut transmission systems is through improvements to those transmission systems. To determine, through power-flow simulations, the potential of new generation and new load reduction measures for resolving the criteria violations, ICF reconfigured the electric systems of western Massachusetts and Connecticut to add extreme and unrealistic amounts of new generation, and also assumed extreme and unrealistic load reductions. Neither set of assumptions eliminated the criteria violations. Only transmission improvements will bring the electric systems of Greater Springfield and north-central Connecticut into compliance with mandatory national and regional reliability standards.

ES.5 TRANSMISSION LINE FACILITY ALTERNATIVES

CL&P and WMECO considered two alternate configurations for the 345-kV GSRP lines before choosing the proposed configuration. The first of these two would, like the proposed configuration, have been between CL&P's North Bloomfield Substation and WMECO's Ludlow Substation, but unlike the proposed configuration would not have been tied into the Agawam Substation. The second alternate configuration would have been a 345-kV line between CL&P's Manchester Substation (Connecticut) and the Ludlow Substation (Massachusetts). As explained in Section H, CL&P and WMECO determined that the proposed configuration was superior to the alternatives, because it provided an alternate supply path to the North Bloomfield Substation and to the Ludlow Substation; provided an additional area bulk-supply point at Agawam Substation; and did not require the use of 115-kV phase-shifting transformers.

ES.6 ROUTING ALTERNATIVES

ES.6.1 Routing Alternatives for the 345-kV Line between the North Bloomfield Substation and the Connecticut/Massachusetts State Border

The proposed overhead line route between the North Bloomfield Substation and the Connecticut/Massachusetts state border is on an existing ROW. The proposed 345-kV line would be built next to existing 115-kV transmission lines. Except for a section approximately 1,000 feet long between Phelps Road and Mountain Road in Suffield, and for a 400-foot long section east of Ratley Road in Suffield, no widening of the existing ROW would be required.

As explained in Section H, CL&P considered alternative routes to the use of the existing overhead transmission line corridor. However, there are no other existing transmission line corridors or other existing utility corridors between the North Bloomfield Substation and the Connecticut/Massachusetts state border; the development of the 345-kV facilities on an entirely new corridor would require the acquisition of easements from private property owners, and would result in comparatively greater environmental effects. An all-underground line between the North Bloomfield and Agawam Substations was assessed. However, such an all-underground design was determined to be impractical based primarily on its unreasonably higher cost – approximately nine times that of the proposed overhead line.

CL&P also identified four potential variations to a portion of the proposed overhead transmission line route from the North Bloomfield Substation to the Connecticut/Massachusetts state border, some in response to expressions of interest from the owners of homes along Newgate and Phelps Roads in East Granby and Suffield. These variations, referred to as the Newgate Road Underground Line Route

Variation, the State Route 168/187 Underground Line Route Variation, the 3.6-Mile In-ROW Underground Line Route Variation, and the 4.6-Mile In-ROW Underground Line Route Variation would replace segments of the overhead 345-kV line with underground cables. The purpose of these variations would be to avoid locating a new overhead 345-kV line on the portion of the ROW that passes by these homes.

Following different road ROWs, the Newgate Road Underground Line Route Variation and the State Route 168/187 Underground Line Route Variation would generally extend from Granby Junction north, through portions of the Towns of East Granby and Suffield. The 3.6 Mile In-ROW Underground Line Route Variation and the 4.6-Mile In-ROW Underground Line Route Variation would be within the existing ROW, through portions of the Towns of East Granby and Suffield. Each variation would require the development of above-ground transition stations at the interconnection points with the overhead line. These transition stations would require between 2 to 4 acres of fenced area at each location to accommodate the equipment needed to connect the 345-kV underground transmission cables to the overhead line.

The location of these line route variations is shown in Figures ES-4, ES-5, ES-6, and ES-7. Each variation is described in detail in Section H.

Figure ES-4: Newgate Road Underground Line Route Variation

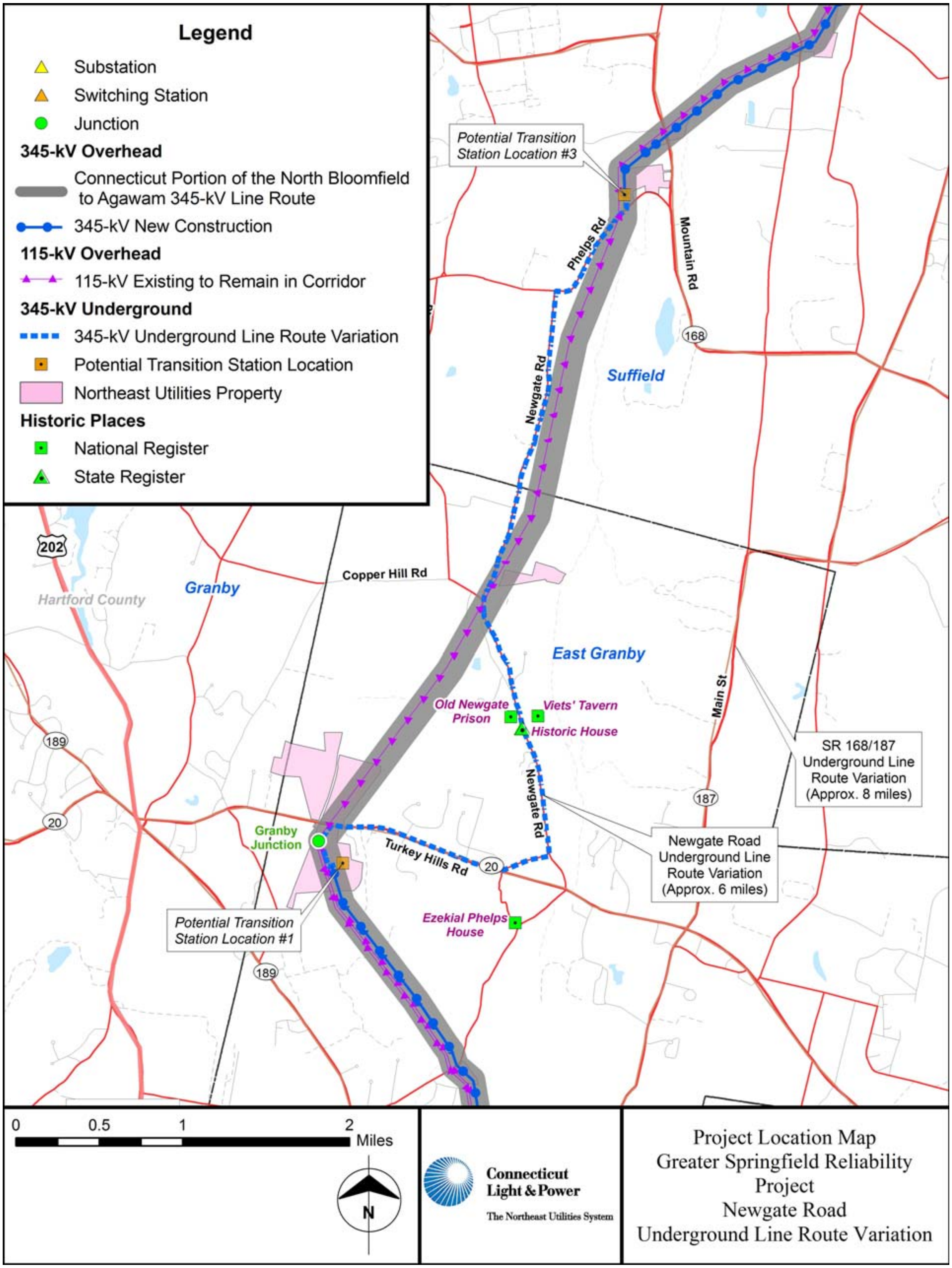


Figure ES-5: State Route 168/187 Underground Line Route Variation

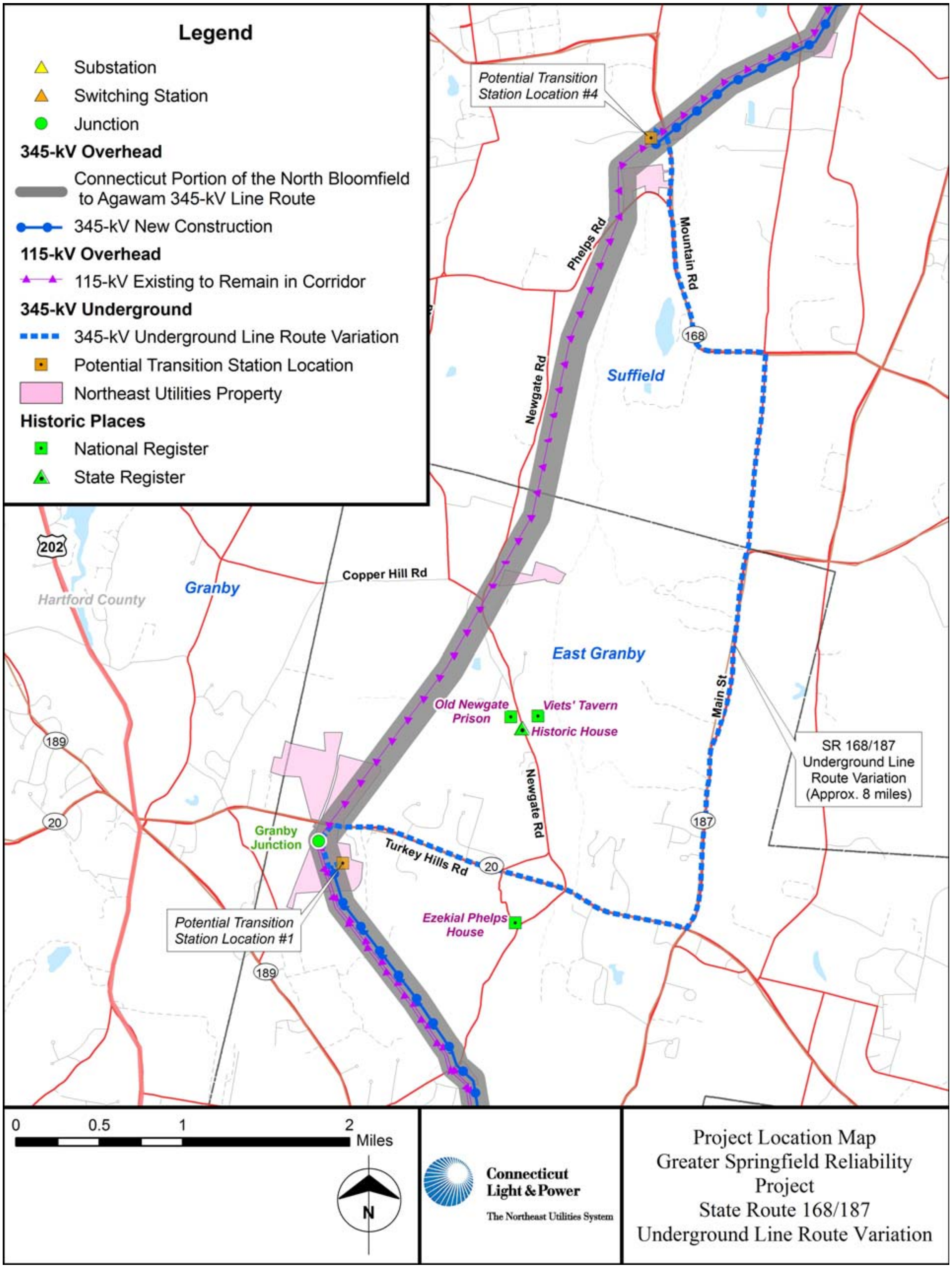


Figure ES-6: 3.6-Mile In-ROW Underground Line Route Variation

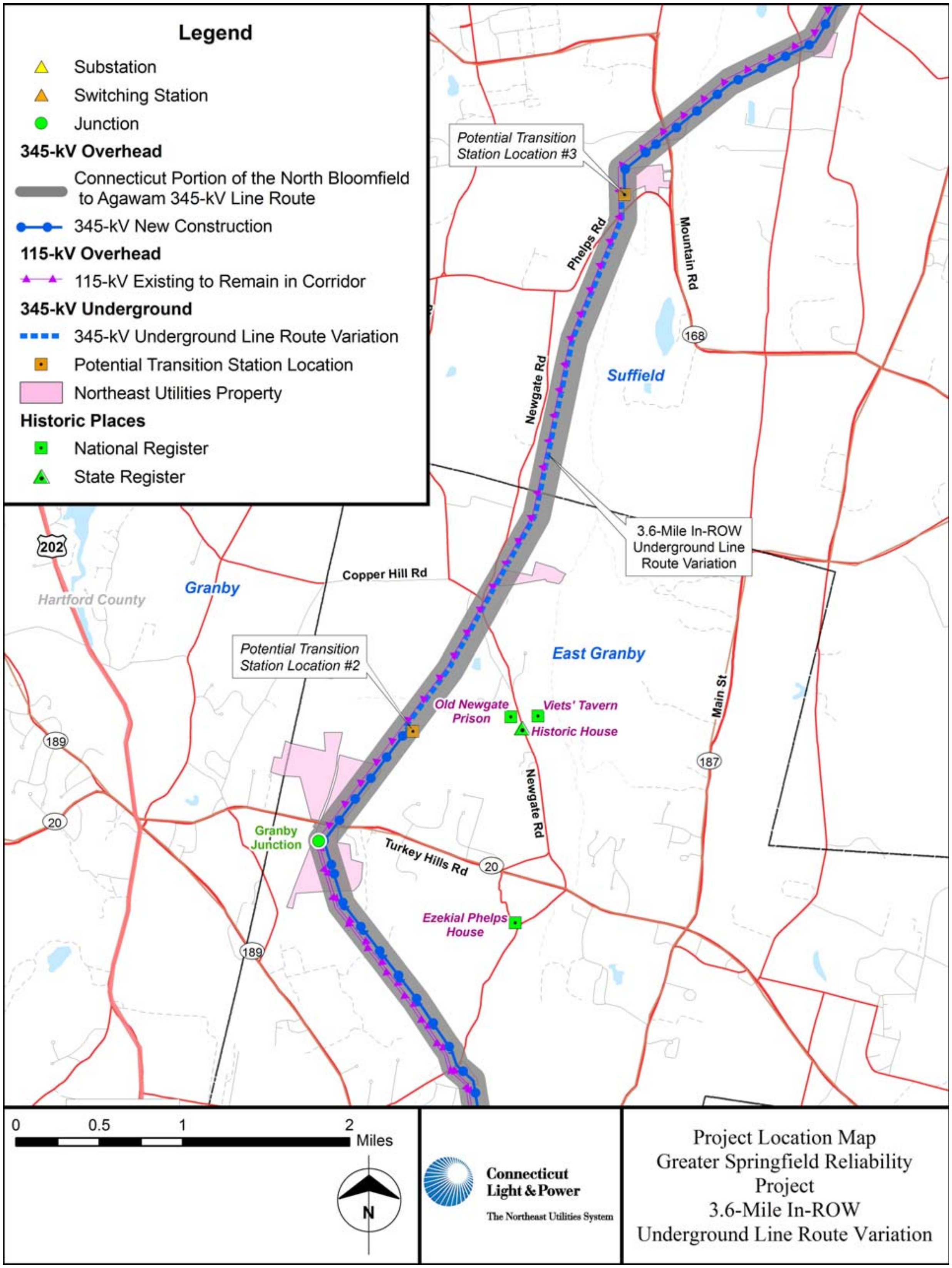
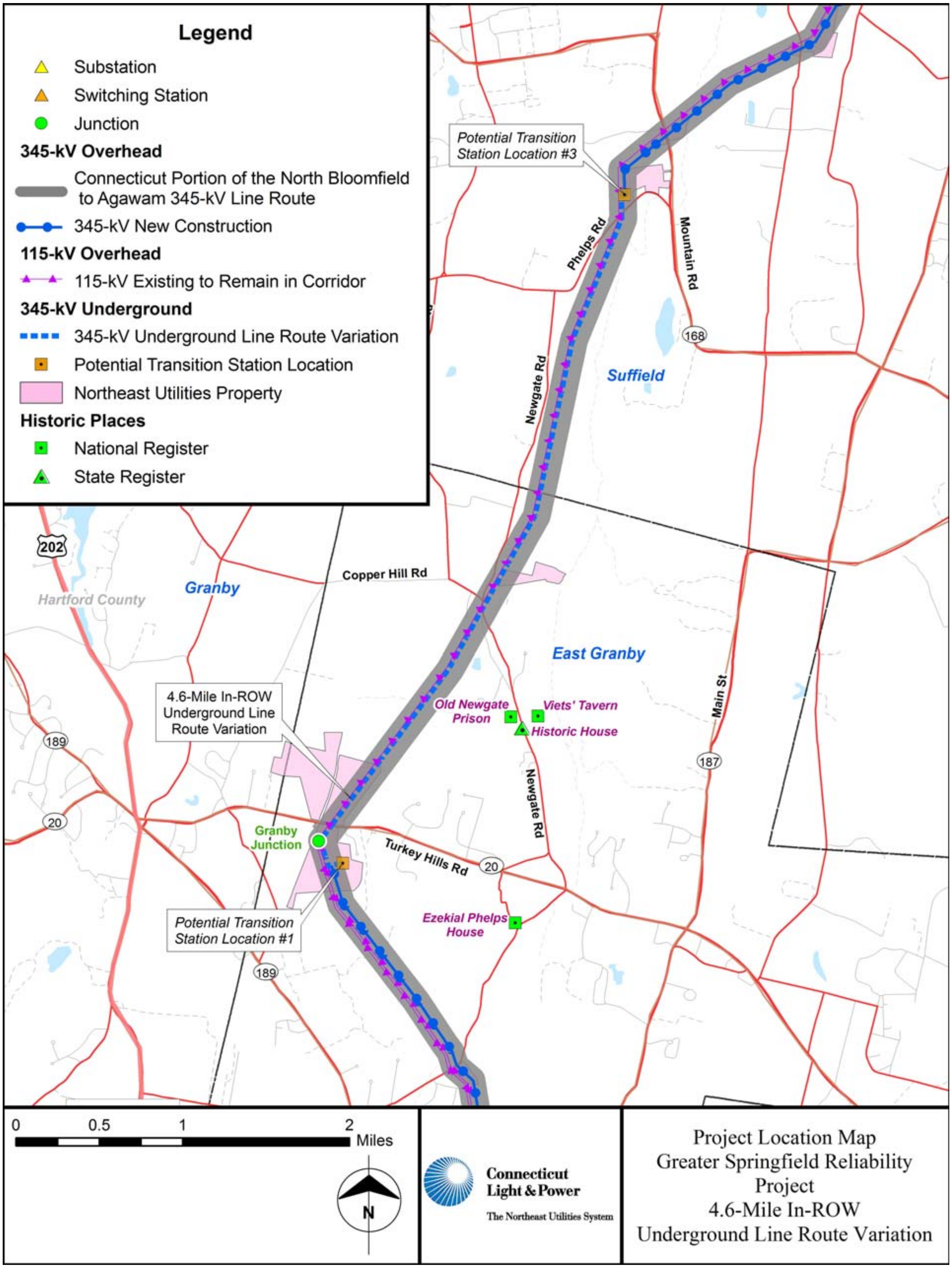


Figure ES-7: 4.6-Mile In-ROW Underground Line Route Variation



ES.6.2 The Connecticut Portion of the Massachusetts Southern Route Alternative for a 345-kV Line between WMECO's Agawam and Ludlow Substations

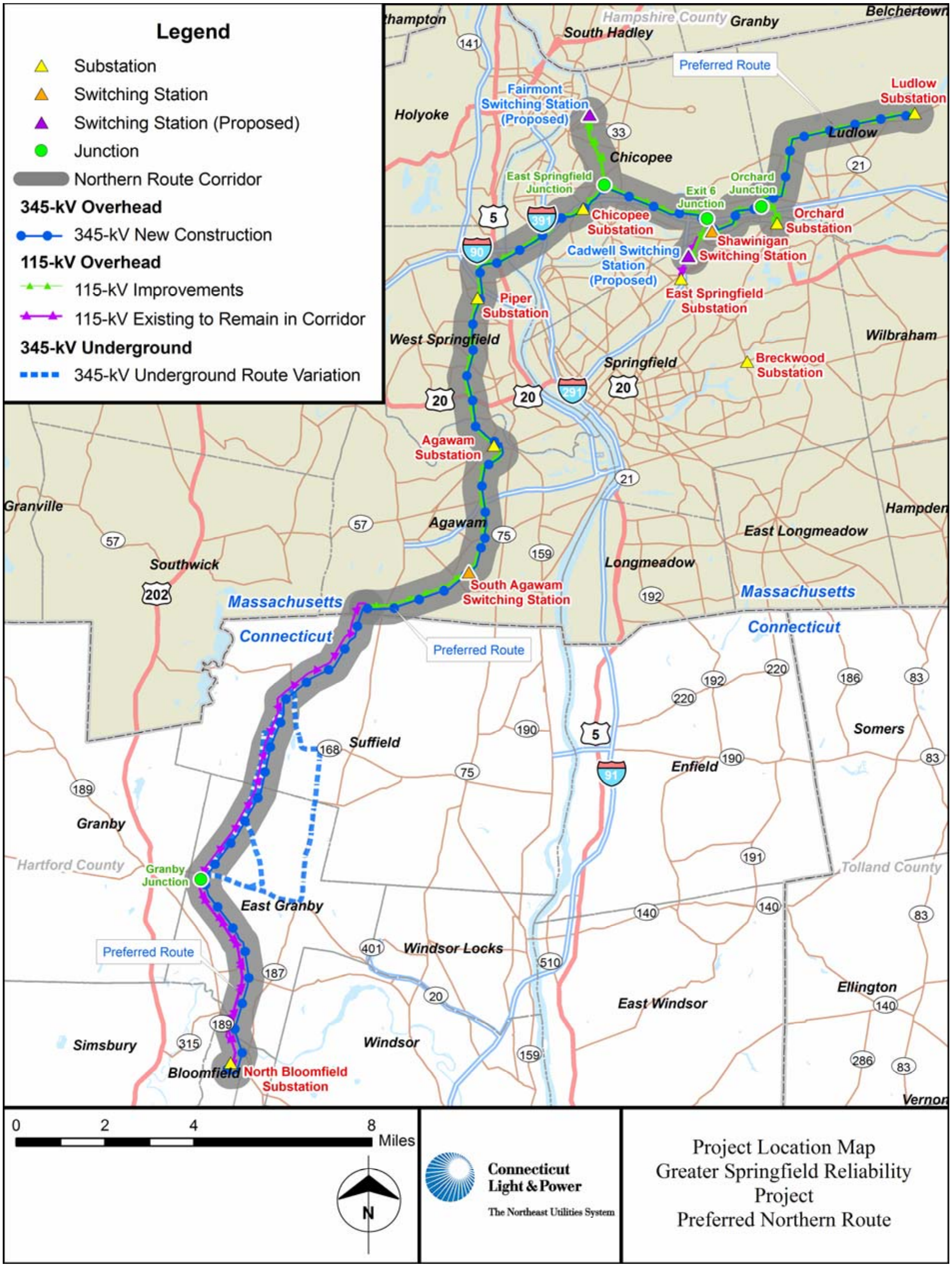
In addition to the Connecticut Portion of the North Bloomfield Substation to Agawam Substation 345-kV transmission line, it is possible that one other segment of new 345-kV line may be located in Connecticut.

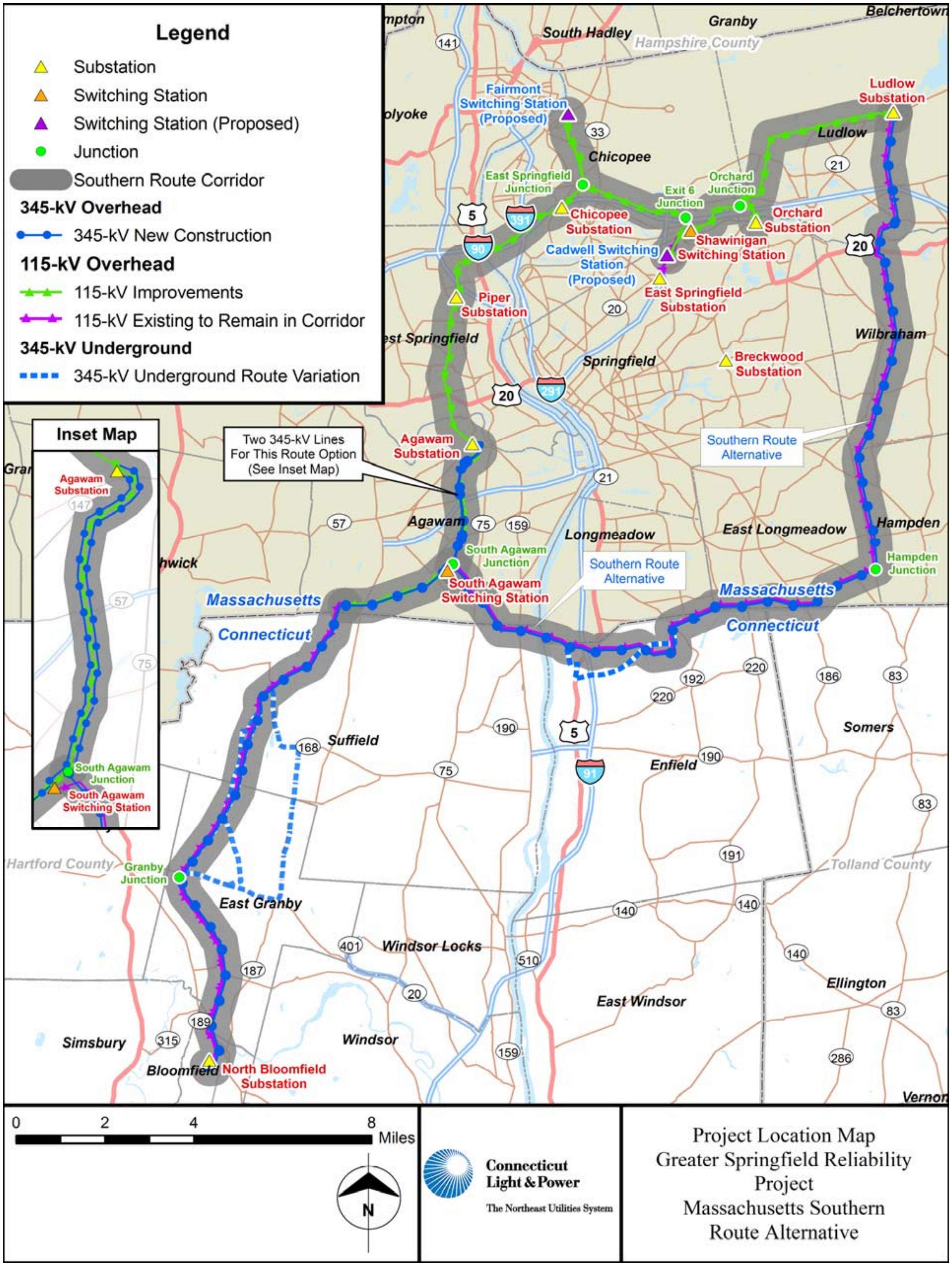
This segment would be part of "geographically distinct designated alternative" to the proposed line route between the Agawam and Ludlow Substations that WMECO is required to present to the Massachusetts Energy Facilities Siting Board (EFSB) as part of its application for approval of the proposed Massachusetts facilities. This alternative route is referred to as the Massachusetts Southern Route Alternative and is illustrated on Figure ES-8. The Massachusetts Southern Route Alternative would be located along existing ROWs, including the existing ROW between Hampden Junction and Ludlow Substation on which the existing 345-kV tie line between Massachusetts and Connecticut is located. Although the majority of this designated alternate route would be located in Massachusetts, part of it crosses into Connecticut for a short distance (approximately 5.4 miles), traversing the northern portions of the Towns of Suffield and Enfield, roughly parallel to the Connecticut/Massachusetts state border.

Should the EFSB determine that this Massachusetts Southern Route Alternative for a 345-kV line between the Agawam and Ludlow Substations is superior to WMECO's proposed route, then CL&P would require approval by the Council of the segment of the route that would be located in Connecticut.

Section H of this Application describes overhead, underground, and hybrid overhead/underground line designs and routes for the potential Connecticut Portion of the Massachusetts Southern Route Alternative for the Agawam to Ludlow 345-kV line.

Figure ES-8: Map Comparison of Corridors for the Preferred Northern Route and the Massachusetts Southern Route Alternative




Legend
Substation
Switching Station
Switching Station (Proposed)
Junction
Southern Route Corridor
345-kV Overhead
345-kV New Construction
115-kV Overhead
115-kV Improvements
115-kV Existing to Remain in Corridor
345-kV Underground
345-kV Underground Route Variation
Inset Map
Agawam Substation
South Agawam Junction
South Agawam Switching Station
Two 345-kV Lines For This Route Option (See Inset Map)
Fairmont Switching Station (Proposed)
East Springfield Junction
Chicopee Substation
Exit 6 Junction
Orchard Junction
Orchard Substation
Shawinigan Switching Station
Cadwell Switching Station (Proposed)
East Springfield Substation
Piper Substation
Breckwood Substation
Ludlow Substation
Hampden Junction
Southern Route Alternative
Granby Junction
North Bloomfield Substation
South Hadley
Granby
Belchertown
Hampshire County
Chicopee
Ludlow
Wilbraham
Springfield
Agawam
Longmeadow
East Longmeadow
Hampden
Massachusetts
Connecticut
Suffield
Enfield
Somers
Hartford County
Tolland County
East Granby
Windsor Locks
East Windsor
Ellington
Simsbury
Windsor
Bloomfield
Vernon
0 2 4 8 Miles
N
Connecticut Light & Power
The Northeast Utilities System
Project Location Map
Greater Springfield Reliability Project
Massachusetts Southern Route Alternative

ES.7 LINE DESIGN

In creating the line design of both GSRP and MMP, initial focus was given to implementing a base design that incorporates standard utility practice to which no-cost measures have been added to aid in the reduction of magnetic field levels at the edge of right-of-way. The base line design for GSRP consists of 345-kV horizontal conductor configuration line built on H-Frame structures in the same right-of-way as the existing 115-kV lines. Part of this base design includes a functional reconfiguration of the existing 115-kV lines. On the MMP, the base design contains a new 115-kV line that is installed in a vertical conductor configuration on steel monopoles within the existing ROW. Using these base designs, calculations have been produced to examine the existing edge-of-ROW magnetic field levels to the proposed base case. The calculation results and comparisons to existing magnetic field levels at the edge of ROW can be located in Section O.

The Connecticut Siting Council's (Council's) Electric and Magnetic Field Best Management Practices for the Construction of Electric Transmission Lines in Connecticut, December 14, 2007 (BMPs) require consideration of line designs in certain areas to reduce the magnetic field levels at ROW edges. Potential statutory facilities adjacent to the corridor were the focus areas for alternate line designs. Additional line-design options considered by CL&P are discussed in Section O and further compared in the Field Management Design Plan (Plan). CL&P has recommended alternative designs for 3.2 miles of the GSRP 345-kV line in East Granby and Suffield as well as alternative designs for MMP. These recommendations are located in the Plan in Appendix O-1 to Section O.

ES.8 COORDINATION OF MASSACHUSETTS AND CONNECTICUT SITING APPROVALS

Since the GSRP will involve construction in both Connecticut and Massachusetts, the transmission elements to be constructed in each state will require the approval of that state's siting agency – in Connecticut, the Council, and in Massachusetts, the EFSB. The approvals of these agencies must be coordinated to ensure that permitted construction in each state is integrated into a single technically, environmentally, and economically practical project.

ES.9 ENVIRONMENTAL EFFECTS[3]

The identification and evaluation of environmental effects associated with the construction and operation of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, the MMP Line Route, and the Connecticut Portion of the Massachusetts Southern Route Alternative first involved research and studies to define the existing environmental features along each alignment, followed by an assessment of how the projects could affect these resources and the mitigation measures that would be applied to minimize potential adverse effects. In order to characterize the existing environmental conditions along the project line routes, CL&P conducted field investigations of the proposed and alternative ROWs, performed baseline research to obtain data regarding environmental features, and consulted with the staff of federal, state, and municipal agencies. In addition, to solicit further data about environmental conditions along and in the vicinity of the planned project facilities, CL&P coordinated with the affected municipalities and the public through outreach programs, including the Municipal Consultation Process required by Connecticut law. Throughout this siting and evaluation process, CL&P identified and considered alternative routes and project facility construction (e.g., locations of crane pads, access roads), with the overall objectives of avoiding or minimizing adverse environmental effects, while providing highly reliable and cost-effective bulk-power transmission to the region.

For each of the projects, CL&P assessed the potential effects of the proposed and alternative transmission line facilities on the following environmental resources:

- Topography, geology, and soils;

[3] Environmental effects described in this Executive Summary are applicable to the base line design. See Section N for environmental effect differences associated with the alternate proposed line design for a 3.2-mile portion of the route in East Granby and Suffield.

- Water resources and water quality (wetlands [including vernal pools], watercourses, floodplains, groundwater, and public water supply areas);
- Biological resources;
- Riparian and upland vegetation;
- Wildlife (including birds);
- Amphibians;
- Fisheries;
- Rare, threatened, endangered or species of special concern;
- Land uses (including scenic and recreational resources; open space and protected areas;
- Transportation and access;
- Archaeological and historic (cultural) resources; and
- Air quality and noise.

CL&P's analyses demonstrate that no long-term, significant adverse environmental effects will occur as a result of the development of the transmission projects in overhead configurations, along the proposed line routes. Short-term and highly localized effects will result during construction. In addition, certain long-term effects will result from the conversion of existing undeveloped properties to utility use for the life of the projects. However, as summarized below, CL&P has identified measures to be implemented during final project design and construction / operation such that adverse effects to environmental resources will be avoided, minimized, or mitigated.

ES.9.1 Connecticut Portion of the North Bloomfield to Agawam 345-kV and MMP Line Routes

The construction and operation of the proposed transmission facilities in overhead configurations along both the Connecticut Portion of the North Bloomfield to Agawam 345-kV and the MMP Line Routes, as well as the associated expansion of the existing North Bloomfield Substation on CL&P-owned property, will minimize adverse environmental effects by collocating the new transmission lines along existing ROWs and on property otherwise devoted to or planned for utility use. In addition, the use of these existing ROWs, which have been in existence for decades, balances environmental, social, and cost considerations. Similarly, while the modifications proposed for the North Bloomfield Substation will require the development of approximately 3 acres of undeveloped CL&P-owned property, because the modifications will be located adjacent to and incorporated into the existing substation, the overall effect will be limited, compared to the alternative of developing a new substation, involving a greater land area, on a privately-owned parcel.

Further, based on recent experience with the development of other 345-kV transmission line projects, historical experience with the maintenance of the existing transmission lines along the North Bloomfield to Agawam and MMP corridors, and the results of field investigations and agency consultations for the proposed line routes, CL&P has a clear understanding of the existing environmental conditions along the routes, and the potential issues and effects associated with overhead line construction and operation. CL&P has applied this information to incorporate mitigation measures into the projects' design and proposed construction techniques, and thereby to minimize adverse environmental effects to the extent practical.

Table ES-1, as follows, presents an overview of the characteristics of the Connecticut Portion of the North Bloomfield to Agawam 345-kV and the MMP Line Routes:

Table ES-1: Summary of Project Characteristics Connecticut Portion of North Bloomfield to Agawam 345-kV and the MMP Line Routes

Route Characteristic	Connecticut Portion North Bloomfield to Agawam 345-kV Line Route	MMP Line Route
Length (Miles total and miles, by town)	11.9 miles Bloomfield (0.9 miles) East Granby (6.2 miles) Suffield (4.8 miles)	2.2 miles Manchester (2.2 miles)
Length along Existing CL&P ROW (within existing easement)	11.9 miles	2.2 miles
Width of Existing ROW (total feet of easement)	305 – 385 feet There are two short segments (1000' and 400') where the ROW width is only 100 feet	350 - 800 feet
Width of Existing Maintained ROW (feet)	180 feet	200 – 400 feet
Additional ROW Where Vegetation Management Required for Proposed Project (width in feet)	75 - 100 feet	0 – 80 feet
Substation Modifications: Additional Acreage Affected	2.7 acres	N/A
Total Acreage Affected (approx.)	145 acres (ROW); 2.7 acres (Substation)	8.9 acres

Table ES-2 summarizes the predominant environmental features and potential environmental effects that would result from the project construction on the Connecticut Portion of the North Bloomfield to Agawam 345-kV and the MMP Line Routes, as well as the typical measures that would be used to minimize or avoid long-term and significant adverse effects. Examples of such mitigation measures, among others, include the location of new structures outside of delineated wetlands where possible, the minimization / avoidance of vegetation removal within riparian areas, and adherence to best management practices and state standards for deploying and maintaining erosion and sediment controls.

Additional mitigation measures may be identified during the course of the Siting Council proceedings or as conditions of the project-specific permits and approvals that will be required from other state and federal agencies, including the CT DEP and the U.S. Army Corps of Engineers (USACE). CL&P would incorporate all relevant environmental mitigation measures and regulatory permit conditions into the Development &Management Plans, which would be prepared for the projects subsequent to Siting Council approval.

Table ES-2: Summary of Environmental Features and Potential Effects Connecticut Portion of North Bloomfield to Agawam 345-kV and MMP Line Routes

Environmental Feature	Connecticut Portion North Bloomfield to Agawam Line Route	Manchester to Meekville Circuit Separation Route	Environmental Effect and Mitigation Summary
Topography, Geology, and Soils	Primarily level topography, bedrock may be encountered	Primarily level topography, near and across Hockanum River floodplain	Alteration of topography along access roads and at crane pads. Potential for erosion and sedimentation. Mitigation: Use of best management practices and standards for erosion and sediment control, pursuant to Connecticut guidelines.
Perennial Stream Crossings (No.)	23 (7 perennial, 16 intermittent)	7 (5 perennial, 2 intermittent)	Watercourses will be spanned by overhead transmission circuits. Pole placement within floodplain and state Stream Channel Encroachment Lines will be minimize to the extent possible. Erosion and sediment controls will be installed and maintained to minimize potential for soil from upland work sites to enter waterbodies.
Primary Named Watercourses Crossed	Farmington River, Holcomb Brook, Muddy Brook	Hockanum River	
Wetland Crossings (Total No. / Amphibian Breeding Habitat)	60 (18)	13 (2)	Some wetlands will be unavoidably affected as a result of access roads (temporary and permanent) and structures that cannot otherwise be located in upland areas. Project design (location of structures and permanent roads outside of wetlands) will minimize effects to the extent possible; compensation programs will be developed as needed, working with the federal and state regulatory agencies, to offset any permanent effects.

Environmental Feature	Connecticut Portion North Bloomfield to Agawam Line Route	Manchester to Meekville Circuit Separation Route	Environmental Effect and Mitigation Summary
Upland Forrest Vegetation Clearing Forested Wetland	126 acres 29 acres	4.4 acres 1.9 acres	Long-term conversion of habitat from wooded to shrub-scrub along maintained ROWs. This effect will be incremental since the existing ROWs are already maintained in low-growth vegetation. Shrub-scrub habitat increase will benefit certain species.
State-Listed Threatened, Endangered, or Species of Special Concern Potential Habitat Crossed (Species Name)	Jefferson salamander Eastern box turtle Freshwater mussel spp. Arrow Clubtail Dragonfly	Barn owl	Special studies have been conducted to assess the potential for habitat on the ROWs. Where species were identified, CL&P will work with the CT DEP to develop species-specific mitigation plans, which may involve construction timing restrictions, environmental monitoring, etc.
Land Use	Land uses adjacent to the existing CL&P ROW include forested areas, interspersed with areas of agricultural land an suburban / rural residential development. The 3-acre site of the proposed North Bloomfield Substation expansion, which abuts the developed substation, is a mix of undeveloped woodlands, wetlands, and shrub-shrub.	Land uses adjacent to the existing CL&P ROW include suburban residential and commercial developments, as well as the Interstate 84 transportation corridor and the Hockanum River and associated wooded floodplain areas.	The development of the proposed transmission facilities will convert presently undeveloped portions of the existing CL&P ROWs and properties to utility use. However, the projects will be located on lands where such utility uses have been planned (by virtue of the existing CL&P easements and fee-owned property), and will be adjacent to existing similar utility uses.
Open Space Areas Crossed	Newgate State Wildlife Management Area Farmington Valley Greenway trail, Metacomet Trail, open space land owned by the Town of Suffield and the Suffield Sportsman's Association	Hockanum River is a state-designated trout management area; M. Leber Memorial Field	The proposed projects follow existing ROWs across the designated open space areas. CL&P will coordinate with the land managing agencies to minimize effects.

Environmental Feature	Connecticut Portion North Bloomfield to Agawam Line Route	Manchester to Meekville Circuit Separation Route	Environmental Effect and Mitigation Summary
Transportation Systems	U.S. Route 202, State Route 20,and State Routes 189, 168	U.S. Route 6; Interstate 84, local roads	The proposed transmission circuits will span existing roads. During construction, the movement of construction vehicles to and from the ROWs along local roads may cause minor, temporary, and highly localized traffic delays.
Cultural Resources	5 Native American sites within 1 mile, no EuroAmerican sites within 1 mile. 3 historic resources (all cemeteries) within 0.25 mile of the route	8 Native American sites within 1 mile, 2 EuroAmerican sites within 1 mile. 1 historic site (NRHP eligible) within 0.25 mile of the route	No adverse effects will occur to standing historic structures. Additional cultural resource field investigations (archaeological) will be performed at sites where earth-moving activities are planned, such as for access roads or structure locations, as well as at the proposed location for the North Bloomfield Substation modifications. All cultural resource work will be coordinated closely with the State Historic Preservation Officer.

ES.9.2 Connecticut Portion of the Massachusetts Southern Route Alternative for the Agawam to Ludlow 345-kV Line

The development of the 5.4-mile Connecticut Portion of this alternative Agawam to Ludlow line route for the Massachusetts portion of the GSRP would result in potential environmental effects that would be similar to those discussed for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. Like the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, the Connecticut portion of the Massachusetts Southern Route Alternative would be aligned within an existing CL&P transmission line ROW. Baseline environmental studies to characterize this transmission line route were performed using the same approach as described for the Connecticut Portion of the North Bloomfield to Agawam 345-kV and MMP Line Routes. Such baseline environmental data then were assessed to define the potential environmental impacts that would result from the construction and operation of a new 345-kV line along this alignment.

In general, the Connecticut portion of the Massachusetts Southern Route Alternative would traverse approximately 5.4 miles near relatively densely developed residential areas in both Enfield and Suffield.

The 345-kV line route also would entail a crossing of the Connecticut River and its associated wooded riparian areas. The new overhead 345-kV line would span the river, adjacent to CL&P's existing 115-kV line. Measures to mitigate the potential adverse environmental effects associated with this transmission line route alternative are similar to those described for the Connecticut Portion of the North Bloomfield to Agawam 345-kV and MMP Line Routes, but would involve more specific measures to minimize adverse effects to the Connecticut River (visual and wooded riparian areas) and to residential developments/statutory facilities.

Table ES-3, below, presents an overview of the characteristics of the Connecticut portion of the Massachusetts Southern Route Alternative:

Table ES-3: Summary of Project Characteristics Connecticut Portion of Massachusetts Southern Route Alternative

Route Characteristic	Connecticut Portion Massachusetts Southern Route Alternative
Length (Miles total and miles, by town)	5.4 miles Enfield (4.4 miles) Suffield (1 mile)
Length along Existing CL&P ROW (within existing easement)	5.4 miles
Width of Existing ROW (total feet of easement)	280 – 300 feet
Width of Existing Maintained ROW (feet)	100 feet
Additional ROW Where Vegetation Management Required for Proposed Project (width in feet)	100 feet
Total Acreage Affected (approx.)	65 acres

Table ES-4 summarizes the predominant environmental features and potential environmental effects that would result from the development of the Connecticut portion of the Massachusetts Southern Route Alternative from Agawam to Ludlow. The table also reviews the typical measures that would be used to minimize or avoid long-term and significant adverse effects.

Table ES-4: Summary of Environmental Features and Potential Effects Connecticut Portion of Massachusetts Southern Route Alternative from Agawam to Ludlow

Environmental Feature	Massachusetts Southern Route Alternative Characteristics	Environmental Effect and Mitigation Summary
Topography, Geology, and Soils	Primarily level topography, bedrock may be encountered in isolated areas	Alteration of topography along access roads and at crane pads. Potential for erosion and sedimentation. Mitigation: Use of best management practices and standards for erosion and sediment control, pursuant to Connecticut guidelines.
Perennial Stream Crossings (No.)	5 (all perennial)	Watercourses will be spanned by overhead transmission circuits. Pole placement within floodplains will be minimized to the extent possible. Erosion and sediment controls will be installed and maintained to minimize potential for soil from upland work sites to enter waterbodies. Connecticut River is New England's largest river ecosystem and also is an American Heritage designated river. Additional overhead lines across the river would have an incremental adverse effect on visual resources.
Primary Named Watercourses Crossed	Connecticut River, Four Mile Brook, Waterworks Brook	
Wetland Crossings (Total No. / Amphibian Breeding Habitat)	27 (3)	Some wetlands will be unavoidably affected as a result of access roads (temporary and permanent) and structures that cannot otherwise be located in upland areas. Project design (location of structures and permanent roads outside of wetlands) will minimize effects to the extent possible; compensation programs will be developed as needed, working with the federal and state regulatory agencies, to offset any permanent effects.
State-Listed Threatened, Endangered, or Species of Special Concern Potential Habitat Crossed (Species Name)	None	
Land Use	Land uses adjacent to the existing CL&P ROW include densely developed single and multi-family residential areas, as well as agricultural lands and forested areas.	The development of the proposed transmission facilities will convert presently undeveloped portions of the existing CL&P ROWs and properties to utility use. However, the projects will be located on lands where such utility uses have been planned (by virtue of the existing CL&P easements and fee-owned property), and will be adjacent to existing similar utility uses.
Open Space Areas Crossed	None	
Transportation Systems	Interstate 91, State Route 192, various local roads (Mapleton Avenue in Suffield; Enfield Street, Brainard Road in Enfield)	The proposed transmission circuits will span existing roads. During construction, the movement of construction vehicles to and from the ROWs along local roads may cause minor, temporary, and highly localized traffic delays.
Cultural Resources	2 Native American sites within 1 mile and 2 EuroAmerican archaeological	No adverse effects will occur to standing historic structures. Additional cultural resource field investigations (archaeological) will be performed at sites where earth-moving

Environmental Feature	Massachusetts Southern Route Alternative Characteristics	Environmental Effect and Mitigation Summary
	sites within 1 mile. No significant historic resources (all cemeteries) within 0.25 mile of the route	activities are planned, such as for access roads or structure locations. All cultural resource work would be coordinated closely with the State Historic Preservation Officer.

ES.10 COST

The estimated initial "all-in" capital cost of the proposed GSRP, escalated to future years of spending (assuming an in-service date of 2013), is $714 million[4]. The portion of this amount attributable to facilities to be in Connecticut is $133 million[5] (less than 20%).

For the MMP, the initial "all-in" capital cost estimate escalated to future years of spending (assuming an in-service date of 2013) is $14 million[5].

These cost estimates assume use of the base line designs for GSRP and MMP. The cost estimates will increase slightly if the Council accepts CL&P's recommendations for alternate line designs for MMP and for a 3.2-mile portion of the Massachusetts Southern Route Alternative.

ES.11 SCHEDULE

Major milestones established for the GSRP and the MMP are as follows:

- GSRP and MMP Municipal Consultation Filing submittal – June, 2008
- GSRP and MMP Open Houses and Town Meetings – 3rd Quarter, 2008

[4] The GSRP cost estimate does not include the cost of physically separating the cabling and power supplies for the primary and backup protective relay systems upgrading communication systems in some substations to meet Bulk Power System specifications, if required, or the increase in cost associated with the proposed line designs in Section O.

[5] Cost estimate is applicable only to the base case line design; see Section O for the estimated cost increases associated with the proposed alternative line design for a portion of the route in East Granby and Suffield and MMP.

- GSRP and MMP Connecticut Siting Council Application Submittal – 4th Quarter, 2008
- GSRP and MMP File applications for State and Federal Permits – 4th Quarter 2008
- GSRP and MMP CSC Approval – 1st Quarter, 2010
- GSRP Proposed Construction Start – 3rd Quarter, 2010
- GSRP Proposed Construction Complete – 1st Quarter, 2013
- MMP Proposed Construction Start – 3rd Quarter, 2010
- MMP Proposed Construction Complete – 2nd Quarter, 2011

SECTION A

PURPOSE

A. PURPOSE

The purpose of the Greater Springfield Reliability Project (GSRP), which involves a proposed new 345-kilovolt (kV) transmission line and other improvements to the electric transmission systems of The Connecticut Light and Power Company (CL&P) in Connecticut and the Western Massachusetts Electric Company (WMECO) in Massachusetts, is to provide safe, reliable, and economic transmission service throughout the Greater Springfield, Massachusetts geographic area and in north-central Connecticut, and to assure that these portions of the transmission grid will comply with mandatory federal and regional reliability standards. At the same time, the GSRP improvements will advance a comprehensive regional plan for improving electric transmission in New England, through extensive coordinated improvements in Connecticut, Massachusetts, and Rhode Island. This comprehensive plan is known as the New England East – West Solution (NEEWS).

The objective of the separate but related Manchester to Meekville Junction Circuit Separation Project (MMP), which involves the modification of approximately 2.2 miles of existing transmission lines in Manchester, Connecticut, is to accommodate the higher power flows associated with the GSRP on the transmission system in north-central Connecticut.

The Greater Springfield transmission system extends generally through the area from CL&P's North Bloomfield Substation in north-central Connecticut to WMECO's Ludlow Substation, located north of the City of Springfield in the Town of Ludlow. The existing transmission system serving this Greater Springfield geographical area is comprised largely of 115-kV lines originally constructed from the 1940s through the early 1970s[1]. This system does not meet current mandatory national and regional reliability criteria. Under conditions existing today, the system can become overloaded during normal conditions with all lines in-service. In the event of the unscheduled outage of a system element, such as a

[1] Many of the towers supporting the 115-kV transmission line between the Agawam Substation in Massachusetts and the North Bloomfield Substation were constructed in the 1920s for a 69-kV line.

transmission line or generator, the system is subject to extensive overload and voltage problems. These problems limit the available power within the Greater Springfield geographical area and the transfers of power over the single existing 345-kV interstate tie line between Massachusetts and Connecticut. These problems become increasingly worse every year as electric usage increases and will be further exacerbated as older generation plants in the area are retired.

Together with the existing 345-kV lines between the North Bloomfield, Barbour Hill and Ludlow Substations, the new North Bloomfield – Agawam – Ludlow 345-kV line, if built as proposed, will complete a 345-kV "loop" through north-central Connecticut and western Massachusetts. This new high-capacity loop will relieve congestion on the 115-kV system that currently both serves the Springfield area and supports interstate transfers between the North Bloomfield, Manchester, and Ludlow Substations. At the same time, the new line will increase the power-transfer capacity between Connecticut and Massachusetts.

The purpose of the MMP, which will involve the separation of circuits between Manchester Substation and Meekville Junction, is to reliably accommodate the higher power flows to CL&P's north-central Connecticut substations (Barbour Hill, North Bloomfield, and Manchester) that the GSRP will enable. The circuits that must be separated are a 345-kV circuit (#395, Barbour Hill – North Bloomfield – Manchester) and a 115-kV circuit (#1448, Manchester – Rood Ave.). At present, the conductors of these two circuits are supported by common line structures for approximately 2.2-mile on a ROW between Manchester Substation and Meekville Junction. Because both circuits are supported on common transmission structures, planning studies must assume that a contingency that would remove either of these circuits from service would remove them both. This is called a "double-circuit contingency", and the circuit separation will eliminate this contingency.

SECTION B

STATUTORY AUTHORITY

B. STATUTORY AUTHORITY

The Connecticut Light and Power Company, (CL&P) is applying to the Connecticut Siting Council pursuant to Section 16-50g et seq. of the General Statutes of Connecticut.

SECTION C

LEGAL NAME

C. LEGAL NAME AND ADDRESS OF APPLICANT

The Connecticut Light and Power Company (CL&P) (a specially chartered Connecticut corporation).

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Berlin, Connecticut 06037

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CL&P
P.O. Box 270
Hartford, Connecticut 06141-0270
Telephone: (860) 665-5000

Internet Address:

Northeast Utilities Transmission Web Site
www.transmission-nu.com

In filing and prosecuting this application CL&P is acting through its agent, Northeast Utilities Service Company (NUSCO). CL&P and NUSCO are both wholly-owned subsidiaries of Northeast Utilities (NU). NUSCO performs services, including transmission planning and permitting services, for affiliated NU companies, including CL&P. NUSCO shares CL&P's address listed above.

SECTION D

APPLICANT CONTACT

D. APPLICANT'S CONTACTS

Correspondence and other communications with regard to the Greater Springfield Reliability Project (GSRP) and the Manchester to Meekville Junction Circuit Separation Project (MMP) should be addressed to, and notices, orders and other papers should be served upon, the following:

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SECTION E

SUMMARY DESCRIPTION OF THE PROJECTS

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E. BRIEF DESCRIPTION OF THE GSRP AND MMP

The Greater Springfield Reliability Project (GSRP) is a set of improvements to the electric transmission systems of The Connecticut Light and Power Company (CL&P) in Connecticut and the Western Massachusetts Electric Company (WMECO) in Massachusetts. These improvements have been carefully designed along existing transmission line rights-of-way (ROWs) to the extent practical.

The Connecticut portion of the GSRP, as more fully discussed in the following sections, will include the development of approximately 12 miles of new 345-kV transmission line, following an existing CL&P ROW, and related facilities. The separate Manchester to Meekville Junction Circuit Separation Project (MMP), which is required to support the GSRP improvements, will involve the separation of existing transmission circuits, also typically within an existing CL&P ROW. The following subsections first summarize the overall GSRP and then briefly discuss the Connecticut portion of the GSRP, as well as the MMP.

In addition, this section also presents and briefly describes the Connecticut portion of an alternative route to a WMECO portion of GSRP. In particular, a 5.4-miles of an alternative route identified by WMECO for the Massachusetts portion of the proposed 345-kV Ludlow to Agawam 345-kV transmission line would extend into north-central Connecticut. Although this alternative, referred to as the Massachusetts Southern Route Alternative, is not WMECO's preferred alignment for this proposed 345-kV line, it is possible that the Massachusetts Energy Facilities Siting Board (EFSB) could nonetheless approve this alignment. If so, then CL&P would request that the Connecticut Siting Council (Council) approve the development of the 5.4-mile Connecticut portion of this alignment.[1]

[1] Note that if the Massachusetts Energy Facilities Siting Board selects the Massachusetts Southern Route Alternative, the 5.4-mile Connecticut segment of this proposed 345-kV line would have to be developed in

E.1 OVERVIEW OF THE GSRP, INCLUDING THE PREFERRED AND ALTERNATIVE MASSACHUSETTS FACILITIES

The GSRP, a majority of which will be developed in Massachusetts, will consist of the construction and operation of a new 345-kV line along approximately 35 miles of overhead line ROWs, consisting of 23 miles in Massachusetts and 12 miles in Connecticut. In addition, the GSRP will entail the construction, reconstruction, and upgrade of 115-kV lines along approximately 27 miles of existing and new overhead line ROWs in Massachusetts, and related substation improvements in both Massachusetts and Connecticut. In Connecticut, the required substation improvements associated with the new 345-kV line would consist of installing a 345-kV switchyard and a 345-kV to 115-kV, 600-Megavolt Ampere (MVA) autotransformer in the North Bloomfield Substation.

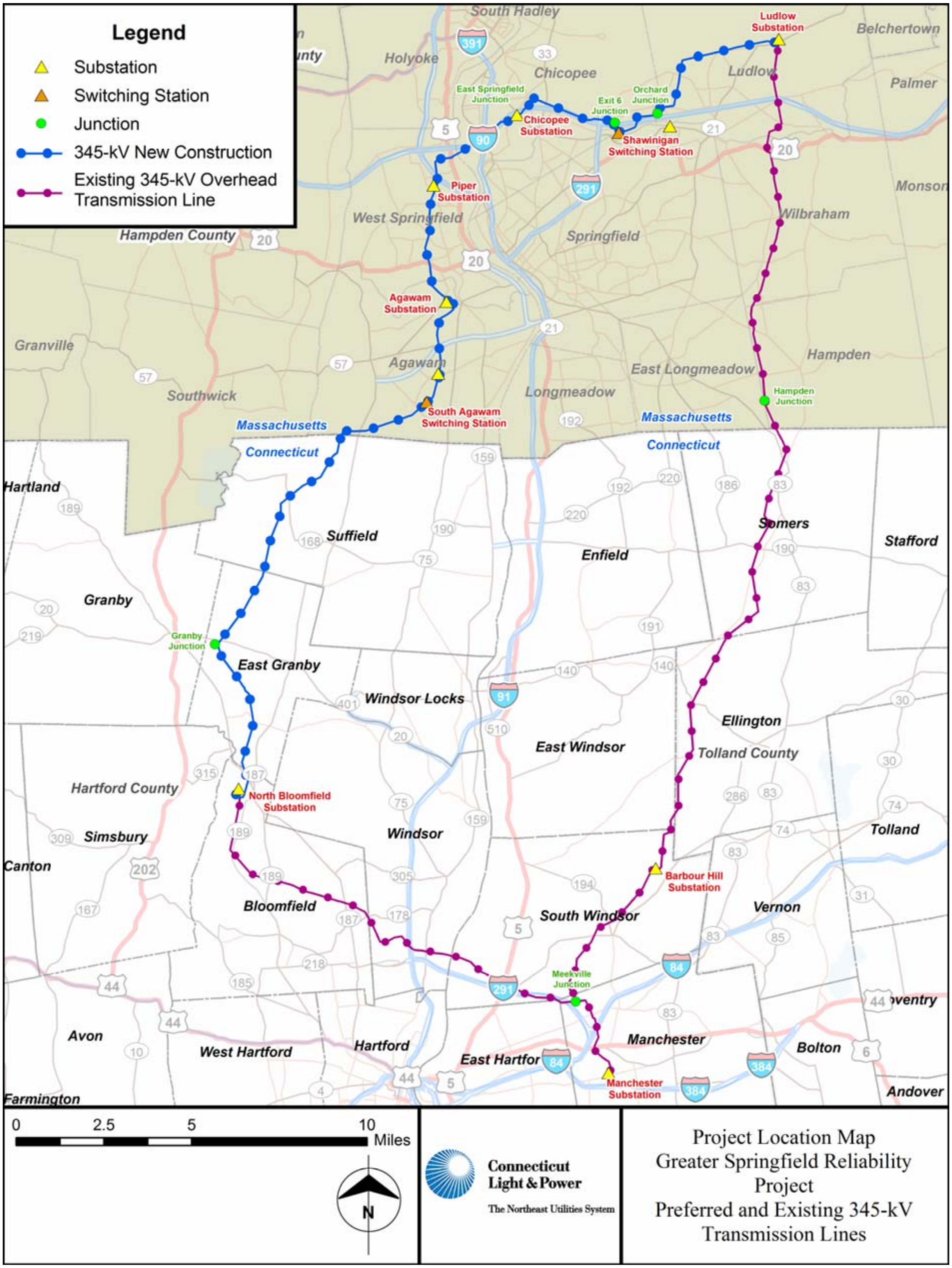
The new 345-kV transmission lines that WMECO and CL&P propose to construct in Massachusetts and Connecticut, respectively, will complete a 345-kV “loop” through north-central Connecticut and western Massachusetts. Such 345-kV loops form the backbone of the electric transmission system and the present Greater Springfield region does not presently have such 345-kV interconnections. The GSRP loop would be formed by the proposed development of the new 345-kV line between WMECO’s Ludlow Substation in Ludlow, Massachusetts and its Agawam Substation in Agawam, Massachusetts and a new 345-kV line between the Agawam Substation and CL&P’s North Bloomfield Substation in Bloomfield, Connecticut. These proposed 345-kV lines would close a 345-kV loop in the Greater Springfield – north-central Connecticut region with the existing 345-kV line between North Bloomfield Substation and CL&P’s Barbour Hill Substation[2] and the existing 345-kV line that extends north from Barbour Hill Substation back to Ludlow Substation.

addition to the proposed 12-mile 345-kV line between the North Bloomfield Substation and the Connecticut/Massachusetts border.

[2] Although this line was originally not connected to the Barbour Hill Substation, modifications to the substation and line that connect the line into the substation were completed in June 2008.

The locations of the existing and proposed 345-kV lines that would form the "loop" described above are depicted in Figure E-1.

Figure E-1 Preferred and Existing 345-kV Transmission Lines



E.2 CONNECTICUT PORTION OF THE GSRP AND MMP

In this Application, CL&P seeks approval of its proposed route for the Connecticut portion of a new overhead 345-kV line between its North Bloomfield Substation in Bloomfield (Connecticut) and WMECO's Agawam Substation in Agawam (Massachusetts), which would be built as part of the GSRP.

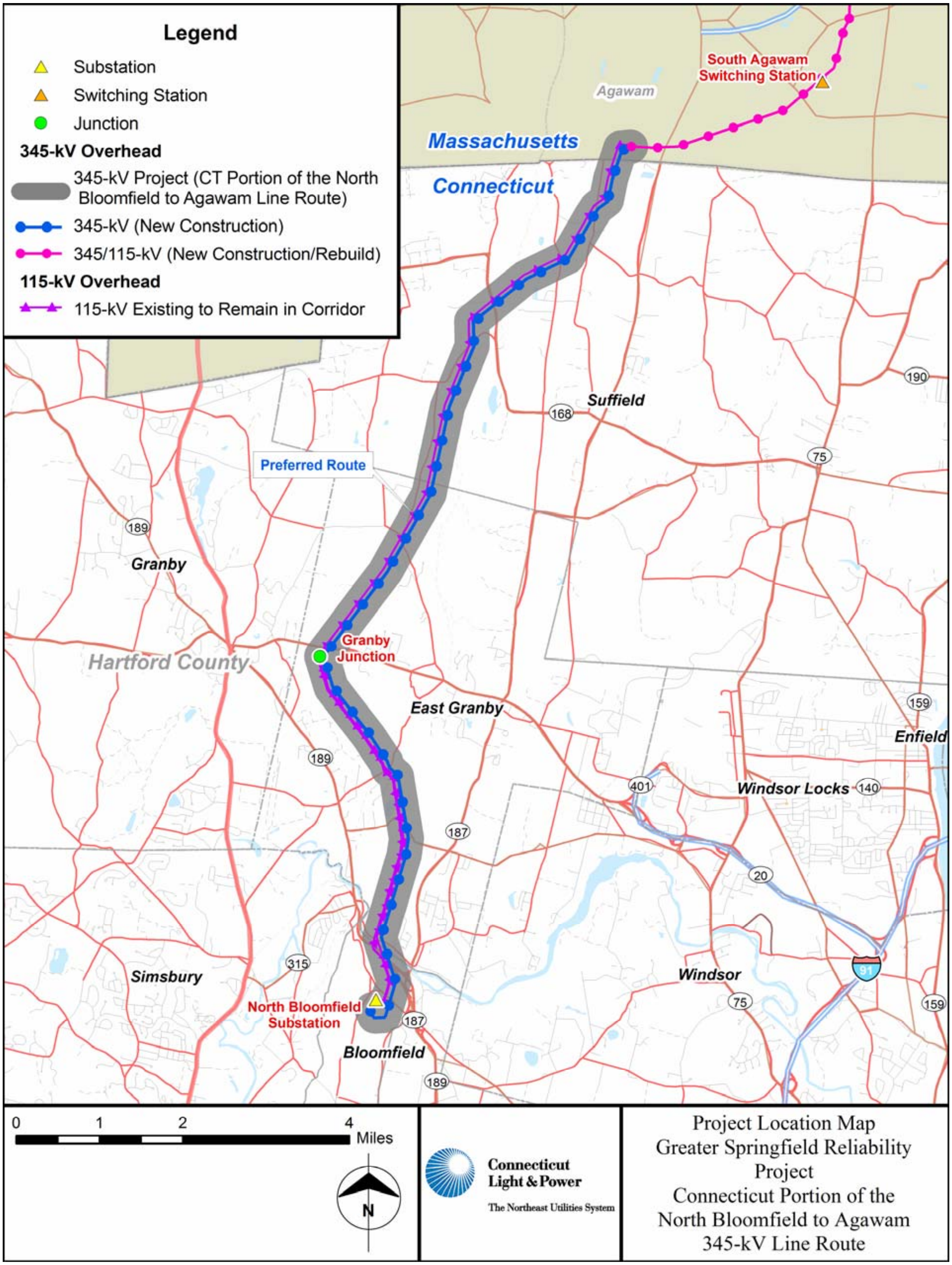
In addition, CL&P presents for the Council's consideration the Connecticut section of an alternate route for a new 345-kV line between WMECO's Agawam (Massachusetts) and Ludlow (Massachusetts) Substations that is proposed as part of the Massachusetts portion of the GSRP. CL&P seeks approval for the Connecticut portion of the alternate route, contingent upon the action of the Massachusetts EFSB. Should the EFSB select the alternate route in lieu of WMECO's proposed route between the Agawam and Ludlow Substations (no part of which would be located in Connecticut), the Council's approval of the Connecticut Portion of the Massachusetts Southern Route Alternative would be required.

Finally, CL&P seeks the approval of the related MMP, which would involve the modification of existing transmission lines in Manchester, Connecticut.

E.2.1 GSRP Facilities

The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route for which approval is sought would be approximately 12 miles long, and would be predominantly within an existing ROW. For a distance of approximately 1,000 feet between Phelps Road and Mountain Road in Suffield, and for a distance of approximately 400 feet east of Ratley Road in Suffield, widening of the ROW would be required. The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route is illustrated in Figure E-2.

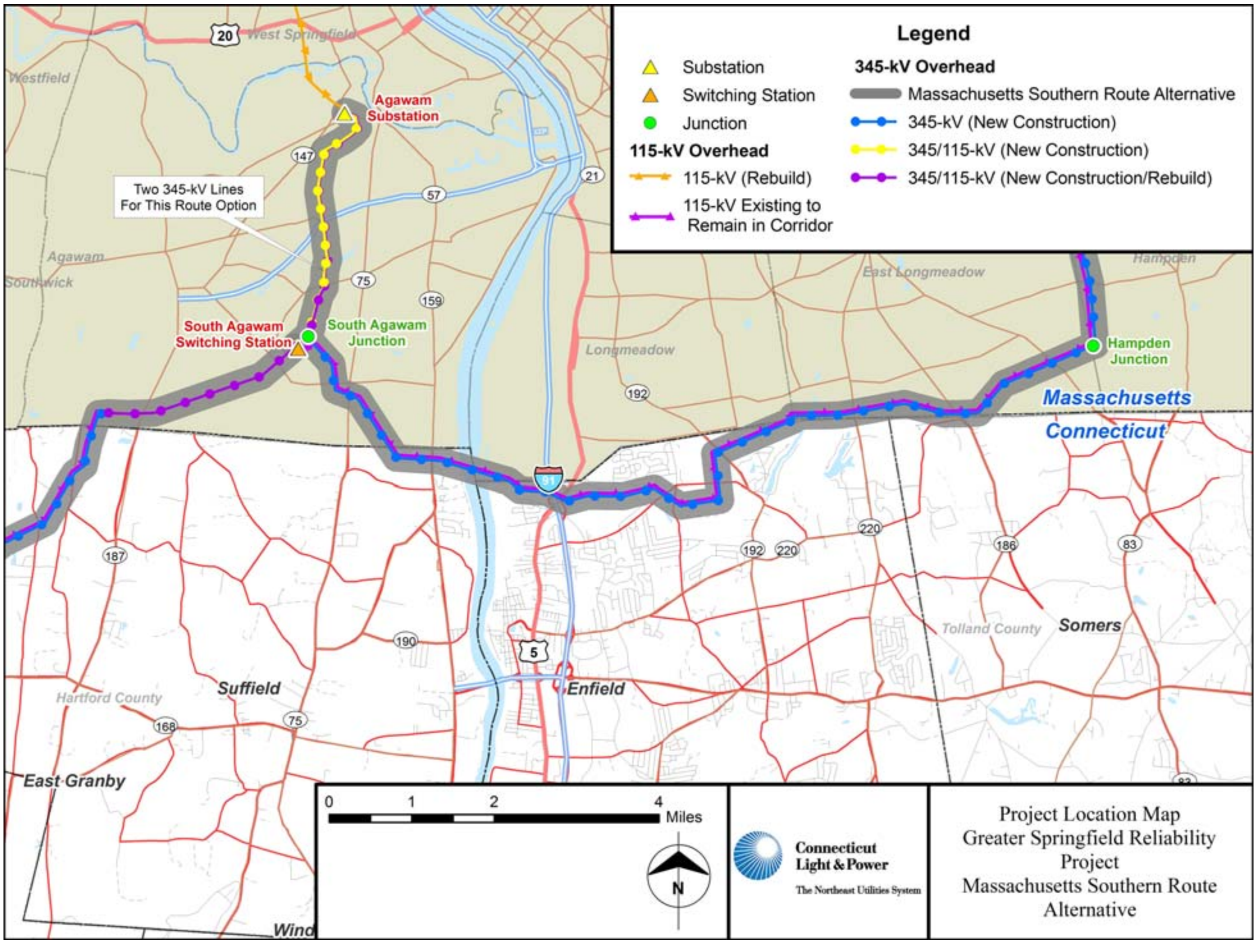
Figure E-2 Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route



The new North Bloomfield to Agawam 345-kV line will functionally replace the two existing 115-kV circuits between the Springfield area and the North Bloomfield Substation. The two existing 115-kV circuits will be bundled together to form a single 115-kV line between the Connecticut/Massachusetts state border and Granby Junction and will be re-connected at this location to an existing 115-kV line to serve local load in western Massachusetts.

The Connecticut portion of the 345-kV line between the Agawam and Ludlow Substations on the Massachusetts Southern Route Alternative would be approximately 5.4 miles long. This route would cross the Massachusetts border into Connecticut in Suffield, traverse Suffield for approximately 1.1 miles, cross the Connecticut River back into Massachusetts for approximately 0.5 miles, and then cross back into Connecticut again in Enfield, where it would continue east for approximately 4.3 miles before crossing back into Massachusetts to continue on to the Ludlow Substation. The Connecticut Portion of this Massachusetts Southern Route Alternative is illustrated in Figure E-3 below.

Figure E-3 Massachusetts Southern Route Alternative

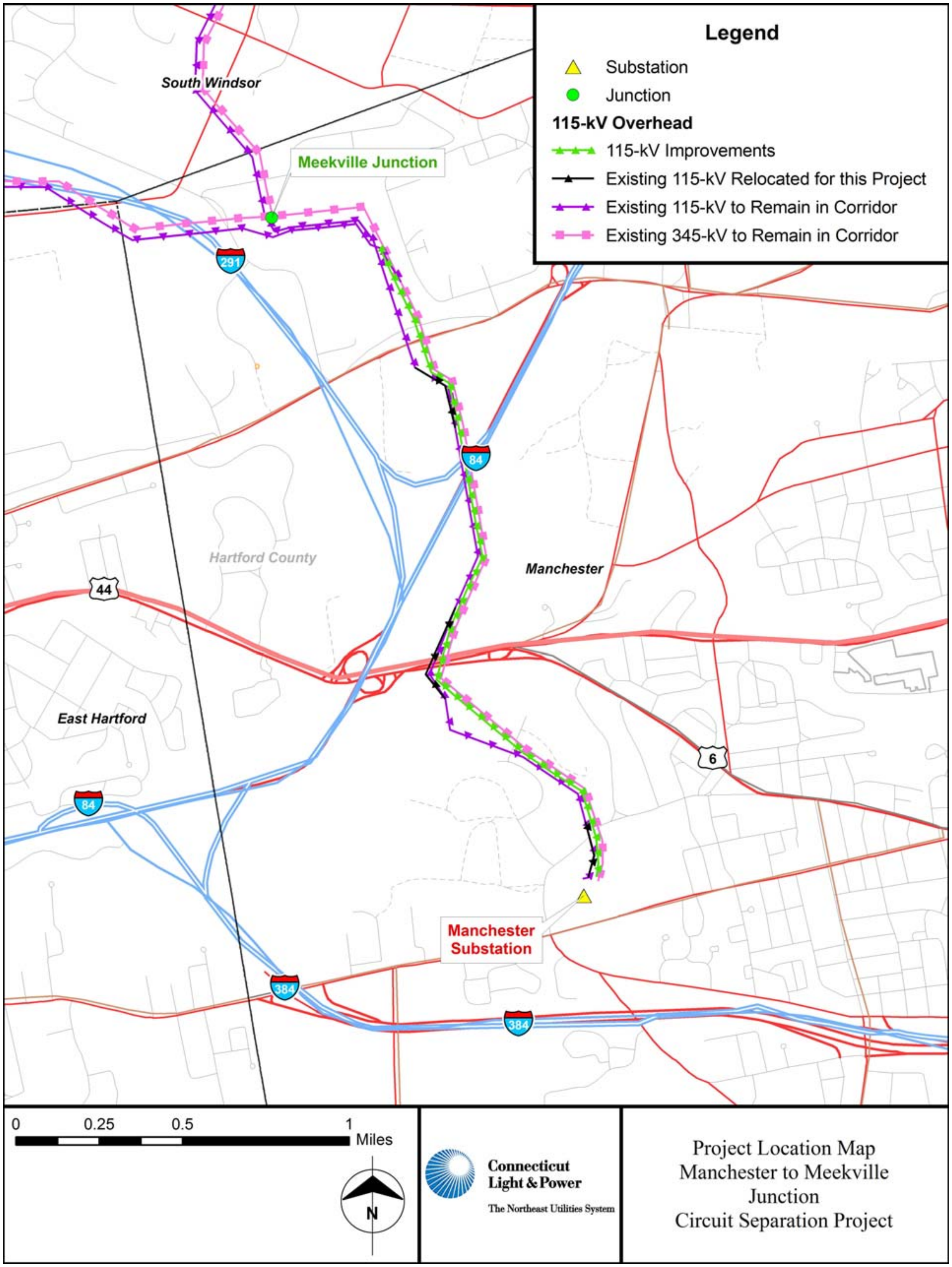


E.2.2 MMP Facilities

The MMP will involve modifications to the existing transmission line between Manchester Substation and Meekville Junction. Specifically, these modifications would be to a 115-kV circuit that presently occupies 2.2 miles of the ROW between Manchester Substation and Meekville Junction. The MMP would be predominantly within the existing ROW, which is located entirely in the Town of Manchester and is generally 350 feet in width. For distance of approximately 120 feet starting at the Tolland Turnpike and heading north, widening of the ROW by approximately 20 feet would be required.

Presently, the 115-kV circuit and a 345-kV circuit are supported on common transmission line structures. For the MMP, the 115-kV circuit would be reconstructed on a new set of structures, and the 345-kV line would be left in place on the existing double-circuit structures, so that each circuit would then be supported on independent transmission structures. The location of this proposed construction is depicted in Figure E-4.

Figure E-4 Manchester to Meekville Junction Circuit Separation Project



E.2.3 Modification of the 115-kV Ties at North Bloomfield

The new North Bloomfield to Agawam 345-kV line will replace the existing 115-kV double-circuit connection between the Springfield area and the North Bloomfield Substation, and an existing 115-kV line from North Bloomfield Substation to Southwick Substation will be replaced by a South Agawam to Southwick line made up by reusing sections of the existing 115-kV lines.

E.3 AERIAL MAPPING

The Connection Portion of the North Bloomfield to Agawam 345-kV Line Route, as well as the MMP and the Connecticut Portion of the Massachusetts Southern Route Alternative, are illustrated on aerial-based maps which are in Volumes 9 and 11. Volumes 9 and 11 also include mapping for the four underground variations detailed in Section H.

Volume 9 contains 400-scale aerial maps which show when applicable:

- Existing overhead line structure locations (there is more than one structure in most locations, even though only one symbol is shown) along with certain individual structure numbers
- Proposed structures (for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and MMP)
- Potential access roads (for for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and MMP)
- Limits for the ROW
- Proposed ROW expansion limits
- Property lines
- Existing land use within and adjacent to the route corridor
- Zoning designations
- Transition stations (for underground route variations)
- Wetlands, watercourses, and the 100 year flood zone.
- Statutory Facilities

Volume 11 contains 100-scale aerial maps illustrating when applicable:

- Existing overhead line structure locations (there is more than one structure at most locations, even though only one symbol is shown), along with individual structure numbers
- Proposed structures (for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and MMP)

- Potential access roads (for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and MMP)
- Limits for the ROW
- Proposed ROW expansion limits
- Property lines
- Zoning designations
- Structure location envelopes (for for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and MMP)
- Transition stations (for underground route variations)
- 2-foot contour lines (for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and MMP)
- Wetlands; watercourses; wetland/watercourses buffers; vernal pools; natural diversity areas; and the 100-year flood zone.

Mapsheets in Volumes 9 and 11 are accompanied by text that describes the area and ROW, including proximity of land use, forests, parks, and Connecticut protected/open space areas.

SECTION F

PROJECT BACKGROUND AND NEED

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F. PROJECT BACKGROUND AND NEED

F.1 PROJECT PURPOSE AND OVERVIEW

F.1.1 Background[1]

New England's transmission system was built over several decades by regulated utilities that were vertically integrated – that is, they planned, owned and operated electric generation, transmission, and distribution facilities. Interconnections between adjoining utilities and neighboring regions existed and were used to maintain reliability and to share excess generation. However, the utilities were not required to allow other utilities to transport electricity over their transmission systems.

Accordingly, each electric utility planned, built and operated generating facilities and transmission infrastructure to complement each other within a single service territory. Moreover, electricity was viewed as a "bundled service" and not as a market commodity subject to trading over the transmission infrastructure. Regulators in each state approved generation and transmission infrastructure and set rates.

During the 1960s, New England's electric utilities, including CL&P, developed a long-term plan for a transmission grid that initially centered on integrating the dispatch of electricity from eleven strategically located large generating stations that could deliver large blocks of power to loads within and between the New England states. The plan was called the "BIG 11 POWERLOOP," and provided the "backbone" of an integrated New England electric utility system, extending from central Maine to south-central Connecticut.

The Northeast Blackout of 1965 highlighted the need for such operational coordination between the region's utility companies, and also prompted creation of the Northeast Power Coordinating Council

[1] This discussion is taken in large part from "Electricity Transmission Infrastructure Development in New England," Polestar Communications & Strategic Analysis, Dec. 2007

(NPCC) in January, 1966. NPCC was a voluntary international electric Regional Reliability Council formed by the utilities in the six New England States, Ontario, Quebec, and the Maritime Provinces of Canada. NPCC established a number of fundamental criteria documents that define the planning, design and operating principles that each participant electric utility company must follow to assure a reliable interconnected power system.

In June, 1968 the North American Electric Reliability Council (NERC) was formed and thereafter established voluntary reliability and operating performance standards for the electric power grid in North America.[2]

In 1971, the New England utilities formed the New England Power Pool (NEPOOL) as a voluntary organization to direct the minute-to-minute operation of the region's power grid to match supply and demand reliably and economically as well as to institute planning and operating reliability standards and requirements.

Restructuring

The electricity industry began undergoing a substantial change when the Energy Policy Act of 1992 created open transmission access by mandating that all utilities allow other generators the use of their lines. Then, in 1996, Federal Energy Regulatory Commission (FERC), by its Orders 888 and 889, further encouraged competition in the wholesale power market by requiring owners of transmission facilities to provide access on request and on a fair and nondiscriminatory basis.

Within a decade, every state in New England except Vermont enacted legislation to "restructure" retail electricity markets. Under restructuring, most public utilities were either required or strongly encouraged to sell their generating plants to companies that would operate them in a competitive marketplace. (Utilities remained regulated and responsible for transmission and local distribution service.) Regulatory

[2] On January 1, 2007, NERC became the North American Reliability Corporation.

jurisdiction over transmission was split between the FERC, with rate setting authority, and state agencies, with responsibility for siting new infrastructure. Restructuring also profoundly changed the operational demands and management requirements of the electric power grid – as the “patch work” system had to function seamlessly across the region as well as with other regions.

Independent System Operators (ISO)

Independent System Operators (ISOs) were created under FERC oversight to implement and administer the competitive, wholesale marketplace to ensure fair and open access as well as reliable operation of the region’s transmission system. In 1997, NEPOOL transferred the day-to-day operation and management of the New England bulk transmission system and generation facilities to ISO New England (ISO-NE). ISO-NE is a not-for-profit corporation that is responsible for operating New England’s bulk-power generation and transmission system, overseeing and administering the region’s wholesale electricity markets, and managing the regional bulk-power-system planning process.

On February 1, 2005 – after a four-year development effort – FERC approved ISO-NE’s designation as a Regional Transmission Organization (RTO). As an RTO, ISO-NE assumed broader authority for the day-to-day management of the region’s transmission system and a greater level of independence to effectively administer the competitive wholesale market. ISO-NE has also been granted authority to conduct regional planning and to direct transmission owners to operate their facilities in a manner that maintains system reliability – including the requirement to upgrade existing transmission lines or build new ones to assure reliability.

Reliability Organizations

The August 2003 Eastern Electricity Blackout – involving portions of the mid-west, northeast and the Canadian Province of Ontario – affected 50 million people and emphasized that electric power grids (which have become increasingly interconnected as a result of technology and restructuring) are only as strong as their weakest links. The blackout prompted federal legislation to make NERC's voluntary reliability criteria mandatory and enforceable.

The Energy Policy Act of 2005 authorized the creation of a self-regulatory "electric reliability organization" (ERO) to develop and enforce these standards. In 2006, FERC approved NERC as that organization. NERC is supervised by FERC and by Canadian governmental authorities. Its criteria relate to the planning and operation of the bulk electricity system and cover areas such as: balancing consumer demand with generation supplies, emergency operations, cyber security, vegetation management, and disturbance reporting. As of June 2007, U.S. utilities and other bulk electricity industry participants that violate reliability criteria requirements will face enforcement actions and fines of up to $1 million per day.

Resource Adequacy and System Security

NERC's definition of reliability encompasses two concepts: adequacy and security. Adequacy is defined as the "ability of the system to supply the aggregate electric power and energy requirements of the consumers at all times" while security is defined as "the ability of the system to withstand sudden disturbances". Adequacy implies that there are sufficient generation and transmission resources available to meet projected needs plus reserves for contingencies; security implies that the system will remain intact and stable even after planned or unplanned transmission facility outages, equipment failures, the loss or unavailability of generation resources.

The provision of resource adequacy within a service territory is no longer within the control of regulated public utilities. Since restructuring, generation has been developed primarily by private entrepreneurs, and the location of the new plants within the region has been influenced by factors other than the location of load pockets, which include: site availability/costs, availability of fuel (typically natural gas), proximity of large bodies of water for cooling, and the cost of local labor.

For instance, Maine has the lowest construction labor rates and land costs in the region, and has sufficient access to fuel (natural gas). As a result, substantial new generating capacity has been built in Maine and therefore located up to hundreds of miles from the "load centers" of Massachusetts and Connecticut. Because the construction of north-south transmission capacity has lagged market development, electric capacity sometimes becomes "bottled up" in Maine during peak periods and cannot be sent to where it is demanded. Therefore, from a regional reliability standpoint, some generating plants are not optimally located.

ISO-NE and state regulators and legislatures have accordingly instituted various policy initiatives designed to encourage the construction of new generation and the deployment of new demand-reduction strategies where they will best contribute to local and regional resource adequacy. Early indications are that these initiatives will result in the addition of substantial new generating capacity. However, the extent of this new capacity – and the extent to which the new entries may cause the retirement of older, less efficient, and more environmentally challenged units - is not yet clear. In the meantime, the regulated providers of transmission services (Transmission Owners, or TOs), such as CL&P and WMECO, are obliged by binding tariff provisions to design and propose transmission improvements that will assure that the bulk power supply system complies with applicable mandatory reliability standards.[3]

Contingency Planning

A key element of these reliability criteria is the consideration of "contingency" events wherein critical generation and/or transmission facilities are assumed to trip out of service or be unavailable. A "contingency" is an unintentional event, usually involving the loss of one or more system elements, which affects the power system.

[3] NERC's "Reliability Standards for the Bulk Electric Systems of North America"; the NPCC's "Basic Criteria for Design and Operation Of Interconnected Power Systems," Document A-02 (revised May 6, 2004); the NPCC's "Bulk Power System Protection Criteria," Document A-05 (revised January 30, 2006); ISO-NE Planning Procedure No. 3, "Reliability Standards for the New England Area Bulk Power Supply System" (effective date October 13, 2006); ISO-NE Planning Procedure No. 5-3, "Guidelines for Conducting and Evaluating Proposed Plan Applications Analysis"; and the "Transmission Planning Guideline" for Northeast Utilities.

If a generating unit or a transmission line is removed from service, increased power flows must immediately be carried on transmission lines that remain in service. Thus, transmission capacity for an area must be designed not only to transmit the imported power required to offset anticipated generating deficits under normal conditions, but also to transmit that imported power reliably following specific contingencies that the system is required to withstand. Otherwise, line flows could exceed emergency transmission line ratings and force the utility to disrupt service to large blocks of customers to prevent permanent damage to the electric system and an uncontrolled loss of additional load.

To evaluate compliance with applicable reliability criteria, planning contingencies are simulated on computer models developed to represent actual and future system conditions. If the simulation shows that transmission lines will overload and/or voltage will not be maintained within acceptable limits under one or more of the contingencies for which the system must be designed, corrective action must be implemented in order to maintain the reliability of the electric grid.

The applicable planning criteria require that the transmission system have sufficient capacity “to integrate all resources and serve area loads” both when all system elements are available and in the event of the loss of a critical generator, transmission circuit, transformer, or certain other specified elements. Moreover, once one of those critical elements is lost from service, the system must be capable of being adjusted within 30 minutes, such that it will continue to operate reliably in the event of a second contingency. Planners use the terms “N-1” and “N-1-1” to designate the contingency conditions in which the system must be capable of reliable operation. N-1 designates the state of the transmission system following the occurrence of a contingency. N-1-1 designates the condition of the system following the occurrence of a contingency, assuming that one element is already out of service.

Unplanned outages of generating units are common in the electric industry. For example, when ISO-NE set a record for peak winter load on January 21, 2003, eight generating units in SWCT, with a total capacity of approximately 1,038 MWs, were unavailable due to problems associated with the extremely cold weather. And for over 12 hours on June 30, 2008, Milford Power Units 1 and 2 tripped off line during a three-day-long forced outage of Millstone Unit 2, making about 1,470 MWs of Connecticut-based generation unavailable on a summer day. In 1996, Connecticut suffered the unplanned loss of 3,200 MWs of nuclear generating capacity, some of it permanently.[4]

Transmission line outages also occur. For example, in November 2002, the Norwalk Harbor – Northport, New York submarine cable system went out of service as a result of damage caused by a boat anchor. The cable system was out of service until June, 2003. (The length of this outage reflects the difficulty of diagnosing and repairing damage in submarine and underground transmission systems. Forced outages of overhead transmission lines are typically much shorter – often measured in hours and rarely more than a few days.)

The reliability criteria seek to assure that the transmission system will survive contingencies even if they occur when the system is serving peak loads and is under stress. Accordingly, the computer modeling of system performance must require the integrated system to serve loads that are forecasted by ISO-NE to occur in the future, including peak loads that would be expected only in the event of extreme weather; to accommodate intra-regional power transfers; and to operate while "reasonably stressed" by the unavailability of generation proximate to concentrations of load. Requiring the transmission system to operate effectively under the stress caused by the unavailability of multiple generating units recognizes that units may be unavailable at any time for many reasons – such as economics, equipment failure, fuel supply and maintenance. Also, environmental restrictions on fossil-fueled generating stations in

[4] The three units of Millstone Nuclear Power Station, totaling 2,668 MWs in capacity were shut down by the Nuclear Regulatory Commission in early 1996. The 591-MW Connecticut Yankee Atomic Plant closed for scheduled refueling in December, 1996 but never re-opened. Millstone Unir 1, a 650-MW unit, also never returned to operation and was retired in 1998. Millstone Unit 3 was returned to service in July, 1998 and Millstone Unit 2 in May, 1999.

Connecticut could affect continuous operation of certain generating units or result in their permanent closure.

The bulk-power supply system is not only planned, but is also operated, so that it can withstand the unplanned loss of system elements. Thus, most transmission lines typically carry currents that are a fraction of those that they could safely carry. Each transmission line is thus available to accept additional current that would instantaneously flow onto it in the event of the sudden loss of other system elements.

F.1.2 The SNETR Study

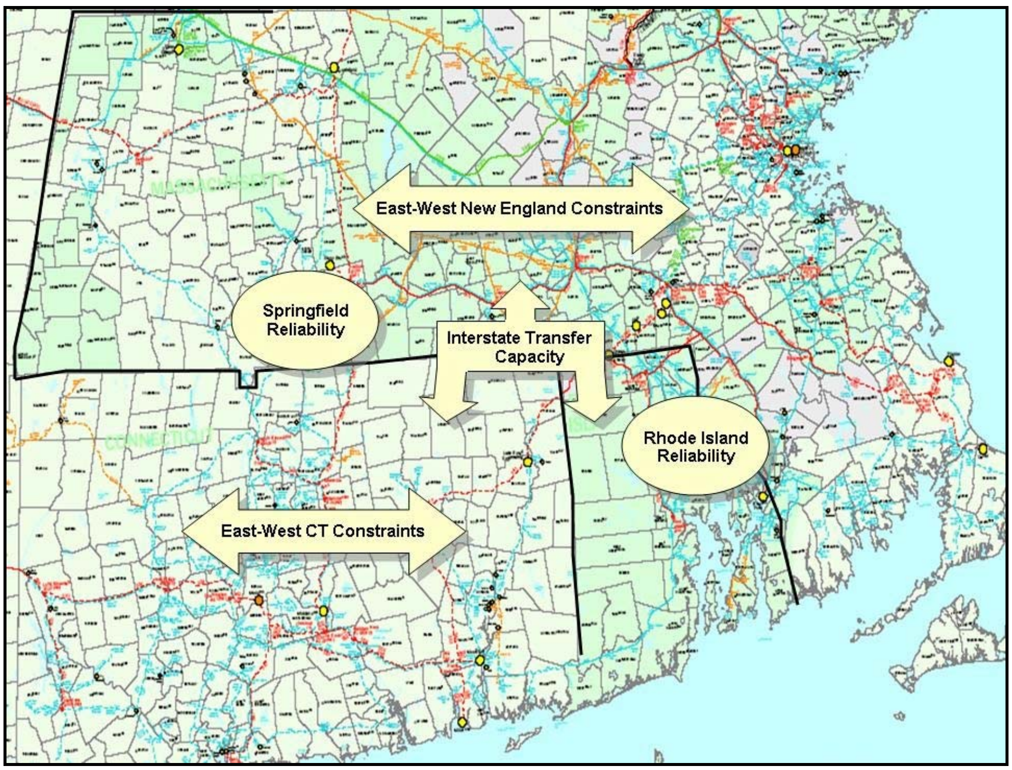
The Southern New England Transmission Reliability (SNETR) Study is the collective name for coordinated series of studies of the deficiencies in the Southern New England electric supply system, which began in 2004. Both the SNETR study and the NEEWS Plan were developed by ISO-NE, and by the planning staffs of NUSCO and National Grid, with the assistance of outside consultants, working together in a "working group" established by ISO-NE. Membership in the working group was open to all New England Transmission Owners.

When the SNETR study effort was undertaken, several major Southern New England transmission projects were in the process of being approved or were under construction, and were expected to be in service by 2009. The working group undertook a study of further improvements that would be needed thereafter to address transmission system problems expected to arise through 2016, assuming the completion of the projects already underway and projected peak-load growth. Initially, these studies considered limitations on east-west power transfers across Southern New England and transfers between Connecticut and southeast Massachusetts and Rhode Island.[5] These limitations had been identified as interdependent (that is, as affecting one another) in ISO's 2003 Regional Transmission Expansion Plan (RTEP03). In the course of studying these interstate power-transfer limitations, the ISO working group

[5] These studies also included issues in the Boston and southeastern Massachusetts areas, which are outside the scope of the NEEWS Plan.

determined that previously identified reliability problems in Greater Springfield and Rhode Island were not simply local issues, but also affected interstate transfer capabilities. In addition, the planners identified constraints in transferring power generated in – or imported into – eastern Connecticut across central Connecticut to the concentrated load in SWCT. These inter-related problems with the Southern New England transmission system are illustrated in Figure F-1.

Figure F-1: Reliability Concerns in the Southern New England Region



A comprehensive plan to address all of these interrelated problems was then developed, at first under the name of the Southern New England Transmission Reliability Plan, and later under the more descriptive project umbrella name of the New England East West Solution. The end result of these processes was the identification of a long range plan comprising four separate projects designed to work together to provide needed improvements in the Southern New England transmission system.

F.1.3 The NEEWS Plan

The five deficiencies illustrated in Figure F-1 are addressed by a combination of four separate NEEWS projects and certain ancillary improvements, such as the Manchester to Meekville Junction Circuit Separation Project **(**MMP). Each project provides needed reliability improvements in its own right, but all are designed to work together to relieve transmission constraints and provide reliable transmission of electric power within and across New England under both normal conditions and following contingency events such as the unplanned outage of one or more transmission lines or generating plants. In general terms, the four NEEWS projects are:

- **The Greater Springfield Reliability Project (GSRP)**, which includes: the construction of a new 345-kV line along approximately 35 miles of overhead line ROW (23 miles in Massachusetts and 12 miles in Connecticut); the construction, reconstruction, and upgrade of 115-kV lines along approximately 27 miles of existing and expanded overhead line ROW in Massachusetts, and related substation improvements in both Massachusetts and Connecticut. In Massachusetts, a new 345-kV switchyard and two new 345-kV to 115-kV, 600-Megavolt Ampere (MVA) autotransformers in the Agawam Substation. In Connecticut, the required substation improvements associated with the new 345-kV line would consist of installing a 345-kV switchyard and a 345-kV to 115-kV, 600-MVA autotransformer in the North Bloomfield Substation. In addition, three 115-kV tie-lines at the North Bloomfield Substation are disconnected from Massachusetts. The **Manchester to Meekville Junction Circuit Separation Project (MMP),** involving the separation of two lines now on common transmission structures along two miles of ROW in Connecticut, has been developed to complement the GSRP.
- **The Interstate Reliability Project (IRP)**, which includes the construction of a new 345-kV line from National Grid's Millbury Switching Station in Massachusetts to its West Farnum Substation in North Smithfield, Rhode Island, to CL&P's Lake Road Substation in Killingly, Connecticut, and to CL&P's Card Street Substation in Lebanon, Connecticut. Overall, the project would

involve approximately 76 miles of new 345-kV lines, including approximately 16 miles in Massachusetts, 22 miles in Rhode Island, and 38 miles in Connecticut, together with related improvements to existing 345-kV and 115-kV facilities.

- **The Central Connecticut Reliability Project (CCRP)**, which includes the construction of a new 345-kV line from CL&P's North Bloomfield Substation to its Frost Bridge Substation in Watertown, a distance of approximately 38 miles, together with related improvements to existing 345-kV and 115-kV facilities.
- **The Rhode Island Reliability Project**, which, as proposed by National Grid, would consist of an approximately 21-mile 345-kV line between its West Farnum Substation in North Smithfield, Rhode Island and its Kent County Substation in Warwick, Rhode Island, together with related improvements to existing 115-kV and 345-kV facilities.

The problems illustrated in Figure F-1 will be addressed by these four NEEWS projects as follows:

- **Regional East – West Power Flows.** Regional east-west power flows across New England are limited due to the potential overloading of existing 345-kV lines that traverse southern Massachusetts from east to west and potential voltage violations at substations served by those lines. Construction of the Interstate Reliability Project, the Central Connecticut Reliability Project, and the Greater Springfield Reliability Project will provide another path for power flowing from east to west, and will allow higher flows in these directions.
- **Connecticut Import Limitations.** Power transfers into Connecticut are limited and will eventually result in the inability to serve load under many contingencies that the system must withstand in order to comply with national and regional reliability standards. The construction of additional 345-kV ties to Rhode Island and Massachusetts will greatly improve the system's ability to serve the load by providing additional paths on which power may flow in the event of a planned or unplanned loss of a system element, such as a transmission line or generating unit, and

thus significantly increase power transfer limits into and out of Connecticut. In addition to improving the security of supply, this increase in import capacity will also yield economic benefits to Connecticut consumers by providing access to lower cost remote sources of power to the north; and is likely to provide environmental and statutory compliance benefits by enabling access to remote renewable and/or low emission power-supply sources.

- **Connecticut East-West Transfers.** Load in Connecticut is heavily concentrated in the southwest quadrant of the state (SWCT), whereas many of Connecticut's generation resources are located in the eastern part of the state. The anticipated completion of a 345-kV loop serving SWCT in 2009 will enable power to move freely through SWCT, and the construction of the Interstate Reliability Project and the GSRP will enable the import of sufficient power to provide more reliable service to the entire state, including SWCT. However, the increased power flows across central Connecticut necessary to serve the growing SWCT load will result in overloads on existing transmission lines following contingency conditions on the transmission system. This "bottleneck" between eastern Connecticut and the SWCT Loop will be eliminated by the addition of another 345-kV connection between these subareas. Providing a less constricted path to SWCT for power generated in eastern Connecticut and imported from central/eastern Massachusetts and Rhode Island will also reduce the amount of power forced to flow through the Springfield 115-kV system.
- **Rhode Island Reliability.** Transmission system reliability and dependence on local generation are the major concerns for the Rhode Island system. System modeling has demonstrated that a number of overload and voltage violations can occur on the Rhode Island transmission facilities following contingency conditions. These problems are caused by a number of contributing factors, both independently and in combination, including: high load growth (especially in southwestern Rhode Island and the coastal communities), generating unit availability, and transmission outages (planned or unplanned). The addition of the new 345-kV line from West Farnum Substation to Kent County Substation and other associated improvements will both

greatly improve the reliability of the state's transmission system and reduce dependence on local generation. The new 345-kV lines from the Millbury Switching Station to West Farnum Substation and from West Farnum Substation to Lake Road Substation would serve a dual role of both improving Rhode Island Reliability and providing an essential component of the new 345-kV Interstate Reliability Project, discussed above.

- **Greater Springfield Reliability.** The Greater Springfield reliability problems and their proposed solution are described above and in detail later on in this document.

The new transmission system connections that would be provided by the four projects together comprise the NEEWS plan and are illustrated in Figure F-2:

Figure F-2: NEEWS Project Elements

F.1.4 Documentation of the Need for the NEEWS Plan and the Greater Springfield Reliability Project

The need for the GSRP, and that for the other NEEWS projects, was described in a report first issued in draft by ISO-NE in 2006 and ultimately published (in both complete form available to qualified ISO-NE participants and in redacted form available to the public) as Southern New England Transmission

Reliability Report – Needs Analysis, January 2008 (Needs Analysis). In the "public" version of the report, certain "Critical Energy Infrastructure Information" (CEII) has been redacted, in order to comply with FERC and ISO-NE security policies[6]. A copy has been filed as part of Volume 5 of this Application.

Having identified the interrelated needs in the Southern New England Region, the ISO-NE working group turned to an analysis of transmission solutions – or "Options" that would address those needs. This part of the coordinated planning effort continued through 2006 and 2007, and included several presentations to the interested stakeholders at meetings of the ISO-NE Planning Advisory Committee (PAC). In April, 2008, ISO-NE posted for comment on its website a final draft of a document that had been developed over that period, which describes a set of "Options" for each component of the NEEWS Plan, entitled New England East-West Solutions (Formerly Southern New England Transmission Reliability) Report 2, Options Analysis, (the Options Analysis). That document has also been since published. A copy of the redacted public version of the Options Analysis is included in Volume 5 of this Application.

NUSCO then evaluated the "Options" identified by the Options Analysis for the Greater Springfield Reliability Project, and determined that the proposed project would provide the most system benefit, at the least cost, and with the fewest environmental effects. That decision process is described in a third report, entitled Northeast Utilities Solution Report for the Springfield Area, July, 2008. A copy of that report is also included in Volume 5 of this Application.

In 2007, ISO-NE included the NEEWS projects in its Transmission Projects Listing, and in 2008, it issued a technical approval for the projects pursuant to section I.3.9 of Attachment K to its Open Access

[6] CEII refers to information vital to the Bulk Power System that, if utilized by someone wishing to do harm, could be critical data providing sufficient detail to enable the disabling of the Bulk Power System. It includes detailed drawings and descriptions of specific weaknesses and vulnerabilities of the transmission system. Parties and intervenors who wish to have access to the CEII material redacted from the Needs Analysis or from the Options Analysis discussed below, should contact ISO-NE Customer Service at (413) 540-4330 for information on how to apply for such access.

Transmission Tariff (OATT).[7] These steps represent ISO-NE's recognition that transmission system reliability need exists, that the GSRP (and the other NEEWS projects) have been proposed to meet that need, and that the projects will not have an adverse impact on the integrated transmission system. Until the market responds by developing credible alternative generation projects, demand-side projects, or merchant transmission facilities, and causes ISO-NE to drop the NEEWS projects from the Listing, CL&P and WMECO have an obligation to develop a backstop transmission plan in order to satisfy that reliability need. (Sec. 8, Attachment K, OATT). That duty is subject to receipt of all ISO-NE technical approvals and other normal permit and licensing requirements.

Although it is designed to work efficiently with the other NEEWS projects, the GSRP stands on its own as fulfilling urgent reliability needs in Greater Springfield and north-central Connecticut. It is needed and will "work" whether all, some, or none of the other NEEWS projects are built. While all of the NEEWS projects have been designed to complement, and not to conflict with one another, the GSRP can stand on its own. To demonstrate this existing and independent need, NUSCO planners have performed extensive new power-flow studies of the Greater Springfield and north central Connecticut area, taking into account updated load forecasts and relevant changes in the electric supply system. These studies examine the need for, and the benefits of, the GSRP without regard to the other NEEWS projects. The results of those studies are presented generally in this section and in detail in a "CEII Appendix" to this Section F[8].

F.2 THE NEW ENGLAND BULK-POWER SUPPLY SYSTEM

The New England bulk-power supply system is integrated and uses regional generating resources to serve regional load (i.e., the demand for electricity measured in MW) independent of state boundaries. Most of

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7 FERC Electric Tariff No. 3, Sec. 3.6(c), Attachment K.

8 Pursuant to FERC, ISO-NE and NUSCO CEII policies and procedures, CEII can not be publicly disclosed without restrictions. Accordingly, while CL&P may disclose the assumptions of its load flow studies, it may not disclose detailed results that identify specific weaknesses or vulnerabilities in the Bulk Power System. CL&P anticipates that the Council, its staff, parties and intervenors to the proceedings on this Application, and their counsel and expert consultants, will be able to obtain access to this CEII Appendix by executing a Non-Disclosure Agreement, pursuant to a Protective Order for which CL&P will apply shortly after its application is filed.

the transmission lines are relatively short and networked as a grid. Therefore, the electrical performance in one part of the system affects other areas of the system.

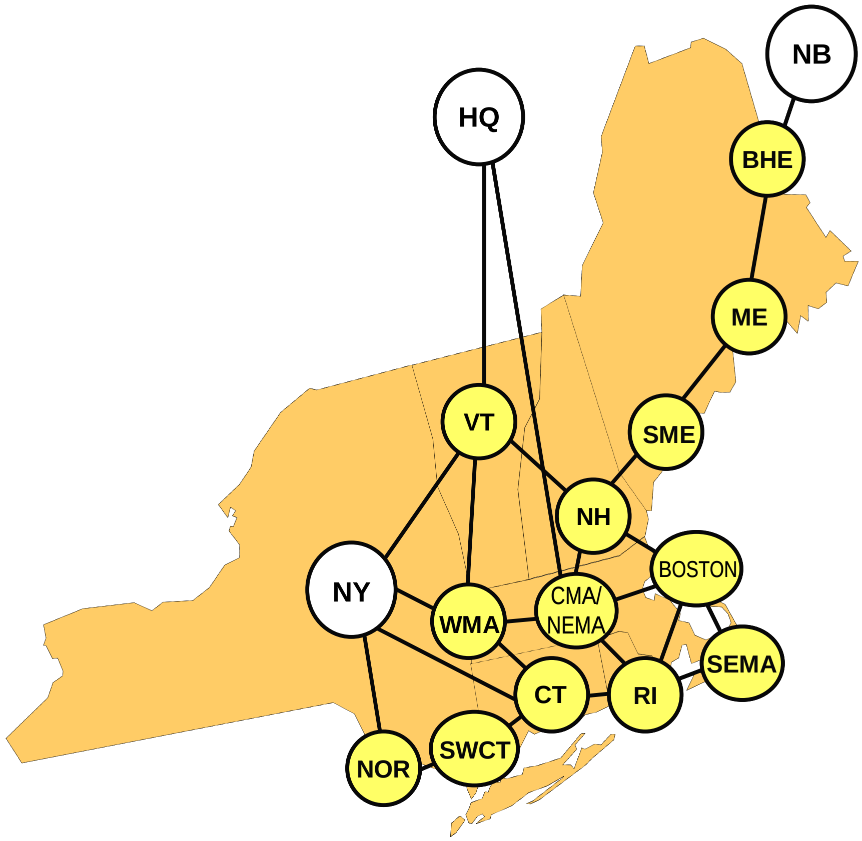
The New England regional electric system serves 14 million people living in a 68,000 square-mile area. More than 350 generating units produce electricity, representing approximately 31,000 MWs of total generating capacity, with most of these units connected to approximately 8,000 miles of high-voltage transmission lines. Thirteen tie-lines interconnect New England with its neighbors, New York and the Canadian provinces of New Brunswick and Québec.

In addition to these power-supply resources, New England depends upon significant demand-reducing resources. As of July 1, 2008, approximately 1,700 MWs of demand-reducing resources were registered as part of the ISO-NE demand-response and price-response programs. Customers in these programs reduce load quickly to enhance system reliability or in response to price signals for compensation based on wholesale electricity prices.

The New England Region reached a new record summer-peak load of 28,130 MWs on August 2, 2006, which was due to extreme temperatures and humidity throughout the region. In accordance with ISO-NE operating procedures, demand-response programs were activated to reduce the load, and this action reduced the peak by approximately 640 MWs. In the absence of these programs, the peak load would have been 28,770 MWs. Normal dispatch, considering economics, generation availability, and transactions with neighboring systems, results in multiple intra-New England power transfers of varying direction, magnitude, and duration. The development of over 11,000 MWs of new generation in New England since 1997, without attendant transmission system upgrades, has resulted in situations where surplus generation in one subarea may not be deliverable to other subareas and is not always available simultaneously with other generation in the region as a whole.

Within New England, 13 subsets of the electric power system, called subareas, have been established to assist in modeling and planning electricity resources. Figure F-3 is a simplified model of the system that shows the ISO-NE subareas and three external control areas. The types of analyses that use the subareas include resource adequacy studies and environmental emission studies. More detailed models are used for other types of analyses, including transmission planning studies, and for the real-time operation of the system.

Figure F-3: RSP Geographic Scope of the New England Bulk Electric Power System



Subarea Designation	Region or State	Subarea or Control Area Designation	Region or State
BHE	Northeastern Maine	**WMA**	Western Massachusetts
ME	Western and central Maine/ Saco Valley, New Hampshire	**SEMA**	Southeastern Massachusetts/ Newport, Rhode Island
SME	Southeastern Maine	**RI**	Rhode Island/bordering MA
NH	Northern, eastern, and central New Hampshire/eastern Vermont and southwestern Maine	**CT**	Northern and eastern Connecticut
VT	Vermont/southwestern New Hampshire	**SWCT**	Southwestern Connecticut
BOSTON	Greater Boston, including the North Shore	**NOR**	Norwalk/Stamford, Connecticut
CMA/NEMA	Central Massachusetts/ northeastern Massachusetts	**NB, NY, and HQ**	New Brunswick (Maritimes), New York, and Hydro-Québec external control areas

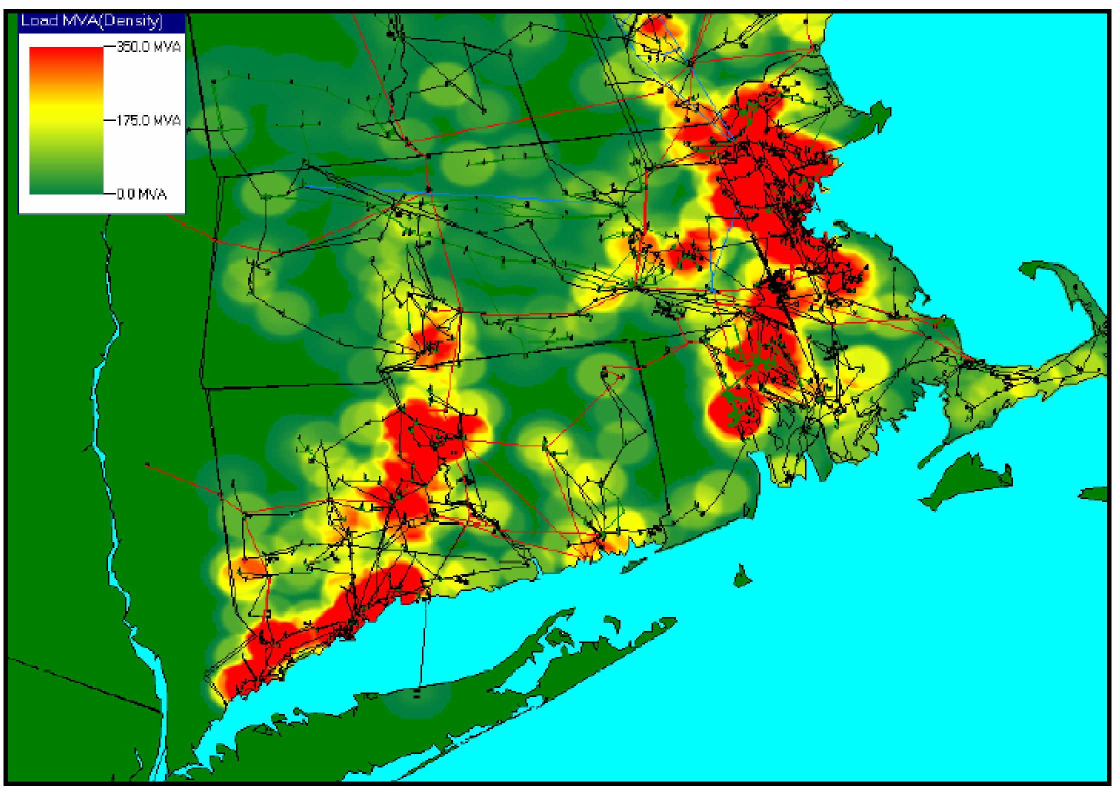
Notes: Some RSP studies investigate conditions in Greater Connecticut, which combines the NOR, SWCT, and Connecticut subareas. This area has similar geographic boundaries to the State of Connecticut but is slightly smaller because of electrical system limitations near the borders with western Massachusetts and Rhode Island. Greater Southwest Connecticut includes the southwest and western portions of Connecticut and consists of the NOR and SWCT subareas. NB includes New Brunswick, Nova Scotia, and Prince Edward Island (i.e., the Maritime Provinces)

F.3 BULK-POWER SUPPLY IN SOUTHERN NEW ENGLAND

The geographic area of southern New England (SNE) encompasses Massachusetts, Rhode Island, and Connecticut. The SNE area accounts for approximately 80 percent of the New England load.

As shown in Figure F-4, the SNE load is concentrated in Boston and its suburbs; central Massachusetts, Springfield, Rhode Island, Hartford, and Southwest Connecticut. These areas of load concentration are called "load pockets" if transmission capability within them is not adequate to reliably import power from other parts of the system, and demand must be met by relying on local generation. Although the Southwest Connecticut area will no longer be a "load pocket" when the Middletown to Norwalk project is in-service, Connecticut as a whole will remain a "load pocket."

Figure F-4: Southern New England Load Concentrations



The GSRP bridges two of the subareas shown in Figure F-3 – WMA and CT, and addresses the reliability of the power supply to two of the "red" areas of load concentration illustrated in Figure F-4 – the Greater Springfield area and north-central Connecticut, which includes Hartford.

F.4 THE EXISTING TRANSMISSION SYSTEM SERVING GREATER SPRINGFIELD AND ITS TIES TO NORTH-CENTRAL CONNECTICUT

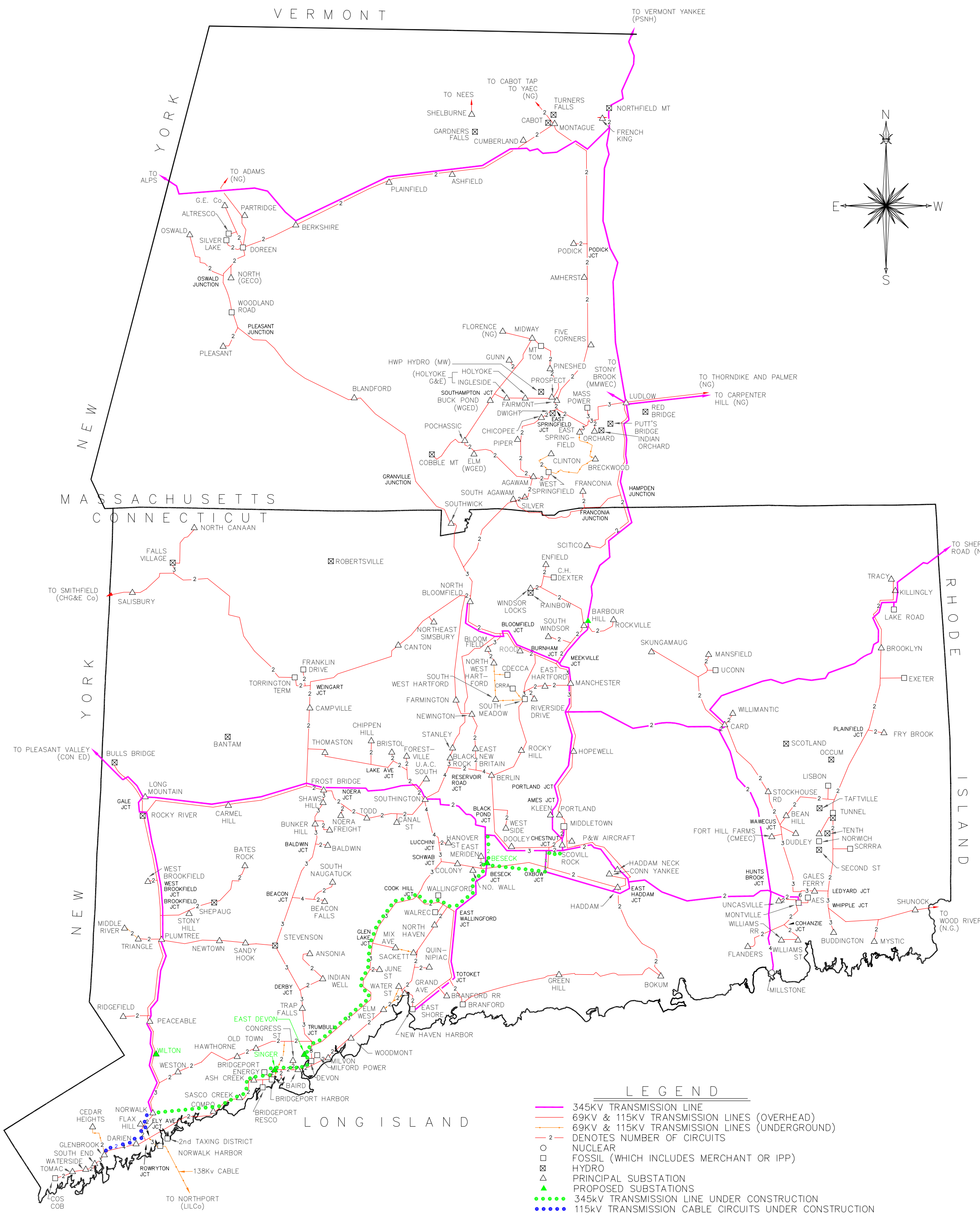
The Springfield study area includes the City of Springfield and extends west to Blandford, south to the Connecticut border, north to Amherst, and easterly to Ludlow. WMECO serves the major portion of the load in this area. Other municipals/utilities that serve load in this area from their own substations are Holyoke Gas & Electric, Chicopee Electric Light, Westfield Gas & Electric, South Hadley Electric, and National Grid.

For this study area, the City of Springfield and surrounding suburbs represents a significant portion of the load. The City of Springfield is a major urban industrial center of metropolitan status at the junction of regional routes between Boston and New York. It is located in southwestern Massachusetts, bordered by Agawam and West Springfield on the west, Chicopee and Ludlow on the north, Wilbraham on the east, and Longmeadow and East Longmeadow on the south. Springfield is 89 miles west of Boston; 25 miles from Hartford, Connecticut; and 134 miles from New York City.

The north-central Connecticut study area borders the Greater Springfield area on the south and extends to the City of Harford and its surrounding suburbs. Hartford is the capital of the State and, after the Boston area, the second largest urban center in Southern New England. Connecticut towns in this study area include Manchester, East Hartford, Hartford, West Hartford, Avon, South Windsor, Windsor, Bloomfield, Simsbury, East Windsor, Windsor Locks, East Granby, Enfield, Suffield, and Granby.

Although the GSRP bears the name of "Greater Springfield," it necessarily addresses reliability issues in Connecticut. The flow of electricity does not respect state borders. Since key transmission lines in the system serving Greater Springfield terminate at substations in Connecticut, the resolution of the Springfield area problems necessarily involves improvements to portions of the electric grid in Connecticut as well. At the same time, the necessity of resolving these Springfield area problems offers an opportunity for reinforcing the reliability of electric supply to north-central Connecticut and to provide needed improvement in the power-transfer capacity between Massachusetts and Connecticut. The western Massachusetts electric system, including the Greater Springfield area and its ties to Connecticut are shown on Figure F-5 and described in the following text:

Figure F-5: Western Massachusetts and Connecticut Transmission Systems



The 345-kV Bulk Power Supply System in the Springfield Area

The major Springfield area interconnection to the 345-kV bulk power transmission network is at WMECO's 345/115-kV Ludlow Substation. Ludlow is the only major bulk-power substation in the Springfield area where the 345-kV and 115-kV transmission networks interconnect, through large autotransformers that "step down" the voltage from 345 kV to 115 kV. The Ludlow Substation is served by 345-kV lines from both the north and the east. It thus enables bulk power generated in Massachusetts at stations such as Northfield Mountain and Stony Brook, and power imported over WMECO's four 345-kV transmission tie-lines with other systems, to be delivered to the Springfield area's 115-kV transmission system. Ludlow Substation is considered a "strong" source or "hub" for the WMECO 115-kV transmission system.

The 345-kV line serving the Ludlow Substation extends south from there to terminate at the Barbour Hill Substation in South Windsor, Connecticut, and is interconnected from Barbour Hill by a 345-kV line to the Manchester and North Bloomfield Substations in Connecticut. Through these connections, the Ludlow Substation provides a strong source of supply to the Connecticut system, collecting power flowing from Massachusetts, Vermont and New York and transferring it to Connecticut. Under typical dispatch conditions, the 345-kV line from Ludlow may supply 30% of the maximum Connecticut import capability of approximately 2,500 MWs[9].

The Springfield Area 115-kV System

The Ludlow Substation serves the Greater Springfield area load by means of four 115-kV transmission circuits that extend westerly into the Springfield area "load pocket," along different routes, interconnecting with several different substations. Two of these 115-kV lines, after passing through Chicopee, Springfield and West Springfield, connect with the Agawam Substation, and from there to the

[9] *See,* Needs Analysis, page 12, Table 3-3. Transfer capacity, or import capability, varies with system conditions and is properly expressed as a range, rather than a single point estimate. 2,500 MWs is at the upper end of the range of the aggregate transport capacity across all of the Connecticut interfaces with neighboring electric systems.

South Agawam Switching Station, and then the North Bloomfield Substation in Connecticut. In the event of equipment outages on either side of the state border, these lines can provide transmission support to help maintain the reliability of the interconnected systems. As described in detail in the CEII Appendix, the Springfield 115-kV system includes underground cables of limited capacity and many double circuit lines (two 115-kV overhead circuits supported by a common line of transmission structures).

The North-Central Connecticut Area 115-kV System

The North Bloomfield 345/115-kV Substation is a primary source for bulk power supply to the north-central Connecticut area. The North Bloomfield Substation serves the north-central Connecticut area load by means of three 115-kV transmission circuits that extend southerly into the Hartford area "load pocket," along similar routes, interconnecting with several different substations. At a location in eastern Bloomfield, two of these 115-kV lines head south toward Hartford and connect with the Northwest Hartford Substation, and from there to the Southwest Hartford Substation and then finally to the South Meadow Substation via a single 115-kV underground cable. Also at this location, a single 115-kV overhead circuit extends easterly toward South Windsor and terminates at the Manchester Substation. At the Bloomfield Substation in Bloomfield, a single 115-kV overhead circuit extends easterly toward South Windsor and turns southerly toward the South Meadow Substation.

As indicated earlier, the North Bloomfield Substation also connects to the three 115-kV circuits from western Massachusetts. These circuits provide a flow-through path between western Massachusetts and Connecticut. In the event of a transmission circuit or equipment outage on either side of the state border, these lines can provide transmission support to help maintain the reliability of the interconnected systems. However, during peak demand periods and heavy power flows into Connecticut, transmission contingencies can cause overloads on these 115-kV transmission circuits with excessive power flows heading toward Connecticut and into the North Bloomfield Substation. In addition, the Hartford 115-kV system includes underground cables of limited capacity. Double circuit line contingencies in north-central Connecticut cause these circuits to overload.

Two other 345/115-kV substations located in South Windsor and Manchester also provide bulk power supply to the north-central Connecticut area load.

The Manchester 345/115-kV Substation serves the north-central Connecticut area load primarily by means of four 115-kV transmission circuits. Two 115-kV circuits head north toward the Barbour Hill Substation and two circuits head west toward the South Meadow Substation.

The Barbour Hill 345/115-kV Substation in South Windsor serves the north-central Connecticut area load primarily by means of two 115-kV transmission circuits. These two 115-kV circuits head northwest toward the Enfield and Windsor Locks Substations.

The transmission circuits between the North Bloomfield, South Meadow and Manchester Substations form a 115-kV loop around Hartford. In addition to direct load serving responsibilities in the Hartford area, this loop also provides a path for power to flows into other Connecticut areas.

F.4.1 Greater Springfield and North-Central Connecticut Area Generation Facilities

Table F-1 lists the larger generation facilities connected to the transmission system in the Greater Springfield area, the dispatch of which affects the reliability of the delivery of power to the area. Total summer capacity listed in Table F-1 is 1,289 MWs.

Table F-1: Greater Springfield Area Generation

Generation	MW
Stony Brook	412
Berkshire Power	280
Mt Tom	147
West Springfield #3	101
MASSPOWER 1	82
MASSPOWER 2	82
MASSPOWER 3	75
West Springfield #1	38
West Springfield #2	38
West Springfield Jet	17
Cobble Mt	17

The Needs Analysis determined that these resources were not sufficient to reliably serve the Springfield area load; and that the Springfield Area would suffer a “load deficiency” in 2009 and through the end of the study period in 2016. Needs Analysis, at 10, 11. Moreover, continued operation of some of the existing units is required to enable the system to withstand contingencies. As ISO-NE has stated in its Regional System Plans (2007 RSP, at p.91):

> Two generators in the Springfield area, West Springfield unit #3 and Berkshire Power, have been frequently designated as daily second-contingency units. These generators, in addition to West Springfield unit #1 and #2, are also needed to support local reliability during peak hours and to avoid overloads, in violation of reliability criteria.

Table F-2 lists the larger generation facilities connected to the transmission system in the north-central Connecticut area, the dispatch of which affects the reliability of the delivery of power to the greater Hartford area. Total summer capacity listed in Table F-2 is 285 MWs.

Table F-2: North-Central Connecticut Area Generation

Generation	MW
South Meadow	138
CRRA	64
Capital District	50
Hartford Hospital	13
Dexter	12
Rainbow	8

The generating units in downtown Hartford provide support to local area loads. However the total power output capability of the combined units is relatively small to the total demand for electricity in the greater Hartford area. Therefore, there is a much greater reliance on the need to import power from outside the area to meets it demand.

F.4.2 Summary of Reliability Deficiencies of the Greater Springfield 115-kV System and Their Impact on the Connecticut System

As described in detail in the CEII Appendix, the 115-kV lines around Springfield, and the 115-kV underground cables that traverse Springfield, serve a double duty of supplying local load and supporting interstate transfers. In fact, under the present system configuration, a portion of the power flowing into Hartford from CL&P's North Bloomfield Substation can come through the Greater Springfield 115-kV system under normal conditions. Under many contingency conditions modeled in accordance with applicable reliability criteria, these power flows cause severe overload and voltage problems on the 115-kV system. The inadequacy of the existing 115-kV lines is compounded because many of the 115-kV circuits in the area share common support structures. Reliability criteria dictate that planners must assume that any contingency that removes one of these circuits from service may also interrupt the other circuit.

These reliability problems exist now, with today's system configuration and loads that have already occurred; and they will continue to grow as the load increases. Accordingly, the improvements proposed to bring the Springfield area system into compliance with applicable reliability criteria include the reconstruction or replacement of approximately 60 miles of 115-kV circuits in Massachusetts that are currently supported by double-circuit structures.

F.4.3 Objectives of the GSRP

The primary objective for the GSRP is to mitigate these problems by accomplishing the following:

- Establish a new 345-kV connection from North Bloomfield Substation in Connecticut to Agawam Substation to Ludlow Substation in Massachusetts, thus complementing the existing Agawam to Ludlow and Ludlow to Barbour Hill to North Bloomfield 345-kV lines to form a 345-kV "loop" through western Massachusetts and north-central Connecticut. This will relieve congestion on the 115-kV transmission system and increase the normal and emergency power-transfer capabilities between Massachusetts and Connecticut;
- Increase Connecticut import capabilities;
- Utilize the existing transmission rights-of-way between Ludlow, Agawam and North Bloomfield Substations;
- Provide an alternate diverse 345-kV source to the North Bloomfield Substation; and
- Establish a new 345/115-kV "hub" west of the Connecticut River and north of the North Bloomfield Substation at the existing Agawam Substation.

F.4.4 The Manchester to Meekville Junction Circuit Separation Project

The power-flow studies performed to develop the GSRP also identified the need for an ancillary Manchester to Meekville Junction Circuit Separation Project (MMP), sometimes also called the Manchester to Meekville Junction Project. As appears in more detail in the CEII Appendix, the modeling of the transmission system with the addition of the GSRP improvements showed that overloads could occur on a portion of the Connecticut 115-kV system, in the event of the simultaneous loss of the 345-kV Barbour Hill-North Bloomfield Manchester #395 circuit and the 115-kV Manchester-Rood Ave. #1448 circuit. The GSRP enables higher flows into Connecticut, and the redistribution of these higher flows in the event of the simultaneous or overlapping loss of these two circuits under certain system conditions would cause other elements of the Connecticut system to overload. Because the two circuits are carried on common transmission structures (for a distance of two miles), planning criteria require that an event interrupting service from either line be assumed to interrupt both of them. Separation of the circuits so that each is supported by its own line of structures eliminates the double circuit contingency and avoids the overload.

F.5 DESCRIPTION OF RELIABILITY ANALYSIS

F.5.1 Initial and Updated Studies

The Needs and Options Analyses were based on load flow simulations using future loads forecast by ISO-NE in 2005 and the solutions were modeled assuming that all of the NEEWS projects were built. In preparation for this Application, NUSCO, with the cooperation of ISO-NE, has performed a new set of power flow studies. These more recent studies are based on the latest (2008) ISO-NE forecast data, and model the impact of the proposed GSRP and the MMP by themselves– without the Interstate Reliability Project or the Central Connecticut Reliability Project in the model. The Rhode Island Reliability Project, for which a siting application has already been filed, was included in the model, but would not have had a significant influence on the pre-GSRP load flow results.

F.5.2 Determination of Future Area Loads

New England utilities rely upon the ISO-NE load forecasts for their transmission planning analyses. These forecasts, as adopted by NUSCO for the planning of the Connecticut transmission system, are regularly reviewed and critiqued by the Connecticut Siting Council in its annual proceeding to review the Forecasts of Loads and Resources by Connecticut utilities and generators.

The ISO-NE load forecast used for transmission planning studies is a 90/10 forecast. This means that the actual peak load has a 10 percent chance of exceeding the forecasted load level and a 90 percent chance of falling below the forecasted load level for each planned seasonal peak. ISO-NE uses this 90/10 demand forecast philosophy to develop its transmission plans to provide greater certainty of reliable electric service under the most severe weather conditions. This approach is consistent with national and regional requirements that contingency testing must include simulated conditions for forecasted load that "reasonably stress" the system (ISO-NE PP3, Section 3). The forecasts look ahead for 10 years and predict both total energy use and seasonal peak loads for New England as a whole, for each of the six New England states, for each of the New England operating companies, and for each substation "bus" within each operating company's system. The complex methodology by which ISO derives these forecasts is publicly disclosed.[10] The ISO "track record" has been very good, although forecasted peak loads tend to occur somewhat sooner than predicted.

The distribution substations in the Greater Springfield area and in Connecticut that are relevant to the GSRP need analysis are identified in Appendix F-1 along with their peak metered loads in 2007 and their projected peak loads for the years up to 2014, reflecting the extreme weather ("90/10") assumptions used by ISO-NE for reliability planning. The power-flow analyses contained in this Application are based on the forecasted load for 2014.

Use of the ISO-NE forecasts in transmission planning studies is complicated by a change in the methodology of accounting for the effects of demand-reducing strategies (variously called Demand-Side Management and Demand Resources) that ISO-NE adopted in 2007. Whereas previously ISO would

[10] For an ISO-NE presentation of current Load Forecasting Methodologies, see: http://www.iso-ne.com/committees/comm_wkgrps/othr/icsp/mtrls/2006/mar282006/load_forecast_methodologies.pdf ("Ehrlich 2006 Load Forecast Presentation").

reduce its forecasts to account for the predictable effects of certain "passive" DSM programs, ISO then decided to treat new Demand Resources as "capacity" resources, so as to put them on an equal footing with other capacity-related resources (such as new generation) in future Forward Capacity Auctions.

Accordingly, 90/10 extreme weather load forecasts should be adjusted for future DSM effects when modeling future system conditions for transmission planning. Otherwise, such forecasts would likely overestimate future loads and the need for transmission improvements.

F.5.3 Assumed Generator Availability

Stressed conditions for area resources require, at a minimum, an assumption that the largest or most critical generating unit in an area is unavailable. Assessing stressed conditions could also include additional reductions in local generation that accomplish other good utility planning objectives such as (i) facilitating increased power transfers from remote power-supply resources to serve both local and regional load; and (ii) eliminating current or future dependence on out-of-merit local generators.

In particular, power-flow analyses indicate that the dispatch of local generators in the Springfield area, particularly the Berkshire Power (280 MWs) and the West Springfield (177 MWs) stations, have a significant impact on transmission line loading in the area. When operating, these units serve local area load requirements and offer some protection from contingencies affecting access to more remote supply sources, such as the many strong sources available through the Ludlow Substation, by reducing the power flow from the Ludlow Substation through the 115-kV transmission system to feed load centers in Springfield and to support regional power transfers. This protection comes, however, at a price: if their operation is the only way to address certain contingencies, local service and local reliability become dependent on generators that may need to be dispatched out-of-merit. Accordingly, if the Springfield 115-kV system were not upgraded, these "must run" generation conditions would persist, and the Greater

Springfield area would lack adequate flexibility to avoid overloads following certain contingencies and also impact regional power flows.

In constructing dispatch conditions that appropriately reflect "stressed" conditions for the Springfield area, NUSCO worked in coordination with ISO-NE, and together, both took all of the above factors into consideration. After considering a number of scenarios, ISO-NE and NUSCO ultimately determined that outages of the two major generating units located to the west of Springfield had the greatest impact on power flows. The critical units are Berkshire Power and West Springfield unit #3. Only three dispatch scenarios were needed to illustrate their importance. In Dispatch 1, the critical unit outage is Berkshire Power and the units at West Springfield Station. In Dispatch 2, all critical units are on-line. In Dispatch 3, MASSPOWER is assumed to be off-line. All other major units are assumed on-line. Table F-3 contains the dispatch scenarios used in the system impact analyses.

Table F-3: Greater Springfield Area Generation Dispatch Scenarios

Generation	Dispatch 1 MW	Dispatch 2 MW	Dispatch 3 MW
Stony Brook	412	412	0
Berkshire Power	0	280	280
Mt Tom	0	147	0
West Springfield #3	0	101	101
MASSPOWER 1	82	82	0
MASSPOWER 2	82	82	0
MASSPOWER 3	75	75	0
West Springfield #1	0	38	38
West Springfield #2	0	38	38
West Springfield Jet	0	17	0
Cobble Mt	17	17	17

F.5.4 Regional Power-Transfer Limits

Transfer capability is the measure of the ability of interconnected electric systems to move or transfer power in a reliable manner from one area to another over all transmission lines (or paths) between those areas under specified system conditions.[11] A system that can accommodate large inter-area transfers is generally more robust and flexible than a system with limited ability to accommodate inter-area transfers. Thus, transfer capability can be used as a rough indicator of relative system security.[12]

The generation dispatch for units in the Springfield area and the transfer of power between western Massachusetts and Connecticut are key determinants of the power flow on transmission lines passing into and through Springfield toward Connecticut. The allowable transfer level for Connecticut (from New York, Massachusetts and Rhode Island) is currently constrained to a maximum of approximately 2,500 MWs for normal conditions and 1,700 MWs under contingencies. When testing system performance under normal and contingent conditions, NUSCO assumes power flows into Connecticut at these transfer limits.

F.5.5 Modeling of Existing System with "All Lines In"

In its 2008 transmission studies, NUSCO first modeled the existing system with all lines assumed to be operable, but assuming a stressed dispatch due to the unavailability of certain generation. As explained in detail in the CEII Appendix, this simulation of the existing system, with no contingencies, produced overloads in violation of applicable reliability criteria.

F.5.6 Contingency Analyses (N-1) and Results

Following the "all-lines-in" power-flow assessment, NUSCO analyzed the performance of the transmission system between western Massachusetts and north-central Connecticut under contingent conditions (when the GSRP would be in-service) in accordance with national and regional reliability

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[11] http://www.nerc.com/pub/sys/all_updl/standards/rs/Glossary_02May07.pdf
[12] http://www.pserc.org/cgi-pserc/getbig/publicatio/2001public/tcc_tutorialjuly01.pdf; page 1

standards. A total of 56 contingencies were simulated. The 56 contingencies include both single-circuit contingencies and double-circuit (common structure) contingencies. These pre-project N-1 contingencies are listed in Appendix F-2.

In this N-1 analysis, each contingency on the list was simulated in power flows with all three dispatches. Accordingly, 168 contingencies in total were simulated in these N-1 analyses. The results of these simulations showed serious overloads on many system elements and severe voltage violations that could collapse the Springfield area 115-kV transmission network and potentially cascade outside of the local area. These results are presented in detail in the CEII Appendix.

F.5.7 Contingency Analyses (N-1-1) and Results

Following the N-1 power-flow assessment, the NUSCO planners analyzed the performance of the transmission system in western Massachusetts and north-central Connecticut under N-1-1 contingency conditions in accordance with national and regional reliability criteria. Under these contingency analyses, an initial transmission circuit element is assumed to be out of service for an extended period of time. Only certain transmission elements are considered to qualify at this stage as the cause of an extended outage. They include 345-kV overhead transmission circuits, 345/115-kV autotransformers, 345-kV and 115-kV underground cables that impact the area under study. Each of these elements can have an extended repair time. An N-1-1 analysis does not include 115-kV overhead transmission elements, as they can be repaired in a relatively short period of time. The D1-dispatch was assumed as the basis for this analysis. That dispatch stresses the 115-kV transmission system from Ludlow to Agawam by having the units at West Springfield, Mt Tom and Berkshire Stations off-line. The Connecticut import interface limit was reduced from 2,500 MWs to 1,700 MWs to reflect lower planning and operating levels following a major 345-kV circuit outage.

The contingency deck was repeated for each new base case containing a qualifying initial transmission element out of service. In effect, each "second" contingency was simulated on a power system without the transmission element assumed to have failed. The set of simulated second contingencies was a sub-set of the initial 56 contingencies. As with the N-1 testing, these N-1-1 contingency analyses resulted in many thermal overload conditions on system elements and voltage problems. These violations of applicable reliability criteria are presented in detail in the CEII Appendix.

F.5.8 Power-Flow Analysis of the Transmission System as Improved By the GSRP Improvements

As explained in the Needs Analysis and the Options Analysis, the GSRP was initially developed on the basis of data available and projections made in 2005. However, it was recently tested using current data and forecasts. To test the transmission system after implementation of the GSRP reinforcements, power-flow studies using current data were performed in 2008. The system as improved by the GSRP and MMP was simulated using the same power-flow cases, including the same dispatches and load levels used to test the pre-project system and reasonably stressed dispatches. A full deck of both N-1 and N-1-1 contingencies was run. The post-GSRP listing of N-1 contingencies is contained in Appendix F-3. As explained in detail in the CEII Appendix, there was only one overload, which occurs in an N-1-1 contingency, and which will be eliminated by the CCRP or, if the CCRP is not built for any reason, by a local area transmission improvement.

F.5.9 Conclusion of Reliability Analysis

In summary, the GSRP is an indivisible, two-state regional reliability project which:

- Provides a second 345-kV transmission circuit between the Ludlow Substation and the North Bloomfield Substation;

- Increases the power transfer capability between Massachusetts and Connecticut by providing a second 345-kV circuit between the Ludlow and the North Bloomfield Substations;
- Increases reliability by the formation of a 345-kV loop which provides two 345-kV sources to the Agawam and the North Bloomfield Substations;
- Increases Connecticut import capabilities;
- Utilizes the existing transmission rights-of-way between Ludlow, Agawam and North Bloomfield Substations;
- Provides an alternate diverse 345-kV source to the North Bloomfield Substation;
- Establishes a new 345/115-kV “hub” west of the Connecticut River and north of the North Bloomfield Substation at the existing Agawam Substation; and
- Eliminates line overloads following multiple first and second contingency events.

The MMP enhances the reliability improvements of the GSRP by eliminating overloads that could occur as a result of a second contingency following the loss of the proposed new 345-kV North Bloomfield to Agawam circuit.

F.6 CONFORMITY OF THE PROPOSED PROJECTS TO A LONG-RANGE PLAN FOR EXPANSION OF THE ELECTRIC POWER GRID

The NEEWS Plan is itself a long-range plan for the expansion of the Southern New England electric power grid. It has been developed through intensive work and study over a period of approximately five years, and has been designed to address all of the major problems of the southern New England bulk-power supply system. In addition, the NEEWS plan has been closely designed and integrated with the nearly completed 345-kV transmission loop in SWCT. Although some additional improvements of the 115-kV system in southern New England will be needed in the next several years, the 345-kV components of NEEWS, if built as proposed, should not require reinforcement for the indefinite future.

F.7 STATUS OF THE OTHER NEEWS PROJECTS

The Rhode Island Reliability Project was proposed in a filing with the Rhode Island Energy Facility Siting Board on September 8, 2008. The Interstate Reliability Project is expected to be proposed in late 2008. The Central Connecticut Reliability Project is expected to be proposed in mid 2009.

F.8 IN-SERVICE DATE

The GSRP is expected to be in-service in late 2012 or in 2013.

APPENDIX F-1

LOAD FORECAST DATE

Connecticut Substation Summer 90/10 Peak Load Forecast

Connecticut Light & Power (Zone 171)

			ACTUAL	FYAF 1.1	CAGR	1.0185									
Substation	**Load kV**	**Bus #**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Baldwin	13.8	73382/73386	55.9	61.5	62.6	63.8	65.0	66.2	67.4	68.6	69.9	71.2	72.5	73.9	75.2
Barbour Hill	23	73454	44.8	49.3	50.2	51.1	52.1	53.0	54.0	55.0	56.0	57.1	58.1	59.2	60.3
Bates Rock	13.8	73378	59.9	65.9	67.1	68.4	69.6	70.9	72.2	73.6	74.9	76.3	77.7	79.1	80.6
Beacon Falls	13.8	73387	59.6	54.6	55.6	56.6	57.6	58.7	59.8	60.9	62.0	63.2	64.3	65.5	66.7
Berlin	13.8	73424	61.3	67.4	68.7	69.9	71.2	72.6	73.9	75.3	76.7	78.1	79.5	81.0	82.5
Berlin	23	73371	14.6	16.1	16.4	16.7	17.0	17.3	17.6	17.9	18.3	18.6	18.9	19.3	19.6
Black Rock	13.8	73417/73418	75.5	83.1	84.6	86.2	87.7	89.4	91.0	92.7	94.4	96.2	97.9	99.8	101.6
Black Rock	4.8	73419	6.4	7.0	7.2	7.3	7.4	7.6	7.7	7.9	8.0	8.2	8.3	8.5	8.6
Bloomfield	23	73467	118.9	130.8	113.2	115.3	117.4	119.6	121.8	124.1	126.4	128.7	131.1	133.5	136.0
Bokum	27.6	73423	73.8	81.2	82.7	84.2	85.8	87.4	89.0	90.6	92.3	94.0	95.7	97.5	99.3
Branford	27.6	73403	80.6	88.7	75.3	76.7	78.1	79.6	81.0	82.5	84.1	85.6	87.2	88.8	90.4
Bristol	13.8	73412	33.9	37.3	38.0	38.7	39.4	40.1	40.9	41.6	42.4	43.2	44.0	44.8	45.6
Bristol	4.8	73413	6.1	6.7	6.8	7.0	7.1	7.2	7.4	7.5	7.6	7.8	7.9	8.1	8.2
Brooklyn	23	73444	26.2	28.8	29.4	29.9	30.4	31.0	31.6	32.2	32.8	33.4	34.0	34.6	35.3
Bulls Bridge	27.6	73381	18.4	20.2	20.6	21.0	21.4	21.8	22.2	22.6	23.0	23.4	23.9	24.3	24.8
Bunker Hill	13.8	73385	60.0	66.0	67.2	68.5	69.7	71.0	72.3	73.7	75.0	76.4	77.8	79.3	80.7
Campville	27.6	73393	47.2	51.9	52.9	53.9	54.9	55.9	56.9	58.0	59.0	60.1	61.2	62.4	63.5
Canal	23	73391	23.9	26.3	26.8	27.3	27.8	28.3	28.8	29.3	29.9	30.4	31.0	31.6	32.2
Canton	23	73396	92.2	101.4	103.3	105.2	107.2	109.1	111.2	113.2	115.3	117.4	119.6	121.8	124.1
Card	23	73434	38.3	42.1	42.9	43.7	44.5	45.3	46.2	47.0	47.9	48.8	49.7	50.6	51.5
Carmel Hill	23	73380	15.4	16.9	17.3	17.6	17.9	18.2	18.6	18.9	19.3	19.6	20.0	20.3	20.7
Cedar Heights	13.2	73362	60.8	66.9	68.1	69.4	70.7	72.0	73.3	74.7	76.0	77.4	78.9	80.3	81.8
Chippen Hill	13.8	73416	26.9	29.6	30.1	30.7	31.3	31.8	32.4	33.0	33.6	34.3	34.9	35.5	36.2
Compo	13.8	73142	38.5	42.4	43.1	43.9	44.7	45.6	46.4	47.3	48.1	49.0	49.9	50.9	51.8
Cos Cob	27.6	73358	91.3	100.4	102.3	104.2	106.1	108.1	110.1	112.1	114.2	116.3	118.4	120.6	122.9
Darien	13.8	73356	48.3	53.1	54.1	55.1	56.1	57.2	58.2	59.3	60.4	61.5	62.7	63.8	65.0
Dooley	13.2	73426	41.7	45.9	46.7	47.6	48.5	49.4	50.3	51.2	52.2	53.1	54.1	55.1	56.1
East Hartford	23	73470	62.4	68.6	69.9	71.2	72.5	73.9	75.2	76.6	78.0	79.5	81.0	82.4	84.0
East Meriden	13.8	73411	43.8	48.2	49.1	50.0	50.9	51.8	52.8	53.8	54.8	55.8	56.8	57.9	58.9
East New Britain	13.8	73427	56.1	61.7	62.9	64.0	65.2	66.4	67.6	68.9	70.2	71.5	72.8	74.1	75.5
Enfield	27.6	73455	32.9	36.2	36.9	37.5	38.2	38.9	39.7	40.4	41.1	41.9	42.7	43.5	44.3
Enfield	23	73456	37.5	41.3	42.0	42.8	43.6	44.4	45.2	46.0	46.9	47.8	48.6	49.5	50.5
Falls Village	13.2	73394	6.4	7.0	7.2	7.3	7.4	7.6	7.7	7.9	8.0	8.2	8.3	8.5	8.6
Farmington	23	73465	108.3	119.1	121.3	123.6	125.9	128.2	130.6	133.0	135.4	137.9	140.5	143.1	145.7
Flanders	23	73447/73449	66.7	73.4	74.7	66.1	67.3	68.6	69.8	71.1	72.5	73.8	75.2	76.6	78.0
Flax Hill	13.8	73369	40.3	44.3	45.2	46.0	46.8	47.7	48.6	49.5	50.4	51.3	52.3	53.2	54.2
Forestville	13.8	73536	97.3	107.0	109.0	111.0	113.1	115.2	117.3	119.5	121.7	123.9	126.2	128.6	130.9
Franklin Drive	13.2	73543	31.1	34.2	34.8	35.5	36.1	36.8	37.5	38.2	38.9	39.6	40.3	41.1	41.9
Freight	13.8	73389	28.1	30.9	31.5	32.1	32.7	33.3	33.9	34.5	35.1	35.8	36.5	37.1	37.8
Fry Brook	23	73443	40.3	44.3	45.2	46.0	46.8	47.7	48.6	49.5	50.4	51.3	52.3	53.2	54.2
Gales Ferry	13.8	73433	13.1	14.4	14.7	14.9	15.2	15.5	15.8	16.1	16.4	16.7	17.0	17.3	17.6
Glenbrook	13.2	73360	103.8	114.2	116.3	118.4	120.6	122.9	125.1	127.5	129.8	132.2	134.7	137.2	139.7
Green Hill	23	73404	102.2	112.4	99.5	101.3	103.2	105.1	107.1	109.1	111.1	113.1	115.2	117.3	119.5
Haddam	23	73422	36.0	39.6	40.3	41.1	41.8	42.6	43.4	44.2	45.0	45.9	46.7	47.6	48.4
Hanover	23	73405/73407	24.1	26.5	27.0	27.5	28.0	28.5	29.1	29.6	30.1	30.7	31.3	31.8	32.4
Hanover	13.8	73406/73408	53.9	59.3	60.4	61.5	62.6	63.8	65.0	66.2	67.4	68.7	69.9	71.2	72.5
Hopewell	23	73472	52.1	57.3	58.4	59.5	60.5	61.7	62.8	64.0	65.2	66.4	67.6	68.8	70.1
Manchester	23	73463	114.0	125.4	127.7	130.1	132.5	134.9	137.4	140.0	142.6	145.2	147.9	150.6	153.4
Mansfield	27.6	73435	18.5	20.4	20.7	21.1	21.5	21.9	22.3	22.7	23.1	23.6	24.0	24.4	24.9
Mansfield	13.8	73436	15.0	16.5	16.8	17.1	17.4	17.8	18.1	18.4	18.8	19.1	19.5	19.8	20.2
Middle River	13.8	73376	76.4	84.0	85.6	87.2	88.8	90.4	92.1	93.8	95.5	97.3	99.1	100.9	102.8

Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mystic	13.8	73430	38.5	42.4	43.1	43.9	44.7	45.6	46.4	47.3	48.1	49.0	49.9	50.9	51.8
Mystic	34.5	73429	12.2	13.4	13.7	13.9	14.2	14.4	14.7	15.0	15.3	15.5	15.8	16.1	16.4
Newington	23	73466	99.6	109.6	111.6	113.7	115.8	117.9	120.1	122.3	124.6	126.9	129.2	131.6	134.0
Newtown	13.8	73392	38.1	41.9	42.7	43.5	44.3	45.1	45.9	46.8	47.6	48.5	49.4	50.3	51.3
Noera	13.8	73399	52.0	57.2	58.3	59.3	60.4	61.6	62.7	63.9	65.0	66.2	67.5	68.7	70.0
North Bloomfield	23	73464	72.2	79.4	75.9	77.3	78.7	80.2	81.7	83.2	84.7	86.3	87.9	89.5	91.2
North Canaan	13.2	73398	15.7	17.3	17.6	17.9	18.2	18.6	18.9	19.3	19.6	20.0	20.4	20.7	21.1
Northeast Simsbury	115	73288	31.0	34.1	34.7	35.4	36.0	36.7	37.4	38.1	38.8	39.5	40.2	41.0	41.7
Northwest Hartford	23	73468	123.2	135.5	138.0	140.6	143.2	145.8	148.5	151.3	154.1	156.9	159.8	162.8	165.8
Norwalk (CMEEC)	27.6	73364	148.4	163.2	166.3	169.3	172.5	175.7	178.9	182.2	185.6	189.0	192.5	196.1	199.7
Norwalk	13.8	73368	73.6	55.0	56.0	57.0	58.1	59.1	60.2	61.3	62.5	63.6	64.8	66.0	67.2
Norwalk	4.8	73365	4.8	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.5
Oxford	13.8	73136	0.0	11.0	11.2	11.4	11.6	11.8	12.1	12.3	12.5	12.7	13.0	13.2	13.5
Peaceable	13.8	73370	40.3	18.3	18.7	19.0	19.4	19.7	20.1	20.5	20.8	21.2	21.6	22.0	22.4
Plumtree	115	73170	0.0	17.0	17.3	17.6	18.0	18.3	18.6	19.0	19.3	19.7	20.0	20.4	20.8
Portland	23	73474	42.6	46.9	47.7	48.6	49.5	50.4	51.4	52.3	53.3	54.3	55.3	56.3	57.3
Ridgefield	13.8	73372	51.7	56.9	57.9	59.0	60.1	61.2	62.3	63.5	64.7	65.9	67.1	68.3	69.6
Riverside Drive	23	73537	42.4	46.6	47.5	48.4	49.3	50.2	51.1	52.1	53.0	54.0	55.0	56.0	57.1
Rockville	27.6	73452	18.5	20.4	20.7	21.1	21.5	21.9	22.3	22.7	23.1	23.6	24.0	24.4	24.9
Rockville	13.8	73453	55.9	61.5	62.6	63.8	65.0	66.2	67.4	68.6	69.9	71.2	72.5	73.9	75.2
Rocky Hill	23	73428	91.1	100.2	102.1	104.0	105.9	107.8	109.8	111.9	113.9	116.0	118.2	120.4	122.6
Rocky River	13.8	73541	57.2	62.9	64.1	65.3	66.5	67.7	69.0	70.2	71.5	72.9	74.2	75.6	77.0
Rood Avenue	23	73307	0.0	0.0	25.0	25.5	25.9	26.4	26.9	27.4	27.9	28.4	28.9	29.5	30.0
Salisbury	13.2	73397	9.5	10.5	10.6	10.8	11.0	11.2	11.5	11.7	11.9	12.1	12.3	12.6	12.8
Sandy Hook	23	73373	11.6	12.8	13.0	13.2	13.5	13.7	14.0	14.2	14.5	14.8	15.0	15.3	15.6
Scitico	23	73457	83.7	92.1	93.8	95.5	97.3	99.1	100.9	102.8	104.7	106.6	108.6	110.6	112.6
Shaws Hill	13.8	73384	40.0	44.0	44.8	45.6	46.5	47.3	48.2	49.1	50.0	50.9	51.9	52.9	53.8
Shepaug	69	73341	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
Shunock	13.8	73477	19.0	20.9	21.3	21.7	22.1	22.5	22.9	23.3	23.8	24.2	24.6	25.1	25.6
Skungamaug	13.8	73437	18.8	20.7	21.1	21.5	21.8	22.3	22.7	23.1	23.5	23.9	24.4	24.8	25.3
South End	13.2	73359	89.3	98.2	100.0	101.9	103.8	105.7	107.7	109.7	111.7	113.7	115.8	118.0	120.2
South Meadow	23	73546	143.3	157.6	160.5	163.5	166.5	169.6	172.8	176.0	179.2	182.5	185.9	189.3	192.8
South Naugatuck	13.8	73388	35.1	38.6	39.3	40.1	40.8	41.5	42.3	43.1	43.9	44.7	45.5	46.4	47.2
South Windsor	13.8	73458	38.3	42.1	42.9	43.7	44.5	45.3	46.2	47.0	47.9	48.8	49.7	50.6	51.5
Southington	27.6	73409	30.8	33.9	34.5	35.1	35.8	36.5	37.1	37.8	38.5	39.2	40.0	40.7	41.4
Southington	13.8	73410	45.0	49.5	50.4	51.3	52.3	53.3	54.3	55.3	56.3	57.3	58.4	59.5	60.6
Southwest Hartford	23	73469	62.1	68.3	69.6	70.9	72.2	73.5	74.9	76.3	77.7	79.1	80.6	82.1	83.6
Stepstone	23	73101	0.0	0.0	30.0	30.6	31.1	31.7	32.3	32.9	33.5	34.1	34.7	35.4	36.0
Stevensen	27.6	73390	12.1	13.3	13.6	13.8	14.1	14.3	14.6	14.9	15.1	15.4	15.7	16.0	16.3
Stony Hill	13.8	73375	72.1	79.3	80.8	82.3	83.8	85.3	86.9	88.5	90.2	91.8	93.5	95.3	97.0
Thomaston	13.2	73395	20.8	22.9	23.3	23.7	24.2	24.6	25.1	25.5	26.0	26.5	27.0	27.5	28.0
Todd	13.8	73402	42.2	46.4	47.3	48.2	49.0	50.0	50.9	51.8	52.8	53.8	54.7	55.8	56.8
Tomac	27.6	73374	26.4	29.0	29.6	30.1	30.7	31.2	31.8	32.4	33.0	33.6	34.2	34.9	35.5
Torrington Terminal	13.2	73478	11.0	12.1	12.3	12.6	12.8	13.0	13.3	13.5	13.8	14.0	14.3	14.5	14.8
Tracy	23	73442	66.7	73.4	74.7	76.1	77.5	79.0	80.4	81.9	83.4	85.0	86.5	88.1	89.8
Triangle	13.8	73377/73383	112.8	107.1	109.1	111.1	113.1	115.2	117.4	119.5	121.7	124.0	126.3	128.6	131.0
Tunnel (CMEEC)	23	73544	46.9	51.6	52.5	53.5	54.5	55.5	56.5	57.6	58.7	59.7	60.8	62.0	63.1
Uncasville	13.2	73445/73451	31.5	34.7	35.3	35.9	36.6	37.3	38.0	38.7	39.4	40.1	40.9	41.6	42.4
Uncasville	27.6	73448	8.5	9.4	9.5	9.7	9.9	10.1	10.2	10.4	10.6	10.8	11.0	11.2	11.4
Waterford	23	73138	0.0	0.0	0.0	52.0	53.0	53.9	54.9	56.0	57.0	58.0	59.1	60.2	61.3
Waterside	13.2	73357	77.4	85.1	86.7	88.3	90.0	91.6	93.3	95.0	96.8	98.6	100.4	102.3	104.2
West Brookfield	13.8	73379	48.0	52.8	53.8	54.8	55.8	56.8	57.9	58.9	60.0	61.1	62.3	63.4	64.6
West Side	13.2	73425	51.0	56.1	57.1	58.2	59.3	60.4	61.5	62.6	63.8	65.0	66.2	67.4	68.6
Weston	27.6	73361/73363	73.8	81.2	82.7	84.2	85.8	87.4	89.0	90.6	92.3	94.0	95.7	97.5	99.3
Williams Street	13.8	73446/73450	55.8	61.4	62.5	21.7	22.1	22.5	22.9	23.3	23.8	24.2	24.6	25.1	25.6
Willimantic	27.6	73440	43.5	47.9	48.7	49.6	50.6	51.5	52.4	53.4	54.4	55.4	56.4	57.5	58.5
Willimantic	4.8	73441	5.5	6.1	6.2	6.3	6.4	6.5	6.6	6.8	6.9	7.0	7.1	7.3	7.4
Wilton	13.8	73140	0.0	52.0	53.0	53.9	54.9	56.0	57.0	58.0	59.1	60.2	61.3	62.5	63.6
Windsor Locks	27.6	73459	18.8	20.7	21.1	21.5	21.8	22.3	22.7	23.1	23.5	23.9	24.4	24.8	25.3

Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Windsor Locks	23	73471	40.6	44.7	45.5	46.3	47.2	48.1	48.9	49.9	50.8	51.7	52.7	53.6	54.6
		Subtotal	**5182.1**	**5700.3**	**5805.8**	**5913.2**	**6022.6**	**6134.0**	**6247.5**	**6363.0**	**6480.8**	**6600.7**	**6722.8**	**6847.1**	**6973.8**

Connecticut Light & Power Service Loads (Zone 171)

Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Pratt & Whitney	115	73249	10.8	11.9	12.1	12.3	12.6	12.8	13.0	13.3	13.5	13.8	14.0	14.3	14.5
Franconia (WMECO)	13.8	73031	9.7	10.7	10.9	11.1	11.3	11.5	11.7	11.9	12.1	12.4	12.6	12.8	13.1
Silver (WMECO)	13.8	73032	6.0	6.6	6.7	6.8	7.0	7.1	7.2	7.4	7.5	7.6	7.8	7.9	8.1
Southwick (WMECO)	13.8	73023	7.3	8.0	8.2	8.3	8.5	8.6	8.8	9.0	9.1	9.3	9.5	9.6	9.8
Jewitt City (CMEEC)	23	73544	-4.3	-4.7	-4.8	-4.9	-5.0	-5.1	-5.2	-5.3	-5.4	-5.5	-5.6	-5.7	-5.8
Norwalk Taxing (CMEEC)	27.6	73622	-32.8	-36.1	-36.7	-37.4	-38.1	-38.8	-39.5	-40.3	-41.0	-41.8	-42.6	-43.3	-44.1
		Subtotal	**-3.3**	**-3.6**	**-3.7**	**-3.8**	**-3.8**	**-3.9**	**-4.0**	**-4.1**	**-4.1**	**-4.2**	**-4.3**	**-4.4**	**-4.4**
		Connecticut Light & Power Total Load =	**5178.8**	**5696.7**	**5802.1**	**5909.4**	**6018.7**	**6130.1**	**6243.5**	**6359.0**	**6476.6**	**6596.4**	**6718.5**	**6842.8**	**6969.4**

CMEEC (Zone 178)

Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Buddington 69kV	34.5	73621	14.5	16.0	16.2	16.5	16.9	17.2	17.5	17.8	18.1	18.5	18.8	19.2	19.5
Buddington 115kV	34.5	73620	73.0	80.3	81.8	83.3	84.8	86.4	88.0	89.6	91.3	93.0	94.7	96.5	98.2
Bean Hill	115	73612	21.9	24.1	24.5	25.0	25.5	25.9	26.4	26.9	27.4	27.9	28.4	28.9	29.5
Dudley	115	73611	30.8	33.9	34.5	35.1	35.8	36.5	37.1	37.8	38.5	39.2	40.0	40.7	41.4
Tenth Street (Tunnel)	69	73617	22.9	25.2	25.7	26.1	26.6	27.1	27.6	28.1	28.6	29.2	29.7	30.3	30.8
North Wallingford	115	73633	27.8	30.6	31.1	31.7	32.3	32.9	33.5	34.1	34.8	35.4	36.1	36.7	37.4
Colony	115	73634	28.7	31.6	32.2	32.7	33.4	34.0	34.6	35.2	35.9	36.6	37.2	37.9	38.6
Stockhouse Road	115	73218	26.5	29.2	29.7	30.2	30.8	31.4	31.9	32.5	33.1	33.8	34.4	35.0	35.7
Fort Hill Farms	115	73291	16.7	18.4	18.7	19.1	19.4	19.8	20.1	20.5	20.9	21.3	21.7	22.1	22.5
Jewitt City (Tunnel)	23	73544	4.3	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8
Norwalk Taxing (Norwalk)	27.6	73622	32.8	36.1	36.7	37.4	38.1	38.8	39.5	40.3	41.0	41.8	42.6	43.3	44.1
Wallingford	115	73631	64.3	70.7	72.0	73.4	74.7	76.1	77.5	79.0	80.4	81.9	83.4	85.0	86.5
		Subtotal	**364.2**	**400.6**	**408.0**	**415.6**	**423.3**	**431.1**	**439.1**	**447.2**	**455.5**	**463.9**	**472.5**	**481.2**	**490.1**

Railroad Loads (Zone 179)

Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Branford	115	73287	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Cos Cob	115	73163	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
Devon	115	73195	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Sasco Creek	115	73173	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
Williams	115	73149/73239	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
		Subtotal	**52.2**	**52.2**	**52.2**	**52.2**	**52.2**	**52.2**	**52.2**	**52.2**	**52.2**	**52.2**	**52.2**	**52.2**	**52.2**

United Illuminating Company (Zone 186)

				FYAF 1.07											
Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Allings	13.8	73744	54.4	58.2	59.3	60.4	61.5	62.6	63.8	65.0	66.2	67.4	68.6	69.9	71.2
Ansonia	13.8	73766	47.4	50.7	51.7	52.6	53.6	54.6	55.6	56.6	57.7	58.7	59.8	60.9	62.0
Ashcreek	13.8	73763	83.8	89.7	91.3	93.0	94.7	96.5	98.3	100.1	101.9	103.8	105.7	107.7	109.7
Baird	13.8	73754	18.6	19.9	20.3	20.6	21.0	21.4	21.8	22.2	22.6	23.0	23.5	23.9	24.3
Barnum	13.8	73752	48.7	52.1	53.1	54.1	55.1	56.1	57.1	58.2	59.2	60.3	61.5	62.6	63.8
Broadway	13.8	73738	49.8	53.3	54.3	55.3	56.3	57.3	58.4	59.5	60.6	61.7	62.8	64.0	65.2
Congress	13.8	73755	29.4	31.5	32.0	32.6	33.2	33.9	34.5	35.1	35.8	36.4	37.1	37.8	38.5
Congress	13.8	73756	75.9	81.2	82.7	84.2	85.8	87.4	89.0	90.7	92.3	94.0	95.8	97.6	99.4
Indian Well	13.8	73765	71.7	76.7	78.1	79.6	81.1	82.6	84.1	85.6	87.2	88.8	90.5	92.2	93.9
East Shore	13.8	73728	41.7	44.6	45.4	46.3	47.1	48.0	48.9	49.8	50.7	51.7	52.6	53.6	54.6
Elmwest	13.8	73742	60.8	65.1	66.3	67.5	68.7	70.0	71.3	72.6	74.0	75.3	76.7	78.1	79.6
Hawthorne	13.8	73770	68	55.8	56.8	57.8	58.9	60.0	61.1	62.2	63.4	64.6	65.8	67.0	68.2
June Street	13.8	73767	44.1	47.2	48.1	48.9	49.9	50.8	51.7	52.7	53.6	54.6	55.7	56.7	57.7
Mill River	13.8	73736	45.3	48.5	49.4	50.3	51.2	52.2	53.1	54.1	55.1	56.1	57.2	58.2	59.3

Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mill River	13.8	73737	43.4	46.4	47.3	48.2	49.1	50.0	50.9	51.8	52.8	53.8	54.8	55.8	56.8
Milvon	13.8	73748	64.9	69.4	70.7	72.0	73.4	74.7	76.1	77.5	79.0	80.4	81.9	83.4	85.0
Mix Avenue	13.8	73735	65.5	70.1	71.4	72.7	74.0	75.4	76.8	78.2	79.7	81.2	82.7	84.2	85.7
Mix Avenue	115	73675	25.6	27.4	27.9	28.4	28.9	29.5	30.0	30.6	31.1	31.7	32.3	32.9	33.5
North Haven	13.8	73731	32.9	35.2	35.9	36.5	37.2	37.9	38.6	39.3	40.0	40.8	41.5	42.3	43.1
Old Town1	13.8	73768	32.5	34.8	35.4	36.1	36.7	37.4	38.1	38.8	39.5	40.3	41.0	41.8	42.5
Old Town2&3	13.8	73769	35.2	37.7	38.4	39.1	39.8	40.5	41.3	42.0	42.8	43.6	44.4	45.2	46.1
Pequonic	13.8	73760	30.9	33.1	33.7	34.3	34.9	35.6	36.2	36.9	37.6	38.3	39.0	39.7	40.4
Quinnipiac	13.8	73730	66.1	70.7	72.0	73.4	74.7	76.1	77.5	78.9	80.4	81.9	83.4	85.0	86.5
Sackett	13.8	73732	47.1	50.4	51.3	52.3	53.2	54.2	55.2	56.3	57.3	58.4	59.4	60.5	61.7
Trap Falls	13.8	72764	62.7	67.1	68.3	69.6	70.9	72.2	73.5	74.9	76.3	77.7	79.1	80.6	82.1
Trumbull Junction	13.8	73761	0	17.0	17.3	17.6	18.0	18.3	18.6	19.0	19.3	19.7	20.0	20.4	20.8
Water Street	13.8	73740	76.9	82.3	83.8	85.4	86.9	88.5	90.2	91.8	93.5	95.3	97.0	98.8	100.7
Woodmont	13.8	73746	73.1	78.2	79.7	81.1	82.6	84.2	85.7	87.3	88.9	90.6	92.2	94.0	95.7
United Illuminating Company Total Load =			**1396.4**	**1494.1**	**1521.8**	**1549.9**	**1578.6**	**1607.8**	**1637.6**	**1667.9**	**1698.7**	**1730.1**	**1762.2**	**1794.7**	**1828.0**

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total Connecticut Load (Zones 171+178+179+186)	**6991.6**	**7643.6**	**7784.1**	**7927.1**	**8072.8**	**8221.2**	**8372.3**	**8526.2**	**8683.0**	**8842.7**	**9005.3**	**9170.9**	**9339.6**

Springfield Area Substation Summer 90/10 Peak Load Forecast

FYAF 1.014 | CAGR 1.014

Springfield Area (Zones 143 - 150)

Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Agawam	13.8	73024	39.6	40.2	40.7	41.3	41.9	42.5	43.0	43.6	44.3	44.9	45.5	46.1	46.8
Amherst	13.8	73017/73018	43.3	43.9	44.5	45.1	45.8	46.4	47.1	47.7	48.4	49.1	49.8	50.5	51.2
Blandford	23.0	73022	13.5	13.7	13.9	14.1	14.3	14.5	14.7	14.9	15.1	15.3	15.5	15.7	16.0
Breckwood	13.8	73027	59.5	60.3	61.2	62.0	62.9	63.8	64.7	65.6	66.5	67.4	68.4	69.3	70.3
Buck Pond (WG&E)	23.0	71753	23.2	23.5	23.9	24.2	24.5	24.9	25.2	25.6	25.9	26.3	26.7	27.0	27.4
Chicopee (CELD)	13.8	71761/71762	90.8	92.1	93.4	94.7	96.0	97.3	98.7	100.1	101.5	102.9	104.3	105.8	107.3
Clinton	13.8	73026	59.2	60.0	60.9	61.7	62.6	63.5	64.4	65.3	66.2	67.1	68.0	69.0	69.9
East Springfield	13.8	73028	54.4	55.2	55.9	56.7	57.5	58.3	59.1	60.0	60.8	61.7	62.5	63.4	64.3
Elm (WG&E)	23.0	71752	55.2	56.0	56.8	57.6	58.4	59.2	60.0	60.8	61.7	62.6	63.4	64.3	65.2
Five Corners (NGrid)	13.2	72479	5.1	5.2	5.2	5.3	5.4	5.5	5.5	5.6	5.7	5.8	5.9	5.9	6.0
Florence (NGrid)	13.8	72491	26.2	26.6	26.9	27.3	27.7	28.1	28.5	28.9	29.3	29.7	30.1	30.5	31.0
Gunn	23.0	73029	29.0	29.4	29.8	30.2	30.7	31.1	31.5	32.0	32.4	32.9	33.3	33.8	34.3
Holyoke (HG&E)	115	71768	31.0	31.4	31.9	32.3	32.8	33.2	33.7	34.2	34.6	35.1	35.6	36.1	36.6
Ingleside (HG&E)	115	71767	30.9	31.3	31.8	32.2	32.7	33.1	33.6	34.1	34.5	35.0	35.5	36.0	36.5
Ludlow	13.8	73021	17.9	18.2	18.4	18.7	18.9	19.2	19.5	19.7	20.0	20.3	20.6	20.9	21.1
Midway (NGrid)	13.8	73025/72492	31.7	32.1	32.6	33.1	33.5	34.0	34.5	34.9	35.4	35.9	36.4	36.9	37.5
Orchard	13.8	73077	33.5	34.0	34.4	34.9	35.4	35.9	36.4	36.9	37.4	38.0	38.5	39.0	39.6
Pineshed (SHEL)	13.8	71758	28.7	29.1	29.5	29.9	30.3	30.8	31.2	31.6	32.1	32.5	33.0	33.4	33.9
Piper	13.8	73030	40.0	40.6	41.1	41.7	42.3	42.9	43.5	44.1	44.7	45.3	46.0	46.6	47.3
Podick	13.8	73019	35.4	35.9	36.4	36.9	37.4	37.9	38.5	39.0	39.6	40.1	40.7	41.2	41.8
Prospect (HG&E)	13.8	73076	12.0	12.2	12.3	12.5	12.7	12.9	13.0	13.2	13.4	13.6	13.8	14.0	14.2
West Springfield	13.8	73081	41.1	41.7	42.3	42.9	43.5	44.1	44.7	45.3	45.9	46.6	47.2	47.9	48.6
		Subtotal =	**801.2**	**812.4**	**823.8**	**835.3**	**847.0**	**858.9**	**870.9**	**883.1**	**895.5**	**908.0**	**920.7**	**933.6**	**946.7**

Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Franconia (+ CL&P)	13.8	73031	46.2	46.8	47.5	48.2	48.8	49.5	50.2	50.9	51.6	52.4	53.1	53.8	54.6
Silver (+ CL&P)	13.8	73032	43.4	44.0	44.6	45.2	45.9	46.5	47.2	47.8	48.5	49.2	49.9	50.6	51.3
Southwick (+ CL&P)	13.8	73023	28.4	28.8	29.2	29.6	30.0	30.4	30.9	31.3	31.7	32.2	32.6	33.1	33.6
		Subtotal =	**118.0**	**119.7**	**121.3**	**123.0**	**124.7**	**126.5**	**128.3**	**130.1**	**131.9**	**133.7**	**135.6**	**137.5**	**139.4**

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Springfield Area Load (excluding CL&P) =	**896.2**	**906.8**	**919.3**	**932.1**	**945.0**	**958.1**	**971.4**	**984.9**	**998.6**	**1012.4**	**1026.5**	**1040.7**	**1055.1**

Springfield Area Service Loads with CL&P (Zone 171)

Substation	Load kV	Bus #	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Scitico (CL&P)	23.0	73457	83.7	92.1	93.8	95.5	97.3	99.1	100.9	102.8	104.7	106.6	108.6	110.6	112.6
Franconia (CL&P)	13.8	73031	9.7	10.7	10.9	11.1	11.3	11.5	11.7	11.9	12.1	12.4	12.6	12.8	13.1
Silver (CL&P)	13.8	73032	6	6.6	6.7	6.8	7.0	7.1	7.2	7.4	7.5	7.6	7.8	7.9	8.1
Southwick (CL&P)	13.8	73023	7.3	8.03	8.2	8.3	8.5	8.6	8.8	9.0	9.1	9.3	9.5	9.6	9.8
Springfield Area Service Loads (including CL&P) =			**1002.9**	**1024.1**	**1038.9**	**1053.9**	**1069.0**	**1084.4**	**1100.1**	**1115.9**	**1132.0**	**1148.3**	**1164.9**	**1181.7**	**1198.7**

Connecticut Light & Power
The Northeast Utilities System

NEW ENGLAND EAST–WEST SOLUTION

APPENDIX F-2

PRE-GSRP N-1 CONTINGENCY LIST

Pre-GSRP
Contingency List

Line #	Substation	Substation	Substation
345-kV			
301-302	Ludlow	Carpenter Hill	Millbury
330	Card	Lake Road	
347	Killingly	Sherman Road	
354	Northfield	Ludlow	
368	Card	Manchester	
381	Northfield	Vermont Yankee	
393/312	Northfield	Berkshire	Alps
395	North Bloomfield	Barbour Hill	Manchester
3348	Lake Road	Killingly	
3419	Barbour Hill	Ludlow	
115-kV			
1007	Agawam	Elm	
1039	Mt. Tom	Midway	
1230	Agawam	Piper	
1254	Fairmont	Shawinigan	Chicopee
1292	Holyoke	Ingleside	
1302	Agawam	Buck Pond	Pochassic
1311	Agawam	West Springfield	
1314	Agawam	Chicopee	
1322	East Springfield	Breckwood	
1327	Fairmont	Pineshed	
1394	Franconia	Scitico	
1412	Agawam	West Springfield	
1426	East Springfield	Orchard	
1428	Mt. Tom	Fairmont	
1433	West Springfield	Breckwood	
1447	Mt. Tom	Pineshed	
1481	East Springfield	Ludlow	
1512	Elm	Blandford	Southwick
1515	Ludlow	New Hampton	
1525	Holyoke	Fairmont	
1552	Ludlow	Orchard	
1657	Ingleside	Gunn Jct.	Buck Pond
1723	East Springfield	Piper	
1768	Southwick	North Bloomfield	Fairmont
1779	Bloomfield	South Meadow	
1781	Agawam	Silver	
1782	Agawam	Silver	
1821	South Agawam	North Bloomfield	
1836	South Agawam	North Bloomfield	

1845	Ludlow	Shawinigan	
1858	South Agawam	Franconia	
1962	Gunn	Midway	
X176	Ludlow	Thorndike	Palmer
Double-Circuit Towers			
Line #	**Circuit 1**	**Circuit 2**	
1448/395	Barbour Hill	Manchester Jct.	
1779/395	Bloomfield-S. Meadow	North Bloomfield-Barbour Hill	Manchester
1007/1302	Agawam-Elm	Agawam-Buck Pond	Pochassic
1230/1314	Agawam-Piper	Agawam-Chicopee	
1254/1723	Fairmont-East Springfield-Piper	Fairmont-Shawinigan-Chicopee	
1311/1412	Agawam	West Springfield	
1314/1723	Agawam-Chicopee	Fairmont-Piper	
1426/1481	East Springfield	Orchard-Ludlow	East Springfield
1481/1552	Ludlow- East Springfield	Ludlow-Orchard	
1781/1782	Agawam	Silver	
1821/1836	South Agawam	North Bloomfield	
Autotransformers			
NBLMFLDT	North Bloomfield Autotransformer		
LUDLOWT	Ludlow Autotransformer		

APPENDIX F-3

POST-GSRP N-1 CONTINGENCY LIST

Post-GSRP Contingency List			
345-kV			
Line #	**Substation**	**Substation**	**Substation**
301	Ludlow	Carpenter Hill	Millbury
330	Card	Lake Road	
347	Killingly	Sherman Road	
354	Northfield	Ludlow	
368	Card	Manchester	
381	Northfield	Vermont Yankee	
395	North Bloomfield	Barbour Hill	Manchester
3196	Agawam	Ludlow	
3216	Agawam	North Bloomfield	
3348	Lake Road	Killingly	
3419	Barbour Hill	Ludlow	
393/312	Northfield	Berkshire	Alps
115-kV			
1007	Agawam	Elm	
1039	Mt. Tom	Midway	
1230	Agawam	Piper	
1292	Holyoke	Ingleside	
1302	Agawam	Buck Pond	Pochassic
1311	Agawam	West Springfield	
1314	Agawam	Chicopee	
1322	East Springfield	Breckwood	
1327	Fairmont	Pineshed	
1394	Franconia	Scitico	
1412	Agawam	West Springfield	
1426	Cadwell	Orchard	
1428	Mt. Tom	Fairmont	
1433	West Springfield	Breckwood	
1447	Mt. Tom	Pineshed	
1481	East Springfield	Ludlow	
1512	Elm	Blandford	Southwick
1515	Ludlow	New Hampton	
1525	Holyoke	Fairmont	
1552	Ludlow	Orchard	
1601	Fairmont	Piper	
1602	Fairmont	Chicopee	
1603	Fairmont	Cadwell	
1604	Fairmont	Shawinigan	
1657	Ingleside	Gunn Jct.	Buck Pond
1768	Southwick	South Agawam	
1779	Bloomfield	South Meadow	
1781	Agawam	Silver	
1782	Agawam	Silver	
1845	Ludlow	Shawinigan	
1858	South Agawam	Franconia	
1962	Gunn	Midway	

5001	Cadwell	East Springfield	
X176	Ludlow	Thorndike	Palmer

Double-Circuit Towers		
Line #	**Circuit No. 1**	**Circuit No. 2**
1779/395	Bloomfield-South Meadow	North Bloomfield-Barbour Hill-Manchester
1314/3196	Agawam-Chicopee	Agawam-Ludow
1602/3196	Fairmont-Chicopee	Agawam-Ludlow
1603/3196	Fairmont-Cadwell	Agawam-Ludlow
1845/3196	Ludlow-Shawinigan	Agawam-Ludlow
1768/3216	South Agawam-Southwick	Agawam-North Bloomfield
1781/3216	Agawam-Silver	Agawam-North Bloomfield
1314/3196	Agawam-Chicopee	Agawam-Ludow
1007/1302	Agawam-Elm	Agawam-Buck Pond-Pochassic
1481/1552	Ludlow-Cadwell	Ludlow-Orchard
1426/1481	Cadwell-Orchard	Ludlow-Cadwell
1602/1603	Faimont-Chicopee	Fairmont-Cadwell

345/115-kV Autotransformers	
AGAWAMT	Agawam
LUDLOWT	Ludlow
NBLMFLDT	North Bloomfield

SECTION G

SYSTEM ALTERNATIVES

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G. SYSTEM ALTERNATIVES

This section complies with the provision in the Council's application guide that an applicant identify "system alternatives and the advantages and disadvantages of each." First, non-transmission system alternatives are addressed, including:

- No action alternative.
- Energy alternatives, including expanded generation capacity (both distributed generation and central station utility generation).
- Strategies to reduce load (demand side management or DSM)

This discussion of non-transmission system alternatives is based on a report of ICF Resources, LLC, *Assessment of Non-Transmission Alternatives for the NEEWS Transmission Projects: Greater Springfield Reliability Project,* (September, 2008) (ICF Report). A copy of the ICF Report, redacted to secure Critical Energy Infrastructure Information (CEII), is provided in Volume 5 of this Application. CL&P anticipates that the Council and its staff, parties and intervenors to the proceeding on this Application, and their counsel and consultants will be able to obtain complete copies of the ICF Report pursuant to a protective order and non-disclosure agreements.

Alternative transmission solutions are next addressed. Part G.2 of this section briefly summarizes how the proposed projects (GSRP and MMP) were developed from a set of transmission system "Options" identified by the previously discussed Options Analysis performed by the ISO-NE Working Group. That development process is described in detail in the GSRP Solution Report, which is provided as part of Volume 5 of this Application.

G.1 NON-TRANSMISSION ALTERNATIVES

G.1.1 No-Action Alternative

Under the no-action alternative, no new transmission facilities would be developed and no improvements would be made to the existing electrical transmission system or generation resources in SWCT. This alternative was rejected because it would do nothing to correct violations of national (NERC) and regional (NPCC and NEPOOL) reliability standards, and thus the Greater Springfield and north-central Connecticut areas would continue to be at risk for electric outages. Moreover, no improvement of the Connecticut import capacity would be realized. Higher cost generation resources would necessarily have to continue to operate to support the Greater Springfield load. Finally, failure to build the GSRP and the MMP would undermine the long range plan of improving the flow of power from east to west across Connecticut and across Southern New England as a whole.

G.1.2 Resource Alternatives

To evaluate whether the addition of distributed generation, generation, or demand management resources could displace or defer the need for the GSRP, NUSCO commissioned a comprehensive study from ICF Resources LLC (ICF).

The reliability violations addressed by the GSRP might theoretically be resolved by adding large amounts of demand and supply resources in Massachusetts or Connecticut. Solving reliability problems as if they were simply resource deficiencies does not, however, address the basic inadequacy of transmission facilities that are few in number, small in current-carrying capacity relative to load and largely consist of double-circuit 115-kV lines. In order to determine whether the addition of new area demand and/or supply resources would provide a reliability solution equivalent to that of the GSRP, the effect of such additions must be tested in the same way that the reliability violations were found in the first instance, and in the same way that the proposed transmission improvements have been proven to be a solution: by running power-flow models to determine if overloads and voltage violations have been eliminated by the addition of the extra resources.

Accordingly, in their Non-Transmission Alternatives Study, ICF considered a variety of resource alternatives including, but not limited to, the addition of distributed generation, large scale generation, combined heat and power supply options, and demand resources. ICF then tested the impact of the combined penetration of these resources on the overall reliability of the study area as determined through power-flow modeling analysis under stressed system conditions. At each stage of the analysis, ICF compared the effectiveness of the resource alternatives that were simulated to the effectiveness of the Project with respect to the reliability of the Greater Springfield area transmission system.

G.1.3 Background of ICF Resources LLC

ICF is a leading management, technology and policy consulting firm with global presence that provides advisory and program implementation services to public and private clients in various sectors including Energy, Environment and Transportation. ICF has extensive consulting experience in the areas including electric power and renewable energy resources. Its clients include government agencies and utilities. ICF also has consulting experience in the field of electric transmission; specifically, in performing system impact studies and stability studies, and cost-benefit assessments.

G.1.4 ICF's Characterization of the Problems

In their Non-Transmission Alternatives Study, ICF presents a brief overview of the many reliability violations that affect the present day Greater Springfield area and north-central Connecticut transmission systems. Contingencies on the 345-kV and 115-kV lines between the Greater Springfield area and north-central Connecticut, as well as on the outdated Springfield area 115-kV lines which frequently have low conductor size and share common structures, result in numerous overloads and voltage violations. This portion of Southern New England faces a challenging match of load requirements, area supply resources and transmission facilities. The Greater Springfield area is adjacent to and interconnected with Connecticut. The entire state of Connecticut is a load pocket with local generation approximately equal to 75% of local peak load and with transfer capability less than 30% of state-wide load. Soon, a transfer capability deficiency in Connecticut will emerge. The number of reliability violations that exist now and can potentially occur in the coming years poses a challenge in designing any cost-effective solution, whether transmission or non-transmission approaches are being considered.

G.1.5 Summary of the ICF Study

The ICF Study is summarized as follows:

G.1.5.1 Alternatives Assessed

In assessing the potential for alternative resources to either displace or defer the GSRP and MMP, ICF considered the following three Non-Transmission options both individually and in combination:

- ***Combined Heat and Power Resources (CHP):*** Resources that would typically serve large industrial or commercial loads with both steam and electric power. They are typically the primary source of power for these loads and hence, there is no direct demand from the loads for regional generation resources. This implies that the demand for transmission services to serve such loads is zero.
- ***Demand-Side Management Resources (DSM):*** Demand Side Management resources tend to reduce the demand for system generation and transmission services either through direct reductions in the load, or the addition of generation as a distributed source[1].
- ***Large Scale Generation:*** Large scale generation resources of appropriate sizes located close to the load demand centers may also help reduce the overall load on the transmission system.

These resource alternatives were tested for their effectiveness in either deferring or displacing the upgrades to the existing transmission system while maintaining the same level of reliability i.e., fully complying with the national and regional reliability criteria. All resource quantities were considered to be market-based in the initial analysis[2]. Thereafter, additional DSM and generation resources, without regard to their economic feasibility, were included in various scenarios that tested the bounds of the

[1] ISO-NE terminology refers to DSM resources as active and passive Demand Response (DR).
[2] See the description of the Reference Case below in this Section G.1.5.4.

ability of non-transmission alternatives to achieve reliability comparable to that provided by the project. In this regard, unlike DSM and large scale generation, the CHP resources included in these subsequent scenarios did not exceed the CHP amounts that were considered economically feasible. See: Table G.1, below, in Section G.1.5.4.

G.1.5.2 Key Assumptions for Alternatives

ICF's Non-Transmission Alternatives Study reviewed the technical potential on a state level by assessing the potential locations that currently are not served by CHP sources. ICF utilized its own projections for forward market prices to assess the economics of the CHP options in combination with market surveys of the penetration rates for the equipment. The resulting additions were 193 MWs in Massachusetts, with 33 MWs in western Massachusetts.

ICF projected DSM savings based on publicly available information for the maximum technically achievable DSM and the market information revealed through the ISO-NE Forward Capacity Auction (FCA) process. For this study, the total demand resources cleared in the first FCA, in addition to those showing interest in the second FCA, was determined to be just over 4,200 MWs. This total represents approximately 12% of the peak capacity requirement in the 2011/12 commitment period throughout New England. The west-central Massachusetts resources that were selected in the 2010/2011 auction amounted to 327 MWs or 8.4 % of the expected West-Central Massachusetts summer peak load in 2010. From analyzing the growth in resources submitted to the FCA between auction periods and from the 2008 Connecticut Integrated Resource Plan, ICF assumed that the total committed demand resources in western Massachusetts area would grow at the same rate as the aggressive technically achievable DSM identified in Connecticut forums as the "demand focus" case[3]. Based on these assumptions, the annual growth rate for demand resources in Massachusetts was determined to be 17 %. This assumed growth rate results in a

[3] CEAB Appendix G, Table 1 of the CEAB's 2008 Comprehensive Plan for Procurement of Energy Resources submitted to the DPUC. CL&P has identified the demand focus case as requiring the expenditure of over an additional billion dollars over the next five years.

total of 527 MW of peak DSM in west-central Massachusetts in 2013 which is about 13% of the total western Massachusetts area load level. It should be noted that although the transmission system reliability violations are all concentrated in the Greater Springfield and north-central Connecticut areas, the DSM and CHP resource additions considered in the study were dispersed within the entire western Massachusetts and Connecticut systems, and not solely in Greater Springfield and north-central Connecticut.

Supply-side resources were also reviewed in this study to ensure that adequate supply was maintained for generation planning purposes. Since resource adequacy called for little additional generation in the Springfield area, under various scenarios studied, numerous large scale generating resources additions at the electrically most ideal sites such as West Springfield and South Agawam (Berkshire Power) were simulated without regard to the economic feasibility and tested for their effectiveness in rendering the overload-prone Springfield transmission system reliable in accordance with the NERC reliability criteria.

In addition to an assessment of how DSM, large scale generation additions, distributed generation additions and a combination of these resource alternatives compared to the GSRP in terms of solving the reliability problems, ICF's study separately attempted to determine the total amount of demand-side reductions that would be necessary to achieve the same reliability benefits as achieved by the GSRP and MMP. This "top-down analysis" was done without regard to whether or not the quantities of DSM resources found to be required were economic or technically feasible, and without regard to whether or not ISO-NE would be able to acquire the control systems and technology to operate the system reliably and securely with such levels of DSM.

G.1.5.3 Power-Flow Model Development

The starting point for the Non-Transmission Alternatives Study analysis was the 2012 power-flow planning case from ISO-NE. This information was provided to ICF under confidentiality restrictions by Northeast Utilities so as to protect Critical Energy Infrastructure Information (CEII) in accordance with

FERC requirements. Since the study year for the alternatives analysis was 2013, there were several modifications that were made to the case to reflect 2013 conditions.

The key assumptions for the power-flow modeling include:

- ***Load Projections:*** The original power-flow case provided was based on a 2005 vintage forecast for load growth. ISO-NE released a revised forecast in April 2008[4] which was adopted for purposes of this analysis. To modify the peak load input, the load at each node was scaled by the ratio of the 2005 and 2008 vintage forecasts. In compliance with standard transmission reliability planning methods, ICF used the extreme weather peak demand forecast (also known as the 90/10 forecast). Under the 90/10 forecast, the western Massachusetts zonal peak demand was estimated to be 2490 MW in 2013 based on the 2008 vintage forecast. The same approach was applied to all areas within New England.
- ***Forced Outage Rate and Spinning Reserves:*** From the dispatch perspective, forced outages and spinning reserves were accounted for in the dispatch. The forced outage rate assumed for Springfield area in this ICF study was 7 percent of the total zonal capacity. To implement the forced outage in the power-flow model, ICF turned off selected generation units to reach 7 percent of the total capacity such that these units were assumed to not be available to meet system demand. The same forced outage rate assumption was used for each zone in New England. A spinning reserve requirement of approximately 15 percent of total capacity was also implemented in the power-flow model across New England. This represents generation capacity that is made available to respond to system contingencies and reflects roughly the largest generation contingency in each zone.

[4] "2008-2017 Forecast Report of Capacity, Energy, Loads, and Transmission," April 2008, ISO New England.

- ***Generation Asset Lifetime:*** With regard to the existing generating assets, ICF assumed that any non-hydro asset within New England that reached the age of 60 years by 2013 would retire. No generators in Springfield were affected by this retirement assumption.
- ***Dispatchable DSM Resources:*** In their analysis, ICF assumed that the dispatchable DSM resources such as the emergency generators and demand response (active DR in ISO-NE's terminology) are reserved for emergency conditions and are not removed from the ISO-NE peak load projection in the power-flow cases.[5] However, the Springfield area peak load was decremented by 225 MW to account for the non-dispatchable DSM resources (passive DR in ISO-NE's terminology) for the power-flow analysis, accounting for about 43% of the total western Massachusetts DSM projection.

G.1.5.4 Study Details

The Study of Non-Transmission Alternatives to Greater Springfield Reliability Project conducted by ICF is comprised of various resource alternatives options delineated above. Table G-1 below illustrates the non-transmission scenarios that were modeled and analyzed by ICF for their effectiveness in eliminating transmission facility overloads in Greater Springfield and north-central Connecticut, in order to render those transmission systems reliable according to national and regional reliability criteria. In an attempt to bound the area's problems and the potential solutions, ICF's study evaluated seven different scenarios, some of which did not observe the original condition that resources added be market-based and economically feasible. Thus, four of the seven scenarios listed in Table G-1 are not resource alternatives to transmission reinforcement but rather, are scenarios simulated to comprehend the extent of the overload problems in the Greater Springfield and north-central Connecticut areas. Thus, the scale of the load reduction modeled in these scenarios render the scenarios to be only hypothetical. These four scenarios attempt to answer the "top-down" question, "How much load in and around the problem areas[6]

[5] ISO-NE views dispatchable DSM as supply side resources

[6] In one case, the load reduction was simulated to occur within the entire Connecticut zone, and was not restricted to the north-central Connecticut area.

needs to be dropped with or without assumed new large scale generation, to resolve the reliability problems in the Greater Springfield and north-central Connecticut areas?" In addition, the scenarios adding between 400 and 600 MWs of new generation in the Greater Springfield area are only hypothetical since resource adequacy does not call for, and would not economically support, such additions. The seven scenarios altogether encompass all the resource alternatives options listed previously i.e., large scale generation additions, zonal demand reductions and focused DSM.

Table G-1: Non-Transmission Resource Alternatives Simulated[7]

Scenario No.	Description
1	Reduce Connecticut Zonal Demand by 1,000 MWs
2	Reduce Western Massachusetts Zonal Demand by 1,000 MWs which includes specific load reduction in certain substations[8]
3	West Springfield and Berkshire power plants operational and new 400-MWs facility at Berkshire Power (Total of 854 MW in Greater Springfield area)
4	West Springfield and Berkshire power plants operational, new 200-MWs facility at Berkshire Power, and new 200-MW facility at Mount Tom (Total of 854 MWs in Greater Springfield area)
5	West Springfield and Berkshire power plants operational, new 400-MWs facility at Berkshire Power, and new 200-MW facility at Mount Tom (Total of 1054 MW in Greater Springfield area)
6	West Springfield and Berkshire power plants operational, reduce CT Zone demand by 500 MWs, and curtail load at Chicopee, Clinton, East Springfield, Agawam, and Breckwood substations
7	Same as Case 6 but with West Springfield and Berkshire power plants unavailable

ICF performed a detailed power-flow analysis of the system assuming both normal and emergency conditions for each of the seven resource alternatives scenarios listed in Table G-1. To begin with, ICF assessed system performance under normal conditions assuming no unplanned failure of a transmission element such as a transmission line, a transformer, a circuit breaker, or a pair of transmission lines on a multiple circuit transmission tower. Next, the process was repeated for the unexpected failure of key transmission elements (N-1 contingency condition).

[7] Exhibit 6-8 in the study report titled "Assessment of Non-Transmission of Alternatives to the NEEWS Transmission Projects: Greater Springfield Reliability Project", Report by ICF Resources, LLC

[8] Specific substations include Chicopee, Clinton, East Springfield, Agawam and Breckwood.

ICF also conducted a similar analysis to evaluate system performance under line-out conditions, that is, following the outage (planned or unplanned) of a single transmission element, a second element was then considered to fail (N-1-1 contingency condition). System performance was measured by monitoring transmission lines for thermal overloads under all three system conditions; Normal, N-1 and N-1-1 conditions.

Furthermore, ICF assessed the ability of the system to operate reliably if the Millstone Unit #3 generation facility was out of service. In this case, other generation facilities were adjusted to replace the lost output. The performance of the system was then examined for transmission facility overloads

G.1.5.5 Study Results & Conclusion

ICF concludes in its study report that no non-transmission alternatives to the Greater Springfield Reliability Project were found to be satisfactory or sufficient in nature to displace or defer the need for the project. This conclusion is supported by results of the power-flow analysis, which indicate that despite the addition of the large scale generation, DSM, and CHP resources previously described, numerous transmission facility overloads occur under contingency conditions and hence, the system fails to fully comply with the mandated national and regional system reliability criteria. Furthermore, ICF in its study report concludes that the GSRP is critical to the reliable operation of the New England transmission grid, and in particular, the transmission systems of Greater Springfield and north-central Connecticut. The results of the additional analyses performed with the project in operation (in contrast with the Non-Transmission Alternatives Assessment) confirm and validate these conclusions. The following sections of this document summarize the results for each of the three resource alternatives options (large scale generation, DSM, zonal load reduction) simulated and tested by ICF in their study.

G.1.5.5.1 Consideration of DSM as a Resource Alternative to Transmission Reinforcement

The downtown Springfield transmission system and the 115-kV western Massachusetts – Connecticut tie lines continue to overload, when load is reduced in accordance with an aggressive DSM "focus case." Even an unrealistic assumption of extraordinarily large and impractical DSM measures does not resolve all of the criteria violations on the Greater Springfield and north-central Connecticut transmission systems. For example, reducing about 273 MWs of coincident peak load within key locations in Springfield (e.g., the Breckwood, Clinton, Agawam, Chicopee and East Springfield substations) and further decrementing Western Massachusetts (WMA) zonal load uniformly by about 727 MWs to represent a total WMA zonal load reduction of 1000 MW (about 44 % of the peak demand projected for the entire western Massachusetts sub-area in 2013)[9] still failed to resolve all the Greater Springfield and north-central Connecticut overloads. As an illustration, Figure G-1 below depicts how, even after such aggressive load reduction, the Greater Springfield and north-central Connecticut area reliability problems continue to persist. Further details can be found in the ICF Report.

[9] The zonal reduction of 1,000 MW was in addition to the focused DSM in west-central Massachusetts (13%) and Connecticut (5%)

Figure G-1: Number of Distinct Facility Overloads under Contingency Conditions (N-1 and N-1-1) for Various Load Reduction Scenarios

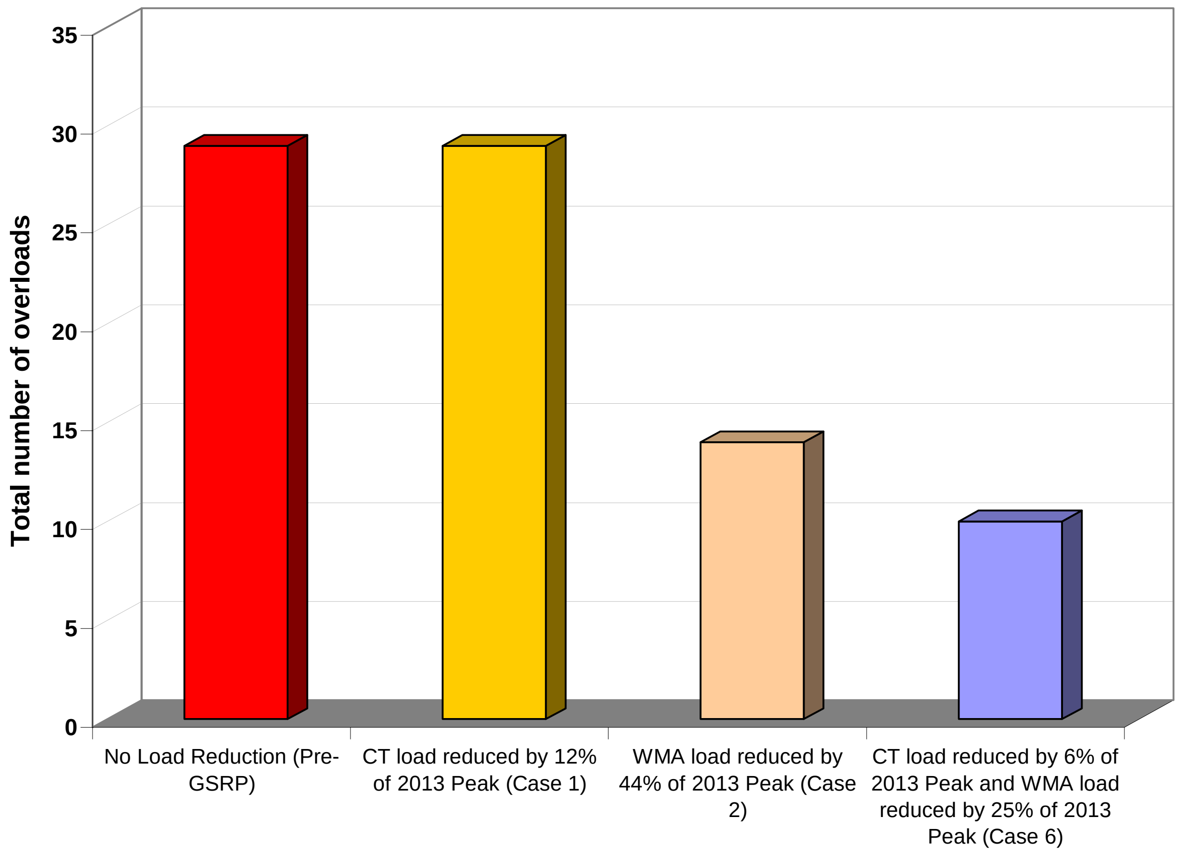


Figure G.1: Greater Springfield and North Central Connecticut area transmission facility overloads[10] as a function of the 2013 Greater Springfield area peak demand projection (bar heights in the chart are approximate). Note that the percent load reduction shown on the graph is in addition to the estimates from the focused DSM case that was modeled in all scenarios tested in the study.

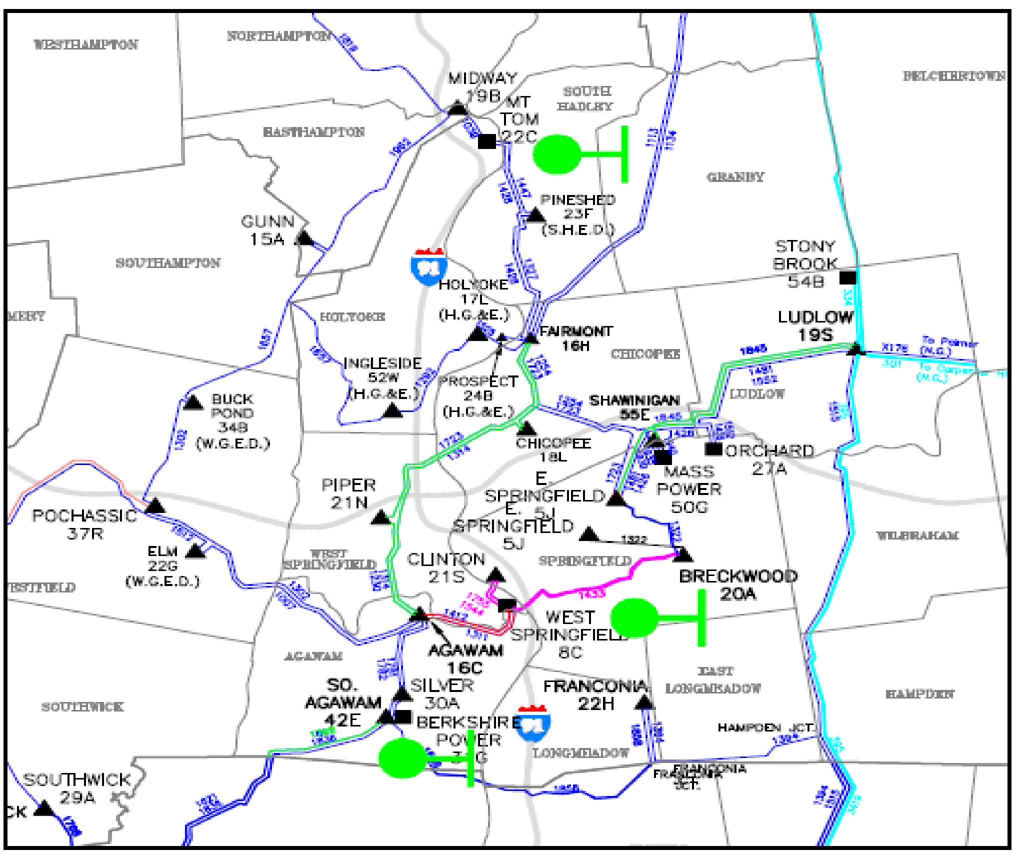
G.1.5.5.2 Consideration of Large Scale Generation as a Resource Alternative to Transmission Reinforcement

Scenarios 3, 4 and 5 in Table G-1 represent large scale generation additions in combination with focused DSM as resource alternatives. Through scenarios 3, 4 and 5, ICF assessed the ability of generation additions at key locations in the western Massachusetts zone to eliminate the Greater Springfield and north-central Connecticut area reliability problems. The scenarios examined included the addition of 200 MW to 400 MW of new generation at the site of Berkshire Power, 200 MW at the Mount Tom site, and

[10] The total number of possible transmission facility overloads is illustrated for those limited scenarios tested by ICF Resources LLC in their analysis; there could be more overloaded facilities under other dispatch scenarios.

the assumption that the existing West Springfield and Berkshire generation facilities are operational during the study period. This latter assumption implies that the West Springfield and Berkshire generation facilities may be required to be operated as "Reliability Must Run" units (under Reliability Agreements under the ISO-NE system in effect until 2010) during the summer peak period. In all the cases tested, ICF found that the generation addition scenarios – both individually and in combination – were not sufficient to relieve the Greater Springfield and north-central Connecticut transmission overloads. Figure G-2 below illustrates the geographical locations where the assumed new generations were modeled in the tested scenarios. Note that the ability of these locations to actually accommodate these hypothetical generators was not considered in choosing the locations for generator additions.

Figure G-2: Geographical locations of assumed new generation additions in scenarios 3, 4 and 5



Further, the results of the generation addition analyses performed by ICF show that generation additions in the downtown Springfield area (downtown Springfield being the most logical site for generation addition) are not effective in repelling the natural flow bias from the northeast (east of the river) under certain contingencies and, instead contribute to higher flows through downtown Springfield to Connecticut, leaving downtown Springfield drawing power from the same sources that cause overloads on the Springfield system. Large scale generation such as that proposed in Stony Brook (north of Ludlow) will only exacerbate Greater Springfield and north-central Connecticut system reliability problems; this generation interconnection would require improvement of the transmission system in order to be built (per ISO-NE). In contrast, the Greater Springfield Reliability Project is expected to be a possible solution for transmitting an additional 300 MWs of power from Stony Brook. Study results also indicate that under certain operating conditions, the large scale generation alternative causes new overloads on the Greater Springfield transmission system. As a result, additional large scale generation cannot solve the Greater Springfield and north-central Connecticut reliability problems.

ISO-NE has evaluated adding significant new generation (in multiple locations under different proposals) in the greater Springfield area and has determined that such additions may not be feasible unless transmission upgrades and modifications are made to the Springfield system. The feasibility studies conducted by ISO-NE in assessing the need for transmission enhancement in Springfield before the possible generation capacity increase/interconnection can be found in the report titled *"Feasibility Study Report for the Thermal, Voltage and Short Circuit Analysis of the Stony Brook Phase 2 Project (280 MW)"*. The full report is available for reference upon request from ISO-NE via the OASIS website.

G.1.5.5.3 Consideration of Large Scale Zonal Load Reduction

Scenarios 1, 2, 6 and 7 in Table G-1 represent large scale load reduction in western Massachusetts, Connecticut and the Greater Springfield area. As described in the earlier sections, the results of the analysis performed in the Non-Transmission Alternatives Study by ICF clearly show that even highly impracticable load reduction levels of up to 1,000 MWs[11] are not viable alternatives to the Greater Springfield Reliability Project. Details can be found in the full study report.

Furthermore, the ICF report points out that these conclusions are based on conservative assumptions used to generate the Reference Case[12]. Less conservative assumptions would result in greater line overloads than were determined in this study. The conservative nature of these assumptions is focused on both the supply and the demand side including the following:

- ICF's analysis under the Reference Case reflects a normal peak-day operation for the system assuming that adequate spinning reserves are maintained and further that no active demand resources are called on. These conditions do not reflect the standard which suggests that transmission planning be performed under reasonably stressed conditions. ICF further examines several generation stress cases in comparison to the Reference Case.
- ICF's analysis does not include any economic assessment of the aggressive levels of DSM (above and beyond the DSM focus case) assumed in its Non-Transmission Alternatives scenarios. The economic challenges facing the DSM focus case itself are illustrated by the Connecticut Energy Advisory Board (CEAB) in its *2008 Comprehensive Plan for the Procurement of Energy Resources* (Approved Aug. 1, 2008) (Comprehensive Plan), in which it estimates the cost of the DSM focus case from 2009 through 2014 for Connecticut alone as in excess of $1.6 billion, of which more than $880 million represents a budget deficit, after application of anticipated

[11] This 1,000-MW reduction would be above and beyond the focused DSM in both west-central Massachusetts and Connecticut, and was modeled in addition to assumed generation additions.

[12] The assumptions in the Reference Case regarding the penetration of additional demand and supply side resources over time are derived considering an aggressive demand side penetration in combination with a primarily economic driven generation addition. Generation additions are primarily driven based on ensuring that adequate reserves are maintained over time. The types of resources added are those which would provide the least cost option to maintain reserves. In addition, units which may already be under construction, or units which had been approved in non-marketed programs (such as the Kleen units in Middletown, Connecticut) at the time this analysis began are considered as generation additions.

revenues from three anticipated funding sources.(Comprehensive Plan, Appendix G, p. 9, Table 1).

- In estimating which generators currently operating under RMR agreements could be expected to retire for economic reasons after RMR agreements expire in 2010, ICF did not treat the Montville (Connecticut) and Middletown (Connecticut) units, which have an aggregate 1,263 MWs capacity, as retiring. However, those units are confronting environmental as well as economic challenges, and their owner, NRG Energy Inc., stated in a July, 2008 Interrogatory response to the Connecticut Siting Council that the Council "should assume for planning purposes" that the units at Montville and Middletown Station would be retired within the Council's forecast period "if they are not repowered under long term contracts or other market based arrangements that provide certainty of revenues" Consistently with this statement, the CEAB Comprehensive Plan recognizes that the cost of complying with environmental regulations could produce the retirement of 1,400 MWs of Connecticut generation.
- ICF's assumed generation outages do not reflect the extreme generation outage conditions which have occurred on occasion in New England. However, the equipment overloads found under ICF's cases could occur under such extreme conditions.

The conservative nature of these assumptions further reinforces the conclusions above given that even under these conservative assumptions, the reliability of the system must be addressed through the proposed transmission upgrade. The proposed transmission upgrades and modifications are expected to solve the Springfield area reliability problem for many years.

G.2 ALTERNATE TRANSMISSION SOLUTIONS CONSIDERED BUT REJECTED

As explained in detail in the *GSRP Solution Report*, a copy of which is included in Volume 5, NUSCO closely evaluated 39 combinations of 345-kV and 115-kV improvements in developing the proposals to be submitted to the Massachusetts and Connecticut Siting authorities. Since there were routing alternatives for many of the components of these 39 “Top System Solutions,” NUSCO screened a total of over 860 system/route combinations. The selection and design of the 115-kV improvements in Massachusetts was complex and challenging. That process is described in detail in the Solution Report, but will not be repeated here, since none of the new or reconstructed 115-kV facilities are proposed to be in Connecticut.

The choices to be made with respect to the portion of the GSRP proposed to be located in Connecticut were far fewer and more straightforward than those required for designing the 115-kV portion of the GSRP. In addition to the 345-kV lines from North Bloomfield to Agawam to Ludlow that CL&P and WMECO now propose, the Options Analysis by the ISO-NE Working Group identified only two other potential 345-kV connections for resolving the Springfield area reliability problems. The choice of this solution dictated that a new 345-kV line between North Bloomfield, Connecticut and the Connecticut/Massachusetts state border would be proposed.

As previously discussed, this selection of the best transmission solution required a further choice between alternate routes for the Agawam to Ludlow segment of the new 345-kV line. The choice of the Northern route, which is entirely within Massachusetts, over the Southern alternative route, which would be partly in Connecticut, is explained in Section H of this Application and in the GSRP Solution Report included in Volume 5 of this Application. This choice was based primarily on environmental impact and cost considerations. The system benefits provided by the proposed improvements would not vary according to which of these two alternate routes were to be chosen (unless a choice of the Southern route resulted in the Connecticut portion of the line being underground.). This section explains the selection of the North Bloomfield – Agawam- Ludlow electrical path as the best 345-kV transmission solution, based primarily on a consideration of system benefits and costs. The comparative environmental effects of the best variants of each of the three “Options” are quite similar.

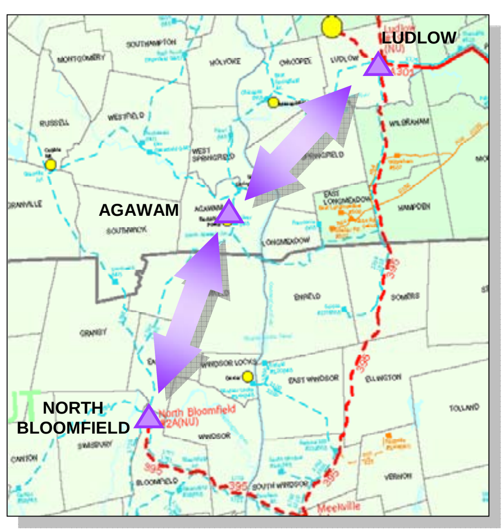
G.2.1 Identifying the North Bloomfield to Agawam to Ludlow Lines as the Best 345-kV Solution

The advantages of the proposed North Bloomfield to Agawam to Ludlow solution have been presented previously in this Application, particularly in Section F. In the Options Analysis, this 345-kV configuration was referred to as "Option A." The other two 345-kV solutions that the ISO-NE working group found to exhibit acceptable system performance were:

- A 345-kV line between the North Bloomfield and Ludlow Substations that did not tie into the Agawam Substation ("Option B"); and
- A 345-kV line from Manchester Substation in Manchester, Connecticut to the Ludlow Substation ("Option C").

The electrical connections that would be affected by these alternatives are illustrated in Figures G-4 and G-5. For comparison, the electrical connections that would be affected by the proposed North Bloomfield to Agawam to Ludlow solution are also displayed in Figure G-3.

Figure G-3: Preferred North Bloomfield – Agawam – Ludlow Solution ("Preferred Solution")



Note: Dotted red lines illustrate existing 345-kV transmission lines, whereas the purple arrows indicate the 345-kV alignments proposed to complete the Greater Springfield 345-kV loop.

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The Options Analysis pointed out that all three of these options provide a new 345-kV connection between western Massachusetts and Connecticut, and that, with respect to the system benefits they provide, the main differences between these plans are whether they provide another area bulk supply point, eliminate the weak western Massachusetts/Connecticut 115-kV ties, or utilize phase shifters to restrain power being wheeled through the area.

When the three basic 345-kV line Options were identified, it was already clear that although all three Options eliminated the weak Massachusetts/Connecticut 115 kV ties, only Option A – the North Bloomfield – Agawam – Ludlow 345-kV line provided another bulk power supply point and did not utilize phase shifters. As explained in the following paragraphs, these characteristics provide significant system benefits and advantages as compared to the other two Options.

Figure G-4: N. Bloomfield – Ludlow („Option B")

(No Connection to Agawam)

Figure G-5: Manchester – Ludlow („Option C")

G.2.1.1 Advantages of a 345-kV Connection to the Agawam Substation

The new bulk power supply point for the Springfield 115-kV system that only the proposed solution provided was at the Agawam Substation. That supply point would not be part of the 345-kV system under either of the other Options. With this additional supply point, bulk power could be provided to the Springfield area's 115-kV system from the south, in addition to the pre-existing supply from the north

(Ludlow). Should the Ludlow Substation supply to the 115-kV transmission system be lost for any reason, there would still be a path from the south for power to flow into the Springfield area to meet customer load and to maintain transmission system voltages within acceptable ranges. Because of this new source, there would be less reliance on the Ludlow autotransformers. Additionally, a double-contingency outage of the Ludlow – Barbour Hill 345-kV line and the Ludlow – Agawam 345-kV line will not interrupt a 345-kV supply to the Agawam Substation, making it a very reliable new source for the Springfield 115-kV system. With the proposed configuration, the Agawam Substation also provides voltage support to the Springfield area. Finally, since all of the area's 115-kV lines tie into the Agawam Substation, it is a strategic location for limiting power flows through the Springfield area; and since it is close to area load centers, it is well sited to provide flexibility in expanding the 115-kV network to serve future growth.

G.2.1.2 Advantage of Avoiding Phase Shifters

Only the proposed solution would not also require the use of 115-kV phase-shifting transformers. These are specially designed transformers for connecting systems at the same voltage in a way to act as a valve to control or limit power flow. A phase-shifting transformer requires additional substation space, adds cost to the Project, and would be unique to the Connecticut and western Massachusetts systems. Parts would have to be obtained and maintained so that reliability is not significantly decreased. Also, as system conditions change, the phase-shifting transformers would have to be adjusted to provide continuous optimum performance. This requirement would place additional burden on those actually operating the system and their support staff providing short-term planning support. Consultations by the planning team with the system operators ascertained that the operators have a strong preference for avoiding the use of phase shifters where possible.

G.2.1.3 Further Investigation of the Options

The NUSCO planners investigated Options B and C further in order to determine whether either of them presented any system benefits, cost, or environmental advantages that would overcome the system benefits advantages of the proposed solution. That analysis confirmed the superiority of the proposed solution.

G.2.1.3.1 Elimination of Option C – Manchester to Ludlow

System Benefits/Disadvantages

Since the Ludlow to Manchester line configuration would not connect to North Bloomfield Substation, it would not increase the reliability of supply to this important substation, which serves an area of Connecticut experiencing higher than average load growth; and it would not create an additional loop around the north-central Connecticut and Springfield area.

Moreover, a new Manchester to Ludlow 345-kV line would be along the same path as the existing Manchester (Connecticut) to Barbour Hill (Connecticut) to Ludlow 345-kV transmission line. Placing the two 345-kV lines on the same right-of-way (ROW) would not be a criteria violation. However, a system with two 345-kV lines on the same ROW would be less reliable than the proposed looped configuration and could interrupt the Massachusetts – Connecticut interconnection if an extreme contingency on the right-of-way affected both 345-kV lines.

Associated Construction Requirements and Cost

The Options Analysis recognized that Option C would require construction of more 115-kV facilities in Connecticut than the other Options. However, further analysis disclosed that these requirements were significantly greater than had been recognized at the time the studies underlying the Options Analysis were done.

Option C would require the following 115-kV construction in Connecticut, which would not be required by Options A or B:

- A new underground 115-kV circuit between the Manchester and South Meadow (Hartford) Substations, constructed in and along public streets, for a distance of approximately 4.7 miles;
- A new underground 115-kV circuit between the Southwest Hartford and South Meadow Substations, a distance of approximately 3.8 miles, which would probably be installed in an existing empty pipe conduit;
- A new underground 115-kV circuit between the Northwest Hartford and Southwest Hartford Substations, constructed in and along public streets for a distance of approximately 3.6 miles;
- Reconductoring the #1783 Farmington to Newington line for a distance of approximately 3 miles with 556-kcmil ACSR conductors, and
- Reconductoring the #1785 Berlin to Newington line for a distance of approximately 3 miles with 795-kcmil ACSR conductors.

A planning grade estimate of the total cost of this work is $230.6 million, broken down in Table G-2.

Table G-2: Hartford Area Construction Summary

Segment	Length (miles)	Cost[1]
Manchester to South Meadow	4.7	$97 million
Southwest Hartford to South Meadow	3.8	$18.9 million
Northwest Hartford to Southwest Hartford	3.6	$73.8 million (one cable only)
Farmington to Newington	3.4	$13.5 million
Berlin to Newington	6.9	$27.4 million

[1]: This cost estimate includes construction costs, overhead costs, financing costs during construction and expected escalation to the in-service date. All other cost estimates will be calculated and stated in a similar way.

In contrast, the only ancillary work required in Connecticut by the choice of Option A is the Manchester to Meekville Junction Circuit Separation Project – which entails the separation of two segments of 345-kV and 115-kV circuits now on common structures, along approximately 2.2 miles of ROW, as described in Section I. The total cost of this work is estimated at $14 million. Therefore, Option C has a cost disadvantage relating to the Connecticut 115-kV work alone of approximately $217 million, as compared to Options A and B.

That cost disadvantage is not offset by any requirements of Options A or B that are not common to Option C (other than the Manchester – Meekville Junction circuit separation.). All three projects require a similar scope of 115-kV line construction and reconstruction in Massachusetts. Moreover, the cost of the 345-kV component of Option C is driven by its length of 31.6 miles, which is only 3.4 miles shorter than the 35-mile length of the new 345-kV line construction for the proposed solution. This Option C cost advantage for the 345-kV portion of the project, together with the advantage of no 345-kV facility costs at Agawam Substation, does not offset the large excess cost of the 115-kV construction.

G.2.1.3.2 Elimination of Option B – North Bloomfield – Ludlow

There are two potential routes along existing ROW's between the North Bloomfield and Ludlow Substations. One would be along the ROW that leads from the North Bloomfield Substation south and east to Meekville Junction in Manchester, Connecticut, turning north from there to Ludlow Substation. The other route would be from North Bloomfield Substation north to the South Agawam Junction, and from there to Ludlow Substation over either of the previously described Northern or Southern Route alternatives. (Note, however, that because the line would not be tied into the Agawam Substation, if the Southern Route were chosen, there would be no 345-kV construction between the South Agawam Junction and Agawam Substation and no 345-kV facility additions at Agawam Substation.) These potential routes are illustrated in Figures G-6 and G-7.

Figure G-6: Potential Routes - Option A

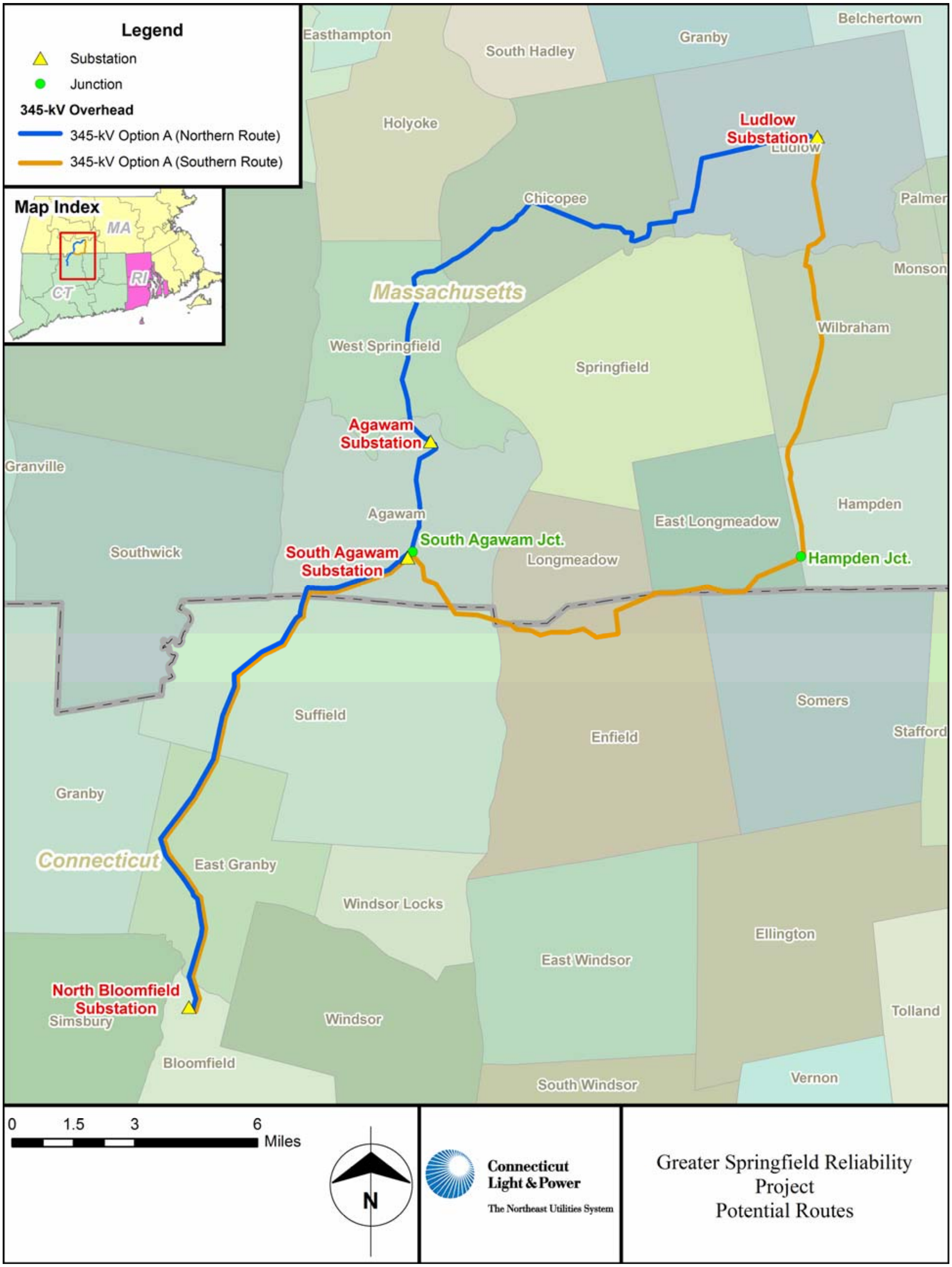
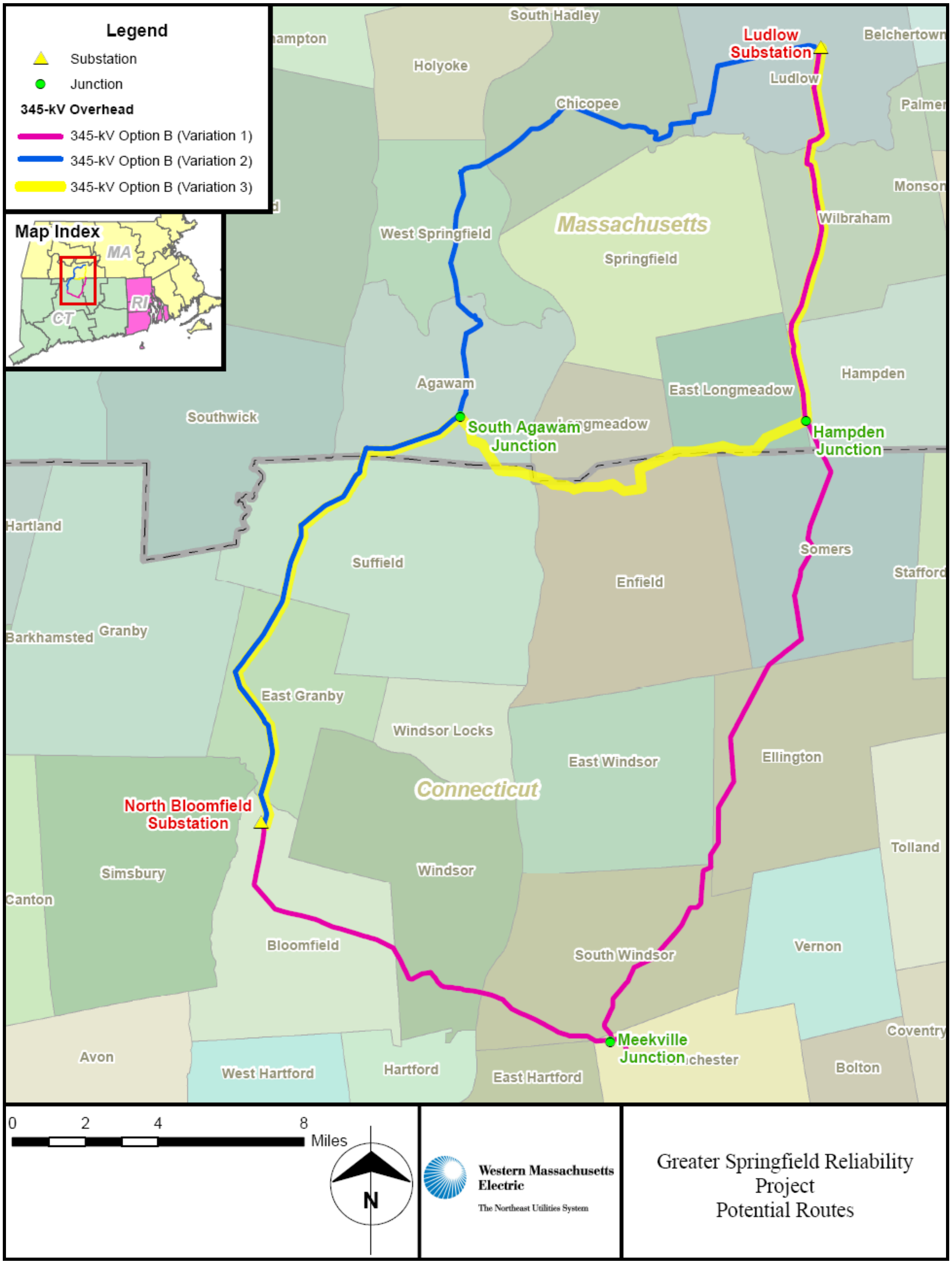


Figure G-7: Potential Routes - Option B



The North Bloomfield – Meekville Junction - Ludlow Route

A 345-kV line constructed along a North Bloomfield – Meekville Junction – Ludlow route (see: Figure G-7, above) would be approximately 44.5 miles long, 31.5 miles of which would be in Connecticut. From Meekville Junction to Ludlow Substation, a distance of approximately 31 miles, the new 345-kV line would be along the same path as the existing Manchester to Barbour Hill (Connecticut) to Ludlow 345-kV transmission line, which would present a reliability disadvantage as compared to the GSRP.

The North Bloomfield – Meekville Junction – Ludlow route would be between approximately 7.2 miles and approximately 9.5 miles (about 19 to 27 percent) longer than the North Bloomfield - South Agawam - Ludlow route (depending on whether the shorter Northerly (total length of 35 miles) or the longer Southerly (total length of 37.3 miles) segment between South Agawam Junction and Ludlow Substation were employed for the latter route). This increased length translates into increased cost: the planning grade estimate is that the North Bloomfield – Meekville Junction – Ludlow route would cost approximately $240 million, as compared to $197 to $210 million for the North Bloomfield – South Agawam Junction – Ludlow 345-kV line routes.

The increased line length of the route through Meekville Junction would also entail increased environmental effects. Further, the social effects of that route would be greater than the route through South Agawam Junction, because there are more densely settled areas along the ROW.

Accordingly, were Option B, the North Bloomfield to Ludlow 345-kV line, to be selected, the proposed route for the line would be one of the two routes through South Agawam Junction and not the route via Meekville Junction.

The North Bloomfield – South Agawam Junction – Ludlow Route

A 345-kV line from North Bloomfield to South Agawam Junction to Ludlow would present virtually all of the same routing choices and environmental effects as does the proposed solution.

The only differences between this configuration and that of the proposed solution would be:

- No expansion of the Agawam Substation to accommodate 345-kV equipment additions and transformation to 115 kV would be required since no connection to the 115-kV system would be made at Agawam Substation with this Option B configuration;
- In place of transformers at the Agawam Substation, this configuration (on both the Northern and the Southern Route) would require much more costly phase shifters installed at the North Bloomfield Substation in Connecticut. In place of these expensive phase shifters, the proposed solution uses a lower cost approach of re-configuring 115-kV lines going south from the South Agawam Substation into Connecticut and cutting these lines off from the North Bloomfield Substation to prevent power from flowing onto the Connecticut 115-kV system there.
- If the Southern Route between South Agawam Junction and Ludlow Substation were chosen, there would be no 345-kV line construction required between the South Agawam Junction and Agawam Substation.

However, the same considerations that favor the selection of the Northern Route segment discussed in Section G.2.1 would apply here as well. The Northern Route for Option B would require the same 35.0 miles of new 345-kV line construction as for the proposed solution. Eliminating a section of 345-kV line back and forth between South Agawam Junction and Agawam Substation, a distance of approximately 3.2 miles one way, would result in the Southern Route for Option B being 6.4 circuit miles shorter than the Southern Route for Option A. However, that leaves the Southern Route for Option B with 37.3 miles of new 345-kV line construction. For the 345-kV line construction, the Southern Route segment would therefore still be more expensive than the Northern Route segment based on the planning grade cost/mile estimates (2.3 miles difference = $13 million). In addition, the environmental and social advantages of the Northern Route would provide reason to prefer it in the same way that these factors strongly favor the proposed solution's use of the Northern Route.

If the Northern Route were chosen for Option B, the only cost difference between Option B and the proposed solution (Option A on the Northern Route) would result from the difference in the scope of the work required to:

> (i) expand the Agawam Substation for 345- to 115-kV transformation, and implement the low cost re-configuration of the 115-kV lines which go south into Connecticut but no longer deliver power at 115 kV to the North Bloomfield Substation (at a total cost of $74 million and $2.6 million, respectively, for a total cost of approximately $76.6 million);

as opposed to that required to

> (ii) install phase shifters, including a spare, at the North Bloomfield Substation (at a total cost of $165 million).

This large difference, of approximately $88 million, provides a second strong leg of support for the selection of the proposed solution. Not only does the proposed solution provide more system benefits, it is also more economic than the best variation of Option B.

Accordingly, after extensive evaluation, the 345-kV solution consisting of the now proposed North Bloomfield to Agawam to Ludlow 345-kV lines, with the Agawam to Ludlow line routed along the Northern route, was identified as the best solution, offering the most system benefits, at lower or comparable cost, and with comparable environmental impacts, as compared to the better variants of the other Options.

SECTION H

ALTERNATIVE GSRP LINE-ROUTE ANALYSES

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H. ALTERNATIVE GSRP LINE-ROUTE ANALYSES

As described in the preceding sections of this Application, and in the *GSRP Solution Report*[1], CL&P determined that a new 345-kV transmission line between the North Bloomfield and Agawam Substations and a new 345-kV line between the Agawam and Ludlow Substations, together with associated substation and 115-kV line upgrades, are required to improve the reliability of the electric system in the Greater Springfield area (including north-central Connecticut). Subsequently, The Connecticut Light and Power Company (CL&P) identified and evaluated route alternatives for a new Greater Springfield Reliability Project (GSRP) 345-kV transmission line between these substations and selected a proposed alignment from among these alternatives.

For the GSRP as a whole, CL&P defined potential alternatives that would meet routing objectives in both states, while achieving the required reliability improvements to the transmission system. In identifying and evaluating such potential alignments and transmission configurations, both underground and overhead transmission line route alternatives were considered.

The overarching issue associated with the consideration of any alternative alignment or configuration was the need to establish a highly reliable 345-kV connection between the existing 345-kV facilities at the North Bloomfield Substation in north-central Connecticut and the Ludlow Substation in western Massachusetts, via the existing Agawam Substation (also in Massachusetts). Thus, practical route alternatives for the transmission facilities were defined by the locations of the existing substations, to which the planned 345-kV transmission lines must connect cost-effectively and efficiently, while minimizing adverse environmental, cultural, and economic effects. Route alternatives were considered for the portions of the GSRP 345-kV transmission lines in both Connecticut and Massachusetts, using

[1] *See,* Section F.1 of this volume. A copy of the *GSRP Solution Report* is provided in Volume 5 of this Application.

standard routing criteria and objectives, while also taking into consideration that the routes in each state must necessarily interconnect.

In addition, in Massachusetts, alternatives were considered for the locations of two new proposed 115-kV switching stations. However, in Connecticut, only one existing substation (CL&P's North Bloomfield Substation, located in the Town of Bloomfield) will be associated with the GSRP. This existing facility will have to be expanded to allow the interconnection of the new 345-kV transmission line. However, the required substation modifications can be accommodated within CL&P's existing property, which is already dedicated to utility uses. No other substation alternatives were considered because the expansion of the existing substation is cost-effective and minimizes environmental effects.

Consequently, this section focuses on the alternative routes identified and considered for the Connecticut portion of the GSRP, and describes the overall alternatives analysis process, which involved the consideration of engineering, environmental, and cost factors. The Connecticut portion of the GSRP includes the North Bloomfield Substation expansion, as well as the proposed 345-kV transmission line that must connect this substation to the Western Massachusetts Electric Company's (WMECO's) portion of the proposed GSRP 345-kV line at the Connecticut/Massachusetts state border. The distance from the North Bloomfield Substation to the Connecticut/Massachusetts state border is approximately 12 miles.

In addition, this section reviews the 5.4-mile Connecticut portion of WMECO's Massachusetts Southern Route Alternative for the Agawam to Ludlow 345-kV line in Massachusetts. Although located predominantly in Massachusetts, a portion of this overhead line-route alternative, which is not the proposed alignment for the Massachusetts portion of the GSRP, extends into the Towns of Enfield and Suffield. As discussed previously, although the Massachusetts Southern Route Alternative for the GSRP Massachusetts facilities is not preferred, the Massachusetts Energy Facilities Siting Board (EFSB) could nonetheless select this option for certification. If so, CL&P would then request the Council to approve the Connecticut portion of this 345-kV line. Consequently, this section identifies and evaluates both the overhead alternative line and an underground line variation.

In particular, this section discusses:

- The routing objectives and criteria that CL&P applied to identify and assess both overhead and underground line-route options for the GSRP (Section H.1);
- The route analysis process, including the methods used to compile information and perform reviews of potential route alternatives (Section H.2);
- The route options that were initially considered but eliminated from detailed consideration due to overriding social, environmental, engineering, or economic factors (Section H.3);
- The proposed line route and route variations that were identified, evaluated, and considered potentially feasible (Section H.4);
- The proposed route (Section H.4.1);
- Potential variations of portions of the proposed route (Section H.4.2);
- An evaluation of the potential route variations in comparison to one another and to the segment of the proposed line route that they would replace (Section H.5.1); and
- A review of the Connecticut portion of the Massachusetts Southern Route Alternative for the Agawam to Ludlow 345-kV line, including an underground line variation to a portion of this overhead line-route option (Section H.6).

H.1 ROUTING OBJECTIVES AND CRITERIA

To identify potential transmission line routes for the GSRP, CL&P applied an established set of route selection objectives and evaluation criteria.

H.1.1 Routing Objectives

The following route selection objectives are used in CL&P's initial planning for new transmission line projects, and were applied to the identification of alternative routes for the GSRP:

- Comply with all statutory requirements, regulations and state and federal siting agency policies
- Achieve a reliable, operable, constructible and cost-effective solution
- Maximize the reasonable, practical and feasible use of existing linear corridors (e.g., transmission lines, highways, pipelines)
- Minimize the need to acquire property by eminent domain
- Minimize adverse effects to sensitive environmental resources
- Minimize adverse effects to significant cultural resources (archaeological and historical)
- Minimize adverse effects on designated scenic resources
- Minimize conflicts with local, state and federal land use plans and resource policies
- Maintain public health and safety

Applying these objectives, potential route alternatives for both overhead and underground transmission line configurations were identified and evaluated using additional route evaluation criteria, as discussed in Sections H.1.2 (overhead transmission lines) and H.1.3 (underground transmission cables). Because overhead and underground transmission line construction and operation are inherently different, the emphasis placed on some of the route evaluation criteria in the analysis of potential route options varied for these two types of line configurations. Overall, multiple factors were considered in evaluating the feasibility of each type of transmission line configuration and associated routing for the project. The following sections describe the criteria used to analyze potential overhead and underground line configurations for the GSRP.

H.1.2 Overhead Line-Route Analysis Criteria

The configuration of overhead transmission lines allows flexibility, provided that a continuous ROW of adequate width is available. Individual structures can often be located to avoid or span conductors over sensitive environmental areas (e.g., wetlands, streams, steep slopes). However, overhead lines require relatively wide ROWs within which certain land uses and tall-growing vegetative community types are precluded (refer to Section J for further discussion of overhead transmission line construction and maintenance procedures).

Taking these issues into account, the following criteria were given primary consideration in evaluating the selection of an overhead transmission line route for the new GSRP 345-kV facilities:

- **Availability of Existing right-of-way (ROW) for the New Line to Follow.** The potential collocation of the 345-kV transmission facilities along existing ROWs (e.g., transmission lines, highways, railroads, pipelines), where linear uses are already established, was a primary routing consideration. The collocation of linear utilities within existing utility corridors is strongly favored by the Federal Energy Regulatory Commission's (FERC's) "Guidelines for the Protection of Natural Historic Scenic and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities," with which any electric transmission line approved by the Council must be consistent.[2] An entirely new 345-kV overhead line route would require a minimum 100-foot-wide ROW, based on a steel-monopole configuration with vertically arranged line conductors. The alignment of the same 345-kV line on an existing corridor (parallel to existing transmission lines) may entail a lesser expansion of an existing ROW or may not require any additional ROW at all.
- **Engineering Considerations.** Whether on existing or new ROWs, the length of the route and constructibility issues must be considered. These include the ability to avoid or minimize

[2] Conn. Gen. Stat. Sec. 16-50p(a)(2)(D)

the location of structures along steep slopes or embankments, in areas of rock outcroppings, or within environmentally sensitive areas, such as wetlands. Engineering requirements for crossing streams, railroads, and other facilities also must be assessed. These considerations are important determinants of cost and, in many cases, environmental effects as well.

- **Avoidance of Conflicts with Developed Areas.** Where possible, it is preferable to avoid conflicts with residential, commercial and industrial land uses such as homes, businesses and airport approach zones. In Connecticut, statutory provisions[3] discourage the construction of a new 345-kV overhead line "adjacent to" certain land uses, including residential areas, private or public schools, licensed child day-care facilities, licensed youth camps, and public playgrounds.
- **Consideration of Visual Effects.** Structure visibility is a significant public concern. It is desirable to avoid areas of visual or historic sensitivity; to identify designs for minimizing structure height; and to consider the potential effects associated with having to remove mature trees that presently serve as visual buffers.
- **Avoidance or Minimization of Effects to Environmental Resources.** In accordance with federal, state, and municipal environmental protection policies, the avoidance or minimization of new or expanded corridors through sensitive environmental resource areas such as parks, wildlife areas, and wetlands is desired.
- **Accessibility.** An overhead line must also be accessible to both construction and maintenance equipment. Although access to all locations along an overhead line route is typically not required, vehicular access to each structure location from some access point is required.

[3] Conn. Gen. Stat. Sec. 16-50p(i)

H.1.3 Underground Line Considerations and Route Analysis Criteria

The vast majority of transmission circuits in Connecticut and in the United States consist of overhead lines. However, underground transmission cable systems, consisting of buried electric cables and splicing chambers (or "vaults") that are buried at specified intervals along a cable route, may warrant consideration when overhead line configurations are impractical or undesirable due to site-specific environmental, social, construction, or regulatory factors. CL&P has recently installed underground transmission cable systems as part of the Bethel-Norwalk Project (345- and 115-kV transmission cables), Middletown-Norwalk Project (345-kV transmission cables) and the Glenbrook Cables Project (115-kV transmission cables) and thus has current experience in such underground cable routing and construction.

H.1.3.1 Technological Considerations for Underground Transmission Lines

A decision to use a 345-kV underground cable system rather than a 345-kV overhead line between the same terminal points involves more than an assessment of the potential locations of the alternative facilities. Rather, the choice between overhead and underground transmission facilities is one between different technologies. Whether the underground technology is selected, or simply assumed for the purposes of a routing analysis, several fundamental differences between the two transmission technologies must be recognized. Once the underground technology is selected (or assumed) routing criteria specifically applicable to underground systems are applied.

The important technological differences between underground and overhead 345-kV transmission systems include:

- Technical Considerations
- Transmission System Operational Considerations
- Power Quality Issues
- Recovery from Outages

Each of these differences is discussed, below.

Technical Considerations

- Alternating current transmission cables have most typically been applied for short distances in urban environments, which characteristically have very strong electrical sources. When long lengths of underground extra high voltage cables installed in suburban or rural settings, which usually are remote from strong sources, the large amounts of cable charging current associated with the long cable lengths, combined with moderate system strength relative to the cable-charging currents, require careful consideration to prevent damage and disruptions to the transmission system and potential damage to customer equipment. Proposed extra high voltage cable installations must therefore be carefully analyzed by power-system engineers, taking into account the design limitations of the cables and substation equipment at the cable terminations.
- Underground 345-kV cables have much lower current-carrying capability compared to typically sized overhead 345-kV transmission line conductors. At 345 kV, to achieve the same power-transfer capacity as an overhead transmission line, multiple underground cables must be installed.
- Due to the electrical characteristics of the insulations employed in all designs of underground transmission cables, and the proximity of the cables to each other when buried, the capacitive charging currents of an underground cable system are significantly higher than those of overhead lines. For most medium- and long-length underground 345-kV transmission systems, special switching devices and large shunt reactors may be required to compensate for the capacitive charging of the underground cables so as to prevent unacceptably high system voltages during normal operating conditions. These devices add operating complexity, decrease system reliability, require additional land, and add appreciable cost.

- When underground cables are installed in isolated segments of an overhead 345-kV transmission circuit, a 2- to 4-acre transition station must be installed at the location where the overhead transmission line conductors are connected to the underground cables. Within the transition station, switching equipment to isolate the underground cables from the overhead line conductors and large shunt reactors may be installed, depending upon the underground cable segment's location in the circuit and its length. A transition station would be required near the Connecticut/Massachusetts state border if an all-underground transmission circuit had to be constructed only for the Connecticut portion of the GSRP.
- When transmission lines or transformers are switched in a transmission system that has a circuit made up of overhead line and underground cable sections, potential problems can arise because of traveling wave reflections. Switching transient voltages traveling along a line will reflect at points of characteristic impedance change, such as where an overhead line and an underground cable are connected one on one. The voltage reflections can lead to excessive voltages which could damage the cable itself or other electrical equipment associated with the overhead transmission system.
- Because of these technical considerations and lower electrical impedances of cables, detailed 60-Hertz load-flow and harmonic transient voltage studies (see Power-Quality Concerns on next page) would have to be conducted by power-system engineers to determine the maximum length of 345-kV underground cables that could be installed at any location on the transmission grid without adversely affecting the New England transmission system.

Transmission System Operational Considerations

- The operation of an all-underground 345-kV cable transmission circuit, or an overhead 345-kV transmission circuit with one or more segments of underground cables, introduces transmission system complexity. When a long underground cable circuit or segment is initially energized, even though it may not be carrying any load, all associated shunt reactors need to be energized to maintain voltages within acceptable levels. When the underground cable circuit starts to carry load, the voltage on portions of the system will instantaneously drop until a sufficient percentage of shunt reactors can be disconnected. If the shunt reactors are not sized properly, or the steps in which a shunt reactor's impedance is changed are too large, unacceptable voltage swings can occur on the system.

- At normal loading, typically only about one-third of the shunt reactors necessary to maintain the voltages at the terminals of the underground cable circuit within acceptable levels may be in service. For some contingencies on the interconnected transmission system, current flow through the underground cables may instantaneously drop to nearly zero. Because only a portion of the shunt reactors are in service and the remaining portion of the shunt reactors cannot be connected instantaneously to increase their compensation for the capacitive charging of the cables, voltages could rise to unacceptably high levels within portions of the transmission system. Unlike an all-overhead transmission system, when long underground cables are present, system operators must be thoroughly trained on the sequential steps that must be followed when placing a system element in service or removing it from service and the interdependence of their actions on the transmission system to ensure that voltages remain within acceptable ranges. In critical or emergency situations, the time required to perform these crucial operating steps could be detrimental to the integrated transmission system.

Power-Quality Concerns

- System engineers need to be concerned with the magnification of harmonic voltages and currents, which are predominately generated by customer loads and during the energization of three-phase transformers. System harmonic resonances arise for applications of longer cables where the transmission system's local strength is moderate relative to the cable-charging currents. Low-order harmonic resonances can cause system failures, including cascading outages, and damage to equipment, including to power transformers. Day-to-day switching events, like the energizing and de-energizing of transmission circuits that occur in the normal operation of the transmission system, can cause amplification of harmonic voltages and currents that can lead to system component failures and severe power quality problems. The amplified harmonic voltages and currents propagate down to the customer level, and can have a detrimental effect on customer equipment and processes. A standard developed by the Institute of Electrical and Electronics Engineers (IEEE) establishes the maximum levels of harmonic voltages and currents that are allowed to exist on the transmission system at different voltage levels to ensure that electric utility and customer equipment and processes are not subject to damage.

Recovery From Outages

- When an outage occurs on an all-underground transmission circuit or a combination overhead and underground transmission circuit, it will take a significantly longer time to isolate a faulted segment of cable before repairs may commence. Transmission circuits with multiple short underground sections further complicate and extend the time it takes to precisely locate where within the overhead or underground cable segment the problem exists. Once located, repair times on the underground cable segment can take weeks to complete, as compared to hours or a few days for most overhead transmission line failure modes. Historically, most underground cable-system failures are associated with cable-splice failures or with termination equipment. The long outage of a transmission circuit negatively effects system operations and reduces the overall reliability of the transmission system.

H.1.3.2 Underground Line-Route Analysis Criteria

In this case, CL&P assumed that a 345-kV underground cable system between North Bloomfield Substation and the Connecticut/Massachusetts state border could be built without causing critical technical problems, such as serious overvoltage conditions associated with excess capacitance; and that, therefore, the reliability disadvantages of the underground system would be only those associated with most underground installations – operating complexity and vulnerability to long outages. For its underground routing analysis, CL&P further assumed that the particular underground technology that would be employed would be a solid-dielectric, cross-linked polyethylene (XLPE)-insulated cable system; and that the cable and associated splice chambers required for the cable system would be installed and maintained in accordance with standard procedures.[4] CL&P then evaluated the potential routes for such a system.

Given typical cable-system design, installation, and maintenance considerations, the following criteria were considered in the identification and evaluation of potential underground line-route options:

- **Environmental Considerations.** Underground line routes are preferably sited away from, rather than through, significant environmental resources. Whereas an overhead transmission line can span steep slopes, rock outcroppings, greenery/vegetation, wetlands, and watercourses, the construction of an underground line requires the excavation of a continuous trench, and the operation of the cable system mandates continuous permanent access along the entire length of the line so that any splice vault can be reached by heavy equipment as necessary for maintenance and repairs. Therefore, any environmentally sensitive areas (such as watercourses, wetlands, and endangered species habitat) located along an underground line route would be directly affected by the excavation of the cable trench and/or splice vaults,

[4] A Tutorial - Underground Electric Power Transmission Cable Systems – in Volume 6 provides a discussion of XLPE and other underground cable technologies; information concerning underground cable system construction and maintenance is also included in Section J.

unless the line can be placed beneath them (such as by a horizontal directional drilling). Similarly, compared to overhead line construction, blasting is more likely to be required to install underground cable systems through areas of shallow depth to bedrock. Accordingly, existing road corridors are usually considered for the installation of underground cables in preference to overland electric transmission ROWs. (However, when sited in roadways, underground lines must be designed to avoid conflicts with pre-existing underground utilities and also may still have to be installed across watercourses and wetlands that the roads may traverse.)

- **Availability of Useable ROW.** A new 345-kV underground line typically requires a 40- to 60-foot wide work area for construction. In addition, land must be available for burying splice vaults, each approximately 10 feet wide by 10 feet deep and up to 32 feet in length. Such vaults, which must be placed at approximately 1,600-foot intervals along the cable route, are required to allow the individual cable lengths to be spliced together.
- **Engineering Considerations.** Steep terrain poses serious problems for underground cable construction and may cause down-hill migration and overstressing of the cable and splices (the point where two cables are physically connected together). Accordingly, one of the primary engineering objectives for an underground cable system is to identify routes that are relatively straight, direct, and have gradual slopes and inclines to minimize construction and maintenance costs, and to avoid downhill cable migration. This preference for level or graduated terrain provides further reason to prefer roads to existing transmission line ROWs when siting underground lines.
- **Social Considerations.** The social objective is to minimize, where possible, the length of cable installation through residential areas and central business districts due to the potential for significant effects to residents and businesses and general traffic disruptions during construction, as well as the potential for conflicts with other in-ground utilities.

- **Land Availability for Line Transition Stations.** Unless terminated at a substation, 345-kV underground transmission systems require above-ground transition stations at each location where the underground cables must interconnect to overhead transmission lines. Such transition stations require approximately 2 to 4 acres of fenced and graded area, depending on topography, equipment, and other site-specific factors, and consist of above-ground facilities within a fenced area, similar in appearance to a transmission substation. The potential of terminating underground line segments at substations and, if transition stations are required, the availability of land, surrounding land uses, and potential effects on natural resources and the visual environment in these required locations must be considered in evaluating potential underground options.

H.2 ROUTE ANALYSIS PROCESS

CL&P incorporated the transmission line routing objectives and criteria into studies that were used to identify and subsequently assess different route options for the new 345-kV line. This process involved a logical progression, whereby a variety of potential alignment alternatives for the location of the transmission facilities were initially identified and then screened for operability and reliability; technical feasibility; property impact; environmental impact and cost. These analyses included the identification and evaluation of existing ROWs and other potential routes or route segments within the GSRP region, using field reconnaissance, aerial photography review, and baseline data interpretation.

The initial route investigation involved the review of street maps and U.S. Geological Survey (USGS) topographic maps to identify existing highways, pipeline corridors, transmission lines, and railroads along which the GSRP facilities could potentially be aligned. Aerial photographs also were evaluated to explore potential new alignment options (e.g., not along existing utility corridors), as well as to identify general land uses along potential alternative routes.

The alternatives identification and evaluation process was performed by a team consisting of CL&P and its specialized engineering and environmental consultants. The general types of potential route alternatives initially identified and reviewed included:

- Use and/or expansion of existing transmission line ROW using an overhead transmission line configuration;
- An all-underground 345-kV line, either within existing transmission corridors or within road ROWs;
- New ROW alternatives;
- Collocation with other existing linear corridors, such as railroads or highways; and
- Hybrid overhead/underground line routes involving the use or expansion of existing ROWs for overhead transmission lines and the use of underground cable aligned either along streets or along the existing overhead transmission line ROW.

The level of investigation of these potential line-route alternatives varied, depending on the viability of the alternative. For example, some initially identified route alternatives were quickly found to be impractical because of overriding environmental issues, engineering constraints, or cost factors. Other alternatives were determined not viable after closer investigation of the reliability issues, potential impacts, engineering concerns, or costs. The route options that were thus eliminated are summarized in Section H.4.

The potentially viable alternatives were examined more closely both in the field and using aerial photography. Engineering information and environmental resource factors along the alternative routes were identified, assessed, and quantified (where possible) for comparative purposes.

For the potentially feasible line-route alternatives, CL&P's team compiled and compared data such as total alternative route length, length through residential, commercial/industrial and undeveloped land uses; width of existing easements followed (i.e., roads, transmission line ROW); the number of wetlands and watercourses crossed; the number of public facilities within 200 feet of the edge of the ROW; and the number of locations where bedrock could be present. Potential underground line routes were also evaluated based on the presence of terrain that could make construction difficult and limit the feasibility of the use of underground technology.

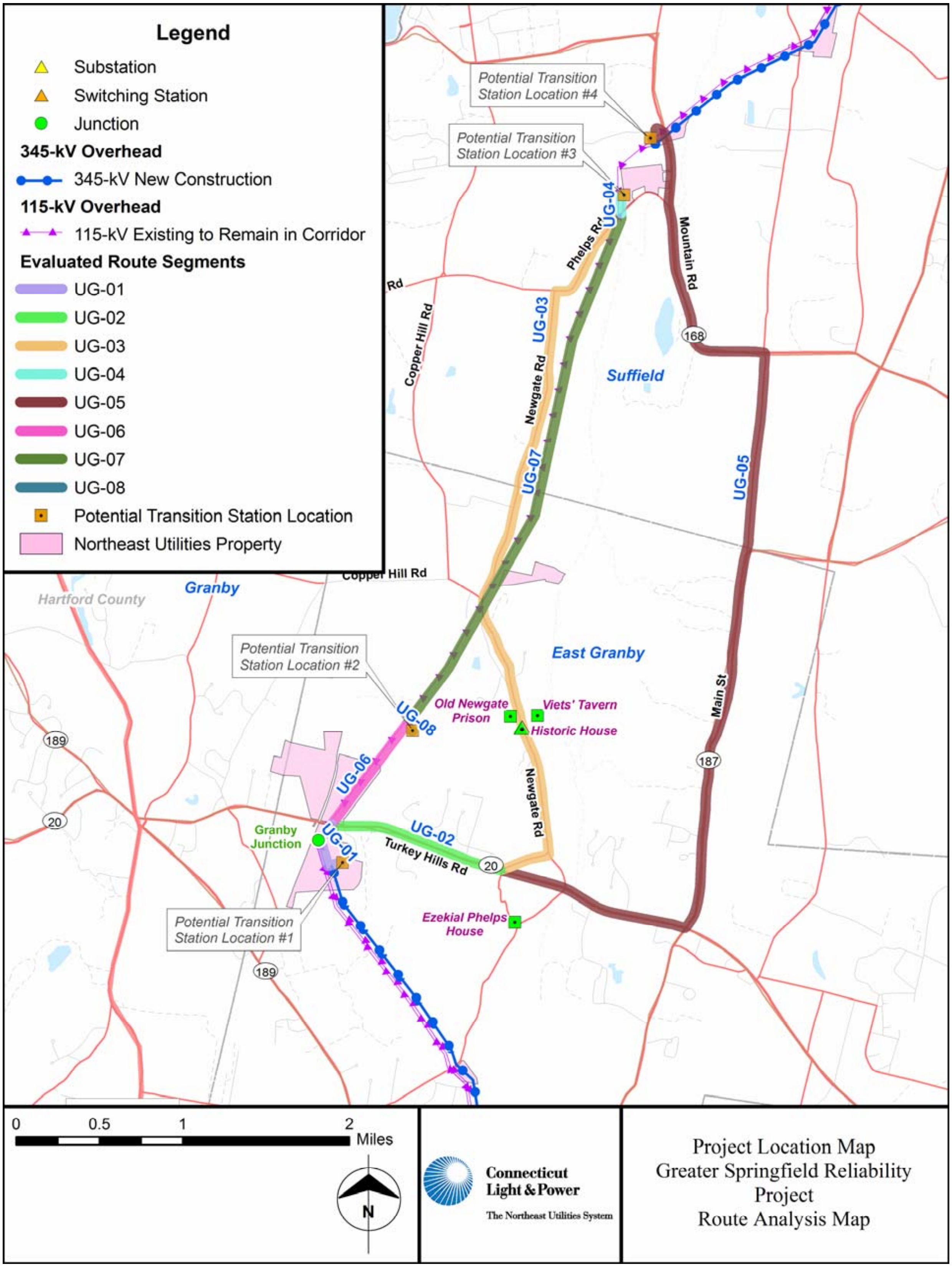
H.3 ROUTE VARIATIONS CONSIDERED BUT ELIMINATED

CL&P's evaluations determined that between the North Bloomfield Substation and the Connecticut/Massachusetts state border, there are a limited number of existing linear corridors along which the proposed 345-kV line could be aligned. For instance, in this region, there are no suitably located railroad or pipeline corridors to follow.

An abandoned railroad corridor that is currently in use as a bike path is located near the CL&P ROW at Granby Junction, where it diverges away from the CL&P transmission line corridor. The bike path corridor would have significantly greater environmental and social impacts for either an overhead or underground transmission line than an existing transmission line ROW and, as a result, was not considered a viable route option. The primary existing corridor is CL&P's existing transmission line ROW, which presently accommodates 115-kV facilities and extends north from the North Bloomfield Substation to interconnect with WMECO's 115-kV system at the Connecticut/Massachusetts state border.

The following subsections identify the line-route variations that were initially identified but subsequently eliminated from consideration as viable options for the proposed 345-kV transmission facilities. These route variations are depicted generally on the Figure H-1 Route Analysis Map.

Figure H-1: Route Analysis Map



H.3.1 New ROW Variation: Underground or Overhead Transmission Configuration

This variation would involve the development of the proposed 345-kV line along an entirely new ROW (sometimes referred to as a "greenfields" corridor), not adjacent to any other existing corridors. An entirely new corridor for a 345-kV overhead transmission line would require a minimum 100-foot-wide ROW, whereas a corridor for a new cross-country (non-street) underground transmission cable system would require a 40- to 60-foot-wide ROW.

However, the development of the 345-kV transmission facilities – either overhead or underground along an entirely new corridor was found to be impractical for both environmental and cost reasons. For example, to develop the proposed 345-kV transmission line along a new corridor, CL&P first would have to acquire new easements from private property owners, at considerable additional cost. To construct the proposed 345-kV facilities, the vegetation along the ROW would have to be removed and new access roads created. Compared to the use of an existing corridor, substantial adverse environmental effects would occur to wetlands, water resources, and land uses. Further, it is unlikely that federal and state environmental regulatory agencies would issue permits for such an entirely new ROW, if other viable options are available. The operation of the new 345-kV transmission line would require the long-term maintenance of the new corridor in land uses that are compatible with utility operation. For example, for an underground line, continuous access would have to be maintained along the ROW, and the ROW itself would have to be maintained in low-growth vegetation. For an overhead transmission line, the ROW would similarly have to be maintained in low-growth vegetation, and access would have to be maintained to structure sites.

Overall, the new corridor option was determined to be impractical based on environmental and cost considerations.

H.3.2 Use of Highway Only Variations

This variation would involve the alignment of the proposed 345-kV facilities (either overhead or underground) entirely within or adjacent to existing highway corridors. However, while the Connecticut GSRP region has a well-developed network of state and local highways, there are no interstate highways (which are characterized by wider ROWs) in the immediate vicinity (Interstate 91 is located approximately 5 to 8 miles to the east, on the eastern side of the Connecticut River).

As a result, the alignment of the Connecticut portion of the GSRP entirely along state and local roads between the North Bloomfield Substation and the Massachusetts state border was evaluated. To assess the feasibility of using these road ROWs for the proposed 345-kV transmission facilities, aerial photography and USGS topographic maps were reviewed, and field reconnaissance of the local and state road network was performed. The principal roads evaluated were State Routes 75, 168, 187 and 189; North/Canal Road, Petersen Road, Copper Hill Road, Griffin Road, Phelps Road, Mountain Road, Ratley Road, Warnertown Road, Main/Stone Street, East/Grand Street, Sheldon Street and Spruce Street.

The primary determinant of construction feasibility was adequate space for the transmission ROW (i.e., an overhead 345-kV transmission line requires an approximately 100-foot-wide ROW, whereas an underground 345-kV cable system requires 40 to 60 feet for construction). Steep side slopes, shallow depth to bedrock, and large wetlands/water resources were also considered major construction limitations. The major social constraint was the availability of adequate ROW without having to displace homes or businesses located adjacent to the state and local roads.

These analyses determined that the location of an overhead 345-kV transmission line along any of the state or local roads would be impractical due to cost, construction constraints, and potential social impacts associated with the need to remove homes or businesses. However, an all-underground transmission line configuration between the North Bloomfield Substation and the state border, following existing roads, was evaluated (refer to Section H.3.3) in further detail. In addition, certain limited portions of the road network were found to be potentially viable for the location of an underground transmission line. Such areas subsequently were evaluated in more detail and considered as potential underground variations to portions of the overhead transmission line configuration (refer to Section H.4 for further discussion).

H.3.3 All-Underground Cable Route Variation from North Bloomfield Substation to Connecticut/Massachusetts State Border

An applicant proposing an overhead electric transmission line must establish that it is "cost effective and the most appropriate variation based on a life-cycle cost analysis of the facility and underground variations to such facility…"[5] Accordingly, CL&P evaluated two "all-underground" transmission cable route variations for the Connecticut portion of the GSRP. These options, as shown in Figures H-2 and H-3, included:

- An underground alignment along CL&P's existing ROW between the North Bloomfield Substation and the Connecticut/Massachusetts state border; and
- An underground alignment within or adjacent to local and state routes, extending from the North Bloomfield Substation to the Connecticut/Massachusetts state border.

[5] Conn. Gen. Stats. Sec. 16-50p(a)(3)(D)

Figure H-2 All-Underground In-ROW Variation Considered But Eliminated

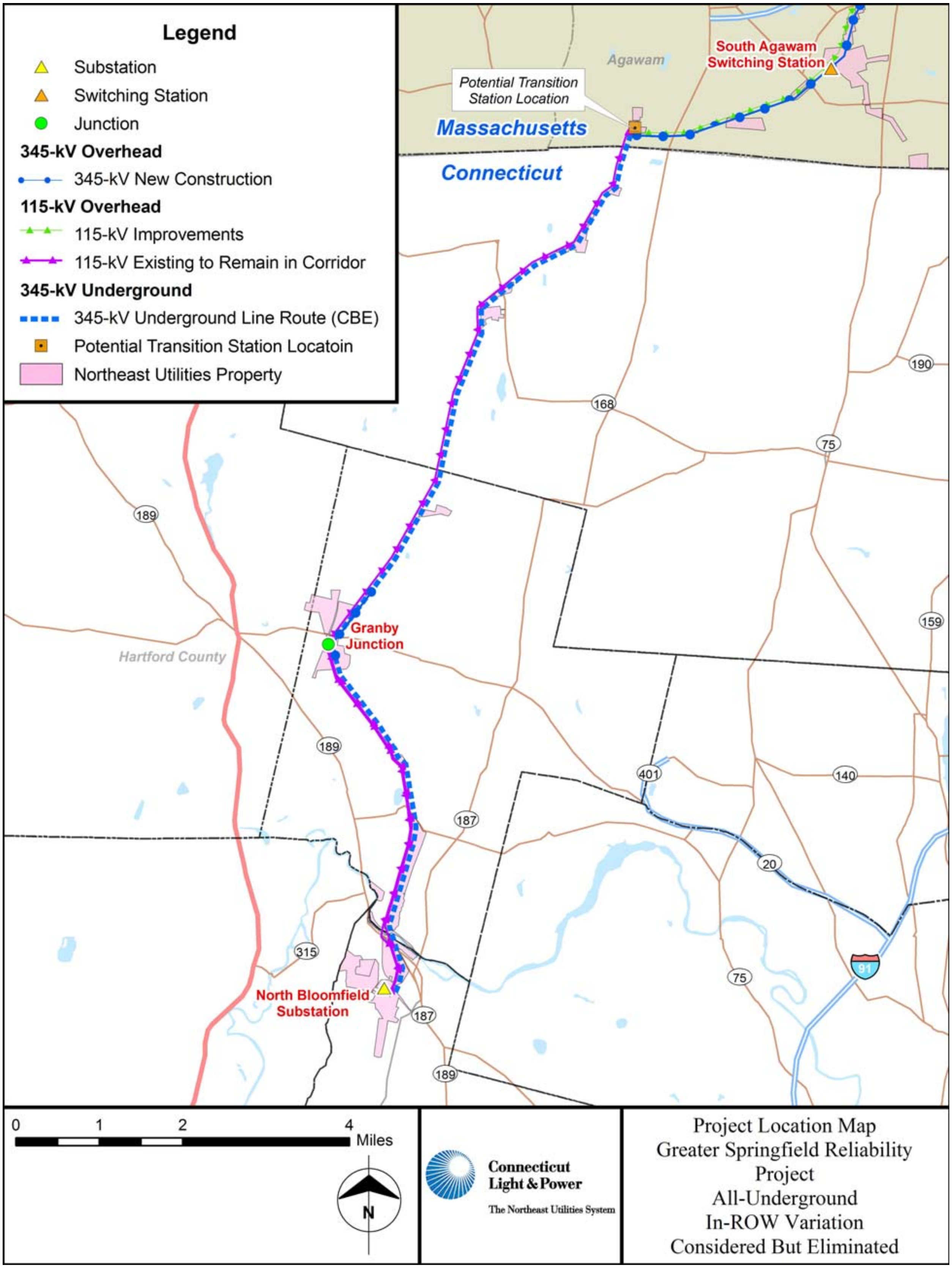
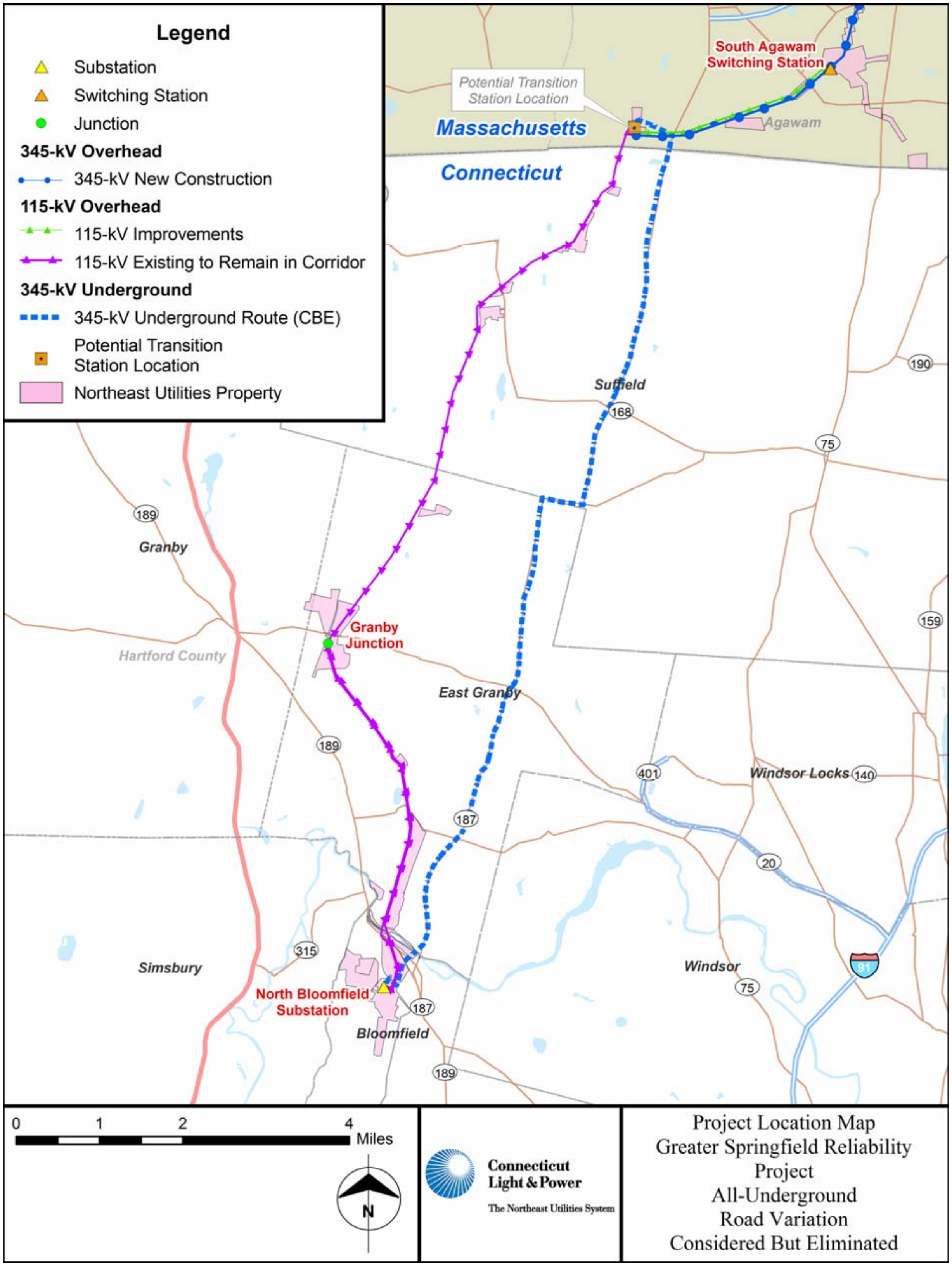


Figure H-3: All-Underground Road Variation Considered But Eliminated



Except where a 345-kV underground cable line section begins at an existing substation, transition stations, occupying 2 to 4 acres, would be required at either end of the transmission cable section in order to interconnect the underground cables to the overhead transmission line. Thus, for an all-underground 345-kV line on the Connecticut portion of the GSRP, a new transition station would be needed near the Massachusetts border, where the underground cables would interconnect to WMECO's overhead transmission line.

As discussed further in the following subsections, an all-underground line route, either within CL&P's existing overhead transmission line ROW or within/adjacent to the local and state road network, was determined to be impractical for the Connecticut portion of the GSRP due primarily to its excessive cost. In addition, compared to overhead lines, such an underground transmission line also would add operating complexity and would result in greater direct adverse environmental effects.

H.3.3.1 All-Underground Line Route Along CL&P's Existing Overhead Transmission Line ROW

This variation would involve the construction and operation of the 345-kV transmission facilities underground, within CL&P's existing ROW between the North Bloomfield Substation and the Connecticut/Massachusetts state border. The cables and associated splice vaults would be located adjacent to the existing 115-kV overhead transmission line, and could be accommodated within CL&P's typically 305- to 385-foot-wide ROW.

Both an in-ROW underground line route and an under-street line route would offer the advantage of avoiding the long-term visual effects associated with the development of another overhead transmission line. As compared to an under-street route, an in-ROW underground route offers the additional advantage of utilizing an existing utility corridor, without major traffic impacts. Underground construction within an existing overland ROW is also usually less expensive than construction in roads, because the trench can be shallower, the construction effort need not be designed and scheduled to accommodate traffic, road pavement (which would have to be replaced) is not disturbed, and there are few pre-existing subterranean utilities that must be avoided. The cost advantage of constructing within the transmission line ROW is enhanced when, as is the case here, the ROW route provides a direct connection between terminal points, whereas the street route between the same terminal points is more circuitous, and therefore longer. Finally, to the extent that magnetic fields are a concern, there may be less public exposure to the magnetic fields from cables buried in a ROW than to cables buried under or alongside public streets. See *Tutorial – Underground Electric Power Transmission Cable System* for the discussion of magnetic fields associated with underground cables in Volume 6.

However, the advantages of in-ROW construction are counterbalanced by the potentially significant adverse environmental impacts associated with the construction of an underground cable system within an overland electric transmission ROW, rather than in an already developed street. See the discussion of "Environmental Considerations" in Section H.5.1.2.

The all-underground variation would typically involve the disturbance to a 40-to 60-foot-wide section of the easement along the entire 12 miles between the North Bloomfield Substation and the Connecticut/Massachusetts state border, as well as the excavation of a continuous trench and associated splice vaults within this area. Numerous wetlands and watercourses, including the Farmington River, would have to be traversed. Based on the use of a 40 to 60-foot-wide ROW (which would be required to accommodate the trench excavation, splice vault excavation, and the creation of a permanent 20-foot-wide access road) a total of about 100 acres of land would be disturbed. Of this, an estimated 6 acres of water resources would be adversely affected by grading, trenching, or the permanent access road. In addition, an additional 2 to 4 acres fenced area at the Massachusetts-border end of the underground cable system segment would be permanently converted to utility use for the development of a transition station to interconnect the overhead and underground components of the transmission line.

The installation of a 12-mile underground 345-kV cable system along the transmission line ROW would require an estimated two years to complete, exclusive of final restoration of all disturbed areas (which may require another year). The initial "capital cost"[6] of such an in-ROW underground transmission cable system in 2008 dollars is estimated at approximately $455 million, as compared to the $41 million estimated cost of the overhead line with an H-frame design. The comparative "life-cycle" costs of the two systems, which take into account the anticipated maintenance costs of each technology over its anticipated useful life, are $648 million for the in-ROW all-underground line variation and $85 million for the overhead line. A comparison table of these costs is included in Table I-4 in section I.5.3 of the Application.

H.3.3.2 All-Underground Route Along or Adjacent to Existing Public Roads

CL&P's consultants, Burns & McDonnell, identified constructible under-street routes between the North Bloomfield Substation and the Connecticut/Massachusetts state border. These routes are illustrated on Figure H-3. It would leave the North Bloomfield Substation, follow Tariffville Road east for approximately 600 feet; continue north within the existing transmission line ROW, crossing the Farmington River adjacent to State Route 187/Main Street; then continue north along State Route 187/Main Street for approximately 5.7 miles to Sheldon Street; east along Sheldon Street for approximately 0.5 miles to Grand Street (State Route 187); and north along Grand Street for approximately 4.5 miles to the Connecticut/Massachusetts state border, where Grand Street becomes Pine Street. The route would then continue north along Pine Street (State Route 187) for approximately 0.2 miles to Barry Street; and west along Barry Street for approximately 0.5 miles, terminating at a potential transition station location south of Barry Street on property owned by WMECO. This route is illustrated by Figure H-3 on page H-22.

[6] All initial capital cost estimates are "all in" costs including direct construction cost, engineering, construction management, AFUDC, NU directs, NU indirects, and contingencies in 2008 dollars, escalated to estimated year of spend.

The initial "capital cost[7] to construct an underground transmission cable system along or adjacent to these existing public roads in 2008 dollars is estimated at approximately $479 million. This is $24 million more than the initial capital cost of the in-ROW variation, and over ten times the cost of the all-overhead line using an H-frame design. The estimated "life-cycle" costs of the all-underground line routed along or adjacent to public roads is $682 million, resulting in an even greater gap between the life-cycle costs of the all-underground transmission cable system within the existing transmission ROW and the all-overhead H-frame line than that between their initial capital costs. A calculation of these comparative costs is included in Appendix H-1 to this volume.

H.3.3.3 All-Underground Line Routes - Conclusion

For a route to be certified by the Council, it must be "technically, environmentally, and economically practical." For the purposes of this analysis, the all-underground potential variations have been assumed to be technically practical, although they would provide more operating complexity than an overhead line. An underground transmission cable system within the existing transmission line ROW is likely not to be an environmentally practical variation. Its far greater direct impacts on water resources as compared to an overhead line would prevent it from qualifying as the "least environmentally damaging practical variation," and thus from obtaining required permits from the USACE and CT DEP. The very large additional cost burdens of both underground variations disqualify them as "economically" practical.

H.4 CONNECTICUT PORTION OF THE NORTH BLOOMFIELD TO AGAWAM 345-kV LINE ROUTE AND POTENTIAL LINE-ROUTE VARIATIONS

Having dismissed the all-underground line variations, CL&P confirmed that development of the Connecticut GSRP line in an overhead configuration, within the existing transmission line ROW between

[7] All initial capital cost estimates are "all in" costs including direct construction cost, engineering, construction management, AFUDC, NU directs, NU indirects, and contingencies in 2008 dollars, escalated to estimated year of spend.

North Bloomfield Substation and the Connecticut/Massachusetts state border is the alternative that would best meet the specified routing objectives and criteria. The general characteristics of this route are summarized in Section H.4.1; detailed information regarding the proposed line route is presented in succeeding sections of this document.

In addition to this proposed line route, CL&P identified four potentially viable underground line variations to a portion of the proposed overhead line, for evaluation pursuant to Section 16-50p(i) of the Connecticut General Statutes (the "Statute"). This provision designates a group of land uses (collectively called here, for convenience, "Statutory Facilities") that the Council must consider in its review of new electric transmission lines. These are, in particular:

- Private or public schools
- Licensed child day-care facilities
- Licensed youth camps
- Public playgrounds
- Residential areas

The Council has previously construed "residential areas" as developed "neighborhoods," not residentially zoned land or sparsely settled rural or semi-rural areas.[8]

The Statute establishes a rebuttable presumption that electric transmission lines with a voltage of 345-kV or greater shall be constructed underground if they are "adjacent to" Statutory Facilities. This presumption may be overcome by a demonstration that it is infeasible to bury the lines for technical or economic reasons. The Council may, in such a case, approve overhead construction of a 345-kV line adjacent to statutory facilities, provided that it will be contained within a buffer zone adequate to protect

[8] CSC Docket 272 (Middletown to Norwalk 345-kV Line), Opinion, April 7, 2007.

public health and safety.[9] A ROW that provides clearance requirements consistent with generally applicable safety standards may qualify as such a buffer zone.[10]

The proposed new overhead 345-kV line would not be adjacent to any public or private school, licensed child day-care facility, licensed youth camp or public playground. The Council may or may not consider a group of homes along the section of the existing ROW between the points where Country Club Lane in East Granby comes closest to the ROW and where Phelps Road in Suffield intersects with the ROW to be sufficiently dense and integral to qualify as a statutory "residential area." The relationship of these homes to one another and to the existing transmission ROW is shown by Sheets 5 to 8 of 10 of the aerial-photography-based alignment maps in Volume 9 of this Application.

CL&P considers that the new line will not be "adjacent to" the homes on the more densely settled westerly side of this section of the ROW. Rather, the new line will be east of and "adjacent to" the existing 115-kV line that presently occupies the existing ROW in this area. These residences are to the west of, and adjacent to, the existing 115-kV line. Residences have also been identified to the east side of the ROW. Similar to the section of homes between the Country Club Lane and Phelps Road crossing, the Council may or may not consider this group of residences to be sufficiently dense and integral to qualify as a statutory "residential area."

Because the Council could determine that settlement along the section of ROW approximately between Country Club Lane and Phelps Road constitutes a "residential area" which is "adjacent to" the new 345-kV line, CL&P developed and assessed underground line-route variations that would substitute for the proposed overhead line along this section of the ROW. These underground line-route variations, which are discussed in Section H.4.2, involve either the installation of a 345-kV cable system within CL&P's existing overhead transmission line easement for a distance of 3.6 to 4.6 miles or the installation of the

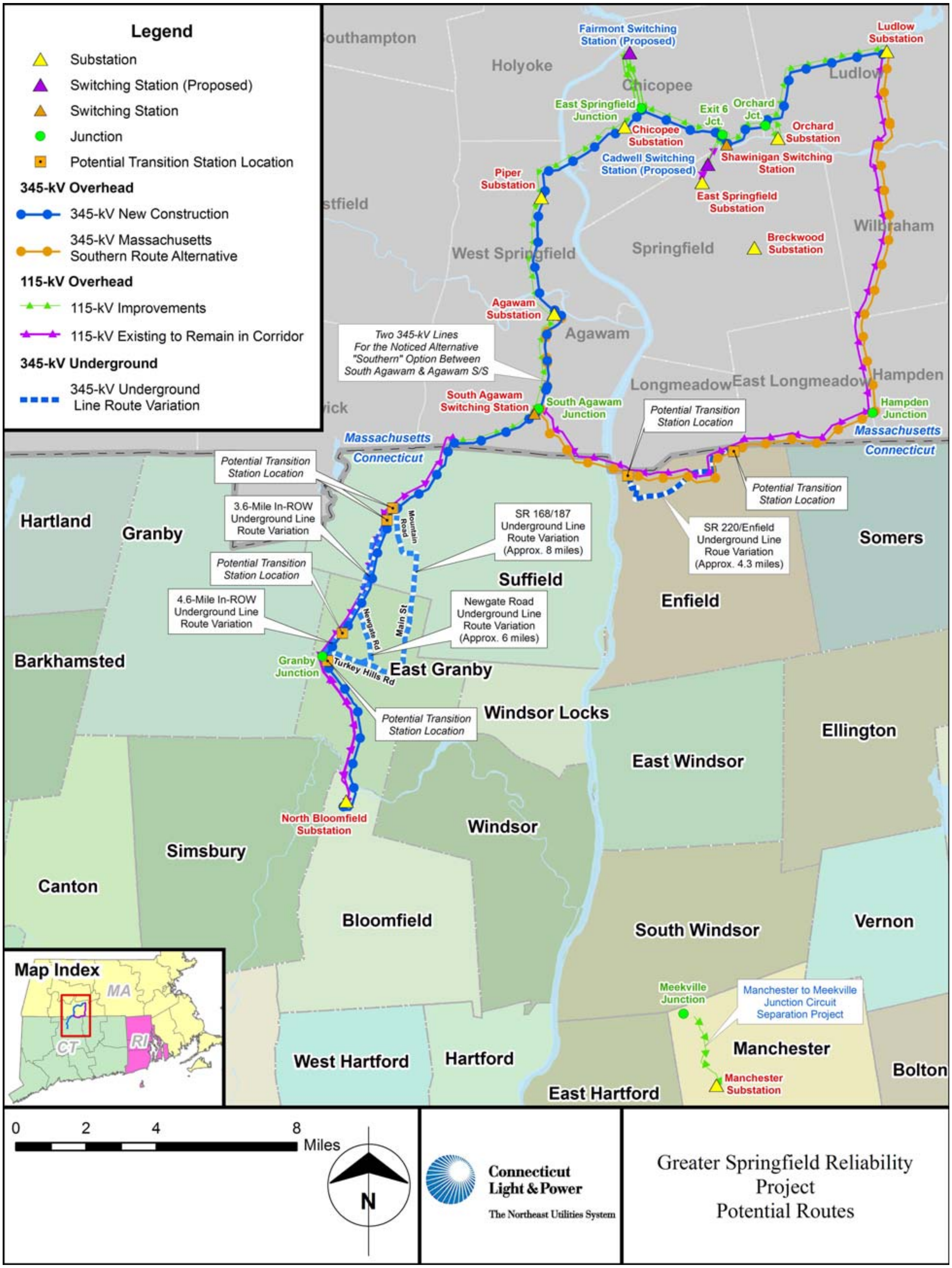
[9] Conn. Gen. Stat. Sec. 16-50p(i).
[10] Conn. Gen. Stat. Sec. 16-50p(i); Docket 272 Opinion at 14; Council's Best Management Practices for Electric and Magnetic Fields, Dec. 14, 2007, at 7Cite – BMPs of Dkt. 272

cable system within or adjacent to public road ROWs for a distance of 6 to 8 miles. The underground alternatives would replace a 3.6- to 5.1-mile section of the proposed overhead 345-kV transmission line route (depending on the underground option selected), and each would involve the development of transition stations on both ends of the underground cable section.

In addition, pursuant to the Council's EMF Best Management Practices (BMP) for Electric Transmission Lines in Connecticut, CL&P developed a Field Management Design Plan (Plan) to reduce the magnetic fields at the edges of the ROW that would be associated with the new and existing overhead lines along the Country Club Lane - Phelps Road section of the ROW. The Plan is included as an Appendix in Section O.

The locations of the proposed line route and the underground line-route variations are illustrated on Figure H-4 and described as follows.

Figure H-4: GSRP Potential Routes



H.4.1 Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route would traverse portions of the municipalities of Bloomfield, East Granby, and Suffield, following a CL&P ROW that has been partially occupied by power lines since 1924. From CL&P's existing North Bloomfield Substation in Bloomfield, the new transmission line would be constructed overhead within the existing CL&P ROW. This ROW continues north across State Route 189 and the Farmington River into East Granby, and then extends northwest, crossing Hatchett Hill Road (State Route 540) and Holcomb Street to Granby Junction. At Granby Junction, the ROW for the new line continues northeast across Turkey Hills Road (State Route 20) and Newgate Road to the East Granby/Suffield town border. The ROW then continues north, crossing Phelps Road, and then northeast, crossing Mountain Road (State Route 168) and Ratley Road to the Connecticut/Massachusetts state border. From the border, the route proceeds northeast and then north within the Town of Agawam, Massachusetts to WMECO's Agawam Substation.

Detailed technical and environmental information concerning the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route is presented in Sections I through N. In addition, the aerial photograph map sheets in Volumes 9 and 11 depict the location of the proposed transmission line route in relation to prominent land-use and environmental features. For each map sheet, the following information is summarized: existing and proposed overhead line structure configurations, route length and ROW width, and pertinent land uses. The first page of the aerial map sheets is a key map showing the location of each map sheet in relation to the proposed route. Table H-1 provides a key to the alignment map sheets, listing the various maps associated with each of the Connecticut municipalities that would be traversed by, or located within 2,500 feet of, the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

Table H-1 Key to Towns Along or Near the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, Aerial Alignment Map Sheets

Town	Traversed by Proposed Route	Aerial Alignment Map Sheet Number
Bloomfield	Yes	1
Simsbury	No	1-2
East Granby	Yes	2-6
Granby	No	4-5
Suffield	Yes	5-10

Figure H-5 provides an overview of this Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

Figure H-5: Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

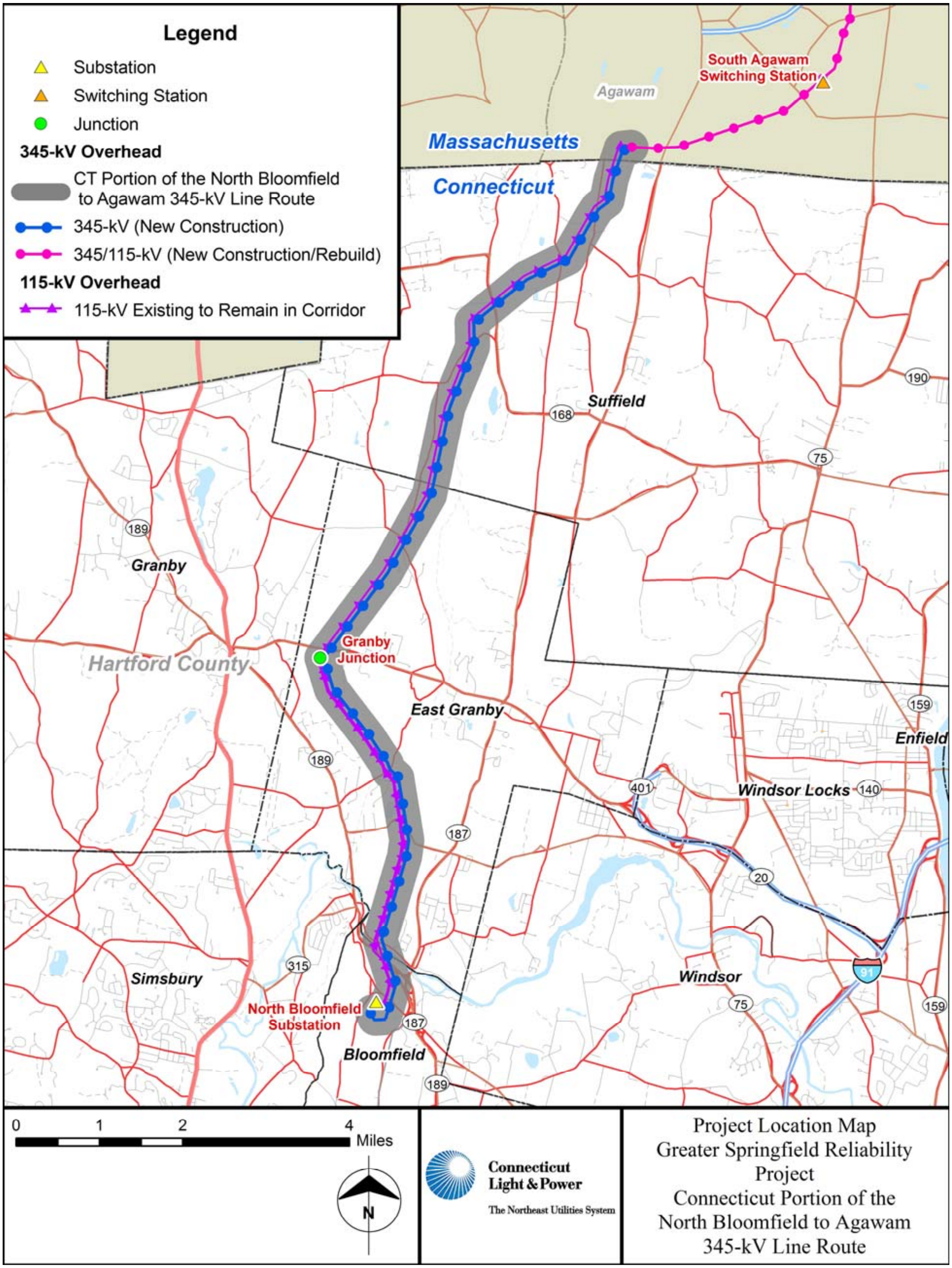


Table H-2 and the following subsection summarizes the primary characteristics of the approximately 12-mile 345-kV line route from North Bloomfield Substation to the Connecticut/Massachusetts state border, and discusses the proposed transmission line modifications (i.e., new 345-kV line and changes to existing 115-kV lines).

Table H-2 Summary of Engineering Design and ROW Characteristics for the Connecticut Portion of the North Bloomfield to Agawam Line Route

Feature	Proposed Route, by Segment	
	North Bloomfield to Granby Junction	**Granby Junction to Connecticut/Massachusetts State Border**
Towns	Bloomfield East Granby	East Granby Suffield
Total Length	4.7 miles	7.2 miles
Existing ROW Width	385 feet	305 feet
Existing Transmission Structure Type	Wood-pole H-frame structures average 60 feet in height and support one 115-kV circuit. Existing lattice-steel towers average 70 feet in height and support two 115-kV circuits. Existing wood distribution line poles are approximately 40 feet in height	Existing lattice-steel towers typically 70 feet in height and support two existing 115-kV circuits.
ROW Width Sufficient for new 345-kV Overhead Line	Yes	Additional ROW width would be required for the new line construction, approximately an additional 100 feet in width for a distance of approximately 1,000 linear feet between Phelps Road and Mountain Road, and for approximately 400 linear feet east of Ratley Road. At both locations, adjacent land is partially owned by CL&P.
Potential 345-kV Structure Type	The "base line" design for the new structures to support the new 345-kV circuit is steel-or wood-pole H-frames averaging about 90 feet in height with a horizontal configuration of the line conductors.	The "base line" design for the new structures to support the new 345-kV circuit is steel-or wood-pole H-frames averaging about 90 feet in height with a horizontal configuration of the line conductors. In its Field Management Design Plan, CL&P proposes to use steel monopoles averaging 110 feet in height with a delta configuration of the line conductors along the section of the ROW between crossings of Phelps and Newgate Roads, in order to reduce magnetic fields at the edges of the ROW.
Existing 115-kV Lines to be Removed	None of the existing line structures are to be removed; however, the existing 115-kV circuit sections will be removed from service once the 345-kV line is completed.	None of the existing line structures are to be removed, and the existing double-circuit 115-kV line will continue in use as a single-circuit.
New Structure Placement Options	New structure placement is based on existing structure locations.	New structure placement is based on existing structure locations.

CL&P contends that an overhead 345-kV line, using either the base H-frame design throughout, or a modification of that design in accordance with the Council's BMPs and CL&P's Field Management Design Plan, should be certified by the Council, rather than a route incorporating any of the underground cable variations, because:

- For the reasons discussed in the introduction to this Section H.4, the "underground presumption" of C.G.S. Section 16-50p(i) does not apply, because the proposed new 345-kV line will not be "adjacent to" any Statutory Facilities.
- If the Council were to determine that the presumption does apply, it will be overcome, because the vastly greater cost of underground line construction, as compared to the section of overhead line that they would replace, would have an unreasonable impact on ratepayers.
- The existing ROW will provide an adequate "buffer zone," especially if the new line is ordered to be built with reduced magnetic field design along this section of the ROW.

Moreover,

- The use of the existing ROW for an overhead line has fewer environmental impacts than construction of an underground transmission system within the existing transmission line ROW underground segment. See Section H.3.3, "All-Underground Cable Route Variations from North Bloomfield Substation to Connecticut/Massachusetts State Border", for a description of the underground variations.
- Inclusion of an underground section will make the North Bloomfield to Agawam 345-kV line more complicated and potentially less reliable than if it were built entirely overhead. See Section H.3.3, "All Underground Cable Route Variations from North Bloomfield Substation to Connecticut/Massachusetts State Border", for a description of the underground variations.

H.4.2 Potential Underground Line-Route Variations to Segments of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

CL&P identified four potential underground route variations. The objective of each of these variations would be to replace a portion of the proposed overhead transmission line route with an underground cable segment, thereby avoiding the location of the new 345-kV transmission line in an overhead configuration on the existing ROW in the vicinity of nearby residences.

CL&P identified two underground line variations that would be aligned along or within road ROWs; these options are referred to as the Newgate Road Underground Line Route Variation and the State Route 168/187 Underground Line Route Variation. In addition, CL&P identified two underground line variations that would be located within portions of the existing transmission line ROW; these options are designated as the 4.6-Mile In-ROW Underground Line Route Variation and the 3.6-Mile In-ROW Underground Line Route Variation.

The four underground line-route variations are alternatives to one another. Each would generally extend from Granby Junction north, through portions of the towns of East Granby and Suffield. Figures H-6, H-7, H-8 and H-9 identify the locations of these four route variations.

Any of the underground line variations would require the installation of a 345-kV cable system consisting of cables within conduits in a trench and cables within splice vaults, as well as transition stations. The vaults (one per each set of three XLPE cables), would be approximately 10 feet wide by 10 feet deep by 32 feet long, and would be buried approximately 1,600 feet apart along the cable route. The trench would normally be 5 feet wide and 7 to 10 feet deep, in order to accommodate conduits for the nine XLPE cables (each cable is approximately 6 inches in diameter) and associated equipment. The transition stations typically require a fenced-in and graded area approximately 2 to 4 acres in size, and would accommodate the equipment needed to connect the 345-kV underground transmission cables to the overhead transmission line. The power cables would be designed for nominal 345-kV operation. Three parallel sets of three XLPE-insulated cables would be installed, and two sets would normally be energized in parallel providing a summer normal capacity rating of approximately 1,200 MVA and a long time emergency (LTE) rating in summer of between 1,800 MW and 2,400 MW, depending upon the pre-emergency cable use. Because the LTE rating of a 345-kV circuit containing a section of these cables would be reduced to 1,200 MW or less following a cable or cable-splice failure, the third set of XLPE cables would be switched into service to restore the rated capacities of the cable system. Without this capability to switch in the third set of cables, on all days following the failure event, the circuit would be limited in summer months to the normal rating of one set of cables, approximately 600 to 700 MW. The location and repair of a cable or splice failure can potentially take many weeks, and absent the third set of cables, customers would be exposed to the burden of congestion costs during those weeks while the transmission system is operated to ensure reduced loadings over this circuit, with or without other transmission system contingencies.

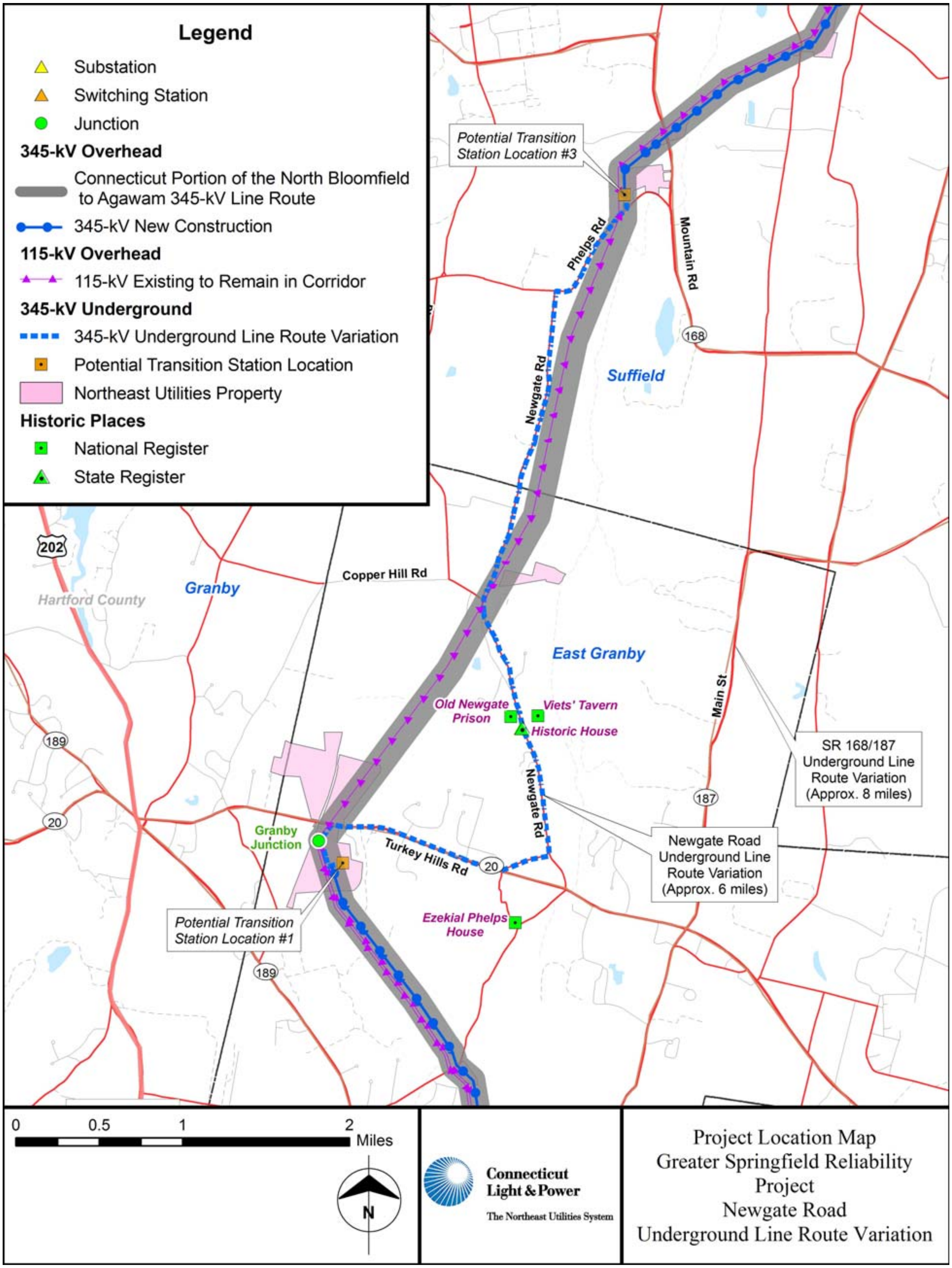
Aerial-photography-based alignment maps and descriptions of these underground cable-route variations are presented in the same format as the proposed overhead transmission line route (refer to Volumes 9 and 11). The following subsections (Sections H.4.2.1 through H.4.2.4) summarize the characteristics of the four underground route variations and evaluate the cost, engineering, and environmental implications that would be associated with the development of each.

Section H.5 compares the underground line-route variations to the portions of the proposed overhead transmission line route that each option would replace.

H.4.2.1 Newgate Road Underground Line Route Variation: East Granby and Suffield

The underground line segment in this variation would extend for about 6 miles, from Granby Junction (East Granby) to the intersection of the ROW with Phelps Road (Suffield), and would replace a 4.6-mile-long section of overhead line (see Figure H-5). The underground cables would be installed within the existing transmission line ROW for a short distance (approximately 1,000 feet) and then within and/or along public roads (Turkey Hills Road/State Route 20, Newgate Road, and Phelps Road.). Transition stations would be located adjacent to the ROW near Granby Junction and near its intersection with Phelps Road. The Granby Junction transition station could be built entirely on CL&P property. The northern transition station near Phelps Road could be partially built on CL&P property, but some (approximately 1 acre) private land would be required as well.

Figure H-6: Newgate Road Underground Line Route Variation

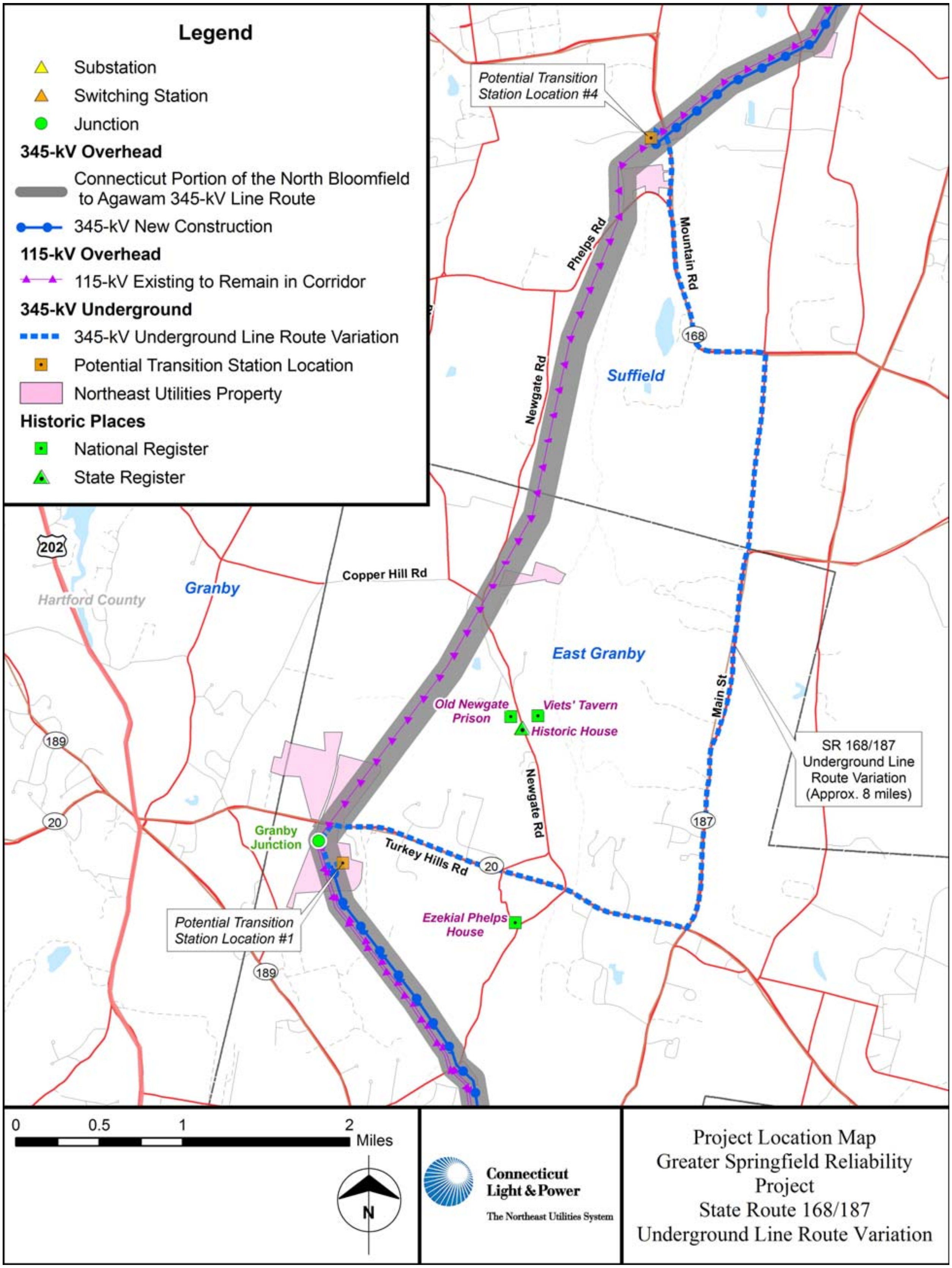


Additional ROW would be required at the northern transition station near Phelps Road; temporary and permanent easements may also be required at the splice-vault locations. A portion of this route would pass by Newgate Prison, which is listed on the National Register of Historic Places and also designated as a National Historic Landmark (a higher status because of its exceptional value to the entire country). Underground mining tunnels that are part of the historic site traverse Newgate Road under the roadway. In addition, the above ground stone walls that comprise Newgate Prison are within 10 feet of the edge of pavement for Newgate Road and may be affected by vibrations associated with construction at this location.

H.4.2.2 State Route 168/187 Underground Line Route Variation: East Granby and Suffield

The underground line segment in this variation would extend for about 8 miles, starting at Granby Junction, where the Newgate Road Underground Line Route Variation would also begin, but would continue farther north, terminating where the existing CL&P transmission line ROW intersects with Phelps Road (Suffield). This variation would replace an approximately 4.6-mile-long section of overhead line (see Figure H-7). The route of this underground variation would be located within the transmission line ROW for a short distance (approximately 1,000 feet) and then within and along Turkey Hills Road (State Route 20), North Main Street, South Stone Street (State Route 187), and Mountain Road (State Route 168). Construction and ROW requirements would be similar to those for the Newgate Road Underground Line Route Variation discussed in the previous section.

Figure H-7: State Route 168/187 Underground Line Route Variation



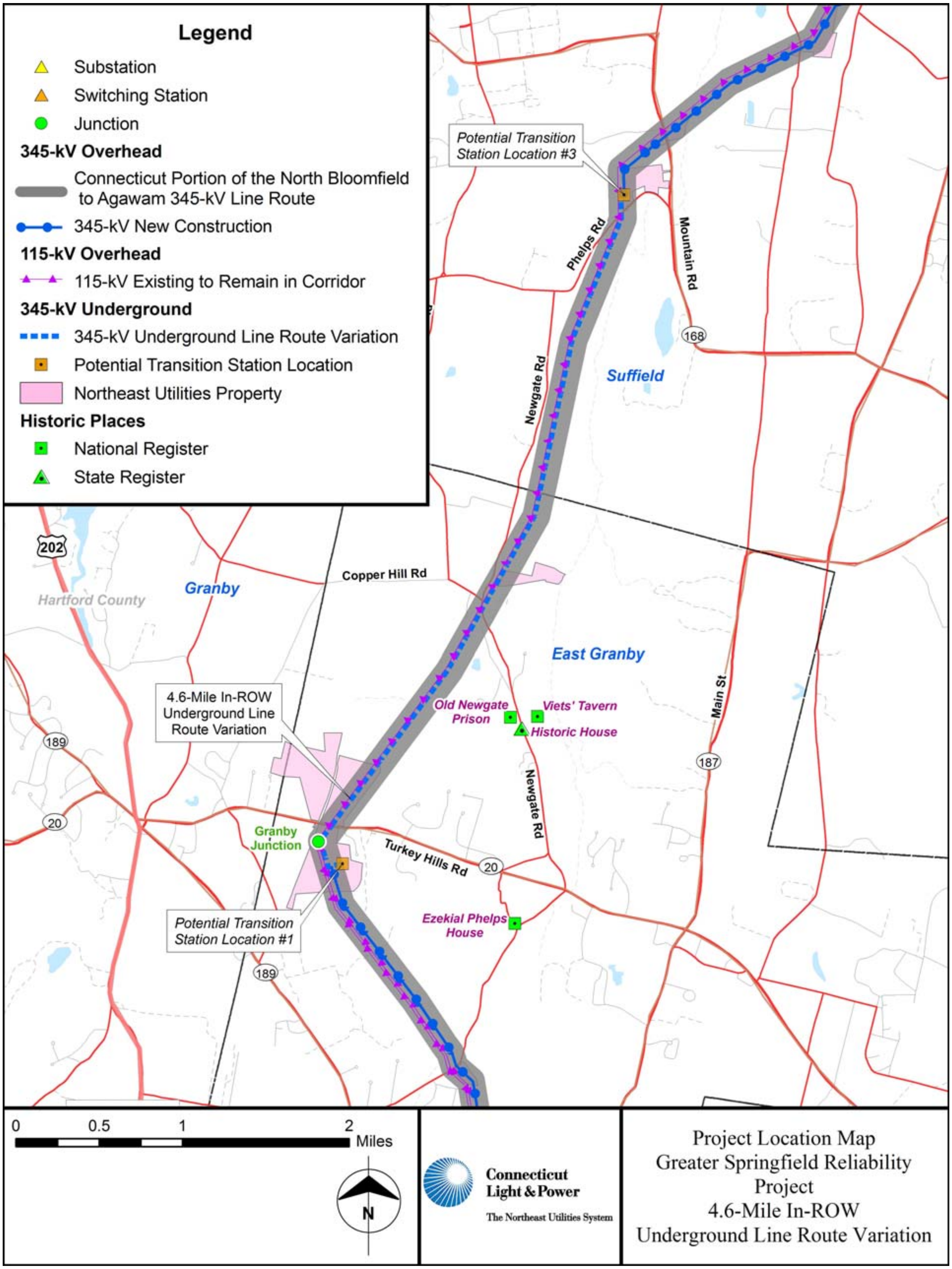
H.4.2.3 4.6-Mile In-ROW Underground Line Route Variation: East Granby and Suffield

The underground line segment in this variation would extend for about 4.6 miles, starting at Granby Junction and extending north within the existing overhead transmission line ROW to a transition station site that has been identified north of Phelps Road (in Suffield) (see Figure H-8). This option would replace a 4.6-mile segment of the proposed overhead transmission line.

Compared to the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route configuration, this underground line route variation would minimize long-term visual effects associated with the installation of the 345-kV overhead line. However, as discussed in Section H.5.1.2 for the all-underground cable route within the ROW that was eliminated from consideration, the burial of the underground cable system within the existing transmission line ROW would result in direct and significant impacts to environmental resources (i.e., upland vegetation, wetlands [including vernal pools], watercourses, critical species habitat, cultural resources) along the ROW. These impacts would occur during the construction phase, and also would remain during the life of the project (operational phase) since a permanent and continuous access road would have to be developed along the ROW to provide access to the entire cable system.

Splice vaults would also be located within the existing ROW and would require additional clearing of vegetation. This route would also cross a large wetland, approximately 1,500 feet long, located north of Turkey Hills Road. Crossing this wetland with a horizontal directional drill (HDD) may be possible, but this distance is at the upper limit of HDD length for 345-kV transmission line ductbank, considering vault spacing requirements and the length needed to tie in the vaults on each side of the HDD. Further geotechnical investigations would be needed to verify that the subsurface conditions are compatible with an HDD of this length. Also, temporary workspace would need to be created for a drill-rig setup, and would encroach on the limits of existing wetlands. Lastly, HDDs are costly and there is a risk of an inadvertent return of drilling fluid to the surface, which could affect the wetland resource.

Figure H-8: 4.6-Mile In-ROW Underground Line Route Variation

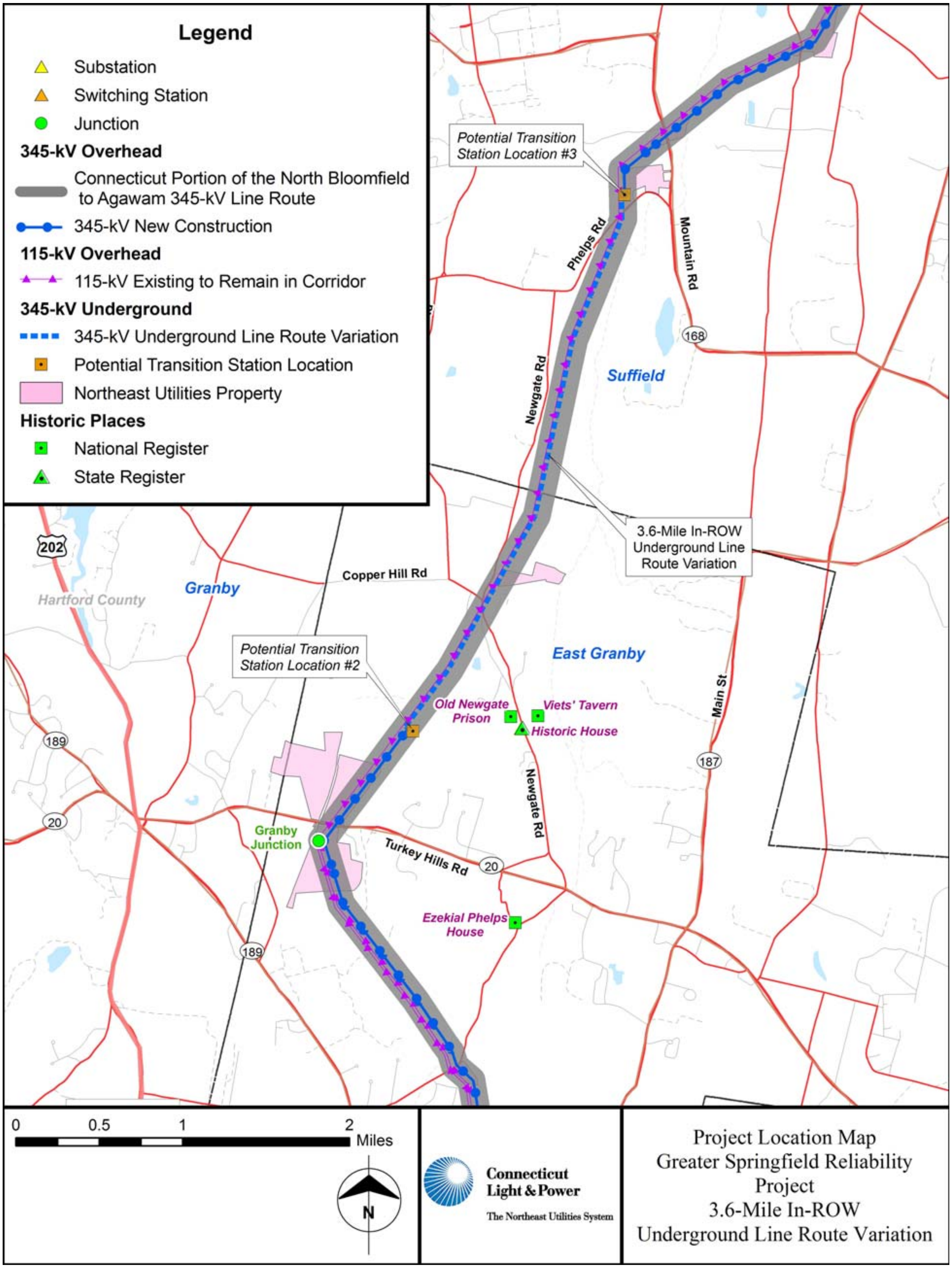


H.4.2.4 3.6-Mile In-ROW Underground Line Route Variation: East Granby and Suffield

The underground line segment in this variation would extend for about 3.6 miles, starting at a potential transition station site (identified on Figure H-9 as Transition Station 2 and located approximately 0.8 miles south of Newgate Road), and extending within the existing overhead transmission line ROW to potential transition station location #3, located north of Phelps Road in Suffield. This route variation was developed as an alternative to reduce the wetland impacts that would be associated with the 4.6-Mile In-ROW Underground Line Route Variation. While this route variation would minimize impacts to water resources, its northerly transition station would have to be located partially within the existing transmission line ROW and partially within property owned by the State of Connecticut, within the Newgate Wildlife Management Area. This variation could not be built unless CL&P were able to obtain the necessary rights to build a transition station on this state land.

Construction impacts would be similar to those described above for the 4.6-Mile In-ROW Underground Route Variation, except that impacts to approximately 9 acres of wetlands would be avoided, and one of the transition stations would require the use of approximately 2 to 4 acres in a protected wildlife preserve.

Figure H-9: 3.6-Mile In-ROW Underground Line Route Variation



H.5 UNDERGROUND LINE ROUTE VARIATION AND PROPOSED OVERHEAD LINE COMPARISONS

The following sections provide additional detail with respect to the comparative costs and environmental impacts of the underground line variations and the segments of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route that they would replace.

H.5.1 Summary of Rationale for Selecting the Proposed Overhead Transmission Line vs. the Underground Line Route Variations

Each of the underground line-route variations would result in some benefits, principally in terms of avoiding the long-term incremental impact of views of a second overhead transmission line on the ROW. However, these benefits would be far outweighed by the significant adverse environmental and cost effects, compared to the use of an overhead 345-kV line configuration along the existing ROW. These effects, which are described further in Section H.5.1.1, H.5.1.2 and H.5.1.3, include:

- **Increased Costs**. The development of an underground cable system would require significant additional capital cost expenditures, compared to the overhead line option. These additional costs would have to be borne by power consumers.
- **Greater Environmental Impacts**. The development of any of the underground line variations would result in significantly greater disturbance to soil resources, would increase the potential for erosion and sedimentation, and would involve direct impacts (associated with trenching required to install the cables and the excavations required for the splice vaults) to water resources.
- **Reliability Issues.** As discussed in Section H.1.3, even assuming that the underground line variations would present no disqualifying issue, such as unacceptable temporary overvoltage conditions, a hybrid line including an underground segment would have greater operating complexity than an all-overhead line.

H.5.1.1 Estimated Cost of Potential Underground Line Route Variations as Compared with the Overhead Line Section They Would Replace

The table below compares the estimated costs of the potential underground line variations and the proposed overhead line within Connecticut. Both of the underground line variations replace approximately 4.6 miles of overhead line. The Newgate Road Underground Line Route Variation includes 6 miles of underground transmission cables and would increase the total project cost by approximately $248 million. The State Route 168/187 Underground Line Route Variation would replace 4.6 miles of overhead transmission line with 8 miles of underground transmission cables; this underground alternative would add approximately $322 million to the total project cost. The 3.6-Mile In-ROW Underground Line Route Variation includes 3.6 miles of underground transmission cables and would increase the total project cost by approximately $154 million. The 4.6-Mile In-ROW Underground Line Route Variation includes 4.6 miles of underground transmission cables and would increase the total project cost by approximately $184 million. The total GSRP cost for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route is approximately $133 million.

Table H-3 Comparison of Costs: Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route to Variations

Underground Alternative Estimates (GSRP - CT)	
Route	**Total CT Project Costs**
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (All OH) - 12 miles	$133,370,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (including 3.6-Mile In-ROW Underground Line Route Variation)	$286,957,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (including 4.6-Mile In-ROW Underground Line Route Variation)	$317,817,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (including Newgate Road Underground Line Route Variation - 6 miles)	$380,631,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (including State Route 168/187 Underground Line Route Variation - 8 miles)	$455,306,000

H.5.1.2 Environmental Considerations in Overhead vs. Underground Line-Route Variation Comparisons

Limits of Vegetation Clearing

Construction of an underground transmission line on the overhead line ROW would require less vegetation clearing than would be required for the overhead line construction along the same route because it would be partially located within a cleared ROW. Clearing would be required to construct access roads, duct-bank trench, and splice vaults. Unlike overhead line ROW, where certain trees may remain, the continuous linear underground construction would require clearing of all existing trees and shrubs in the direct path of the construction.

In addition, temporary construction work areas would be required to accommodate heavy construction equipment, including the large cranes required to lift the splice vaults into place, as well as to store quantities of materials and supplies needed for the underground cable construction, such as trench boxes, other shoring materials, flow-fill and other suitable backfill materials. At the same time, locations would be required for the storage of excavated materials, including stockpiles of topsoil and subsoil. Areas for equipment parking, equipment turnaround, and equipment storage also would be required.

Temporary and Permanent Access Roads

Access roads would be required for the entire length of the in-ROW underground line routes, including through wetlands. In areas where splice vaults are to be located, the access roads may need to be widened or expanded across a wider width of the ROW to allow access directly to the vault locations for the delivery of the cable. All the access roads would need to be wider, and of better quality than the access roads typically utilized for overhead line construction access. Due to their height and weight, reels of the underground cable are transported using special permit vehicles which would need access to each splice vault along the length of the underground line route. Approximately 3.6 to 4.6 miles of permanent access roads would need to be installed for the in-ROW underground line routes and an estimated 3.4 miles of narrower and lower quality access roads for the overhead route, some of which could be temporary and removed after construction is complete.

For maintenance purposes at splice vaults and transition stations, the access roads will need to remain in place and be continually cleared of vegetative growth following construction. If an underground cable fails during operation, it will need to be replaced as soon as possible, which would require vehicular access with oversized vehicles. An underground cable could fail in any section; therefore, nearly all roads which provide access to splice vaults would need to remain.

Permanent Wetland Impacts

Most access roads will need to remain in place across existing wetlands to provide access to splice vaults and transition stations, and the fact that access roads need to be properly maintained causes permanent impacts to wetlands. In some cases, the width of wetland impact may be 50 feet wide or greater, as embankments would need to be constructed to cross the wetlands.

Visibility

Although a majority of the underground transmission line would not be visible to the public, the underground route would have visibility impacts associated with the two transition stations in locations that currently do not have these facilities. The footprint for a transition station would be 2 to 4 acres. Potential transition station location 2 would probably not be visible from the existing overhead transmission line crossing at Newgate Road looking south, but may be visible from other locations along Newgate Road such as Old Newgate Prison. Potential transition station location 3, located just north of Phelps Road, would be visible from the existing overhead transmission line crossing at Phelps Road and from residences adjacent to the location.

The 345-kV overhead line would be visible at road crossings and some residences along the route. A majority of the residences along the overhead transmission line route are located adjacent to and to the west of the existing transmission line ROW so that the new overhead line would be somewhat less visible to those residences than if it were located on the west side of the ROW.

H.5.1.3 Comparison of the Comparative Summary of the Proposed 345-kV Overhead Line and Underground Line Route Variations

The following table compare each of the underground line-route variations to the portion of the proposed overhead 345-kV line that each would replace. As this table illustrates, the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route is superior to the underground line variations based on cost, environmental features, and construction/engineering considerations.

Table H-4 Comparative Summary of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route 345-kV Overhead Line and 3.6-Mile In-ROW, 4.6-Mile In-ROW, Newgate Road and State Route 168/187 Underground Line Route Variations, East Granby and Suffield

Criteria	Overhead 345-kV Line Segment[11] (Proposed Route)	Underground Variation (3.6-Mile In-ROW)	Underground Variation (4.6-Mile In-ROW)	Underground Variation (Newgate Road)	Underground Variation (State Route 168/187)
Route Segment Length	Ranges from 3.6 to 5 miles	3.6 miles	4.6 miles	6 miles	8 miles
Location (Towns)	East Granby, Suffield	East Granby, Suffield	East Granby, Suffield	East Granby, Suffield	East Granby, Suffield
Total Connecticut Project Estimated Cost*	$134 million	$287 million	$318 million	$381 million	$456 million
Additional ROW or Land Required (Y or N); If Y, Acreage	N	Y (two transition stations, totaling 4 to 8 acres)	Y (two transition stations, totaling 4 to 8 acres)	Y (two transition stations, totaling 4 to 8 acres)	Y (two transition stations, totaling 4 to 8 acres)
Additional Private Property Acquisition Required (Y or N); If Y, acreage	N	Y (for transition stations and additional underground easement rights along existing	Y (for transition stations and additional underground easement rights along existing overhead transmission	Y (for transition stations and additional underground easement rights for any locations off	Y (for transition stations and additional underground easement rights for any locations off road ROW)

[11] Includes only portion of overhead transmission line that would be replaced by the underground variation.

Criteria	Overhead 345-kV Line Segment[11] (Proposed Route)	Underground Variation (3.6-Mile In-ROW)	Underground Variation (4.6-Mile In-ROW)	Underground Variation (Newgate Road)	Underground Variation (State Route 168/187)
		overhead transmission line ROW)	line ROW)	road ROW)	
Vegetation Clearing Required (Total)	38.2 to 42.6 acres (estimated)	4.9 acres (estimated)	10.0 acres (estimated)	4.3 acres (estimated)	3.4 acres (estimated)
Wetlands Affected	7.1 to 17.4 acres (estimated)	2.2 acres (estimated)	11.2 acres (estimated)	0.1 acres (estimated)	0.1 acres (estimated)
Streams Crossed (No.)	6	5	6	8	8
Access Roads	Temporary and/or Permanent access required to structures along route	Permanent access required along entire route (approx. 3.6 miles). Will affect 8.7 acres permanently, based on a 20-foot-wide road	Permanent access required along entire route (approx. 4.6 miles). Will affect 11.2 acres permanently, based on a 20-foot-wide road		
Visibility	Adjacent to existing 115-kV line; modifications to visual environment due to location of new 345-kV line within existing ROW	Changes associated with two new transition stations	Changes associated with two new transition stations	Changes associated with two new transition stations	Changes associated with two new transition stations

**Note: Project cost is based on cost for the Connecticut portion of the routes to be a total cost (underground and overhead for each variation) from North Bloomfield Substation to the Connecticut/Massachusetts state border.*

These comparisons caused CL&P to conclude that none of the underground line variations are superior to the proposed overhead line route. However, if the Council requires the undergrounding of a portion of the GSRP 345-kV line, CL&P could potentially construct and operate any of the underground line variations, albeit it at significantly greater costs to consumers, and with greater environmental impacts. Further, it should be recognized that comparatively significant and unavoidable impacts to water resources would be associated with locating the underground cable system within the existing transmission line ROW, and this may not represent a "least environmentally damaging practical alternative", as defined by the USACE, pursuant to Section 404 of the federal Clean Water Act. Similarly, such significant effects to water resources may not be acceptable to the CT DEP, which must issue a water quality certificate to the Connecticut portion of the GSRP, pursuant to Section 401 of the federal Clean Water Act. Thus, the underground line variations on the ROW would face regulatory hurdles and may not, after detailed and comparative analysis by agencies other than the Council, be permittable.

H.6 CONNECTICUT PORTIONS OF THE MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE FOR THE AGAWAM TO LUDLOW 345-kV LINE

H.6.1 Background of the Massachusetts Southern Route Alternative for the Agawam to Ludlow 345-kV Line

Each of the two alternate Agawam to Ludlow 345-kV line routes would be located on existing ROWs, and together with the North Bloomfield to Agawam line would establish the required North Bloomfield-Agawam-Ludlow 345-kV connection. The two alternate routes between Agawam and Ludlow are illustrated in Figure H-4; as this figure illustrates, the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route would locate the 345-kV line around the City of Springfield to the north and west, while the Massachusetts Southern Route Alternative would align the 345-kV facilities to the east and south through Greater Springfield.

In its application to the Massachusetts EFSB, WMECO will express a strong preference for approval of the Northern Route, because it has fewer environmental impacts, and will cost less, compared to the Massachusetts Southern Route Alternative. The support for this position is set forth in detail in the *GSRP Solution Report,* provided as part of Volume 5 of this Application, at pages 3-14 to 3-26. The Northern Route is located entirely in Massachusetts. However, the EFSB may nevertheless determine to approve the Massachusetts Southern Route Alternative. Since a portion of that route would be located in

Connecticut, CL&P must seek approval for that portion of the route from the Council, contingent on its being selected by the EFSB.

The Massachusetts Southern Route Alternative would extend from Agawam Substation south to South Agawam Junction, and then east, following existing ROWs which generally parallel the Connecticut/Massachusetts state border, before turning north (at Hampden Junction) to reach the Ludlow Substation. For a distance of approximately 3.2 miles between the Agawam Substation and South Agawam Junction, the new 345-kV line, if built on this route, would share the ROW with the new North Bloomfield to Agawam 345-kV line, so that this segment of ROW would have to be widened by approximately 65 feet, assuming vertical line configurations.

This section summarizes the variations considered for the Connecticut Portion of the Massachusetts Southern Route Alternative. However, because the Massachusetts Southern Route Alternative was identified to follow existing overhead transmission line corridors, only two options were considered:

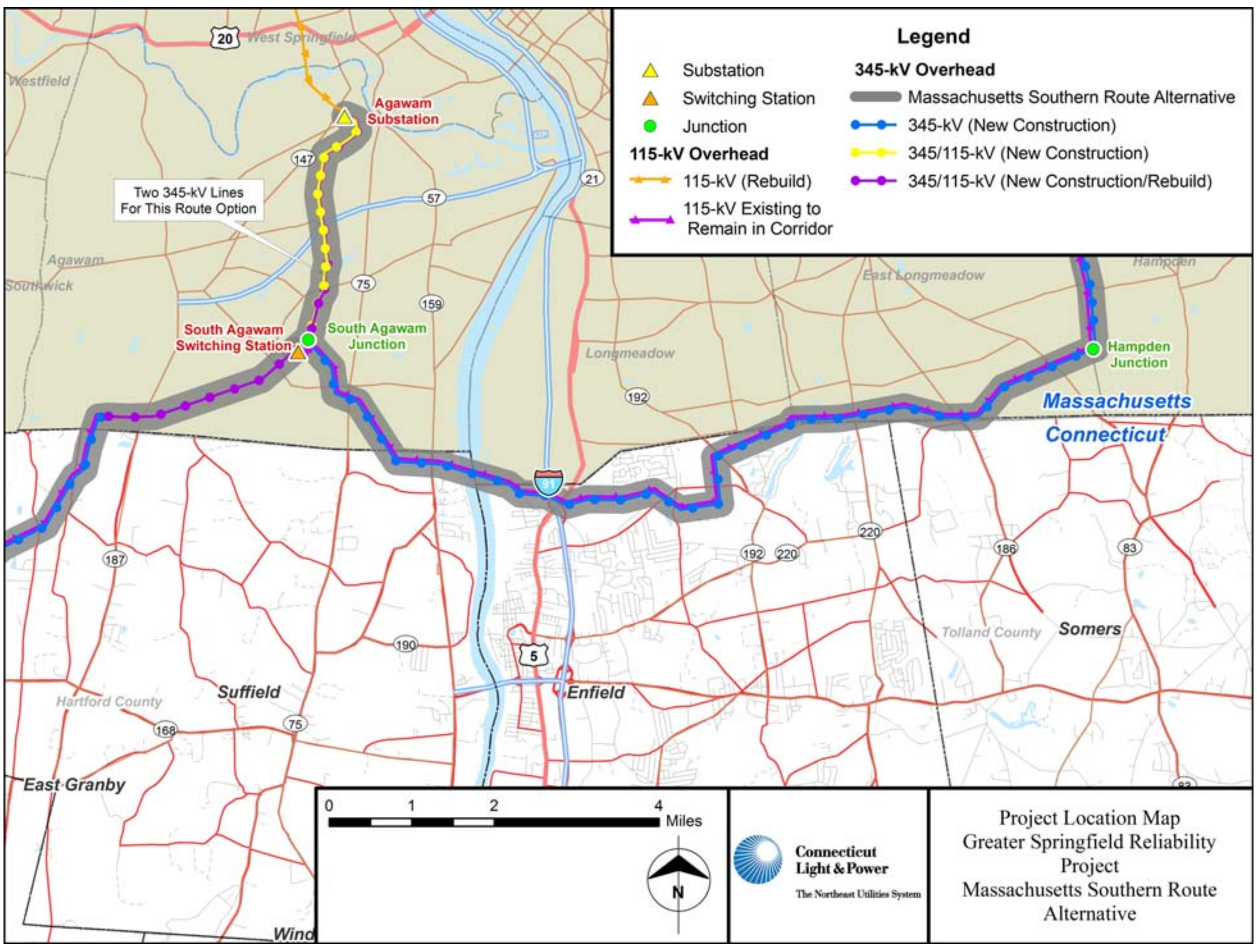
- The alignment of the 345-kV line within the existing overhead transmission line ROW; or
- A hybrid alignment of the 345-kV line within the existing overhead transmission line ROW, except for a 4.3-mile underground variation, along which the 345-kV line would be routed to avoid proximity to various residences that could potentially qualify as Council statutory "residential areas".

Following an existing CL&P ROW, the Connecticut Portion of the Massachusetts Southern Route Alternative would traverse approximately 3.7 miles of densely developed neighborhoods in Enfield, beginning west of Interstate 91 and continuing east, past North Maple Street (State Route 192) to Mayfield Road. These neighborhoods appear to qualify as statutory "residential areas."

H.6.2 Connecticut Portion of the Massachusetts Southern Route Alternative Overhead Line Configuration

This overhead line route would extend south from Agawam Substation and then east from South Agawam Junction along existing transmission line ROWs. Approximately 5.4 miles of this route would be located in Connecticut (refer to Figure H-10). The route would cross the Massachusetts border into Connecticut in Suffield, traverse Suffield for approximately 1.1 mile, cross the Connecticut River back into Massachusetts for less than 1 mile, and then crosses back into Connecticut again in Enfield, where it continues east for about 4.3 miles before crossing back into Massachusetts to continue north to the Ludlow Substation, following an existing WMECO ROW.

Figure H-10: Massachusetts Southern Route Alternative



The existing ROW along the Connecticut portion of this route is generally 280 to 300 feet wide. There is an existing 115-kV circuit on the ROW, supported by wood-pole H-frame structures that average 60 feet in height. There is sufficient room on the ROW for a new 345-kV overhead line. Standard construction in this circumstance would consist of steel-pole or wood-pole H-frame structures averaging about 90 feet in height.

About 3.7 miles of the Connecticut portion of the ROW in Enfield beginning west of Interstate 91 and continuing east, past North Maples Street (State Route 192) to Mayfield Road is bordered on both sides by dense residential development that appears to conform to the Council's definition of "residential areas." In order to reduce magnetic field levels in these areas, taller steel monopoles of 110 feet or higher, with the conductors arrayed in a vertical or delta configuration may be used.

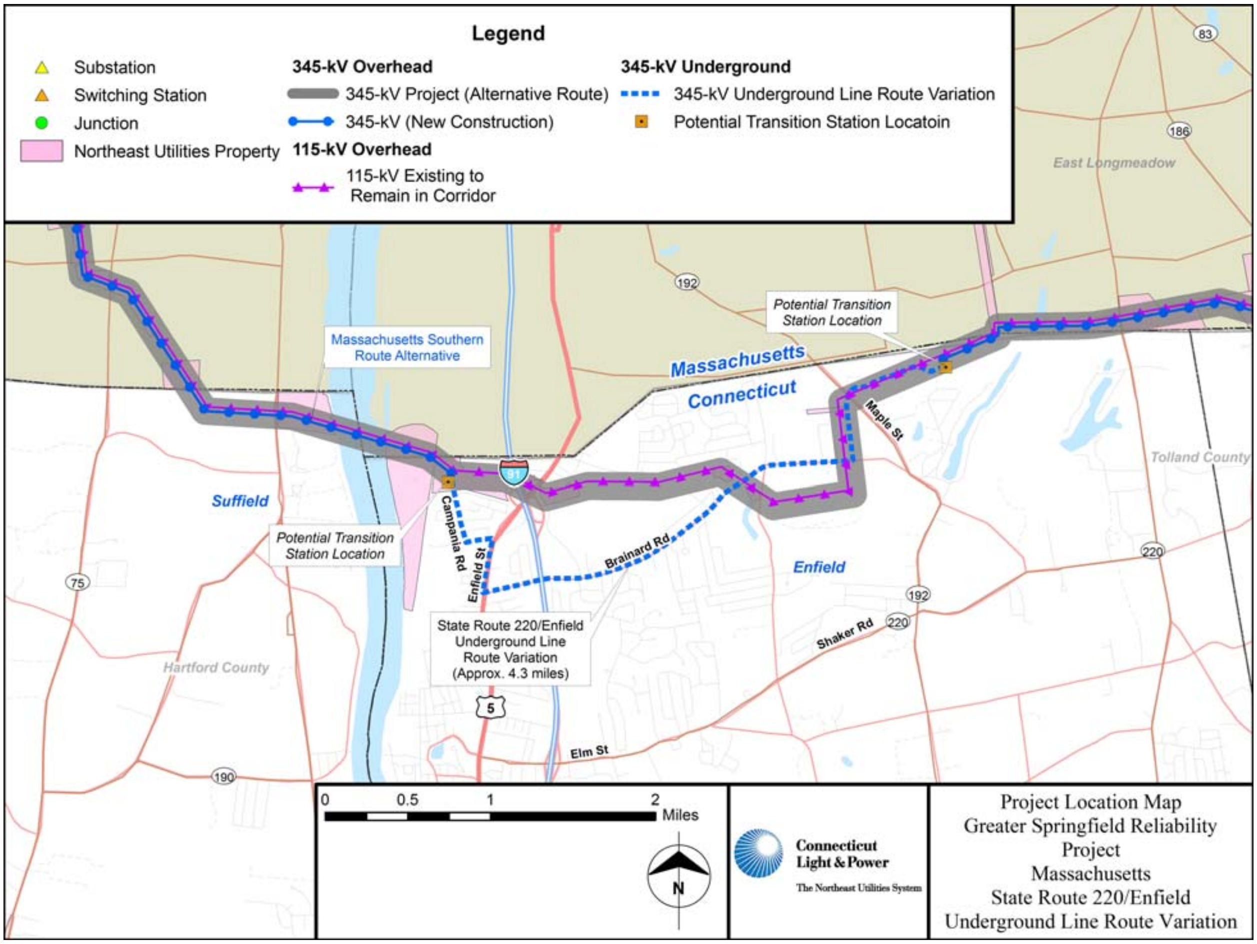
H.6.3 Connecticut Portion of the Massachusetts Southern Route Alternative Underground Line Route Variation

This hybrid overhead-underground line route would substitute an underground cable segment for the section of overhead line that would be adjacent to the residential areas in Enfield (refer to Figure H-11). Thus, a 3.7-mile portion of the overhead 5.4-mile Massachusetts Southern Route Alternative would be replaced by an approximately 4.3-mile section of nine underground cables. This cable system would be installed primarily in and adjacent to state and local public roads.

The 345-kV underground cable system would diverge from the existing overhead ROW at Campania Road (west of Interstate 91) in Enfield, and would rejoin the overhead line ROW at its intersection with Mayfield Drive in Enfield. A transition station would be required at each end of the cable route. Between these points, the underground line would be installed primarily in state and local public roads, but a 0.4-mile segment also would be located within the existing transmission line ROW. The roads traversed would include Campania Road, Manning Road, U.S. Route 5, Brainard Road, and Mayfield Drive. The two transition stations, each of which would require 2 to 4 acres of fenced and graded area, with above-ground termination facilities, could be located primarily on CL&P property, but would also require some additional acquisition of private land. Other principal features of this variation include:

- Additional ROW would be required at the eastern transition station near Mayfield Drive; temporary and/or permanent easements may also be required at the splice-vault locations.
- Three splice-vaults (one per each set of three XLPE cables), 10 feet wide by 10 feet deep by 32 feet long, would be buried approximately 1,600 feet apart along the route.
- Nine 8-inch PVC conduits for the 345-kV XLPE cables; three 2-inch PVC conduits for the grounding conductors; three 2-inch PVC conduits for the fiber optic relaying cables; and three 2-inch conduits for the temperature sensing fiber cables would be placed in a trench normally 5 to 7 feet wide and 7 to 10 feet deep.

Figure H-11: Massachusetts State Route 220/Enfield Underground Line Route Variation



The following table compares the underground line variation to the Connecticut Portion of the Massachusetts Southern Route Alternative overhead 345-kV line that it would replace (Table H-5). As this table illustrates, an overhead line on the Massachusetts Southern Route Alternative is superior to the underground line variation based on cost, environmental impacts, and construction/engineering considerations.

Table H-5 Comparative Summary of the Massachusetts Southern Route Alternative 345-kV Overhead Line and Enfield Underground Variation, Enfield

Criteria	Overhead 345-kV Line Segment[12] (Massachusetts Southern Route Alternative)	Underground Line Variation (Enfield Underground Variation)
Route Segment Length	3.7 miles	4.3 miles
Location (Towns)	Enfield	Enfield
Estimated Cost	$15 million	$184 million
Additional ROW or Land Required (Y or N); If Y, Acreage	N	Y (two transition stations, totaling 4 to 8 acres)
Additional Private Property Acquisition Required (Y or N); If Y, acreage	N	Y (for transition stations and additional underground easement rights for any locations off road ROW and along existing overhead transmission line ROW)
Vegetation Clearing Required (Total)	35.9 acres (estimated)	3.4 acres (estimated)
Wetlands Affected	6.8 acres (estimated)	0.1 acres (estimated)
Streams Crossed (No.)	2	2
Access Roads	Temporary and/or Permanent access required along route. Preliminary have not been developed.	Permanent access required along route. Preliminary have not been developed.
Visibility	Adjacent to existing 115-kV line; modifications to visual environment due to location of new 345-kV line within existing ROW	Changes associated with two new transition stations

[12] Includes only portion of overhead transmission line that would be replaced by the underground variation.

APPENDIX H-1

COST COMPARISON

Northeast Utilities
Life Cycle Costs - All OH (12 miles)
9/12/2008

		2 x				
Life Cycle Cost Analysis		1590 ACSR				
Type of Construction	345kV SC					
Miles	12					
			FC rate		Fixed Cost	
Construction Cost	41,290,000	x	0.146	=	6,028,340	
Land	-	x	0.146	=	0	
Total					6028340	
PV Discount		10.0%		Green values from 2007 CSC Life Cycle Study		
O&M rate		0.7%				
O&M escallation		4%				
First-year Load		1492	amps/phase			
Load growth (annual)		1.2%				

	Year	**Carrying Costs**	**O&M Costs**	**Loss Costs**	**Total Costs**	**PV Factor**	**PV Cost**	**Cumul PV**
1	**2013**	6,028,340	**$ 283,212**	$ 1,029,623	$ 7,341,175	0.91	$ 6,673,796	$ 6,673,796
2	2014	6,028,340	294,540	1,107,207	7,430,087	0.83	6,140,568	12,814,364
3	2015	6,028,340	306,322	1,190,636	7,525,298	0.75	5,653,868	18,468,232
4	2016	6,028,340	318,575	1,280,352	7,627,267	0.68	5,209,526	23,677,758
5	2017	6,028,340	331,318	1,376,828	7,736,486	0.62	4,803,749	28,481,507
6	2018	6,028,340	344,571	1,480,574	7,853,484	0.56	4,433,087	32,914,594
7	2019	6,028,340	358,354	1,592,137	7,978,830	0.51	4,094,402	37,008,996
8	2020	6,028,340	372,688	1,712,106	8,113,134	0.47	3,784,837	40,793,833
9	2021	6,028,340	387,595	1,841,115	8,257,051	0.42	3,501,796	44,295,628
10	2022	6,028,340	403,099	1,979,846	8,411,285	0.39	3,242,914	47,538,543
11	2023	6,028,340	419,223	2,129,030	8,576,592	0.35	3,006,043	50,544,586
12	2024	6,028,340	435,992	2,289,454	8,753,786	0.32	2,789,226	53,333,812
13	2025	6,028,340	453,432	2,461,968	8,943,739	0.29	2,590,683	55,924,495
14	2026	6,028,340	471,569	2,647,480	9,147,389	0.26	2,408,793	58,333,288
15	2027	6,028,340	490,432	2,846,971	9,365,742	0.24	2,242,084	60,575,372
16	2028	6,028,340	510,049	3,061,493	9,599,882	0.22	2,089,214	62,664,586
17	2029	6,028,340	530,451	3,292,180	9,850,971	0.20	1,948,962	64,613,548
18	2030	6,028,340	551,669	3,540,250	10,120,259	0.18	1,820,218	66,433,766
19	2031	6,028,340	573,736	3,807,012	10,409,088	0.16	1,701,969	68,135,735
20	2032	6,028,340	596,685	4,093,875	10,718,900	0.15	1,593,296	69,729,031
21	2033	6,028,340	620,552	4,402,354	11,051,246	0.14	1,493,361	71,222,392
22	2034	6,028,340	645,374	4,734,076	11,407,791	0.12	1,401,401	72,623,793
23	2035	6,028,340	671,189	5,090,795	11,790,324	0.11	1,316,722	73,940,515
24	2036	6,028,340	698,037	5,474,392	12,200,769	0.10	1,238,690	75,179,205
25	2037	6,028,340	725,958	5,886,894	12,641,192	0.09	1,166,731	76,345,937
26	2038	6,028,340	754,997	6,330,479	13,113,815	0.08	1,100,321	77,446,257
27	2039	6,028,340	785,197	6,807,488	13,621,024	0.08	1,038,980	78,485,238
28	2040	6,028,340	816,605	7,320,440	14,165,385	0.07	982,275	79,467,513
29	2041	6,028,340	849,269	7,872,044	14,749,653	0.06	929,809	80,397,322
30	2042	6,028,340	883,239	8,465,212	15,376,791	0.06	881,222	81,278,544
31	2043	6,028,340	918,569	9,103,076	16,049,985	0.05	836,183	82,114,727
32	2044	6,028,340	955,312	9,789,004	16,772,655	0.05	794,394	82,909,121
33	2045	6,028,340	993,524	10,526,617	17,548,481	0.04	755,581	83,664,702
34	2046	6,028,340	1,033,265	11,319,810	18,381,415	0.04	719,495	84,384,196
35	2047	6,028,340	1,074,596	12,172,771	19,275,707	0.04	685,909	**$85,070,105**

Northeast Utilities
Life Cycle Costs - 345-kV CT All UG in ROW (Estimated cost does not include mitigation for wetlands or easement acquisition)
9/12/2008

Life Cycle Cost Analysis	**345-kV**	Highlighted values indicate change from original workbook			
Type of Construction	9-duct XLPE ROW				
Miles	12.2				
			FC rate		Fixed Cost
Construction Cost	454,568,000	x	0.146	=	66366928
Land	-	x	0.146	=	0
Total					66366928

PV Discount	10.0%	
O&M rate	0.038%	
O&M escallation	4%	
First-year Load	872	amps/phase
Load growth (annual)	1%	

	Year	**Carrying Costs**	**O&M Costs**	**Loss Costs**	**Total Costs**	**PV Factor**	**PV Cost**	**Cumul PV**
1	2013	$ 66,366,928	$ 173,418	$ 304,638	$66,844,984	0.91	$ 60,768,167	$ 60,768,167
2	2014	$ 66,366,928	$ 180,354	$ 322,668	$66,869,951	0.83	$ 55,264,422	$ 116,032,589
3	2015	$ 66,366,928	$ 187,569	$ 341,810	$66,896,307	0.75	$ 50,260,186	$ 166,292,775
4	2016	$ 66,366,928	$ 195,071	$ 362,137	$66,924,136	0.68	$ 45,710,085	$ 212,002,860
5	2017	$ 66,366,928	$ 202,874	$ 383,723	$66,953,525	0.62	$ 41,572,871	$ 253,575,731
6	2018	$ 66,366,928	$ 210,989	$ 406,651	$66,984,568	0.56	$ 37,811,042	$ 291,386,774
7	2019	$ 66,366,928	$ 219,429	$ 431,007	$67,017,364	0.51	$ 34,390,504	$ 325,777,278
8	2020	$ 66,366,928	$ 228,206	$ 456,884	$67,052,018	0.47	$ 31,280,261	$ 357,057,539
9	2021	$ 66,366,928	$ 237,334	$ 484,381	$67,088,643	0.42	$ 28,452,134	$ 385,509,673
10	2022	$ 66,366,928	$ 246,828	$ 513,603	$67,127,359	0.39	$ 25,880,503	$ 411,390,175
11	2023	$ 66,366,928	$ 256,701	$ 544,664	$67,168,292	0.35	$ 23,542,077	$ 434,932,252
12	2024	$ 66,366,928	$ 266,969	$ 577,683	$67,211,580	0.32	$ 21,415,681	$ 456,347,933
13	2025	$ 66,366,928	$ 277,647	$ 612,789	$67,257,364	0.29	$ 19,482,063	$ 475,829,995
14	2026	$ 66,366,928	$ 288,753	$ 650,119	$67,305,800	0.26	$ 17,723,721	$ 493,553,716
15	2027	$ 66,366,928	$ 300,303	$ 689,820	$67,357,051	0.24	$ 16,124,742	$ 509,678,459
16	2028	$ 66,366,928	$ 312,316	$ 732,047	$67,411,291	0.22	$ 14,670,661	$ 524,349,120
17	2029	$ 66,366,928	$ 324,808	$ 776,970	$67,468,706	0.20	$ 13,348,324	$ 537,697,443
18	2030	$ 66,366,928	$ 337,800	$ 824,765	$67,529,493	0.18	$ 12,145,773	$ 549,843,216
19	2031	$ 66,366,928	$ 351,313	$ 875,624	$67,593,865	0.16	$ 11,052,137	$ 560,895,353
20	2032	$ 66,366,928	$ 365,365	$ 929,751	$67,662,044	0.15	$ 10,057,532	$ 570,952,885
21	2033	$ 66,366,928	$ 379,980	$ 987,364	$67,734,272	0.14	$ 9,152,971	$ 580,105,856
22	2034	$ 66,366,928	$ 395,179	$ 1,048,696	$67,810,803	0.12	$ 8,330,284	$ 588,436,140
23	2035	$ 66,366,928	$ 410,986	$ 1,113,996	$67,891,910	0.11	$ 7,582,043	$ 596,018,183
24	2036	$ 66,366,928	$ 427,425	$ 1,183,531	$67,977,884	0.10	$ 6,901,495	$ 602,919,679
25	2037	$ 66,366,928	$ 444,522	$ 1,257,584	$68,069,035	0.09	$ 6,282,500	$ 609,202,178
26	2038	$ 66,366,928	$ 462,303	$ 1,336,462	$68,165,693	0.08	$ 5,719,473	$ 614,921,652
27	2039	$ 66,366,928	$ 480,795	$ 1,420,489	$68,268,212	0.08	$ 5,207,341	$ 620,128,993
28	2040	$ 66,366,928	$ 500,027	$ 1,510,013	$68,376,968	0.07	$ 4,741,488	$ 624,870,481
29	2041	$ 66,366,928	$ 520,028	$ 1,605,407	$68,492,364	0.06	$ 4,317,718	$ 629,188,199
30	2042	$ 66,366,928	$ 540,829	$ 1,707,071	$68,614,828	0.06	$ 3,932,217	$ 633,120,415
31	2043	$ 66,366,928	$ 562,463	$ 1,815,429	$68,744,820	0.05	$ 3,581,515	$ 636,701,930
32	2044	$ 66,366,928	$ 584,961	$ 1,930,939	$68,882,828	0.05	$ 3,262,459	$ 639,964,389
33	2045	$ 66,366,928	$ 608,360	$ 2,054,088	$69,029,376	0.04	$ 2,972,182	$ 642,936,571
34	2046	$ 66,366,928	$ 632,694	$ 2,185,400	$69,185,022	0.04	$ 2,708,076	$ 645,644,646
35	2047	$ 66,366,928	$ 658,002	$ 2,325,432	$69,350,362	0.04	$ 2,467,770	$ 648,112,417

Northeast Utilities
Life Cycle Costs - 345-kV CT All UG along adjacent streets
9/11/2008

Life Cycle Cost Analysis **345-kV** Highlighted values indicate change from original workbook

Type of Construction	9-duct XLPE Streets				
Miles	12.2				
			FC rate		Fixed Cost
Construction Cost	478,546,000	x	0.146	=	69867716
Land	-	x	0.146	=	0
Total					69867716

PV Discount	10.0%	
O&M rate	0.038%	
O&M escallation	4%	
First-year Load	872	amps/phase
Load growth (annual)	1%	

	Year	Carrying Costs	O&M Costs	Loss Costs	Total Costs	PV Factor	PV Cost	Cumul PV
1	**2013**	69867716	$ 182,565	$ 304,638	$70,354,919	0.91	$ 63,959,018	$ 63,959,018
2	2014	69867716	189,868	322,668	70,380,252	0.83	58,165,498	122,124,515
3	2015	69867716	197,463	341,810	70,406,989	0.75	52,897,813	175,022,328
4	2016	69867716	205,361	362,137	70,435,214	0.68	48,108,199	223,130,527
5	2017	69867716	213,576	383,723	70,465,014	0.62	43,753,230	266,883,757
6	2018	69867716	222,119	406,651	70,496,485	0.56	39,793,428	306,677,185
7	2019	69867716	231,003	431,007	70,529,726	0.51	36,192,902	342,870,087
8	2020	69867716	240,244	456,884	70,564,843	0.47	32,919,020	375,789,107
9	2021	69867716	249,853	484,381	70,601,950	0.42	29,942,119	405,731,226
10	2022	69867716	259,847	513,603	70,641,167	0.39	27,235,228	432,966,454
11	2023	69867716	270,241	544,664	70,682,621	0.35	24,773,828	457,740,281
12	2024	69867716	281,051	577,683	70,726,450	0.32	22,535,627	480,275,908
13	2025	69867716	292,293	612,789	70,772,798	0.29	20,500,359	500,776,266
14	2026	69867716	303,985	650,119	70,821,820	0.26	18,649,599	519,425,865
15	2027	69867716	316,144	689,820	70,873,680	0.24	16,966,595	536,392,460
16	2028	69867716	328,790	732,047	70,928,553	0.22	15,436,120	551,828,580
17	2029	69867716	341,941	776,970	70,986,627	0.20	14,044,326	565,872,906
18	2030	69867716	355,619	824,765	71,048,100	0.18	12,778,625	578,651,531
19	2031	69867716	369,844	875,624	71,113,184	0.16	11,627,574	590,279,105
20	2032	69867716	384,638	929,751	71,182,105	0.15	10,580,766	600,859,871
21	2033	69867716	400,023	987,364	71,255,103	0.14	9,628,743	610,488,614
22	2034	69867716	416,024	1,048,696	71,332,436	0.12	8,762,903	619,251,516
23	2035	69867716	432,665	1,113,996	71,414,377	0.11	7,975,426	627,226,943
24	2036	69867716	449,972	1,183,531	71,501,218	0.10	7,259,204	634,486,147
25	2037	69867716	467,971	1,257,584	71,593,271	0.09	6,607,772	641,093,919
26	2038	69867716	486,689	1,336,462	71,690,867	0.08	6,015,255	647,109,174
27	2039	69867716	506,157	1,420,489	71,794,361	0.08	5,476,308	652,585,481
28	2040	69867716	526,403	1,510,013	71,904,132	0.07	4,986,073	657,571,555
29	2041	69867716	547,459	1,605,407	72,020,583	0.06	4,540,135	662,111,690
30	2042	69867716	569,358	1,707,071	72,144,144	0.06	4,134,477	666,246,166
31	2043	69867716	592,132	1,815,429	72,275,277	0.05	3,765,447	670,011,613
32	2044	69867716	615,817	1,930,939	72,414,472	0.05	3,429,726	673,441,339
33	2045	69867716	640,450	2,054,088	72,562,254	0.04	3,124,296	676,565,635
34	2046	69867716	666,068	2,185,400	72,719,184	0.04	2,846,412	679,412,047
35	2047	69867716	692,711	2,325,432	72,885,859	0.04	2,593,578	682,005,625

SECTION I

TECHNICAL DESCRIPTION OF PROPOSED FACILITIES

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I. TECHNICAL DESCRIPTION OF PROPOSED FACILITIES

As described in Section H, after considering both underground and overhead line technologies along various potential routes, CL&P identified as the proposed configuration for the Connecticut portion of the Greater Springfield Reliability Project the use of an overhead line along the approximately 12-mile long existing transmission corridor between North Bloomfield Substation and the Connecticut/Massachusetts state border.

This section provides technical descriptions for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (Section I.1), the Manchester to Meekville Junction Circuit Separation Project (Section I.2), and Connecticut portion of the Massachusetts Southern Route Alternative for the Agawam to Ludlow 345-kV line (Section I.3.) Technical information for each project includes:

- Estimated construction and life-cycle costs;
- Conductor sizes and specifications;
- Overhead line structure design, appearance and height;
- Route length by municipality;
- Initial design voltages and capacities;
- ROWs and access ways;
- Proposed structure location envelopes[1];
- Substation data; and
- Service area.

[1] "Structure location envelope" refers to the 100-foot area on either side of the anticipated location of a new transmission line structure.

I.1 BASE DESIGN OF PROPOSED CONNECTICUT FACILITIES FOR THE GSRP

I.1.1 345-kV Conductor Sizes and Specification

The proposed overhead 345-kV line will consist of three phases, each of which would consist of a bundle of two 1,590,000 circular mil (1,590-kcmil) aluminum conductors with steel reinforcement (ACSR). The new line would be protected by an overhead lightning shield wire, 19 No. 10 Alumoweld, and a second shield wire would contain optical glass fibers for communications purposes (also known as Optical Ground Wire or "OPGW").

I.1.2 Design and Appearance

The design and appearance of the proposed overhead line that would be aligned along the approximately 12 miles of CL&P ROW between the North Bloomfield Substation and the Connecticut/Massachusetts state border, is described below. The description of the proposed facilities is presented in terms of the two ROW segments which comprise the approximately 12-mile route.

I.1.2.1 Segment 1 (North Bloomfield - Granby Junction) –Cross-Section XS-1 in Volume 10

I.1.2.1.1 Existing ROW and Facilities

- Total ROW length is 4.7 miles.
- ROW width is generally 385 feet.
- Existing transmission line facilities occupying the ROW consist of wood-pole H-frame structures typically 60 feet in height that support one 115-kV circuit. Existing lattice-steel towers typically 70 feet in height support two 115-kV circuits. Existing wood distribution line poles are approximately 40 feet in height.

I.1.2.1.2 Proposed GSRP Facilities

- The new 345-kV circuit will be supported by steel or wood pole H-frame structures averaging 90 feet in height, with a horizontal configuration of the line conductors. The new structures would typically be placed near the existing structure locations. Of the 385 feet of existing ROW, approximately 195 feet are currently being maintained for the existing transmission facilities. With the addition of the new 345-kV line, approximately 290 feet would be maintained; the remainder of the ROW (approximately 95 feet) would not be affected.
- In order to maintain continuity of service, the existing 115-kV circuits must be maintained in service as the new 345-kV line is constructed adjacent to them. When construction of the new line is complete, the 115-kV circuit sections from North Bloomfield Substation north to Granby Junction will be de-energized and removed from service, and the new 345-kV circuit will be energized and put into service. None of the existing transmission or distribution line structures would be dismantled and removed from the ROW as part of the GSRP construction effort. Rather, CL&P will consider performing such work in the future pursuant to a Petition, as has been the case with other facilities that have been removed from service due to the Middletown to Norwalk project. Before proposing the removal of any existing lines, CL&P would need to confirm that they would not likely be useful in the near future.

I.1.2.2 Segment 2 (Granby Junction - CT/MA State Border) – Cross-Section XS-2 in Volume 10

I.1.2.2.1 Existing ROW and Facilities

- Total ROW length is 7.2 miles.
- ROW width is generally 305 feet.
- Existing lattice-steel towers typically 70 feet in height support two existing 115-kV circuits.

I.1.2.2.2 Proposed GSRP Facilities

- None of the existing line structures would be removed. The existing double-circuit 115-kV line would continue in use, with the two circuits “bundled” together to operate as a single-circuit from South Agawam Switching Station to Southwick Substation via Granby Junction. This would be accomplished by bundling the circuit conductors together at approximately 1-mile intervals.
- Additional ROW width would be required for the new 345-kV line construction, approximately an additional 100 feet in width for a distance of approximately 1,000 linear feet between Phelps Road and Mountain Road, and for approximately 400 linear feet east of Ratley Road. At both locations, adjacent land is partially owned by CL&P (See Section H).
- Structures proposed in the base design to support the new 345-kV circuit conductors are: steel- or laminated-wood-pole H-frame structures averaging 90 feet in height with a horizontal configuration of the line conductors.
- Other structures considered were steel monopoles averaging 130 feet in height with a vertical configuration of the line conductors; and steel monopoles averaging 110 feet in height with a delta configuration of the line conductors.
- New line-structure placement is typically near to existing structure locations.
- A section of ROW approximately between the closest approach of Country Club Lane in East Granby and the crossing of Phelps Road in Suffield, has been identified as a focus area for application of the Council’s EMF Best Management Practices (See Section O). In this area, a new 345-kV line employing steel-monopole structures with a delta configuration of the line conductors is proposed. The average height of these poles will be 110 feet. This section is approximately 3.2 miles long.
- Of the 305 feet of existing ROW, approximately 110 feet are currently being maintained for the existing transmission line. The new 345-kV line would increase the maintained ROW width to approximately 205 feet; approximately 100 feet of the ROW would remain unaffected by the GSRP.

I.2 BASE DESIGN OF PROPOSED MMP

I.2.1 Conductor Sizes and Specifications

One existing 115-kV transmission circuit between Manchester Substation and Meekville Junction would be replaced on a new line of steel monopoles using bundled 1,590-kcmil ACSR conductors. The existing circuit conductors (bundled 954,000 circular mil ACSR conductors) would remain on the lattice-steel towers.

I.2.2 Design and Appearance

The existing double-circuit lattice-steel towers along the east side of the ROW currently support an existing 115-kV circuit and a 345-kV circuit and would remain. The existing 115-kV transmission circuit on these towers would be replaced on a separate line of steel-monopole structures. The details of this work are described below.

I.2.2.1 Existing ROW and Facilities

- Total ROW length of the circuit-separation route is approximately 2.2 miles.
- Existing ROW width is generally 350 feet.
- A line of existing lattice-steel towers averaging 155 feet in height supports one 115-kV circuit and one 345-kV circuit, both of which have 345-kV class conductor bundles, insulation and conductor spacings for a majority of the route. To the west of this line, a second line of existing lattice-steel towers with a typical height of 130 feet supports two 115-kV circuits. Existing wood distribution poles on portions of the ROW are approximately 40 feet in height.

I.2.2.2 Proposed MMP Facilities

- The ROW width is typically sufficient to install a new 115-kV overhead line in between the two existing double-circuit transmission lines. For approximately 120 feet north of the Tolland Turnpike the ROW would need to be expanded by approximately 20 feet.
- Structures proposed to support the circuit separation are steel monopoles with a typical height of 155 feet with a vertical configuration of the line conductors. The proposed line location is between the existing lines to minimize additional clearing and other environmental impacts. The proposed new structure heights would be about the same as the existing 345-kV lattice-steel towers, ranging between 120 and 190 feet in height, and the new 115-kV line will utilize 345-kV class conductor bundles, insulation and conductor spacings.
- None of the existing transmission lines would be removed; however, approximately four of the existing 115-kV double-circuit lattice-steel structures in different locations throughout the corridor would need to be relocated to accommodate the new transmission line. Most of the existing wood distribution poles would need to be relocated to accommodate the new 115-kV overhead line.
- New line structure placements are proposed to be in the vicinity of existing structure locations.
- Additional vegetation clearing would be minimal since the reconstructed line would be placed in between two existing transmission lines.

I.3 BASE DESIGN OF THE CONNECTICUT PORTIONS OF THE MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE

I.3.1 Conductor Sizes and Specifications

The proposed Agawam to Ludlow 345-kV line along the Massachusetts Southern Route Alternative would also utilize 1,590-kcmil ACSR conductors, two per phase. Also, the new line would be protected by an OPGW cable and a second 19 No. 10 Alumoweld shield wire as required.

I.3.2 Design and Appearance

The design and appearance of the proposed overhead line that would be aligned along the approximately 5.4 miles of CL&P ROW between the Connecticut/Massachusetts state border southeast of the South Agawam Switching Station and the Connecticut/Massachusetts state border near Franconia Junction, is described below. The description of the proposed facilities is presented in terms of the two ROW segments that comprise the 5.4-mile route. The segments are separated by a short segment that crosses into the Massachusetts near the Connecticut River Crossing.

I.3.2.1 Segment 1 (CT/MA State Border – Connecticut River) – Cross-Section XS-S05 in Volume 10

I.3.2.1.1 Existing ROW and Facilities

- Total ROW length of this section is approximately 1.1 miles.
- Existing ROW width is generally 300 feet.
- Existing transmission line facilities occupying the ROW consist of wood-pole H-frame structures typically 60 feet in height that support one 115-kV circuit.
- The Connecticut River crossing structure is much taller, approximately 215 feet in height.

I.3.2.1.2 Proposed GSRP Facilities

- The existing line and its wood-pole H-frame structures would remain.
- Existing ROW width is sufficient for a new 345-kV overhead line.
- New line-structure placement would typically be near the existing structure locations.
- Of the 300 feet of existing ROW, approximately 110 feet are currently being maintained for the existing transmission facilities. With the addition of the new 345-kV line, approximately 205 feet would be maintained. The remainder of the ROW (approximately 95 feet) would not be affected.

I.3.2.2 Segment 2 (Connecticut River - CT/MA State Border) – Cross-Section XS-S07 in Volume 10

I.3.2.2.1 Existing ROW and Facilities

- Total ROW length of this section is approximately 4.3 miles.
- Existing ROW width generally ranges from 280 feet to 300 feet.
- Existing transmission line facilities occupying the ROW consist of wood-pole H-frame structures typically 60 feet in height that support one 115-kV circuit.

I.3.2.2.2 Proposed GSRP Facilities

- The existing line and its wood-pole H-frame structures would remain.
- Existing ROW width is sufficient for a new 345-kV overhead line.
- New line-structure placement would typically be near the existing structure locations.
- Of the 280 to 300 feet of existing ROW, approximately 110 feet are currently being maintained for the existing transmission facilities. With the addition of the new 345-kV line, approximately 205 feet would be maintained. The remainder of the ROW (approximately 75 to 95 feet) would not be affected.

I.4 LINE CONFIGURATION AND ENGINEERING REQUIREMENTS

I.4.1 Segments by Municipality

The aerial photograph mapsheets in Volumes 9 and 11 depict the locations of both the proposed GSRP 345-kV transmission line route and the ROW where the MMP circuits will be separated, in relation to prominent land-use and environmental features. For each mapsheet, the following information is included: existing and proposed overhead line structure configurations, route length and ROW width, and pertinent land uses. The first page of the aerial mapsheets is a key map showing the location of each mapsheet in relation to the proposed route. Table I-1 provides a key to the alignment map sheets, listing the various maps associated with each of the Connecticut municipalities that would be traversed by, or located within 2,500 feet of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and the Manchester to Meekville Junction Circuit Separation Project.

Table I-1 Key to Towns Along or Near the Proposed Projects, Aerial Alignment Map Sheets

Town	Traversed by the CT Portion of the North Bloomfield to Agawam 345-kV Line Route, MMP and Connecticut Portion of the Massachusetts Southern Route Alternative	Aerial Alignment Mapsheet Numbers		Cross-Section
		100 Scale	400 Scale	
Bloomfield	Yes	1 – 5 of 45	1 of 10	XS-1
Simsbury	No	NA	1 & 2 of 10	NA
East Granby	Yes	5 – 28 of 45	2 – 6 of 10	XS-1, XS-2, XS-2BMP
Granby	No	NA	NA	NA
Suffield	Yes	28 – 45 of 45	6 -10 of 10	XS-2, XS-2BMP
Manchester	Yes	1-11 of 11	1 - 3 of 13	XS-21, XS-21BMP
South Windsor	No	NA	3 of 3	NA
East Hartford	No	NA	3 of 3	NA
Enfield	Yes	1 – 21 of 21	1 – 5 of 5	XS-S05, S07

I.4.2 Initial and Design Voltages and Capacities

The new North Bloomfield to Agawam line would be designed for nominal 345-kV operation. The bundled 1,590-kcmil ACSR conductors would provide approximately 2,040 MVA of summer normal line capacity at 345 kV – more than is needed or would be used. The size of the conductors has not been dictated by capacity requirements, but rather is a design choice made to reduce corona, thereby holding audible noise and radio-frequency noise production in wet weather to very low levels. For 345-kV lines, using two conductors per phase, and then using conductors with larger diameters, greatly reduces electric fields, and therefore corona, on conductor surfaces.

The replacement Manchester Substation to Meekville Junction 115-kV line would use bundled 1,590-kcmil ACSR conductors, which would provide approximately 680 MVA of summer normal line capacity at 115 kV. Electric field intensity on the surface of conductors for 115-kV transmission lines typically do not produce significant levels of corona. The rebuilt line would be designed for nominal 345 kV operation but would operate initially at nominal 115 kV. Constructing the line so that it could be operated at 345 kV will allow for system upgrades including replacing the existing three terminal 345-kV circuit with a set of two-terminal circuits.

The Massachusetts Southern Route Alternative will utilize the same conductor and design voltage level because the requirements for the Ludlow to Agawam 345-kV line are independent of the route selected. As with the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, the proposed line would be designed for nominal 345-kV configuration utilizing bundled 1,590-kcmil ACSR conductors.

I.4.3 ROW and Access Way Requirements

The width of the existing ROW along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route for the 345-kV line varies. The existing ROW is generally 385 feet wide from North

Bloomfield Substation to Granby Junction and generally 305 feet wide from Granby Junction to the Connecticut/Massachusetts state border. These typical ROW widths are shown on the cross-section drawings in Volume 10 and in Table I-2.

CL&P has designed the overhead 345-kV line to use the existing ROW. There are only two small areas of the proposed GSRP ROW in Connecticut where additional easement will be required to accommodate the new 345-kV overhead line. In Suffield, the existing CL&P transmission line ROW includes two locations where the ROW width is reduced: these are a 1,000-foot-long section of the ROW between Phelps Road and Mountain Road and a 400-foot-long section east of Ratley Road. In these locations, up to an additional 100 feet of ROW width may be required.

The Manchester to Meekville Junction Circuit Separation Project would typically occur within CL&P's existing ROW. The existing ROW width varies, but is typically 350 feet wide. There is one parcel located near Tolland Turnpike that would require additional easements. Approximately 2,400 square feet would be required on this parcel. A typical cross-section drawing for this circuit separation project can be found in Volume 10. Summary information is included and is in Table I-2.

The Massachusetts Southern Route Alternative would require a new 345-kV line on existing transmission corridors in Enfield, Connecticut. The existing ROW in Enfield, Connecticut is typically 280 to 300 feet wide and has sufficient room to install the proposed 345-kV transmission facilities. These typical ROW widths are shown on the cross-section drawings XS-S05 and XS-S07 in Volume 10 and in Table I-2.

Table I-2 Summary of Existing and Proposed ROW Configurations: GSRP and MMP

Transmission Line Segment (Municipality)	Approx. Mileage	Existing Structure Configurations and Typical ROW Width		Proposed 345-kV/Reconstructed 115-kV Configurations and Typical ROW Width	
		Structure Type and Height	ROW Width (feet)	Structure Type and Height	ROW Width (feet)
GSRP Segment 1 North Bloomfield to Granby Junction (Bloomfield, East Granby)	4.7	One 115-kV wood-pole H-frame structure line typically 60 feet in height, one distribution line, single wood-pole distribution line typically 40 feet in height, and one double-circuit 115-kV lattice-steel structure line typically 70 feet in height	~385	Install one steel- or wood-pole 345-kV H-frame line, typically 90 feet in height. Existing structures to remain. Figure XS-1 in Volume 10	385 (No additional ROW required)
GSRP Segment 2 Granby Junction to CT/MA state border (East Granby, Suffield)	7.2	One double-circuit 115-kV lattice-steel structure line typically 70 feet in height	~305	Install one steel- or wood-pole 345-kV H-frame line, typically 90 feet in height. Existing structures to remain. Figure XS-2 in Volume 10	305 (except for a 400-foot-long and 1,000-foot-long section, both in Suffield)
Manchester Substation to Meekville Junction	2.2	One double-circuit 345/115 kV lattice-steel structure line typically 155 feet in height. One double-circuit 115-kV lattice-steel structure line typically 130 feet in height. One double-circuit wood-pole distribution line averaging 40 feet in height.	~350	Install one steel-monopole 115-kV single circuit line, averaging 155 feet in height. New pole will be configured with 345-kV layout and hardware. Existing structures to remain. Figure XS-23 in Volume 1	350 (An additional 20 foot width would be required for 120 feet near Tolland Turnpike, otherwise, no expansion required)
Southern Route CT/MA state border to Connecticut River	1.1	One 115-kV wood-pole H-frame structure line typically 60 feet in height	~300	Install one steel- or wood-pole 345-kV H-frame line, typically 90 feet in height. Existing structures to remain Figure XS-S05 in Volume 10	300 (No additional ROW required)
Southern Route CT/MA state border to Connecticut River	4.1	One 115-kV wood-pole H-frame structure line typically 60 feet in height	~280	Install one steel- or wood-pole 345-kV H-frame line, typically 90 feet in height. Existing structures to remain Figure XS-S07 in Volume 10	280 (No additiona ROW required)

Referenced Figures refer to Typical Cross-Sections in Volume 10.

I.4.4 Proposed Structure Location Envelopes

Along the overhead line route, the preliminary locations of each of the proposed transmission line structures were determined using transmission line design software (Power Line System's "PLS-CADD"™) as shown on the plan and profile drawings (Volume 10, *Plan & Profile Drawings*), as well as on the 100 scale aerial photos (Volume 11, *Aerial Photographs-100 scale*).

In selecting potential locations for new line structures, CL&P applied overhead line-route analysis criteria listed in Section H.1.2; therefore, the new structures were initially spotted adjacent to the locations of existing structures, to the extent possible. The structure locations may change based upon information obtained from subsurface investigations, final engineering and environmental surveys, constructability reviews, input from the municipalities and regulatory agencies, and the Council's approval. After this information has been analyzed, final detailed line engineering will determine the exact locations of the structures. The final locations will typically be within the 100 foot envelope ahead or back from the proposed structure locations along the structure centerline.

I.4.5 Modification of North Bloomfield Substation

The North Bloomfield Substation is located in the northeast portion of a 34-acre site, owned by CL&P, near the intersection of Hoskins Road and Tariffville Road. The proposed modifications at the North Bloomfield Substation that would be required for the GSRP include constructing a new 345-kV switchyard to interconnect the existing 345-kV line that extends into the substation from the south and the proposed new 345-kV line that would extend into the substation from the north, as well as two 345/115-kV autotransformers (one new and one existing), with space provisions for future 345-kV line connections, and expansion of the existing relay and control enclosure.

In the 115-kV switchyard, a bus tie will be removed, and the new autotransformer will be connected to the bus using an existing circuit breaker. The construction of the above modifications would take place within the substation property. A section of the substation fence would have to be relocated but would remain within CL&P's property. Based on the existing substation footprint of approximately 7 acres, existing substation fence would be relocated approximately 32 feet to the northwest, 292 feet to the south east and 193 feet to the southwest, for a total expansion of approximately 2.7 acres within the existing property. These modifications are illustrated in Volume 7 of the Application.

I.4.6 Service Areas Benefits

The GSRP and the MMP would provide immediate benefits to the service areas of Greater Springfield and north-central Connecticut. In combination with the other NEEWS projects, these projects would provide benefits to all of Connecticut and to the Southern New England region.

I.5 ESTIMATED PROJECT COSTS

I.5.1 Estimated Capital Cost of all GSRP[2] Facilities, Connecticut and Massachusetts

Description	Opinion of Probable Costs	
	OH Transmission	Substation
Build a new 345-kV overhead line from Ludlow 19S Substation to Agawam 16C Substation	$151,871,000	
Build a new 345-kV overhead line from Agawam 16C Substation to North Bloomfield 2A Substation (MA Only)	$57,288,000	
Build a new 345-kV line from Agawam 16C Substation to North Bloomfield 2A Substation (CT Only)	$41,290,000	
Rebuild lines 1781 / 1782 and reconfigure 115-kV system (1768 / 1836 / 1821)	$14,630,000	
Break Three-Terminal Circuits 1254/1723 into Two-Terminal Circuits creating a total of four (4) circuits (1601-1604)	$40,796,000	
Place 1845 line on the Ludlow to Agawam 345/115-kV double-circuit line structures	$3,875,000	
Rebuild lines 1481, 1426, and 1552 from Cadwell 50F Switching Station to Ludlow 19S Substation	$49,462,000	
Rebuild lines 1601, 1602, 1314, and 1230 from Agawam 16C Substation to E. Springfield Jct.	$28,432,000	
Ludlow 19S Substation		$67,500,000
Agawam 16C Substation		$77,743,000
North Bloomfield 2A Substation		$92,080,000
Fairmont 16H Switching Station (Greenfield)		$49,111,000
Cadwell 50F Switching Station		$21,013,000
Miscellaneous Substations		$19,133,000
Project Total	$387,644,000	$326,580,000

I.5.2 Estimated Capital Cost of Connecticut Portion of GSRP Facilities

Description	Opinion of Probable Costs	
	OH Transmission	Substation
Build a new 345-kV line from Mass/CT state border to North Bloomfield 2A Substation	$41,290,000	$0
North Bloomfield 2A Substation	$0	$92,080,000
CT Project Total Costs	$133,370,000	

[2] GSRP cost estimate for all OH line along the Preferred Northern Route in Massachusetts.

I.5.3 Life-Cycle Cost

Table I-3 Comparison of Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route to Underground Variations

Underground Alternative Estimates (GSRP - CT)	
Route	**Total CT Project Costs**
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (All OH) - 12 miles	$133,370,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route Including 3.6-Mile In-ROW Underground Line Route Variation	$286,957,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route Including 4.6-Mile In-ROW Underground Line Route Variation	$317,817,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route Including Newgate Road Underground Line Route Variation (6 miles)	$380,631,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route Including State Route 168/187 Underground Route Line Variation (8 miles)	$455,306,000

CL&P performed a present-value analysis of capital and operating costs over a 35-year economic life in accordance with the Council's *Life-Cycle Cost Studies for Overhead and Underground Transmission Lines* (2007). The following items were considered:

- Annual carrying charges of the capital cost (I.4.1 above)
- Annual operation and maintenance costs
- Cost of energy losses
- Cost of capacity

The life-cycle costs calculated for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and underground line route variations are shown in Table I-4.

Table I-4 Comparison of Life-Cycle Costs for the Connecticut Portion of the North Bloomfield to Agawam Line Route and Variations

Description	Overhead Life-Cycle Cost	Underground Life-Cycle Cost	Total Life-Cycle Cost[1]
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (All OH) - 12 miles	$84,900,000	$0	$84,900,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route with the 3.6-Mile In-ROW Underground Line Route Variation (3.6 miles UG, 8.4 miles OH)	$59,500,000	$236,300,000	$295,800,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route with the 4.6-Mile In-ROW Underground Line Route Variation (4.6 miles UG, 7.4 miles OH)	$52,500,000	$318,300,000	$370,800,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route with the Newgate Road Underground Line Route Variation (6.0 miles UG, 7.4 miles OH)	$53,100,000	$374,200,000	$427,300,000
Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route with the State Route 168/167 Underground Line Route Variation (8.0 miles UG, 7.4 miles OH)	$53,100,000	$480,700,000	$533,800,000

[1]: The total life cycle cost does not reflect cost associated with substations which is applicable to all alternatives but it does include cost for the line transition stations.

SECTION J

CONSTRUCTION STEPS

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J. CONSTRUCTION STEPS

The proposed GSRP and MMP would be constructed in accordance with established industry practices, as well as CL&P's specifications. In addition, construction activities would conform to any conditions identified in permits obtained for the GSRP and MMP.

The following subsections describe the general procedures that would be used for the installation of both the overhead (Section J.1) and underground (Section J.2) portions of the transmission line. The proposed configuration of transmission lines along each route segment is depicted on the cross-section drawings in Volume 10 *(Typical Cross Sections and Photo Simulations)*.

J.1 OVERHEAD TRANSMISSION LINE CONSTRUCTION

J.1.1 Overview of Overhead Line Construction

CL&P will construct the GSRP and MMP in several stages, some of which will overlap in time. The following construction activities, materials, and equipment are generally expected to be involved in the construction of the overhead transmission lines on or adjacent to the existing or expanded transmission ROWs:

- Surveys to stake monumented line of corridor, ROW boundaries, and future structure locations.
- Identification and marking of wetland and watercourse areas.
- Identification and marking of cultural resources concerns.
- Identification and marking of sensitive environmental resource areas to be avoided.
- Establishment of field construction areas and preparation of staging and lay-down areas.
- Establish erosion and sediment controls – pickups and other small trucks, or small track vehicle.

- Clear for new access roads or improve existing roads – flatbed truck, brush hog, bulldozer, bucket trucks for canopy trimming, tree shear for larger trees, wood chipper.
- Construction of new access roads or maintain existing roads to provide a travel way of at least 15 to 20 feet in width – bulldozer or front loader, dump trucks for crushed stone or gravel, pickups or stake-body trucks for culverts, wetland mats, mat installer; roads may be wood, gravel, or matted; using culverts or crushed stone for wet areas; roads may be temporary or permanent. Roads must have sufficient width and capacity for heavy construction equipment, both over-the-road and off-road vehicles, including oversize tractor trailers. The need for access for flatbed trailers and concrete trucks often determines the scope of access road improvements. Road grades must be negotiable for over-the-road trucks; 10 percent maximum, and less if wet weather or surface conditions provide traction problems. Vehicles with tracks or tires are used.
- Preparation of staging and laydown areas if they are to be off the ROW. The preparation process and equipment is the same as for access roads unless existing areas are to be used. Establish field office trailer, sanitary facilities and parking areas.
- Preparation of work area at sites of existing and new structures, if necessary, because of slopes or surface conditions. Typically, work at structure sites will be contained within the existing ROW. The same equipment is needed as for access road preparation and staging areas.
- Construction of foundations and erection/assembly of new structures – same equipment and material as for access road preparation with addition of caissons for foundations; flatbed trucks for structure components, auger, excavator, cranes, other trucks for reinforcing rods, concrete trucks for structures requiring concrete pads or foundations, bucket trucks and hardware, conductor reels, and conductor pulling rigs. Dump trucks are needed for the foundation work if excess excavated material has to be removed from the ROW. In wet conditions or if groundwater is encountered during excavation, the water will be pumped from the excavated areas and discharged in accordance with applicable local and state requirements. As with all other

activities, this would require Council approval and would have to comply with any applicable regulation.

- Removal of existing structures – bucket trucks for dismantling existing lines, with reel trailers to haul out old conductors, trucks to haul out old hardware, flatbed truck with crane to remove structures, trucks with hydraulic steel sheers to cut steel supports or components, stake or dump trucks to haul out smaller components.
- Restoration – all debris is hauled off the ROW for disposal; but brush may be piled, scattered, or chipped. In some areas if allowed, disturbed ground is back bladed to its preconstruction contours unless directed otherwise. If the work site is in an agricultural field, the soil can be decompacted by disking. Erosion controls are left in place until vegetation is re-established. Steep areas may be stabilized with jute netting or pre-made erosion control fabric containing seed, mulch, and fertilizer. Access roads where culverts or crushed stone fords were installed will be left in place or removed as directed by the Council. Periodic monitoring and reporting with on-site inspection by the Council is required until it is determined that restoration has been achieved.

J.1.2 Material Staging Sites

A combination of temporary storage areas, staging areas and laydown areas would be necessary to support construction. The typical use of each type of area is described in following sub-sections.

For the transmission facilities, material staging sites would be required at locations in the vicinity of the transmission line corridor. Although the areas do not necessarily have to be adjacent to the transmission line ROW, the closer these areas are to the ROW, the less the disturbance would be to the public. Whenever possible, material storage, staging and laydown areas would be set up on property already owned by CL&P. In order to minimize the impact on the public, if CL&P-owned property is not available in the vicinity of construction, areas such as parking lots or land that is not in use would be considered, as long as the areas are of sufficient size and in the vicinity of construction. The contractor performing construction would be responsible for selecting sites for material staging and would also be responsible for making arrangements with property owners for use of the land during construction.

J.1.2.1 Storage Areas

Storage areas typically range in size from approximately two to five acres. These areas would be used to temporarily store construction materials, equipment, and supplies. Additionally, storage areas would be used for mobile construction offices; for parking of personal vehicles of the construction crews; for parking construction vehicles and equipment; and for performing minor maintenance, if needed, on construction equipment. Components for new structures may be temporarily stored at these locations prior to their delivery to structure sites. Assembly of materials or structures may also occur at these areas prior to their delivery on site. These areas may also be used for temporary storage for structures that have been dismantled prior to their disposal off-site.

Storage areas would typically be selected based on their proximity to the actual work location. As construction of the transmission line progresses, storage areas are typically moved in order to keep equipment and materials nearer to the locations where line construction work is being performed. Once a storage area is no longer used to support construction activities, it would be returned to its preconstruction condition as requested by the property owners.

J.1.2.2 Staging Areas

These sites are generally less than two acres in size. Staging areas would be used for temporarily stockpiling tubular sections of the steel monopoles, materials that comprise the H-frames and associated equipment for overhead line construction. These areas would be located along each of the construction segments of the route. Steel and wood, along with equipment from disassembled structures may be temporarily held at these areas prior to their off-site removal and/or disposal. As construction progresses, staging areas would likely be relocated to coincide with construction work. When a particular staging area is no longer required, the site would be returned to its condition prior to construction as requested by the property owners.

J.1.2.3 Laydown Areas

In general, laydown areas would be located at line-structure sites, within the transmission line ROW and typically within the envelope noted on the *Aerial Photographs – 100 Scale* (Volume 11). Materials and equipment associated with the dismantlement of existing structures or the erection of new structures would be placed at these locations during construction for the new structures. Efforts would be made to minimize the impact on adjacent property owners while this site work occurs. Upon completion of site construction, each laydown area would be appropriately restored as requested by the property owners.

Based on the criteria noted above, a preliminary review of potential storage and staging areas associated with construction support of the Project was conducted. From this review, an inventory of possible sites was prepared and is provided in Table J-1 *(Review of Potential Material Staging Sites)*. The table summarizes, by municipality, locations in the vicinity of the proposed route that have sufficient area for construction support. The actual locations of the sites proposed for use during construction would be dependent upon detailed final engineering, along with input from the contractor responsible for constructing the line.

Table J-1 Review of Potential Material Staging Sites

Town	Area	Type of Site
Bloomfield	North Bloomfield Substation	Storage
Manchester	JC Penney Logistics Support Facility	Storage
Manchester	Manchester Landfill	Staging
South Windsor	United Steel Corneau Way	Storage
Suffield	Mountain Road at Babbs Road	Storage
Suffield	Sheldon Farm (Supply)	Storage
Windsor	1404 Blue Hills Avenue	Storage

J.1.3 Construction Field Office

Field offices provide headquarters for engineering and supervision in the area where work is being performed. These offices would typically be located on existing property owned by CL&P or on the existing transmission line ROW. Efforts would be made to locate field offices within other sites such as storage or substation areas. As construction progresses on the transmission line, field offices may be relocated to stay near the areas of activity. Any temporary disturbance caused by construction field offices would be repaired or returned to its original condition as requested by the property owners.

J.1.4 Temporary Erosion and Sedimentation Controls

Temporary erosion controls (e.g., silt fence, hay/straw bales, filter socks, mulch, temporary and/or permanent reseeding) would be installed as needed, prior to clearing operations in compliance with *2002 Connecticut Guidelines for Soil Erosion and Sedimentation Control*. The placement of such temporary controls would be appropriate to minimize the potential for erosion and sedimentation in areas where soils have been disturbed. Permanent stabilization of disturbed soils may be required as well, particularly in areas where no future construction will occur and wetlands/watercourses are nearby. The need for and extent of temporary or permanent erosion and sedimentation controls would be a function of considerations such as:

- Slope (steepness, potential for erosion, and presence of resources such as wetlands or streams at bottom of slope)
- Type of vegetation removal method used and extent of vegetative cover remaining after clearing (e.g., presence/absence of understory or herbaceous vegetation that would minimize the potential for erosion and degree of soil disturbance as a result of the movements of clearing equipment)
- Type of soil
- Soil moisture regimes
- Schedule of future construction activities
- Proximity of cleared areas to water resources, roads, or other sensitive environmental resources
- Time of year: The types of erosion and sedimentation control methods for a particular area would depend on the time of year. For example, reseeding would not typically be effective during the winter months. In winter, with frozen ground, controls other than re-seeding (such as wood chips, straw and hay, geotextile fabric, waterbars, or crushed stone) would be used to stabilize disturbed areas until seeding can be performed.
- Extreme weather conditions during or immediately following soil disturbance

J.1.5 Vegetation Removal

CL&P is currently maintaining the vegetation along the existing corridors within or adjacent to where the overhead 345-kV transmission line is proposed. Since April 7, 2006, CL&P's ROW vegetation maintenance practices have been required to comply with mandatory standards adopted by the National Electric Reliability Corporation following the August 14, 2003 Northeast blackout, which was found to have been triggered by line outages caused by overgrown vegetation. Such vegetation management is designed to allow the reliable operation of the transmission facilities by preventing the growth of trees or invasive vegetation that would interfere with the transmission facilities or access along the ROW. As a result, the vegetation on the ROW within the maintained portions of the ROW typically consists of shrubs, herbaceous species, and other low-growing species. Presently unused or non-maintained portions of the ROW that are not proximate to the existing line may support taller vegetation.

To accommodate the new 345-kV facilities, vegetation removal will be required. Vegetation along the ROW will only be removed where necessary to allow construction, to provide and maintain access to and, as needed, along the ROW, or to provide safe distances between the conductors/wires and woody vegetation. For much of its length, the entire width of the ROW will not need to be cleared in order to accommodate the new line.

While undesirable tall-growing woody species, within the ROW and proximate to the existing or new lines will be removed, desirable species will be preserved to the extent practical. In selected cases, certain desirable low-growing trees may be kept on the ROW in certain locations and only trimmed to assure adequate clearance from wires and structures pursuant to CL&P's *Right-of-Way Vegetation Initial Clearance Standard for 115-kV and 345-kV Transmission Lines*. Generally, all tall-growing tree species will be removed from the right-of-way and low-growing tree species and taller shrub species will be retained in the areas outside of the conductor zones (the area directly under the conductors extending outward a distance of 15 feet from the outermost conductors).

These activities will modify, but will not eliminate vegetation and wildlife habitat. In general, the principal effect of vegetation clearing along the ROWs will be to forested habitat, which will be removed (where required) and will be replaced over time with native shrubs, forbs and grasses resulting in an old field and brush habitat.

Vegetation removal for construction will be performed using mechanical methods. Appropriate erosion and sediment controls will be deployed as necessary (refer to Section J.1.4).

During and after the 345-kV line construction, off-ROW "danger" trees which could pose hazards to the integrity of the transmission line also will be identified and removed. Danger trees are weak, broken, decaying or infested trees that could cause flashovers or contact the structures or conductors or violate the conductor zones if they were to fall towards the right-of-way.

Where removal of woody vegetation is required, vegetation will be cut flush with the ground surface to the extent possible and treated (herbicide). Where practical, trees will be felled parallel to the ROW to minimize the potential for off-ROW vegetation damage.

To stabilize disturbed sites after the completion of construction, CL&P may seed disturbed areas with appropriate grass-type mixes. Vegetative species compatible with the use of the corridor for transmission line purposes are expected to regenerate naturally, over time. CL&P will promote the re-growth of desirable species by implementing vegetation maintenance practices to control tall-growing tree and undesirable invasive species, thereby enabling native plants to dominate.

CL&P will take particular care to maintain vegetation along streams and within wetlands to the extent possible. In general, CL&P may alter to some degree vegetation management activities in the following areas; provided that the same construction and operation of the facilities is maintained:

- Areas of visual sensitivity where vegetation removal may be limited for aesthetic purposes
- Steep slopes and valleys which are spanned by transmission lines
- Agricultural lands
- Residential areas where maintained landscapes do not interfere with the construction or operation of the facilities.

J.1.6 Access Roads

Continuous access along the existing ROW is generally not required for the 345-kV overhead transmission line, although access is required to each transmission structure location. Because the overhead line would follow existing well-established ROWs, existing access roads are generally already in place and are expected to be used during construction.

Along most of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and MMP corridor, the ROW has been in existence for over 80 years, and as a result, some access is already available. This existing access typically would be expanded and used for construction access wherever possible. However, it is expected that most of these existing roads will have to be improved or otherwise prepared for construction use. In particular, the access roads must be improved to assure appropriate grades and to be of sufficient width and capacity to safely support heavy construction equipment, such as oversize flat-bed trailers, cranes, and concrete trucks. Typically, grades must be 10 percent or less.

Access road improvements may include clearing of vegetation along the road, and widening roadway travel surfaces as needed to provide a travel surface of typically 15 to 20 feet. Access roads may be graveled and where streams or wetlands must be crossed, culverts and wetland mats may be used or, if already present, improved. Erosion and sedimentation controls will be installed before the commencement of any work on access roads.

CL&P has performed an initial review of existing access roads that lead to the transmission line ROW for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and for the MMP. Based on this initial review, an inventory of possible access roads was prepared. Tables J-2 and J-3 summarize the public roads and other sites that may provide the access to the transmission line ROW. Included for reference is the corresponding Segment Number from the 400-Scale Aerial Route Maps in Volume 9, which illustrates the location of the roadways with respect to the access roads, transmission lines, substations and transmission line junctions. A detailed evaluation of the access roads required for construction will be conducted and included in the Development & Management (D&M) Plan that will be prepared for the Connecticut Portion of the North Bloomfield to Agawam 345-kV and MMP Line Routes.

Table J-2 Review of Potential Access Roads for Connecticut Portion of The North Bloomfield to Agawam 345-kV Line Route

Town	400-Scale Aerial Route Map	Existing Access to ROW via the following Town/City streets or sites:
Bloomfield	1 of 10	Duncaster Road
Bloomfield	1 of 10	Tariffville Road
Bloomfield	1 of 10	Hartford Ave (Route 189)
East Granby	1 of 10	Tunxis Avenue
East Granby	2/3 of 10	Hatchett Hill Road (Route 540)
East Granby	3 of 10	Adams Drive
East Granby	3 of 10	Holcomb Street
East Granby	4 of 10	Turkey Hills Road (Route 20)
East Granby	6 of 10	Newgate Road
East Granby	6 of 10	Wyncairn Road
Suffield	8 of 10	Phelps Road
Suffield	8 of 10	Mountain Road (Route 168)
Suffield	9 of 10	Stone Street
Suffield	10 of 10	Colson Street
Suffield	10 of 10	Ratley Road

Table J-3 Review of Potential Access Roads for Manchester to Meekville Junction Circuit Separation Project

Town	400-Scale Aerial Route Map	Existing Access to ROW via the following Town/City streets or sites:
Manchester	1 of 3	Olcott Street
Manchester	1 of 3	Thrall Road
Manchester	1 of 3	Middle Turnpike (U.S. Route 6)
Manchester	2 of 3	I-84/I-291 Interchange
Manchester	2 of 3	Tolland Turnpike
Manchester	3 of 3	Chapel Road
Manchester	3 of 3	Burnham Street

J.1.7 Foundation Work

Most excavations for overhead line-structure foundations are expected to be accomplished using mechanical excavators and pneumatic hammers. However, if required, a controlled drilling and blasting plan would be developed by a certified blasting contractor and approved by CL&P, in compliance with state and local regulations. Residents would be contacted in advance of the blasting and pre-blast surveys would be performed as appropriate. The specific locations where blasting would be required would be determined by conducting field studies (borings) at the proposed structure locations. In the unlikely event that there is damage to a property as a result of the blasting, CL&P will compensate the property owner for the actual damage. Fencing or other barricades would be placed around excavations for structures during non-working hours.

J.1.8 Structure Installation

Structures (steel poles and H-frames) would be delivered to their installation locations in sections and assembled and installed with a crane. Insulators and connecting hardware would be installed on most structures at this time.

J.1.9 Conductor Work

The installation of the overhead line conductors and shield wires would require the use of special equipment at pre-determined locations, at intervals of up to 3 miles apart. The wires would be pulled under tension to avoid contacting the ground and other objects. The remaining insulators and hardware would be installed at angle and deadend structures, and the wires would be sagged to the design tension and connected to the hardware in accordance with industry standards and design specifications.

For the overhead line conductor and wire installations, approximately 11 pulling sites for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and 4 for MMP would be established along the ROW. These sites are typically 50 to 75 feet wide and 100 to 200 feet long, and are usually located in the ROW. The selection of the conductor pulling site would be determined when the final line design is completed.

The selection of conductor pulling sites will be based on accessibility, terrain, angles within the sections where the conductors would be pulled, the locations of deadend structures, the length of conductors to be pulled, puller capacity, and snub structure loads including placement of pullers, tensioners and conductor anchors. Other considerations include the placement of reel stands, pilot line winders, reel winders, and the ability to provide an adequate temporary grounding system. The locations of the puller, tensioners, and other conductor pulling equipment would be in an area that would not overload the structures. Most of the equipment associated with pulling conductors would be set up in the transmission line ROW, thereby minimizing the overall impact of these operations. Steps would be taken to minimize temporary disturbance to adjacent landowners from noise and activity associated with the pulling operation. These sites and others would be finalized and identified in the D&M Plan.

J.1.10 Cleanup and Restoration of ROW

Disturbed ground would be back-bladed to approximate preconstruction contours, unless CL&P is directed otherwise. For work sites in actively used agricultural fields, the soil may be de-compacted by disking or equivalent methods. Erosion controls would be left in place until removal is approved by the Council. Steep areas would be stabilized with jute netting, pre-made erosion control fabric containing seed, mulch, and fertilizer or the equivalent.

Access roads where culverts or crushed stone fords were installed would be left in place or removed as directed by the Council in accordance with other permit conditions.

Periodic monitoring and reporting with on-site inspection by the Council would occur to ensure compliance with all aspects of the siting decision.

J.1.11 Special Procedures: Rock Removal (Blasting), Dewatering, Material Handling

J.1.11.1 Blasting

If blasting is necessary, CL&P would adhere to the following procedures:

- A certified blasting specialist would develop site-specific blasting procedures, taking into account geologic conditions and nearby structures and assuring compliance with State regulations.
- The blasting plan would be provided to the local Fire Marshal for approval. Blasting charges would be designed to loosen only the material that must be removed to provide a stable foundation, and to avoid fracturing other rock.
- CL&P would seek to meet with each property owner in proximity to the blasting to explain where and when the blasting is expected to occur, and why blasting is necessary.

- Pre-blast surveys, to document existing conditions, would be conducted for any property within a specified distance of the area where blasting would occur. This distance would be determined by CL&P's blasting contractor, in consultation with the Fire Marshal and with the CL&P's approval.
- The areas where blasting would occur would be covered with heavy blanketing materials and charges would be sized appropriately.
- Seismographs would measure each blast to confirm that levels are within prescribed limits.
- Excavated material that cannot otherwise be used at the site would be removed and properly disposed of elsewhere.

J.1.11.2 Soils and Groundwater

During the construction of the transmission lines the effective management of soils and groundwater will be a key consideration. As part of the final GSRP and MMP design, CL&P will develop specific plans for characterizing the soils and groundwater (i.e., presence/absence of contaminants) and subsequently for handling and managing such materials. Such plans will be developed based on the results of agency file reviews, pre-construction sampling and analyses along the approved GSRP and MMP routes, and the incorporation of applicable permit requirements. The following summarizes the approach that CL&P expects to apply in developing such plans.

CL&P will follow the guidance issued by the CT DEP for Utility Company Excavation. The CT DEP currently recommends the following procedure to be followed by utilities that encounter contaminated soil during repair or construction activities. This applies to cases where the contaminated soil/waste are encountered on property not owned by the utility, and the contamination was not created by the utility.

The utility may reuse the contaminated soil in the same excavation within the same area of concern without prior approval by CT DEP provided:

- Any condition that would be a significant environmental hazard as defined in Connecticut General Statutes Section 22a-6(u) is reported by the utility and that the location is identified on a map submitted to the CT DEP Remediation Division.
- Any excess contaminated material is disposed in accordance with solid and hazardous waste regulations as appropriate.
- The upper one foot of the excavation is filled with clean fill material or paved.

Any sampling required to determine whether a significant environmental hazard exists or how excess spoils will be disposed will be the responsibility of the contractors performing the excavation.

Pre-Construction Studies

Prior to construction of the GSRP and MMP, CL&P will commission a due-diligence review of existing data regarding the current and historical uses of areas along the ROWs, properties along the ROWs, and nearby off-site sources. The scope of the due-diligence work will comply with Sections 8.1 and 8.2 of the ASTM Standard E1527-05. The objective of the work will be to identify known locations of potential sources of past or current contamination, such as leaking underground storage tanks, sites designated as hazardous by federal or state government, locations of reported spills of oil or hazardous material, etc.

Based on the results of the due-diligence research review, a sampling and analysis plan will be developed to characterize the soils and groundwater along the specific GSRP and MMP line routes. This plan will identify the locations and depths of the samples that will be collected, as well as the analytical tests that will be performed on the samples. The field investigations will be completed in accordance with an In-Situ Soil and Groundwater Characterization Work Plan (Characterization Work Plan) that will be developed subsequent to the completion of the due diligence work. The objective of this Characterization Work Plan will be to obtain in-situ soil and groundwater data for the purpose of obtaining future approval for disposal/reuse of soil and planning/permitting for discharge of water. In-situ characterization data will be collected in the vicinity of sites of environmental concern identified in the due-diligence review and at appropriate intervals along the route to support approval of future soil reuse/disposal activities.

The results of the field investigations will be used to determine where oil and/or hazardous material is present in the soil or groundwater at levels equal to or greater than the applicable reportable concentration values. Iterative sampling and analysis may be completed, as needed, to define the extent of such areas along the ROW. Such investigation will not extend beyond the GSRP or MMP ROW or construction limits.

J.1.11.3 Soils Handling and Management

Locations Where In-Situ Levels Exceed Applicable Reportable Concentrations of Contaminants

A material handling plan will be prepared, as necessary, to notify CT DEP of CL&P's intent to undertake handling of potential impacted soils at various locations along the GSRP and MMP routes, as necessary. The material handling plan would be implemented in areas where excavation of potentially contaminated soils and dewatering of potentially contaminated groundwater may be necessary during construction/installation activities. The material handling plan will define how to properly handle and manage soil and groundwater that is excavated during proposed site activities in order to minimize exposure to the general public and environmental receptors.

Excavated materials to be transported from the site will be loaded directly onto trucks for off-site disposal at an appropriate facility or stockpiled temporarily at a permitted facility before being disposed at a permanent facility. Soil transported from the GSRP and MMP ROWs will be transported under Bill of Lading or a Hazardous Waste Manifest as appropriate. These soils will be disposed of in accordance with the applicable federal, state and local regulations.

Locations Where In-Situ Levels Do Not Exceed Applicable Reportable Concentrations of Contaminants

Construction of portions of the GSRP and MMP will occur in areas where known or observed historical contamination does not exist. In such areas, a material handling plan is not required. A Material Handling Guideline (MHG) will be developed to direct future management and disposal of solid and liquid Excess Materials generated during construction of the GSRP and MMP in these areas.

J.1.11.4 Construction Site Dewatering

Neither the construction nor the operation of the GSRP and MMP is expected to result in adverse effects on groundwater resources or public water supplies. During construction, care will be taken to avoid effects to municipal water lines that may be located within road ROW.

It is possible that groundwater may be encountered during excavations for overhead structure foundations, for cable system installation (if underground route variations are selected) or during subsurface construction activities at the North Bloomfield Substation.

If groundwater is encountered during excavation, the water will be pumped from the excavated areas and discharged in accordance with applicable local and state requirements. Depending on regulatory authorizations, the water may be discharged on-site into appropriate sediment control basin or directly into municipal storm water catch basins; pumped first to a temporary fractionization (frac) tank and then discharged to the municipal storm water system, or pumped into a tanker truck for disposal at appropriate wastewater treatment facilities located outside of the GSRP and MMP area. Residual silt/sediment collected at the bottom of the frac tanks will be disposed off-site at an appropriately designated disposal facility. Proper catch-basin inlet protection will be installed at catch-basin grates to prevent construction-generated soil excavate and debris from entering the existing roadway stormwater system.

J.2 UNDERGROUND TRANSMISSION LINE CONSTRUCTION

J.2.1 Overview of Underground Line Construction

CL&P would follow typical underground transmission cable construction procedures if portions of the 345-kV line are required to be constructed underground (e.g., along one of the underground line route variations).

J.2.2 Sequence of Underground Construction

J.2.2.1 Construction Within Roadways

Underground cable construction procedures within or adjacent to public roadways are summarized as follows:

- The first step in the construction process is to deploy appropriate erosion and sedimentation controls (e.g., catch basin protection, silt fence or straw bales) at locations where pavement or soils will be disturbed. Within roads and other paved areas, the pavement would then be saw cut and removed.
- At approximately 1,600-foot intervals along each circuit cable route, pre-cast concrete splice vaults (one for each circuit) will be installed below ground. Depending on the amount of space, the vaults may be arranged so that two vaults are nested together (dual vaults), side-by-side, or staggered linearly along the route. The length of an underground cable section between splice vaults (and therefore the location of the splice vaults) is determined based on engineering requirements (such as maximum allowable pulling tensions; the cable weight/length that can fit on a reel and be safely shipped, and cross-bonding requirements) and land constraints. The specific locations of splice vaults will be determined during final engineering design and in some areas could be significantly closer than the 1,600-foot interval stated above.

- For safety purposes, the splice vault excavations are shored and fenced. Vault sites also may be demarcated by concrete (Jersey) barriers or equivalent. Vault installation within roadways may require the closure of two travel lanes in the immediate vicinity of the vault construction.
- Each vault will have two entry points to the surface. After backfilling, these entry points are identifiable as manhole covers, and are set flush with the ground or road surface.
- To install the duct bank for the XLPE-insulated cables, a trench 7 to 10 feet deep and approximately 5 feet wide would be excavated within a typical construction area of 40 to 60 feet wide. This trench would typically be stabilized using trench boxes or other type of shoring. Excavated material (e.g., pavement, subsoil) would be placed directly into dump trucks and hauled away to a suitable disposal site or hauled to a temporary storage site for screening/testing prior to final disposal or re-use in the excavations for backfill. If groundwater is encountered, dewatering would be performed in accordance with authorizations from applicable regulatory agencies and may involve discharge to catch basins, temporary settling basins, frac tanks, or vacuum trucks. Since underground cable installation would involve both the excavation of a continuous trench and areas for splice vaults, it is very probable that rock would be encountered. Such rock would have to be removed using mechanical methods, or possibly mechanical methods supplemented by controlled drilling and blasting. Should drilling and controlled blasting be necessary for the underground cable, it would be performed only pursuant to a plan incorporating multiple safeguards that would be subject to specific approval by the Council, and in consultation with local authorities.
- The duct bank system would consist of nine 8-inch PVC conduits for the XLPE-insulated cables; three 2-inch PVC conduits for the ground-continuity conductors; three 2-inch PVC conduits for the fiber optic relaying cables; and three 2-inch conduits for the temperature-sensing fiber optic cables. The conduit is installed in sections, each of which will be about 10 to 20 feet long, and would have a bell and spigot connection. Conduit sections are joined by swabbing the bell and

spigot with glue then pushing the sections together. After installation in the trench, the conduits are encased in high-strength concrete. The duct bank would then be backfilled with a low-strength fluidized thermal backfill (FTB) with sufficient thermal characteristics to dissipate the heat generated by the cable system.

- Trenching, conduit installation, and backfilling would proceed progressively along the route such that relatively short sections of trench (under favorable conditions, typically 200 feet per crew) will be open at any given time and location. During non-work hours, temporary cover (steel plates) will be installed over the open trench within paved roads to maintain traffic flow over the work area. After backfilling, the trench area will be repaved using a temporary asphalt patch or equivalent. Disturbed areas will be permanently repaved as part of final restoration.
- After the vaults and duct bank are in place, the conduits are swabbed and tested (proofed), using an internal inspection device (mandrel) to check for defects. Mandrelling is a testing procedure in which a 'pig' (a painted aluminum or wood cylindrical object that is slightly smaller in diameter than the conduit) is pulled through the conduit. This is done to ensure that the 'pig' can pass easily, verifying that the conduit has not been crushed, damaged, or installed improperly. After successful proofing, the transmission cables and ground continuity conductors will be installed and spliced. Cable reels will be delivered by special tractor trailers to the vaults, where the cable will be pulled into the conduit using a truck-mounted winch and cable handling equipment.
- To install each transmission cable and ground-continuity conductor within the conduits, a large cable reel will be set up over a splice vault, and a winch will be set up at one of the adjacent splice-vault locations. The cables and ground-continuity conductors (during separate mobilizations) will then be pulled into their conduits by winching a pull rope attached to the ends of each cable. The splice vaults will also be used as pull points for installing the temperature-sensing fiber optic cables under a separate pulling operation. In addition, pull boxes will be installed near the splice vaults for the pulling and splicing operations required for the remaining fiber optic cables.

- After the transmission cables and ground-continuity conductors are pulled into their respective conduits, the ends will be spliced together in the vaults. Because of the time-consuming and precise nature of spicing high-voltage transmission cables, the sensitivity of the cables to moisture (moisture is detrimental to the life of the cable), and the need to maintain a clean working environment, splicing XLPE-insulated cables involves a complex procedure and requires a controlled atmosphere. The ‘clean room’ atmosphere will be provided by an enclosure or vehicle that must be located over the manhole access points during the splicing process. It typically takes 10 to 14 days to complete the splices in each vault (three XLPE 345-kV cable splices in each splice vault). Each cable and associated splice will then be stacked vertically and supported on the wall of the splice vault.
- At the ends of the cable routes, terminations are connected to the cables at 345-kV line transition stations where they transition to overhead transmission lines. Further discussion on the transition station facilities can be found in Section J.3.

J.2.2.2 Construction Within the ROW

Underground cable construction procedures within the ROW are summarized as follows:

- The first step in the construction process is to clear and grade continuous access roads along the duct bank route. Access roads will be required to handle all anticipated construction equipment and material deliveries, including concrete trucks, splice vaults, and cable reels. See Table J-2 for list of potential access roads.
- To mitigate soil disturbance and impacts to adjacent properties it will be necessary to deploy appropriate erosion and sedimentation controls (e.g., catch basin protection, silt fence or straw bales).
- At approximately 1,600-foot intervals along each circuit cable route, pre-cast concrete splice vaults (one for each circuit) will be installed below ground. Depending on the amount of space,

the vaults may be arranged so that two vaults are nested together (dual vaults), side-by-side, or staggered linearly along the route. The length of an underground cable section between splice vaults (and therefore the location of the splice vaults) is determined based on engineering requirements (such as maximum allowable pulling tensions; the cable weight/length that can fit on a reel and be safely shipped, and cross-bonding requirements) and land constraints. The specific locations of splice vaults will be determined during final engineering design and in some areas could be significantly closer than the 1,600-foot interval stated above.

- For safety purposes, the splice vault excavations are shored and fenced.
- Each vault will have two entry points to the surface. After backfilling, these entry points are identifiable as manhole covers, and are set flush with the ground.
- To install the duct bank for the XLPE-insulated cables, a trench 7 feet deep and approximately 5 feet wide would be excavated within a typical construction area of 40 to 60 feet wide. This trench would typically be stabilized using trench boxes or other type of shoring. Excavated material (e.g., pavement, subsoil) would be placed directly into dump trucks and hauled away to a suitable disposal site or hauled to a temporary storage site for screening/testing prior to final disposal or re-use in the excavations for backfill. If groundwater is encountered, dewatering would be performed in accordance with authorizations from applicable regulatory agencies and may involve discharge to catch basins, temporary settling basins, frac tanks, or vacuum trucks. Since underground cable installation would involve both the excavation of a continuous trench and areas for splice vaults, it is very probable that rock would be encountered. Such rock would have to be removed using mechanical methods, or possibly mechanical methods supplemented by controlled drilling and blasting. Should drilling and controlled blasting be necessary for the underground cable, it would be performed only pursuant to a plan incorporating multiple safeguards that would be subject to specific approval by the Council, and in consultation with local authorities.

- The duct bank system would consist of nine 8-inch PVC conduits for the XLPE-insulated cables; three 2-inch PVC conduits for the ground-continuity conductors; three 2-inch PVC conduits for the fiber optic relaying cables; and three 2-inch conduits for the temperature-sensing fiber optic cables. The conduit is installed in sections, each of which will be about 10 to 20 feet long, and would have a bell and spigot connection. Conduit sections are joined by swabbing the bell and spigot with glue then pushing the sections together. After installation in the trench, the conduits are encased in high-strength concrete. The duct bank would then be backfilled with a low-strength fluidized thermal backfill (FTB) with sufficient thermal characteristics to dissipate the heat generated by the cable system.
- Trenching, conduit installation, and backfilling would proceed progressively along the route such that relatively short sections of trench (under favorable conditions, typically 200 feet per crew) will be open at any given time and location.
- After the vaults and duct bank are in place, the conduits are swabbed and tested (proofed), using an internal inspection device (mandrel) to check for defects. Mandrelling is a testing procedure in which a ‘pig’ (a painted aluminum or wood cylindrical object that is slightly smaller in diameter than the conduit) is pulled through the conduit. This is done to ensure that the ‘pig’ can pass easily, verifying that the conduit has not been crushed, damaged, or installed improperly. After successful proofing, the transmission cables and ground continuity conductors will be installed and spliced. Cable reels will be delivered by special tractor trailers to the vaults, where the cable will be pulled into the conduit using a truck-mounted winch and cable handling equipment.
- To install each transmission cable and ground-continuity conductor within the conduits, a large cable reel will be set up over a splice vault, and a winch will be set up at one of the adjacent splice-vault locations. The cables and ground-continuity conductors (during separate mobilizations) will then be pulled into their conduits by winching a pull rope attached to the ends of each cable. The splice vaults will also be used as pull points for installing the temperature-

sensing fiber optic cables under a separate pulling operation. In addition, pull boxes will be installed near the splice vaults for the pulling and splicing operations required for the remaining fiber optic cables.

- After the transmission cables and ground-continuity conductors are pulled into their respective conduits, the ends will be spliced together in the vaults. Because of the time-consuming and precise nature of spicing high-voltage transmission cables, the sensitivity of the cables to moisture (moisture is detrimental to the life of the cable), and the need to maintain a clean working environment, splicing XLPE-insulated cables involves a complex procedure and requires a controlled atmosphere. The 'clean room' atmosphere will be provided by an enclosure or vehicle that must be located over the manhole access points during the splicing process. It typically takes 10 to 14 days to complete the splices in each vault (three XLPE 345-kV cable splices in each splice vault). Each cable and associated splice will then be stacked vertically and supported on the wall of the splice vault.
- At the ends of the cable routes, terminations are connected to the cables at 345-kV line transition stations where they transition to overhead transmission lines. Further discussion on the transition station facilities can be found in Section J.3.

J.2.3 Temporary Erosion and Sedimentation Controls

Temporary erosion controls (e.g., silt fence, hay/straw bales, filter socks, mulch, temporary and/or permanent reseeding) would be installed as needed in accordance with the *2002 Connecticut Erosion and Sedimentation Guidelines*, at any time during the clearing operations. The placement of such temporary controls would be appropriate to minimize the potential for erosion and sedimentation in areas where soils have been disturbed. Permanent stabilization of disturbed soils may be required as well, particularly in areas where no future construction will occur and wetlands/watercourses are nearby. The need for and extent of temporary or permanent erosion and sedimentation controls would be a function of considerations such as:

- Slope (steepness, potential for erosion, and presence of resources such as wetlands or streams at bottom of slope)
- Type of vegetation removal method used and extent of vegetative cover remaining after clearing (e.g., presence/absence of understory or herbaceous vegetation that would minimize the potential for erosion and degree of soil disturbance as a result of the movements of clearing equipment)
- Type of soil
- Soil moisture regimes
- Schedule of future construction activities
- Proximity of cleared areas to water resources, roads, or other sensitive environmental resources
- Time of year: The types of erosion and sedimentation control methods for a particular area would depend on the time of year. For example, reseeding would not typically be effective during the winter months. In winter, with frozen ground, controls other than re-seeding (such as wood chips, straw and hay, geotextile fabric, waterbars, or crushed stone) would be used to stabilize disturbed areas until seeding can be performed.
- Extreme weather conditions during or immediately following soil disturbance

J.2.4 Vegetation Removal

For underground construction within the roadway, minimum clearing is required. For underground construction within the ROW, vegetation removal to create a typical construction area 40 to 60 feet wide is required. Additional clearing would also be needed for transition stations, splice vaults and staging areas.

J.2.5 Splice-Vault Requirements

The outside dimensions of splice vaults for 345-kV XLPE cables are approximately 10 feet wide by 10 feet deep and up to 32 feet in length (one per each set of XLPE cables). The installation of each splice vault therefore requires an excavation area approximately 14 feet wide, 13 feet deep, and 36 feet long. At approximately 1,600-foot intervals along the cable route, pre-cast splice vaults will be installed below ground. Splice vaults located along but outside of public roadways require a minimum of 12,000 square feet of permanent easement for future access to perform maintenance and repairs. An additional minimum 4,300 square feet of temporary easement would be required during the initial construction phase. The burial depth of each vault would vary, based on site-specific topographic conditions and the cable depth (based on factors such as the avoidance of other buried utilities). Vaults may be installed within public roadways or, in order to avoid conflicts with other utilities buried beneath the roadways, may be installed in other suitable locations adjacent to such roads (e.g., beneath parking lots, sidewalks, road shoulders, or road medians). However, when vaults are installed off-road for this reason, while duct banks are within the road, the duct bank must cross other parallel buried utilities twice for each vault, which greatly complicates the design and construction.

J.2.6 Special Procedures: Rock Removal (Blasting), Dewatering, Material Handling

Since underground cable installation would involve both the excavation of a continuous trench and areas for splice vaults, it is probable that rock would be encountered at some locations. Such rock would have to be removed using mechanical methods, or mechanical methods supplemented by controlled drilling and blasting. If drilling and blasting become necessary for the underground cable, CL&P would adhere to the procedures outlined in section J.1.11.1.

J.3 TRANSITION STATIONS

A 345-kV line transition station is required whenever an underground cable segment of the line connects to an overhead section of the line. Such transition stations typically require a fenced and graded area approximately 2 to 4 acres in size. Within the line transition station would be a terminal structure, pothead stands, potheads and surge arresters, circuit breakers, and a control enclosure. The protective relaying systems and Supervisory Control and Data Acquisition (SCADA) equipment, battery systems, etc. would reside inside the control enclosure. Shunt reactors that resemble large power transformers may also be required in some transition stations.

J.4 CONSTRUCTION PROCEDURE FOR MODIFICATION OF THE NORTH BLOOMFIELD SUBSTATION

J.4.1 Overview of Substation Construction

The modification of the existing substation will involve several phases. The expansion of the 345-kV switchyards at the North Bloomfield Substation will involve an expansion of the existing substation fence line to accommodate the planned facilities but will not require the purchase of additional property.

The following summarizes the sequential approach that will be used to modify the existing substation. The actual sequence of construction activities and methods of construction may vary based on the specific engineering design ultimately developed. Further, it is anticipated that more detailed construction requirements and, as appropriate, environmental mitigation measures specific to the substation may be defined during the Council's review process.

J.4.2 Site Preparation

Site preparation work may include, as necessary:

- Installation of temporary soil erosion and sedimentation controls (e.g., silt fence, straw bales). Such controls will be maintained, as necessary, throughout the construction process.
- Clearing of vegetation from work areas
- Creating temporary access to the sites for heavy construction equipment
- Grading to create a level work area
- Excavation of unsuitable soils
- Installation of fencing
- Typical construction equipment is expected to include bulldozers, backhoes, man-lift vehicles, compressors, trucks (various sizes), large capacity crane (e.g., 100-ton), and flat-bed trailers.

Changes to current grades and drainage are proposed to support expansion at the south end of the North Bloomfield Substation. Changes to grading would include cutting and filling the substation expansion area to provide a level grade for the installation and operation of substation equipment and to contain insulating fluids. Change to drainage pattern would occur where necessary to maintain drainage away from substation equipment. However, care would be taken to retain natural drainage patterns and prevent additional runoff attributable to the new earthwork to the extent possible. Any existing run-off flow patterns from the house lots onto or adjacent to the proposed expansion should be maintained and not altered by the proposed expansion at North Bloomfield Substation.

J.4.3 Foundations and Equipment

Foundation construction will commence after the completion of rough grading. The foundation installation process typically involves excavation, form work, use of steel reinforcement, construction of the transformer sumps, and concrete placement. Excavated material will either be reused on-site or disposed of off-site in accordance with applicable requirements.

After the foundations are installed, construction activities will shift to the erection of structures and equipment including:

- Steel Structures
- Transformers
- Bus and Insulators
- Circuit Breakers
- Gas Insulated Line (GIL)
- Switches
- Voltage & Potential Transformers
- Lightning Masts
- Lighting
- Control Enclosure or Expansion of existing Enclosure
- Cable Trench
- Capacitor Banks
- Series Reactors
- Splice Vaults
- Ground Grid
- Arresters
- Conduits and Cables

J.4.4 Testing and Interconnections

All of the substation equipment will be commission-tested prior to final connection to the transmission grid. New structures and associated conductors and wires will be installed, as necessary, to connect the substation to the new 345-kV facilities.

J.4.5 Final Cleanup, Site Security and Landscaping

After the completion of construction, any remaining construction debris will be collected and removed from the site. Temporary erosion controls will be maintained until the disturbed areas are satisfactorily stabilized. The need for landscaping typically will be discussed during the D&M Plan development phase of the siting process. Landscape plans and specifications, if appropriate, typically will be identified as part of the final engineering and design.

J.5 TRAFFIC CONSIDERATION AND HOURS OF OPERATION

Construction traffic would be localized and short term and is not expected to adversely affect local traffic. The well-established public road network in the Project area would afford ready access for construction vehicles and equipment to work sites. The construction-related traffic increase will be small relative to total traffic volume on public roads in the area. In addition, the construction traffic will be intermittent, temporary and will end once the GSRP and MMP are completed. The addition of this traffic for the duration of these projects is not expected to result in any additional congestion or change in operating conditions along the roadways adjacent to the ROW.

Traffic entering and exiting the ROW from public roadways will increase during the construction phase of the GSRP and MMP. CL&P would develop an access plan for the contractors, along with applicable traffic control plans, to safely navigate construction vehicles onto and off of the ROW with as minimal disruption to traffic along the public way as possible.

Existing access to the North Bloomfield Substation is made via Hoskins Road/Tariffville Road. Post-construction site conditions would not significantly affect existing traffic patterns. Construction is expected to occur during normal work hours, but is also dependent on the scheduling of allowable line outages.

SECTION K

SAFETY INFORMATION

K. SAFETY INFORMATION

K.1 COMPLIANCE WITH APPLICABLE CODES AND STANDARDS

The projects' overhead transmission line facilities and any underground line variation would be constructed in full compliance with the standards of the National Electrical Safety Code (NESC), the Institute of Electrical and Electronic Engineers (IEEE), the American National Standards Institute (ANSI), good utility practice, and DPUC regulations covering the method and manner of high voltage line construction. Should the line experience a short circuit, high speed protective relaying would immediately remove the line from service, thereby protecting the public as well as the transmission line, associated substation equipment and the transmission system.

K.1.1 Emergency Operations and Shutdown

Should one of the lines experience an insulation or conductor failure, high-speed protective relaying would immediately remove the line from service, thereby protecting the public and the line. Should equipment at the substations experience a failure, protective relaying would immediately remove the equipment from service, thereby protecting the public and the equipment within the substations.

Protective relaying equipment is incorporated into the project design to automatically detect abnormal system conditions and send a protective trip signal to the respective circuit breaker(s) at each end of a line to isolate the faulted section of the transmission system. The protective relaying schemes include fully redundant primary and backup equipment so that an outage of one scheme does not require the portion of the transmission system being monitored by the protective relaying equipment to be removed from service.

Fiber optic strands would be installed within the lightning shield wires above the overhead line and in separate conduits for underground line construction. These provide a robust and reliable communications path for the protection systems. Additionally, the overhead transmission line facilities may also provide for electronic communications between substations using signals impressed upon the overhead conductors ("carrier signal") to support protective relaying and operations (*Note: a carrier signal generally does not work on underground cables because the capacitance is too high*).

Fire/smoke detection systems would be installed within the new control and relay enclosure at North Bloomfield Substation. If fire or smoke is detected, these systems automatically activate an alarm at Connecticut Valley Electric Exchange (CONVEX), thereby allowing system operators to take appropriate action. Control and relay enclosures are equipped with fire extinguishers.

The new autotransformer at North Bloomfield Substation would have an insulating fluid that would require a secondary containment system for fluid leaks or spills. The secondary containment system will conform to Northeast Utilities Design and Application Standard SUB047.004.

K.1.2 Fire Suppression Technology

Fire/smoke detection systems are already in place at the North Bloomfield Substation. In the event that fire or smoke is detected, these fire/smoke detection systems would automatically activate an alarm at CONVEX, and the system operators then would take the appropriate action. The control and relay enclosures at each substation are equipped with fire extinguishers.

The new protective relaying and associated equipment within the substations, along with a Supervisory Control and Data Acquisition (SCADA) system for remote control and equipment monitoring, will be housed in the 345/115-kV Relay & Control Enclosure. The 345/115-kV Relay & Control enclosure will have smoke detectors installed which would be monitored from a remote location.

K.2 ELECTRIC AND MAGNETIC FIELDS

Electric and magnetic fields (EMF) are two forms of energy that surround an electrical device. Transmission lines are sources of EMF, as are other substantial components of electric power infrastructure, ranging from transformers at substations to the wiring and appliances in a home. Any piece of machinery run by electricity can be a source of EMF.

To address a range of concerns regarding potential health risks from exposure to transmission line EMF, in December of 2007, the Council issued a policy document entitled "*Electric and Magnetic Field Best Management Practices for the Construction of Electric Transmission Lines in Connecticut*" (BMPs). This document summarized the latest information regarding scientific knowledge and consensus on EMF health concerns, and it adopted policies concerning the reduction of magnetic fields (MF) associated with proposed new transmission lines.

In the BMPs, the Council recognized "that a causal link between power-line MF exposure and demonstrated health effects has not been established, even after much scientific investigation in the U.S. and abroad," and that "timely additional research is unlikely to prove the safety of power-line MF to the satisfaction of all." Accordingly, the Council decided "to continue its cautious approach to transmission line siting that has guided its Best Management Practices since 1993." As the CSC states in its BMPs "this continuing policy is based on the Council's recognition of and agreement with conclusions shared by a wide range of public health consensus groups, and also, in part, on a review which the Council commissioned as to the weight of scientific evidence regarding possible links between power-line MF and adverse health effects. Under this policy, the Council will continue to advocate the use of effective no-cost and low-cost technologies and management techniques on a project-specific basis to reduce MF exposure to the public while allowing for the development of efficient and cost-effective electrical transmission projects.

Pursuant to this policy, the Council's BMPs "require an applicant proposing to build an overhead electric transmission line to develop and present a Field Management Design Plan that identifies measures to reduce magnetic field levels that would otherwise occur along an electric transmission right-of-way, particularly where the line will be "adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds.

The BMPs also require transmission line applicants to present calculations of magnetic fields under pre-project and post-project conditions, assuming the use of different transmission line design alternatives. The purpose of this requirement is to "allow for an evaluation of how MF levels differ between alternative power line configurations," so that the Council can direct the applicant to "achieve reduced MF levels when possible through practical design changes." However, the reduction of magnetic fields is only one of the factors that the Council will consider in approving particular line designs. Others include "cost, system reliability, aesthetics, and environmental quality."

In addition to specific information about a proposed transmission line, the Council considers certain general EMF information in the course of a proceeding on a transmission line application, including "evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF." Accordingly, CL&P commissioned an independent expert to prepare a report concerning any such developments, which is provided as part of Section O of this Application. See Appendix O-6, *EMF and Health: Review and Update of the Scientific Research December 2007 – June 2008*. All of the EMF information required by the BMP, including a Field Management Design Plan, is provided in Section O of this Application.

SECTION L

DESCRIPTION OF EXISTING ENVIRONMENT ALONG PROPOSED LINE ROUTES (GSRP AND MMP) AND AT THE NORTH BLOOMFIELD SUBSTATION

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L. DESCRIPTION OF EXISTING ENVIRONMENT ALONG PROPOSED LINE ROUTES (GSRP AND MMP) AND AT THE NORTH BLOOMFIELD SUBSTATION

This section describes the existing environmental resources along and in the vicinity of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (including the North Bloomfield Substation) and the MMP. Section M discusses the existing environmental conditions along the underground line route variations to the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, as well as along the 5.4-mile Connecticut segment of the Massachusetts Southern Route Alternative.

For the Connecticut Portion of the North Bloomfield to Agawam 345-kV and MMP Line Routes, information pertaining to existing environmental conditions was collected using available published resource information, the CT DEP Geographic information System (GIS) database, and the Environmental Systems Research Institute, Inc. (ESRI) database. In addition, CL&P consulted with various federal, state and local agencies and conducted field investigations of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, the MMP ROWs, and North Bloomfield Substation.

Two sets of maps depicting the environmental conditions along the Connecticut Portion of the North Bloomfield to Agawam 345-kV and the MMP Line Routes are provided: the 1”=400’ aerial photographs presented in Volume 9 *Aerial Photographs - 400 Scale* show the proposed project facilities in relation to environmental features in the surrounding area, whereas the 1”=100’ aerial photographs presented in Volume 11 *Aerial Photographs - 100 Scale* are included to provide a closer view of the features in the immediate vicinity of the each project route. Both sets of aerial photographs, which were derived from aerial photography, show the Connecticut Portion of the North Bloomfield to Agawam 345-kV and the MMP Line Routes and the nearby principal land-use features and natural resources, including:

- Location of existing transmission line ROWs, substation, structures and existing access roads;
- Vegetative community types;
- Areas of steep slopes and rock outcrops;
- Residential, commercial, and industrial uses;
- Municipal boundaries;
- Municipal zoning classifications;
- Wetlands, including locations of surveyed wetland boundary flags;
- Watercourses and waterbodies, including streams, rivers and lakes, as well as drainage ditches and culverts;
- Floodplain boundaries as identified by the Federal Emergency Management Agency (FEMA);
- Public recreational, scenic, open space, and other protected areas, including forests, parks, water supplies, hunting/wildlife management areas; and
- Statutory facilities, identified by the Council as settled areas, schools, day-care centers, youth camps, and group homes.

To verify and update the information depicted on the aerial photographs, CL&P conducted field investigations and other reconnaissance of the project line routes. In addition, CL&P compiled information concerning current land use, future land use patterns, natural and cultural resources, and other environmental resources as a result of consultations with the public and with federal, state, and local agency representatives. Further, CL&P prepared and distributed a Municipal Consultation Filing, pursuant to Council requirements, to the municipalities potentially affected by the GSRP and the MMP. The municipal consultation package provided the municipalities with technical reports and information concerning the project need, alternative route/site selection process, existing environmental features, and potential environmental effects and mitigation measures. Through this municipal consultation process, CL&P solicited feedback and recommendations from each municipality that may assist CL&P in designing and constructing the proposed transmission improvements.

Further, in accordance with the Council's *Application Guide for Terrestrial Electric Transmission Line Facilities* dated August, 2007 CL&P commissioned the performance of studies of natural resources (including wetlands and watercourses, amphibian breeding habitats, and breeding bird habitat) and cultural resources along the ROWs. Volumes 2, 3, and 4 include complete copies of such detailed environmental investigations. The results of these studies are summarized in this section.

L.1 CONNECTICUT PORTION OF THE NORTH BLOOMFIELD TO AGAWAM 345-kV LINE ROUTE

L.1.1 Topography, Geology and Soils

L.1.1.1 Topography

The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route for the new 345-kV transmission line traverses approximately 12 miles in a northeasterly direction starting at the existing North Bloomfield Substation in Bloomfield, Connecticut. From there, the ROW continues through the towns of East Granby and Suffield to the Connecticut/Massachusetts State border.

The project area lies within the Central Lowlands physiographic province. In the project area, elevation ranges from 50 feet above sea level to greater than 500 feet above sea level where the ROW crosses the West Suffield Mountain range.

L.1.1.2 Geology

The project area is located in the Connecticut Valley Lowlands Region, which was formed by erosion of sedimentary rocks before the glacial period. Connecticut's bedrock geology has a direct effect on landscape forms due to differing resistances to weathering and erosion. These sedimentary rocks are typically composed of sandstone, shale, and conglomerate particles and interspersed with volcanic rocks during the Jurassic and Triassic period approximately 190 to 200 million years ago. Surficial geology within the project area consists of sand and gravel, sand, till or bedrock, fine grained deposits, and stratified sand and gravel deposits.

Depth to bedrock along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route has been estimated based on a review of soils and surficial geology maps. The depth to bedrock is identified by soil type in Table L-1 (*Soils and Soil Characteristics Along the Connecticut Portion of the North Bloomfield to Agawam345-kV Line Route*). The U.S. Geological Survey (USGS) map contained in Volume 9 depicts the surficial geologic conditions (i.e., depth of till and other deposits overlying bedrock) along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

L.1.1.3 Soils

The U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) maps soil types and produces county-wide soils maps. These county soils maps provide information concerning soil characteristics, including but not limited to depth to bedrock, slope, drainage, erosion potential, development constraints, agricultural suitability, and areas of hydric soils.

Table L-1 (*Soils and Soil Characteristics Along the Connecticut Portion of the North Bloomfield to Agawam345-kV Line Route*) summarizes the principal soil associations, as identified by the USDA NRCS[1], in the general vicinity of the GSRP route. This information provides a useful baseline for identifying areas of wetland soils, assessing the potential for erosion and sedimentation during construction, and for planning appropriate erosion and sedimentation controls to be implemented during construction.

[1] The NRCS was formerly the Soil Conservation Service (SCS).

Field investigations were conducted to identify Connecticut wetlands, which are delineated based on the presence of “hydric” soils. Hydric soils consist of poorly drained, very poorly drained, alluvial or floodplain soils. Wetlands along the route were identified and described by registered soil scientists during 2007 and 2008. Refer to the discussion in Section L.1.2.2 and in Volume 2, *Inventory and Delineation of Wetland and Watercourse Along the Connecticut Portion of the Greater Springfield Reliability Project*.

Table L-1 Soils and Soil Characteristics along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

Map Unit Name and Symbol	Parent Material	Hydric (Yes or No)	Depth to Bedrock (inches)	Depth to water Table (feet)
6 Willbraham and Menlo soils	coarse-loamy lodgment till	Yes	20-36	1.5
9 Scitico, Shaker, and Maybid soils	clayey glaciolacustrine deposits	Yes	>72	0.5
12 Raypol silt loam	coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	Yes	>72	1.0
15 Scarboro muck	of sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	Yes	>72	0.5
18 Catden and Freetown	woody organic material	Yes	>72	1.5
21A Ninigret and Tisbury soils	coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	1.5
28A Elmridge fine sandy loam	coarse-loamy eolian sands over clayey glaciolacustrine deposits	No	>72	1.5
29B Agawam fine sandy loam	coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits	No	>72	>6.0
34A Merrimac sandy loam	gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0
36B Windsor loamy sand	eolian sands over sandy glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0
36C Windsor loamy sand	eolian sands over sandy glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0
36A Windsor loamy sand	eolian sands over sandy glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0

Map Unit Name and Symbol	Parent Material	Hydric (Yes or No)	Depth to Bedrock (inches)	Depth to water Table (feet)
40B Ludlow silt loam	coarse-loamy lodgment till derived from basalt and/or sandstone and shale	No	20 – 40	1.5
42C Ludlow silt loam	coarse-loamy lodgment till derived from basalt and/or sandstone and shale	No	20 – 40	1.5
44B Rainbow silt loam	eolian deposits over coarse-loamy lodgment till derived from gneiss and/or schist and/or sandstone and/or basalt	No	20 – 40	1.5
53B Wapping very fine sandy loam	coarse-loamy eolian deposits over sandy and gravelly melt-out till	No	>72	1.5 – 2.5
54B Wapping very fine sandy loam	coarse-loamy eolian deposits over sandy and gravelly melt-out till	No	>72	1.5 – 2.5
63C Cheshire fine sandy loam	coarse-loamy melt-out till	No	>72	>6.0
66B Narragansett silt loam	coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or sandstone and shale	No	>72	>6.0
66C Narragansett silt loam	coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or sandstone and shale	No	>72	>6.0
67C Narragansett silt loam	coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or sandstone and shale	No	>72	>6.0
67B Narragansett silt loam	coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or sandstone and shale	No	>72	>6.0
68C Narragansett silt loam	coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or sandstone and shale	No	>72	>6.0
68D Narragansett silt loam	coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or sandstone and shale	No	>72	>6.0
77C Cheshire-Holyoke complex	coarse-loamy melt-out till derived from basalt and/or sandstone and shale	No	>72	>6.0

Map Unit Name and Symbol	Parent Material	Hydric (Yes or No)	Depth to Bedrock (inches)	Depth to water Table (feet)
77D Cheshire-Holyoke	coarse-loamy melt-out till derived from basalt and/or sandstone and shale	No	>72	>6.0
78E Holyoke-Rock outcrop complex	loamy eolian deposits over melt-out till derived from basalt and/or sandstone and shale	No	10 – 20	>6.0
79E Rock0outcrop complex	eolian deposits over melt-out till derived from basalt and/or sandstone and shale	No	0 – 4	>6.0
82C Broadbrook silt loam	eolian deposits over coarse-loamy lodgment till	No	20-40	1.5 – 2.5
82D Broadbrook silt loam	eolian deposits over coarse-loamy lodgment till	No	20-40	1.5 – 2.5
83C Broadbrook silt loam	eolian deposits over coarse-loamy lodgment till	No	20-40	1.5 – 2.5
103 Rippowam fine sandy loam	coarse-loamy alluvium	Yes	>72	1.5
302 Dumps	Miscellaneous area			
308 Udorthents, smoothed	Drift	No	>72	2 – 4.5

L.1.2 Water Resources

Water resources within the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route include inland wetlands, watercourses (intermittent and perennial streams and rivers), waterbodies (lakes and ponds), and groundwater resources. CL&P conducted both baseline research/desktop studies and field investigations to identify and delineate state and federal wetlands and watercourses. Baseline research was conducted, utilizing the following resources, to determine the approximate location and extent of wetlands along the ROW: U.S. Fish and Wildlife Service (US FWS) National Wetlands Inventory (NWI) Mapping, CT DEP Wetland Soils Mapping, and USDA/NRCS Soil Surveys. Following the desktop research, field studies were conducted (throughout 2007 and the spring and early summer of 2008) to field locate, delineate, and confirm the locations of inland wetlands and watercourses along the ROW.

L.1.2.1 Drainage Basins and Streams

Connecticut is divided geographically into eight major drainage basins/watersheds. The Connecticut Portion of the North Bloomfield to Agawam 345-kV line ROW traverses portions of the Lower Connecticut, Farmington, and Westfield River Basins. Within these basins, the project ROW spans seven perennial watercourses, the largest of which is the Farmington River, and 16 intermittent watercourses. All of these watercourses are presently spanned by the existing overhead transmission line that occupies the ROW. A list of the watercourses crossed, along with their state surface water quality classification, are included in Table L-2 *(Watercourses Traversed Along the Connecticut Portion of the North Bloomfield to Agawam345-kV Line Route).* The watercourse locations were initially identified through desktop analysis, and later confirmed though field surveys conducted along the ROW. As this table shows, most of the streams exhibit good water quality.

Table L-2 Watercourses Traversed along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

Municipality	Series Number[1] and Name where Applicable	CL&P Stream Number	Water Quality / Fisheries Classification Where Applicable[2]	Type (P or I)[3]	Comments
North Bloomfield	S08HF001 Griffin Brook	S9-78	B	P	Associated with W08HF002 and W08HF004
North Bloomfield	S08HF006	S9-79	A	I	Associated with W08HF006
North Bloomfield/ East Granby	S08HF002 Farmington River	S9-81	B/ Coldwater (trout) and warm water (small mouth bass)	P	Associated with W08HF009
East Granby	S08HF003	S9-82	B/Coldwater	I	Receives flow from S08HF004 via culvert under Tunxis Ave.
East Granby	S08HF004	S9-83A	A	I	Tributary to the Farmington River
East Granby	S07HF008A	S9-83	A	I	Associated with W07HF009
East Granby	S07HF008B	S9-84	A	I	Associated with W07HF009
East Granby	S07HF003	S9-85	A	I	Associated with W07HF007 and W07HF007A

Municipality	Series Number[1] and Name where Applicable	CL&P Stream Number	Water Quality / Fisheries Classification Where Applicable[2]	Type (P or I)[3]	Comments
East Granby	S07HF002 Holcomb Brook/Muddy Brook	S9-87	B	P	Associated with W07HF005 and MW07HF001
East Granby	S07HF001	S9-90	A	I	Associated with W07HF004
East Granby	S01HF001A	S9-91	A	P	Associated with W01HF001
East Granby	S01HF001	S9-92	A	P	Associated with W01HF007
East Granby	S01HF002	S9-93	A	P	Associated with W01HF008
East Granby	S01HF003	S9-94	A	I	Associated with W01HF013
East Granby	S01HF004	S9-95	A	I	Associated with W01HF013
Suffield	S01HF005	S9-96	A	I	Associated with W01HF014
Suffield	S01HF006	S9-97	A	I	Associated with W01HF016
Suffield	S01HF007	S9-98	A	I	
Suffield	S01HF018A	S9-99	A	I	Associated with W01HF018
Suffield	S01HF008	S9-100	A	I	Associated with W01HF019
Suffield	S01HF009	S9-101	A	I	Associated with W01HF020
Suffield	S01HF010	S9-102	A	I	Associated with W01HF020
Suffield	S01HF025	S1-1	A	P	Associated with W01HF025

1. Series number and CL&P stream number represent the same resource. The series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of watercourses. The CL&P stream number was generated as a mapping convention.
2. Data obtained from hard copy CT DEP map entitled Water Quality Classifications, Connecticut River and Southcentral Coastal Basins, Adopted February 1993.
3. P = perennial / I = intermittent (stream designations).

Portions of the Farmington River have been classified by the National Park Service as Wild and Scenic River corridors. While the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route does traverse the Farmington River, it does not cross any parts of the river that currently have a Wild and Scenic classification. The Wild and Scenic Rivers Act includes a provision for the U.S. Secretary of the Interior to authorize rivers for study as potential components of the National Wild and Scenic Rivers System. Reaches of the Farmington River are currently being evaluated to determine if they should be incorporated into the National System.

The CT DEP maintains detailed water resources information concerning each of these basins and promotes watershed management efforts to improve water quality. The CT DEP also has established

Water Quality Standards and Classifications, which identify the water quality management objectives for each stream and are central to the state's clean water program. Overall, Connecticut's water quality policies are to protect surface and groundwater from degradation; restore degraded surface waters to conditions suitable for fishing and swimming; restore degraded surface and groundwater to protect existing and designated uses; and provide a framework for establishing priorities for pollution abatement. Water use goals have been established for surface waters and groundwater. These goals are listed in Table L-3 (*Summary of Connecticut Water Use Goals).*

Table L-3 Summary of Connecticut Water Use Goals

Water Resource	Classification Use Description
Surface Waters	
Class AA	Public water supply, fish and wildlife habitat, recreation.
Class A	Potential public water supply, fish and wildlife habitat, recreation, industrial water supply, agricultural water supply.
Class B	Fish and wildlife habitat, recreation, industrial water supply, agricultural water supply, discharge of treated wastewaters.
Class C, D	Goal is Class B. Impaired water quality affecting one or more Class B uses.
Ground Waters	
Class GAA	Public water supply.
Class GA	Existing private water supply and potential public water supply suitable for drinking without treatment.
Class GB	Industrial water supply and miscellaneous non-drinking supply.
Class GC	Assimilation of wastes, such as landfill leachate.

Source: CT DEP December 2002.

L.1.2.2 Wetlands

During the biological field investigations performed in 2007 and 2008, the wetlands and watercourses along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route were characterized using Connecticut delineation methodology pursuant to the Connecticut Inland Wetlands and Watercourses Act, CGS §§ 22a-36 through 22a-45 ("the Act".)[2] Specific descriptions of each of the watercourses and associated vegetation are included in the *Inventory and Delineation of Wetlands and*

[2] During the field investigations, wetlands also were delineated using the U.S. Army Corps of Engineers wetland delineation methods for federal jurisdictional wetlands.

Watercourses Along the Connecticut Portion of the Greater Springfield Reliability Project (Volume 2). The report summarizes the characteristics of each wetland and watercourse and includes representative photographs and wetland data forms. The Act defines a wetland as land, including submerged land, which consists of poorly drained, very poorly drained, alluvial, and floodplain soils as defined by the National Cooperative Soils Survey. Such areas may include filled, graded, or excavated sites which possess an aquatic (saturated) moisture regime as defined by the USDA Cooperative Soil Survey. The Act defines watercourses as rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs, and also other bodies of water, natural or artificial, public or private, which are contained within, flow through or border upon the state or any portion thereof.

The biological field investigations performed in 2007 and in 2008 also relied on the Federal Method for identifying jurisdictional wetlands and and watercourses. According to the 1987 *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987; Corps Manual), areas must exhibit three distinct characteristics to be considered wetlands:

1. The prevalent vegetation must consist of plants adapted to life in hydric soil conditions. These species, due to morphological, physiological, and/or reproductive adaptations, can and do persist in anaerobic soil conditions;
2. Soils in wetlands must be classified as hydric or they must possess characteristics that are associated with reducing soil conditions; and,
3. The soil must be inundated either permanently or periodically at mean water depths less than 6.6 feet (two meters) or the soil must be saturated at the surface for some time during the growing season of the prevalent vegetation.

Wetlands meeting these criteria are subject to federal jurisdiction under Section 404 of the Federal Clean Water Act. During the process of delineating the wetlands associated with the subject ROWs both state and federal methodologies were employed, and state and federal wetland criteria were evaluated.

However, and while this is not always the case, state and federal wetland boundaries associated with the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route are concurrent. In Connecticut, state and federal boundaries are often different. Frequently this is a result of areas of alluvial and floodplain soils, which may not also exhibit a wetland plant community and evidence of wetland hydrology, emanating from wetland areas which do possess the three parameters discussed above which qualify them as federal wetlands. As a result, some locations on the Connecticut landscape do require distinct state and federal wetland boundaries. This was not found to be the case on the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

Inland wetlands and watercourse locations are generally depicted on the *Aerial Photographs - 400 Scale* (Volume 9), which identifies each wetland and watercourse along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, keyed to the *Inventory and Delineation of Wetlands and Watercourses Along the Connecticut Portion of the Greater Springfield Reliability Project* in Volume 2. Wetlands were classified as palustrine forested (PFO), palustrine scrub-shrub (PSS), or palustrine emergent (PEM) in accordance with Classification of Wetlands and Deepwater Habitats of the United States, Cowardin et al. (1979). These wetland classifications are further described below. In some cases, a wetland could be characterized by more than one wetland classification type or have inclusions of multiple cover types. In those situations, wetlands have been categorized by the most dominant classification type.

Each wetland and watercourse boundary was demarcated by numbered flagging, which was subsequently surveyed in the field using a Trimble Global Positioning System (GPS) survey unit. The surveyed wetland boundaries (as identified by the numbered flags) are depicted in Volume 11, *Aerial Photographs - 100 Scale,* and the *Inventory and Delineation of Wetland and Watercourse Along the Connecticut Portion of the Greater Springfield Reliability Project* (Volume 2) details the methods used and results of this wetland delineation. As indicated above, the Connecticut delineation methodology and the threeparameter method for determining federal jurisdictional wetlands as defined in the USACE Wetland Delineation Manual (Environmental Laboratory 1987) were used during the wetland surveys.

Table L-4 (*Delineated Wetlands along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route*) lists the 60 wetlands along the route. (Note that 21 of these 60 wetlands are associated with either perennial or intermittent watercourses and are also listed in Table L-2).

Table L-4 Delineated Wetlands along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Wetland Class[2]
North Bloomfield	W04HF001	W9-212	PFO
North Bloomfield	W04HF012	W9-213	PFO
North Bloomfield	W08HF002	W9-215	PFO
North Bloomfield	W08HF003	W9-216	PEM/PSS
North Bloomfield	W08HF004	W9-215	PFO
North Bloomfield	W08HF006	W9-214	PFO
North Bloomfield	W08HF008	W9-217	PEM
North Bloomfield	W08HF009	W9-218	PFO
East Granby	W08HF011	W9-219	PFO
East Granby	W09HF001	W9-220	PFO/PSS
East Granby	W09HF002	W9-221	PFO/PSS/PEM
East Granby	W04HF003	W9-222	PFO/PSS/PEM
East Granby	W04HF004	W9-223	PFO/PSS/PEM
East Granby	W04HF005	W9-224	PFO/PSS/PEM
East Granby	W07HF019	W9-225	PEM
East Granby	W07HF018	W9-226	PSS
East Granby	W07HF017	W9-227	PSS
East Granby	W07HF016	W9-229	PFO
East Granby	W07HF015	W9-228	PSS
East Granby	W07HF014	W9-230	PSS
East Granby	W07HF013	W9-231	PFO
East Granby	W07HF012	W9-232	PFO/PSS
East Granby	W07HF011	W9-232A	OW
East Granby	W07HF010	W9-233	PFO
East Granby	W07HF009	W9-234	PFO
East Granby	W07HF008	W9-235	PSS
East Granby	W07HF007	W9-236	PFO

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Wetland Class[2]
East Granby	W07HF007A	W9-236	PFO
East Granby	W07HF006	W9-237	PSS
East Granby	W07HF005	W9-238	PEM
East Granby	W07HF004	W9-239	PSS
East Granby	W07HF004A	W9-240	PSS
East Granby	W07HF003	W9-241	PEM
East Granby	W07HF002	W9-242	OW
East Granby	W07HF001	W9-243	PSS
East Granby	W01HF001	W9-244	PFO/PSS
East Granby	W01HF002	W9-245	PFO
East Granby	W01HF003	W9-246	PFO/PEM
East Granby	W01HF004	W9-248	PSS/PFO
East Granby	W01HF005	W9-247	PEM
East Granby	W01HF006	W9-249	PSS/PFO
East Granby	W01HF007	W9-250	PSS/PFO
East Granby	W01HF008	W9-251	PFO
East Granby	W01HF009	W9-252	PEM
East Granby	W01HF010	W9-253	PFO/PEM
East Granby	W01HF011	W9-254	PEM/PSS
East Granby	W01HF012	W9-255	PEM/PSS
East Granby	W01HF013	W9-256	PEM/OW
East Granby/Suffield	W01HF014	W9-257	PFO/PEM
Suffield	W01HF015	W9-258	PFO
Suffield	W01HF016	W9-259	PFO/PSS
Suffield	W01HF017	W9-260	PSS/PFO
Suffield	W01HF018	W9-261	PEM
Suffield	W01HF019	W9-262	PFO
Suffield	W01HF020	W9-263	PFO/PSS
Suffield	W01HF021	W9-264	PFO/PEM
Suffield	W01HF022	W9-265	PEM
Suffield	W01HF023	W9-266	PEM
Suffield	W01HF024	W9-267	PEM/PFO
Suffield	W01HF025	W1-1	PEM/PFO

1. Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated as a mapping convention;
2. Wetlands classification according to Cowardin et al 1979; PEM = Palustrine Emergent Wetland; PFO = Palustrine Forested Wetland; PSS = Palustrine Scrub-Shrub Wetland; OW = Open water.

Based on the 2007 field surveys, in the maintained portions of the existing ROW that the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route follows, the majority of the wetlands are well-vegetated and dominated by palustrine scrub-shrub wetland (PSS) and shallow palustrine emergent wetland (PEM) communities. In the majority of locations, these scrub-shrub wetlands and shallow emergent wetlands extend past the maintained portion of the existing transmission line ROW, transitioning into wetlands characterized by palustrine forested wetlands (PFO) consisting of mixed hardwood deciduous and coniferous vegetation.

One of the principal functions of wetlands is wildlife habitat, including amphibian breeding and vernal pool habitat. The CT DEP defines vernal pools as small bodies of standing fresh water found throughout the spring that typically result from various combinations of snowmelt, precipitation and high water tables associated with the spring season. These depressions can be natural or man-made (CT DEP 2008). In most years these areas become completely dry, losing water through infiltration and evaporation. Field investigations must coincide with the amphibian breeding and/or larval development time periods to determine if an area is functioning as a vernal pool.

CL&P consultants conducted the vernal pool/amphibian breeding habitat surveys in March and April of 2008 and found 18 wetlands that function as vernal pools along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. The surveys were conducted during the optimum time to identify areas that function as vernal pools and/or amphibian breeding habitat, which is after the first significant rain events in the spring, when evening low temperatures remain in the 40s (^{o} Fahrenheit). A detailed discussion of amphibian breeding habitats and vernal pools confirmed within the inland wetlands identified along the project ROW is provided in Section L.1.3.4 and the *Inventory of Vernal Pools and Amphibian Breeding Habitats Along the Connecticut Portion of the Greater Springfield Reliability Project* in Volume 4.

L.1.2.3 Groundwater Resources and Public Water Supplies

Potable water along and adjacent to the ROW is provided by The Metropolitan District (MDC) and by the Connecticut Water Company. The MDC provides water to Bloomfield and to parts of East Granby. The water sources for the MDC are the Barkhamstead Reservoir, located approximately 8.9 miles west of the ROW, and the Nepaug Reservoir, located approximately 10.9 miles southwest of the ROW. The Connecticut Water Company provides water to Suffield (as well as to Enfield) from one of 90 groundwater sources and 20 reservoirs. Many Town of Granby residents receive their water through private wells, whereas the Salmon Brook District and Aquarion Water Company supply groundwater to residents and businesses in the town center.

Table L-3 above summarizes Connecticut's Water Use Goals as identified by the CT DEP. The majority of the surface waters crossed by or in the vicinity of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route has been given a classification of A and others are currently classified as B. The groundwater areas crossed by and/or in the vicinity of the corridor have been classified as GB. Based on CT DEP data, no public wells, aquifer protection public supply wells, or Connecticut Aquifer Protection Areas are crossed by or are in the vicinity of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

L.1.2.4 Flood Zones

The Federal Emergency Management Agency (FEMA) which classifies flood zones for insurance and floodplain management purposes, has prepared Flood Insurance Rate Maps (FIRM) that designate certain areas according to the frequency of flooding. An area within the 100-year flood designation is expected to flood at least once every 100 years. The FEMA floodplain boundaries for watercourses in the project area are depicted on the maps in Volumes 9 and 11. The ROW is associated with the 100-year flood boundary of Griffin Brook, the Farmington River, and Muddy Brook.

L.1.3 Biological Resources

L.1.3.1 Vegetation Communities

Vegetation along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route ROW consists of a mix of associations and cover types, which provide a variety of wildlife habitat. The line is proposed for location primarily within or adjacent to existing overhead transmission line ROWs, along which vegetation is managed to assure consistency with transmission line use. Vegetation within the existing transmission line ROW has been managed for approximately 80 years in accordance with CL&P's vegetation management program, which means that trees that could interfere with the operation of the existing lines are eliminated from within the cleared portions of the ROW, with trees along the edges periodically trimmed or removed. As a result, the predominant vegetation types within the existing maintained transmission line ROW consist of dense shrub and herbaceous growth, whereas the primary vegetation types within the non-maintained portions of the ROW are deciduous (hardwood) and mixed hardwood forest (in varying successional stages), intermixed with areas of agricultural use, maintained lawns, and wetlands.

The *Aerial Photographs - 400 Scale* (Volume 9) illustrate the different vegetation types along and in the vicinity of the route. The predominant vegetation types within the existing transmission line ROW consist of dense shrub and herbaceous growth.

Specifically, as illustrated on these maps (which also depict the wetlands and watercourse locations determined by the field delineations performed for the project), eight habitat types are found along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route as follows:

- **Old Field/Shrub land:** This habitat type includes the existing maintained ROW in most areas as well as adjacent abandoned fields, natural shrub lands, and early successional forests.

- **Mature Mixed Forest:** This forest type includes mature mixed deciduous/coniferous forests adjacent to the existing ROW in upland areas. Mature mixed forests consist typically of tree species common to the Northeast such as maples, oaks, hickories, spruce, and pine. The ratio of deciduous to coniferous species and age of stands varies.
- **Forested Wetland:** Forested wetlands generally include red maple swamps dominated by a mature tree canopy.
- **Scrub-Shrub Wetland:** Shrub swamp areas exist either within or adjacent to the existing ROW. These types of wetlands typically include components of emergent marsh where shrub coverage is substantial.
- **Emergent Wetland:** Emergent marshes are dominated by herbaceous wetland plant species.
- **Open Water:** Substantial areas of open water found along the existing ROW such as lakes, ponds, reservoirs, and large streams/rivers, and the vegetation found along the shorelines of these areas. Most open water areas would be spanned with no clearing required.
- **Agricultural Lands:** This includes cultivated fields, croplands, hay fields, pastures, and orchards in active agricultural use.
- **Urbanized Areas:** Urban areas refers to suburban and urban residential developments, subdivisions, cultural grasslands, areas developed for industrial or commercial use, recreational areas such as parks and golf courses, and maintained lawns, and roadside vegetation. The urbanized portions of the project may possess designated "public shade" trees.

These eight habitat types occur either within the maintained portions of the existing ROW, or in adjacent, presently un-maintained areas, where some amount of additional clearing would be required for construction (as indicated by the cut line depicted on *Aerial Photographs – 400 Scale,* Volume 9). Habitat types outside of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, where no additional vegetation clearing would be required, were not included (refer to Section I for further information on the existing width of maintained vegetation along the ROW).

Overall, the footprint of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route encompasses approximately 485 acres. Of this, approximately 102 acres are presently forested (upland and wetland), including 100 acres of wooded areas within the existing CL&P ROW and approximately 2.3 acres of forest lands located within the ROW footprint, but outside of the existing ROW (i.e., the area that would be required for the ROW expansion) in the Town of Suffield. As noted previously, the dominant habitat type along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route is comprised of open field shrub land within the maintained portion of the ROW, and upland forest along unmaintained portions of the existing ROW, consisting of approximately 131 acres and 211 acres, respectively.

L.1.3.2 Wildlife

L.1.3.2.1 General Wildlife Description

The following summarizes some of the wildlife species typical for each of the major vegetation types found along the route, as identified in Volume 9, *Aerial Photographs-400 Scale,* and as discussed in Section L.1.3.1. Additional descriptions of amphibians and birds inhabiting the project region are included in Sections L.1.3.4 and L.1.3.5, respectively.

- **Mature Mixed Forest:** In general, forest vegetation supports a high diversity of wildlife. Many species exhibit a preference for either coniferous or deciduous forest types, or for various age classes of forest stands, whereas other species may be found in a wide range of forest habitat types. Further, wildlife species may exhibit seasonal habitat preferences. For example, white-tailed deer may utilize mature deciduous forest areas in the fall when oak and beech mast crops are available for food, but move in the winter into coniferous areas that provide better shelter from snow and wind. At other times, deer would utilize agricultural lands, wetlands, or residential areas. Species typically common in forested habitats include white-tailed deer, rabbit, coyote, fox, striped skunk, Virginia opossum, chipmunk, squirrel, and numerous small mammals (e.g., deer mouse, red-backed vole, shrews, bats). Various species of birds, as well as reptiles and amphibians (collectively referred to as herpetofauna), also are common in forested areas. Birds typical of forested areas include raptors (owls, hawks), grouse, wild turkey, woodpeckers, and numerous species of songbirds. Herpetofauna likely to occur in forested areas include salamanders, as well as certain species of toads, frogs, turtles and snakes.

- **Old Field/Shrub Lands:** Species that inhabit these areas rely on herbaceous vegetation, grasses, shrubs, and young trees for food and cover. Open lands that are bordered by forest habitat generally support the greatest variety of wildlife because of the interspersion of different habitat types. Mammalian wildlife typical of these habitats include small mammals such as meadow voles, short-tailed shrews, and deer mice; predators such as red fox, coyote, weasel, skunk, and raccoon; woodchuck, rabbit, and white-tailed deer. Various species of birds and herpetofauna also typically are present.
- **Wetlands/Open Water:** Freshwater wetlands and other aquatic habitat (e.g., streams, ponds) provide excellent habitat for a wide range of wildlife species. Many of the species that use forested and shrubland (successional upland) habitats also utilize forested wetland, shrub swamp, shallow marsh, or wet meadow communities. In addition, there are species that are adapted primarily to wetland or other aquatic habitat. These include mink, beaver, otter, muskrat and water shrew; as well as birds such as heron, waterfowl and certain types of raptors and songbirds. Herpetofauna are particularly adapted to wetlands and aquatic habitats; typical species include most salamanders at some time in their life cycle, frogs, turtles and snakes.
- **Agricultural and Urban Lands:** A variety of habitats are included in this category, such as cultivated crop fields, hay fields, pastures, orchards, suburban and urban residential areas, commercial and industrial developments, recreational areas (e.g., golf courses, parks), maintained lawns, and roadways. Wildlife in these habitats can be abundant as animals are attracted to human food sources (e.g., crop fields, orchards, bird feeders, landfills), but the species inhabiting them must be tolerant to some degree of human disturbance. Some of the most recognizable

wildlife species can be found in these areas, such as white-tailed deer, raccoons, woodchucks, and birds such as Canada geese, robins, house sparrows, and the numerous species that frequent feeders. Other less visible species such as red fox, coyotes, and skunk are also common. Nuisance wildlife species such as crows, rats, and other small rodents are often abundant in these habitats. Some wildlife species are even dependent on human activity to thrive, such as birds that nest almost exclusively in human structures (e.g., chimney swift, barn swallow, purple martin). Herpetofauna tend to be scarce in these habitats because they are typically less tolerant of human activity than birds or mammals.

L.1.3.2.2 Designated Wildlife Management Areas

One wildlife management area (WMA) and certain other wildlife use areas are designated along or in the vicinity of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. These are described below and identified on the maps in Volume 9, *Aerial Photographs - 400 Scale*. In addition to these designated wildlife management properties, several other forested areas and parks exist along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, as described in Section L.1.4.2.

State Facilities

The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route traverses one State-designated wildlife management area, the Newgate Wildlife Management Area in East Granby, which is managed by the CT DEP. This WMA encompasses approximately 450 acres and is managed by CT DEP for hunting activities. The area is open for small game, waterfowl, turkey, and deer hunting. The route crosses approximately 0.7 miles through this area along CL&P's existing transmission line ROW.

Municipal or Private Wildlife Areas

In Suffield, the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route traverses along the existing CL&P ROW through 0.3 miles of property owned by the Suffield Sportsman's

Association, the total area of which is 4.1 acres and is used for archery, shooting, fishing, and hunter safety classes. In addition, the Suffield Land Conservancy owns a 45-acre wildlife preserve that also encompasses a portion of the Metacomet Trail. The Metacomet Trail travels 115 miles through Connecticut, Massachusetts, and New Hampshire. A full description is provided in Section L.1.4.2. The ROW runs adjacent to land owned by the Suffield Land Conservancy, but does not cross it. These areas provide habitat for wildlife species typical of forested areas such as white-tailed deer, rabbit, coyote, fox, striped skunk, Virginia opossum, chipmunk, squirrel, and other small mammals (e.g., deer mouse, red-backed vole, shrews, bats etc.), with various species of birds also occurring in these areas.

L.1.3.3 Fisheries

The inland fishery resources in the watercourses along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route can generally be classified as cold-water or warm-water. Cold-water fisheries are considered more sensitive than warm-water fisheries because the fish species that comprise cold-water fisheries are less tolerant of habitat disturbance and poor water quality.

Based on a review of data concerning freshwater fisheries maintained by the CT DEP Inland Fisheries Division, the perennial streams in the project area provide habitat for various fish species, ranging from various trout species to white sucker. The CT DEP's inland fisheries management efforts for rivers and streams are directed primarily toward providing trout fishing opportunities, which have traditionally been an important part of Connecticut's angling activity[3]. The implementation of the CT DEP's 1999 *Trout Management Plan*, which was developed based on the compilation of fish population, physical habitat and water chemistry information for approximately 800 Connecticut streams, is designed to improve fishing quality by diversifying angler opportunities. The *Trout Management Plan* designates various special management areas for trout. These include: streams where self-sustaining wild trout populations

[3] CT DEP also has a *Bass Management Plan,* which recognizes the importance of warm water species (e.g., smallmouth and largemouth bass, northern pike, panfish and catfish) to angling in the state. However, because such warm water fish species in the project area are found primarily in lakes and ponds (which the proposed project would generally not affect), this discussion focuses on coldwater fisheries (trout).

are encouraged through catch-and-release angling; trout management areas; streams where CT DEP stocks catchable size hatchery trout; trophy trout areas (which are stocked with larger hatchery trout); trout parks (which offer easy access to the public and are stocked more frequently to promote angler success); and streams believed to be able to support sea-run trout (anadromous brown trout).

Within the project region, CT DEP data indicates that the majority of the streams do not support wild trout populations. As a result, the CT DEP typically stocks hatchery-raised adult-sized trout for put-and-take purposes in publicly-accessible portions of certain rivers. The Farmington River and Muddy River are both stocked with trout by the CT DEP. The Farmington River is monitored under catch and release regulations part of the year and is opened to harvest the rest of the year. Monitoring techniques implemented along the corridor include designated fishing seasons, length limits, and creel limits.

As of March 2006, the CT DEP implemented an alewife and blueback herring fishery closure throughout the entire state of Connecticut as a result of declining population numbers of these fish. Alewife and blueback herring are referred to as river herring, and migrate between freshwater and saltwater and utilize freshwater habitats for spawning.

L.1.3.4 Amphibians

Field investigations for amphibians were performed in conjunction with the identification and evaluation of wetlands located along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. All wetlands along the ROW with potentially suitable vernal pool/amphibian breeding habitat were investigated during the spring and early summer of 2008 (coinciding with the amphibian breeding season) to confirm the presence/absence of such amphibian breeding activity. A detailed account of the survey methodology and results can be found in the *Inventory of Vernal Pools and Amphibian Breeding Habitats Along the Connecticut Portion of the Greater Springfield Reliability Project* in Volume 4.

Vernal pools are generally characterized in Connecticut as isolated topographical depressions that contain vernal or ephemeral ponding (standing water for approximately two months) with no inflow and no permanent finfish populations. The CT DEP defines vernal pools as small bodies of standing fresh water found throughout the spring that typically result from various combinations of snowmelt, precipitation, and high water tables associated with the spring season. These depressions can be natural or man-made. In most years, these areas become completely dry, losing water through evapotranspirtation and infiltration. Vernal pools vary in many aspects including appearance, water source, hydroperiod, water quality and surrounding habitats. Field investigations must coincide with the amphibian breeding and/or larval development time periods to determine if an area is functioning as a vernal pool.

In Connecticut, to meet the definition of a vernal pool, the following four criteria must be met:

- It contains water for approximately two months during the growing season
- It occurs within a confined depression or basin that lacks a permanent outlet stream
- It lacks any fish populations
- It dries out most years, usually by late summer

Many species critically rely upon vernal pool habitat for reproductive success, and these species are referred to as obligate vernal pool species. According to the CT DEP (2008), obligate vernal pool species that may have ranges within the project area include the following:

- wood frog (Rana sylvatica)
- spotted salamander (Ambystoma maculatum)
- Jefferson salamander (Ambystoma jeffersonianum)
- marbled salamander (Ambystoma opacum)
- fairy shrimp (Branchiopoda anostraca)

For the purposes of this report, a vernal pool was defined as areas that held obligate species in the 2008 breeding season and that meet the majority of the vernal pool criteria. "Amphibian breeding habitat" refers to areas in which signs of breeding facultative amphibians have been observed. These distinctions were made by field biologists on site during the surveys in 2008.

As a result of field investigations of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, 18 amphibian breeding habitats/vernal pools were confirmed by ENSR's field biologists. All confirmed vernal pools and amphibian breeding habitats are listed in Table L-5 *Vernal Pool Habitat Associated with the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route*. These areas were identified based upon physical characteristics of the wetlands observed in the field, such as pools of water (when present), calls of obligate vernal pool amphibians, direct evidence of obligate amphibian breeding (egg masses, amphibian larvae), distinct depressions in wetlands combined with water stained leaves, significant water marks on vegetation and/or rocks, as well as marked pit and mound topography.

The areas described above include the "classic vernal pool" generally thought of as a distinct, isolated depression, which is not connected to any other wetland as well as the "cryptic vernal pool", which is often imbedded in a larger wetland are and, associated with additional wetland and/or watercourse areas.

Table L-5 Vernal Pool Habitat Associated with the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Observed Obligate Species[2]
East Granby	W04HF003	W9-222	spotted salamander, marbled salamander, wood frog, finger nail clams, fairy shrimp
East Granby	W04HF004	W9-223	spotted salamander, Jefferson salamander
East Granby	W04HF005	W9-224	spotted salamander, Jefferson salamander
East Granby	W07HF019	W9-225	spotted salamander, wood frog
East Granby	W07HF011	W9-232A	spotted salamander, wood frog
East Granby	W07HF007	W9-236	wood frog

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Observed Obligate Species[2]
East Granby	W07HF003	W9-241	spotted salamander, wood frog
East Granby	W07HF002	W9-242	spotted salamander
East Granby	W07HF001	W9-243	spotted salamander, wood frog
East Granby	W01HF001	W9-244	spotted salamander, wood frog
East Granby	W01HF006	W9-249	spotted salamander, fairy shrimp
East Granby	W01HF010	W9-253	wood frog
East Granby/Suffield	W01HF014	W9-257	Potential Vernal Pool (off of ROW)
Suffield	W01HF020	W9-263	spotted salamander, wood frog
Suffield	W01HF021	W9-264	wood frog
Suffield	W01HF022	W9-265	spotted salamander, wood frog
Suffield	W01HF024	W9-267	spotted salamander, wood frog
Suffield	W01HF025	W1-1	spotted salamander, wood frog

1: Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during field surveys. The CL&P wetland number was generated as a mapping convention;
2: Vernal Pool Species observed confirming vernal pool/amphibian habitat.

L.1.3.5 Birds

As detailed in the report presented in Volume 4, research was conducted regarding the bird species that might inhabit the GSRP area. These studies were designed to identify the bird species that are known or expected to breed in Connecticut and may occur in the GSRP vicinity; assess the birds' potential use of the ROW and adjacent habitats; and evaluate the potential impacts of construction and operation of the proposed project on such species.

The inventory of potential breeding birds in the GSRP area was compiled based on a review of published data concerning breeding birds in north-central Connecticut, as well as field reconnaissance of the subject ROW. Research concerning avian utilization of habitats on the ROW and agency consultation have also been incorporated into this document.

The Atlas of Breeding Birds of Connecticut (*Atlas;* Bevier [ed] 1994) was the primary source consulted to determine which bird species are likely to breed in the project area. The *Atlas* compiles the results of a comprehensive and systematic survey of Connecticut's breeding birds and their habitats. The *Atlas* was initiated to determine what species of birds nest in Connecticut and what parts of the state are utilized by each species. The *Atlas* is based on field surveys conducted over a five-year period from 1982 to 1986 and incorporated the collective effort of more than 500 volunteers.

For this breeding bird inventory, in addition to conducting a literature review of all bird species known to breed in north-central Connecticut, biologists have conducted field reconnaissance of all reaches of the subject ROW. Assessments of general habitat cover types as well as notations of dominant plant species assemblages within cover types have been documented. To facilitate the field portion of this inventory, aerial photographs with ROW limits overlaid on them were used for mapping during the field investigations. As a result of the field work, and as described above, eight habitat cover types have been identified. As a result of this review, 140 bird species were listed as potentially occurring in the project area. A table listing which bird species could potentially be found along the ROW is included as part of the bird study conducted for GSRP.

L.1.3.6 Rare, Threatened and Endangered Species

CL&P requested that the U. S. Fish and Wildlife Service (US FWS) and the CT DEP Natural Diversity Database, Environmental & Geographic Information Center (NDDB) review the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route to determine whether there is a potential for the project to affect species identified by federal or state agencies as rare, threatened, endangered or species of special concern. In November 2007, the USFWS indicated that the project area is not within the vicinity of any federally protected rare, threatened, endangered or species of special concern (See USFWS Consultation Letter and Response in Volume 4). With no federally-listed, rare, threatened, endangered or species of special concern or critical habitat under the jurisdiction of the USFWS in the area, preparation of a Biological Assessment or further consultation with the USFWS under Section 7 of the Endangered Species Act is not required. However, the NDDB has identified one species which does have federal status. This species is the dwarf wedge mussel (*Alasmidonta heterodon*). According to the NDDB, this species is present in the Farmington River.

CL&P submitted a rare species request for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route to the NDDB in a letter dated October 1, 2007. The CT DEP responded to the October 1, 2007 NU request with two letters, one dated March 10, 2008 and another dated March 17, 2008. In addition, CL&P submitted a rare species request for the Manchester Substation to Meekville Junction component of the GSRP to the NDDB in a letter dated April 7, 2008. The CT DEP has responded to the April 7, 2008 CL&P rare species request letter with a letter dated April 24, 2008. All correspondences received from the CTDEP are included in Volume 4*, Federal, State and Municipal Agencies Correspondence*.

During the course of the rare, threatened, endangered or species of special concern correspondence described above, ENSR and Burns and McDonnell (environmental and engineering consultants retained by CL&P to assist with the Project) met with the CT DEP on April 1, 2008 to discuss in more detail the potential rare species implications for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. The following is a summary of the rare species surveys and related activities ENSR has completed thus far for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, as well as a species specific discussion on anticipated actions.

As recommended by the CT DEP during the April 1 2008 meeting, surveys for Jefferson salamanders were initiated by ENSR in the Spring of 2008 and are discussed below. Additionally, and as recommended by the CT DEP, surveys for Bush's sedge (*Carex bushii*) have been completed, the results of which are likewise discussed below. The CT DEP has not required surveys for Eastern box turtles but is instead recommending multiple actions during the construction phase to ensure the well-being of this species. These measures are discussed below. The CT DEP has not required surveys for freshwater mussels and dragonflies. However, they have stressed the importance of proper erosion and sediment control to ensure the long term viability of these species and the habitat they utilize. These issues are discussed further below.

The NDDB's March 10, 2008 and March 17, 2008 correspondence to CL&P regarding the project stated that there are seven species listed as endangered, threatened or species of special concern that have been reported to occur in the vicinity of the GSRP route. These species are identified in Table L-6 (*Summary of Rare, Threatened, and Endangered Species Along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route).*

Table L-6 Summary of Rare, Threatened and Endangered Species Along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

Species (Scientific Name)	Species (Common Name)	Status*	General Location Reported in NDDB and Habitat Type
Terrapene carolina	Eastern box turtle	SSC	Old fields and deciduous forests
Margaritifera margaritifera	Eastern pearlshell mussel	SSC	Headwater Tributary to Muddy Brook
Ambystoma jeffersonianum	Jefferson salamander	SSC	Steep, rocky areas in or near undisturbed second growth deciduous forest
Stylurus spiniceps	Arrow clubtail dragonfly	SSC	Farmington River and trees along the river
Alasmidonta heterodon	Dwarf wedge mussel	SE , FE	Farmington River
Ligurnia nasuta	Eastern pond mussel	SSC	Farmington River
Carex bushii	Bush's sedge	SSC	Dry grasslands, forest margins

*Key: SSC=State Species of Special Concern, ST=State Threatened, SE=State Endangered, FE= Federally Endangered

As indicated in Table L-6, of the seven species, three are mussel species found in streams that are spanned by the existing CL&P transmission facilities; one is an amphibian (Jefferson salamander), one is a reptile (Eastern box turtle), one is a dragonfly (Arrow clubtail), and one is a plant (Bush's sedge).

During an April 1, 2008 meeting with CL&P representatives, the CT DEP recommended egg mass surveys as well as live trapping using minnow traps in an effort to locate Jefferson Salamander

(*Ambystoma jeffersonianum*) breeding adults. Accordingly, and as directed by the CT DEP, intensive Jefferson Salamander (*Ambystoma jeffersonianum*) surveys were conducted on the ROW in East Granby, Connecticut in the spring of 2008, in accordance with a detailed CT DEP-approved protocol and under a Scientific Collection Permit.

The Jefferson Salamander prefers both deciduous and coniferous forests, where they can be found beneath logs, rocks, leaf litter, or in burrows of small woodland animals. Wetlands that retain water into midsummer are vital for breeding, as the salamanders will migrate there annually to reproduce and an extended hydroperiod is necessary to ensure larvae have time to develop successfully to the metamorph stage.

As a result of the surveys, the presence of Jefferson Salamanders has been confirmed within a portion of the existing ROW. Shortly after the surveys were completed, ENSR generated and submitted to the CT DEP a Special Animal Survey Form and supporting materials, including mapping, that documented the results of the salamander surveys. As a result of the confirmed presence of this species along the ROW, the CT DEP may require seasonal restrictions on work activities to reduce any potential negative impacts to this species. In areas where Jefferson Salamanders have been confirmed, the CT DEP, in their correspondence with CL&P dated March 10, 2008, recommended that, to the extent practical, construction activities on the ROW be performed when the salamanders are dormant, in October through February. (Refer to the impact and mitigation discussion in Section N for additional information.)

As noted above, the NDDB has indicated the potential presence of Eastern box turtles on the subject ROW. In Connecticut, Eastern box turtles utilize upland deciduous forests with openings and edge habitats, as well as various types of wetland habitats including forested, scrub/shrub and emergent wetlands. The young are semi-aquatic and have been documented using lentic[4] and slow moving lotic[5]

[4] Wetland habitats associated with standing waters such as lakes, ponds and other open water bodies.
[5] Wetland habitats associated with flowing waters such as rivers, streams and floodplain habitats.

habitats. Eastern box turtles will also utilize these wetland habitats during periods of hot and dry weather. Eastern box turtles hibernate on land underground at a depth of six inches to two feet. Nesting habitat consists of areas of sandy soils, commonly with a southerly aspect.

Regarding the Eastern box turtle, the CT DEP is currently recommending habitat characterization surveys to determine the locations of potentially suitable habitats, pre-construction sweep surveys to locate and remove any box turtles from the active work areas, pre-construction reconaissance surveys for nesting habitat, installation of turtle exclusion fencing, contractor awareness training and the parking of equipment on established roadways and other designated areas at night, as opposed to areas that could potentially serve as box turtle habitat. The CT DEP further stated its concern relative to clearing activities. In the initial CT DEP response letter dated March 10, 2008 the CT DEP recommended the work be done in the dormant season, October through April. Subsequent to that, and as a result of the April 1, 2008 meeting with the CT DEP, the preference, if clearing becomes a necessity, is to do it during the active period for the box turtles (late spring, summer and early fall) to avoid disturbing the turtles when they are dormant.

Three species of freshwater mussels have been identified by the CT NDDB as potentially occurring close to the project area. These species are the Eastern Pearlshell mussel (*Margaritifera margaritifera*) , the dwarf wedgemussel (*Alasmidonta heterodon*) and the Eastern Pond mussel (*Ligumia nasuta*). Two of these, the Eastern Pond mussel and the dwarfwedge mussel are mapped by the CT NDDB as potentially occurring in the Farmington River near the Spoonville Bridge area. The third species, the Eastern Pearlshell mussel may potentially occur in a headwater tributary stream to Muddy Brook, on the ROW in East Granby, Connecticut. As currrently designed, the GSRP has no in-water work proposed within these major watercourses.

The Arrow Clubtail Dragonfly (*Stylurus spiniceps*), has been identified by the CT NDDB as potentially occurring in proximity to the project. This species is listed in Connecticut as a Species of Special Concern. For the majority of their life cycle, the dragonflies are aquatic nymphs and undergo several molts during this phase of their development. While in the nymph stage, they burrow deeply into the sandy substrates of the streams and rivers they inhabit. When a nymph is ready to emerge, it will crawl out of the water onto any object which protrues from the water surface (rocks, logs, etc). In a process known as eclosion the nymph transforms into an adult. Freshly emerged adults subsequently seek shelter in the adjacent vegetation where they feed on other flying insects and mature physically, a process that can take several days to a week or more. Once mature, males and females return the water to breed.

If there are no in-water work activities proposed, dragonflies are not a concern. However, as with the freshwater mussels, the CT DEP has stressed the importance of proper installation and maintenance of erosion and sediment controls, as well as maintaining an undisturbed riparian buffer zone to the subject waterbodies. Collectively, these measures will help to ensure the habitats of these species are not negatively affected by sediment deposition from the surrounding uplands.

Additionally, and as directed by the CT DEP, field surveys were performed on June 26, 2008 for Bush's Sedge (*Carex bushii*). As a result of the survey, the presence of a small population of this rare sedge was confirmed on the ROW. Habitats of this plant species include dry to moist prairies, fields, and meadows in full sun. The CT DEP has indicated that the location of the plants should be flagged in the field prior to construction and the plants would need to be avoided and/or transplanted to avoid any effects as a result of construction activities.

L.1.4 Existing Land Use

L.1.4.1 Overall Land-Use Patterns

The GSRP region is characterized by a variety of land uses and cover types, including undeveloped forested lands, designated recreational areas, transportation corridors (state and local roadways), agricultural areas, and residential and commercial developments. The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route will be located almost entirely within an existing overhead transmission line ROW, within which the land is predominantly maintained in scrub-shrub cover, consistent with utility use. As illustrated on the Volume 9 maps, the primary land uses adjacent to the existing ROW include residential areas, agricultural land, and forested land.

The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route will commence at CL&P's existing North Bloomfield Substation in the northern portion of the Town of Bloomfield. Marion Wilcox Park and St. Andrew's Cemetery are located across from the existing North Bloomfield Substation. Leaving the substation, the route proceeds to the north, through primarily forested areas. The route crosses State Route 189 and the wooded floodplain along the Farmington River, proceeding north into the Town of East Granby.

In East Granby, the route follows the existing transmission line ROW across Tunxis Avenue and continues in a northerly direction. Land adjacent to the existing ROW is mostly forested, and is characterized by both forested wetlands and forested uplands. The route crosses Hatchet Hill Road and is east of Marsh Pond. The route follows the existing transmission line ROW near a residential area near Holcomb Street. After crossing Holcomb Street, the route continues in a northwesterly direction, passing near lands that are predominately forested with some agricultural lands interspersed. The route continues to the northwest in East Granby through forested and agricultural areas before reaching Granby Junction.

At Granby Junction, the route turns to the north and crosses Turkey Hills Road. Between Turkey Hills Road (State Route 20) and the residential development associated with Country Club Lane, the land adjacent to the route is characterized primarily by forested areas associated with the Newgate State WMA. Continuing in a northerly direction, the route passes between Copper Hill Terrace and Woodledge Drive, traversing near lands characterized by a mix of forested and residential uses. The Copper Hill Country Club golf course is located to the west of the ROW.

The route traverses Wyncairn Road before crossing into the Town of Suffield. In Suffield, the route follows the existing ROW through forested areas; residential areas are located to the west of the existing ROW, along Newgate Road. Other lands in the vicinity are devoted to recreation or preservation uses (i.e., properties owned by the Suffield Land Conservancy and the Suffield Sportsman's Association). The route crosses Mountain Road and traverses predominately forested areas with some low-density residential development and agricultural areas before reaching the Connecticut/Massachusetts state border.

L.1.4.2 Parks, Open Space, Recreational and Public Trust Lands

The project route traverses several recreational and scenic areas, as described below and displayed on the maps in Volume 9. The line has been designed such that the conductors would span the areas that are environmentally sensitive, or that are used as recreational/scenic areas by the public wherever possible.

- **Talcott Mountain State Park:** Located in Bloomfield, the park is located south of the Farmington River, approximately 0.3 miles west of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. The park includes facilities for hiking and picnicking, and provides opportunities for scenic viewing. It is maintained by CT DEP with the assistance of the Connecticut Forest and Park Association. A portion of the Metacomet Trail traverses the park.

- **<u>Metacomet Trail:</u>** The Metacomet Trail spans approximately 115 miles in length, beginning in central Connecticut in Berlin, continues in a northerly direction through Massachusetts and terminates at Mount Monadnock in southern New Hampshire. In Connecticut, the trail spans approximately 51 miles and is maintained by the Connecticut Forest and Park Association and other trail groups. The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route crosses the Metacomet Trail in Suffield, where the Trail is aligned through the Spenser Wildlife Management Area. The House of Representatives passed the New England Scenic Trail Designation Act on January 29, 2008 and is still waiting approval from the Senate. The intent of the Act is to amend the National Trail System Act to designate the Monandock, Metacomet, and Mattabesett (MMM) Trail System (of which the Metacomet Trail is a part) as a New England National Scenic Trail. The Act would direct the Secretary of Interior to use the "Trail Management Blueprint" as a framework for managing and administering the trail system. The Trail Management Blueprint is identified in the *Metacomet Monadnock Mattabesett Trail System, National Scenic Trail Feasibility Study and Environmental Assessment Draft Report.* The Trail Management Blueprint addresses issues such as landowner uses and rights, trail access and protection, trail management and maintenance.
- **<u>Marion Wilcox Park:</u>** Marion Wilcox Park is a town park consisting of 212 acres in Bloomfield, located southwest of the North Bloomfield Substation. The Marion Wilcox Park includes hiking trails, flowers and gardens, picnic areas, vistas, and a portion of the Metacomet Blue Trail.
- **<u>Newgate WMA:</u>** The Newgate WMA is a state managed area located in East Granby and associated with the Farmington Valley Greenway. The WMA encompasses approximately 450 acres and is managed by CT DEP for regulated hunting activities. The area is open to provide habitat for small game, waterfowl, turkey, and deer hunting.

- **<u>The Farmington Valley Greenway:</u>** The Farmington Valley Greenway is a bike path located near the Newgate WMA. To date, the bike path is partially competed and is a part of the Rails to Trails Conservation Program. At its completion, the bike path will span approximately 60 miles, the majority of which will be in East Granby.
- **<u>Suffield Sportsman's Association:</u>** The existing ROW along which the Connecticut Portion of the North Bloomfield to Agawam 345-kV line will be aligned traverses property owned by the Suffield Sportsman's Association. This property offers sporting opportunities including archery, shooting, fishing, and hunter safety classes.
- **<u>Spencer Woods:</u>** Spencer Woods Wildlife Preserve is located in Suffield and contains a portion of the Metacomet Trail. The property is a local wildlife preserve owned and maintained by the Suffield Land Conservancy. Spencer Woods is associated with the Open Space Land.
- **<u>Fox Run at Copper Hill Golf Course:</u>** The Fox Run at Copper Hill Golf Course is a nine-hole golf course located on Copper Hill Road in East Granby.

L.1.4.3 Statutory Facilities

Section 16-50p(i) of Public Utility Environmental Standards Act (PUESA) designates a group of land uses (for convenience, sometimes collectively called, "Statutory Facilities") that the Council must consider in its review of new electric transmission lines. These are, in particular:

- Private or public schools
- Licensed child day-care facilities
- Licensed youth camps
- Public playgrounds
- Residential areas

"Residential areas" is construed to mean developed "neighborhoods," not residentially zoned land or sparsely settled rural or semi-rural areas.

The Act establishes a rebuttable presumption that electric transmission lines with a voltage of 345-kV or greater, shall be constructed underground if they are "adjacent to" Statutory Facilities. This presumption may be overcome by a demonstration that it is infeasible to bury the lines for technical or economic reasons. The Council may, in such a case, approve overhead construction of a 345-kV line adjacent to statutory facilities, provided that it will be contained within a buffer zone adequate to protect public health and safety. A ROW that provides clearance requirements consistent with generally applicable safety standards may qualify as such a buffer zone.

L.1.4.3.1 Schools, Day-Care Facilities, Camps & Playground

A public records review and field inspection of the Connecticut Portion of the North Bloomfield to Agawam 345-kV line ROW, which was performed in August 2008, indicates that the proposed new overhead 345-kV line would not be adjacent to any public or private school, licensed child day-care facility, licensed youth camp or public playground.

L.1.4.3.2 "Residential Areas"

Residential uses in the project area range from single-family, low-density home developments to suburban neighborhoods. The aerial photographs in Volumes 9 and 11 illustrate the location of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route in relation to residential uses.

The Council may or may not consider a group of homes along the section of the existing ROW between Newgate Road and Phelps Road to be sufficiently dense and integral to qualify as a statutory "residential area." However, CL&P considers that the new 345-kV line will not be "adjacent to" these homes. Rather, the new line will be aligned east of and "adjacent to" the existing 115-kV line that presently occupies the existing ROW in this area, whereas most of the residences are to the west of the existing 115-kV line.

There are some residences located to the south of the ROW on Holcomb Street, and CL&P does not consider this area to be densely occupied. Additionally, residential developments have been identified to the east side of the ROW. Similar to the section of homes between Newgate Road and Phelps Road, the Council may or may not consider this group of homes to be sufficiently dense and integral to qualify as a statutory "residential area."

L.1.5 Federal, State, and Local Land-Use Plans/Future Land-Use Development

The three Connecticut municipalities that would be traversed by the Connecticut Portion of the North Bloomfield to Agawam 345-kV line route have established land use plans, all of which coincide with the goals and objectives of the GSRP. The Capital Region Council is the regional planning agency for the areas crossed by the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. The municipal, regional, and state land use plans are summarized below.

- **Conservation and Development Policies Plan for Connecticut 2005-2010 – State of Connecticut:** CL&P reviewed the Conservation and Development Policies Plan for Connecticut 2005 - 2010 (C&D Plan) prepared by the Connecticut Office of Policy and Management for information relating to the State's growth. The objective of the C&D Plan is to guide and balance response to human, environmental, and economic needs in a manner that best suits Connecticut's future. Based upon the general planning information provided in the C&D Plan, the project is consistent with the overall goals and objectives of the Plan and serves a public need by providing for the reliable transmission of electricity. As stated in the C&D Plan, "The ability to redevelop Connecticut's Regional Centers requires that existing infrastructure be maintained and updated to support compact urban development. This holds true and is particularly relevant regarding electric capacity and delivery systems" (p. 22). There are no Regional Centers within the towns of Bloomfield, East Granby or Suffield. Although the transmission line ROW traverses the Newgate WMA, an area of Preserved Open Space, the ROW will not be expanded to accommodate the new line and will not affect the permanent protection of this dedicated open space.

- **Plan of Conservation and Development – Capital Region Council:** The primary goals of the Capital Region Council's Plan of Conservation and Development (Council Plan) are growth, development, and conservation. The Council Plan characterizes municipalities in its region in four primary categories as listed below.
    - Rural – less than 500 people per square mile – East Granby, Somers, Suffield, Granby
    - Suburban – 500 to 1250 people per square mile – Bloomfield
    - Fully Suburban – 1251 to 3000 people per square mile – Enfield
    - Urban – more that 3000 people per square mile

The Capital Region has experienced an increase in population growth, which is expected to continue to increase in the future. The Council Plan identifies the need to continue growth and development, to conserve existing open space, and to accommodate the needs of the growing population of the capital region.

Bloomfield

Bloomfield is a suburban town whose Municipal Land Use Plan was designed in such a manner that allows Bloomfield to retain its small town character, to continue to protect and "invest" in open space and agricultural practices, to promote growth in traditional family units to continue to promote economic development activities in industrial zones, to update the Town's roadways and other public facilities, and to enact regulations to create central growth. Bloomfield's Municipal Plan primarily strives to concentrate new development (non-residential) in three mixed-use centers where the existing roadway system and infrastructure can accommodate growth without adding to the cost of the existing systems.

East Granby

East Granby is a rural town whose Municipal Land Use Plan is consistent with both the State Plan of Conservation and Development and the Regional Plan of Conservation and Development. East Granby's municipal plan focuses predominantly on the growth of the East Granby village center and on balanced growth in general. Relative to utilities, the plan states that the town will continue to encourage utilities to be constructed underground, especially within the village center area.

Suffield

Suffield is a rural town whose most recent Plan of Conservation and Development was published in 1999. Suffield's Plan strives to identify significant open space land and to preserve those areas. Suffield's Regional Plan of Development, which dates to 1978, states that "the goal and policy statements…were directed at encouraging a regional development pattern that provides the necessary balance between the man-made and natural environment, minimizing adverse effects on environmentally sensitive areas and scarce natural resources such as flood plains, wetlands, ridge lines, agriculture, forest land, and park lands." The Town of Suffield still follows these goals. Relative to the construction of new transmission lines, the 1999 plan stated that CL&P indicated that electrical supply lines for Suffield were adequate and that no plans for expansion were in place at that time. Therefore, the plan did not provide any stipulations or goals for transmission lines. Due to population and industrial growth in the region since 1999, the need to provide additional transmission services to the area has been established by CL&P.

Granby

The Granby Plan of Conservation and Development was revised in March of 2007. The primary goals of the town's plan are to remain primarily a rural residential community with both agricultural and recreational activities and businesses, to expand residential development in a manner that maintains

Granby's rural atmosphere, preserves existing neighborhoods, and creates neighborhoods with useable open space and pedestrian linkages. Relative to Open Space Land, the town strives to increase the amount of open space, and to expand Open Space areas by using corridors, paths, or trails to link a variety of existing open space parcels. Granby's Plan of Conservation and Development also strives to maintain the current level of services to the community.

L.1.6 Transportation Systems and Utility Crossings

The road transportation network in the vicinity of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route is well developed and consists primarily of state and local roads. Interstate 91 is located approximately 10 miles to the east of and generally parallel to the route. Other principal roads include U.S. Route 202 and state routes 197, 189, 20, 168, and 526. Table L-7 (*Road Crossings – Connecticut Portion of the North Bloomfield to South Agawam 345-kV Line Route*) lists the roads crossed by the route. The aerial photographs in Volumes 9 and 11 identify the various roads traversed by and in the vicinity of the proposed route.

Table L-7 Road Crossings – Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

Road Name	Municipality	Road Type
Tariffville Road	Bloomfield	Local Road
State Highway 189	Bloomfield	State
Tunxis Avenue	East Granby	Local Road
Hatchett Hill Road	East Granby	State
Holcomb Street	East Granby	Local Road
Turkey Hills Road/Route 20	East Granby	State
Newgate Road	East Granby	Local Road
Wyncairn	East Granby	Local Road
Phelps Road	Suffield	Local Road
Mountain Road/Route 168	Suffield	State
North Stone Street	Suffield	Local Road
Colson Street	Suffield	Local Road
Ratley Road	Suffield	Local Road

L.1.7 Cultural (Archaeological and Historic) Resources

Cultural resources include buried archaeological sites, standing historic structures, or thematically-related groups of structures. To be considered significant and eligible for listing on the National or State Registers of Historic Places (NRHP/SRHP), a cultural resource must exhibit physical integrity and contribute to American history, architecture, archaeology, technology, or culture; and must possess at least one of the following four criteria:

- Association with important historic events;
- Association with important persons;
- Distinctive design or physical characteristics; and/or
- Potential to provide important new information about prehistory or history.

The Connecticut State Historic Preservation Office (SHPO), a part of the Connecticut Commission on Arts, Tourism, Culture, History, and Film, is responsible for reviewing projects to assure that significant cultural resources will be protected or otherwise preserved. CL&P consulted with the SHPO regarding the studies required to identify and evaluate the known or potential significant cultural resources for the GSRP, and conducted a Cultural Resources Assessment (CRA). The SHPO concurred with the scope of work, based on similar studies completed for CL&P's recent Bethel-Norwalk and Middletown-Norwalk transmission projects. CL&P provided the CRA report to the SHPO for review, and received SHPO concurrence with report findings and conclusions in a letter dated February 8, 2008. CL&P is sensitive to Connecticut's cultural heritage and committed to working with the SHPO in protecting and mitigating potential impacts to these resources. Correspondence with the SHPO is included in Volume 4.

Raber Associates (Raber), a firm specializing in historical and social sciences, was retained to compile information about the history and prehistory of the project area; to identify the known cultural resources along and in the vicinity of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line

Route; to identify historic cemeteries and architectural or engineering resources that could be visually affected by the proposed overhead facilities, and to make recommendations regarding the potential for locating as yet undiscovered resources during the development of the GSRP. Raber's CRA report, which addresses both archaeological and historic resources, is included in Volume 3.

The Raber study was performed using methods consistent with the Environmental Primer for Connecticut's Archaeological Resources. The assessment of visual resources on historic resources followed the guidelines in CGS Section 16-50p(a)(4)(c) and the regulations of the Federal Advisory Council on Historic Preservation (36 CFR Section 800.5). The CRA report was prepared using both research and reconnaissance-level field investigations.

The CRA report is based on information obtained from the Office of State Archaeology, previously published technical studies of cultural resources, reviews of the NRHP and SRHP listings, the Historic American Engineering Record (HAER) Connecticut Inventory, and consultations with the SHPO and the Connecticut State Archaeologist. As is standard procedure, the report does not provide exact locational information about buried archaeological sites in order to protect the integrity of such resources.

The following summarizes the principal findings of the *Historical and Archaeological Assessment of Connecticut Sections of the Connecticut Light & Power Company Greater Springfield Reliability Project* (refer to Volume 3 for a more detailed discussion of cultural resources).

The Native American occupation of the project area occurred over a long span of time, beginning about 10,000 BC and continuing to about 1600 AD, when the Contact period of early historic times began. Hundreds of prehistoric Native American sites have been reported in northern Connecticut as a whole, although no specific archaeological studies have been conducted along the entire Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. Accordingly, the purpose of the archaeological portion of the Raber study was to conduct an assessment of the project area, based on the results of which recommendations for future reconnaissance investigations were developed. Based on the review of published information and on data concerning environmental conditions, project areas were classified for archaeological sensitivity. For example, Native American sites are unlikely to be encountered in areas that are too steep, poorly drained, or disturbed.

Based on a review of the previous research (state files), five Native American archaeological sites are reported within approximately 1 mile of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route; all of these sites appear to be seasonal hunting or fishing sites. One fishing site near the Farmington River, used between Middle Archaic and Woodland times, appears eligible for the NRHP and is approximately 800 feet from the existing transmission line ROW; the remaining known sites are at least 3,500 feet from this ROW. Based on known information about archaeological resources and environmental conditions, the Raber report identified the potential sensitivity of the areas along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route for the location of unreported Native American resources. Such areas are identified generally in the text and on the maps of the *Historical and Archaeological Assessment of Connecticut Sections of the Connecticut Light & Power Company Greater Springfield Reliability Project* (refer to Volume 3).

State site files reported no EuroAmerican archaeological sites within approximately 1 mile of the route. Several unreported sites have visible remains within the ROW. Two railroad cuts from the late 19th and early 20th centuries cross the existing transmission corridor in Bloomfield and East Granby, but inspection of these sites does not suggest they retain any historic engineering significance. The 1899 Hartford Electric Light Company hydroelectric plant on the Farmington River was heavily damaged in the 1955 flood and the powerhouse was subsequently razed, leaving the site with no remaining historic engineering significance. Historical maps do not suggest other EuroAmerican sites within the corridor.

Three significant historic resources, all cemeteries used beginning c1740-1784 and in one case still active, were identified within approximately 0.25 mile of the route. Under C.G.S. Section 19a-315, these cemeteries would be subject to protection as ancient burying grounds. No properties listed on the NRHP or SRHP are reported within approximately 0.25 mile of the route.

L.1.8 Air Quality

Ambient air quality is affected by pollutants emitted from both mobile sources (e.g., automobiles or trucks) and stationary sources (e.g., manufacturing facilities, power plants, gasoline stations). In addition, naturally occurring pollutants, such as radon gas or emissions from forest fires, affect air quality. In addition to emissions from sources within the state, Connecticut's air quality is significantly affected by pollutants that are emitted in states located to the south and west, and then transported into Connecticut by prevailing winds. Ambient air quality in the state is monitored and evaluated by the CT DEP. Air quality conditions are assessed in terms of compliance with the National Ambient Air Quality Standards (NAAQS) for selected "criteria" pollutants, as well as conformance with regulations governing the release of toxic or hazardous air pollutants.

The state is currently designated as in attainment or is unclassified with respect to the NAAQS standards for five criteria air pollutants: particulate matter no greater than 10 micrometers in diameter (PM_{10}); sulfur dioxide (SO_2); nitrogen dioxide (NO_2); carbon monoxide (CO); and lead (Pb). The state is currently designated as being in non-attainment with the 8-hour NAAQS standard for ozone (O_3). EPA has recently implemented regulation of particulate matter no greater than 2.5 micrometers in diameter ($PM_{2.5}$). Fairfield and New Haven Counties are currently designated as non-attainment for $PM_{2.5}$ at this time.

Ambient air quality monitoring data are available to characterize ambient concentrations of criteria pollutants in the areas around East Granby, Suffield, and Bloomfield. Given multiple sites of available monitoring in the area, two sets of representative data were developed for the East Granby-Suffield area and Bloomfield area, respectively. Data from the three most recent years available were used (generally 2005-2007). Table L-8 summarizes the monitoring data considered to be most representative of ambient air quality in the East Granby-Suffield area for the period. Table L-9 summarizes the monitoring data considered to be most representative of ambient air quality in the Bloomfield area. The tables list the maximum annual average concentrations in each year and near peak short-term concentrations. The highest of the second-highest concentrations are listed for all short-term averaging periods except for the 24-hour $PM_{2.5}$ and 8-hour O_3 where the 98th percentile (three-year average of the 8th highest value) and the highest of the fourth-highest concentration are listed respectively. All data were obtained from the USEPA AIRDATA database (http://www.epa.gov/air/data/index.html).

In comparison to the NAAQS listed in Tables L-8 and L-9, the ambient background concentrations are less than the standard for all pollutants and averaging periods with the exception of 8-hour O_3. East Granby, Suffield, and Bloomfield are all within a non-attainment area for 8-hour ozone where the three-year average of the fourth-highest daily maximum concentrations exceeds the standard of 147 $\mu g/m^3$. However, the non-attainment area is considered to be moderate since the three-year average does not exceed 210 $\mu g/m^3$.

Table L-8 Ambient Air Quality Concentrations Around East Granby and Suffield, CT

Pollutant	Monitor	Averaging Period	Concentration (µg/m³) 2005	2006	2007	NAAQS (µg/m³)
CO	Mcauliffe Park, East Hartford, CT	1-hour	3,105	3,105	2,300	40,000
		8-hour	2,185	1,955	1,380	10,000
NO_2	Mcauliffe Park, East Hartford, CT	Annual	30.1	24.5	22.6	100
PM_{10}	Mcauliffe Park, East Hartford, CT	24-hour	31	36	28	150
		Annual	15	16	16	50
$PM_{2.5}$ (1)	Mcauliffe Park, East Hartford, CT	24-hour	31.5			35
		Annual	11.5	10.7	10.0	15
O_3 (2)	Route 190, Shenipsit State Forest, Tolland Co., CT	8-hour	178.6			147
SO_2 (3)	85 High Street, East Hartford, CT	3-hour	70.7	94.3	52.4	1300
		24-hour	49.8	49.8	31.4	365
		Annual	7.9	10.5	5.2	80
Pb (4)	Shed Meadow And Bank Street, Waterbury, CT	Calendar quarter	0.01	0.01	0.01	1.5

Source: http://www.epa.gov/air/data/index.html

(1) Short-term value is a three-year average of the 8th highest concentration.
(2) Value is a three-year average of the 4th highest concentration.
(3) The most recent data set for this monitor was from 2004-2006.
(4) The most recent data set for this monitor was from 2000-2002.

Table L-9 Ambient Air Quality Concentrations Around Bloomfield, CT

Pollutant	Monitor	Averaging Period	Concentration ($\mu g/m^3$)			NAAQS ($\mu g/m^3$)
			2005	2006	2007	
CO	Courthouse at 155 Morgan St., Hartford, CT	1-hour	11,385	8,050	6,440	40,000
		8-hour	5,060	4,600	3,795	10,000
NO_2	Mcauliffe Park, East Hartford, CT	Annual	30.1	24.5	22.6	100
PM_{10}	Mcauliffe Park, East Hartford, CT	24-hour	31	36	28	150
		Annual	15	16	16	50
$PM_{2.5}$ (1)	Mcauliffe Park, East Hartford, CT	24-hour	31.5			35
		Annual	11.5	10.7	10.0	15
O_3 (2)	Mcauliffe Park, East Hartford, CT	8-hour	177.3			147
SO_2 (3)	85 High Street, East Hartford, CT	3-hour	70.5	94.3	52.4	1300
		24-hour	49.8	49.8	31.4	365
		Annual	7.9	10.5	5.2	80
Pb (4)	Shed Meadow And Bank Street, Waterbury, CT	Calendar quarter	0.01	0.01	0.01	1.5

Source: http://www.epa.gov/air/data/index.html

(1) Short-term value is a three-year average of the 8^{th} highest concentration.
(2) Value is a three-year average of the 4^{th} highest concentration.
(3) The most recent data set for this monitor was from 2004-2006.
(4) The most recent data set for this monitor was from 2000-2002.

L.1.9 Noise

For the most past, the GSRP region is characterized by rural and suburban environments, where ambient sound levels are influenced by diverse factors such as vehicular traffic, commercial and industrial activities, and outdoor activities typical of both rural and developed environments. Receptors to noise in the GSRP area include residences, schools, and designated recreational areas. The extent of noise effects to humans at a given receptor is dependent upon a number of factors, including the change in noise level from the ambient, the duration and character of the noise, the presence of other, non-project sources of noise, people's attitudes concerning the project, the number of people exposed, and the type of activity affected by the noise (e.g., sleep, recreation, conversation).

Existing noise levels in the vicinity of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route vary as a function of land use, and can be expected to range from sound levels typical of an urban environment to those typical of quiet, rural areas. Noise levels also are variable throughout the day, and are influenced by diverse factors such as vehicular traffic, commercial and industrial activities, and outdoor activities typical of suburban environments. Table L-10 (*Typical Noise Levels Associated with Different Indoor and Outdoor Activities*) lists typical sound levels associated with different types of environments and activities.

The State of Connecticut noise regulations (RCSA Section 22a-69-1 to 22a-69-7.4) identify the limits of sound that can be emitted from certain types of land uses. The State regulations define daytime versus nighttime noise periods, classify noise zones based on land use, and identify noise standards for each zone. Table L-11 (*State of Connecticut Noise-Control Regulations by Emitter and Receptor Land-Use Classification)* summarizes Connecticut's noise zone standards, by emitter (source) and receptor (receiver) noise classification. In general, the regulations specify that noise emitters must not cause the emission of excessive noise beyond the boundaries of their noise zone so as to exceed the allowable noise levels on a receptor's land.

As illustrated in Table L-11, the allowable noise levels vary by type of noise emitter and type of noise receptor; for example, an industrial noise emitter is allowed a 70 dBA level on other industrial receptors, but only a 61 dBA (daytime) level on residential areas. Where multiple noise emitter/noise receptor types exist on the same property, the least restrictive limits apply.

The regulation also prohibits the production of prominent, audible discrete tones. If a facility produces such sounds, the applicable limits in Table L-11 are reduced by five dBA to offset the undesirable nature of tonal sound in the environment. The regulation defines prominent discrete tones on the basis of one-third octave band sound levels.

Construction noise is exempted under RCSA Section 22a-69-1.8(h); therefore the noise limits presented in Table L-11 do not apply to construction of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

In accordance with Connecticut statutes (CGS § 22a-73), municipalities also may adopt noise-control ordinances. Such ordinances must be approved by the Commissioner of CT DEP and be consistent with the state noise regulations.

Table L-10 Typical Noise Levels Associated with Different Indoor and Outdoor Activities

Outdoor Noise Levels	A-Weighted Sound Level (dBA)	Indoor Noise Levels
Jet aircraft take-off at 100 feet	+120	
Riveting machine at operator's position	+110	
Cut-off saw at operator's position	+100	
Elevated subway at 50 feet		
		Newspaper press
Automobile horn at 10 feet		
	+90	Industrial boiler room
Diesel truck at 50 feet		Food blender at 3 feet
Noisy urban daytime	+80	Garbage disposal at 3 feet
Diesel bus at 50 feet		
		Shouting at 3 feet
	+70	
Gas lawn mower at 100 feet		Vacuum cleaner at 10 feet
Quiet urban daytime	+60	Normal conversation at 5 - 10 feet
		Large business office
Quiet urban nighttime	+50	Open office area background level
Substation (transformer)	+43	
Quiet suburban nighttime		
	+40	Large conference room
		Small theater (background)
Quiet rural nighttime	+30	Soft whisper at 2 feet
		Bedroom at nighttime
	+20	Concert hall

Table L-11 State of Connecticut Noise-Control Regulations by Emitter and Receptor Land-Use Classification

Noise Emitter Class	Noise Receptor Class			
	C: Industrial	B: Generally Commercial	A: Residential Day	A: Residential Night
C: Industrial	70 dBA	66 dBA	61 dBA	51 dBA
B: Generally Commercial	62 dBA	62 dBA	55 dBA	45 dBA
A: Residential	62 dBA	55 dBA	55 dBA	45 dBA

Definitions:
Day = 7:00 AM to 9:00 PM Monday – Saturday; 9:00 AM to 9:00 PM Sunday
Night=9:00 PM to 7:00 AM Monday – Saturday; 9:00 PM to 9:00 AM Sunday

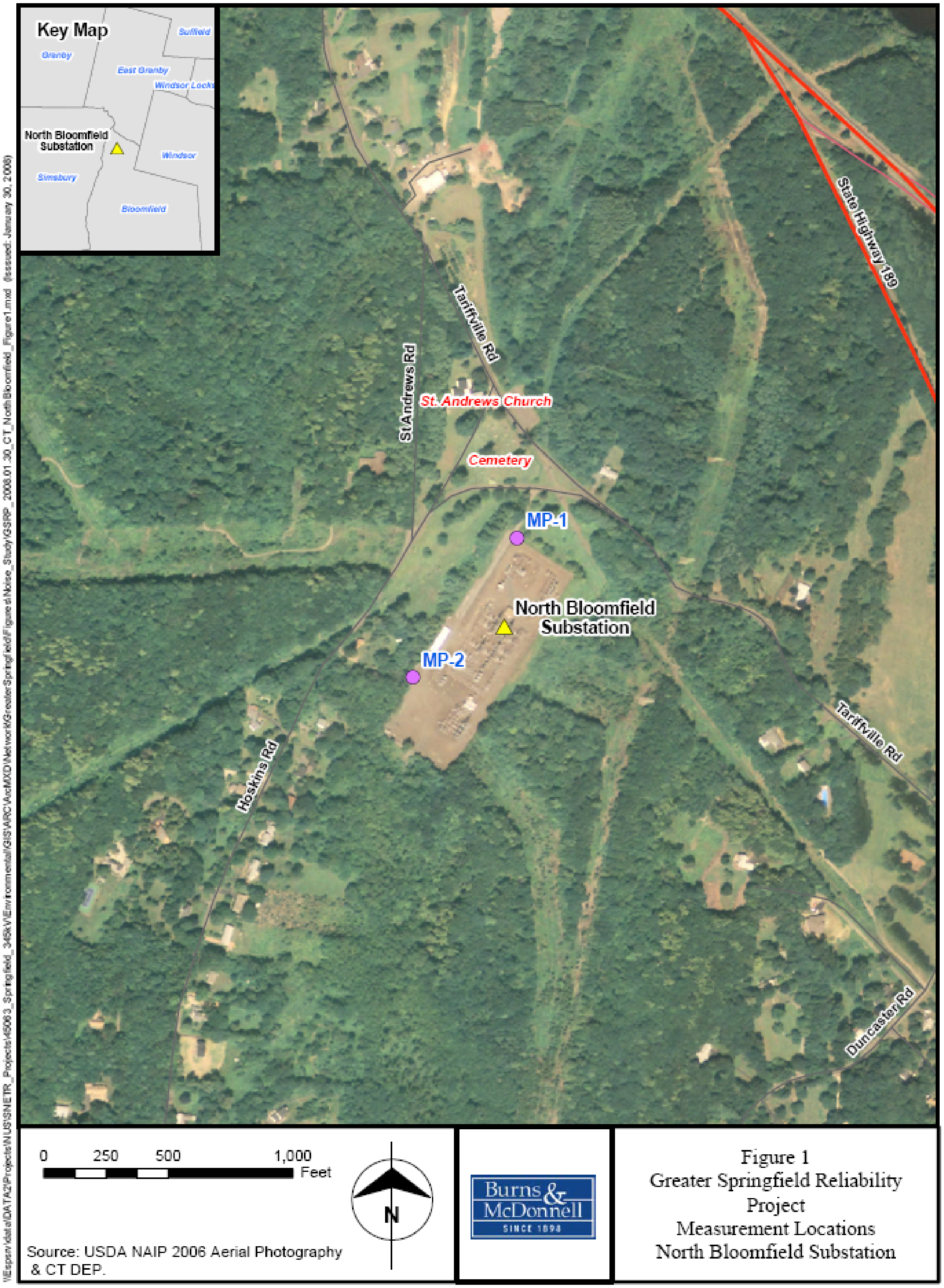
The North Bloomfield Substation would be classified as a Class C Noise Emitter. It is most conservative to assume the area surrounding the substation is classified as a Class A Noise Receptor (or residential) zone. Therefore, the applicable noise limits, with a five dBA offset, for the North Bloomfield Substation during the day and night are 61 and 51 dBA, respectively. Further, meeting limits of 56 and 46 dBA, respectively, will offset any prominent discrete tones.

L.1.9.1 Existing Noise Measurements

On January 7, 2008, between the hours of 5:00 P.M. and 6:00 P.M., and on January 8, 2008, between the hours of 1:00 A.M. and 2:00 A.M., 5:00 A.M. and 6:00 A.M., and 10:00 A.M. and 11:00 A.M., Burns & McDonnell personnel obtained environmental sound level measurements to capture the ambient sound levels near the existing North Bloomfield Substation, located in the Town of Bloomfield. The land use surrounding the North Bloomfield Substation consists of undeveloped upland forest and rural residential areas. St. Andrews Church and cemetery are also located in the vicinity of the substation (see Figure L-1).

Weather conditions were favorable for conducting ambient sound measurements during all survey periods. On January 7, 2008, winds were calm and temperatures were approximately 39 degrees Fahrenheit with 79 percent relative humidity. On January 8, 2008, winds were calm during all three measurement periods. Temperatures were approximately 36 degrees Fahrenheit with 92 percent relative humidity during the 1:00 A.M. to 2:00 A.M. period, 37 degrees Fahrenheit with 96 percent relative humidity during the 5:00 A.M. to 6:00 A.M. period, and 44 degrees Fahrenheit with 96 percent relative humidity during the 10:00 A.M. to 11:00 A.M. measurement period.

Figure L-1: Measurement Locations North Bloomfield Substation



Sound level measurements were made at two locations around the existing fenceline of the North Bloomfield Substation, and in the direction of nearby residences as shown in Figure L-1. These locations were selected because they were deemed to be representative of existing environmental conditions, are near sensitive noise receivers, and were accessible. Measurements were taken using two Larson-Davis Model 824 Type I sound level meters. The sound level meter was calibrated before each set of measurements. None of the calibration level changes exceeded ± 0.3 dB. A windscreen was used at all times on the meter, and the meter was mounted on a tripod, approximately five feet above ground with the microphone directed toward the substation. The meter measured overall L_{eq} sound levels along with octave band and one-third octave band frequency sound levels.

At each location, sound levels at each frequency band were measured and logged by the noise meter. Fifteen-minute measurement samples were recorded during each of the measurement periods. The sound levels varied at each measurement point depending on the proximity to the substation and the extraneous sounds that occurred during the measurement points. The measurement points were located at approximately the same elevation as the existing substation.

Extraneous noises during the measurement periods included noise associated with the substation, traffic, planes overhead, and birds. The existing North Bloomfield Substation was audible during most of the measurement periods. The measured, A-weighted L_{eq} sound levels are presented in Table L-12. Ambient A-weighted sound levels varied from a low of 36.4 dBA at Measurement Point (MP) 2 during the night to a high of 49.6 dBA at both MP1 and MP2 during the early evening.

Table L-12 Existing Ambient Noise Level Measurements (L_{eq})

Time Period	Measurement Point	Location Description	Existing Ambient Noise (dBA)
1/7/08; 5 P.M. - 6 P.M.	MP1	NW corner of substation fenceline	49.6
	MP2	SW side of substation fenceline	49.6
1/8/08; 1 A.M.- 2 A.M.	MP1	NW corner of substation fenceline	39.6
	MP2	SW side of substation fenceline	36.4
1/8/08; 5 A.M.- 6 A.M.	MP1	NW corner of substation fenceline	42.3
	MP2	SW side of substation fenceline	40.8
1/8/08; 10 A.M.- 11 A.M.	MP1	NW corner of substation fenceline	45.2
	MP2	SW side of substation fenceline	42.3

L.1.9.2 Operational Noise Levels

CL&P plans to install a second 345/115-kV autotransformer at the North Bloomfield Substation which will consist of standard single-phase units. CL&P also plans to install additional breakers and a control house at the existing substation. The only new noise source at the substation will be the proposed transformer as the breakers and control house are not expected to create any additional noise. In order to evaluate the sound predicted from the new transformer, the proposed noise source was modeled using industry-accepted sound modeling software which calculated the expected sound levels at the identified receivers. The program used to model the new transformer was the Computer Aided Design for Noise Abatement (CadnaA), Version 3.7, published by DataKustik, Ltd., Munich, Germany. The CadnaA program is a scaled, three-dimensional program which takes into account each piece of noise-emitting equipment on the Project site and predicts sound levels in circular contours of equal sound pressure. Appropriate sound generation sources are applied for all sound radiating surfaces and points. The model calculates sound propagation based on ISO 9613-2:1996, General Method of Calculation. ISO 9613 and CadnaA assess the sound levels based on the Octave Band Center Frequency range from 31.5 to 8,000 Hz.

The sound power levels emitted from the transformer were predicted based on vendor's data. Table L-13 presents the sound power level at each of the octave bands, as well as the overall sound power levels for the transformer. Vendor data for the sound power level at the lower and higher octave bands was not available. As a conservative approach, existing buildings and structures were not included in the model.

Table L-13 New Transformer Sound Power Levels at Each Octave Band Frequency

Equipment	dB at Octave Band Frequency (Hz)									Total Sound Power Level (dB)	Total Sound Power Level (dBA)
	32	63	125	250	500	1000	2000	4000	8000		
Transformer	---	76.9	85.8	79.5	70.6	62.1	---	---	---	87.3	74.6

The predicted sound levels from the CadnaA noise model at each measurement point are presented in Table L-14. These sound levels are a result of the proposed noise-emitting equipment (transformers) that will be installed at the existing North Bloomfield Substation as part of this project. Existing background measurements (which include the current North Bloomfield Substation operation) were logarithmically added to the expected sound levels from the proposed project to determine total sound levels at each measurement location when the new project is operational, and are presented in Table L-14 as well.

Table L-14 Predicted Sound Pressure Levels

Measurement Point	Time Period	Existing Ambient Noise Levels (dBA)	Estimated Noise Levels from Project (dBA)	Overall Projected Noise Levels (Existing Ambient with New Project Operating) (dBA)
MP1	5 P.M. – 6 P.M.	49.6	19.1	49.6
MP2	5 P.M. – 6 P.M.	49.6	39.1	50.0
MP1	1 A.M.- 2 A.M.	39.6	19.1	39.6
MP2	1 A.M.- 2 A.M.	36.4	39.1	41.0
MP1	5 A.M. – 6 A.M.	42.3	19.1	42.3
MP2	5 A.M. – 6 A.M.	40.8	39.1	43.0
MP1	10 A.M. – 11 A.M.	45.2	19.1	45.2
MP2	10 A.M. – 11 A.M.	42.3	39.1	44.0

The overall projected noise levels (existing ambient noise levels logarithmically added to the new transformer operating noise levels) were compared to the applicable Connecticut noise regulations in Table L-15. Since the Connecticut noise regulations prohibit the production of prominent, audible discrete tones, the applicable overall noise limits are reduced by five dBA to offset the undesirable nature of tonal sound in the environment.

Table L-15 Overall Projected Noise Levels and Connecticut Noise Limits for Receptor Class A

Measurement Point	Time Period	Overall Projected Noise Levels (Existing Ambient with New Project Operating) (dBA)	Connecticut Noise Limits for Receptor Class A minus 5 dBA (dBA)*
MP1	5 P.M. – 6 P.M.	49.6	56
MP2	5 P.M. – 6 P.M.	50.0	56
MP1	1 A.M.- 2 A.M.	39.6	46
MP2	1 A.M.- 2 A.M.	41.0	46
MP1	5 A.M. – 6 A.M.	42.3	46
MP2	5 A.M. – 6 A.M.	43.0	46
MP1	10 A.M. – 11 A.M.	45.2	56
MP2	10 A.M. – 11 A.M.	44.0	56

*Noise daytime limits for Receptor Class A were used for measurement periods between the hours of 7 A.M. and 10 P.M. and night-time limits were used for measurement periods between the hours of 10 P.M. and 7 A.M.

L.1.9.3 Conclusions and Recommendations

As shown by the above results, it is predicted that the overall projected noise levels at the North Bloomfield Substation (after the proposed transformer is operating) will not exceed either the day- or night-time Connecticut noise limits, even when the regulations are reduced by 5 dBA to avoid prominent discrete tone. Therefore, the proposed modifications at the North Bloomfield Substation will be in compliance with all Connecticut noise regulations.

L.2 MANCHESTER TO MEEKVILLE JUNCTION CIRCUIT SEPARATION PROJECT (MMP)

As described in Section H, the proposed MMP would extend for approximately 2.2 miles and would be located entirely within the Town of Manchester, within an existing CL&P ROW that is approximately 350 feet wide. The CL&P ROW presently traverses mainly forested areas and floodplain associated with the Hockanum River. The ROW is surrounded by urban, residential, and transportation land uses. A 115-kV line and 345-kV line presently occupy the same transmission structures along this segment of ROW. The proposed line separation would require the removal of the 115-kV circuit from this line of double-circuit structures, and the reconstruction of the 115-kV circuit on new independent structures, also within the existing CL&P ROW.

The following subsections summarize the environmental characteristics of the MMP. Environmental factors (e.g., noise, air quality) that are common to both this 2.2-mile segment and the overall GSRP in Connecticut are not repeated. For a discussion of these resources, refer to Section L.1.

L.2.1 Topography, Geology and Soils

The topography and surficial geology along the MMP Line Route is somewhat different than what was observed for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. While glaciolacustrine, glaciofluvial, eolian and organic deposits are present on both routes, the MMP is dominated by these materials and largely lacks deposits of glacial till. The surficial geology along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route has a large component of the latter. Surficial geologic deposits determine what types of soils can ultimately form in any given area. Table L-16 (*General Characteristics of Soil Associations along the MMP Line Route*) summarizes the principal soil associations, as identified by the USDA NRCS[6], in the general vicinity of the MMP Line Route.

Table L-16 General Characteristics of Soil Associations along the MMP Line Route

Map Unit Name and Symbol	Parent Material	Hydric (Yes or No)	Depth to Bedrock (inches)	Depth to water Table (feet)
12 Raypol silt loam	coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	Yes	>72	1.0
15 Scarboro muck	sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	Yes	>72	0.5
17 Timakwa and Natchaug	Woody organic material over sandy and gravelly glaciofluvial deposits and woody organic material over loamy alluvium and/or loamy glaciofluvial deposits and till	Yes	>72	0.0-1.0
21A Ninigret and Tisbury soils	coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	1.5
32A Haven and Enfield, 0 to 3 percent slopes	Coarse-loamy or coarse-silty eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	--
32B Haven and Enfield, 3 to 8 percent slopes	Coarse-loamy or coarse-silty eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	--
37C Manchester gravelly sandy loam, 3 to 15 percent slopes	Sandy and gravelly glaciofluvial deposits derived from sandstone and shale and/or basalt	No	>72	--
104 Bash silt loam	Coarse-loamy alluvium derived from sandstone and shale	Yes	>72	0.5-1.5
108 Saco silt loam	Coarse-silty alluvium	Yes	>72	0.0-0.5
109	alluvium	Yes	>72	0.0-1.0

[6] The NRCS was formerly the Soil Conservation Service (SCS).

Map Unit Name and Symbol	Parent Material	Hydric (Yes or No)	Depth to Bedrock (inches)	Depth to water Table (feet)
Fluvaquents-Udifluvents				
302 Dumps	Miscellaneous area			
306 Udorthents-Urban	Drift			
308 Udorthents, smoothed	Drift	No	>72	2 – 4.5

-- No Data Given. No bedrock or water encountered to survey depth.

L.2.2 Water Resources

Field surveys of wetlands and water resources were conducted along the MMP Line Route using the same procedures as described for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. Specific descriptions of each of the watercourses and associated vegetation along the MMP Line Route are included in the *Inventory and Delineation of Wetlands and Watercourses Along the Connecticut Portion of the Greater Springfield Reliability Project* (Volume 2).

In general, water resources along the route have been historically affected by the maintenance of the ROW in low-growing vegetation to assure the safe operation of the existing overhead transmission lines. Refer to Section J for more information regarding the proposed techniques for installing the transmission line across water resources.

L.2.2.1 Drainage Basins and Streams

The MMP Line Route traverses portions of the Lower Connecticut drainage basin. The route spans five perennial waterbodies, the largest of which is the Hockanum River, and two intermittent streams. All of these streams are presently traversed by the existing overhead transmission lines. A list of the watercourses crossed, along with their surface water quality classification, are included in Table L-17 *(Watercourses Traversed Along the MMP).*

Table L-17 Watercourses Traversed along the MMP

Series Number[1] and Name where Applicable	CL&P Stream Number	Water Quality / Fisheries Classification Where Applicable[2]	Type (P or I)[3]	Comments
S01HF001 Hop Brook	S15-201	C/B	P	Associated with W01HF001 Hop Brook
S01HF002	S15-200	A	I	Associated with W88HA-021
S01HF003 Hop Brook	S15-202	C/B	P	Associated with W01HF002 Hop Brook
S01HF004 Hop Brook	S15-203	C/B	P	Associated with W01HF003 Hop Brook
S01HF005 Hockanum River	S15-204	C/B	P	Associated with W01HF003 Hockanum River
S01HF006 Hockanum River	S15-205	C/B	P	Associated with W88HA013 Hockanum River
S01HF007	S15-207	A	I	Associated with W01HF008

1. Series number and CL&P stream number represent the same resource. The series number was generated by CL&P's environmental consultant (ENSR) GPS Survey of watercourses. The CL&P stream number was generated as a mapping convention;.
2. Data obtained from hard copy CT DEP map entitled Water Quality Classifications, Connecticut River and Southcentral Coastal Basins, Adopted February 1993.
3. P = perennial / I = intermittent (stream designations).

The MMP includes structures that are currently located within the Stream Channel Encroachment Lines (SCEL) associated with the Hockanum River. The CT DEP's Bureau of Water Protection and Land Reuse's Inland Water Resources Division regulates the placement of encroachments and obstructions riverward of SCEL to lessen hazards to property due to flooding. To date, SCEL for 270 linear miles of riverine floodplain throughout the State of Connecticut have been established. As stated above, the SCEL associated with the Hockanum River has existing CL&P structures within the SCEL as well as existing structures that currently span segments of the SCEL.

L.2.2.2 Wetlands

The Inventory and Delineation of Wetland and Watercourses along the Connecticut Portion of the Greater Springfield Reliability Project in Volume 2 summarizes the characteristics of each wetland and watercourse along the MMP Line Route, and includes representative photographs and wetland data forms.

During the biological field investigations performed in 2008, the wetlands and watercourses along the MMP Line Route were characterized using Connecticut delineation methodology pursuant to the Connecticut Inland Wetlands and Watercourses Act, CGS §§ 22a-36 through 22a-45, and the 1987 *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987; Corps Manual.)

The results of the field studies, which also generally characterized upland vegetation types along the route, are summarized below. Wetland and watercourse locations are generally depicted on the *Aerial Photographs - 400 Scale* (Volume 9), which identifies each wetland and watercourse along the route, keyed to the *Inventory and Delineation of Wetlands and Watercourses Along the Connecticut Portion of the Greater Springfield Reliability Project* in Volume 2. The surveyed wetland boundaries (as identified by the numbered flags) are depicted in Volume 11, *Aerial Photographs - 100 Scale,* and the *Inventory and Delineation of Wetlands and Watercourses Along the Connecticut Portion of the Greater Springfield Reliability Project* (Volume 2) details the methods used and results of this wetland delineation.

Table L-18 (*Delineated Wetlands along the MMP)* lists the 13 wetlands systems identified along the proposed MMP Line Route.

Table L-18 Delineated Wetlands Along the MMP

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Wetland Class[2]
Manchester	W01HF001	W15-501	PSS/PFO
Manchester	W88HA021	W15-500	PSS/PFO
Manchester	W88HA021A	W15-502	PFO
Manchester	W01HF002	W15-503	PFO
Manchester	W01HF003	W15-504	PEM/PSS/PFO
Manchester	W88HA013	W15-507	PSS/PFO
Manchester	W01HF004	W15-512	PEM/PSS
Manchester	W01HF005	W15-513	PEM
Manchester	W01HF006	W15-514	PEM/PSS/PFO
Manchester	W01HF007	W15-515	PEM
Manchester	W01HF008	W15-516	PEM/PSS
Manchester	W01HF009	W15-518	PEM/PSS/PFO
Manchester	W01HF010	W15-517	PSS

1. Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated as a mapping convention;

2. Wetlands classification according to Cowardin et al 1979; PEM = Palustrine Emergent Wetland; PFO = Palustrine Forested Wetland; PSS = Palustrine Scrub-Shrub Wetland

Based on the 2008 field surveys, the majority of the wetlands along the MMP Line Route, which is aligned entirely within the existing transmission line ROW, are well-vegetated and dominated by some combination of forested wetland, scrub-shrub wetland and shallow emergent wetland communities. In many locations, the wetland in the maintained portion of the ROW is dominated by shrub swamp and shallow marsh wetlands and extends off the existing transmission line ROW, transitioning into forested wetland.

Of the wetlands along the MMP Line Route, two areas were identified and confirmed as amphibian breeding habitats/vernal pools. Section L.2.3.4 describes these areas in more detail.

L.2.2.3 Groundwater Resources and Public Water Supplies

The MMP Line Route traverses 2.1 miles of the Love Lane/New State Road Aquifer Protection Area. The closest public supply well associated with the Love Lane New State Road stratified drift aquifer is located off Love Lane, approximately 0.5 miles north of the Manchester Substation. Connecticut's Aquifer Protection Area Program protects major public water supply wells in sand and gravel aquifers to ensure a plentiful supply of public drinking water for present and future generations. Aquifer Protection Areas (sometimes referred to as "wellhead protection areas") are being designated around the state's 127 active well fields in 81 towns in sand and gravel aquifers that serve more than 1,000 people. Land use regulations will be established in those areas to minimize the potential for contamination of the well field. These regulations restrict development of certain new land use activities that use, store, handle, or dispose of hazardous materials. Additionally, the regulations require existing regulated land uses to register and follow best management practices for permitted regulated activities. The Town of Manchester is in the process of completing final aquifer protection mapping and adopting protection regulations that must be approved by the CT DEP and the town.

The groundwater areas crossed by and/or in the vicinity of the Manchester Substation to Meekville Junction corridor have been classified as GA, GA-impaired, or GB.

Potable water along and adjacent to the route is provided by the Manchester Water and Sewer Department, which is supplied by seven surface water reservoirs and ten active wells. As stated above, the closest public water supply is the public supply well associated with the Love Lane New State Road stratified drift aquifer.

L.2.2.4 Flood Zones

The MMP Line Route traverses the 100-year flood boundary of the Hockanum River. The FEMA floodplain boundaries for watercourses in the project area are depicted on the maps in Volumes 9 and 11.

L.2.3 Biological Resources

L.2.3.1 Vegetative Communities

The MMP Line Route crosses or is located near various types of vegetative communities that provide a variety of wildlife habitat. With the exception of the agricultural lands cover type, the habitat types found along this route are the same as those described for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. A description of these vegetative communities can be found in Section L.1.3.1

L.2.3.2 Wildlife

L.2.3.2.1 General Wildlife Description

A description of the wildlife species typical for each of the major vegetative types can be found in Section L.1.3.2.1.

L.2.3.2.2 Designated Wildlife Management Areas

No designated wildlife management areas are found in the vicinity of the MMP Line Route; however, the Hockanum River corridor is a state-designated trout management area overseen by the CT DEP.

L.2.3.3 Fisheries

The MMP Line Route would span the Hockanum River, within the existing CL&P overhead transmission line ROW. The section of river from Vernon, Connecticut to the Manchester/East Hartford town line, a portion of which is traversed by the existing ROW, is designated as a trout management area (See Section L.1.3.3 for a description of the CT DEP Trout Management Plan). Trout Management Areas are designated by the CT DEP to signify those high-quality fisheries managed to offer year-round fishing opportunities. To accommodate fishing activities and maintain fishery resources, certain portions of the Hockanum River are heavily stocked with trout by the CT DEP.

L.2.3.4 Amphibians

Along the Manchester to Meekville Junction route, and as listed in Table L-19, two amphibian breeding habitats/vernal pools were identified during the spring 2008 surveys. These two amphibian breeding locations were identified using the same survey techniques described in Section L.1.3.4 for the GSRP. Both locations are within the existing CL&P ROW.

Table L-19 Vernal Pool Habitat Associated with the MMP

Municipality	Wetland Series Number[1]	Northeast Utilities Wetland Number	Adjacent Tower Number	Observed Obligate Species[2]
Manchester	W01HF003	W15-504	20007	spotted salamander, wood frog
Manchester	W88HA013	W15-507	6286	wood frog larvae

[1]: . Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated as a mapping convention;

[2]: Vernal Pool Species observed confirming vernal pool/amphibian habitat.

L.2.3.5 Birds

Although differing proportions of particular habitats could result in greater or lesser numbers of bird species expected to occur within those habitats, in general terms, the species assemblage is expected to be similar for the MMP Line Route, as compared to the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

In addition, CL&P received correspondence from the NDDB, dated April 24, 2008, indicating that the NDDB's records show that there are historic records of a state-endangered species, the Barn Owl (*Tyto alba*), in the vicinity of this project site. This species is discussed in the following subsection (Section L.2.3.6) and *Inventory of Potential Breeding Bird Species and Habitats Along the Connecticut Portions of the Greater Springfield Reliability Project* in Volume 4 for a discussion of this species and what measures/surveys were taken to address this issue.

L.2.3.6 Rare, Threatened and Endangered Species

The NDDB's April 24, 2008 correspondence to CL&P (which is included in Volume 4) regarding the MMP stated that there are historic records of the state endangered Barn Owl in the vicinity of the route. In Connecticut, Barn Owls utilize semi-open low lying habitats such as agricultural areas, pastures, grasslands and similar habitats. Feeding primarily on rodents, Barn Owls also require nesting cavities which may consist of hollow trees, barns, steeples and abandoned buildings.

The CT DEP Wildlife Division has advised that site-specific surveys for this species would be required. In response, biologists visually inspected the entire length of the MMP for any potential Barn Owl nesting habitat, including large diameter trees with cavities, abandoned buildings, or any other suitable structure in proximity to grassy fields, old fields, or wet meadows (foraging habitats). During the spring of 2008 surveys, no active Barn Owl nest sites or individuals were encountered. In addition, because the ROW is dominated by woody vegetation such as shrub and sapling thickets, as opposed to predominantly open fields and meadows, the ROW offers extremely limited foraging habitat for Barn Owls. Two areas along the MMP Line Route not dominated by shrub and sapling thickets were identified as potential foraging habitat for Barn Owls, with only one being located within the CL&P transmission line ROW. A discussion of this survey is located in the *Inventory of Potential Breeding Bird Species and Habitats Along the Connecticut Portions of the Greater Springfield Reliability Project* in Volume 4. The addendum also contains a figure which identifies the small area of potential Barn Owl foraging habitat located on the ROW as well as the areas immediately west of the ROW which Barn Owls could potentially utilize.

L.2.4 Existing Land Use

L.2.4.1 Overall Land-Use Patterns

The MMP Line Route is located in northwestern Manchester Municipal. Land use plans were reviewed, and land uses along and adjacent to the existing transmission line ROW within which the circuit separation would be performed were characterized.

As illustrated on Volume 9 maps, after leaving the Manchester Substation, the ROW extends northwest and crosses Olcott Road to US Route 6 through forested areas bordered by urban development. The ROW then traverses the Hockanum River and a large wetland before spanning Interstate 84. After spanning the highway, the ROW continues north to cross the Tolland Turnpike, entering Meekville Junction adjacent to commercial/industrial and residential areas.

L.2.4.2 Parks, Open Space, Recreational and Public Trust Lands

The MMP Line Route is aligned within an established CL&P ROW, located in a largely urban setting. James M. Leber Memorial Field is located adjacent to the ROW off Love Lane. Leber field is owned by the Town of Manchester and consists of one baseball field and associated facilities. The field is located to the east of the existing transmission line ROW. The route also spans the Laurel Marsh Trail, which is a 3.5-mile loop located on the south side of Route 44. The trail is associated with the Hockanum River and provides views of marsh areas, mature forests, and water birds.

L.2.4.3 Statutory Facilities

There are three Statutory Facilities near the east edge of the MMP ROW: James M. Leber Memorial Field, Howell Cheney V-T School, and East Catholic High School, all of which are to the east of the ROW. Whether or not any of these facilities are considered to be “adjacent to” the ROW, the “underground presumption” of C.G.S. §16-50p(i) will not apply. No new 345-kV line is proposed to be constructed as part of the MMP. Rather, an existing 345-kV line will be left in place. On the other hand, the Council's EMF Best Management Practices (BMPs) do apply to the proposed construction. In contrast to the underground presumption, the BMPs apply not just to new 345-kV lines, but to all transmission lines above 69-kV, and to "modifications" of existing lines as well as the construction of new lines. In this case, the 115-kV circuit that currently shares a line of double circuit structures with the 345-kV circuit will be modified by being moved off of the common structures and placed on its own set of structures, to the west of the existing double circuit structures. Accordingly, CL&P has included the MMP in its EMF Field Management Design Plan in Section O Appendix O-1.

L.2.5 Federal, State, and Local Land-Use Plans/Future Land-Use Development

Manchester is also a part of the Capitol Region regional planning area, so the state land use plans for Manchester are the same as those listed for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and are described in Section L.1.5. However, while the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route traverses more rural and suburban areas with more open space, the MMP Line Route traverses mainly forested areas surrounded by urban and suburban development. Therefore the parts of the Conservation and Development Policies Plan for Connecticut applicable to the MMP Line Route are those concerning development of industry and commerce and improvement of infrastructure to support neighborhood development. The MMP goals are consistent with the C&D plan in that it will provide infrastructure to support growth of the area within and surrounding Manchester.

Manchester

Manchester is a suburban town with a Plan of Conservation and Development focusing on guiding development for the five-year period 2005 to 2010. During this period, Manchester's goals include the retention and enhancement of retail diversity, promotion of the community as an economic destination to local businesses, and increased areas of open space and recreation.

L.2.6 Transportation Systems and Utility Crossings

The road transportation network in the vicinity of the MMP is well developed. The Manchester to Meekville Junction route would cross several roads, including Olcott Street, Thrall Road, US Route 6, Interstate 84, and Meekville Road.

L.2.7 Cultural (Archaeological and Historic) Resources

Initial cultural resource studies were performed for the MMP, using the same methods as described for the GSRP in Section L.1.7. The results of these studies are summarized below and described in detail in the cultural resources report included in Volume 2.

Hundreds of prehistoric Native American sites have been reported in central Connecticut, although no specific archaeological studies have been conducted along the MMP Line Route. The purpose of the archaeological portion of the cultural resource studies was to conduct an assessment of the MMP area, in order to document recorded archaeological sites in the vicinity and to classify areas along the route in terms of archaeological sensitivity.

Eight Native American archaeological sites are reported within approximately 1 mile of the MMP Line Route. None have been determined eligible for the NRHP. Although most have not been excavated extensively, the sites include artifacts dating from Late Archaic to Contact periods, and represented at least two villages and one burial site from the Contact period located approximately 700 to 4,000 feet from the MMP Line Route. No sites have been found within the ROW, but reported sites are within 500 feet of the MMP Line Route. Based on known information about archaeological resources and environmental conditions, the *Cultural Resource Assessment Report* identified the potential sensitivity of the areas along the MMP Line Route for the location of unreported Native American resources. Such areas are identified generally in the text and on the maps of the *Cultural Resource Assessment Report*. The *Historical and Archaeological Assessment of Connecticut Sections of the Connecticut Light & Power*

Company Greater Springfield Reliability Project, which addresses both archaeological and historic resources, is included in Volume 3.

State site files reported two poorly-documented EuroAmerican archaeological sites within approximately one mile of the MMP Line Route. None have been determined eligible for the NRHP, and at least one has probably been destroyed. Historical maps and other information do not suggest EuroAmerican sites within the MMP Line Route.

To analyze the potential visual effects of the project facilities on significant historic properties, research was performed to identify known significant historic resources within 0.25 mile of the Manchester to Meekville Junction route. This viewshed distance was based on discussion with the SHPO and similar, previous studies. Photographic documentation for identification of potential visual effects was conducted for any historic architectural properties within 0.25 mile of the route.

One significant historic resource was identified within approximately 0.25 mile of the route: the c1835 Charles Bunce House identified as eligible for the NRHP.

L.2.8 Air Quality

Ambient air quality monitoring data are available to characterize ambient concentrations of criteria pollutants in the area around Manchester. Table L-20 summarizes the most recent available monitoring data considered to be most representative of ambient air quality in the Manchester area. Data from the three most recent years available were used (generally 2005-2007). The table lists the maximum annual average concentrations in each year and near peak short-term concentrations. The highest of the second-highest concentrations are listed for all short term averaging periods except for the 24 hour $PM_{2.5}$ and 8 hour O_3 where the 98^{th} percentile and the highest of the fourth highest concentration are listed respectively. All data were obtained from the USEPA AIRDATA database (http://www.epa.gov/air/data/index.html).

In comparison to the National Ambient Air Quality Standards (NAAQS) listed in Table L-20, the ambient background concentrations are less than the standard for all pollutants and averaging periods with the exception of 8 hour O_3. Manchester is within a non-attainment area for 8 hour ozone where the three year average of the fourth highest daily maximum concentrations exceeds the standard of 147 $\mu g/m^3$. However, the non-attainment area is considered to be moderate since the three year average does not exceed 210 $\mu g/m^3$.

Table L-20 Ambient Air Quality Concentrations Around Manchester, CT

Pollutant	Monitor	Averaging Period	Concentration (μg/m³)			NAAQS (μg/m³)
			2005	2006	2007	
CO	Courthouse at 155 Morgan St., Hartford, CT	1-hour	11,385	8,050	6,440	40,000
		8-hour	5,060	4,600	3,795	10,000
NO_2	Mcauliffe Park, East Hartford, CT	Annual	30.1	24.5	22.6	100
PM_{10}	Mcauliffe Park, East Hartford, CT	24-hour	31	36	28	150
		Annual	15	16	16	50
$PM_{2.5}$ (1)	Mcauliffe Park, East Hartford, CT	24-hour	31.5			35
		Annual	11.5	10.7	10.0	15
O_3 (2)	Mcauliffe Park, East Hartford, CT	8-hour	177.3			147
SO_2 (3)	85 High Street, East Hartford, CT	3-hour	70.5	94.3	52.4	1300
		24-hour	49.8	49.8	31.4	365
		Annual	7.9	10.5	5.2	80
Pb (4)	Shed Meadow And Bank Street, Waterbury, CT	Calendar quarter	0.01	0.01	0.01	1.5
Source: http://www.epa.gov/air/data/index.html						

(1) Short-term value is a three year average of the 8th highest concentration.
(2) Value is a three year average of the 4th highest concentration.
(3) The most recent data set for this monitor was from 2004-2006.
(4) The most recent data set for this monitor was from 2000-2002.

SECTION M

EXISTING ENVIRONMENT: UNDERGROUND LINE ROUTE VARIATIONS FOR CONNECTICUT PORTION OF THE NORTH BLOOMFIELD TO AGAWAM 345-KV LINE ROUTE AND CONNECTICUT PORTION OF SOUTHERN ROUTE ALTERNATIVE FOR THE AGAWAM TO LUDLOW 345-KV LINE ROUTE

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This section describes the existing environment along and in the vicinity of the alternative underground cable routes that have been identified as variations to portions of the proposed 12-mile overhead 345-kV GSRP line between the North Bloomfield Substation and the Connecticut/Massachusetts state border. These underground line route variations, discussed in Sections M.1 through M.4, are:

- The Newgate Road Underground Line Route Variation
- State Route 168/187 Underground Line Route Variation
- 4.6-Mile In-ROW Underground Line Route Variation
- 3.6-Mile In-ROW Underground Line Route Variation

In addition, the section also characterizes the existing environment along the 5.4-mile segment of the Connecticut Portion of the Southern Route Alternative for the Agawam to Ludlow 345-kV Line Route that extends into Connecticut. As discussed in Section H, this route is not the preferred alignment for the Massachusetts portion of the GSRP; however, if the Massachusetts siting authorities approve this alignment, CL&P then would seek approval from the Siting Council to construct and operate the 5.4-mile portion of this alignment in Connecticut. Accordingly, Section M.5 provides baseline environmental information regarding both the 5.4-mile overhead 345-kV alignment for this route, as well as for an underground cable route variation that has been identified as an option to avoid the location of a new 345-kV overhead line near areas of dense residential development along a portion of the overhead route.

Aerial map sheets depicting the environmental characteristics along each of these alternative routes are included in Volumes 9 and 11.

No alternative routes were identified for the MMP because, as discussed in Section H, the proposed MMP will involve a circuit separation located entirely on CL&P's existing 2.2-mile ROW between Manchester Substation and Meekville Junction. Any routing options to the use of this existing ROW would necessarily involve the creation of a new transmission line corridor.[1]

Information regarding the existing environmental conditions along all of these route options was collected using the same research, GIS data collection and mapping, and field methods as described in Section L.

M.1 NEWGATE ROAD UNDERGROUND LINE ROUTE VARIATION: EAST GRANBY/SUFFIELD

The Newgate Road Underground Line Route Variation would extend for about 6 miles, from Granby Junction (East Granby) to the intersection of the overhead ROW with Phelps Road (Suffield). This underground line route variation would replace a 4.6-mile section of proposed overhead 345-kV line (see Figure M-1). The underground line route variation would extend for approximately 4 miles in East Granby and 2 miles in Suffield. A key land-use feature passed by this variation would be Newgate Prison, which is listed on the National Register of Historic Places and also designated as a National Historic Landmark (a higher status because of its exceptional value to the entire country). In addition, the route would pass Viets Tavern, which is also listed on the National Register of Historic Places.

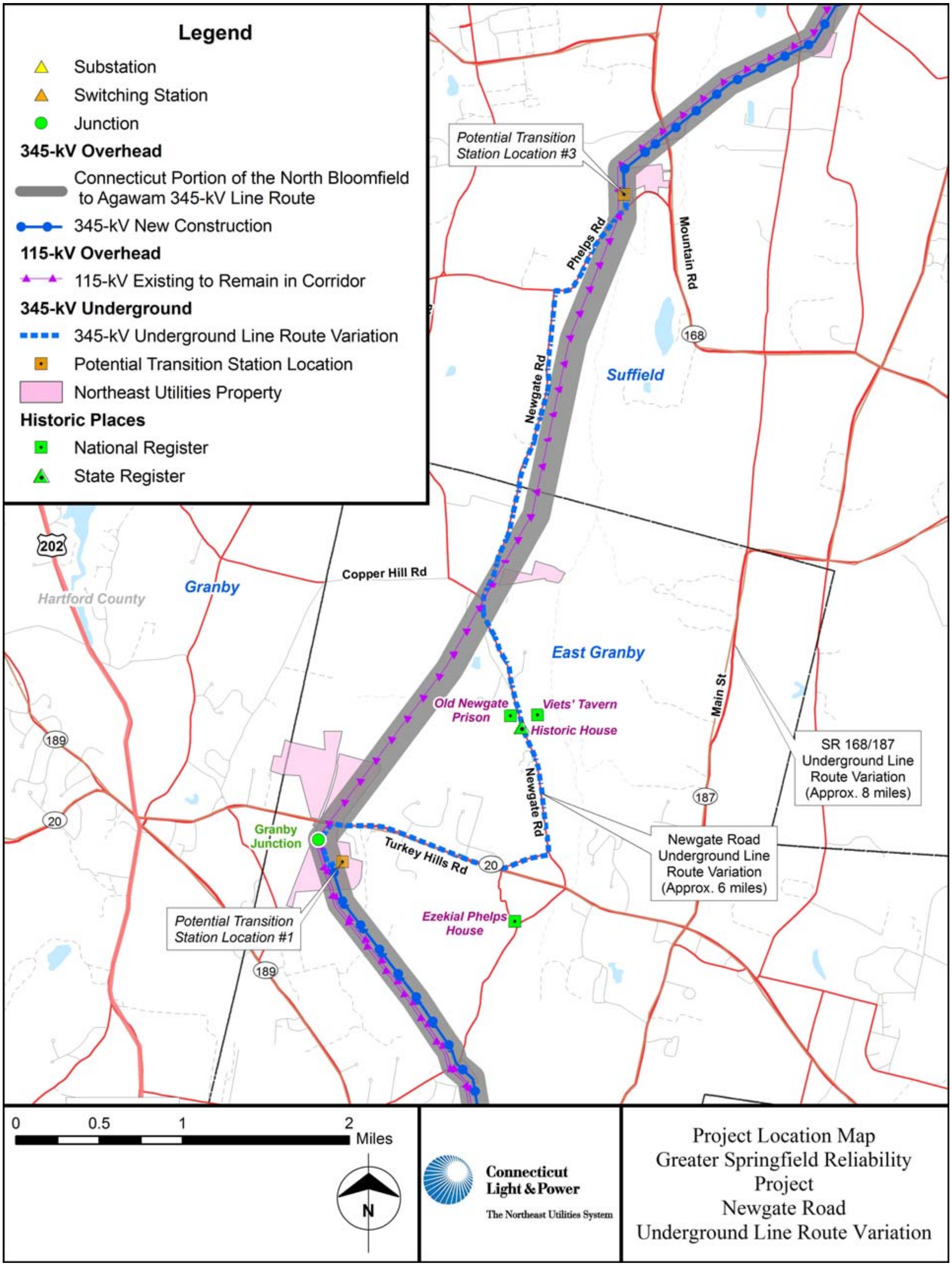
As illustrated on Figure M-1, along this variation, the underground cables would be installed within the existing overhead transmission line ROW for a short distance (approximately 1,000 feet) and then would

[1] Note: Underground variations to the 2.2-mile MMP also were not considered because the need for a continuous cable system trench/splice vaults and transition stations at either end of an underground route would require the disturbance to and development of additional land for utility purposes, causing substantially greater environmental effects than would occur if the overhead circuits were simply separated along the existing ROW as proposed.

be aligned within or near public roads (Turkey Hills Road/State Route 20, Newgate Road and Phelps Road.) Transition stations would be located adjacent and within the overhead ROW near Granby Junction and near Phelps Road, primarily on CL&P property, but also in part on private land that would have to be acquired for the Phelps Road transition station (approximately one acre).

Along the route, temporary and permanent easements from private landowners also may be required along segments of the route where the cables and/or splice vaults could not be placed within public road ROW (due to conflicts with pre-existing underground utilities).

Figure M-1 Newgate Road Underground Line Route Variation



M.1.1 Topography, Geology and Soils

Because of their proximity, the topography, soils, and geologic conditions along the Newgate Road Underground line route variations are generally the same as those described for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. The major difference between this underground line route variation and the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route is its placement underground in established public roadways. For that reason, depth to bedrock and depth to groundwater are important considerations. The details of both for each soil type are shown in Table L-1 in Section L.1.1.3. The depth to bedrock in the vicinity of the variation ranges from 20 inches below the surface to greater than 72 inches; the latter is applicable to the majority of soil types. The placement of this variation within roadways avoids the Rock Outcrop Complex soils category, except in areas where the underground duct bank and/or underground vaults would be relocated off-roadway where exposed ledge or shallow bedrock could be encountered. The depth to groundwater ranges from 1.5 feet to over 6 feet, though the majority of soil types have a depth to groundwater of over 6 feet. Because the variation is within roadways, it is unlikely that groundwater would be closer than 1.5 feet to the surface, since the original roadway construction would have presumably involved the placement of fill to establish an elevated base. Deep excavations, however, for vault installations or to excavate a bore pit or pilot hole for a horizontal directional drill (trenchless technologies) may result in encountering shallow bedrock or a shallow groundwater table.

M.1.2 Water Resources

Although the underground variation would likely be located primarily within or adjacent to road ROW, it is possible that deviations from the paved ROW may be required. In addition, approximately 1,000 feet of the variation would be aligned underground, within CL&P's existing overhead transmission line ROW. As a result, streams and wetlands were delineated and mapped adjacent to the road ROW. Tables M-1 and M-2 list the water resources along Newgate Road Underground Line Route Variation. No vernal pools were identified immediately adjacent to this underground line route variation (See Volume 9 maps).

Similarly, this underground line route variation does not traverse the 100-year floodplain boundary of any streams, based on a review of the FEMA Flood Insurance Rate Maps.

M.1.2.1 Drainage Basins and Streams

The variation is located in the same drainage basins/watersheds as the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. Compared to the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, where all waterway crossings would be spanned, the Newgate Road Underground Line Route Variation crosses more developed areas, with fewer streams, and most of the streams traversed are small and channelized. In the vicinity of the Newgate Road Underground Line Route Variation, a total of 22 streams (14 perennial and eight intermittent) were identified. As illustrated in Volumes 9 and 11, *Aerial Photographs - 400 Scale,* and *Aerial Photographs - 100 Scale*, all of the watercourse crossings along the underground alternative are adjacent to or near existing road crossings.

Table M -1. Streams Crossed Along the Newgate Road Underground Line Route Variation

Town	Series Number and Stream Name (if applicable) [1]	CL&P Stream Number	Water Quality Classification/ Fisheries Information Where Applicable[2]	Type (P/I)[3]	Comments
East Granby	S01HF001UG	S10-103	A	I	Associated with W01HF003UG
East Granby	S01HF002UG	S10-104	A	I	Associated with W01HF004UG
East Granby	S01HF003UG	S10-106	A	I	Associated with W01HF005UG
East Granby	S01HF004UG	S10-105	A	P	Associated with W01HF006UG
East Granby	S01HF005UG	S10-107	A	I	Associated with W01HF007UG
East Granby	S01HF006UG	S10-108	A	P	Associated with W01HF012UG
East Granby	S01HF007UG	S10-109	A	P	Associated with W01HF009UG
East Granby	S05HD001UG	S11-119	A	P	Receives drainage from S05HD002 Unnamed stream
East Granby	S05HD002UG	S11-120	A	P	Discharges to S05HD001
East Granby	S05HD003UG	S11-121	A	I	Discharges to S05HD004 Unnamed stream
East Granby	S05HD004UG	S11-122	A	I	Receives drainage from S05HD003 Unnamed stream
East Granby	S05HD005UG	S11-123	A	P	Associated with W05HD001 Discharges to S006 Unnamed stream
East Granby	S05HD006UG	S11-124	A	P	Associated with W05HD002 Receives drainage from S005 Unnamed stream
Suffield	S05HD007UG	S11-126	A	I	Connected via culvert under Newgate Road to S008 Unnamed stream
Suffield	S05HD008UG	S11-125	A	I	Connected via culvert under Newgate Road to S007 Unnamed stream
Suffield	S05HD009UG	S11-127	A	P	Discharges to S010 under Newgate Road Unnamed stream

Town	Series Number and Stream Name (if applicable) [1]	CL&P Stream Number	Water Quality Classification/ Fisheries Information Where Applicable[2]	Type (P/I)[3]	Comments
Suffield	S05HD010UG	S11-128	A	P	Receives drainage from S009 Unnamed stream
Suffield	S05HD011UG	S11-129	A	P	Discharges to W05HD003 Unnamed stream
Suffield	S05HD012UG	S11-130	A	P	Discharges to S011 Unnamed stream
Suffield	S05HD013UG	S11-133	A	P	Discharges to S014 Unnamed stream
Suffield	S05HD014UG	S11-131	A	P	Receives drainage from S013 and Discharges to S015 Unnamed stream
Suffield	S05HD015UG	S11-132	A	P	Receives drainage from S014 Unnamed stream

1. Series Number and CL&P Number represent the same resource. Series Number refers to waterbody numbers designated during GPS Survey and in the ENSR reports (Volume 2) and illustrated on the aerial photographs in Volume 9. The CL&P Number refers to numbers designated for mapping conventions.

2. Data obtained from hard copy CT DEP map entitled Water Quality Classification, Connecticut River and Southcentral Coastal Basins, Adopted February 1993.

3. P=Perennial/I=intermittent (stream designations).

M.1.2.2 Wetlands

In the vicinity of the Newgate Road Underground Line Route Variation, a total of 13 wetlands were identified. No vernal pools were identified during field investigations. These wetlands are listed in Table M-2 *(List of Wetlands Along The Newgate Road Underground Line Route Variation.)*

Table M -2. List of Wetlands Along The Newgate Road Underground Line Route Variation

Wetland Series Number[1]	CL&P Wetland Number	Town	Wetland Class[2]
W01HF003UG	W10-268	East Granby	PSS
W01HF004UG	W10-269	East Granby	PSS
W01HF005UG	W10-270	East Granby	PSS
W01HF006UG	W10-271	East Granby	PSS
W01HF007UG	W10-272	East Granby	PSS
W01HF008UG	W10-273	East Granby	PFO
W01HF009UG	W10-276	East Granby	PSS
W01HF010UG	W10-274	East Granby	PFO
W01HF012UG	W10-275	East Granby	PSS
W05HD001UG	W11-308	East Granby	PFO
W01HF003UG	W11-309	East Granby	PFO
W05HD003UG	W11-310	Suffield	PFO
W05HD004UG	W11-311	Suffield	PFO

1. Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated for mapping convention;
2. Wetlands classification according to Cowardin et al 1979; PEM = Palustrine Emergent Wetland; PFO – Palustrine Forested Wetland; PSS = Palustrine Scrub-Shrub Wetland

M.1.2.3 Groundwater Resources and Public Water Supplies

Many of the residents of the Town of East Granby receive their water through private wells, and the Salmon Brook District and Aquarion Water Company supply groundwater to residents and businesses in the town center. The Connecticut Water Company provides water to the Town of Suffield from one of 90 groundwater sources and 20 reservoirs. Table L-3 in Section L summarizes Connecticut's Water Use Goals as identified by the CT DEP. The surface waters crossed by or in the vicinity of the Newgate Road Underground line route variation have been given a classification of Class A. The groundwater areas crossed by and/or in the vicinity of the Newgate Road Underground Line Route Variation have been classified as GB. No public wells, aquifer protection public supply wells, or Connecticut Aquifer Protection Areas are crossed by or within the vicinity of the Newgate Road Underground Line Route Variation. The approximate depth of water tables for each soil type in the vicinity of the variation is provided in Section L, Subsection L.1.1.3, Table L-1. In general, the depth to groundwater ranges from

1.5 feet to over 6 feet, though the majority of soil types have a depth to groundwater of over 6 feet. Because the variation is within roadways, it is unlikely that groundwater would be closer than 1.5 feet to the surface beneath the public roadway.

M.1.3 Biological Resources

The following sections discuss the vegetative and wildlife communities found along the underground variation. Because no vernal pools were identified along the Newgate Road Underground Line Route Variation, there are no amphibian breeding habitats to consider. In addition, CL&P consulted with the CT DEP concerning habitat for rare, threatened, and endangered species that may be affected during construction. In that consultation, detailed in Section L, it was decided that if construction was to occur within public roadway ROW, then no restrictions regarding rare, threatened, or endangered species would apply.

M.1.3.1 Vegetative Communities

The biological resources in the vicinity of the Newgate Road Underground Line Route Variation are similar to those identified for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

The underground line route variation is proposed for location within or adjacent to roadways. As a result, the vegetative communities near the variation are characteristic of those found along roads (that is, a mix of maintained lawns, mowed road shoulders, and – within the road setback – forested areas. In general, along the Turkey Hills Road portion of the variation in East Granby, the nearby vegetation is characterized by residential lawn and ornamental vegetation, interspersed with open forested land. To the northeast, the route follows the existing road network (Old Road) through a forested area. Continuing along Newgate Road, the variation crosses through rural areas characterized predominately by forested lands and residential areas with lawn/ornamental vegetation.

During the field surveys of the underground routes, ENSR identified a potential specimen red oak tree (approximately 9.5-foot diameter at breast height (DBH)) located at the intersection of Turkey Hills Road and Old Road, on the south side of Old Road. This oak tree may potentially qualify as a Connecticut Notable Tree or possibly a Connecticut Champion Tree. Established in 1985, the Notable Tree Project collects and distributes information about Connecticut's largest and most historic trees, both native and introduced. It is a volunteer enterprise sponsored by the Connecticut Botanical Society, The Connecticut College Arboretum, and the Connecticut Urban Forest Council.

Underground construction in the vicinity of the potential specimen tree identified by ENSR may adversely affect its root system and therefore the health of the tree. If this route were chosen, care would be taken to avoid major roots to the extent practical. However, it would be difficult to determine the extent of the root system beneath the road prior to excavation. Excavation activities, however, would occur beneath the drip line of the tree and would encounter the root systems.

M.1.3.2 Wildlife

The wildlife communities in the vicinity of the Newgate Road Underground Line Route Variation can be expected to be similar to those identified for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

M.1.4 Existing Land Use

M.1.4.1 Overall Land Use Patterns: Statutory Facilities

The Newgate Road Underground Line Route Variation begins near Granby Junction in East Granby and traverses east along Turkey Hills Road (State Route 20), which is bordered by homes. The variation diverges from State Route 20 at Old Road, and then continues north along Newgate Road, which is bordered predominantly by forested areas and several homes. In addition, the route follows Newgate Road past the Newgate Prison and a trailhead to the Newgate Wildlife Management Area (WMA.) Continuing in a northeasterly direction, the variation crosses the overhead transmission line west of

Woodledge Drive and east of Copper Hill Terrace. Newgate Road parallels the existing overhead transmission line, crossing the intersection of Newgate Road and Wyncairn Road and continues on to the north through areas that are predominantly forested with some residences. The variation continues east and then north along Phelps Road to an interconnection with the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

Overall, land uses adjacent to the route variation consist primarily of a mix of forested and agricultural lands, with some associated suburban/rural residential uses. There are groups of homes located along Turkey Hills Road and Newgate Road that the Council may determine to be a "residential area." As of Summer 2008, there were no other potential "residential areas" and no private or public schools, licensed child day-care facilities, licensed youth camps, or public playgrounds along the route of the Newgate Road Underground Line Route Variation.

M.1.4.2 Residential Uses

Residential uses near the underground variation range from single-family, low-density residential developments to rural and agricultural areas. The aerial photographs in Volumes 9 and 11 provide further information about development in the vicinity of the variation.

M.1.4.3 Parks, Open Space, Recreational and Public Trust Lands

The Newgate Road Underground Line Route Variation traverses in the vicinity of several of the same recreational and scenic areas as the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, including the Newgate WMA, Fox Run at Copper Hill Golf Course, the Suffield Sportsman's Association, and the Spencer Woods WMA. However, near these areas, the underground variation would be located within or adjacent to existing public roadways.

M.1.5 Transportation Systems and Utility Crossings

The Newgate Road Underground Line Route Variation would be aligned within or adjacent to the state and local roads, including State Route 20, Old Road, and Newgate Road. Other roads that intersect the variation include Coppergate, Woodledge, and Copper Hill Road in East Granby, as well as Phelps Road in Suffield (refer to Volumes 9 and 11).

M.1.6 Cultural (Archaeological and Historic) Resources

The regional cultural resource information presented for the proposed overhead line route (Section L) also is applicable to the Newgate Road Underground Line Route Variation. In addition, however, the variation traverses near several National Registers of Historic Places (NRHP) sites, including Old Newgate Prison and Copper Mine. These significant cultural resources, which are described further in the *Historical and Archaeological Assessment of Connecticut Sections of the Connecticut Light & Power Company Greater Springfield Reliability Project* in Volume 3, include:

- Three poorly-defined Native American archaeological sites are known to occur within approximately one mile of the Newgate Road Underground Line Route Variation. All of these sites appear to be eligible for the NRHP.
- Three significant and closely-associated EuroAmerican resources, with above- and below ground components, are located very near or immediately adjacent to the variation along approximately 1000 feet of Newgate Road:
  - Old Newgate Prison and Copper Mine are listed on the NRHP and also designated as a National Historic Landmark (a higher status because of its exceptional value to the entire country). The Newgate Prison is nationally significant as the first prison in what became the United States operated by a state-level government. The prison operated from 1773-1782 and 1790-1827. Below the prison was the largest mine opened in the early 18th century.
  - Viets Tavern, listed on the NRHP.

- Viets Cemetery, used in 1777 and 1810 and subject to protection under C.G.S. Section 19a-315 as an ancient burying ground.

In the vicinity of these resources, the variation traverses areas where bedrock is very close to the surface. Some components at the prison site are structurally unstable and subject to potential effects of rock removal for underground construction.

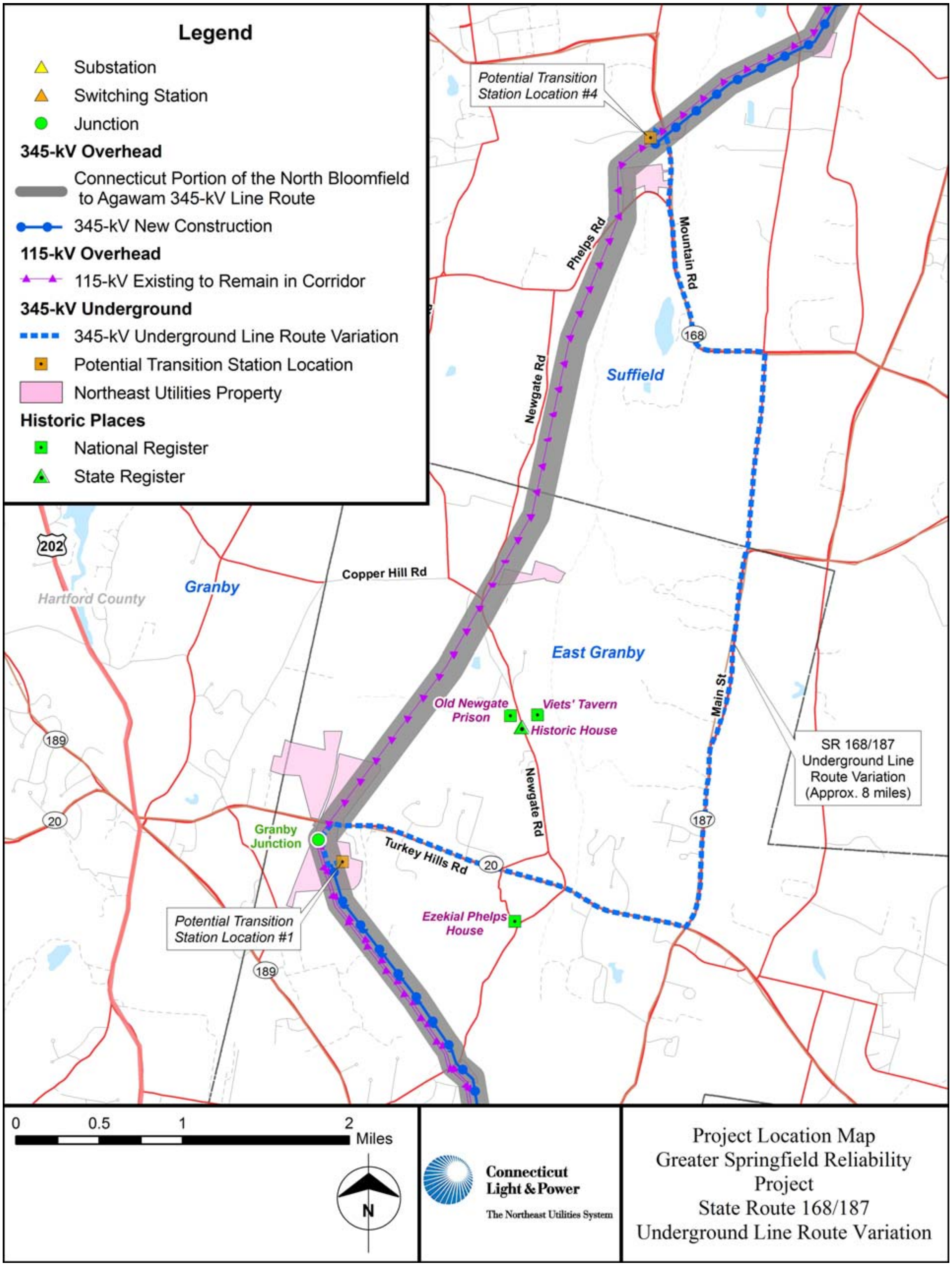
M.1.7 Air Quality

Air quality for the Newgate Road Underground Line Route Variation is generally the same as that found along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and is described in Section L.

M.2 STATE ROUTE 168/187 UNDERGROUND LINE ROUTE VARIATION: EAST GRANBY/SUFFIELD

The State Route 168/187 Underground Variation would extend for about 8 miles, starting at Granby Junction, where the Newgate Road Underground Line Route Variation would also begin, but would end farther north, reconnecting to the proposed overhead transmission line ROW at the intersection of Mountain Road (Suffield) (see Figure M-2). The route variation would extend for approximately 5 miles in East Granby and 3 miles in Suffield. This variation would extend along Turkey Hills Road (State Route 20), North Main Street, South Stone Street (State Route 187), and Mountain Road (State Route 168).

Figure M-2 State Route 168/187 Underground Line Route Variation



M.2.1 Topography, Geology, and Soils

Because of their proximity, the topography, soils, and geologic conditions along the State Route 168/187 Underground Line Route Variation are generally the same as those described for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. Similar to the discussion presented in Subsection M.1.1, the major difference between this variation and the proposed overhead line route is its placement underground in established public roadways. The depth to bedrock in the vicinity of the variation ranges from 20 inches below the surface to greater than 72 inches; the latter is applicable to the majority of soil types. The placement of this variation within roadways avoids the Rock Outcrop Complex soils category, except in areas where the underground duct bank and/or underground vaults would be relocated off-roadway where exposed ledge or shallow bedrock could be encountered. The depth to groundwater ranges from 1.5 feet to over 6 feet, though the majority of soil types have a depth to groundwater of over 6 feet. Because the variation is within roadways, it is unlikely that groundwater would be closer than 1.5 feet to the surface, since the original roadway construction would have presumably involved the placement of fill to establish an elevated base. Deep excavations, however, for vault installations or to excavate a bore pit or pilot hole for a horizontal directional drill (trenchless technologies), may result in encountering shallow bedrock or a shallow groundwater table.

M.2.2 Water Resources

Although the underground line route variation would likely be located primarily within or adjacent to road ROW, it is possible that deviations from the paved ROW may be required. As a result, streams and wetlands were delineated and mapped adjacent to the road ROW. As illustrated in Table M-3 and Table M-4, a total of 16 water bodies and 42 wetlands were delineated along the State Route 168/187 Underground Line Route Variation.

M.2.2.1 Drainage Basins and Streams

In the vicinity of the State Route 168/187 Underground Line Route Variation, a total of 16 streams were crossed, including 12 perennial and four intermittent streams. A list of these streams along with their water quality designations can be found in Table M-3. The variation is located in the same drainage basins/watersheds as the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. All overhead waterway crossings would be spanned; the underground variation crosses more developed areas where existing streams have been channelized and/or diverted through culverts by past roadway construction. Many of the streams that are traversed along the underground route generally are small and channelized. However, the narrow work corridor along the existing roadway would not preclude the option of open-trench excavation to cross the streams, and/or replacement of the existing culverts post-conduit installation. The State Route 168/187 Underground Line Route Variation crosses Muddy Brook, Holcomb Brook, Creamery Brook, Austin Brook, and Stony Brook. Of these watercourses, only Stony Brook is stocked with trout by CT DEP for recreational fishing in the vicinity of the variation. As illustrated in Volumes 9 and 11, *Aerial Photographs - 400 Scale,* and *Aerial Photographs - 100 Scale*, all of the watercourse crossings along the underground route variation are adjacent to or near existing road crossings. The approximate depth of water tables is provided in Section L, Subsection L.1.1.3, Table L-1.

Table M -3. Streams Crossed Along the State Route 168/187 Underground Line Route Variation

Town	Series Number and Stream Name (if applicable)[1]	CL&P Stream Number	Water Quality Classification/ Fisheries Information Where Applicable[2]	Type (P/I)[3]	Comments
East Granby	S01HF001UG/ Muddy Brook	S10-103	A	P	Associated with W01HF003UG
East Granby	S01HF002UG/ Muddy Brook	S10-104	A	P	Associated with W01HF004UG
East Granby	S01HF003UG /Muddy Brook	S10-106	A	P	Connected to S01HF004UG via culvert under Route 20
East Granby	S01HF004UG /Muddy Brook	S10-105	A	P	Associated with W01HF006UG

Town	Series Number and Stream Name (if applicable)[1]	CL&P Stream Number	Water Quality Classification/ Fisheries Information Where Applicable[2]	Type (P/I)[3]	Comments
East Granby	S01HF005UG	S10-107	A	I	Associated with W01HF007UG Unnamed stream
East Granby	S01HF006UG /Holcomb Brook	S10-108	A	P	Associated with W01HF012UGconnected to S01HF009UG via culvert under Route 20
East Granby	S01HF007UG /Holcomb Brook	S10-109	A	P	Associated with W01HF009UG
East Granby	S01HF008UG /Creamery Brook	S10-111	A	P	Associated with W01HF019UG connected to S01HF009UG via culvert under Route 20
East Granby	S01HF009UG /Creamery Brook	S10-110	A	P	Associated with W01HF024
East Granby	S01HF010UG /Creamery Brook	S10-113	A	P	Associated with W01HF021UG and W01HF026UG connected via culvert under Route 187
East Granby	S01HF010aUG	S10-112	A	P	Creamery Brook
East Granby	S01HF011UG	S10-114	A	I	West side of Route 187 west of W01HF28UG Unnamed stream
East Granby	S01HF012UG /Austin Brook	S10-115	A	P	Associated with W01HF025UG connected to S01HF013UG via culvert under Route 187
East Granby	S01HF013UG /Stony Brook	S10-116	A	P	Associated with W01HF030UG
Suffield	S01HF014UG	S10-118	A	I	Associated with W01HF027UG connected to S01HF015UG via culvert under Route 168 Unnamed stream
Suffield	S01HF015UG	S10-117	A	I	Associated with W01HF034UG Unnamed stream

1. Series Number and CL&P Number represent the same resource. Series Number refers to waterbody numbers designated during GPS Survey and in the ENSR reports (Volume 2) and illustrated on the aerial photographs in Volume 9. The CL&P Number refers to numbers designated for mapping conventions.
2. Data obtained from hard copy CT DEP map entitled Water Quality Classifications, Connecticut River and Southcentral Coastal Basins, Adopted February 1993.
3. P = perennial / I = intermittent (stream designations).

M.2.2.2 Wetlands

In the vicinity of the State Route 168/187 Underground Line Route Variation, a total of 42 wetlands were identified. No vernal pools were identified. These wetlands are listed in Table M-4 *(List of Wetlands Along The State Route 168/187 Underground Line Route Variation)*.

Table M -4. List of Wetlands Along the State Route 168/187 Underground Line Route Variation

Wetland Series Number[1]	Northeast Utilities Wetland Number	Town	Wetland Class[2]	Comments
W01HF001	W9-244	East Granby	PSS/PFO	Ties to W01HF001
W01HF002	W9-245	East Granby	PSS/PFO	Ties to W07HF001
W01HF003UG	W10-268	East Granby	PFO	Associated with S01HF001UG
W01HF004UG	W10-269	East Granby	PFO	Associated with S01HF002UG
W01HF005UG	W10-270	East Granby	PEM	Associated with S01HF003UG
W01HF006UG	W10-271	East Granby	PEM/PFO	Associated with S01Hf004UG
W01HF007UG	W10-272	East Granby	PFO	Associated with S01HF005UG
W01HF008UG	W10-273	East Granby	PFO	--
W01HF009UG	W10-276	East Granby	PEM	Associated with S01HF007UG
W01HF010UG	W10-274	East Granby	PFO	--
W01HF011UG	W10-279	East Granby	PEM	--
W01HF012UG	W10-275	East Granby	PSS	Associated with S01HF006UG
W01HF013UG	W10-280	East Granby	PFO	--
W01HF014UG	W10-277	East Granby	PFO	--
W01HF015UG	W10-282	East Granby	PFO	--
W01HF016UG	W10-278	East Granby	PEM	--
W01HF017UG	W10-285	East Granby	PSS	--
W01HF018UG	W10-281	East Granby	PSS/PEM	--
W01HF019UG	W10-286	East Granby	PEM	Associated with S02HF008UG
W01HF020UG	W10-283	East Granby	PFO	
W01HF021UG	W10-289	East Granby	PFO	Associated with S01HF010UG
W01HF022UG	W10-284	East Granby	PFO	--
W01HF023UG	W10-291	East Granby	PFO/PSS	--
W01HF024UG	W10-287	East Granby	PFO	Associated with S01HF009UG
W01HF025UG	W10-293	East Granby	PEM	Associated with S01HF012UG
W01HF026UG	W10-288	East Granby	PSS/PEM	Associated with S01UG010UG
W01HF027UG	W10-296	Suffield	PFO	Associated with S01HF014UG
W01HF028UG	W10-290	Suffield	PFO	--
W01HF029UG	W10-297	Suffield	PEM	--
W01HF030UG	W10-292	Suffield	PEM	Associated with S01HF013UG
W01HF031UG	W10-300	Suffield	PEM	--
W01HF032UG	W10-294	Suffield	PEM/OW	Man-made farm-pond
W01HF033UG	W10-301	Suffield	PSS/PFO	--
W01HF034UG	W10-295	Suffield	PFO	Associated with S01HF015UG
W01HF035UG	W10-303	Suffield	PFO	Associated with man-made drainage swale
W01HF036UG	W10-298	Suffield	PEM	Maintained wet meadow
W01HF037UG	W10-304	Suffield	PFO/PSS	--
W01HF038UG	W10-299	Suffield	PSS/PEM	--

Wetland Series Number[1]	Northeast Utilities Wetland Number	Town	Wetland Class[2]	Comments
W01HF039UG	W10-305	Suffield	PFO	--
W01HF040UG	W10-302	Suffield	PFO	--
W01HF041UG	W10-306	Suffield	PSS	--
W01HF042UG	W10-307	Suffield	PFO	--

1. Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated for mapping convention;
2. Wetlands classification according to Cowardin et al 1979; PEM = Palustrine Emergent Wetland; PFO – Palustrine Forested Wetland; PSS = Palustrine Scrub-Shrub Wetland

M.2.2.3 Groundwater Resources and Public Water Supplies

The public water supplies for the State Route 168/187 Underground Line Route Variation are the same as those for the Newgate Road Underground Line Route Variation and are described in Section M.1.2.3. Table L-3 in Section L summarizes Connecticut's Water Use Goals as identified by the CT DEP. The majority of the surface waters crossed by or in the vicinity of the State Route 168/187 Underground Line Route Variation have been given a classification of A, and the groundwater areas have been classified as GB. No public wells, or Connecticut Aquifer Protection Areas are crossed by or within the vicinity of the proposed State Route 168/187 Underground Line Route Variation. The depth to groundwater ranges from 1.5 feet to over 6 feet, though the majority of soil types have a depth to groundwater of over 6 feet. Because the variation is within roadways, it is unlikely that groundwater would be closer than 1.5 feet to the surface beneath the public roadway.

M.2.2.4 Flood Zones

FEMA, which classifies flood zones for insurance and floodplain management purposes, has prepared maps that designate certain areas according to the frequency of flooding. An area within the 100-year flood designation is expected to flood at least once every 100 years. The FEMA floodplain boundaries for watercourses along the route variation are depicted on the maps in Volume 11 *Aerial Photographs - 100 Scale*. The Route 168/187 Underground Line Route Variation traverses the 100-year flood boundary of Creamery Brook, Austin Brook, and Stony Brook.

M.2.3 Biological Resources

The following sections discuss the vegetative and wildlife communities found along the underground variation. Because no vernal pools were identified along the State Route 168/187 Underground Line Route Variation, there are no amphibian breeding habitats to consider. In addition, CL&P consulted with the CT DEP concerning habitat for rare, threatened, and endangered species that may be affected during construction. In that consultation, detailed in Section L, it was decided that if construction was to occur within public roadway ROW, then no restrictions regarding rare, threatened, or endangered species would apply.

M.2.3.1 Vegetative Communities

The vegetative communities in the vicinity of the State Route 168/187 Underground Line Route Variation are similar to those identified for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, except that the vegetative habitats along the road ROW are affected by road maintenance activities (e.g., mowing along road shoulders), as well as by proximity to residential areas that are characterized by maintained lawns and ornamental vegetation.

The State Route 168/187 Underground Line Route Variation begins near Granby Junction in East Granby and extends to the east along Turkey Hills Road, which is characterized by residential development interspersed with open forested land. It then continues to the north along State Route 187 and northwest along State Route 168 in a rural area characterized by forested areas and residences.

M.2.3.2 Wildlife Communities

The wildlife communities in the vicinity of the State Route 168/187 Underground Line Route Variation can be expected to be similar to those identified for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

M.2.4 Existing Land Use

M.2.4.1 Overall Land Use Patterns

The State Route 168/187 Underground Line Route Variation would commence north of Granby Junction in East Granby and would traverse in an easterly direction, along Turkey Hills Road (State Route 20), which in this area is bordered predominantly by residential and forested areas. The variation would diverge to the north from State Route 20, following North Main Street/State Route 187. The land use in this area is characterized by forested and agricultural areas, with limited residential neighborhoods. The variation would traverse past the East Granby Farms Recreation Area, a town park overseen by the East Granby Parks and Recreation Commission, and would continue along North Main Street/State Route 187 until crossing into Suffield. In Suffield, the variation would extend north along Stone Street before heading west along Mountain Road. The area surrounding Mountain Road is characterized predominantly by densely forested areas, along with some agricultural land. As Mountain Road bends to the north, it passes Sunrise Park, Sunrise Park Cub Scout Day Camp, Alcorn Wildlife Preserve, and Spencer Woods Wildlife Preserve before connecting with the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

Land uses adjacent to this route variation consist primarily of a mix of forested and suburban/rural residential uses. With respect to proximity to statutory facilities, at this time the variation traverses along roads that border residential areas, as well as near the camps and parks described above.

M.2.4.2 Residential Uses

Residential uses in the vicinity of the State Route 168/187 Underground Line Route Variation range from single-family, low-density residential developments to rural and agricultural areas. The aerial photographs in Volumes 9 and 11 provide further information about residential land use in the vicinity of the proposed variation.

M.2.4.3 Parks, Open Space, Recreation, and Public Trust Lands

The State Route 168/187 Underground Line Route Variation travels in the vicinity of several of the same recreational and scenic areas as the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, including the Metacomet Trail, the Alcorn Wildlife Preserve, the East Granby Farms Recreation Area and the Spencer Woods Wildlife Preserve. In addition, the variation travels adjacent to Sunrise Park, which includes the Sunrise Park Scout Day Camp. Sunrise Park consists of land overseen by the Suffield Conservation Commission and offers passive recreational activities including walking trails and activities associated with White's Pond, located inside the park.

M.2.5 Transportation Systems and Utility Crossings

The State Route 168/187 Underground Line Route Variation would be aligned along and would intersect several state and local roads. In addition to State Route 168, these include State Routes 20 and 187, as well as Randall Avenue, Horseshoe Drive, Holcomb Street, Metacomet Drive, Center Street, and Creamery Brook in East Granby and Stone Street and Mountain Road in Suffield (refer to Volumes 9 and 11, *Aerial Photographs – 400 Scale and Aerial Photographs – 100 Scale,* and to Volume 9 *Overview of Route on USGS Map*).

M.2.6 Cultural (Archaeological and Historic) Resources

State Route 168/187 Underground Line Route Variation traverses near several NRHP sites, including:

- Four Native American archaeological sites are known to occur within approximately one mile of the Route 168/187 Underground Line Route Variation, all of which appear to be seasonal hunting or fishing sites used from Late Archaic to Woodland periods. One is approximately 400 feet from the underground route. None appear to be eligible for the NRHP.
- Two EuroAmerican archaeological sites have been reported adjacent to the underground route along Route 20 west of the center of East Granby, a tenant farmhouse and a cigar shop with related house. Both were determined eligible for, and one was listed on, the NRHP. Because of

on-going road reconstruction, the tenant farmhouse site was protected with fill, and the cigar shop/house was destroyed after archaeological mitigation.

- Two other significant historic resources were identified within approximately 500 feet of the route variation. A 500-foot distance from the underground route was considered, rather than 0.25 mile (as described for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route), because the underground facilities would be installed within or adjacent to roads and thus would have no potential for effects on historic resources outside of those in the immediate vicinity. (For example, the underground cable would not be visible after installation and thus would not affect the visual context of historic resources). The 500-foot distance was chosen to plan for any necessary protective measures against blasting effects. The resources include the large East Granby Historic District, listed on the NRHP, and the East Granby Center Cemetery which is part of the district and also subject to protection under C.G.S. Section 19a-315 as an ancient burying ground.

M.3 4.6-MILE IN-ROW UNDERGROUND LINE ROUTE VARIATION

This section describes the environmental features along the underground line route variation that would extend for 4.6 miles and would be placed within the same existing ROW as the Connecticut Portion of the Bloomfield to Agawam 345-kV line. Because this variation is a subsection of the overhead ROW, those sections that are the same as the GSRP route (i.e. noise, air quality, etc.), are not repeated in the following environmental description.

The underground line segment in this variation is an alternative to both the Newgate Road Underground Line Route Variation and the State Route 168/187 Line Route Variation discussed in the previous sections as it would essentially replace the same segment of overhead transmission lines. The 4.6-Mile In-ROW Underground Line Route Variation would begin at Granby Junction and extend north within the existing overhead transmission line ROW to a transition station site that has been identified north of Phelps Road in Suffield.

M.3.1 Topography, Geology, and Soils

Because this variation would be placed within a section of the same existing overhead ROW as the Connecticut Portion of the North Bloomfield to Agawam 345-kV line ROW, the topography, geology, and soils found along both routes would be the same. The major difference with this variation is its placement underground in established overhead ROW. For that reason, depth to bedrock and depth to groundwater are important considerations. The details of both for each soil type are shown in Table L-1 in Section L.1.1.3. The depth to bedrock in the vicinity of the variation ranges from rock outcrop in which bedrock ranges from the surface to greater than 72 inches below the surface; the latter is applicable to the majority of soil types. The depth to groundwater ranges from 0.5 feet to over 6 feet, though the majority of soil types have a depth to groundwater of over 6 feet.

M.3.2 Water Resources

The underground line route variation would be located within a section of the same existing overhead ROW as the Connecticut Portion of the North Bloomfield to Agawam 345-kV line. The watercourses and wetlands for this variation are therefore identical to those along the corresponding section of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. Table M-5 and M-6 list the water resources along 4.6-mile In-ROW Underground Line Route Variation.

M.3.2.1 Drainage Basins and Streams

The variation is located in the same drainage basins/watersheds as the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. In the vicinity of the 4.6-mile In-ROW Underground Line Route Variation, a total of eight streams (three perennial and five intermittent) were identified. These watercourses are illustrated in Volumes 9 and 11, *Aerial Photographs - 400 Scale,* and *Aerial Photographs - 100 Scale*.

Table M -5. Watercourses Traversed along the 4.6-Mile In-ROW Underground Line Route Variation

Municipality	Series Number[1] and Name where Applicable	CL&P Stream Number	Water Quality / Fisheries Classification Where Applicable[2]	Type (P or I)[3]	Comments
East Granby	S01HF001A	S9-91	A	P	Associated with W01HF001
East Granby	S01HF001	S9-92	A	P	Associated with W01HF007
East Granby	S01HF002	S9-93	A	P	Associated with W01HF008
East Granby	S01HF003	S9-94	A	I	Associated with W01HF013
East Granby	S01HF004	S9-95	A	I	Associated with W01HF013
Suffield	S01HF005	S9-96	A	I	Associated with W01HF014
Suffield	S01HF006	S9-97	A	I	Associated with W01HF016
Suffield	S01HF007	S9-98	A	I	

1. Series Number and CL&P No. represent the same resource. Series Number refers to waterbody numbers designated during GPS Survey and in the ENSR reports (Volume 2) and illustrated on the aerial photographs in Volume 9. The CL&P Number refers to numbers designated for mapping conventions.

2. Data obtained from hard copy CT DEP map entitled Water Quality Classifications, Connecticut River and Southcentral Coastal Basins, Adopted February 1993.

3. P = perennial / I = intermittent (stream designations).

M.3.2.2 Wetlands

In the vicinity of the 4.6-mile In-ROW Underground Line Route Variation, a total of 18 wetlands were identified. These wetlands are listed in Table M-6 *(List of Wetlands along the 4.6-Mile In-ROW Underground Line Route Variation).*

Table M -6. List of Wetlands along the 4.6-Mile In-ROW Underground Line Route Variation

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Wetland Class[2]
East Granby	W07HF001	W9-243	PSS
East Granby	W01HF001	W9-244	PFO/PSS
East Granby	W01HF002	W9-245	PFO
East Granby	W01HF003	W9-246	PFO/PEM
East Granby	W01HF004	W9-248	PSS/PFO
East Granby	W01HF005	W9-247	PEM
East Granby	W01HF006	W9-249	PSS/PFO
East Granby	W01HF007	W9-250	PSS/PFO
East Granby	W01HF008	W9-251	PFO
East Granby	W01HF009	W9-252	PEM
East Granby	W01HF010	W9-253	PFO/PEM
East Granby	W01HF011	W9-254	PEM/PSS
East Granby	W01HF012	W9-255	PEM/PSS
East Granby	W01HF013	W9-256	PEM/OW
East Granby/Suffield	W01HF014	W9-257	PFO/PEM
Suffield	W01HF015	W9-258	PFO
Suffield	W01HF016	W9-259	PFO/PSS
Suffield	W01HF017	W9-260	PSS/PFO

1. Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated for mapping convention;

2. Wetlands classification according to Cowardin et al 1979; PEM = Palustrine Emergent Wetland; PFO = Palustrine Forested Wetland; PSS = Palustrine Scrub-Shrub Wetland; OW = Open water.

M.3.2.3 Groundwater Resources and Public Water Supplies

Potable water along and adjacent to the 4.6-mile In-ROW Underground Line Route Variation is the same as found along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. In general, the depth to groundwater ranges from 0.5 feet to over 6 feet below the surface, though the majority of soil types have a depth to groundwater of over 6 feet. Table L-1 in Section L.1.1.3 lists the specific depth to groundwater for each soil type.

M.3.3 Biological Resources

The vegetative and wildlife communities found along the 4.6-Mile In-ROW Underground Line Route Variation are the same as those found along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. The variation traverses the same wildlife management areas as the GSRP route.

M.3.3.1 Amphibians

Amphibian breeding habitat for the 4.6-Mile In-ROW Underground Line Route Variation is the same as the corresponding section of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. Five vernal pools were found during field investigation, and they are listed in Table M-7.

Table M -7. Vernal Pool Habitat Associated with the 4.6-Mile In-ROW Underground Line Route Variation

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Observed Obligate Species[2]
East Granby	W07HF001	W9-243	spotted salamander, wood frog
East Granby	W01HF001	W9-244	spotted salamander, wood frog
East Granby	W01HF006	W9-249	spotted salamander, fairy shrimp
East Granby	W01HF010	W9-253	wood frog
East Granby/Suffield	W01HF014	W9-257	Potential Vernal Pool (off of ROW)

[1]: Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GSP Survey of wetlands. The CL&P wetland number was generated for mapping convention;
[2]: Vernal Pool Species observed confirming vernal pool/amphibian habitat.

M.3.3.2 Rare, Threatened and Endangered Species

Along the 4.6-Mile In-ROW Underground Line Route Variation are two state-listed species, the Eastern box turtle and the Eastern pearlshell mussel. See Section L.1.3.6 for a discussion of these species.

M.3.4 Existing Land Use

The 4.6-Mile In-ROW Underground Line Route Variation would begin near Granby Junction south of Turkey Hills Road and extend north passing the Newgate Wildlife Management Area, Metacomet Trial, the Farmington Valley Greenway, Suffield Sportsman's Association, Spenser Woods Wildlife Preserve, and the Fox Run Golf Course. See Section L.1.4 for a description of these resources and a description of the land use along this section of ROW. The variation continues into Suffield and ends at a potential transition station site located north of Phelps Road.

M.4 3.6-MILE IN-ROW UNDERGROUND LINE ROUTE VARIATION

This section describes the environmental features along the underground variation that would extend for 3.6 miles and would be placed within the existing ROW. Because this variation is a subsection of the overhead ROW, those sections that are the same as the GSRP overhead line route (i.e. noise, air quality, etc.), are not repeated in the following environmental description.

The underground line segment in this variation is an alternative to the previously described 4.6-Mile In-ROW Underground Line Route Variation and was developed to reduce the wetland effects associated with the 4.6-Mile In-ROW Underground Line Route Variation. However, the 3.6-Mile In-ROW Underground Line Route Variation would also essentially replace the same segment of overhead transmission lines as the Newgate Road Underground Line Route Variation, the State Route 168/187 Underground Line Route Variation, and the 4.6-Mile In-ROW Underground Line Route Variation. The 3.6-Mile In-ROW Underground Line Route Variation would begin at a transition station approximately 0.8 miles south of Newgate Road and extend north within the existing overhead transmission line ROW to a transition station site that has been identified north of Phelps Road in Suffield.

M.4.1 Topography, Geology, and Soils

Because this variation would be placed within a section of the same existing overhead ROW as the Connecticut Portion of the North Bloomfield to Agawam 345-kV line route ROW, the topography, geology, and soils found along both routes would be the same. The major difference with this variation is its placement underground in established overhead ROW. For that reason, depth to bedrock and depth to groundwater are important considerations. The details of both for each soil type are shown in Table L-1 in Section L.1.1.3. The depth to bedrock in the vicinity of the variation ranges from rock outcrop in which bedrock ranges from the surface to greater than 72 inches below the surface; the latter is applicable to the majority of soil types. The depth to groundwater ranges from 0.5 feet to over 6 feet, though the majority of soil types have a depth to groundwater of over 6 feet.

M.4.2 Water Resources

This underground variation would be located within a section of the same existing overhead ROW as the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. The watercourses and wetlands for this variation are therefore identical to those along the corresponding section of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. Tables M-8 and M-9 list the water resources along 4.6-Mile In-ROW Underground Line Route Variation.

M.4.2.1 Drainage Basins and Streams

The variation is located in same drainage basins/watersheds as the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. In the vicinity of the 3.6-Mile In-ROW Underground Line Route Variation, a total of seven streams (two perennial and five intermittent) were identified. These watercourse are illustrated in Volumes 9 and 11, *Aerial Photographs - 400 Scale,* and *Aerial Photographs - 100 Scale*.

Table M -8. Watercourses Traversed along the 3.6-Mile In-ROW Underground Line Route Variation

Municipality	Series Number[1] and Name where Applicable	CL&P Stream Number	Water Quality / Fisheries Classification Where Applicable[2]	Type (P or I)[3]	Comments
East Granby	S01HF001	S9-92	A	P	Associated with W01HF007
East Granby	S01HF002	S9-93	A	P	Associated with W01HF008
East Granby	S01HF003	S9-94	A	I	Associated with W01HF013
East Granby	S01HF004	S9-95	A	I	Associated with W01HF013
Suffield	S01HF005	S9-96	A	I	Associated with W01HF014
Suffield	S01HF006	S9-97	A	I	Associated with W01HF016
Suffield	S01HF007	S9-98	A	I	

1. Series Number and CL&P Number represent the same resource. Series Number refers to waterbody numbers designated during GPS Survey and in the ENSR reports (Volume 2) and illustrated on the aerial photographs in Volume 9. The CL&P Number refers to numbers designated for mapping conventions.

2. Data obtained from hard copy CT DEP map entitled Water Quality Classifications, Connecticut River and Southcentral Coastal Basins, Adopted February 1993.

3. P = perennial / I = intermittent (stream designations).

M.4.2.2 Wetlands

In the vicinity of the 3.6-Mile In-ROW Underground Line Route Variation, a total of 12 wetlands were identified. These wetlands are listed in Table M-9 *(List of Wetlands along the 3.6-Mile In-ROW Underground Line Route Variation).*

Table M -9. List of Wetlands along the 3.6-Mile In-ROW Underground Line Route Variation

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Wetland Class[2]
East Granby	W01HF006	W9-249	PSS/PFO
East Granby	W01HF007	W9-250	PSS/PFO
East Granby	W01HF008	W9-251	PFO
East Granby	W01HF009	W9-252	PEM
East Granby	W01HF010	W9-253	PFO/PEM
East Granby	W01HF011	W9-254	PEM/PSS
East Granby	W01HF012	W9-255	PEM/PSS
East Granby	W01HF013	W9-256	PEM/OW
East Granby/Suffield	W01HF014	W9-257	PFO/PEM
Suffield	W01HF015	W9-258	PFO
Suffield	W01HF016	W9-259	PFO/PSS
Suffield	W01HF017	W9-260	PSS/PFO

1. Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated for mapping convention;
2. Wetlands classification according to Cowardin et al 1979; PEM = Palustrine Emergent Wetland; PFO = Palustrine Forested Wetland; PSS = Palustrine Scrub-Shrub Wetland; OW = Open water.

M.4.2.3 Groundwater Resources and Public Water Supplies

Potable water along and adjacent to the 3.6-Mile In-ROW Underground Line Route Variation is the same as found along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. In general, the depth to groundwater ranges from 0.5 feet to over 6 feet below the surface, though the majority of soil types have a depth to groundwater of over 6 feet. Table L-1 in Section L.1.1.3 lists the specific depth to groundwater for each soil type.

M.4.3 Biological Resources

The vegetative and wildlife communities found along the 3.6-Mile In-ROW Underground Line Route Variation are the same as those found along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. The variation traverses the same wildlife management areas as the GSRP overhead line route.

M.4.3.1 Amphibians

Amphibian breeding habitat for the 3.6-Mile In-ROW Underground Line Route Variation is the same as the corresponding section of the Connecticut potion of the North Bloomfield to Agawam 345-kV Line Route. Three vernal pools were found during field investigation; these are listed in Table M-10.

Table M -10. Vernal Pool Habitat Associated with the 3.6-Mile In-ROW Underground Line Route Variation

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Observed Obligate Species[2]
East Granby	W01HF006	W9-249	spotted salamander, fairy shrimp
East Granby	W01HF010	W9-253	wood frog
East Granby/Suffield	W01HF014	W9-257	Potential Vernal Pool (off of ROW)

[1]: Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated for mapping convention;

[2]: Vernal Pool Species observed confirming vernal pool/amphibian habitat.

M.4.3.2 Rare, Threatened and Endangered Species

Along the 3.6-Mile In-ROW Underground Line Route Variation are two state-listed species, the Eastern box turtle and the Eastern pearlshell mussel. See Section L.1.3.6 for a discussion of these species.

M.4.4 Existing Land Use

The 3.6-Mile In-ROW Underground Line Route Variation would begin at a potential transition station north of Turkey Hills Road and extend north passing the Newgate Wildlife Management Area, Metacomet Trail, the Farmington Valley Greenway, Suffield Sportsman's Association, Spencer Woods Wildlife Preserve, and the Fox Run Golf Course. See Section L.1.4 for a description of these resources and a description of the land use along this section of ROW. The underground variation continues into Suffield and ends at a potential transition station located north of Phelps Road.

M.5 CONNECTICUT PORTION OF MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE FOR THE AGAWAM TO LUDLOW 345-kV LINE ROUTE

M.5.1 Massachusetts Southern Route Alternative

This section describes the environmental features along the Connecticut Portion of the Massachusetts Southern Route Alternative for the Agawam to Ludlow 345-kV Line Route (overhead) in the towns of Enfield and Suffield, as well as an underground line variation to a portion of this overhead route in Enfield that has been identified as an option for aligning the route away from statutory facilities (Section M.5.2).

As described in Section H.6, the Connecticut Portion of the Massachusetts Southern Route Alternative would extend for approximately 5.4 miles in the municipalities of Suffield (1.1 mile) and Enfield (4.3 miles). The route would traverse the Connecticut River near the Connecticut/Massachusetts State border (which also forms the boundary between Suffield and Enfield). Along this alternative route in Connecticut, the proposed 345-kV line would be aligned overhead within an existing CL&P ROW (presently occupied by 115-kV facilities) that varies in width from approximately 280 to 385 feet.

M.5.1.1 Topography, Geology and Soils

The topography and geologic conditions along the Massachusetts Southern Route Alternative is somewhat different than what was observed for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. While glaciolacustrine, glaciofluvial, eolian and organic deposits are present on both routes, the Massachusetts Southern Route Alternative is dominated by these materials, particularly eolian deposits, and lacks deposits of glacial till. The surficial geology along the proposed GSRP overhead line route has a large component of the latter. Surficial geologic deposits determine what types of soils can ultimately form in any given area. In addition, the Massachusetts Southern Alternative Route traverses lands at a lower elevation than the preferred route, as the landscape dips toward the

Connecticut River. The soil associations found along the Connecticut Portion of the Massachusetts Southern Route Alternative and an underground line variation are summarized in Table M-11.

Table M -11. General Characteristics of Soil Associations Along the Massachusetts Southern Route Alternative and Underground Variation

Map Unit Symbol	Parent Material	Hydric (Yes or No)	Depth to Bedrock (inches)	Depth to water Table (feet)
13 Walpole sandy loam	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	Yes	>72	1.0
21A Ninigret and Tisbury soils	coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	1.5
32A Haven and Enfield soils	coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0
34A Hartford sandy loam	gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0
36B Windsor loamy sand	eolian sands over sandy glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0
36C Windsor loamy sand	eolian sands over sandy glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0
36A Windsor loamy sand	eolian sands over sandy glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0
82B Broadbrook silt loam	eolian deposits over coarse-loamy lodgment till derived from gneiss and/or schist and/or andstone and/or basalt	No	20-40	1.5-2.5
221A Ninigret-Urban land complex	coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	1.5-2.5
235B Penwood-Urban land complex	Sandy glaciofluvial deposits derived from sandstone and shale	No	>72	>6.0
236B Windsor-Urban land complex	eolian sands over sandy glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>72	>6.0
304 Udorthents, loamy, very steep	Glaciolacustrine deposits	No	>72	4.5
305	Gravelly outwash	No	>72	2.0-4.5

Map Unit Symbol	Parent Material	Hydric (Yes or No)	Depth to Bedrock (inches)	Depth to water Table (feet)
Udorthents-Pits, complex, gravelly				
306 Udorthents-Urban land complex	Drift	No	>72	4.5
307 Urban land	Miscellaneous area			

Source: USDA Natural Resources Conservation Service, Soil Surveys of Hartford and Tolland Counties, CT, and Hampden County, MA

M.5.1.2 Water Resources

Field surveys of wetlands and water resources were conducted along the Massachusetts Southern Route Alternative using the same procedures (see Section L) as described for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

M.5.1.2.1 Drainage Basins and Streams

Connecticut is divided geographically into eight major drainage basins/watersheds. The Massachusetts Southern Route Alternative ROW traverses portions of the Lower Connecticut River Basin. Within these basins, the Massachusetts Southern Route Alternative spans five perennial watercourses, the largest of which is the Connecticut River. The Connecticut River is New England's largest river ecosystem and was designated as one of the Nation's first American Heritage Rivers. The Connecticut River watershed encompasses over 11,000 square miles of wild, rural and urban lands in parts of Connecticut, Massachusetts, New Hampshire and Vermont. The river is utilized for a variety of purposes including recreation, aesthetics, boating, and fishing.

In addition, the Massachusetts Southern Route Alternative crosses the Four Mile Brook and Waterworks Brook. All of these watercourses, including the Connecticut River, are presently spanned by existing overhead transmission lines. A list of the watercourses crossed, along with their water quality classification, are included in Table M-12.

The Connecticut River is a designated watercourse within the CT DEP Stream Channel Encroachment Line (SCEL) program. The SCELs associated with the Connecticut River are spanned by existing CL&P overhead lines.

Table M -12. Streams Crossed Along the Massachusetts Southern Route Alternative

Town	Series Number and Stream Name (if applicable)[1]	CL&P Stream Number	Water Quality Classification/ Fisheries Information Where Applicable[2]	Type (P/I)[3]	Comments
Suffield	S04HD029 Four Mile Brook	S8-56	A	P	Associated with W04HD029
Suffield	S04HD008	S8-57	A	P	Associated with W04HD031
Suffield	S04HD009 Connecticut River	S8-58	B	P	Associated with W04HD034
Enfield	S04HD010	S8-59	A	P	Associated with W04HD035
Enfield	S04HD012 Waterworks Brook	S8-59A	A	P	Associated with W04HD038

1. Series Number and CL&P Number represent the same resource. Series Number refers to waterbody numbers designated in the ENSR reports (Volume 2) and illustrated on the aerial photographs in Volume 9, CL&P Number refers to numbers designated by CL&P for mapping conventions.

2. Data obtained from hard copy CT DEP map entitled Water Quality Classification, Connecticut River and Southcentral Coastal Basins, Adopted February 1993.

3. P=Perennial/I=intermittent (stream designations).

M.5.1.2.2 Wetlands

A total of 27 wetlands were identified along the Massachusetts Southern Route Alternative. Three confirmed vernal pools were identified. These wetlands are listed in Table M-13 *(List of Wetlands Along The Massachusetts Southern Route Alternative)*.

Table M -13. List of Wetlands Along The Massachusetts Southern Route Alternative

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Wetland Class[2]
Suffield/Agawam	W04HA026	W8-142	PEM/PFO
Suffield	W04HD027	W8-143	PEM/PFO
Suffield	W04HD028	W8-144	PSS/PFO
Suffield	W04HD029	W8-145	PSS/PFO
Suffield	W04HD030	W8-146	PEM
Suffield	W04HD031	W8-147	PFO
Enfield/Suffield	W04HD034	W8-148	PFO
Enfield	W04HD033	W8-150	PEM/PFO
Enfield	W04HA032	W8-149	PFO/PEM
Enfield	W04HD035	W8-151	PEM/PFO/PSS
Enfield	W04HD036	W8-152	PEM/PFO
Enfield	W04HD037	W8-152A	PEM/PFO
Enfield	W04HD039	W8-152B	PEM/PFO
Enfield	W04HD040	W8-152C	PSS/PFO
Enfield	W04HD041	W8-152D	PSS/PFO
Enfield	W04HD043	W8-152E	POW/PFO
Enfield	W04HD044	W8-152F	PFO
Enfield	W04HD045	W8-152G	PSS/PFO
Enfield	W04HD046	W8-152H	PEM/PSS
Enfield	W04HD047	W8-152I	PFO
Enfield	W04HD048	W8-152J	PEM/PFO
Enfield	W04HD049	W8-152K	PEM/PFO
Enfield	W04HD050	W8-152L	PEM
Enfield	W04HD053	W8152M	PEM/PFO
Enfield	W04HD054	W8-152N	PEM/PFO/PSS
Enfield	W04HD055	W8-152O	PFO/PSS
Enfield	W04HD056	W8-153	PEM/PFO/PSS

1. Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GSP Survey of wetlands. The CL&P wetland number was generated for mapping convention;
2. Wetlands classification according to Cowardin et al 1979; PEM = Palustrine Emergent Wetland; PFO – Palustrine Forested Wetland; PSS = Palustrine Scrub-Shrub Wetland

M.5.1.2.3 Groundwater Resources and Public Water Supplies

Table L-3 in Section L summarizes Connecticut's Water Use Goals. The Connecticut Water Company provides water to the municipalities of Enfield and Suffield from one of 90 groundwater sources and 20 reservoirs. The majority of the surface waters crossed by or in the vicinity of the Massachusetts Southern Route Alternative have been given a classification of A and others are currently classified as B. The groundwater areas crossed by and/or in the vicinity of the alternative route have been classified as GB.

The portion of the Massachusetts Southern Route Alternative that traverses the Town of Enfield, approximately 3.7 miles, is within a Connecticut Aquifer Protection District. See Section L.2.2.3 for a description of Connecticut's Aquifer Protection Program. The Town of Enfield is in the process of completing final aquifer protection mapping for the area associated with the Massachusetts Southern Route Alternative. The town has adopted protection regulations that are in accordance with the Connecticut statutes. Regulated activities which require a permit can be found in C.G.S. Section 22a-354i-5, and the best management practices for regulated activities are described in C.G.S. Section 22a-345i-9.

M.5.1.3 Flood Zones

The Massachusetts Southern Route Alternative traverses the 100-year flood boundaries, as designated by FEMA, of the Connecticut River, Four Mile Brook, and Waterworks Brook. These floodplain boundaries are depicted on the aerial alignment maps of the alternative (refer to Volume 9).

M.5.1.4 Biological Resources

M.5.1.4.1 Vegetative Communities

As illustrated on the Volume 9 maps, the existing ROW along which the Massachusetts Southern Route Alternative would be located traverses or is aligned near a variety of vegetative communities, ranging from forested floodplain areas along the Connecticut River, to forested uplands, agricultural areas, shrub-scrub areas, and suburban residential areas. The west side of the Connecticut River has very little forested floodplain and is mostly upland forest with a small strip of wetland immediately west of the river. On the east side of the river, the route traverses Longmeadow, Massachusetts for a brief stretch before entering Enfield, Connecticut. In this area, there is a larger tract of forested floodplain which contains rich habitat supporting several species, including Massachusetts state-listed plants. This habitat ends well before the route crosses back into Connecticut.

M.5.1.4.2 Fisheries

The Massachusetts Southern Route Alternative would span the Connecticut River, adjacent to existing CL&P overhead transmission lines. The Connecticut River watershed encompasses over 11,000 square miles of wild, rural and urban lands in parts of Connecticut, Massachusetts, New Hampshire and Vermont. The river is utilized for recreational fishing over its entire length in Connecticut. Though it is not stocked with any species, fisheries resources include large and smallmouth bass, trout, northern pike, and alewives/black herring.

The Connecticut River also contains shortnose sturgeon, Connecticut's only endangered fish species. Shortnose sturgeon are typically anadromous, migrating from the ocean to fresh water specifically to reproduce. However, of the two populations in the Connecticut River system (formed by the construction of dams), one is considered to be partially landlocked and the other is likely to be amphidromous, moving between fresh and salt water. Shortnose sturgeon reproduce in the spring. They broadcast their eggs in areas with rubble substrate. Once hatched, the young fish drift downstream and may eventually swim to brackish water.

The Massachusetts Southern Route Alternative also spans Four Mile Brook and Waterworks Brook. Neither of these watercourses are designated as stocked with any species by the CT DEP and they are not regulated fishery recourses. Both watercourses are warm-water resources and can be expected to contain various species such as largemouth bass, white sucker, red-fin pickerel, creek chub and pumpkin seed.

M.5.1.4.3 Amphibians

Three confirmed vernal pools have been identified by field biologists during the spring 2008 surveys, and they are listed in Table M-14. The three locations are within the existing CL&P ROW. A summary of the survey methodology can be found in Section L.1.3.4 and a detailed account of the survey methodology as well as the results can be found in the *Inventory of Vernal Pools and Amphibian*

Breeding Habitats Along the Connecticut Portion of the Greater Springfield Reliability Project in Volume 4.

Table M -14. Vernal Pool Habitat Associated with the Massachusetts Southern Route Alternative

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Adjacent Tower Number	Observed Obligate Species[2]
Enfield	W04HD035	W8-151	22023 to 22024	wood frog
Enfield	W04HD045	W8-152G	22043	Potential Vernal Pool
Enfield	W04HD55	W8-156A	22058	spotted salamander, wood frog

[1]: Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated for mapping convention;

[2]: Vernal Pool Species observed confirming vernal pool/amphibian habitat.

M.5.1.4.4 Rare, Threatened and Endangered Species

In November 2007, the U.S. Fish and Wildlife Service (US FWS) indicated that the project area is not within the vicinity of any federally protected threatened or rare species (See US FWS Consultation Letter and Response in Volume 4). With no federally-listed, threatened or endangered species or critical habitat under the jurisdiction of the US FWS, preparation of a Biological Assessment or further consultation with the US FWS under Section 7 of the Endangered Species Act is not required.

In conjunction with the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, CL&P submitted a rare species request for the Massachusetts Southern Route Alternative. The CT DEP Natural Diversity Database, Environmental & Geographic Information Center (NDDB) has indicated that there are four listed species associated with the Connecticut River. These species are the endangered Shortnose sturgeon (*Acipenser brevirostrum*), the endangered Bald Eagle (*Haliaeetus leucocephalus*), the threatened Riverine clubtail dragonfly (*Stylurus amnicola*), and the species of special concern Arrow clubtail dragonfly (*Stylurus spiniceps*). Because CL&P is not proposing any in-river construction activities, the CT DEP is not overly concerned with issues associated with these species as they relate to the project activities. However, the CT DEP has stressed the importance of proper installation and maintenance of erosion and sediment controls, as well as maintaining an undisturbed riparian buffer zone to the subject waterbodies. These measures will ensure no adverse effects occur to riverine habitats.

M.5.1.5 Existing Land Use

M.5.1.5.1 Overall Land Use Patterns

The Massachusetts Southern Route Alternative would traverse the northeastern portion of the Town of Suffield and northern portions of the Town of Enfield. Land-use plans for both towns were reviewed, and land uses along and adjacent to the transmission line ROW within which the 345-kV line would be aligned were characterized.

As illustrated on the Volume 9 maps, extending southeast from the Connecticut/Massachusetts state border into Suffield, the Southern Route Alternative would follow an existing CL&P transmission ROW, traversing mostly agricultural lands. After crossing Mapleton Avenue, the route would span the Connecticut River. Immediately after crossing the river, the route would re-enter Massachusetts, traversing a small portion of Longmeadow, before diverging south again into the Town of Enfield. Continuing east across Campania Road, the route would be aligned near mainly forest and residential areas before crossing Interstate 91 and Enfield Street. After crossing Enfield Street, the route would continue to the east, traversing a forested area near various residential developments along and in the vicinity of Brainard Road. The route would span Maple Street and continue east near Mayfield Drive before crossing back into Massachusetts.

CL&P has determined that the Massachusetts Southern Route Alternative would be aligned near various residential subdivisions and other dwelling units (condominiums and apartment complexes) that could qualify as statutory facilities. At this time, certain other possible statutory facilities (e.g., schools, licensed day-cares) have been identified near the Massachusetts Southern Route Alternative. These facilities are illustrated on the Volume 9 maps.

M.5.1.5.2 Parks, Open Space, Recreational and Public Trust Lands

The Massachusetts Southern Route Alternative would be in the vicinity of the St. Martha Church and School, Bright Horizons Family Solutions Daycare, and two home day-cares.

M.5.1.5.3 Residential Areas

Residential land uses in the vicinity of the Southern Route Alternative range from single-family, low-density residential developments to urban neighborhoods. The aerial photographs in Volumes 9 and 11 provide further information about residential land use in the vicinity of the proposed alternative.

M.5.1.5.4 Federal, State, and Local Use Plans/Future Land Use Development

The Town of Suffield's most recent Plan of Conservation and Development was published in 1999. Suffield's Plan strives to identify and preserve significant open space land. Suffield's Regional Plan of Development, which dates to 1978, states that "the goal and policy statements…were directed at encouraging a regional development pattern that provides the necessary balance between the man-made and natural environment, minimizing adverse effects on environmentally sensitive areas and scarce natural resources such as flood plains, wetlands, ridge lines, agriculture, forest land, and park lands." The Town of Suffield still follows these goals. Relative to the construction of new transmission lines, the 1999 plan stated that CL&P indicated that electrical supply lines for Suffield were adequate and that no plans for expansion were in place at that time. Therefore, the plan did not provide any stipulations or goals for transmission lines. Due to population and industrial growth in the region since 1999, the need to provide additional transmission services to the area has been established by CL&P.

The Town of Enfield Plan of Conservation and Development was last updated in 1998 and includes community goals of revitalizing older neighborhoods, protecting open space and farmland, ongoing capital improvement and maintenance to supply sufficient service to meet the needs of Enfield. In addition, the land use plan seeks to allow development at suburban densities, but include a mix of residential, commercial, and industrial land uses.

A description of the Suffield land use plan as well as state land use plans can be found in Section L.1.5.

M.5.1.6 Transportation Systems and Utility Crossings

As listed in Table M-15, the Massachusetts Southern Route Alternative would traverse various state and local roads, as well as Interstate 91.

Table M -15. Road Crossings – Massachusetts Southern Route Alternative (Connecticut Only)

Road Name	Town	Road Type
Mapleton Avenue	Suffield	Highway
Interstate 91	Enfield	Federal
Enfield Street	Enfield	Highway
Bright Meadow Boulevard	Enfield	Local Road
Brainard Road	Enfield	Local Road
George Washington Road	Enfield	Local Road
Hampton Chase Road	Enfield	Local Road
Brainard Road	Enfield	Local Road
Maple Street/Route 192	Enfield	State
Mayfield Drive	Enfield	Local Road
Dartmoor	Enfield	Local Road
Dartmoor	Enfield	Local Road

M.5.1.7 Cultural (Archaeological and Historic) Resources

The recorded cultural resources located in the vicinity of the Connecticut Portion of the Massachusetts Southern Route Alternative include:

- Two Native American archaeological sites reported within approximately 1 mile of the Southern Route Alternative overhead line route, one a lone surface find and the other a cemetery which appears to have been located in Longmeadow, Massachusetts.
- State site files reported two EuroAmerican archaeological sites within approximately 1 mile of this route, the closest of which is 4,500 feet away. Neither has been determined eligible for the NRHP. Historical maps do not suggest other EuroAmerican sites within the corridor.

No significant historic resources are reported within approximately 0.25 mile of the Southern Route Alternative.

M.5.1.8 Air Quality

Air quality for the Massachusetts Southern Route Alternative is generally the same as that found along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and is described in Section L.

M.5.1.9 Noise

Existing noise levels in the vicinity of the Massachusetts Southern Route Alternative are typical of the uses traversed – that is, a mix of more densely developed suburban residential areas, intermixed with rural land uses. See Section L for a discussion of noise levels as well as state regulations concerning noise.

M.5.2 Massachusetts State Route 220/Enfield Underground Line Route Variation

As described in Section H and illustrated on the Volume 9 maps, the Connecticut portion of the Massachusetts Southern Route Alternative, if aligned overhead along CL&P's existing ROW, would traverse residential neighborhoods in Enfield. Pursuant to the Siting Council procedures, CL&P has identified an underground cable variation to the overhead transmission configuration near these residential developments.

This underground variation would extend approximately 4.3 miles across the northern portion of the Town of Enfield, and would replace a 3.7-mile segment of the overhead Massachusetts Southern Route Alternative. This route would be located primarily within or adjacent to state and local public road ROW, except for a 0.4-mile segment that would traverse along the overhead transmission line ROW. A 345-kV line transition station is required whenever an underground cable segment of the line connects to an overhead section of the line. Such transition stations typically require an area approximately two to four fenced acres which CL&P may need to acquire.

The environmental features in the vicinity of this underground variation are generally the same as those summarized for the overhead route, except as further described below.

M.5.2.1 Topography, Geology, and Soils

The topography, soils, and geologic conditions along the Massachusetts State Route 220/Enfield Underground Line Route Variation are generally the same as those described for the Southern Route Alternative. The major difference between this variation and the overhead Massachusetts Southern Route Alternative is its placement underground in established public roadways. For that reason, depth to bedrock and depth to groundwater are important considerations. The details of both for each soil type are shown in Table M-11 in Section M.5.1.1. The depth to bedrock in the vicinity of the variation ranges from 20 inches below the surface to greater than 72 inches; the latter is applicable to the majority of soil types. The depth to groundwater ranges from 1 foot to over 6 feet, though the majority of soil types have a depth to groundwater of over 6 feet.

M.5.2.2 Water Resources

Although the underground variation would likely be located primarily within or adjacent to road ROW, it is possible that deviations from the paved ROW may be required. As a result, streams and wetlands were delineated and mapped adjacent to the road ROW. As illustrated in Table M-16 and Table M-17, a total of three waterbodies and seven wetlands respectively were delineated along the Massachusetts State Route 220/Enfield Underground Line Route Variation.

M.5.2.2.1 Drainage Basins and Streams

The Massachusetts State Route 220/Enfield Underground Line Route Variation is located within the Lower Connecticut River drainage basin. For part of its length, this underground variation traverses the same ROW as the Southern Route Alternative. Where the underground variation traverses public roadways, the route is more developed and the streams are generally small and channelized. This underground variation would cross three perennial watercourses, the largest of which is Waterworks Brook. As illustrated in Volumes 9 and 11, *Aerial Photographs - 400 Scale,* and *Aerial Photographs - 100 Scale*, all of the watercourse crossings along the underground portion of the proposed route are adjacent to or near existing road crossings.

Table M -16. Streams Along the Massachusetts State Route 220/Enfield Underground Line Route Variation

Town	Series Number[1] and Name (if Applicable)	CL&P Stream Number	Water Quality / Fisheries Classification where applicable[2]	Type (P or I)[3]	Comments
Enfield	S01HF016UG Waterworks Brook	S8-59B	A	P	Associated with W01HF043UG
Enfield	S01HF017UG Waterworks Brook	S8-59C	A	P	Associated with W01HF046UG
Enfield	S04HD010	S8-59	A	P	Associated with W01HF044UG

1. Series Number and CL&P Number represent the same resource. Series Number refers to waterbody numbers designated during GPS Survey and in the ENSR reports (Volume 2) and illustrated on the aerial photographs in Volume 9. The CL&P Number refers to numbers designated for mapping conventions.
2. Data obtained from hard copy CT DEP map entitled Water Quality Classification, Connecticut River and Southcentral Coastal Basins, Adopted February 1993.
3. P=Perennial/I=intermittent (stream designations).

M.5.2.2.2 Wetlands

A total of 4 wetlands were identified. No vernal pools were found during field investigations. These wetlands are listed in Table M-17 *(List of Wetlands Along The Massachusetts State Route 220/Enfield Underground Line Route Variation)*.

Table M -17. List of Wetlands Along The Massachusetts State Route 220/Enfield Underground Line Route Variation

Municipality	Wetland Series Number[1]	CL&P Wetland Number	Wetland Class[2]
Enfield	W04HD035	W8-151	PEM/PFO/PSS
Enfield	W01HF043 UG	W8-151A	PEM
Enfield	W01HF046 UG	W8-152B	PFO
Enfield	W04HD050	W8-152L	PEM
Enfield	W04HD053	W8152M	PEM/PFO
Enfield	W04HD054	W8-152N	PEM/PFO/PSS
Enfield	W04HD055	W8-152O	PFO/PSS

1 Wetland series number and CL&P wetland number represent the same resource. The Wetland series number was generated by CL&P's environmental consultant (ENSR) during GPS Survey of wetlands. The CL&P wetland number was generated for mapping convention;
2. Wetlands classification according to Cowardin et al 1979; PEM = Palustrine Emergent Wetland; PFO – Palustrine Forested Wetland; PSS = Palustrine Scrub-Shrub Wetland

M.5.2.2.3 Groundwater Resources and Public Water Supplies

The groundwater resources and public water supplies are the same as those described for the Southern Route Alternative and are described in Section M.5.1.2.3. The depth to groundwater ranges from one foot to over six feet, though the majority of soil types have a depth to groundwater of over six feet.

The entire Massachusetts State Route 220/Enfield Underground Line Route Variation, approximately 4.3 miles, is within a Connecticut Aquifer Protection District. This is the same Aquifer Protection District as was described for the Southern Route Alternative.

M.5.2.2.4 Flood Zones

The Southern Route Alternative Underground Line Variation traverses the 100-year floodplain of Waterworks Brook. These FEMA floodplain boundaries are depicted on the maps in Volume 11, *Aerial Photographs - 100 Scale.*

M.5.2.3 Biological Resources

The following sections discuss the vegetative and wildlife communities found along the underground variation. Because no vernal pools were identified along the Massachusetts State Route 220/Enfield Underground Line Route Variation, there are no amphibian breeding habitats to consider. In addition, CL&P consulted with the CT DEP concerning habitat for rare, threatened, and endangered species that may be impacted during construction. In that consultation, detailed in Section L, it was decided that if construction was to occur within public roadway ROW, then no restrictions regarding rare, threatened, or endangered species would apply.

M.5.2.3.1 Vegetative Communities

The Massachusetts State Route 220/Enfield Underground Line Route Variation would be located predominately within or adjacent to existing public road ROW, which traverse developed areas. In general, the vegetation in the vicinity of the underground variation to the Massachusetts Southern Route Alternative is characteristic of developed urban and suburban areas (e.g., managed lawn and ornamental trees and shrubs).

M.5.2.3.2 Wildlife Communities

The wildlife communities in the vicinity of the Massachusetts State Route 220/Enfield Underground Line Route Variation can be expected to be those common to urban and suburban habitats.

M.5.2.4 Existing Land Use

M.5.2.4.1 Overall Land Use Patterns

The underground variation would be aligned primarily along residential streets within Enfield. In particular, the route would diverge from the overhead ROW to traverse along a residential street (Campania Road). The route would extend along Campania Road, as well as other residential streets, including Manning Road, Enfield Street, and Brainard Road. The underground variation would continue in an easterly direction through settled areas along Brainard Road until the overhead route crosses

Brainard Road. The underground variation would parallel the overhead route until connecting with Mayfield Drive just north of Maple Street. The route then would extend along Mayfield Drive before connecting back into the overhead route north of the Connecticut/Massachusetts border.

Other land uses along the underground variation include town-owned open space, the Prudence Crandall School, St. Martha Church and School, and Brainard Park. The park, for which Enfield has adopted a master plan, is town-owned and includes baseball fields, picnic areas, and walking trails. Further, the park is adjacent to additional municipal open space land.

M.5.2.4.2 Residential Areas

Residential land uses in the vicinity of the Massachusetts State Route 220/Enfield Underground Line Route Variation range from single-family, low-density residential developments to urban neighborhoods. The aerial photographs in Volumes 9 and 11 provide further information about residential areas in the vicinity of the Massachusetts State Route 220/Enfield Underground Line Route Variation.

M.5.2.4.3 Parks, Open Space, Recreation, and Public Trust Lands

The Southern Route Alternative Underground Line Variation travels within the roadway located in front of Town of Enfield-designated open space and Brainard Park.

M.5.2.5 Transportation Systems and Utility Crossings

The Massachusetts State Route 220/Enfield Underground Line Route Variation would be aligned along or would intersect several state and local roads (refer to the Volume 9 and Table M-18).

Table M -18. Road Crossings – Massachusetts State Route 220/Enfield Underground Line Route Variation

Road Name[1]	Town	Road Type
Kalish Avenue	Enfield	Local Road
Bernardino Avenue	Enfield	Local Road
Gammello Avenue	Enfield	Local Road
Campania Road	Enfield	Local Road
Stephen Drive	Enfield	Local Road
Campania Road	Enfield	Local Road
Catalina Drive	Enfield	Local Road
Manning Road	Enfield	Local Road
University Place	Enfield	Local Road
Dartmouth Street	Enfield	Local Road
Enfield Street/Route 5	Enfield	State
Fairlane Road	Enfield	Local Road
Lancer Drive	Enfield	Local Road
Interstate 91	Enfield	Federal
Brainard Road	Enfield	Local Road
Winding Lane	Enfield	Local Road
Glen Oak Drive	Enfield	Local Road
Varno Lane	Enfield	Local Road
George Washington Road	Enfield	Local Road
Brainard Road	Enfield	Local Road
Debbie Lane	Enfield	Local Road
Forest Drive	Enfield	Local Road
Forest Drive	Enfield	Local Road
Maple Street/Route 192	Enfield	State
Mayfield Drive	Enfield	Local Road
Mayfield Drive	Enfield	Local Road
Mayfield Drive	Enfield	Local Road
Dartmoor Road	Enfield	Local Road

1: Includes roadways that intersect the underground variation

M.5.2.6 Cultural (Archaeological and Historic) Resources

The recorded cultural resources located in the vicinity of the underground variation include the following:

- Two Native American archaeological sites are reported within approximately 1 mile of the Southern Route Alternative underground variation, one a lone surface find and the other a cemetery which appears to have been located in Longmeadow, Massachusetts.

- State site files reported two EuroAmerican archaeological sites within approximately 1 mile of this route, the closest of which is 4,000 feet away. Neither has been determined eligible for the NRHP, and one has been determined not eligible. Historical maps do not suggest other EuroAmerican sites within the corridor.

No significant historic resources are reported within approximately 500 feet of the Massachusetts State Route 220/Enfield Underground Line Route Variation.

M.5.2.7 Air Quality

Air quality for the Massachusetts State Route 220/Enfield Underground Line Route Variation is generally the same as that found along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and is described in Section L.

M.5.2.8 Noise

Existing noise levels in the vicinity of the Massachusetts State Route 220/Enfield Underground Line Route Variation are typical of those found in urban and suburban residential areas. See Section L for a discussion of noise levels as well as state regulations concerning noise.

SECTION N

POTENTIAL ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES

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N. POTENTIAL ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES

This section identifies and analyzes the potential short- and long-term environmental effects that may occur as a result of the construction and operation of the facilities along the proposed overhead line routes, as well as, alternatively, along the underground route variations that have been identified to these routes. In addition, the section describes the measures that CL&P proposes to implement to avoid and/or minimize adverse effects on such environmental resources.

Section N.1 discusses the potential environmental effects and mitigation measures that would be associated with the construction and operation of the overhead 345-kV facilities along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, as well as the construction and operation of the Manchester to Meekville Junction Circuit Separation Project (MMP) facilities. Section N.1 also identifies and evaluates the potential environmental effects and mitigation measures that would be associated with the proposed modifications to the North Bloomfield Substation, which are required to support the proposed new 345-kV transmission line.

Section N.2 describes the potential environmental effects and mitigation measures that would occur as a result of the construction and operation of portions of the North Bloomfield to Agawam 345-kV line along the four underground variations, each one of which could be used to replace a similar portion of the proposed overhead line route. This section describes the potential effects of the development of an underground cable segment within or adjacent to road ROWs (i.e., the Newgate Road and State Route 168/187 Underground Line Route Variations) or within CL&P's existing overhead transmission line ROW (i.e., the 3.6-Mile and 4.6-Mile In-ROW Underground Line Route Variations.)

Section N.3 discusses the potential effects that would result from the construction and operation of the 5.4-mile Connecticut portion of the overhead 345-kV line alternative between Agawam and Ludlow substations for the Massachusetts portion of the GSRP. The potential effects of the underground variation that were identified for a portion of this 5.4-mile overhead line route also are evaluated. Possible mitigation measures are discussed for the development of the 345-kV line route along both the overhead line route and the underground variation.

Overall, CL&P has assessed the potential effects of the proposed and alternative project facilities on the following resources:

- Topography, geology, and soils;
- Water resources and water quality (wetlands [including vernal pools], watercourses, floodplains, groundwater, and public water supply areas);
- Biological resources
  - Riparian and upland vegetation;
  - Wildlife (including birds);
  - Amphibians;
  - Fisheries; and
  - Threatened/endangered species;
- Land uses (including scenic and recreational resources; open space and protected areas; local, state, and federal land use plans; existing and future development);
- Transportation and access;
- Archaeological and historic (cultural) resources; and
- Air quality and noise.

N.1 CONNECTICUT PORTION OF THE NORTH BLOOMFIELD TO AGAWAM 345-kV AND MMP OVERHEAD LINE ROUTES

The construction and operation of the proposed transmission facilities in an overhead configuration along both the Connecticut Portion of the North Bloomfield to Agawam 345-kV and the MMP Line Routes would result in similar effects on certain environmental resources (e.g., topography, geology, soils, air quality, noise). Likewise, some of the measures that CL&P proposes to minimize or avert adverse effects to environmental resources would be common to both overhead line facilities.

To avoid redundancy, the following subsections combine the discussion of the potential effects and mitigation measures that would be common to the development of the two overhead line routes. For the potential environmental effects or mitigation measures that would differ between the two routes (e.g., water resources, certain biological resources), separate route-specific discussions are provided. Sections N.1.1 through N.1.8 describe the potential environmental effects and mitigation measures associated with the construction and operation of the overhead line routes. Section N.1.9 discusses the potential environmental effects and mitigation measures for the modifications to the North Bloomfield Substation.

Overall, the development of the facilities along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and the existing MMP ROW, as well as the associated expansion of the existing North Bloomfield Substation on CL&P-owned property, would minimize adverse environmental effects by collocating the new transmission lines along existing ROWs and on property otherwise devoted to utility use. Further, based on recent experience with the development of other 345-kV transmission line projects, historical experience with the maintenance of the existing transmission lines along the North Bloomfield to Agawam and MMP corridors, and on the results of field investigations and agency consultations for the proposed line routes, CL&P has a clear understanding of the existing environmental conditions along the routes, and the potential issues and effects associated with overhead line construction and operation. CL&P has applied this information to incorporate mitigation measures into the projects' design and proposed construction techniques, and thereby to minimize adverse environmental effects to the extent practical. Examples of such mitigation measures include the location of new structures outside of delineated wetlands where possible and the avoidance of vegetation removal within riparian areas.

In addition to the mitigation measures identified in this section, other measures may be identified during the course of the Council proceedings and/or the process of applying for project-specific permits and approvals from other state and federal agencies, including the CT DEP and the U.S. Army Corps of Engineers (USACE). CL&P would incorporate all relevant environmental mitigation measures and regulatory permit conditions into the D&M Plans or other specifications for the projects.

N.1.1 Topography, Geology, and Soils

The development of the proposed transmission lines along the existing CL&P ROWs would have negligible effects on topography and geology. Soil resources would be affected by the creation or expansion of access roads along the ROW, as well as by the earth-disturbing activities required to install the transmission line structures. Effects on soil resources would be short-term, lasting only for the duration of the construction period, until re-vegetation or other forms of site stabilization are achieved.

In general, the construction of the proposed transmission line projects will result in minor changes in topography, localized at structure locations or along access roads. For example, grading, which would change elevations, would only be performed to create level areas for the installation of structures, and to improve existing access roads or to create new access roads along the ROWs in order to provide safe passage for construction equipment. Changes in the grades adjacent to proposed structure locations may be required for the construction of crane pads, where fill may be imported to provide a safe and level work area around each structure location. Crane pads may be removed in some locations after construction. Grading would not be required along the ROW where the terrain is flat and open, where no access road improvements are needed, or where the conductors span the underlying terrain.

Where grading and earth disturbing activities are required, temporary erosion and sediment control measures would be installed to minimize the potential for soil erosion and sedimentation off the ROW or into watercourses or wetlands. Temporary erosion controls (e.g., silt fence, hay/straw bales, filter socks, mulching, and temporary reseeding) would be deployed as necessary after clearing or grading, or at other times during construction, in areas of land disturbance. The need for and extent of temporary and permanent erosion and sedimentation controls would be a function of considerations such as:

- Slope (steepness, potential for erosion, and presence of resources such as wetlands or streams at bottom of slope).
- Type of vegetation removal method used and extent of vegetative cover remaining after removal (e.g., presence/absence of understory or herbaceous vegetation that would minimize the potential for erosion and degree of soil disturbance as a result of the movements of clearing equipment).
- Type of soil and erodibility factor (K value).
- Soil moisture regimes.
- Schedule of future construction activities.
- Proximity of cleared areas to water resources, roads, or other sensitive environmental resources.
- Time of year: The types of erosion and sedimentation control methods for a particular area would depend on the time of year. For example, reseeding would not typically be effective during the winter months. In winter, with frozen ground, controls other than re-seeding (such as the use of wood chips, straw and hay, geotextile fabric, waterbars, or crushed stone) would be used to stabilize disturbed areas until seeding can be performed.
- Extreme weather conditions during or immediately following soil disturbance.

The measures selected would be appropriate to minimize the potential for erosion and sedimentation in areas where soils are disturbed. CL&P would adhere to its *2007 Connecticut Best Management Practice Manual*, and would prepare a project-specific Erosion and Sedimentation Control Plan, in compliance with the *2002 Connecticut Guidelines for Soil Erosion and Sedimentation Control*, which would be included as part of the project-specific D&M Plans.

Typically, temporary erosion controls would be installed based on the judgment of the CL&P's in-field representatives. Temporary erosion controls may be placed in the following types of areas, in accordance with site-specific field determinations:

- Across or along portions of cleared ROW, at intervals dictated by slope, amount of vegetative cover remaining, and down-slope environmental resources.
- Across or along accessways within the transmission line ROW.
- Across areas of disturbed soils on slopes leading to streams and wetlands.
- Around portions of construction work sites that must unavoidably be located in wetlands.

The temporary erosion controls would be maintained, as necessary, throughout the period of active construction until restoration has been deemed successful, as determined by standard criteria for storm water pollution control/prevention and erosion control. In addition to silt fence or hay/straw bales, temporary erosion controls may include the use of mulch, jute netting (or equivalent), erosion control blankets, reseeding to establish a temporary vegetative cover, temporary or permanent diversion berms (if warranted), and/or other equivalent structural or vegetative measures. After the completion of construction activities in any area, permanent stabilization measures (e.g., seeding, mulching) would be performed.

During the course of periodic post-construction inspections, CL&P would determine the appropriate time frame for removing these temporary erosion controls. This determination would be made based on the effectiveness of restoration measures, such as percent re-vegetative cover achieved, in accordance with applicable permit and certificate requirements.

Blasting and Rock Removal

For the most part, blasting is not expected to be needed to install structures along the project ROWs. As currently proposed, the proposed transmission line structures are expected to be steel H-frames, wood H-frames, or steel poles; few of these structure types would require foundations with anchor bolts. The preferred techniques for removing rock, if encountered, would be to use either mechanical methods (e.g., mechanical excavators and pneumatic hammers) or mechanical methods supplemented by controlled drilling and blasting.

Potential effects from rock removal may include dust and vibration/noise from rock drilling, blasting (if required), and removal. If blasting is required, CL&P would develop a blasting control plan in compliance with state, industry, and corporate standards; this plan would be provided to the state and local Fire Marshals.

Further, if blasting is necessary, CL&P would employ methods to minimize adverse effects. For example, blasting charges, if required, would be designed to loosen only the material that must be removed to provide a stable foundation for an overhead structure.

Excess rock (if any) generated from construction activities may be stockpiled at approved locations along the ROWs, with the landowner's permission, to create wildlife habitat, or placed across or along the ROWs to provide barriers to unauthorized vehicular traffic along the ROWs. The rock also may be used to re-construct stone walls, if any such walls are affected by the construction activities. Excess rock would not be deposited in wetlands or watercourses. Any excess rock not otherwise used along the ROW would be disposed off-site at an appropriate location, pursuant to regulatory requirements.

N.1.2 Water Resources and Water Quality

The potential surface water resource/water quality effects associated with overhead transmission line construction are expected to be minor, short-term, and highly localized. The operation of the projects would not cause any long-term effects to water quality. Potential effects to water resources typically stem from erosion and sedimentation into watercourses or wetlands as a result of soil disturbance and vegetation removal, or from the installation of transmission line structures or access roads within water resources (wetlands or watercourses).

In designing and planning for constructing the transmission lines, CL&P proposes to avoid direct work in watercourses, minimize work in wetlands, and employ best management practices to limit the potential for effects associated with erosion / sedimentation or spills into water resources from construction activities in nearby upland areas. Construction activities involving earth disturbance would temporarily increase the potential for erosion and sedimentation, which could temporarily affect the quality of watercourses or wetlands along the ROWs.

However, the implementation and maintenance of best management practices can effectively control soil erosion and reduce the risks of potential adverse effects on water quality. Further, a storm water pollution control plan will be prepared, in accordance with CT DEP permit requirements; CL&P will require its construction contractor(s) to adhere to this plan, as well as to any other best management practices and regulatory conditions relevant to water resources, in order to minimize the potential for soil erosion and sedimentation during all phases of construction.

Similarly, CL&P would implement its construction best management practices to minimize effects from soil erosion and limit the potential for spills/leaks from construction equipment. CL&P would clean up and contain any spills/leaks in accordance with its emergency response plan and CT DEP requirements.

The project ROWs will traverse various watercourses and wetlands. Any construction work in these water resources will be in accordance with not only CL&P's best management practices, but also the conditions of the regulatory approvals that will be required from the USACE, New England District, and the CT DEP. Pursuant to Section 404 of the federal Clean Water Act and Section 10 of the Rivers and Harbors Act (as applicable), CL&P will file an Individual Permit application with the USACE-New England District for work in waters of the U.S. The USACE has indicated that the entire GSRP (i.e., in Connecticut and Massachusetts, and including the MMP) is considered, from a federal regulatory perspective, as a single and complete project. Thus, it is anticipated that the USACE will issue a single permit for the GSRP as a whole, and that such a permit will include conditions designed to further assure that potential adverse effects to water resources are minimized or mitigated.

In addition, the CT DEP will review the project jointly with the USACE regarding the issuance of an individual water quality certification pursuant to Section 401 of the Clean Water Act. CL&P will submit to CT DEP a General Permit Registration for the Discharge of Storm Water and Dewatering Wastewaters from Construction Activities, and will prepare an associated project-specific Storm Water Pollution Control Plan, both of which will be developed during and in conjunction with the preparation of the Development and Management (D&M) Plans, as required by the Council. CL&P will incorporate all water resource permits received from the USACE and the CT DEP into the project specifications, to which the construction contractors must adhere during the construction of the GSRP and MMP.

N.1.2.1 Wetlands

Along both the Connecticut Portion of the North Bloomfield to Agawam 345-kV and the MMP line routes, the proposed transmission lines would be constructed and operated in existing ROWs, where the wetlands have historically been affected by vegetation maintenance programs. Specifically, pursuant to CL&P vegetation management practices, these wetlands are maintained in scrub-shrub and emergent wetland cover types. In addition, approximately 11 existing structures along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and 9 existing structures along the MMP Line Route are presently located in wetlands.

The development of the proposed transmission lines in these maintained ROWs will result in incremental, long-term effects on wetlands associated with the following activities:

- **Vegetation clearing and maintenance**. Within the footprint of the new transmission lines, forested wetland vegetation will be have to be removed in order to construct and safely operate the new overhead transmission facilities. As a result, forested wetlands along the expanded ROWs will be converted to shrub-scrub or emergent marsh wetland types. This will not create a loss of overall wetland habitat, but rather a long-term change in habitat type, from forested to shrub-scrub or emergent marsh.
- **Improvement or creation of new access roads**. In certain areas where no upland alternatives are available, existing access roads through wetlands along the ROWs will have to be improved or new access roads through wetlands will have to be developed in order to reach structure sites. Access may consist of timber mats, which would be temporarily used only for construction and then removed from the wetlands. In some areas, gravel type roads (approximately 20 feet wide) would be required to provide safe access for construction and for the operation and maintenance of the transmission facilities. Long-term effects will result where such access roads must remain in place in wetlands to provide access for operation and maintenance activities.
- **Structure installation in wetlands**. CL&P has and will continue to make design modifications, if practical, to avoid the installation of structures in wetlands. However, in certain areas, the location of structures in wetlands will be unavoidable. The installation of structures in wetlands will result in short-term effects associated with the creation of

temporary work (crane) pads for equipment, as well as long-term effects associated with the displacement of wetland acreage by the structure footings.

- **Temporary structure supports in wetlands**. As part of the construction of the new transmission lines, temporary poles may have to be installed in wetlands, located along the ROW at road crossings. Such temporary poles are needed during conductor stringing to prevent the wires from sagging into the road travel lanes. These temporary poles would be removed following the completion of the stringing operation.

Tables N-1 and N-2 summarize the potential effects of the Connecticut Portion of the North Bloomfield to Agawam 345-kV and MMP Line Routes, respectively, on wetlands.[1] As summarized in Table N-1, based on preliminary design data, along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, approximately 26 acres of forested wetland vegetation would have to be removed to clear an additional 100 feet on average along the existing ROW. Such forested wetlands will be converted to and maintained as scrub-shrub and emergent wetland cover types. Along the MMP ROW, approximately 1.4 acres of forested wetland vegetation would be cleared and converted to shrub-scrub or emergent wetland cover types (refer to Table N-2).

[1] Floodplain soils are also accounted for as part of the wetland impact discussion because in Connecticut, state wetlands are defined based solely on soil type, including floodplain soils.

Table N-1 Summary of Potential Effects on Wetlands, Watercourses and Floodplains Along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route

Impact Type	Palustrine Emergent Wetland (acres)	Forested Wetland (acres)	Palustrine Scrub-Shrub Wetland (acres)	Non-Wetland Floodplain (acres)	Total (acres)
Town of Suffield					
Crane Pads	0.20	0.31	0.42	0.33	1.26
Access Roads	0.08	0.20	0.50	0.17	0.95
Public Roads Adjacency	0.08	0.04	0.06	0.00	0.18
New Structure Foundations	0.01	0.01	0.01	0.01	0.04
Tree Clearing Within Existing ROW	0.00	7.76	0.00	0.00	7.76
Tree Clearing to Widen ROW	0.00	0.00	0.00	0.00	0.00
Total	0.37	8.32	0.99	0.51	10.19
Town of East Granby					
Crane Pads	0.00	1.13	0.18	0.24	1.55
Access Roads	0.04	0.40	1.30	0.10	1.84
Public Roads Adjacency	0.00	0.06	0.12	0.00	0.18
New Structure Foundations	0.00	0.02	0.00	0.01	0.03
Tree Clearing Within Existing ROW	0.00	17.19	0.00	0.00	17.19
Tree Clearing to Widen ROW	0.00	0.00	0.00	0.00	0.00
Total	0.04	18.80	1.60	0.35	20.79
Town of Bloomfield					
Crane Pads	0.00	0.00	0.00	0.01	0.01
Access Roads	0.01	0.02	0.00	0.04	0.07
Public Roads Adjacency	0.00	0.07	0.00	0.02	0.09

Impact Type	**Palustrine Emergent Wetland (acres)**	**Forested Wetland (acres)**	**Palustrine Scrub-Shrub Wetland (acres)**	**Non-Wetland Floodplain (acres)**	**Total (acres)**
New Structure Foundations	0.00	0.00	0.00	0.00	0.00
Tree Clearing Within Existing ROW	0.00	1.41	0.00	0.00	1.41
Tree Clearing to Widen ROW	0.00	0.00	0.00	0.00	0.00
Total	0.01	1.5	0.00	0.07	1.58
TOTAL	0.42	28.62	2.59	0.93	32.56

Notes: Potential effects on wetlands were estimated based on the following assumptions:

Forested clearing width along the ROW for the new 345-kV transmission line is estimated at 100 feet.

Crane pad dimensions of 100 feet by 100 feet.

Total access road widths of approximately 20 feet (for existing access roads, this would involve an 8-foot expansion of the present 12-foot-wide wide roads).

Public Roads Adjacency is defined as wetlands within 30 feet of a roadway crossing, where temporary structures may be required to facilitate the stringing of wires, etc. for the new transmission lines. A short-term disturbance area of approximately 10 feet by 10 feet is assumed at each such temporary pole site.

Table N-2 Summary of Potential Effects to Wetlands, Watercourses and Floodplains

Town of Manchester, Manchester Substation to Meekville Junction

Impact Type	Palustrine Emergent Wetland (acres)	Palustrine Forested Wetland (acres)	Palustrine Scrub-Shrub Wetland (acres)	Non-Wetland Floodplain (acres)	Total (acres)
Crane Pads	0.00	0.22	2.08	0.91	3.21
Access Roads	0.04	0.09	1.00	1.35	2.48
Public Roads Adjacency	0.01	0.20	0.31	4.52	5.04
New Structure Foundations	0.00	0.01	0.01	0.01	0.03
Tree Clearing Within Existing ROW	0.00	1.41	0.00	0.00	1.41
Tree Clearing to Widen ROW	0.00	0.00	0.00	0.00	0.00
Total	0.05	1.93	3.40	6.79	12.17

Notes: Potential effects on wetlands were estimated based on the following assumptions:

Forested clearing width along the ROW for the new 345-kV transmission line is estimated at 100 feet.

Crane pad dimensions of 100 feet by 100 feet.

Total access road widths of approximately 20 feet (for existing access roads, this would involve an 8-foot expansion of the present 12-foot-wide wide roads).

Public Roads Adjacency is defined as wetlands within 30 feet of a roadway crossing, where temporary structures may be required to facilitate the stringing of wires, etc. for the new transmission lines. A short-term disturbance area of approximately 10 feet by 10 feet is assumed at each such temporary pole site.

To minimize or avoid adverse effects to wetlands, CL&P has attempted to locate new transmission structures in upland areas wherever practical and to limit the access roads required across wetlands if there are practical upland alternative access roads available. Where structures will unavoidably have to be located in wetlands, CL&P will make every effort to limit the impacts to the wetlands, either by reducing the size of the crane pad or by re-configuring the crane pad, if practical, to avoid placement of temporary fill in wetlands. In general, where a new structure must be located in a wetland, a temporary timber pad will be used for construction support. In some wetland areas, however, field conditions (such as thickness of organics, depth of water or steep slopes, etc.) may require the use of a temporary gravel pad to provide a safe working surface. The temporary fill used for the crane pads in wetlands may be removed after the completion of structure installation.

Best management practices, as detailed in the Northeast Utilities Transmission Group Best Management Practices Manual for the State of Connecticut, *Construction & Maintenance Environmental Requirements* (December 2007), will be employed to minimize disturbances to wetlands during construction of the Connecticut Portion of the North Bloomfield to Agawam 345-kVand the MMP Line Routes. The boundaries of the wetlands along the ROWs would be clearly demarcated (i.e., re-flagged by a registered soil scientist) prior to the commencement of work. When working in or traversing such wetlands, CL&P would:

- Install, inspect, and maintain erosion and sediment controls and other applicable construction best management practices.
- Limit grading for access roads and structure foundations in wetlands to the amount necessary to provide a safe workspace.
- Install temporary timber matting or geotexile and stone pads for access roads across wetlands or to establish safe and stable construction work areas/crane pads within wetlands, where necessary. The type of stabilization measures to be used in wetlands will depend on soil saturation.
- Restore wetlands, after transmission facility construction, to pre-construction configurations and contours to the extent practicable.
- Comply with the conditions of federal and state permit conditions related to wetlands.
- Do not pile cut woody wetland vegetation so as to block surface water flows within or otherwise to adversely affect the integrity of the wetland.

- Cut forested wetland vegetation without removing stumps unless it is determined that intact stumps pose a safety concern for the installation of structures, movement of equipment, or the safety of personnel.
- Avoid or minimize access through wetlands to the extent practical. Where access roads must be improved or developed, the roads would be designed, where practical, so as not to interfere with surface water flow or the functions of the wetland.
- Install temporary erosion controls around work sites in or near wetlands to minimize the potential for erosion and sedimentation.
- Refuel construction equipment (apart from equipment that cannot be practically moved) 100 feet or more from a wetland. If refueling must occur within a wetland, temporary containment will be provided.
- Do not store petroleum products within 100 feet of a wetland.
- Restore structure work sites in and temporary accessways through wetlands following the completion of line installation activities.

To provide new access across wetlands (where no access road currently exists), CL&P would either construct a new gravel access road underlain by geotextile fabric; or install a timber mat (swamp mat) road. In wetlands where there is a deep organic layer or the wetlands are prone to extended inundation, the gravel access roads would remain in place permanently to provide a firm base for future access to the transmission facilities. The surficial fill materials used to construct the access roads would be removed down to the pre-construction elevation so as to not interfere with the surface hydrology of the wetland. The underlying material would serve as either a firm base for equipment access or for the future placement of temporary timber mats to cross these larger wetland systems. CL&P anticipates that this practice of establishing a permanent “access road base” may occur in some wetland systems. All other timber mat or gravel access roads would be removed in their entirety after construction.

Temporary and permanent effects on floodplains will occur at localized areas within the ROW that lie within the 100-year FEMA floodplain boundary of major rivers and streams. Along the MMP Line Route, certain new structures will have to be located within the Hockanum River floodplain and SCEL. The unavoidable location of these structures in the floodplain is expected to have a negligible effect on flood storage potential. CL&P will coordinate with the CT DEP and will apply for a permit, for any proposed structures within the SCEL. Temporary fill placed within the Hockanum River and any other floodplains for temporary access roads or crane pads would be removed following the completion of construction.

Because certain structures will unavoidably have to be located in wetlands, the projects will result in a minor amount of permanent wetland fill associated with the structure foundations. Permanent access roads also will have to remain in certain wetlands. Such fill will displace wetland soils and vegetation and thus will constitute a long-term adverse effect. To compensate for such wetland impacts, CL&P would coordinate with the CT DEP and USACE to assess compensatory mitigation options.The amount of compensatory mitigation required will depend on the final project designs and the amount of permanent wetland effects. Compensatory wetland mitigation options for the projects may include wetlands restoration and/or enhancement along the project ROWs, mitigation banking, wetlands restoration and/or enhancement, wetlands creation (on or off the ROWs), wetlands preservation, and/or conservation restrictions.

N.1.2.2 Rivers and Streams

All of the watercourses located along the Connecticut Portion of the North Bloomfield to Agawam 345-kVand MMP Line Routes are presently spanned by existing transmission lines, and certain of the smaller stream crossings along these existing ROWs also are traversed by existing utility access roads. Because the development of the proposed transmission lines would not create a new corridor across these watercourses and, for the most part, would not involve in-stream activities, the projects would have limited and short-term overall effects on streams and water quality.

CL&P proposes to avoid direct construction work in watercourses to the extent feasible and to limit the potential for effects associated with erosion, sedimentation, or spills into streams and rivers from nearby upland construction activities. The proposed transmission lines would span all watercourses, although temporary and possibly permanent access will be required (i.e., use of existing access roads or creation of new access roads) across the smaller stream crossings along the ROWs. Thus, no access would be required across the larger watercourses, such as the Farmington and Muddy Rivers along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and the Hockanum River along the MMP Line Route; instead, the ROW would be accessed from either side of these rivers.

Crossings of smaller streams by construction equipment would be minimized to the extent possible. Existing access roads, which already cross these watercourses along the ROWs, would be utilized whenever possible.

Vegetation removal would be minimized along streams. Only the minimum amount of vegetation necessary for the construction and safe operation of the transmission facilities (including the provision of access) would be removed. Vegetation removal near streams would be performed selectively, to preserve desirable streamside vegetation for habitat enhancement, shading, bank stabilization, and erosion/sedimentation control.

Potential effects on watercourses may occur from vegetation removal within riparian zones/buffers (as necessary to allow safe construction or to maintain appropriate clearance from conductors) and the movement of construction equipment across watercourses involving the use of temporary equipment bridges or permanent access roads. Temporary bridges consisting of timber mats (or equivalent) may be used for equipment to cross streams, where alternative means of access is not available. Use of such materials will allow for the avoidance of effects on banks and stream bottom sediments.

However, in general, culverted access roads have historically been installed across the smaller existing watercourses along the ROWs. Prior to construction, integrity inspections of the culverts will be conducted, and culvert structures deemed to either be in disrepair or unable to support the weights of the anticipated construction vehicles would be replaced at the same location and designed to maintain the stream flows. New culverts may be required where no culvert currently exists. These new culverted crossings would be designed and installed in accordance with the USACE and CT DEP Inland Water Resources Division guidelines.

The MMP Line Route will traverse the SCEL of the Hockanum River. Certain structures will unavoidably have to be located within the SCEL. CL&P will apply for a permit from the CT DEP for the construction and operation of any proposed transmission facilities within the Hockanum River SCEL. The permit application will include a review of the potential effects of the proposed transmission facilities on the floodplain environment, including wildlife and fisheries habitats, and on flooding and flood hazards. Subsequently, work within the SCEL will be performed in accordance with the conditions of the CT DEP permit.

CL&P would implement the following mitigation measures to minimize the potential effects of construction activities in or near watercourses:

- Where existing access roads that cross stream bottoms must be improved, clean materials will be used (e.g., clean riprap or equivalent, rock fords). To the extent possible, the improvement of existing access roads across streams that support fishery resources will be scheduled to avoid conflicts with fish spawning/migration.

- Water flows (if water is present at the time of construction) would not be constrained at any time during construction.
- Concrete (used for structure foundations) would not be mixed or placed so as to enter a watercourse.
- Installation of new culverts at currently day-lighted stream reaches will be avoided to the greatest extent.
- To the extent feasible, a riparian zone of existing vegetation will be maintained from the banks of the watercourse.
- Permit conditions imposed on construction by regulatory agencies would be followed.

N.1.2.3 Groundwater Resources and Public & Private Water Supplies

Neither the construction nor the operation of the projects would result in effects on groundwater resources, public water supplies, or private groundwater wells located near the proposed transmission line routes. The operation of the overhead transmission lines would not adversely affect groundwater resources or potable water supplies.

The excavations required for the installation of the overhead transmission line structures and foundations are expected to be above any aquifers used for potable water supply. Groundwater may be encountered in low areas where excavation for some structure foundations may be necessary. However, it is unlikely that the excavation or limited blasting (if any) associated with the installation of certain structure foundations would affect groundwater used for water supply. In the event that groundwater is encountered during excavation for overhead structures or foundations, dewatering would be performed in accordance with applicable permit conditions and best management practices. Such practices may include pumping the water into temporary settling/dewatering basins, followed by discharge (via filter materials) back onto the ground to allow for infiltration; into catch basins (if permitted by the CT DEP, the municipality and the Council); or into a tank truck and then transported off-site to a suitable disposal location.

During construction activities, CL&P would require its contractors to adhere to its best management practices and any project-specific regulatory requirements regarding the storage and handling of any hazardous materials used during the work. Proper containment and handling of potentially hazardous materials such as diesel fuel, motor oil, grease and other lubricants, will be required. Further, CL&P will require its contractors to adhere to its standard emergency response plan or to a project-specific spill prevention, containment, and response plan, which may be developed to incorporate the standard hazardous materials storage, handling, and response procedures, as applicable to the Connecticut Portion of the North Bloomfield to Agawam 345-kV and MMP line projects.

Construction staging areas and contractor yards, which would be identified during the preparation of the D&M Plan, would typically be located at existing developed areas (parking lots, existing storage yards), where the storage of construction materials and equipment, including fuels and lubricants, would not conflict with aquifer protection areas. CL&P and/or its contractor would perform due diligence on any yard site; CL&P's standards for spill prevention, control, and response, erosion / sediment control, and other best management practices would apply.

N.1.3 Biological Resources

N.1.3.1 Wildlife and Vegetation

Because both of the proposed transmission line routes would be aligned along existing utility corridors, effects on vegetation communities and wildlife assemblages would occur within and parallel to the existing ROWs, which are maintained in shrub-scrub or other open habitat types. For the most part, the vegetative communities that would be affected by the proposed projects along and adjacent to these existing ROWs are common to the region.

In order to install and operate the proposed facilities, additional vegetation will have to be removed for construction and thereafter maintained in low-growth shrubs or grasses. In the areas where forested vegetation removal is required, the projects will have long-term, but incremental and localized, effects on vegetation and associated wildlife habitats.

The creation of additional shrub land habitat along the maintained ROWs would represent a long-term positive effect on some species, since shrub land habitat is otherwise declining in New England. This decline is a result of various factors (e.g., development, ecological succession, absence of fire). In this regard, transmission line ROWs are considered a major source of shrub land habitat.[2]

Along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, the construction of the proposed 345-kV line would result in the removal of some vegetation within the existing 115-kV corridor, as well as additional tree clearing and vegetation removal. In order to widen the maintained portion of the existing ROW by approximately 100 feet, approximately 103 acres of upland deciduous and coniferous forest would be cut. In addition, approximately 26 acres of palustrine (mostly deciduous) forested wetland would have to be cleared of woody vegetation. Along the MMP Line Route, approximately 3.7 acres of forested upland vegetation would have to be cleared and maintained in shrub or grass cover types along the existing ROW. In addition, approximately 1.4 acres of palustrine (mostly deciduous) forested wetland would have to be cleared of woody vegetation.

Vegetation removal to widen the ROW and provide equipment access would be performed using mechanized methods. Where removal of woody vegetation is required, vegetation will be cut flush with the ground surface to the extent possible. Where practical, trees will be felled parallel to the ROW to minimize the potential for off-ROW vegetation damage.

The removal of vegetation along the proposed transmission line route would modify, but would not eliminate, vegetative cover types and therefore wildlife habitats. In general, the principal effect would be

[2] Shrubland habitat information from "Wildlife Habitat in Connecticut: Shrubland", Laura Saucier, Habitat Management Program, in *Connecticut Wildlife*, July/August 2003.

the removal of existing mature mixed forest areas – moving the current forested edge habitat, and replacing the existing edge with old field and shrub land and open field habitats. In forested wetlands, the removal of the tree canopy would create scrub-shrub swamp wetlands, such as are present along the existing ROW, including areas of open emergent wetland and wet meadow habitat.

Vegetation on the existing CL&P ROW is managed in accordance with CL&P's vegetation management program; accordingly, trees that could interfere with the operation of the existing lines are removed from within the cleared portions of the ROW and trees along the edges are periodically trimmed or removed. The operation of the new transmission facilities would require the maintenance of a wider existing ROW in low-growth shrub land and open field habitats.

However, the management and maintenance of ROWs create early successional habitats dominated by scrub-shrub vegetation and open areas with dense grasses and other herbaceous vegetation. Scrub-shrub habitats within the ROW can provide wildlife habitat such as nesting for birds, browse for deer, and cover for small mammals (Ballard et al., 2004)[3]. These habitat types are increasingly rare in the northeast (due to the conversion of farms to forest and the loss of habitat caused by development) but tend to offer habitats preferred by particular organisms for certain stages of their annual life-cycles.

N.1.3.2 Wildlife Resources

The removal of mature trees within the ROW will affect wildlife species composition by favoring species that prefer shrub land/emergent habitat to those that inhabit forested communities. During construction, temporary displacement of wildlife may occur due to the initial disturbance from vegetation clearing, and the operation of construction equipment. However, the ability of the area to provide wildlife habitat is not expected to be adversely affected post-construction. Conversely, a study conducted by Nickerson and Thibodeau (1984) indicated an increase in wildlife utilization, especially in avian species, following

[3] Ballard, B.D., H.L. Whittier, and C.A. Nowak. 2004. Northeastern Shrubs and Short Tree Identification, A Guide for Right-of-way Vegetation Management. State University of New York-College of Environmental Science and Forestry.

clearing of ROWs[4]. The study attributed this increase in wildlife usage to the conversion of forested areas into both wetland and upland shrub and emergent plant communities. The maintenance of the ROW provided edge effect feeding, nesting, and cover habitat for various species. The ROW also serves as open corridors connecting non-contiguous natural areas.

Larger, more mobile species, typically large mammals, would be displaced from the ROW vicinity by construction activities. Adverse effects to wildlife will be highly localized to the immediate construction sites; further, adverse effects will be minimized by adhering to mitigation measures, such as seasonal construction timing windows to avoid critical periods in species' life cycles. Following construction, wildlife species will re-colonize the habitats along the ROW.

Overall, the operation and maintenance of the new transmission lines would involve a localized shift in wildlife populations using the ROWs from those favoring forested habitats to those utilizing shrub land or old field habitats. This would have a localized positive effect on wildlife species that utilize shrub land habitat, including mammals (e.g., New England cottontail, white-tailed deer, eastern mole, bats) and various bird species (e.g., American woodcock, prairie warbler, brown thrasher, field sparrow, eastern towhee, red-tailed hawk, indigo bunting, gray catbird). Because shrub land and old field habitat are becoming less prevalent in Connecticut, this increase in shrub land and old field habitat would have a positive effect on habitat diversity and would benefit species that use such habitat.

N.1.3.3 Vegetation Management and Preservation Goals and Methods

The objective of CL&P's well-established vegetation management program is to maintain safe access to its transmission facilities and to promote the growth of vegetative communities along its ROWs that are compatible with transmission line operation and in accordance with federal and state standards.

[4] Nickerson, N.H. and F.R. Thibodeau. 1984. Wetlands and Rights-of-way. Final Report Submitted to the New England Power Company, 25 Research Drive, Westboro, MA.

To stabilize disturbed sites after the installation of the transmission facilities, CL&P would restore the contours, seed, and mulch disturbed areas with appropriate grass-type mixes and hay/straw mulch. Vegetative species compatible with the use of the ROW for transmission line purposes are expected to regenerate naturally, over time. CL&P will promote the re-growth of desirable species by implementing vegetative maintenance practices to control tall-growing tree and undesirable invasive species, thereby enabling native plants to dominate.

CL&P will take particular care to maintain vegetation along watercourses and within wetlands to the extent possible. In general, CL&P may alter, to some degree, its vegetation management activities in the following areas:

- Areas of visual sensitivity where vegetation removal may be limited for aesthetic purposes.
- Steep slopes and valleys that are spanned by transmission lines.
- Agricultural lands.
- Near homes where owner-maintained landscapes do not interfere with the construction or operation of the facilities.
- Within wetlands, amphibian breeding habitats, or along streams to preserve some shrub cover.
- To the extent feasible, maintain a vegetated riparian zone adjacent to watercourses and waterbodies.

While CL&P has historically conducted ROW vegetation maintenance as a matter of good utility practice, since April 7, 2006, all public utilities have been required to comply with mandatory standards adopted by the North American Electric Reliability Council (NERC) following the August 14, 2003 Northeast blackout, an event which was found to have been triggered by line outages caused by overgrown vegetation. CL&P's vegetation management practices are designed to allow the safe operation of transmission lines by preventing the growth of trees or invasive vegetation that would interfere with the transmission facilities or access along the ROW. As a result, the vegetation on the ROW within the maintained portions of CL&P's ROW typically consists of shrubs, herbaceous species, and other low-growing species. Presently, unused or non-maintained portions of CL&P's ROW that are not proximate to the existing line may support taller vegetation, as long as it will not conflict with the construction or operation of the lines.

While undesirable tall-growing woody species, within the ROW and proximate to the existing or new lines will be removed during construction, desirable species will be preserved to the extent practical. In selected locations, certain desirable low-growing trees that, due to their growth characteristics and locations relative to the new line, may be allowed to remain on the ROW and trimmed to assure adequate clearance from wires and structures, pursuant to CL&P's *Right-of-Way Vegetation Initial Clearance Standard for 115-kV and 345-kV Transmission Lines*. However, any vegetation that is preserved during construction activities may be removed in the future in accordance with CL&P's *Specification for Rights-of-Way Vegetation Management*. Generally, all tall growing tree species will be removed from the ROW and low-growing tree species and taller shrub species will be retained in the areas outside of the conductor zones (the area directly under the conductors extending outward a distance of 15 feet from the outermost conductors).

During and following the new transmission line construction, off-ROW "danger" trees, that have been determined to present an imminent hazard to the integrity of the lines, also will be identified and removed. Hazardous danger trees are structurally weak, broken, damaged, decaying or infested trees that could contact the structures or conductors or violate the conductor clearance zones if they were to fail and fall towards the ROW.

N.1.3.4 Fisheries

Although the proposed transmission line routes traverse several watercourses that contain fisheries (e.g., the Farmington and Muddy Rivers along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and the Hockanum River along the MMP Line Route), the projects will have limited, if any, adverse effect on fisheries resources. No new structures are proposed to be installed in any watercourses, and CL&P plans to avoid or minimize the use of access roads that would involve direct disturbance to stream banks and substrates.

Although the proposed transmission lines would be designed to span watercourses, access roads will be required across certain watercourses that may support fisheries. In addition, riparian vegetation may have to be removed to allow construction or to provide for the safe operation of the lines. Access across major watercourses would be avoided by using alternative access routes to the ROW. Access across other watercourses on the ROW would be accomplished using temporary equipment bridges, which would be designed and installed to span watercourses.

Riparian vegetation along the ROW would be maintained along the banks, in order to provide shade, and vegetation would be cut only if required to maintain safe clearances and access to and from the transmission facilities. Measures also would be taken to minimize the potential for sedimentation into watercourses resulting from construction activities in nearby upland areas. In particular, temporary soil erosion and sedimentation controls would be installed around areas of disturbed soils at work sites up gradient from streams. These temporary erosion controls would remain in place until the disturbed areas are re-vegetated or otherwise stabilized.

N.1.3.5 Amphibians

Based on the results of field surveys, the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route will traverse or be located near 18 amphibian breeding habitats/vernal pools on the ROW. Two amphibian breeding habitats/vernal pools were identified along the MMP Line Route.

The species identified along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route during the surveys included spotted salamanders, Jefferson salamanders, wood frogs, spring peepers and green frogs. The breeding population of the Jefferson salamander, a state-listed species of special concern, was confirmed in two wetlands. The species identified along the MMP Line Route were the spotted salamander and wood frog.

The majority of the confirmed amphibian breeding habitats occupy areas on the existing ROW where there is shrub-scrub growth, and extend into the forested areas along the proposed ROW for the new transmission line. In this respect, the existing ROW is affording habitat for these species and, after the completion of construction, the expanded areas of maintained vegetation along the new ROW will increase the available habitat.

However, potential effects on amphibians could occur during construction, particularly if work activities are performed during critical amphibian breeding or migration periods. Such impacts could occur from activities such as vegetation removal; access road development; movements of heavy equipment on access roads; sedimentation into amphibian habitats; destruction of structural habitat features; or through the use of equipment staging areas (crane pads) and timber mats in breeding habitats during breeding periods.

Structure locations and construction work areas have been designed to avoid amphibian breeding habitats to the extent feasible. To the extent practicable, new structures would be located outside of wetlands that provide for amphibian breeding. However, several of the breeding areas exist within large wetland systems that contain one or a number of structures. Therefore, it is not feasible to avoid such expansive areas entirely. As a result, some new structures may need to be placed in wetlands that function as amphibian breeding habitat. Additionally, access to these structure sites will be required, which may result in temporary effects to the functions of the amphibian breeding habitat.

The spring migration and breeding period for adult male salamanders (spotted and Jefferson salamanders) extends approximately from March 1st through May 1st, and for species such as the marbled salamander the migration and breeding season extends approximately from September 1st through October 31st. CL&P will continue to consult with the CT DEP to identify appropriate measures to minimize or avoid adverse effects on these species (refer also to Section N.1.3.7). Among the measures currently under consideration are:

- Where feasible, and taking into consideration electrical outage constraints, adhering to the seasonal window for clearing the ROW to avoid effects on amphibian breeding habitats,
- Siting the majority of the proposed structure locations outside of confirmed amphibian breeding pools,
- Evaluating the use of temporary timber mat access roads in lieu of constructing gravel access roads in the vicinity of amphibian breeding habitat;
- Minimizing removal of low-growth vegetation surrounding the breeding pools,
- Incorporating the maintenance of vegetation cover within and around the amphibian breeding pools into CL&P's vegetation maintenance program for the ROW,
- Implementing an effective erosion and sediment control plan to avoid and/or minimize the deposition of sediment into the breeding pools.

N.1.3.6 Birds

The primary effects on birds from the proposed projects will result from habitat modification due to vegetation clearing during construction, and ROW vegetation management activities during operation. During construction, existing mature woody vegetation along the ROW will be removed. After the completion of construction, the ROW will be maintained in low-growing shrub land habitat typical of CL&P's existing maintained ROW and consistent with federal and regional safety standards for overhead transmission lines.

Therefore, a net long-term loss of woodland habitat will occur. This effect will be mitigated by aligning the proposed transmission lines along existing ROWs, and limiting vegetation clearing to areas required for the construction and safe operation of the project facilities. As previously stated, the loss of woodland habitat will be offset by a corresponding increase in early successional habitats. These types of habitats are in decline in Connecticut, as agricultural lands are abandoned and revert to their previously forested state or are developed.

In general, the types of habitats found along the project ROWs are common to the region. The principal effect of the Project therefore will be to expand the amount of acreage maintained along the ROW in scrub-shrub habitat type.

Species that utilize forested habitats (mixed deciduous forest/conifers and forested wetlands) could be affected to a greater extent, as mature woody vegetation will be cleared where necessary and replaced permanently with early successional and more open habitats. The projects would have a long-term beneficial impact to bird species that utilize habitats such as old field/shrub and sapling thickets, shrub swamps, emergent marsh, and to a lesser degree open water, as the amount of this habitat type would permanently increase.

Creating a wider ROW than that which currently exists to accommodate the proposed new transmission lines would not be expected to adversely affect bird populations, and may benefit shrub land species that nest on the ROW. Studies of a 100-foot ROW in Massachusetts indicated nest predation was highest along the ROW/forest edge, and a wider ROW may therefore actually benefit shrub land-nesting species by providing more potential nesting sites away from the edge habitat (King and Byers 2002)[5]. Recent declines in populations of shrub land birds in the Northeast are a growing concern among avian

[5] King, D.I. and B.E. Byers. 2002. An Evaluation of Powerline ROWs as Habitat for Early Successional Shrubland Birds. Wildlife Society Bulletin, 30(3), 868-874.

conservationists. Consequently, any adverse impacts to woodland species would be mitigated to a large extent by benefits to shrub land bird species.

The projects are also expected to result in minor, temporary adverse effects to bird species utilizing old field/shrub and sapling thicket habitats resulting from construction of the transmission structures and other facilities (e.g. primarily access roads). These would result from human disturbance during construction activities and temporary loss of habitat in areas cleared for construction. However, construction in any one area would be of short duration and areas disturbed during construction would be allowed to revert back to old field/shrub and sapling thickets following completion of construction activities.

Construction activities, and in particular, vegetation clearing can effect avian populations. Some avifauna will be temporarily displaced, possibly impacting breeding and nesting activities depending on the time of year. In general, the nesting season for a majority of the breeding birds extends from May 1st through July 31st. Tree clearing and vegetation removal within the ROW during this period could result in a loss of a breeding season for those species that have established nests within the proposed work corridor.

CL&P is still evaluating the sequence of construction activities and if scheduling of line outages and other planning considerations can be made to clear the ROW outside of the breeding bird season, CL&P will make every attempt to accommodate this timing of activities.

N.1.3.7 Rare, Threatened, and Endangered Species

N.1.3.7.1 North Bloomfield – Agawam Line Route

Based on consultations with the CT NDDB, followed by field surveys, several threatened, endangered, or species of special concern have been confirmed to occur in the vicinity of the transmission line route. These include one species of turtle, one amphibian species, one plant species, three freshwater mussel species, and one dragonfly. CL&P is aware that potential effects to state-listed species could occur during the construction of the project and is particularly cognizant of the need to carefully design and implement measures to minimize or avoid the potential for such adverse effects on such listed species.

The following summarizes the potential impacts and mitigation measures that CL&P has identified to date with respect to these species.

Jefferson Salamander (*Ambystoma jeffersonianum*)

Permanent and temporary detrimental effects may occur to this species and its habitat. The primary long-term effect is the clearing of forest cover as a result of widening the cleared limits of the existing ROW. The permanent removal of the forest canopy will affect the structural composition of the perimeter of the amphibian breeding habitat. However, the re-establishment of low-growth scrub-shrub vegetation within and adjacent to this breeding habitat will help to offset the loss of forest canopy, as a relatively large portion of the confirmed breeding habitat for this salamander species occurs within CL&P's existing, maintained ROW. The Jefferson salamader's prime migration and breeding season generally extends from March 1st through May 1st; as a result, efforts will be made to avoid construction activities in amphibian breeding areas during this period. Similarly, soil erosion controls will be properly deployed around construction sites in nearby upland areas to prevent or minimize the potential for sedimentation (which could adverse affect water quality) into the amphibian breeding pools.

Potential effects on the Jefferson salamander would be minimized by restricting construction activities in the vicinity of the species' known habitats to the extent feasible. The CT DEP has recommended the following measures to minimize or avoid adverse effects on the salamander:

- Perform construction in the vicinity of the species' reported habitats from October – February, during the dormant season to avoid conflicts with the breeding season and migration of young adults.

- Avoid the location of new structures within amphibian breeding pools.
- Limit the removal of canopy covering, which shades the breeding pools and regulates the temperature regime of the breeding pools.

CL&P proposes to adhere to the seasonal window in regard to clearing the ROW to avoid effects on the amphibian breeding habitats. However, precluding the remainder of the construction activities during this seasonal window is not feasible due to outage constraints and other engineering and construction limitations.

CL&P has sited the majority of the proposed structure locations outside of confirmed amphibian breeding pools, however, avoidance of all breeding habitats within wetland systems is not feasible without introducing other incremental effects, such as additional tree clearing and widening of the ROW to avoid specific habitat types.

Tree clearing and vegetation removal is unavoidable. To mitigate the potential effects, CL&P would schedule the clearing during the species' dormant season, minimize removal of low-growth vegetation surrounding the breeding pools, and incorporating the maintenance of vegetation cover to these pools into CL&P's vegetation maintenance program for the ROW. Potential construction related effects would be minimized by implementing an effective erosion and sediment control plan to avoid and/or minimize transport of sediments to the breeding pools.

Eastern Box Turtle (*Terrapene carolina*)

Eastern box turtles could potentially occur along the ROW during construction and thus could be directly affected by the movement of construction equipment. In addition to direct mortality of individual turtles, Eastern box turtles could be temporarily displaced from habitat on the ROW. For example, construction activities occurring in old field habitats during June through October could result in disruption and/or displacement of box turtles during this active season. Tree clearing during the dormant stages box turtle activity (generally November through April) could result in disruption or killing of individual species during the hibernation period.

Potential effects on the state-listed species of turtle would be minimized or avoided by restricting construction activities to the extent possible in the vicinity of the known turtle habitats. To avoid critical periods in these species' lifecycles, the CT DEP has recommended that clearing activities be conducted during the active period for the box turtle (late spring, summer and early fall) to avoid disturbing the turtles when they are dormant. CL&P is currently evaluating the feasibility of performing the clearing within potential turtle habitat during the CT DEP's recommended timeframe. For work activities proposed outside of this time period in Eastern box turtle habitat, the CT DEP Wildlife Division recommends the following mitigation measures:

1. Installing turtle exclusion fencing around the work area prior to construction;
2. Conducting a sweep of the work area prior to construction;
3. Workers are apprised of the possible presence of this species;
4. Any turtles that are discovered be moved, unharmed to an area immediately outside the fenced or construction area and pointed in the same direction it was headed;
5. All equipment used for the Project be staged on the roadways. No vehicles or heavy machinery should be parked in any Eastern box turtle habitat;
6. Work conducted in early morning or evening hours be conducted with special care so as not to harm basking or foraging individuals; and
7. That construction not be done in old field habitat from June through October.

CL&P would comply with condition numbers 1-4 during construction. CL&P would comply with condition number 6 by providing an environmental inspector to monitor construction activities within potential box turtle habitat. CL&P would comply with condition number 5 to the extent practicable. It may not be feasible to mobilize certain pieces of equipment, such as cranes supporting new structures, multiple times a day to locate it outside potential habitat. In regard to condition number 7, CL&P is continuing to evaluate the feasibility or working within this timeframe and will continue to coordinate with the CT DEP NDDB.

Freshwater Mussels – Eastern Pearlshell Mussel (*Margaritifera margaritifera*), Dwarf Wedge Mussel (*Alasmidonta heterodon*) and Eastern Pond Mussel (*Ligumia nasuta*)

Although these freshwater mussels are purported to inhabit certain of the watercourses traversed by the ROW, the project will not directly affect any of these watercourses and therefore will not affect these species. Potential short-term, indirect effects could result from sedimentation into these watercourses as a result of construction activities in nearby upland areas. However, the preservation of vegetated riparian buffer zones and the proper installation and maintenance of erosion and sediment controls would avoid and/or minimize effects on these watercourses.

The CT DEP has recommended the proper installation and maintenance of erosion and sediment controls as well as maintaining an undisturbed riparian zone to the identied watercourses. The CT DEP has also recommended that no vegetation be removed from the stream banks adjacent to the mussel habitat as land clearing activities may affect the mussels. In response, CL&P would implement an effective soil erosion and sediment control plan to avoid and/or minimize sedimentation and siltation effects on the watercourses. CL&P would also maintain an undisturbed riparian zone along these watercourses to minimize construction-related disturbances.

Arrow Clubtail Dragonfly (*Stylurus spiniceps*)

Potential effects to the arrow clubtail dragonfly, which has been reported to inhabit one of the perennial watercourses along the ROW, could occur if construction activities cause a reduction in water quality (either by direct in-water disturbance or indirect effects associated with sedimentation/runoff into the watercourse as a result of earth-disturbing activities in adjacent areas). However, CL&P does not propose any in-water activities in the vicinity of the dragonfly habitat. Maintaining a vegetated riparian zone during construction and implementing an effective soil erosion and sediment control plan to avoid sedimentation of the watercourse will avoid the potential for adverse effects on the dragonfly, and in particular, its aquatic life cycle. It is anticipated that a riparian buffer would be maintained adjacent to the watercourse.

Bush's Sedge (*Carex bushii*)

A small population of *Carex bushii* has been confirmed to occur on the ROW. This species is adapted to disturbed areas and prefers open field/scrub land habitats such as those on the maintained ROW. Potential effects on this species include damaging and/or destroying the plants communities through the expansion of existing access roads or by equipment travel over the ROW. However, periodic disturbances associated with management and maintenance of the ROW can create early successional habitats that could promote the further establishment of *Carex bushii* on the ROW.

As requested by the CT DEP, CL&P proposes to conduct pre-construction reconnaissance sweeps/surveys to locate any plants within the ROW. Any identified plant locations will be marked for avoidance during construction. If avoidance is not possible, CL&P would, in consultation with the CT DEP NDDB, transplant the affected plants to a location outside of the construction area.

N.1.3.7.2 Manchester to Meekville Junction Circuit Separation Project

In response to the CT NDDB April 24, 2008 correspondence to CL&P regarding the potential for the state endangered barn owl (*Tyto alba*) to occur in the vicinity of the MMP Line Route, surveys of the ROW were performed to assess the potential for barn owl utilization of the project area. Although one potential foraging area was identified, no barn owls were observed.

No significant effects to the barn owl would occur as a result of the MMP. Construction activities may temporarily disturb this potential foraging habitat; however, re--establishment of vegetation on the ROW after the completion of construction would provide continued foraging habitat for the barn owl. Overall, the maintenance of the ROW in low growth vegetation and open field habitat could potentially benefit the barn owl by providing additional potential foraging habitat.

N.1.4 Land Use, Recreational/Scenic Resources, and Land Use Plans

Municipal consultations and evaluations of land use documents indicate that the development of the transmission line facilities would not conflict with local land use plans, because the proposed transmission facilities would be developed predominantly within existing, long-established ROWs that are already dedicated to energy use. Along the transmission line routes, CL&P's existing easements already preclude permanent non-utility structures. All of the MMP Line Route and all but approximately 3 acres of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route will be developed within existing CL&P easements or within CL&P fee properties. Along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, two easements for the additional 3 acres in the Town of Suffield would be required for the installation of the new 345-kV transmission line. CL&P would need to obtain these easements from private landowners.

CL&P has solicited input from the various affected municipalities along the transmission line routes and will continue to coordinate with such municipalities as planning for the GSRP and MMP progress. CL&P has also reviewed the *Conservation and Development Policies Plans for Connecticut 2005-2010* (C&D Plan) prepared by the Connecticut Office of Policy and Management for information relating to the State's growth in general, and the municipalities of Bloomfield, East Granby, and Suffield. The objective of the C&D Plan is to guide and balance response to human, environmental, and economic needs in a manner that best suits Connecticut's future.

Based upon the general planning information provided in the C&D Plan, the GSRP and MMP are consistent with the overall goals and objectives of the C&D Plan and serve a public need for reliable transmission of electricity for the State of Connecticut. As stated in the C&D Plan, "The ability to redevelop Connecticut's Regional Centers requires that existing infrastructure be maintained and updated to support compact urban development. This holds true and is particularly relevant regarding electric capacity and delivery systems" (p. 22).

CL&P has reviewed the *Capital Region Council Plan of Conservation and Development***.** The primary goals of the Capital Region Council's Plan of Conservation and Development (Council Plan) are growth, development, and conservation. The Capital Region has experienced an increase in population growth, which is expected to continue to increase in the future. The Council Plan identifies the need to continue growth and development, to conserve existing open space, and to accommodate the needs of the growing population of the capital region.

The objective of the Project is to maintain the reliability of the transmission system, consistent with the ISO-NE requirements. The reliability attributes of the Project are also consistent with regional policies, as outlined by the Northeast Power Coordinating Council (NPCC), which establishes and maintains reliability standards for the six New England states, New York, and several Canadian provinces. The NPCC is one of ten regional reliability councils that encompass the NERC, which provides uniform design and operating standards for electricity generation and delivery systems. The NPCC requires transmission systems to be designed and operated so that the loss of a major portion of the system will not result from reasonably foreseeable contingencies. The Project is designed to be consistent with regional reliability policies.

The Project is also consistent with state and local policies on several levels. The Project is designed to be consistent with the mandates of the CSC, which has jurisdiction to approve the Project based on a showing that the Project provides a reliable energy supply for the State of Connecticut with a minimum impact on the environment at the lowest possible cost. Accordingly, the Project will be consistent with state energy policy as it relates to the siting of terrestrial electric transmission line facilities.

Moreover, the Project will be constructed and operated to comply fully with the State of Connecticut's environmental policies. CL&P will obtain all the necessary permits and approvals, including CT DEP review. Accordingly, by meeting the requirements for securing state, regional and local permits, as applicable, the Project will be in compliance with applicable state and local environmental policies.

N.1.4.1 Existing and Future Development

The proposed projects will result in both short-term and long-term effects on land uses. Because the majority of the ROWs along which the projects will be located have been dedicated to utility use for approximately 80 years, the addition of the proposed transmission lines to these ROWs will have a limited and localized effect on land uses.

In the two portions of the Town of Suffield where the development of the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route will require expansion beyond the existing ROW, approximately 3 acres of private lands will have to be acquired for utility easement purposes. In these two areas (i.e., north of Ratley Road and between Phelps Road and Mountain Road), the property is currently undeveloped forest land. As a result of the development of the project, these forested areas will have to be cleared of vegetation and only uses consistent with the safe operation of the transmission line will be allowed.

Constructing the new transmission lines within the existing ROWs will result in tree clearing and vegetation removal outside of the existing "cut-line", as currently viewed along the ROW. However, because the proposed lines will be collocated within the same ROWs as the existing lines, the GSRP and MMP are expected to be compatible with existing and future land uses and developments. The easements held by CL&P currently preclude the development of non-utility structures on the ROWs, and this restriction will continue, but is not expected to affect adjacent land uses that parallel and/or cross the ROW. Table N-3 summarizes the potential effects to land uses, by land use category, along the Connecticut Portion of the North Bloomfield to Agawam 345-kV and the MMP Line Routes.

Table N-3 Summary of Potential Land Use Effects[6]

Impact Type	OFS (acres)	ROW (acres)	UF (acres)	AG (acres)	HY (acres)	CI (acres)	OW (acres)	Total (acres)
Town of Suffield								
Crane Pads	2.64	0.01	5.66	0.22	0.27	0.00	0.00	8.80
Access Roads	3.36	0.06	0.60	0.53	0.41	0.00	0.00	4.96
New Structure Foundations	0.02	0.00	0.12	0.00	0.01	0.00	0.00	0.15
Tree Clearing Within Existing ROW	0.00	0.00	39.46	0.00	0.00	0.00	0.00	39.46
Tree Clearing to Expand ROW	0.00	0.00	2.34	0.00	0.00	0.00	0.00	2.34
Total	6.02	0.07	48.18	0.75	0.69	0.00	0.00	55.71
Town of East Granby								
Crane Pads	3.71	0.11	8.41	0.85	0.00	0.00	0.00	13.08
Access Roads	5.10	0.09	2.31	0.41	0.01	0.00	0.00	7.92
New Structure Foundations	0.03	0.00	0.16	0.01	0.00	0.00	0.00	0.20
Tree	0.00	0.00	52.53	0.00	0.00	0.00	0.00	52.53

6 Land use designators correspond to the categories identified on the aerial map segments.

Clearing Within Existing ROW								
Tree Clearing to Expand ROW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	8.84	0.20	63.41	1.27	0.01	0.00	0.00	73.73
Town of Bloomfield								
Crane Pads	0.32	0.00	1.44	0.00	0.00	0.00	0.00	1.76
Access Roads	0.94	0.04	0.86	0.00	0.00	0.18	0.00	2.02
New Structure Foundations	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.05
Tree Clearing Within Existing ROW	0.00	0.00	11.65	0.00	0.00	0.00	0.00	11.65
Tree Clearing to Expand ROW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.27	0.04	13.99	0.00	0.00	0.18	0.00	15.48
Town of Manchester								
Crane Pads	2.40	0.00	0.47	0.00	0.00	0.00	0.00	2.87
Access Roads	2.00	0.10	0.20	0.00	0.00	0.03	0.00	2.33
New Structure Foundations	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.02
Tree Clearing to Widen ROW	0.00	0.00	3.68	0.00	0.00	0.00	0.00	3.68
Tree Clearing to Expand ROW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	4.41	0.10	4.36	0.00	0.00	0.03	0.00	8.90

Notes: Crane Pad dimension of 100 feet by 100 feet. Access Road width of 20 feet. New Structure Foundation disturbance of 10 feet by 10 feet. Tree Clearing width of 100 feet.

N.1.4.2 Open Space and Protected Areas

The Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route follows the existing transmission line ROW across various recreational areas, the use of which will be temporarily affected during construction. The MMP Line Route also traverses near recreational areas, as well as across the Hockanum River, which is utilized for fishing. In general, the effects of the GSRP and MMP on recreational uses will be short-term, lasting only for the duration of construction. The operation of the new transmission lines will not significant alter the use of the recreational areas along the ROWs.

The recreational facilities traversed by the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route include the Farmington Valley Greenway/Farmington Canal Heritage Trail, Newgate Wildlife Management Area, Metacomet Trail (which is managed by the Connecticut Forest and Park Association), Suffield Land Conservancy, and Suffield Sportsman's Association. As part of the pre-construction planning process, CL&P will consult with representatives of these affected recreational areas to identify site-specific mitigation measures, including possible construction scheduling and ROW restoration. CL&P would develop and submit an anticipated construction schedule to these entities, outlining CL&P's intentions, proposed closures, detours/re-routes, and other mitigation measures to minimize disruptions to these recreational elements along the ROW.

N.1.4.3 Methods to Prevent and Discourage Unauthorized Use of ROW

CL&P's existing transmission line easements restrict the types of activities that can be conducted within the ROWs. Easements typically prohibit the construction of buildings, pools, and other structures within the ROWs. Locked gates are installed along the ROW at public access points to prevent unauthorized off-road vehicular use of the ROWs. In addition, CL&P has policies that address requests from property owners and other parties external to CL&P. These policies outline an evaluation process and provide guidelines for allowing certain uses (such as driveways or parking lots), where appropriate. Requests for uses that are prohibited by the easement agreements, or that would otherwise pose safety, engineering, environmental or other concerns, are rejected.

Where CL&P holds an easement versus land ownership in fee, CL&P must receive landowner approval prior to installing fences, gates, etc. along the ROW. CL&P seeks to work with landowners and agencies to discourage unwarranted access onto and the use of its ROWs. CL&P does install signs warning the general public of the overhead hazards posed by contact with the high voltage transmission line. CL&P regularly installs fences, gates, barricades and access control berms to discourage access onto the ROW.

N.1.5 Transportation and Access

The proposed North Bloomfield to Agawam and MMP Line Routes would traverse various local and state roads. In addition, the MMP Line Route will span Interstate 84. The transmission line conductors would span these roads and would not affect the long-term use of the transportation facilities.

The well-established public road network in the project areas also would afford ready access to the ROWs for construction vehicles and equipment. Further, the ROWs would be used to provide access to construction sites; where possible, access roads that exist within the existing transmission ROWs would be improved for this purpose. New access roads will be developed along the ROWs as needed.

During construction, personnel traveling to and from work sites, as well as the movement of construction equipment, may cause temporary and localized increases in traffic volumes, and may require temporary detours. However, any such traffic volume increases would be short-term. Further, CL&P would employ local police to direct traffic at construction work sites along roads, as needed, and would erect appropriate traffic signs to indicate the presence of construction work zones. In addition, CL&P would develop an access and traffic control plan for the construction contractor(s); the objective of this plan would be to define requirements for traffic controls and to provide for the safe ingress and egress to the ROWs for construction equipment and other vehicles.

N.1.6 Cultural (Archaeological and Historic) Resources

The Historical and Archaeological Assessment of Connecticut Sections of the Connecticut Light & Power Company Greater Springfield Reliability Project (Volume 3) identifies the cultural resources that could potentially be affected by the GSRP and MMP. This report defines the known or potential archaeological resources within the project area and also evaluates the potential visual effects of the GSRP and MMP on historic properties listed or eligible for listing on the State and National registers of historic places.

The archaeological portion of the assessment was conducted in accordance with the standards of the Connecticut State Historic Preservation Office (SHPO) *Environmental Primer for Connecticut's Archaeological Resources.* The assessment of potential visual effects on historic structures was performed in accordance with C.G.S. Section 16-50p(a)(4)(C) and in the regulations of the federal Advisory Council on Historic Preservation (36 CFR 800.5).

For the archaeological evaluations, a resource assessment was performed involving the analysis of background data, as a prerequisite to a reconnaissance survey, which includes surface inspection and subsurface testing. The assessment included visual inspection of the existing transmission line structure locations, and analysis of the ROWs to access the presence of characteristics that affect the potential for archaeological site location (i.e., slope, drainage, ledge, ground disturbance, land fill). The study also involved an extensive review of documentary sources, as well as personal consultations with SHPO and the Connecticut State Archaeologist. The resulting assessment provides the basis for recommendations for future reconnaissance investigations, which would be conducted when the final project configuration is determined. (Note that such archaeological investigations involving subsurface testing would be performed in areas that the GSRP and MMP would directly affect due to activities such as earth moving, excavation, access road improvements or developments, etc.)

The Historical and Archaeological Assessment of Connecticut Sections of the Connecticut Light & Power Company Greater Springfield Reliability Project (Raber Associates, Volume 3) determined that approximately 6.7 miles of the North Bloomfield to Agawam Line Route appears sensitive for undocumented Native American archaeological resources. CL&P will consult with the Connecticut SHPO upon completion of the Phase 1B reconnaissance survey to develop appropriate testing measures to be implemented during Phase 2 activities. Any sites found and determined to be eligible for the National Register of Historic Places, and therefore deemed significant, will be avoided if possible. If avoidance is not possible, Phase 3 mitigation strategy will be developed for review and approval by the SHPO. These strategies will then be implemented to minimize or alleviate significant adverse impacts to the site(s).

The assessment identified three protected historic cemeteries within 0.25 miles of proposed route facilities. Visual analysis indicated there would be no known or likely adverse visual effects on these resources.

N.1.7 Air Quality

The development of the transmission line projects would result in short-term (lasting only for the duration of the construction period), highly localized effects on air quality during construction, primarily from fugitive dust from land disturbance and vehicular emissions associated with the operation of the construction equipment. As necessary, fugitive dust emissions will be suppressed by the use of watering on access roads. Crushed stone aprons would be installed at all access road entrances to public roadways to minimize tracking of soil onto the pavement. Vehicular emissions will be limited by requiring contractors to properly maintain construction equipment and vehicles.

There are no anticipated long-term effects on air quality associated with the operation of the existing transmission lines.

N.1.8 Noise

Construction-related noise would be short-term (lasting only for the duration of the construction period) and would generally stem from the operation of construction equipment, truck traffic, earth moving, vehicles and equipment, jackhammers and structure erection equipment (cranes) etc. Overall, the development of the transmission facilities would result in sound levels that are typical of construction projects.

Noise generated disturbances could affect certain receptors including residences, schools, and designated recreational areas. The extent of a noise impact to humans at a sensitive receptor is dependent upon a number of factors, including the change in noise level from the ambient; the duration and character of the noise; the presence of other, non-project sources of noise; people's attitudes concerning the Project; the number of people exposed to the noise; and the type of activity affected by the noise (e.g., sleep, recreation, conversation).

The impact of construction-generated noise also would depend on the location of the noise source, because sound attenuates with distance and with the presence of vegetative buffers or other barriers. Transmission line (345-kV) noise can vary from inaudible levels during fair weather through barely audible levels in relatively dry snow or light fog to distinctly audible levels in rain or wet snow. The noise level is relatively low to begin with, as it attenuates quickly with distance from the line, and may be most noticeable during foul weather, however, during these conditions few receptors would typically be near the lines to hear the increase in sound levels.

N.1.9 North Bloomfield Substation Modifications

The modifications proposed at the existing North Bloomfield Substation to accommodate the 345-kV North Bloomfield – Agawam project facilities would be generally minor, but long-term, and would be accomplished within the existing CL&P property line, but outside of the existing substation fence line.

Approximately 2.7 acres of the 34.2-acre CL&P property would be developed to accommodate the new 345-kV interconnections (approximately 6.8 acres of this property are currently developed for the existing substation facilities).

The specific modifications proposed to the substation are described in Section I. As discussed below, these modifications would have generally minor and highly localized but long-term environmental effects.

N.1.9.1 Geology, Topography, and Soils

The addition of new facilities to the North Bloomfield Substation would require site preparation work, including clearing, grading and other soil disturbance (e.g., excavations) to install the foundations and erect the new 345-kV transmission line facilities. Mechanical methods would be used to install foundations into bedrock, if encountered.

N.1.9.2 Water Resources and Wetlands

The expansion of the North Bloomfield Substation would result in unavoidable direct effects to inland wetlands, as well as activities within the Town of Bloomfield locally regulated 100-foot wetland and 200-foot watercourse upland review areas, and encroachment into the 100-year floodplain of Griffin Brook. Four inland wetlands have been identified and flagged in the vicinity of the substation, two of which will be affected by the substation expansion. Appropriate temporary erosion and sedimentation controls would be installed around disturbed areas within the station in order to minimize the potential for sedimentation into these water resources.

Approximately 0.78 acre of wetland would be permanently affected by the substation expansion, including 0.76 acre of forested/scrub-shrub wetland and 0.02 acre of isolated forested wetland. The majority of direct wetland effects are proposed within an area that has undergone historic disturbance activities. These activities were associated with an approved expansion of the original substation (circa

1978) to its current configuration, including filling, grading activities and re-routing of an existing intermittent watercourse around the perimeter of the substation. The substation expansion will also result in the permanent effect/displacement of approximately 400 cubic yards of flood storage capacity within the 100-year floodplain associated with Griffin Brook.

The loss of flood storage volume will be mitigated though the creation of compensatory flood storage volume along Griffin Brook, which is also intended to mitigate for the loss of functions and values of the affected wetlands. Additional mitigation activities to compensate for the loss of inland wetlands at the substation site will be incorporated into the overall wetland mitigation plan for the GSRP. The overall wetland mitigation plan will be developed based on consultations with the involved regulatory agencies and in compliance with applicable regulations.

N.1.9.3 Water Quality

The existing North Bloomfield Substation is equipped with secondary containment structures to contain transformer oil in the event of a spill or inadvertent release of oil. Modifications to the North Bloomfield Substation would include maintaining the existing secondary containment structures, as well as the construction of new secondary containment systems for the two new autotransformers, in accordance with Northeast Utilities Substation Standards, *Secondary Oil Containment for Electrical Equipment*. The new autotransformers will have an insulating fluid that will require a secondary containment system. The containment will be sized to accommodate 110 percent of the volume of fluid contained in the autotransformer. Appropriate spill prevention, control and countermeasure procedures would be implemented during construction to minimize the potential for inadvertent spills or leaks from construction equipment and during operation of the facility to avoid or minimize the potential for spills or leaks from fuel stored on site to power an emergency generator.

N.1.9.4 Vegetation and Wildlife

The expansion of the substation would involve the removal of approximately 2 acres of mostly deciduous upland forest and approximately 0.7 acres of deciduous forested wetland. The existing mixed hardwood vegetative community that currently characterizes the site would be replaced by additional fenced substation yard and the wildlife species that utilize this area would be displaced. Other large mixed hardwood communities are present adjacent to the area proposed to be cleared and can be expected to provide habitat for the displaced wildlife species. The expansion of the substation would represent a long-term, and localized, change in vegetation and wildlife.

N.1.9.5 Threatened, Endangered, and Special Concern Species

There are no known records of threatened, endangered or species of special concern reported by the CT NDDB in the vicinity of the Substation. However, as a result of field investigations for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route, both a wood turtle and a box turtle were observed in the vicinity of the substation. As a result, CL&P is submitting information on these sightings to the CT DEP NDDB, and will coordinate with the CT DEP regarding the identification and implementation of measures to mitigate potential effects on these species during the construction and operation of the substation modifications.

N.1.9.6 Land Use Plans and Existing/Future Development

The proposed modifications to the substation would be consistent with the existing and planned use of the property for utility purposes. CL&P owns the existing substation site, as well as various other parcels in the vicinity. No additional land would have to be acquired for the proposed station modifications.

N.1.9.7 Visual Resources

The modifications proposed to the North Bloomfield Substation would have a minor, incremental effect on visual resources. The substation has been in existence since 1950's, and the new 345-kV facilities would not appreciably alter the existing appearance of the station. The new 345-kV line structure would be approximately 90 feet tall, which is similar in height to the existing structures at the station. Moreover, the station is in a remote, wooded area, where it is not visible from private residences or public areas.

N.1.9.8 Transportation

Existing access to the North Bloomfield Substation is made via Hoskins Road/Tariffville Road. The construction of the proposed substation modifications would have a minor and short-term effect on vehicular traffic on the local roads leading to the site. At times, localized traffic congestion may occur when heavy construction equipment or electric components are transported to the site. The movement of construction workers and equipment in general also would temporarily cause increased traffic on local roads leading to the site. Construction is expected to occur during normal work hours, but is also dependent on the scheduling of allowable line outages.

However, such impacts would be minor and localized. Post-construction site conditions would not significantly affect existing traffic patterns.

N.1.9.9 Cultural Resources

The Historical and Archaeological Assessment of Connecticut Sections of the Connecticut Light & Power Company Greater Springfield Reliability Project (Raber Associates, Volume 3) did not identify any known archaeological or historic sites in the immediate vicinity of the substation. The St. Andres cemetery, a protected historic cemetery, is located across the road from the North Bloomfield Substation. Visual analysis of the area indicated there would be no significant adverse effects to associated visual resources.

N.1.9.10 Noise

Noise is generated primarily from three sources within a substation: the transformers; the transformer cooling fans; and the control house air conditioning units. It is not expected that these sources would be operating simultaneously for any duration of time because this would represent an extreme overload condition on the system. The modifications to the existing North Bloomfield Substation would result in minor changes to the noise environment in the immediate vicinity. CL&P has incorporated measures to minimize noise into the initial design of the modified substation facilities.

N.2 UNDERGROUND VARIATIONS FOR THE NORTH BLOOMFIELD TO AGAWAM 345-kV LINE ROUTE

The construction and operation of portions of the North Bloomfield to Agawam 345-kV Line Route underground, either within or adjacent to road ROWs or along sections of the existing CL&P transmission line corridor, will have effects on environmental resources that differ from overhead transmission line construction and operation. Further, the effects of constructing and operating an underground cable system within road ROWs will differ in some respects from the development of the same type of system "overland", within the transmission line ROW.

The following sections first describe the potential effects of underground cable system construction and operation on environmental resources (Sections N.2.1 through N.2.8) and then provide a description of the effects of the development of the two transition stations that would be required for the development of any of the underground variations (Section N.2.9).

N.2.1 Topography, Geology and Soils

Underground cable system construction – either within or adjacent to road ROWs or along the transmission line ROW -- would result in effects to topography, geology, and soils as a result of grading, excavation (possibly requiring blasting or other rock removal activities), and soil disturbance. Unlike the development of an overhead transmission line along which such activities are only required along access roads at a structure locations, the installation of an underground cable system will require continuous and linear grading, excavation (of a trench for the cable conduit and splice vaults), and soil disturbance along the entire length of the underground cable route.

In addition, subsurface conditions along the underground cable routes would have to be characterized prior to construction in order to develop a subsurface profile (to assess locations where bedrock and groundwater would be encountered) and also to test the quality of soils and groundwater. Based on the results of these analyses, a materials-handling plan would be prepared that would define how excavated soils and groundwater encountered during the trenching process are to be managed.

The installation of the underground cables and splice vaults along road ROWs (i.e., the Newgate Road and State Route 168/187 Underground Line Route Variations) would not require extensive grading and thus would have minimal adverse effects on topography and geology in most areas. In general, a construction ROW of approximately 40 feet is needed to install the cable system along roads. However, in areas where the cables or splice vaults must be located off-road, such as at watercourse crossings, clearing and grading would be necessary to cut stream banks, excavate the trench through the stream bed, and otherwise level the terrain so that the cable system or vaults could be installed safely and at an appropriate elevation below grade. Extra work space also would be required in such areas to stage the watercourse crossings. In addition, extra work space for other staging areas, such as at any jack and bore sites or in areas where construction equipment and materials would have to be temporarily stored, also may involve localized earth-disturbing activities such as clearing and grading.

In contrast, the installation of a cable system along the transmission line ROW would involve extensive clearing and grading along the entire length of the underground variation ROWs; such grading would be required to create permanent access roads[7], provide a level work space for construction equipment, and achieve appropriate subsurface elevations for the installation of the entire cable system (cables and splice vaults). A ROW width of approximately 60 feet would be required to install the cable system within the existing transmission line ROWs. This wider construction ROW would be needed to accommodate an access road, as well as the excavated trench/splice vault areas. Tree clearing would be required beyond

[7] Access roads would be developed and used during construction, but would have to remain in place permanently because access to the entire underground cable systems is required for operation and maintenance purposes.

the limits of the existing maintained ROW corridor. A minimum 30 foot off-set from the centerline of the existing overhead lines is required for the underground cable, and thus additional tree clearing and vegetation removal would be required to provide a construction corridor for the underground facilities. Within this construction area, it is anticipated that all vegetation would have to be removed and the area would have to be graded to create a level work space.

Whether along a road ROW or within the transmission line ROW, XLPE cable installation would involve the excavation of a continuous trench (approximately 7 - 10 feet deep and 5 feet wide at the bottom, and typically with a 10-foot-wide opening at the surface), as well as concrete splice vaults (each of which would require an excavation area approximately 13 feet wide by 13 feet high and 35 feet long) at approximately 1,600-foot intervals along the route. The required excavations may be deeper or wider, depending on soil conditions and, when trenching along roads in particular, depending on whether the cable system must be installed below other buried utilities (e.g., water lines, sanitary sewers, storm sewers). Trench boxes and other types of shoring will be required to support the trenches while the conduit is being installed. Shoring also is typically required at splice vault installations.

To excavate the trench and splice vaults for the underground cables through areas of rock, special rock removal methods would be required. The preferred techniques for removing rock would be mechanical methods (e.g., mechanical excavators and pneumatic hammers) or mechanical methods supplemented by controlled blasting. Such rock removal activities would result in dust and vibration/noise in the immediate vicinity of the excavation work. Controlled blasting would only be used if other methods of rock removal are not practical. If blasting is required, the same mitigation measures described for the overhead line in Section N.1.1 would be followed.

Because underground cable installation is time-consuming, the length of time that soils or excavations are exposed in any one location (and therefore subject to the potential for erosion or sedimentation into water resources) can be significant and may range up to several months. The amount of construction time required at any one location depends on subsurface conditions, particularly whether bedrock or groundwater are encountered in the excavations.

During cable system excavation, measures would have to be implemented to contain temporary soil/material storage piles and to avoid sedimentation into watercourses or wetlands, either from erosion of disturbed soils or from sedimentation caused by excavation dewatering. Temporary erosion and sedimentation control measures would have to be installed, consistent with CL&P's established plans and with the *2002 Connecticut Guidelines for Soil Erosion and Sedimentation Control*. For work within and adjacent-to-road ROWs, typical erosion and sediment control measures may include catch basin protection, the use of fractionization tanks, or the use of dewatering structures or filter bags. Such temporary controls would typically be maintained until the restoration of disturbed work sites is deemed successful, as determined by standard criteria for storm water pollution prevention and erosion control.

After the completion of conduit and splice vault installation, the excavated trench and splice vault areas would be backfilled with special "flowable fill", a concrete mix that is designed to dissipate heat from the cables. For the most part, the material originally excavated from the trench would not be used as backfill. Instead, soils would be trucked off-site and disposed of at approved sites, in accordance with applicable regulations and as defined in the materials handling plan.

After the completion of cable system installation, disturbed ROW areas would be restored to grade to the extent practical. Along the Newgate Road and State Route 186/187 Underground Line Route Variations, disturbed pavement would be resurfaced and affected road shoulders/curbing/sidewalks would be repaired. Along the in-ROW underground variations, the ROW would be reseeded and allowed to revegetate, except for the 20-foot-wide permanent access road, which would be maintained for operation and maintenance purposes.

N.2.2 Water Resources and Water Quality

The construction and operation of the underground variations would involve both direct and, potentially, indirect effects to water resources. All of the underground variation line routes traverse both wetlands and watercourses. While the Newgate Road and State Route 168/187 Underground Line Route Variations may be constructed within road ROWs, above or below certain of these water resources, avoidance of effects to all water resources is unlikely since in some areas along these routes, it is anticipated that it would not be feasible to install the cable system on bridges or culverts. As a result, some in-water construction would be required. Further, while subsurface techniques, such as jack and bore or horizontal directional drill (HDD) may be considered for some larger watercourse crossings, even these techniques, which are both costly and time-consuming would involve some effects to water resources. For example, jack and bores near watercourses typically encounter groundwater, which must be pumped continuously from the excavated pits and which typically requires ultimate discharge to a surface water. HDDs require withdrawal of water for the drilling fluid mix, and also may result in inadvertent returns of the drilling fluid/drill cutting mix to the surface water.

The in-ROW underground variations would involve work along a continuous ROW through, and direct effects to, all water resources within the construction footprint. To allow for ongoing construction and maintenance, it would be necessary to construct a much more extensive and permanent access road along the ROW for an in-ROW underground line. The construction of such an access road would affect wetlands and watercourses on the ROW.

Potential effects to water resources associated with underground cable system construction include sedimentation and turbidity that may be caused by clearing and grading of stream banks, excavation in wetlands and streams, trench/vault dewatering, and backfilling. In addition, the soils disturbed along the cleared ROW could erode, resulting in effects to water quality. In general, along the in-ROW underground variation routes, the clearing and grading of the ROW would expose large areas of soil to erosional forces and would eliminate areas of riparian vegetation along stream banks.

The operation of construction equipment and vehicles along the ROWs, as well as the refueling of construction machinery and the storage of fuel, oil, or other fluids near water resources could create a potential for contamination due to accidental releases to the environment. Spills to water resources could migrate downstream and could affect aquatic organisms and water quality.

The use of flowable fill, rather than native backfill in the trench and splice vaults, also could have a long-term, localized adverse effect on water resources. It is possible that the flowable fill could disrupt natural subsurface water flows or could affect infiltration rates. This could be a potential concern along the in-ROW underground variations, rather than for the construction of the Newgate Road and State Route 168/187 Underground Line Route Variations, which would be aligned mostly within paved road ROWs.

Neither the construction nor the operation of the underground variations would result in significant adverse effects to groundwater resources or public water supplies. However, groundwater is likely to be encountered along all of the underground variations and would have to be carefully managed throughout the excavation phases of construction. Trench dewatering, whether along roads or along the CL&P transmission line ROW, has the potential to cause the discharge of turbid or sediment-laden water to streams and wetlands.

In general, if groundwater is encountered during trench or splice vault construction, the water would be pumped from the excavated areas and discharged in accordance with the requirements of applicable regulations. Depending on regulatory authorizations and on the alignment of the underground variation, the water may be pumped into municipal storm water catch basins, to the sanitary sewer system, into temporary settling basins and sediment filter bags, or watercourses (if the water is sufficiently free of sediment). Alternatively, water may be pumped into a tank truck for off-site disposal.

Further, along the Newgate Road and State Route 168/187 Underground Line Route Variations and where the in-ROW variations traverse roads, the cable system would have to be carefully aligned so as to avoid impacts to municipal water lines, as well as storm and sanitary sewers. Excavations for trenches or splice vaults would have to be performed carefully to avoid conflicts with these existing utilities.

To minimize adverse effects to water resources during the construction of the underground variations, CL&P would implement the same types of mitigation measures as discussed for the overhead line routes in Section N.1.2.

N.2.3 Biological Resources

The effects of underground cable system installation and operation on biological resources would differ substantially, depending upon whether the underground alignment is aligned within or adjacent to existing road ROWs or within the more sensitive CL&P transmission line ROW.

N.2.3.1 Wildlife and Vegetation

The construction and operation of underground transmission cables along the Newgate Road and State Route 168/187 Underground Line Route Variations would result in minimal effects on vegetation and wildlife resources because both of these variations would be aligned primarily within or adjacent to existing paved road ROWs in rural/suburban areas. Along a majority of these route variations, vegetation would not likely be affected, with the exception of vegetation within or near road shoulders, the removal of trees or tree branches that overhang the roadways, or riparian or wetland vegetation that may be affected if the cable system must be aligned across water resources outside of the road ROWs.

Along the Newgate Road Underground Line Route Variation, near the intersection of Turkey Hills Road and Old Road, the specimen red oak tree (as discussion in Section M.1.3.1) may be affected by construction. This tree is located very close to the road and, as a result, cable system excavation work could affect the tree’s root system.

Further, if splice vaults must be located outside of road ROWs (as may be requested by ConnDOT along state roads), existing lawns, trees, and ornamental vegetation may have to be removed in some locations. The amount and type of vegetation affected would depend on the actual locations of the splice vaults. In such areas, after the completion of the cable system installation, some lawn and ornamental vegetation would be restored where it would not affect future access for inspections and repairs.

The construction of the cable system along the Newgate Road and State Route 168/187 Underground Line Route Variations also would have a minimal effect on wildlife because limited vegetation resources would be impacted. The species common to roadside areas would be expected to avoid work sites while construction activities are ongoing.

In contrast, the construction and operation of an underground cable system along the route variations within the CL&P transmission line corridor would result in both temporary and permanent effects on vegetation and wildlife resources within and adjacent to the ROW. Along the entire underground cable ROW, vegetation would have to be cleared, stumps removed, and the ROW then would be graded. After the completion of the cable system installation, temporary work areas would be reseeded and then allowed to revegetate naturally, except that the areas over the cable trench and splice vaults would be maintained in low-growth vegetation. However, along the permanent graveled access road that would have to be created and maintained along the entire underground cable system, vegetation would be precluded for the life of the project.

As a result of the construction and operation of the underground cable variations within the CL&P ROW, wildlife habitat would be altered both temporarily and permanently due to the vegetation changes described above. Construction activities would have direct effects on wildlife within the ROW in terms of displacement, disturbance, and (for less mobile species), mortality.

In addition, clearing the ROW of vegetation would reduce cover, nesting, and foraging habitats for some wildlife. In forested areas, the principal effect of the vegetation clearing and the long-term maintenance of the ROW in low growth vegetation would be a change in the species using areas from those favoring wooded habitats to those that prefer edge habitats or shrub-scrub or open habitats. As described in Section N.1.3 for the overhead transmission line route, the conversion of forested habitat to shrub-scrub would be advantageous to some species.

N.2.3.2 Fisheries

All of the underground route variations traverse watercourses, some of which can be expected to support fisheries. Where the installation of the underground cable system can be accomplished without disturbing stream banks or stream beds (e.g., along the Newgate Road and State Route 168/187 Underground Line Route Variations where the cable system can be installed above or below streams), no adverse effects would occur to water quality, fisheries, or other aquatic organisms. CL&P would minimize the potential for indirect effects (e.g., sedimentation into watercourses) by installing temporary soil erosion and sedimentation controls around areas of disturbed soils at work sites located near streams. These temporary erosion controls would remain in place until the disturbed areas are restabilized.

Along the underground variations located within CL&P's existing transmission line corridor, the cable system would have to be installed across watercourses, causing direct effects to water quality and fishery resources. These direct effects will be unavoidable, since subsurface methods such as horizontal directional drilling or jack and bore would not be practical for all of the numerous small watercourse crossings along the ROW. To mitigate effects to fishery resources, CL&P would consult with CT DEP to identify appropriate timing windows for in-water construction to avoid fish spawning periods. In addition, construction methods, such as dam and pump or dam and flume, can be selected to minimize adverse effects to water quality and thus to fish habitat.

N.2.3.3 Amphibians

Minimal effects to amphibians would occur as a result of the development of the Newgate Road and State Route 168/187 Underground Line Route Variations, assuming that all or most of the cable system along these routes would be aligned within or adjacent to road ROWs.

In contrast, the 3.6-Mile and the 4.6-Mile In-ROW Underground Line Route Variations would result in direct and unavoidable disturbance to all wetlands along the cable system routes, including to amphibian breeding habitat. Impacts would be both short-term (during construction and until the affected wetlands revegetate) and long-term (as a result of the conversion of forested wetlands to emergent marsh or shrub-scrub). The wetlands containing amphibian breeding habitat along the in-ROW underground variations are the same as those identified for the corresponding sections of the overhead route in Section N.1.3. Measures to mitigate adverse effects to amphibians may include options such as adherence to construction timing windows (to avoid breeding periods), and the employment of herpetologists to monitor the ROW prior to and during construction and to remove amphibians from the construction work space.

N.2.3.4 Birds

In general, the underground variations along the road ROWs (i.e., Newgate Road and State Route 168/187 Underground Line Route Variations) would have minor effects on bird species because limited vegetative habitats would be affected. The 3.6-Mile and the 4.6-Mile In-ROW Underground Line Route Variations, in contrast, would require vegetation clearing and the long-term alteration of vegetative community types; as a result, the overall effects on birds from the construction and operation of these variations would be similar to those described for the overhead line routes in Section N.1.3.

N.2.3.5 Rare, Threatened and Endangered Species

The development of the Newgate Road and State Route 168/187 Underground Line Variations will have minimal effects on rare, threatened, endangered or species of special concern. CL&P has consulted with

NDDB regarding these variations. The NDDB is not concerned about construction occurring in established roadway ROW and so mitigation measures were deemed unnecessary.

Along the in ROW underground variations are two state-listed species, the Eastern box turtle and the Eastern pearlshell mussel. As described in Section N.1.3.5, CL&P is considering several mitigation measures concerning these two species. The Eastern box turtles could potentially occur along the ROW during construction and thus could be directly affected by the movement of construction equipment, as well as by excavations for the trench or for the splice vaults. In general, CL&P would apply the same types of mitigation measures as described for the overhead transmission lines to avoid or minimize adverse effects to turtle individuals and habitat.

While the Eastern pearlshell mussels would not be directly affected by construction of overhead transmission lines designed to span watercourses in which they may occur, installation of underground transmission lines would require excavation across watercourses and therefore, could unavoidably impact mussel habitat, if such habitat exists at or in the vicinity of the proposed cable crossings. Because the cable system must be installed beneath the watercourses that may contain mussel habitat, CL&P could not employ the same mitigation measures (described in Section N.2.2) for the overhead line configuration. Mitigation measures that may be applicable to the avoidance or minimization of impacts to mussels along the underground routes include the installation and maintenance of erosion and sediment controls to minimize sedimentation and runoff from upland construction sites, as well as the consideration of subsurface trenchless installation techniques (e.g., jack and bore, HDDs) to avoid direct disturbance to mussel habitat. However, such trenchless techniques may not be feasible (due to subsurface conditions) and, even if applied, may nonetheless result in impacts to the mussel habitat (i.e., inadvertent returns of drilling fluid to the surface when performing HDDs). Other options include the use of dry ditch type cable installation techniques involving dam and pump or dam and flume techniques. For any cable installation technique, some disturbance to the riparian zones adjacent to watercourses is likely to be required, despite the fact that the CT DEP has recommended that no vegetation be removed from the stream banks adjacent to the mussel habitat as land clearing activities may affect the mussels.

N.2.4 Land Use, Land-Use Plans, and Recreational/Scenic Resources

The underground variations would not conflict with local, regional, state, or federal land use plans, because the proposed transmission cables would be located along or adjacent to existing road ROWs or within the existing CL&P transmission line corridor.

The construction and operation of the underground cable variations would not result in long-term effects on either recreational or scenic resources. Construction work within road ROWs or within the transmission line ROW would not result in long-term adverse effects on recreational resources, but could cause temporary, highly localized nuisance effects (e.g., noise, dust, and traffic congestion) to recreational activities in areas such as the Newgate WMA, the East Granby Farms Recreational Area, Sunrise Park Cub Scout Day Camp, Spencer Wood Wildlife Management Preserve, and Suffield Land Conservancy. However, these effects would be limited in duration to the period of active construction in the immediate vicinity of each recreational area, and would depend on the type of construction work at each location, as well as the schedule for such activities. Construction work could be designed and scheduled to avoid or limit the potential for interference with recreational activities. However, it should be noted that underground trenching, duct bank installation, and backfilling work, as well as the excavations for and installation of splice vaults can require substantial time at any one location, depending on the subsurface conditions encountered (e.g., presence of rock, groundwater). As a result, construction work could extend over multiple months.

Except for views of work areas during the construction period and views of transition stations described in Section N.2.9, the underground cable system would not affect visual resources.

N.2.5 Transportation and Access

The development of the underground variations along the CL&P transmission line ROW would have minor effects on transportation and access, which would be similar to those described for the overhead line routes in Section N.1.5. The operation of the underground cables along the CL&P ROW would not affect transportation patterns.

In comparison, the construction and operation of the Newgate Road or State Route 168/187 Underground Line Route Variations would have temporary, but potentially locally significant, effects on traffic patterns. Because these underground variations would be located primarily within road ROWs, construction activities would require temporary lane closures and would result in traffic disruption, delays, detours, and/or congestion. Construction workers traveling to work sites, as well as the movement of construction equipment, also could temporarily cause localized increases in traffic volumes, further aggravating traffic congestion.

To mitigate potential interference with traffic flow along public roads, construction within road ROWs could be performed during non-peak travel times, or at night. However, while night work would potentially minimize traffic disruption, the noise effects on nearby residents would have to be balanced. Measures would be taken to maintain vehicular access to adjacent businesses and nearby residential areas during the construction period. In addition, CL&P would:

- Coordinate with municipal officials and involved highway authorities (including ConnDOT) to schedule construction activities in order to minimize traffic-related effects, such as detours, peak travel time disruptions, and congestion, as well as to assure that access is maintained for emergency vehicles.
- Develop a *Traffic Control Plan*, for inclusion in the D&M Plan, which would address the specific concerns of each affected municipality.

- Coordinate construction activities with state and municipal officials so that construction activities do not interfere with special events such as parades and fairs.
- Employ police personnel, where required, to direct traffic at construction work sites along roads.
- Erect appropriate traffic signs and work area protection measures to indicate the presence of construction work zones.

Specific construction management measures would be finalized with the representatives of each affected municipality and, for state roads, with ConnDOT, and would be included in the D&M Plan.

The operation of the underground cables along the underground route variations would not affect transportation patterns, except when cable system maintenance or repair, requiring access to the splice vaults or other portions of the buried cable, is necessary.

N.2.6 Cultural (Archaeological and Historic) Resources

The Cultural Resources Assessment Historical and Archaeological Assessment of Connecticut Sections of the Connecticut Light & Power Company Greater Springfield Reliability Project Report (prepared by Raber Associates; refer to Volume 3) identifies the cultural resources that could potentially be affected by the underground variations, including the identification of known or potential archaeological resources in the vicinity of each route and the evaluation of the potential visual effects of the project on historic properties listed or eligible for listing on the State and National registers of historic places.

The construction and operation of the underground variations along the CL&P transmission line ROW would have the same types of effects as described for the overhead line route in Section N.1.6. Along the underground route variations, additional archaeological testing would be required to determine the potential for unrecorded buried sites. No adverse effects on standing historic structures would result from the construction or operation of the underground variations along the CL&P ROW.

The Newgate Road Underground Line Route Variation traverses directly in front of the NRHP-listed Old Newgate Prison, as well as one other NRHP-listed structure and a protected historic cemetery. The excavations required to install the cable system in this area could potentially affect the integrity of these structures, particularly if rock is encountered in the excavations and rock hammering or controlled blasting were required. There is potential for significant adverse effects on these structures, one of which is also a National Historic Landmark.

In addition, along the Newgate Road and State Route 168/187 Underground Line Route Variations, in areas where off-road ROW work would be required, an additional assessment of Native American archaeological sensitivity may be needed to make a final determination as to whether reconnaissance (field) testing would be necessary to confirm the presence or absence of archaeological sites.

N.2.7 Air Quality

The development of a cable system along any of the underground route variations would result in short-term, highly localized effects on air quality during construction, primarily from fugitive dust and vehicular emissions associated with cable trench and splice vault excavations. For in-road cable system installation, saw cutting of pavement also would generate dust and silt-laden water. During dry periods, to minimize the amount of fugitive dust generated by construction activities, water would be used as needed to wet down excavated spoil piles and dirt/gravel access roads.

There would be no adverse effects on air quality associated with the operation of the facilities.

N.2.8 Noise

During construction of the underground cable system along any of the route variations, activities such as vegetation clearing, grading, access road development, trench excavation (particularly involving rock drilling, jack-hammering or blasting), the installation of splice vaults, and the general operation of construction equipment would increase ambient sound levels. Along the Newgate Road and State Route

168/187 Underground Line Route Variations, saw-cutting of pavement, pavement removal, and re-paving also would cause noise emissions. The operation of the underground cables would not result in any adverse noise impacts.

Construction-related noise would be short-term and highly localized in the vicinity of work sites. However, there are noise sensitive sites (receptors) in the vicinity of the underground variations. These include residences, schools, and public recreational areas. Because of the slow pace of underground construction work, noise-emitting activities could be localized in the vicinity of these receptors for several months or more.

In addition, it is possible that some of the underground cable construction work along the Newgate Road and State Route 168/187 Underground Line Route Variations may occur at night, to minimize the potential for traffic congestion associated with lane closures or detours. Humans are more sensitive to increases in ambient sound levels at night; as a result, such night construction work could result in greater perceived adverse noise impacts, particularly on sensitive noise receptors.

N.2.9 Transition Stations

The development of any of the underground variations would require the associated construction and operation of two transition stations - one located at either end of the underground system. For all of the underground variations, with the exception of the 3.6-mile In-ROW Underground Variation, the southern transition station would be located adjacent to Granby Junction, on CL&P-owned property. The southern transition station for the 3.6-Mile In-ROW Underground Line Route Variation would be located north of Turkey Hills Road, adjacent to the existing ROW and within the Newgate WMA. The northern transition station would be the same for the Newgate Road Underground Line Route Variation, 3.6-Mile and 4.6-Mile In-ROW Underground Line Route Variations. The State Route 168/187 Underground Line Route Variation would require a different transition station site.

The following subsections describe the potential effects of the Granby Junction Transition Station (which is common to all of the underground variations except the 3.6-Mile In-ROW Underground Line Route Variation; refer to Section N.2.9.1); the transition station that would be located within the Newgate WMA for the 3.6-Mile In-ROW Underground Line Route Variation (refer to Section N.2.9.2); and the potential environmental effects for the northern transition station site (refer to Section N.2.9.3).

N.2.9.1 Granby Junction Transition Station Site

The potential transition station site would be situated on about four acres of undeveloped, forest land owned by CL&P and located on and adjacent to CL&P's existing transmission line ROW in East Granby. The development of this site for a transition station would result in a permanent change in land use, as well as impacts to topography, vegetation, wildlife, and visual resources.

The development of the site would require the removal of approximately four acres of forested vegetation, permanently displacing the existing wildlife habitat that this woodland community provides. Subsequently, the site would be graded to create a level area for the transition station facilities, and thereafter developed for utility purposes. Potential short-term impacts to soil resources, associated with earth-moving activities and the increased potential for erosion, would occur during the construction of the station.

The development of the transition station site, which is within an upland area, would not affect water resources (i.e., watercourses, wetlands, or floodplains). Although construction activities involving refueling and the storage of fuels and lubricants, etc. would increase the probability of accidental spills, standard spill prevention and response procedures would be applied to mitigate the potential for adverse effects.

The eastern boundary of the transition station site would be located approximately 150 feet southwest from a residential subdivision located off Granger Circle in East Granby. A buffer of mature trees would be maintained between the transition station and the Granger Circle cul-de-sac. However, the transition station would permanently change the visual landscape as a result of views of the above-ground station facilities.

N.2.9.2 3.6-Mile In-ROW Underground Line Route Variation Transition Station Site

The potential transition station site would be situated on approximately four acres of undeveloped, forest land located on and adjacent to CL&P's existing transmission line ROW in East Granby as well as within the Newgate WMA. The development of this site for a transition station would result in a permanent change in land use, as well as impacts to topography, vegetation, wildlife, and visual resources.

The development of the site would require the removal of approximately four acres of forested vegetation, permanently displacing the existing wildlife habitat that this woodland community provides. All 4 acres encompass private land that would have to be purchased for the development of the station. Subsequently, the site would be graded to create a level area for the transition station facilities, and thereafter developed for utility purposes. Potential short-term impacts to soil resources, associated with earth-moving activities and the increased potential for erosion, would occur during the construction of the station.

The development of the site would not affect any wetlands, watercourses, or floodplains, but would involve the removal of all existing vegetation within the site. The existing forested community that currently characterizes the site would be replaced by the fenced transition station yard, and the wildlife species that utilize this site would be displaced. The CT DEP NDDB has not identified any threatened, endangered or species of special concern in the vicinity of the proposed transition station.

The development of the transition station would create permanent visual changes to the character of the Newgate WMA. Although the site would be located adjacent to the existing CL&P overhead transmission line corridor, the transition station facilities would constitute a visual contrast with the other undeveloped lands within the WMA.

N.2.9.3 Newgate Road Transition Station Site

The Newgate Road Transition Station would be located on about four acres of undeveloped land in Suffield. The transition station would be located to the northwest of Phelps Road and would be accessed via the construction of a permanent access road from Phelps Road.

Approximately two acres of the transition station site is owned by CL&P, while two acres encompass private land that would have to be purchased for the development of the station. A portion of the transition station site, which is within the existing CL&P ROW, includes land owned by the Suffield Sportsman's Association.

The transition station site is undeveloped, except for the overhead CL&P transmission line ROW, which traverses the property. Vegetation on the site is upland forest, along with the shrub-scrub vegetation that characterizes the transmission line ROW.

Land uses along this portion of Phelps Road in the vicinity of the site consist of open, vacant land, and residential areas. Single-family homes are located to the east and west of the transition station site. A buffer of mature trees would be maintained between the transition station and these homes.

The development of the site would not affect any wetlands, watercourses, or floodplains, but would involve the removal of all existing vegetation within the site. The existing forested community that currently characterizes the majority of the site would be replaced by the fenced transition station yard, and the wildlife species that utilize this site would be displaced. The CT DEP NDDB has not identified any threatened, endangered or species of special concern in the vicinity of the proposed transition station.

N.2.9.4 State Route 168/187 Underground Variation Transition Station Site

The State Route 168/187 Transition Station would be located west of Mountain Road (Route 168) in Suffield. The site would be accessed via the construction of a permanent access road from Mountain Road.

The potential transition station site consists of undeveloped forest land and is traversed by the CL&P overhead transmission line ROW, along which shrub-scrub vegetation predominates. Approximately one acre of the four acre site are owned by CL&P. The remaining three acres are privately owned and would have to be acquired for the development of the station.

Land uses along Mountain Road in the vicinity of the transition station site consist of open, vacant land, single-family homes, and a municipal facility operated by the Town of Suffield. This site would be located adjacent to a municipal waste facility, which may require CL&P to obtain additional easements from the Town of Suffield. The potential transition station would extend across the ROW and would occupy land on both sides of the ROW. A buffer of mature trees would be maintained between the transition station and Mountain Road, with the exception of the maintained ROW corridor.

The development of the site would not affect wetlands, watercourses, or floodplains. However, the existing forested and shrub-scrub vegetative communities that currently characterize the site would be replaced by the fenced transition station yard, and the wildlife species that utilize this site would be displaced.

N.3 CONNECTICUT PORTION OF THE MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE FROM AGAWAM TO LUDLOW 345-kV LINE ROUTE

This section reviews the environmental effects that would be associated with the development of the 5.4 mile Connecticut portion of the alternative Agawam to Ludlow 345-kV line route for the Massachusetts portion of the GSRP. Potential effects and mitigation measures are described for both the potential overhead transmission line configuration and the underground route variation that has been identified to a portion of this overhead alignment.

In general, the types of effects associated with the construction and operation of the potential overhead 345-kV transmission line along this route would be similar to those described in Section N.1 for the proposed North Bloomfield to Agawam line. Accordingly, Section N.3.1 focuses on the effects and mitigation measures unique to this line route (e.g., the required crossing of the Connecticut River) and references Section N.1 for the other effects that would be similar to those discussed for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. Section N.3.2 identifies and evaluates the potential environmental effects and mitigation measures for the development of the underground variation to a portion of the Massachusetts Southern Route Alternative.

N.3.1 Overhead Line Route

N.3.1.1 Topography, Geology, and Soils

The effects on topography, geology, and soils that would be associated with the construction and operation of the new 345-kV line along the Massachusetts Southern Route Alternative would be generally the same as those described for the overhead line route in Section N.1.1. The construction of the new transmission line would alter topography only where grading is necessary to improve or create new access roads or to install work areas around structure sites.

Depth to bedrock along most of the route is greater than six feet; as a result, installation of structure foundations is not expected to encounter extensive rock areas. Erosion and sedimentation control measures would be deployed and maintained where soils are disturbed during construction.

In addition, the Connecticut Portion of the Massachusetts Southern Route Alternative traverse agricultural lands, where special soil preservation methods may be required during construction. Typically, construction activities in agricultural lands would be performed so as to minimize crop damage and the mixing of topsoil and subsoil layers. As part of ROW restoration, decompaction may be performed in agricultural areas to assist in achieving pre-construction soil texture.

N.3.1.2 Water Resources

The Connecticut Portion of the Massachusetts Southern Route Alternative would traverse the Connecticut River, as well as four smaller watercourses. Although riparian vegetation along these watercourses would be preserved to the extent practical, potential effects associated with the construction of the overhead line route could include tree clearing and vegetation removal within the riparian zone, the increased potential for sedimentation due to earth-moving activities in adjacent upland areas, as well as the increased potential for accidental spills of fuels and lubricants due to the operation of construction equipment and vehicles. The CT DEP also has established SCELs along the Connecticut River; as a result, if the Massachusetts Southern Route Alternative is selected by the Massachusetts EFSB, and structures will be proposed within the SCEL, CL&P would have to apply to the CT DEP for a SCEL permit for the crossing of the river.

There are 27 wetlands along the 5.4-mile overhead ROW, three of which have been identified as vernal pools. While CL&P would attempt to locate new structures in upland areas and to avoid the permanent alignment of access roads through wetlands, it is likely that some structures and permanent access roads would have to be situated in wetlands. In such cases, both the structure footings and some access roads would represent permanent fill. Mitigation or compensation for these permanent effects, as described in Section N.1 would be required.

N.3.1.3 Groundwater and Public Water Supplies

The Connecticut Portion of the Massachusetts Southern Route Alternative that traverses the Town of Enfield is within a Connecticut Aquifer Protection District. The excavations required for the installation of the overhead transmission line structure foundations are expected to be above any aquifers used for potable water supply. In the event that groundwater is encountered during excavation for overhead structure foundations, dewatering would be performed in accordance with applicable permit conditions and best management practices.

N.3.1.4 Biological Resources

The construction and operation of the Connecticut Portion of the Massachusetts Southern Route Alternative would result in effects on vegetation, wildlife, fisheries, and birds that would be similar to those described for the overhead line route in Section N.1. The CT NDDB has indicated that there are four listed species associated with the Connecticut River described in M.5.1.4.4. These species are the Shortnose sturgeon, Bald Eagle, Riverine clubtail dragonfly, and Arrow clubtail dragonfly. Because CL&P is not proposing any in-river construction activities, the CT DEP has not identified specific concerns with respect to potential effects to these species as a result of project construction activities. However, if construction activities would involve tree clearing within 300 feet of the Connecticut River, pre-construction field surveys would be required to determine if potential bald eagle roost trees and nest sites are present within the potential impact area and, if so, to determine appropriate mitigation measures. CL&P would employ erosion and sediment controls, and preservation of an undistrubed vegetated riparian zone to avoid adverse effects on riverine habitats.

In general, the western part of the Connecticut Portion of the Massachusetts Southern Route Alternative would be aligned through agricultural areas, where limited vegetation removal would be required and no long-term effects on vegetative communities would occur. The eastern portion of the route traverses more forested areas, where trees would have to be cleared from the ROW, resulting in a long-term conversion to shrub-scrub or open field type habitats. The effects to wildlife would be similar to those described for the overhead lines in Section N.1.

The Massachusetts Southern Route Alternative would cross three vernal pool wetlands identified as supporting amphibian breeding habitat. The measures that would be implemented to minimize or avoid adverse effects on these habitats would be the same as described for the overhead line routes in Section N.1.

N.3.1.5 Land Use, Statutory Facilities, Recreational Resources, and Scenic Resources

The proposed 345-kV line would be located within CL&P's existing ROW and thus would not require any additional land acquisition. In addition, with the exception of the Connecticut River crossing, the overhead 345-kV line would not be in the vicinity of any designated scenic resources. At the Connecticut River, the new 345-kV line would be located adjacent to an existing 115-kV transmission line that presently spans the river. Land on either side of the river crossing is predominantly forest; a large tract of this forest land on the eastern side of the river (in Enfield) is owned by CL&P.

The existing ROW traverses near various residential areas in the Town of Enfield, and is located in the vicinity of several day care facilities and a school, which would constitute statutory facilities as defined by the CSC. In accordance with the CSC requirements, CL&P has identified an alternative underground route variation that would avoid an overhead 345-kV line route near these facilities; the potential effects of the construction and operation of this underground variation are described in Section N.3.2.

N.3.1.6 Transportation and Access

The Connecticut Portion of the Massachusetts Southern Route Alternative would not result in long-term adverse effects on transportation or traffic patterns. The conductors would span Interstate 91 and 11 other state and local roads. Installation of the wires across the interstate and other roads would be coordinated with the appropriate highway authorities. The existing road network, along with access roads along the existing CL&P ROW, will be used to reach structure sites and other construction support areas.

N.3.1.7 Cultural (Archaeological and Historic) Resources

The Historical and Archaeological Assessment of Connecticut Sections of the Connecticut Light & Power Company Greater Springfield Reliability Project (Raber Associates, Volume 3) determined that approximately 3 miles of the Connecticut Portion of the Massachusetts Southern Route alternative appears sensitive for undocumented Native American archaeological resources, which would require reconnaissance studies to determine if the construction of the new 345-kV line would have the potential to affect as yet unrecorded sites within the ROW. There are no significant historic resources within 0.25 mile of the ROW, and thus the development of the new 345-kV line would have no visual effect (from a visual perspective) on any standing historic structures.

N.3.1.8 Air Quality

The construction of the line will result in localized effects on air quality associated with the operation of construction equipment and the generation of fugitive dust, as described in Section N.1. The operation of the new 345-kV line will not result in adverse effects on air quality.

N.3.1.9 Noise

Noise effects will be similar to those described for the overhead lines in Section N.1. However, the eastern portion of the 5.4-mile route traverses near certain subdivisions in the Town of Enfield, where increased noise levels resulting from construction activities may be noticeable to residents.

N.3.2 Massachusetts State Route 220/Enfield Underground Line Route Variation

The 4.3-mile underground variation, which would replace a 3.7-mile section of the overhead 345-kV line route, was identified to avoid the location of the overhead line adjacent to residential areas in Enfield. Approximately 3.9 miles of the underground variation would be aligned within or adjacent to state and local road ROWs that traverse predominantly residential areas of Enfield. Approximately 0.4 miles of the underground route would be located within a forested portion of CL&P's ROW between Brainard Road and Maple Street.

The effects associated with the development of the underground variation would be similar to those described in Section N.2 for the underground variations located in road ROWs and in cross-country ROWs. Because this underground variation traverses along roads primarily within residential neighborhoods, the principal effects associated with construction will be traffic disruptions, noise, dust, and disturbance to lawns, sidewalks, and ornamental vegetation. These nuisance type effects could be locally significant, but would be short-term, lasting only for the construction period. Effects associated with the portion of the underground alternative that traverses forested ROW may include extensive grading, sedimentation in water resources, and vegetation clearing.

The entire underground route is within a Connecticut Aquifer Protection District. Excavation dewatering, if groundwater is encountered, could temporarily affect water quality if proper procedures are not developed and implemented. In the event that groundwater is encountered during excavation for overhead structure foundations, dewatering would be performed in accordance with applicable permit conditions and best management practices.

N.3.2.1 Transition Stations

Transition stations consisting of approximately 2 to 4 acres of fenced area would have to be developed on either end of the underground variation. The western transition station site would be located on CL&P-owned property; this property, which is predominantly forested, encompasses the existing overhead line ROW. A forested wetland borders the site to the north, and a residential subdivision abuts the site to the southeast. The eastern transition station site, which would be located in a forested area near the Massachusetts border, would be located on privately-owned property, which also encompasses a portion of the existing CL&P overhead ROW. This privately-owned land would have to be acquired for the development of the transition station. Wetlands border the site to the northwest and east.

The development of these transition stations would require vegetation removal, tree clearing, and grading, as well as the conversion of each site from predominantly forested land to utility purposes for the life of the transmission facilities. The western transition station could potentially be visible to residents of the subdivision along Campania Road and Kalish Avenue. In addition, soil erosion and sedimentation control measures would have to be implemented to protect nearby wetlands from indirect effects associated with the development of the transition stations.

SECTION O

ELECTRIC AND MAGNETIC FIELDS (EMF)

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O. ELECTRIC AND MAGNETIC FIELDS (EMF)

Section O.1 provides general background information about EMF – what it is and what typical levels are encountered in our environment. Section O.2 describes the requirements of the Connecticut Siting Council (Council) for addressing EMF. Section O.3 outlines the methods for measuring and calculating fields. Section O.4 summarizes the magnetic field measurements and calculations that were developed to comply with key requirements of the Council's EMF Best Management Practices (BMP) with respect to the three sets of transmission line improvements discussed in this application:

(a) the Connecticut portion of the proposed GSRP route between North Bloomfield Substation and the Connecticut/Massachusetts state border;

(b) the Connecticut portion of the Massachusetts Southern Route Alternative between the Ludlow and Agawam Substations proposed by the Western Massachusetts Electric Company (WMECO); and

(c) the Manchester to Meekville Junction Circuit Separation Project (MMP).

Section O.5 summarizes new developments in EMF health research since the adoption of the latest BMP, and Section O.6 provides a summary of actions demonstrating consistency with Council guidelines. Appendix O-1 contains an evaluation of alternative designs to reduce magnetic fields for each of these improvements in a Field Design Management Plan (Plan).

O.1 ELECTRIC AND MAGNETIC FIELDS FROM POWER LINES AND OTHER SOURCES

Electricity used in our homes and workplaces is transmitted over considerable distances from generation sources to distribution systems. Electricity is transmitted as alternating current (AC) to all homes and over the electric lines that deliver power to our neighborhoods, factories and commercial establishments.

The power provided by electric utilities in North America oscillates 60 times per second, i.e., at a frequency of 60 hertz (Hz).

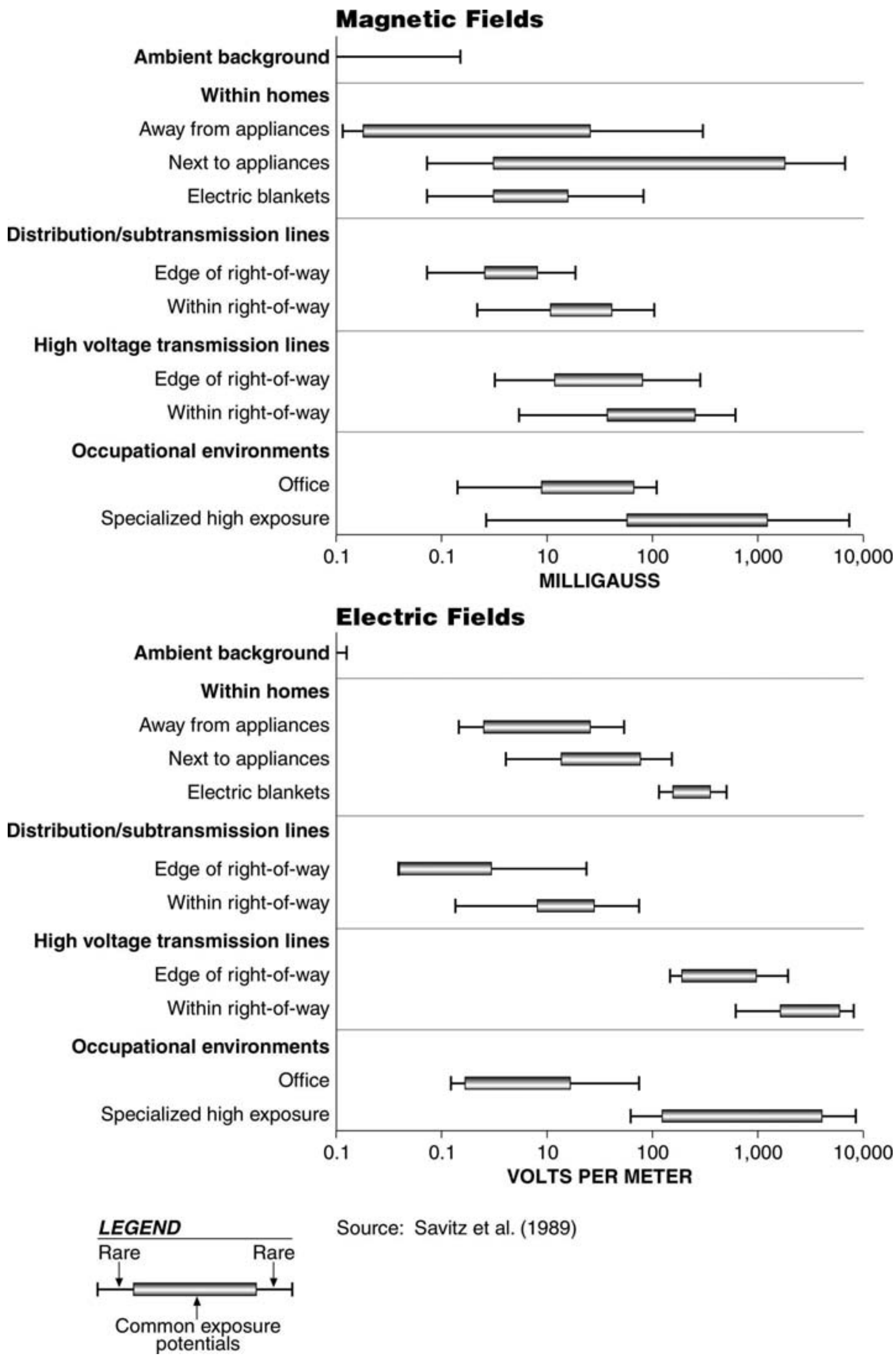
Electric fields are the result of voltages applied to electrical conductors and equipment. The electric field is expressed in measurement units of volts per meter (V/m) or kilovolts per meter (kV/m); 1 kV/m is equal to 1,000 V/m. Most objects including fences, shrubbery, and buildings easily block electric fields. Therefore, certain appliances within homes and the workplace are the major sources of electric fields indoors, while power lines are the major sources of electric fields outdoors (Figure O-1, lower panel).

Magnetic fields are produced by the flow of electric currents; however, unlike electric fields, most materials do not readily block magnetic fields. The level of a magnetic field is commonly expressed as magnetic flux density in units called gauss (G), or in milligauss (mG), where 1 G = 1,000 mG[1]. The magnetic field level at any point depends on characteristics of the source, including the arrangement of conductors, the amount of current flow through the source, and its distance from the point of measurement. The levels of both electric fields and magnetic fields diminish with increasing distance from the source.

Background AC magnetic field levels in our homes are generally less than 20 mG, even when not near a particular source, such as some appliances. Higher magnetic field levels are measured in the vicinity of distribution lines, sub-transmission lines, and transmission lines (Figure O-1, upper panel).

[1] Scientists more commonly refer to magnetic flux density at these levels in units of microtesla (μT). Magnetic flux density in milligauss units can be converted to μT by dividing by 10, i.e., 1 milligauss = 0.1 μT.

Figure O-1: Electric and Magnetic Field Levels in the Environment

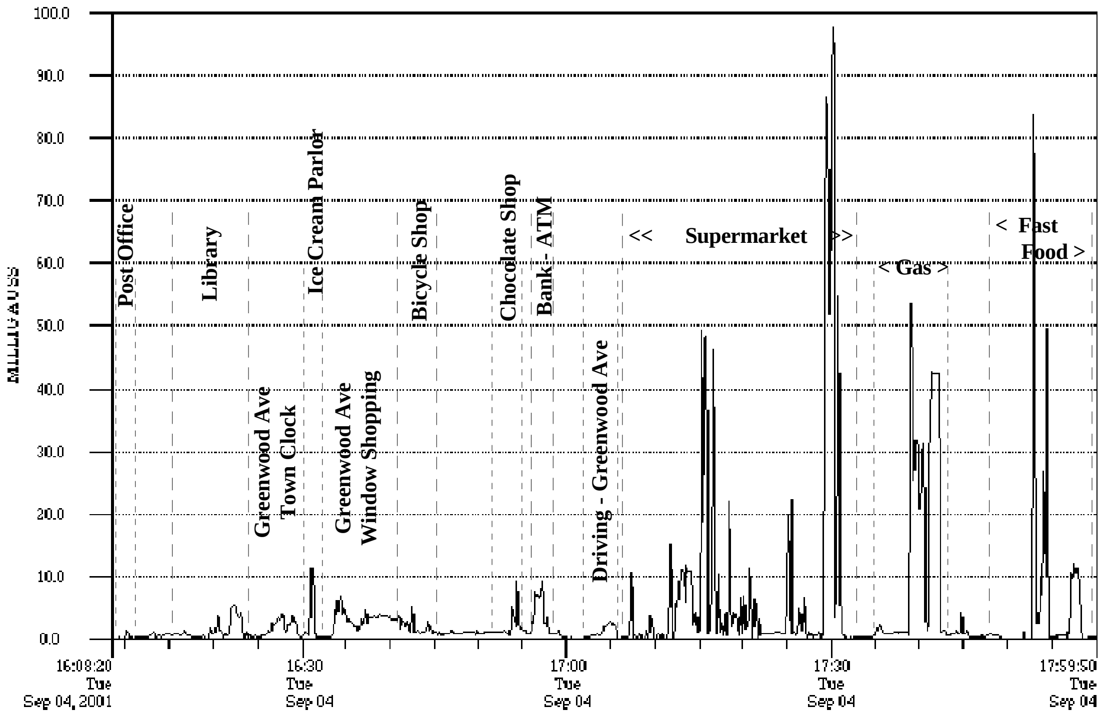


Source: Savitz et al. (1989)

The strongest sources of AC magnetic fields that we encounter indoors are electrical appliances (fields near appliances vary over a wide range, from a fraction of a mG to a thousand mG or more). For example, Gauger (1985) reports the maximum AC magnetic field at 3 cm from a sampling of appliances as 3,000 mG (can opener), 2,000 mG (hair dryer), 5 mG (oven), and 0.7 mG (refrigerator). Similar measurements have shown that there is a tremendous variability among appliances made by different manufacturers. The potential contribution of different sources to overall exposure over long periods is not very well characterized, but both repeated exposure to higher fields for short times and longer exposure to lower intensity fields for a long time contribute to one's total exposure.

Considering EMF from a perspective of specific sources or environments, as in Figure O-1, does not fully reflect the variations in a person's personal exposure as encountered in everyday life. To illustrate this, magnetic field measurements recorded by a meter worn at the waist while going about daily activities in a Connecticut town for two hours are shown in Figure O-2. Activities included a visit to the post office and the library, walking along the street, getting ice cream, browsing in the bicycle shop, stopping in the chocolate shop, going to the bank/ATM, driving along streets, shopping in a supermarket, stopping for gas, and getting something to eat at a fast food restaurant.

Figure O-2: Typical Magnetic Field Personal Exposures



A maximum magnetic field of 97.6 mG was measured in the supermarket (Table O-1). This figure shows that we encounter magnetic fields whose intensity varies over a wide range from moment to moment in everyday life. Other patterns of exposure to magnetic fields could well be very different. For example, a rider on commuter or long distance trains in Connecticut would encounter higher average power-frequency magnetic fields of perhaps 14 to 50 mG during a trip with peak values in the range of 100 to 400 mG (DOT/FRA, 2006).

Table O-1: Summary of Magnetic Fields Measured in a Connecticut Town (Bethel)

Magnetic Field Levels (milligauss, mG)		
Maximum	Average	Median
97.55*	4.57	1.10

*Maximum occurred in the supermarket

O.2 EMF REGULATIONS AND GUIDELINES IN CONNECTICUT

Since 1993, the Council has required that proposed new electric transmission lines be designed in compliance with the EMF BMP. In December 2007, after a two-year proceeding, the Council adopted a complete revision of the BMP, adding new requirements based on policies previously implemented by the State of California (CSC, 2007a, hereafter referred to as "BMP"). The revised BMP document was supported by an independent scientist retained by the Council (Dr. Peter Valberg), by a panel of scientists presented by the Connecticut Department of Public Health, and by scientists presented by The Connecticut Light & Power Company (CL&P) and The United Illuminating Company, including Dr. Michael Repacholi, the recently retired Coordinator of the World Health Organization's Radiation and Environmental Health Unit. The BMP provides "precautionary guidelines" (BMP, p.4) for reduction of magnetic field levels associated with new electric transmission lines at the edges of electric transmission rights-of-way (ROWs) and beyond, especially where the new line would be adjacent to residential areas, public and private schools, licensed day-care centers, licensed youth camps, and public playgrounds.

In adopting the BMP, the Council recognized that "the weight of scientific evidence indicates that exposure to electric fields, beyond levels traditionally established for safety, does not cause adverse health effects" and that scientific literature "reflects the lack of credible scientific evidence for a causal relationship between MF [magnetic field] exposure and adverse health effects" (BMP, pp. 2-3). Still, as part of its statutory duties, including its duty under Connecticut General Statutes §16-50j *et seq*. to address public health and safety, the Council follows procedures to ensure that a proposed transmission line will not pose an undue safety or health hazard to persons or property. These statutes and the BMP require that an applicant for approval of an electric transmission line provide:

1. *Measurements and Calculations*. An application must include an assessment of the impacts of any electromagnetic fields produced by the proposed transmission line (§16-50*l*(a)(1)(A)(ix)), including routes in proximity "to residential areas, private or public schools, licensed child day-

care facilities, licensed youth camps, and public playgrounds," (BMP, p. 4) and "electromagnetic field impacts on public health and safety" (§16-50 p(a)(3)(B)). This is to be met by taking measurements of existing electric and magnetic fields at the boundaries adjacent to the above facilities, with extrapolated calculations of exposure levels during expected normal and peak normal line loading. In particular, "an applicant shall provide design alternatives and calculations of MF for pre-project and post-project conditions, under 1) peak load conditions at the time of the application filing, and 2) projected seasonal maximum 24-hour average current load on the line anticipated within five years after the line is placed into operation" (BMP, p. 7).

2. *Proposed Magnetic Field Reduction Measures.* The Council expects that applicants will propose no-cost/low-cost measures to reduce magnetic fields by one or more engineering controls via a Field Management Design Plan (Plan). The Plan should "depict the proposed transmission line project designed according to standard good utility practice and incorporate "no-cost" MF mitigation design features. The Applicant shall then modify the base design by adding low-cost MF mitigation design features specifically where portions of the project are adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds" (BMP, p. 4).

3. *Demonstration of Consistency.* A statement describing the consistency of the proposed mitigation design with the BMP (p. 6, 8), and buffer zone requirements (C.G.S. § 16-50p(a)(3)(D).

In addition, the Council will take administrative notice of completed and ongoing scientific and medical research on electromagnetic fields (§16-50o(b)) and "consider and review evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF" (BMP, p. 5).

O.2.1 Statement of Compliance With BMP and Buffer Zone Requirements

Section O.4 provides measurements and calculations, developed in accordance with the BMP, with respect to each set of transmission line improvements presented in this application – the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route (GSRP); the potential Connecticut Portion of the Massachusetts Southern Route Alternative (for which only contingent approval is sought); and the Manchester to Meekville Junction Circuit Separation Project (MMP).

Appendix O-1 contains a Field Management Design Plan (Plan) based in part on these calculations, for the GSRP and MMP transmission line improvements. In compliance with the BMP, the Plan begins with a "base" design of the proposed new or modified transmission lines that incorporates standard utility practice with "no-cost" magnetic field mitigation design features. The Plan then examines modified line designs that incorporate "low-cost" magnetic field mitigation design features at locations where the proposed transmission line could be considered by the Council to be adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds. After examining multiple potential "BMP" designs that would lower magnetic field levels at the edges of the ROW, as compared to those that would be associated with the base design, the Plan recommends one BMP design for each of the GSRP and MMP ROWs as best fitting the Council's guidelines. These guidelines seek to achieve magnetic field reductions at ROW edges of 15% or more as compared to the levels associated with a base line design, with an investment of up to 4% of the estimated project cost using the base line design, including the cost of the each project's related substation work.

The Plan, if adopted by the Council, would reduce magnetic field levels at the edges of the GSRP and MMP ROWs by more than the 15% goal of the BMP, and would produce magnetic field levels less than those commonly encountered by the U.S. population along many electric transmission ROWs, near many electric distribution lines, and in other everyday settings. Accordingly, the ROW would provide an adequate buffer zone between any new or modified lines and any adjacent residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds.

Section O.5 provides the updated information concerning scientific research that constitutes the final component considered in determining compliance with the BMP and related Buffer Zone requirements listed above.

O.3 METHODS FOR EMF MEASUREMENTS AND CALCULATIONS

The major sources of EMF associated with this transmission project are the proposed and existing transmission lines on the existing ROW. Transformers and other equipment within the associated substations are also potential EMF sources, but would have little or no impact on exposure to the general public because experience indicates that EMF levels from substations "attenuate sharply with distance and will often be reduced to a general ambient level at the substation property lines. The exception is where transmission and distribution lines enter the substation" (IEEE Std. 1127-1990). Hence, addressing the EMF associated with transmission lines effectively addresses EMF potential exposures from substations.

O.3.1 Field Measurements of EMF from Existing Sources

Field measurements were taken at selected locations along and adjacent to the sections of the proposed ROW. The measurements were taken at a height of one meter (3.28 feet) above ground in accordance with the industry standard protocol for taking measurements near power lines (IEEE Std. 644-1994a). Both electric and magnetic fields were expressed as the total field computed as the resultant of field vectors measured along vertical, transverse, and longitudinal axes.[2] The electric field was measured in units of kV/m with a single-axis field sensor and meter (Electric Field Measurements, Inc.). The magnetic field was measured in units of mG by orthogonally mounted sensing coils whose output was

[2] Measurements along the vertical, transverse, and longitudinal axes were recorded as root-mean-square (rms) magnitudes. "Root mean square" refers to the common mathematical method of defining the effective voltage, current, or field of an AC system.

logged by a digital recording meter (EMDEX II). These instruments meet the IEEE instrumentation standard for obtaining valid and accurate field measurements at power line frequencies (IEEE Std.1308-1994b). The meters were calibrated by the manufacturers by methods like those described in IEEE Std. 644-1994a.

It is important to remember that measurements of the magnetic field present a 'snapshot' of the conditions at a point in time. Within a day, and over the course of days, months, and even seasons, the magnetic field will change at any given location depending upon the amount and the patterns of power supply and demand within the state and surrounding region. In contrast, the unperturbed electric field is quite stable over time.

O.3.2 Calculations of EMF from Transmission Lines

The BMP require transmission line applicants to "provide design alternatives and calculations of MF for pre-project and post-project conditions, under 1) peak load conditions and 2) projected seasonal maximum 24-hour average current load on the line anticipated within five years after the line is placed into operation." An applicant may also provide calculations based on other loading conditions that are more representative of time-weighted MF levels near to or on a transmission ROW.

Pre- and post-construction electric and magnetic field levels were calculated using computer algorithms developed by the Bonneville Power Administration, an agency of the U.S. Department of Energy (BPA, 1991). These algorithms have been shown to accurately predict electric and magnetic fields measured near power lines. The inputs to the program are data regarding voltage, current flow, circuit phasing, and conductor configurations. The fields associated with power lines were estimated along profiles perpendicular to lines at the point of lowest conductor sag, i.e., closest to the ground or opposite points of interest. All calculations were referenced to a height of 1 meter (3.28 feet) above ground according to standard practice (IEEE Std. 644-1994a). The program assumed that the transmission conductors were at maximum sag for the entire distance between structures and flat terrain, and was instructed to model balanced currents on all phases. The electric field from the overhead conductors was also calculated at the point of lowest conductor sag.

The calculation of magnetic fields requires determining the currents that will flow on the lines of interest under each set of conditions to be studied. For the Connecticut transmission system, these currents are determined by factors including: system load level, generation dispatch, Connecticut import level and east-west power transfer levels, and assumptions about transmission line load flows as described below.

For the base designs, Exponent evaluated the possible phasing of the new and reconfigured lines to identify a phasing of these circuits that would minimize the magnetic field level at the edge of the ROW with the highest magnetic field. Between 6 and 215 phasing combinations were evaluated in each cross-section, the number depending on the number of transmission circuits in the cross-section.

System Configuration

CL&P determined that the system to be modeled in 2012 was one that included transmission system changes which are already approved by ISO-NE and included in their system reliability models as of April 30, 2008, and which have expected in-service dates before 2012. For the 2017 modeling, this system topology was modified to include all four of the NEEWS projects in their proposed line configurations and not just the proposed project.

The Massachusetts Southern Route Alternative of the proposed Agawam to Ludlow 345-kV line is longer than the Massachusetts' Preferred Northern Route and therefore would have different electrical impedance and hence would affect system load flows somewhat. Likewise, any other line-route variations including undergrounding would cause small changes in line impedances and forecasted load flows. For purposes of magnetic field calculations for these project routes and design variations, however, the circuit currents were assumed not to change.

System Load Level

The BMP require transmission line applicants to "provide design alternatives and calculations of MF for pre-project and post-project conditions, under 1) peak load conditions at the time of the application filing, and 2) projected seasonal maximum 24-hour average current load on the line anticipated within five years after the line is placed into operation." An applicant may also present calculations based on other loading conditions that are more typical throughout the year, and thus more representative of time-weighted MF levels near to or on a transmission line ROW.

CL&P determined that it would provide magnetic field calculations for the year 2012 to represent the pre-project conditions, and the year 2017 to represent the post-project conditions five years later. CL&P elected to estimate an **annual peak load (APL)** conservatively from the ISO-NE's projected 90/10 system peak loads for the peak load condition on the transmission system in 2012 and to estimate 2017 peak loads by scaling ISO-NE's projected 90/10 level in 2016 to 2017 using the load-growth rates in their 2007 to 2016 Forecast Report of Capacity, Energy, Loads and Transmission, i.e., 32,250 MWs in 2012 and 33,949 MWs in 2017.

Peak daily average loads (PDAL) over a 24-hour period were estimated from the average load on these 90/10 peak-load days and were then estimated to be 26,970 MWs in 2012 and 28,300 MW in 2017, or about 83% of the peak hourly loads.

High conservative estimates of **annual average loads (AAL)** were based on a 61% annual load factor of the New England Transmission System, i.e., 19,830 MWs in 2012 and 20,700 MWs in 2017. CL&P supplied the results of system load-flow modeling of APL, PDAL, and AAL to its consultant, Exponent for the modeling of magnetic fields in 2012 and 2017.

In addition, where distribution circuits are located on the project ROW, their peak loads in 2012 and 2017 were estimated by applying an annual 1% growth rate to June 2008 peak values. Their non-peak loading conditions were then estimated by use of the same percentages indicated above for the transmission circuits.

In summary, CL&P undertook magnetic field calculations for three pre-project loading conditions in 2012 and three post-project loading conditions in 2017. These were called Annual Peak Load (APL), Peak-Day Average Load (PDAL), and Annual Average Load (AAL). By the choice of load levels, and by the choice below of import levels and generation dispatches, the resulting magnetic field calculations in each case will yield conservatively high values. Therefore, the AAL case should not be construed as indicative of an annual average exposure case, but rather a possible, more likely a conservatively high, estimate of such a case.

Generation Dispatch, CT Import Level and CT East-West Transfer Level

The planning for the NEEWS projects determined that together these projects would enable an increase in the Connecticut import limit and in the Connecticut east-west transfer capability. Therefore, CL&P elected for magnetic field modeling to conservatively model system load-flow conditions under which these interfaces were heavily utilized. With higher power imports and Connecticut east-west power transfers, the generation dispatch within Connecticut must be reduced correspondingly. For example, the Lake Road generation dispatch is set at zero for this modeling, except for the peak-load condition where it is set at a high-end capability of 900 MWs. Since the Kleen Energy generating facility in Middletown is currently in construction, it too was included as existing and available in the 2012 and 2017 system models, but it was dispatched at zero for this modeling.

For the three 2012 and three 2017 load conditions, the following table details the selected generation dispatches for units in, or strongly affecting, the Springfield area line loads. These represent reasonable generation dispatches for the purpose of these MF calculations. (Kleen Energy is not listed but was assumed to be off-line in each of these loading scenarios. Lake Road at zero may not be a reasonable assumption for the non-peak-load conditions, but the principal effect of operating the Lake Road units would be to slightly decrease the loads over the proposed 345-kV lines from North Bloomfield to Ludlow.) The bottom rows of the table indicate the assumed Connecticut import level, Connecticut east-west transfer level, and New York-New England transfer level corresponding to each of the generation dispatches. For conservatism again, the Connecticut import levels and Connecticut east-west transfer levels were set at their upper limits for the peak hour (APL case), and at about 75% of these upper limits for the PDAL and AAL cases.

Table O-2: Generation dispatches and transfers in MW assumed for load-flow models

Generation	APL PreNEEWS	PDAL PreNEEWS	AAL PreNEEWS	APL PostNEEWS	PDAL PostNEEWS	AAL PostNEEWS
Lake Road	900	0	0	900	0	0
Northfield	810	540	540	810	540	540
Stony Brook	412	412	412	412	412	412
Berkshire Power	280	280	280	280	280	280
West Springfield #1	0	0	0	0	0	0
West Springfield #2	0	0	0	0	0	0
West Springfield #3	101	101	101	101	101	101
Mt Tom	147	0	0	147	0	0
MASSPOWER 1	82	82	82	82	82	82
MASSPOWER 2	82	82	82	82	82	82
MASSPOWER 3	75	75	75	75	75	75
Prospect	26	26	26	26	26	26
Orchard	4	4	4	4	4	4
Springfield PF	6	6	6	6	6	6
West Springfield Jet	0	0	0	0	0	0
Agawam PF	1.6	1.6	1.6	1.6	1.6	1.6
Woodland Jet	0	0	0	0	0	0
Doreen Jet	0	0	0	0	0	0
Altresco 1 &2	65	65	65	65	65	65
Altresco 3&4	80.5	80.5	80.5	80.5	80.5	80.5
CT Import	2500	1900	1900	3600	2700	2700
CT E-W Transfer	1900	1700	1500	3400	2600	2300
NY-NE Transfer	0	0	0	0	0	0

O.4 MAGNETIC FIELD MEASUREMENTS AND CALCULATIONS DEVELOPED TO COMPLY WITH BMP AND TO DEVELOP THE PLAN

Spot measurements of existing magnetic and electric field levels were taken along each of the ROWs where construction is proposed or could occur with a focus on sections where groups of residences are adjacent to the ROW [termed hereafter as a "focus area"] or statutory facilities are nearby, as described in the Council's Application Guidelines (CSC, 2007b). Calculations of magnetic fields for existing lines under pre-NEEWS conditions in 2012 and post-NEEWS conditions in 2017 for proposed new and reconfigured lines were performed for the Plan at the AAL, which are most useful for predicting field levels for any 'typical' day, and these values are presented below in profiles and tables. In addition, magnetic field levels at 25-foot intervals are also presented for the base design, alternative designs, and route variations at AAL, APL and PDAL, together with associated electric field levels, in Appendices O-3, O-4, and O-5.

O.4.1 The Connecticut Portion of the North Bloomfield to Agawam Line

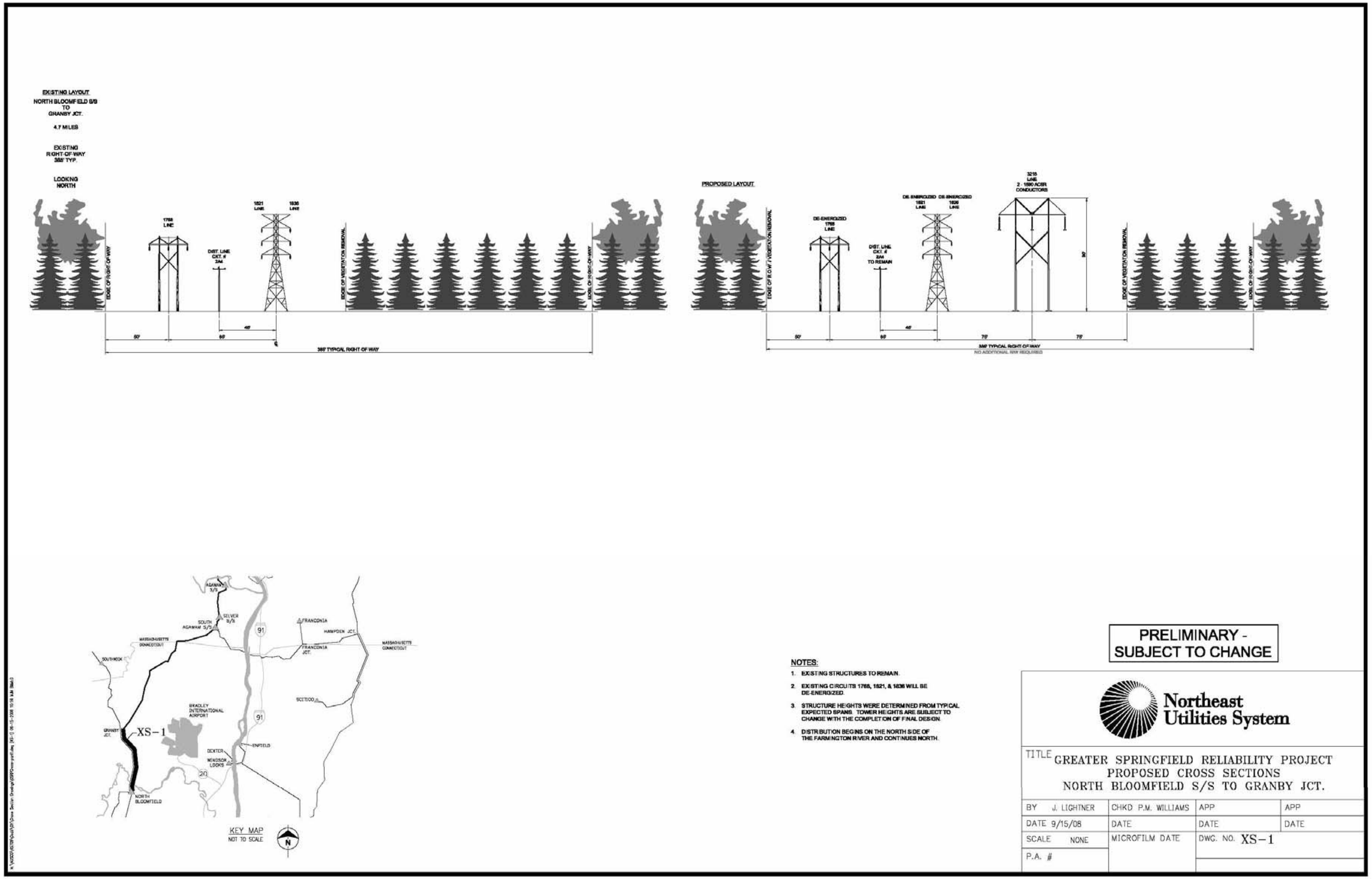
There are two different configurations of transmission lines currently on the ROW described by different cross sections between the North Bloomfield Substation and the Connecticut/Massachusetts state border.

O.4.1.1 North Bloomfield – Granby Junction – XS-1

O.4.1.1.1 Existing Line Configurations and EMF

The section of the ROW between North Bloomfield and Granby Junction (Cross-Section No. 1 or XS-1) is 4.7 miles long and is typically 385 feet wide. Currently on this section of the ROW are: (a) a line of lattice steel towers typically 75 to 95 feet high that support two 115-kV circuits (circuits #1821/1836); (b) a 23-kV line on wood poles; and (c) a 115-kV line (circuit #1768) on a line of wood-pole H-frames typically 60 feet high. The configuration of this cross-section is shown as the "Existing Layout" in Figure O-3. No statutory facilities or "focus areas" were identified in the vicinity of this cross-section.

Figure O-3: Cross-Section XS-1: North Bloomfield Substation to Granby Junction



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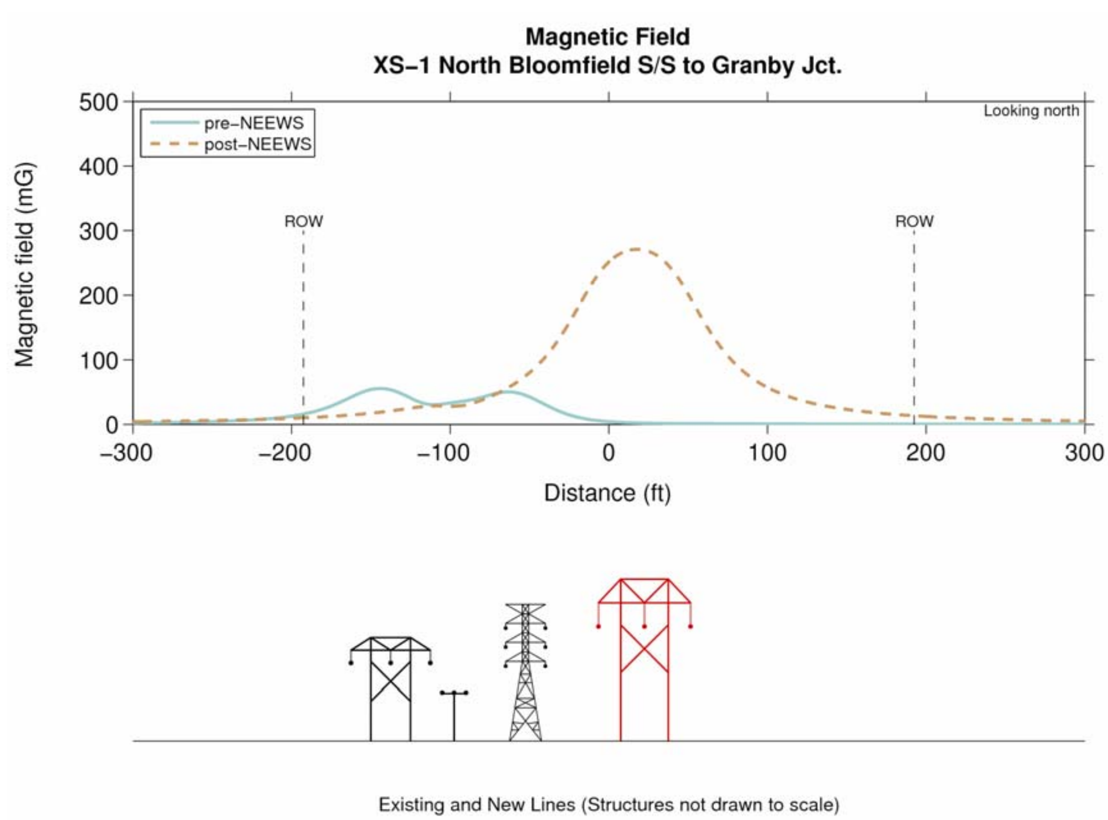
O.4.1.1.2 Proposed Changes to Existing Line Configurations and Magnetic Fields

The new 345-kV transmission line (to be known as circuit #3216) would be supported on steel- or wood-pole H-frame structures typically 90 feet high and centered 75 feet to the east of the double-circuit 115-kV line, which will be de-energized, as shown as the "Proposed Layout" in Figure O-3.

Magnetic field profiles across the ROW produced by both existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure O-4.

Figure O-4: Profile XS-1: North Bloomfield Substation to Granby Junction – Magnetic fields under pre-NEEWS (2012) and post-NEEWS (2017) conditions at AAL



The calculated levels of both magnetic and electric fields at the ROW edges before and after construction of this section of the GSRP are summarized in Table O-3.

Table O-3: Summary of pre-NEEWS (2012) and post-NEEWS (2017) EMF levels at the edge of the ROW at annual average loading (AAL) - North Bloomfield – Granby Junction – XS-1

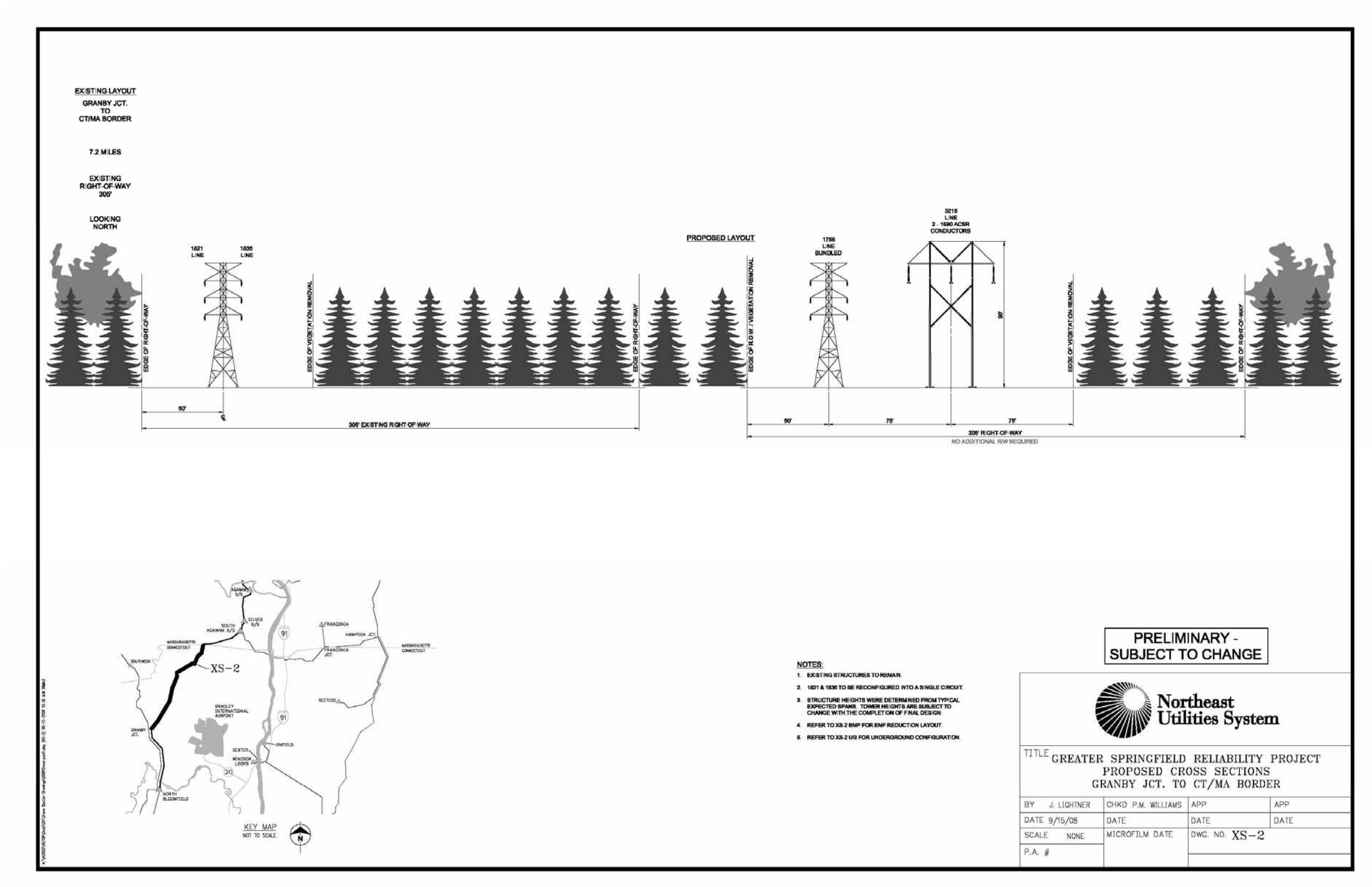
	Magnetic Field (mG)		Electric Field (kV/m)	
Cross Section	**West/North ROW**	**East/South ROW**	**West/North ROW**	**East/South ROW**
XS-1 – Pre	16.0	0.5	0.46	0.00
XS-1 – Post	10.2	13.4	0.01	0.18

O.4.1.2 Granby Junction to CT/MA State Border – XS-2

O.4.1.2.1 Existing Line Configurations and EMF

The section of the ROW between Granby Junction and the Connecticut/Massachusetts state border (Cross-Section No. 2 or XS-2) is 7.2 miles long and is typically 305 feet wide. The double-circuit lattice steel towers supporting the 115-kV circuits #1821 and #1836 continue along this section of the ROW. There are no other lines now on this section of the ROW. The configuration of this cross-section is shown as the “Existing Layout” in Figure O-5.

Figure O-5: Cross-Section XS-2: Granby Junction to CT/MA State Border



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A collection of homes, i.e., a residential “focus area” is adjacent to the ROW in XS. A summary of magnetic and electric field measurements taken at the edge of the XS-2 ROW in the vicinity of these locations is shown in Table O-4.

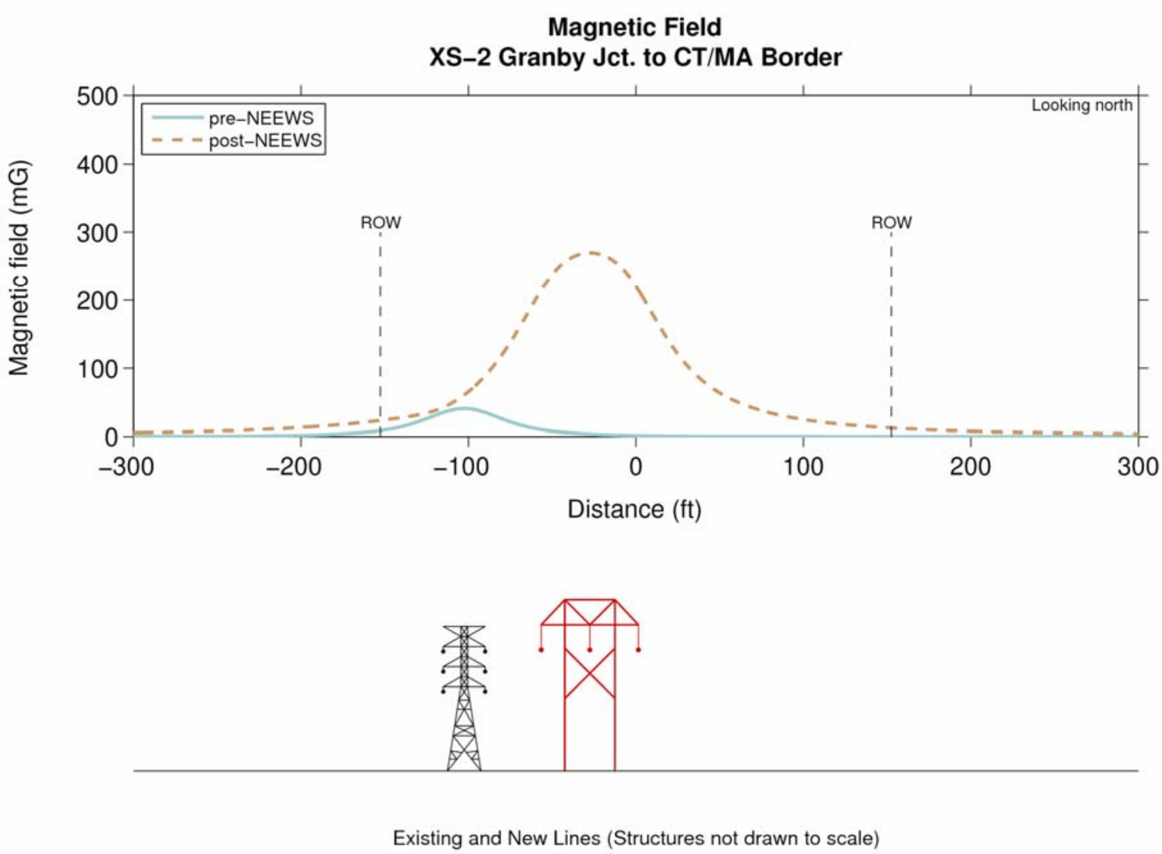
Table O-4: Measured electric and magnetic fields for North Bloomfield – Granby Junction – XS-2 in the vicinity of statutory facilities and a residential “focus area”

Location Name/Address	Town	Location Label	Cross-Section	Arial Segment	Magnetic Field (mG)	Electric Field (kV/m)	Distance from CL of new 345-kV circuit (ft)
Residential “focus area” Between existing structures 3191 – 3221 [Adjacent]	East Granby		XS-2	North Bloomfield to South Agawam Mapsheet 05-08 of 10	0.1 – 0.7**	0.03 – 0.13**	OH East of ROW, 191 – 490 West of ROW, 125 – 606

** Range of measurements made at several different locations along this section

Magnetic field profiles across the ROW produced by both existing and proposed lines along this section of the ROW, assuming annual average loads, were calculated as shown in Figure O-6.

Figure O-6: Profile XS-2: Granby Junction to CT/MA State Border – Magnetic fields under pre-NEEWS (2012) and post-NEEWS (2017) conditions at AAL



O.4.1.2.2 Proposed Changes to Existing Line Configurations and Magnetic Fields

The new 345-kV transmission line will be constructed to the east of the existing lattice steel tower line that now supports 115-kV circuits #1821 and #1826. The conductors of these two circuits would be bundled together as a "split-phase" line and subsequently operated as a section of a new #1768 circuit between the South Agawam Switching Station and Southwick Substation. The bundled circuit section would be connected at Granby Junction to an existing circuit #1768 segment to Southwick Substation. The base design for the new 345-kV line along this section of the ROW is the same as that to be employed on XS-1 – using steel- or wood-pole H-frame structures centered 75 feet to the east of the existing lattice towers. This base design configuration is shown as the "Proposed Layout" in Figure O-5.

At least an additional 100 feet of ROW would be added to sections of the route between Phelps Road and Mountain Road (1,000 feet) and east of Ratley Road (400 feet) in the Town of Suffield.

Along approximately 3.2 miles of this 7.2-mile-long section (from existing 115-kV line structures 3191 to 3221, or roughly between the points where Phelps Road in Suffield intersects with the ROW and where Country Club Lane in East Granby comes closest to the ROW), there are groups of residences near the ROW that CL&P treated as a "focus area" for reducing magnetic field levels along the edge of the ROW. CL&P concludes in the Plan (Appendix O-1) that the use of delta monopole structures, typically 110 feet high, centered 75-feet east of the centerline of line 1768 would be most consistent with the BMP. Other configurations are also evaluated in that Plan. The "Proposed Layout" of this mitigation design designated as XS-2 BMP is shown in Figure O-7.

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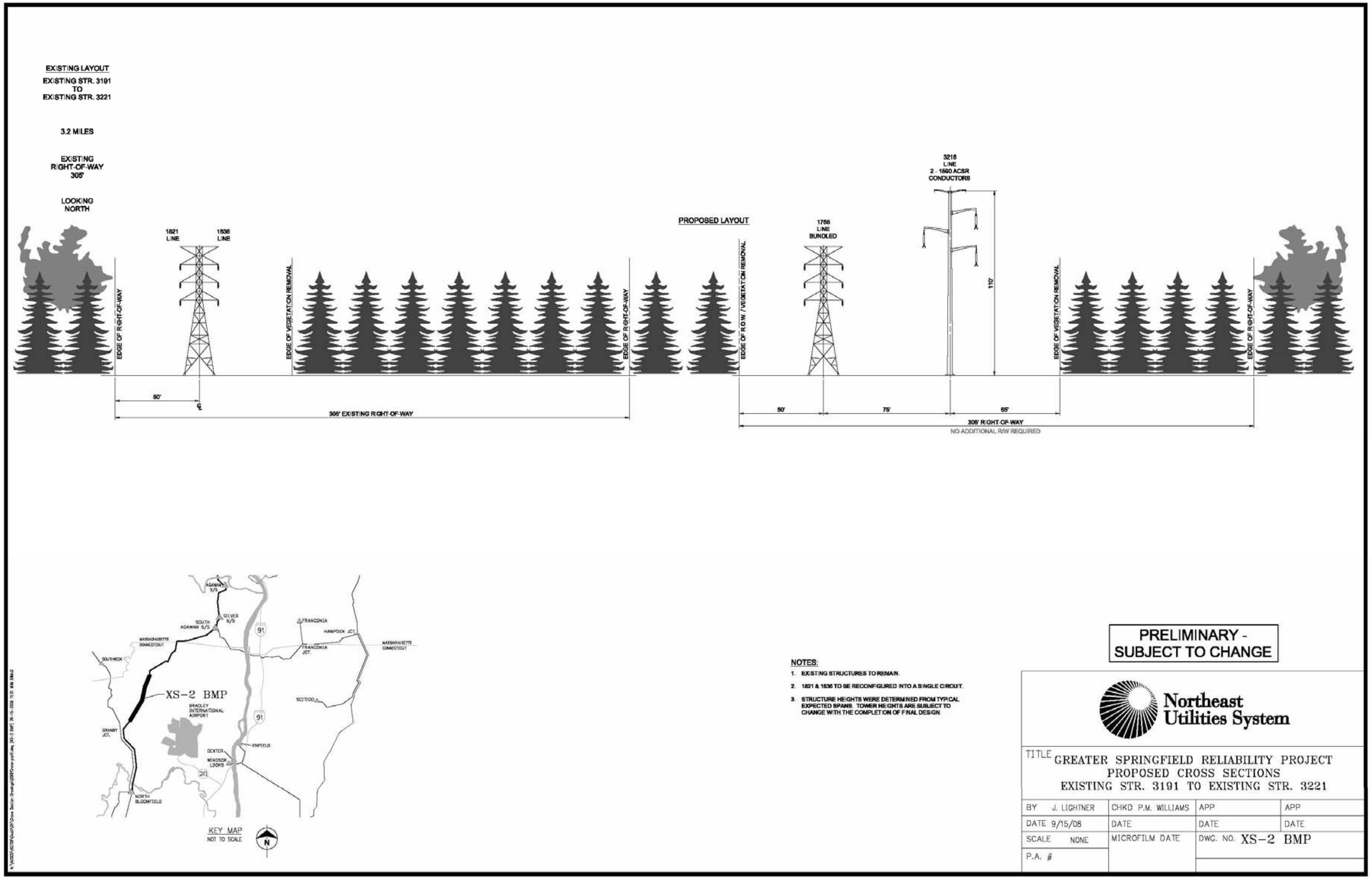
Figure O-7: Cross-Section XS-2: BMP – Existing Str. 3191 to Existing Str. 3221



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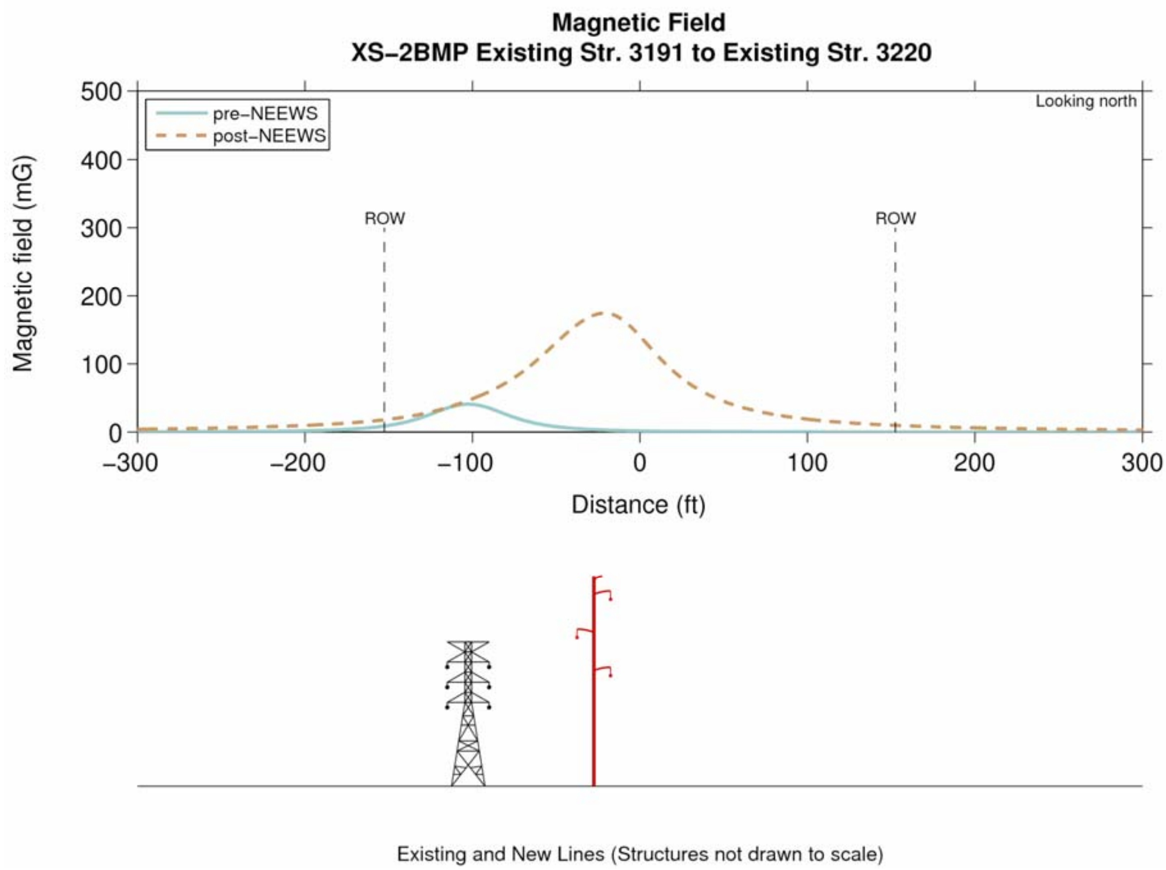
The calculated magnetic field profiles for the existing 115-kV lines and with the proposed BMP delta configuration option for the proposed line are shown in Figure O-8.

Figure O-8: Profile XS-2 BMP: Existing Str. 3191 to Existing Str. 3221 – Magnetic fields under pre-NEEWS (2012) and post-NEEWS (2017) conditions at AAL



The post-construction magnetic fields at the ROW edges along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route ROW have been calculated, assuming both the overhead base design and the delta configuration recommended in the Plan, and the AAL load condition. These calculated fields are set forth in Table O-5 below, along with the calculated pre-construction fields for comparison purposes.

Table O-5: Summary of pre-NEEWS (2012) and post-NEEWS (2017) EMF levels at the edge of the ROW at annual average loading (AAL) - Granby Junction to CT/MA State Border (XS-2)

	Magnetic Field (mG)		Electric Field (kV/m)	
Cross Section	**West/North ROW**	**East/South ROW**	**West/North ROW**	**East/South ROW**
XS-2 – Pre	8.7	0.1	0.09	0.00
XS-2 – Post	23.5	12.6	0.11	0.15
XS-2 BMP – Post	17.9	9.8	0.15	0.14

O.4.1.3 Magnetic Fields Associated with Underground Line Variations

CL&P also considered four underground line variations to the Connecticut Portion of the North Bloomfield to Agawam 345-kV line between existing structures 3191 and 3221 along portions of XS-2, should an underground line and route be selected to replace the portion of the XS-2 overhead line route adjacent to a residential "focus area." Two of these variations are assumed to be constructed primarily under streets, and two would be constructed entirely within the ROW. The trench depth and cable configuration for the in-ROW and under-street variations would be the same.

Table O-6: Measured electric and magnetic fields at ROW edge near statutory and potential residential areas in the vicinity of possible underground line variations to XS-2 - Granby Junction to CT/MA State Border

Location *Name/Address	Town	Location Label*	Cross-Section	Aerial Segment	Magnetic Field (mG)	Electric Field (kV/m)	Distance from CL of new 345-kV circuit (ft)
Newgate Road and SR 168/187 Underground Variations							
YMCA Allgrove School Fun Company 33 Turkey Hills Road [ADJACENT]	East Granby	DC-1	XS-2 UG ROAD	Underground Variation Mapsheet 02 of 08	2.8	0.1	UG -107
East Granby Congregational Nursery 9 Rainbow Road, Route 20 (parking lot behind building) [ADJACENT]	East Granby	DC-2	XS-2 UG ROAD	Underground Variation Mapsheet 03 of 08	0.8	--	UG - 310
East Granby Congregational Nursery 9 Rainbow Road, Route 20 (driveway in front of building) [ADJACENT]	East Granby	DC-2	XS-2 UG ROAD	Underground Variation Mapsheet 03 of 08	1.2	0.1	UG - 310
Allgrove School 33 Turkey Hill Road [ADJACENT]	East Granby	SC-1	XS-2 UG ROAD	Underground Variation Mapsheet 02 of 08	2.2	--	UG - 99
Sunrise Park Day Camp 2075 Mountain Road, Route 168 [ADJACENT]	Suffield	YC-1	XS-2 UG ROAD	Underground Variation Mapsheet 06 of 08	0.3	--	UG - 144

-- Shielding by vegetation prevented the collection of measurable electric field levels at this location from existing sources, e.g., distribution lines and service drops.

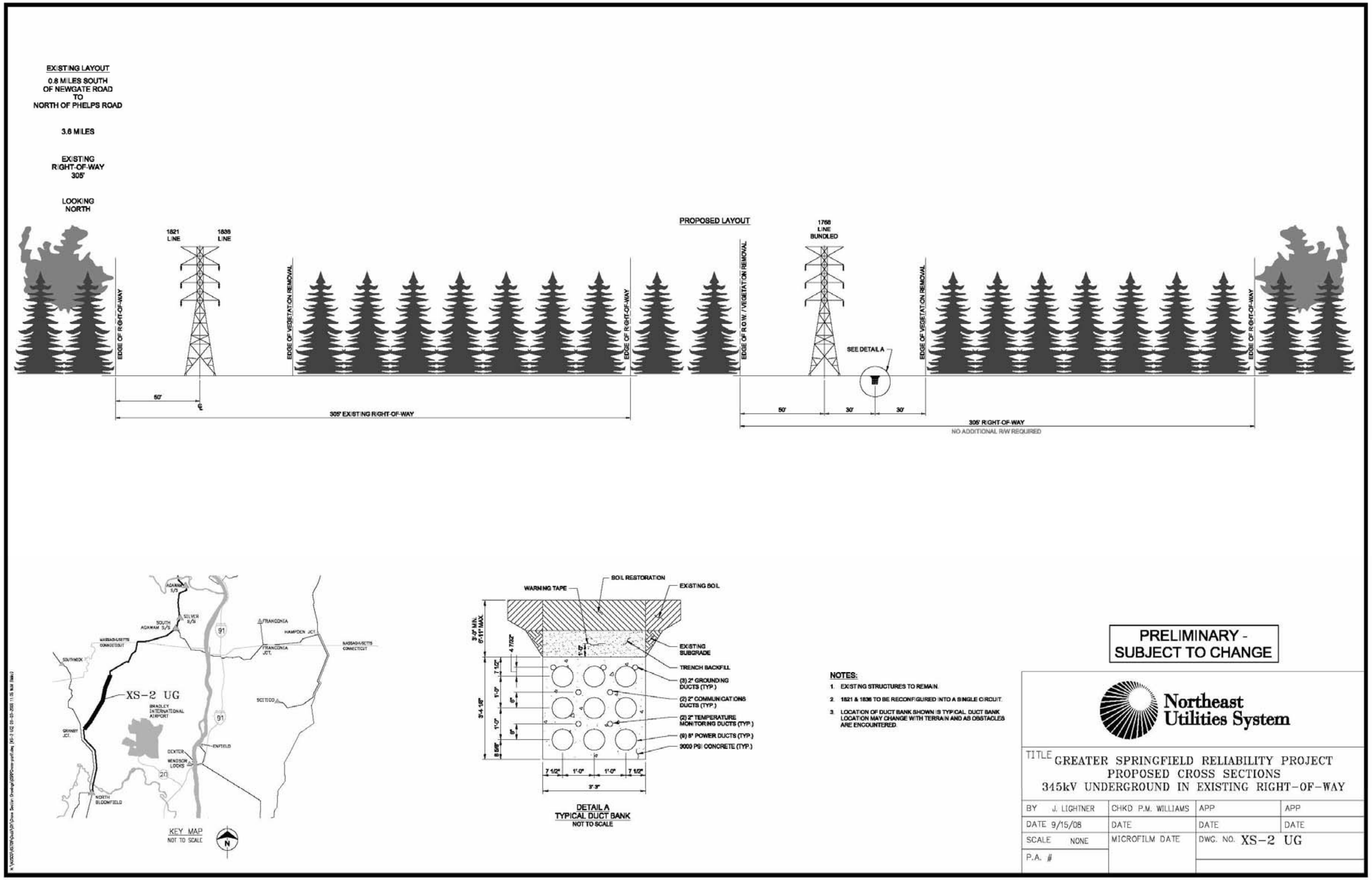
O.4.1.3.1 In-Right-of-Way Variations

Part or all of several underground line variation routes would use the existing ROW. One thousand feet of the Newgate Road Underground Line Route Variation would be constructed beneath the ROW exiting

Granby Junction (the rest continuing underneath town streets). The 4.6-Mile In-ROW Underground Line Route Variation and 3.6-Mile In-ROW Underground Line Route Variation would be constructed entirely within the existing overhead corridor. The 4.6-mile In-ROW Underground Line Route Variation would start near Granby Junction at a potential transition station and end at a potential transition station north of Phelps Road. The 3.6-Mile In-ROW Underground Line Route Variation would start approximately 1 mile north of Granby Junction and end at a potential transition station north of Phelps Road.

The layouts of the existing overhead line and proposed underground line configurations on the ROW are shown in Figure O-9 below.

Figure O-9: Cross-Section XS-2 UG – Granby Junction to Phelps Road transition station – UG Variations along the ROW



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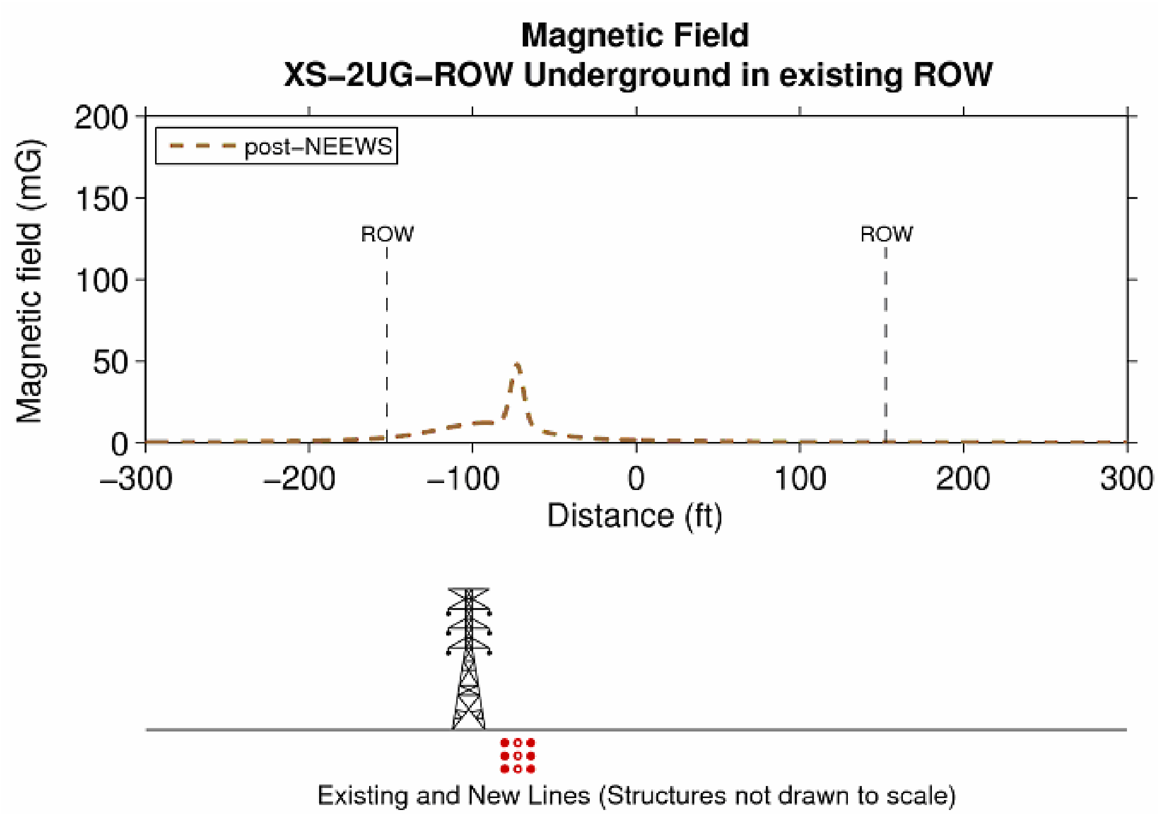
The combined magnetic field produced by the existing 115-kV overhead lines and the proposed underground 345-kV line is shown in the post-construction profile in Figure O-10.

Figure O-10: Profile XS-2 UG: 4.6-mile/3.6-mile UG line variations within ROW to Phelps Road transition station – Magnetic fields under pre-NEEWS (2012) and post-NEEWS (2017) conditions at AAL[3]



O.4.1.3.2 Street Variations

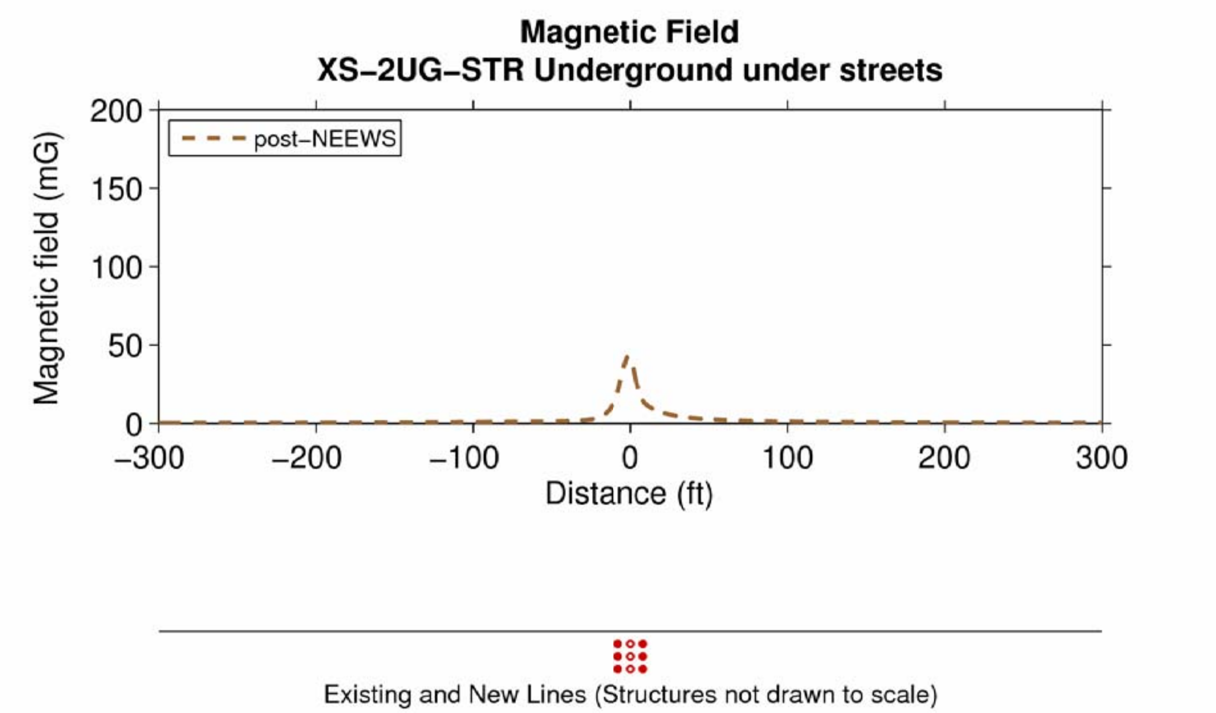
Two other possible underground variations of the line route north from Granby Junction in XS-2 would be constructed under town streets with the same configuration of the underground cables illustrated in the insert to Figure O-9. Most of the 6-mile Newgate Road Underground Line Route Variation (save 1,000 feet) would be constructed under streets to replace a 4.6-mile section of new 345-kV overhead line.

[3] Higher magnetic fields than shown in this profile would be produced over splicing vaults where the cables are more widely separated than shown here.

Between the beginning and the end of the variation on the ROW, virtually the entire State Route 168/187 Underground Line Route Variation would extend under streets for 8 miles between transition stations at Granby Junction and Phelps Road.

The magnetic field produced by the underground line variation under streets is shown in Figure O-11. This calculated field profile does not reflect the combined effect of the magnetic field from the underground line together with the fields from any existing sources along the streets, e.g., distribution lines.

Figure O-11: Profile XS-2 UG Variation in streets – Magnetic fields under post-NEEWS (2107) conditions at AAL[4]



The calculated magnetic fields associated with the operation of underground cables constructed in the ROW or in streets at a distance of 25 feet are summarized in Table O-7.

[4] Higher magnetic fields than shown in this profile would be produced over splicing vaults where the cables are more widely separated than shown here.

Table O-7: Summary of pre-NEEWS (2012) and post-NEEWS (2017) magnetic field levels at annual average loading (AAL) – underground variations for part of Granby Junction to CT/MA State Border (XS-2)

	Magnetic Field (mG)	
Cross Section	**West/North ROW***	**East/South ROW***
XS-2 – Post	23.5	12.6
XS-2 UG variation– Post (in ROW)	3.2	0.5
XS-2 UG variation– Post (under streets)	2.6	5.6

* 25 feet from centerline for underground construction

O.4.2 The Potential Connecticut Portion of the Massachusetts Southern Route Alternative for the Agawam to Ludlow 345-kV Line

O.4.2.1 Connecticut Border (Suffield) to Massachusetts Border (Enfield)

This alternative route for the Agawam to Ludlow 345-kV line extends south from Agawam Substation and then east from South Agawam Junction along existing transmission line ROWs, including segments totaling 5.4 miles within Enfield, Connecticut.

O.4.2.1.1 Existing Line Configuration

In Connecticut the ROW width is 280 to 300 feet, and it is occupied by a 115-kV wood-pole H-frame line, circuit #1858. The layouts of this existing line configuration in cross-sections (XS-S05 and XS-S07) of this route are shown in Figures O-12, and O-13, respectively.

Figure O-12: Cross-Section XS-S05 – CT border to CT River

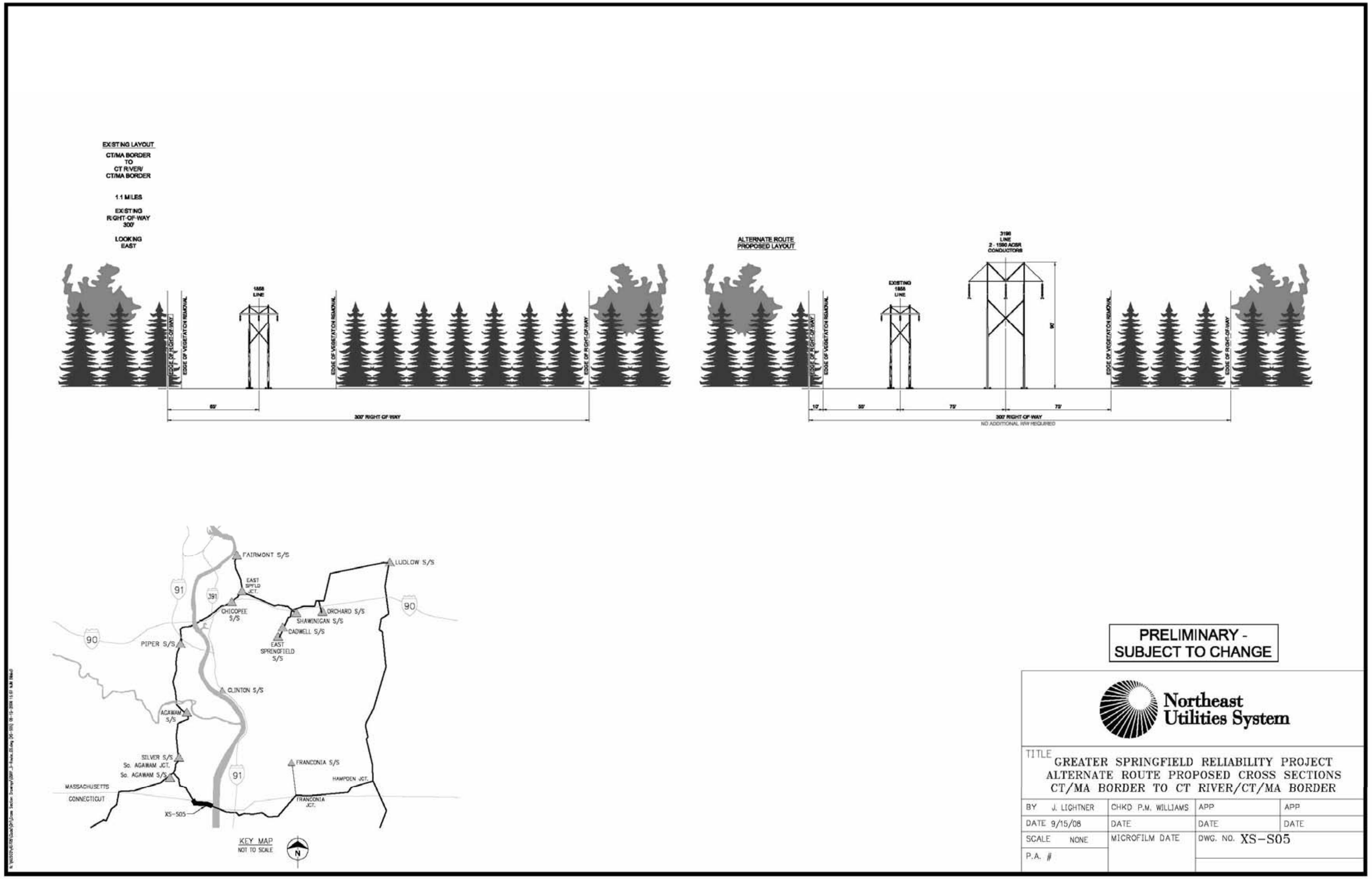


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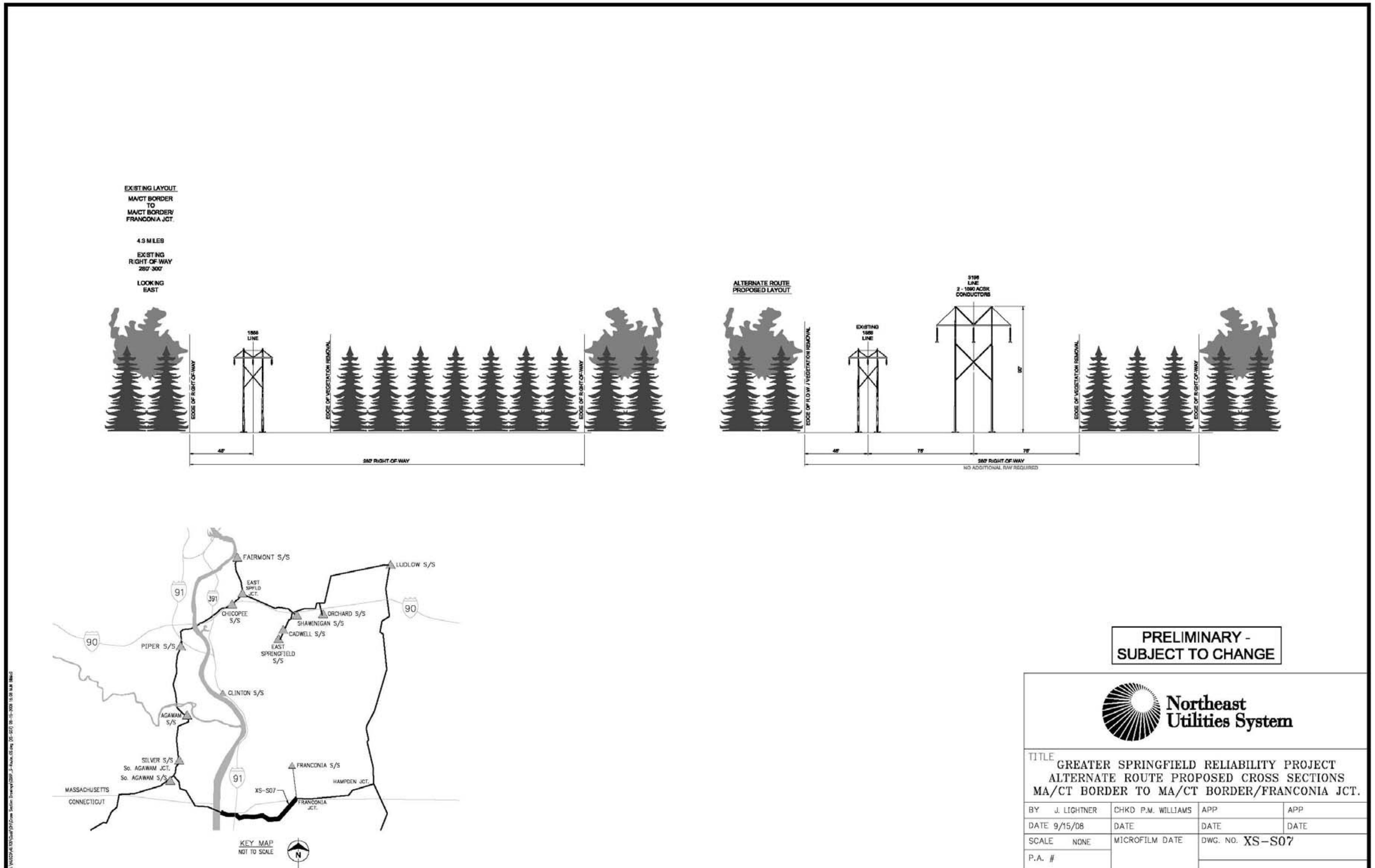
Figure O-13: XS-S07 – CT border to MA border



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O.4.2.1.2 Potential Changes to Existing Line Configuration

Were the Massachusetts Southern Route Alternative between the Agawam and Ludlow Substations to be chosen, the new 345-kV line would be supported by steel- or wood-pole H-frame structures and would cross the Connecticut/ Massachusetts state border in Suffield for 1.1 mile to the Connecticut River (XS-S05) where it would cross back into Massachusetts. The route re-enters Connecticut further east in Enfield and continues for about 4.3 miles (XS-S07) before crossing back into Massachusetts *en route* to the Ludlow Substation. The configurations for this line are illustrated in Figures O-12 and O-13.

In the Town of Enfield there are residential areas adjacent to the ROW of the XS-S07 section of the Massachusetts Southern Route Alternative. No overhead BMP line-design alternative for this section has yet been developed, but as discussed later, an underground line-route variation has been evaluated in the event that the Council selects this alternative route and determines that the underground presumption of Section 16-50p(i) requires that overhead construction in this area be avoided.

O.4.2.1.3 EMF Associated with Existing and Proposed Line Configurations

The measurements of magnetic and electric fields at the edges of the ROW (or 25 feet from the centerline of the underground line variation) in the vicinity of statutory facilities or residential “focus areas” are presented in Table O-8 below.

Table O-8: Measured electric and magnetic fields at ROW edge of Massachusetts Southern Route Alternative in the vicinity of "focus areas" and 'statutory' facilities

Location Name/Address	Town	Location Label*	Cross-Section	Arial Segment #	Magnetic Field (mG)	Electric Field (kV/m)	Distance from CL of new 345-kV circuit (ft)
Residential "focus area" Between existing structures 22024 – 22058 [ADJACENT]	Enfield		XS-S07	South Agawam to Ludlow "Southern" Route Alternative Mapsheets 02-05 of 05	0.4 – 5.0**	0.02 – 0.16**	OH North of ROW 162 – 455 South of ROW 125 – 390
Malissa Griffith 38 Sword Avenue	Enfield	DC-3	XS-S07	South Agawam to Ludlow "Southern" Route Alternative Mapsheet 03 of 05	1.2	1.0	OH - 356 UG - 1372
SR220/Enfield Underground Line Route Variation							
Stepping Stones Early Learning Center 41 Brainard Road	Enfield	DC-5	XS-S07	South Agawam to Ludlow Southern Route Alternative Underground Variation Mapsheet 01 of 04	0.4	0.1	UG - 224

** Range of measurements made at several different locations along route.

The calculated magnetic fields associated with the existing 115-kV transmission line (pre-construction) and the existing and new 345-kV line (post-construction) for cross sections XS-S05 and XS-S07 are shown in Figures O-14 and O-15, respectively.

Figure O-14: Profile XS-S05: CT border to CT River – Magnetic fields under pre-NEEWS (2012) and post-NEEWS (2017) conditions at AAL

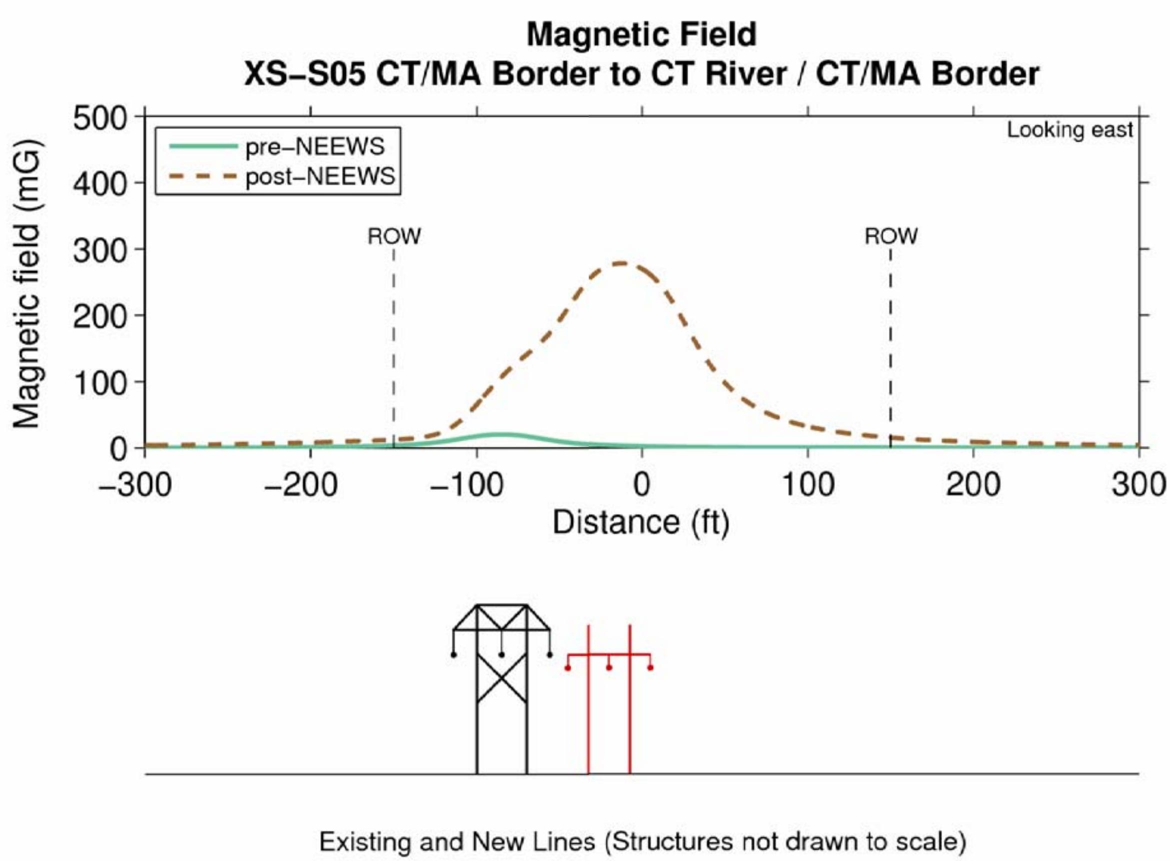
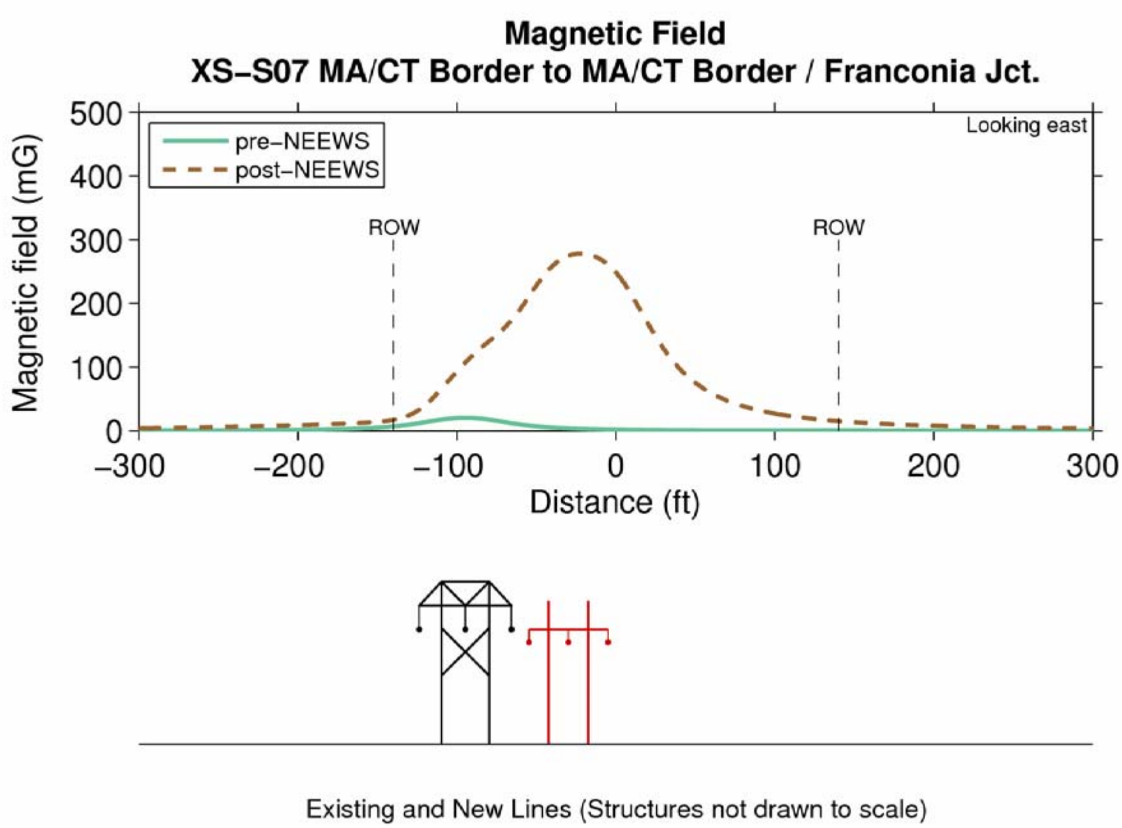


Figure O-15: Profile XS-S07: CT border to CT River – Magnetic fields under pre-NEEWS (2012) and post-NEEWS (2017) conditions at AAL

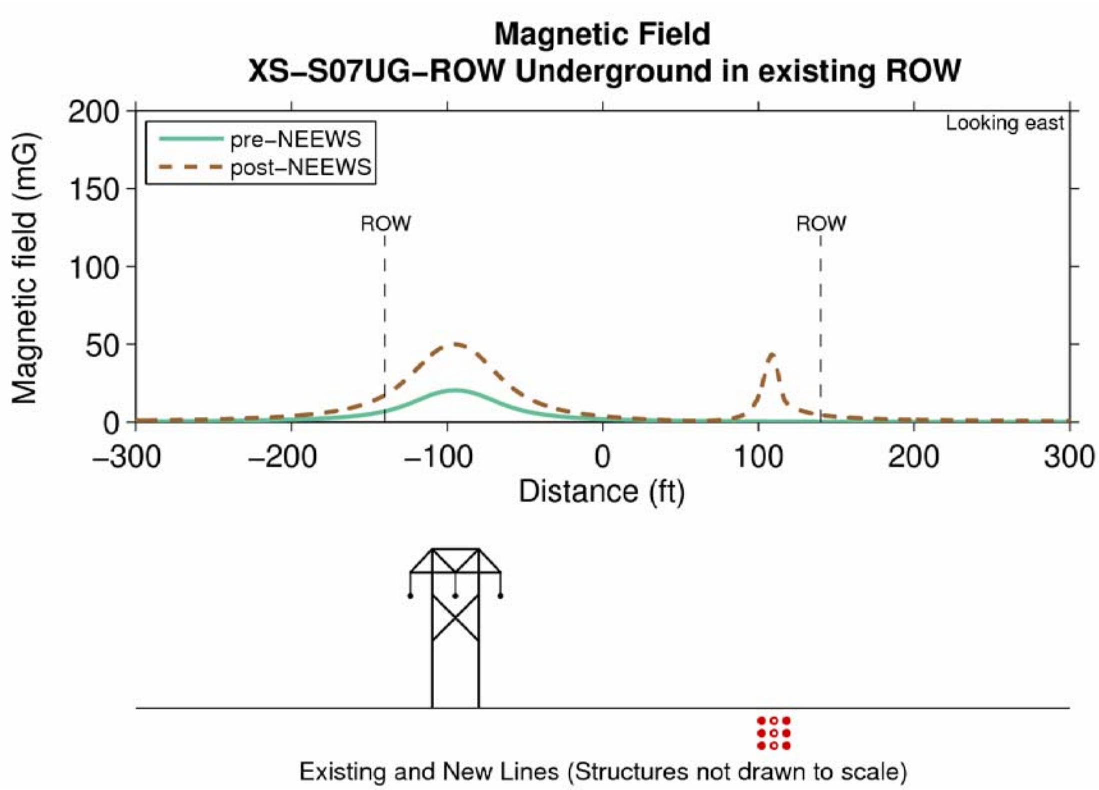


O.4.2.2 State Route 220/Enfield Underground Line Route Variation

CL&P evaluated a possible underground line route variation to the proposed overhead line route between existing structure 22024 and existing structure 22058 in the town of Enfield. The first part of the variation would be constructed within the existing ROW and the remainder would be constructed under streets. The trench depth and cable configuration for the in-ROW and under-street variations would be the same as previously shown in Figure O-9.

The combined magnetic field produced by the existing 115-kV overhead line and a 345-kV line constructed underground within the ROW is shown in the post-construction profile in Figure O-16 below.

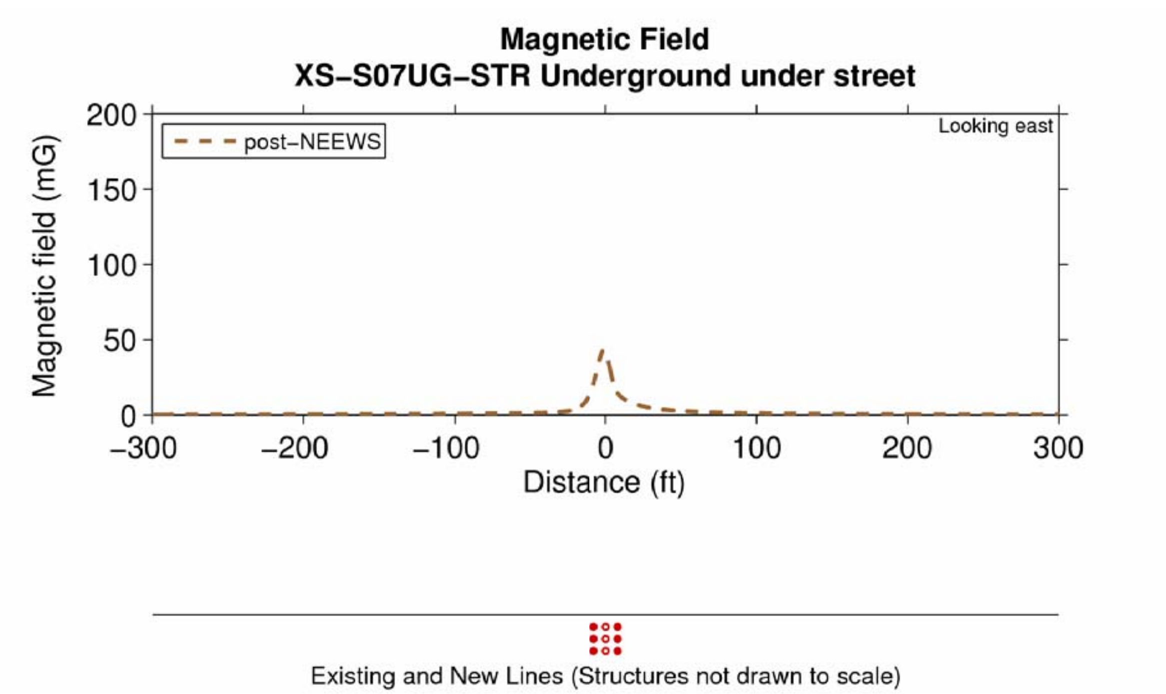
Figure O-16: Profile XS-S07 UG variation within ROW – Magnetic fields under pre-NEEWS (2012) and post-NEEWS (2017) conditions at AAL[5]



Another possible underground line variation involves the construction of the 345-kV cables underground in streets. The calculated magnetic field profile for this case is shown in Figure O-17.

[5] Higher magnetic fields than shown in this profile would be produced over splicing vaults where the cables are more widely separated than shown here.

Figure O-17: Profile XS-S07 UG variation in streets – Magnetic fields under post-NEEWS (2017) conditions at AAL[6]



The calculated magnetic fields for the existing lines, the base design configuration, and underground variations are summarized in Table O-9.

[6] Higher magnetic fields than shown in this profile would be produced over splicing vaults where the cables are more widely separated than shown here.

Table O-9: Summary of Pre-NEEWS (2012) and Post- NEEWS (2017) EMF Levels at the edge of the right-of-way at annual average loading (AAL) - Southern Alternative Route for Agawam to Ludlow Line

	Magnetic Field (mG)		Electric Field (kV/m)	
Cross Section	**West/North ROW***	**East/South ROW***	**West/North ROW***	**East/South ROW***
XS-S05 – Pre	3.8	0.3	0.31	0.01
XS-S05 – Post	12.5	15.2	0.42	0.22
XS-S06 – Pre	3.4	0.9	0.27	0.04
XS-S06 – Post	5.0	111.2	0.30	3.08
XS-S07 – Pre	7.0	0.3	0.66	0.01
XS-S07 – Post	17.3	15.2	0.81	0.22
XS-S07 – Post UG ROW	17.4	4.6	NC	NC
XS-S07 – Post UG street	2.6	5.7	NC	NC

* 25 feet from centerline for underground construction

NC – not calculated as there will be no electric field produced above ground by the buried cables.

O.4.3 The Manchester to Meekville Junction Circuit Separation Project (MMP)

O.4.3.1 Existing Line Configurations and EMF

The MMP involves the simple reconfiguration of existing circuits over an existing 2.2 mile, 350-foot wide, ROW segment. The goal is to relocate the 115-kV circuit (part of circuit #1448) to a separate line of structures to improve reliability.

An existing 115-kV line supports circuits #1763 and #1310 on double-circuit lattice-steel structures on the west side of the ROW. In addition on the east side of the ROW, double-circuit lattice-steel structures support the 115-kV circuit #1448 and the 345-kV circuit #3419. Over some of the route, a 23-kV distribution line on wood poles is located between the two lines of lattice-steel structures. The configuration of this cross section is shown as the “Existing Layout” in Figure O-18.

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Figure O-18: Cross-Section XS-21: Manchester Substation to Meekville Junction

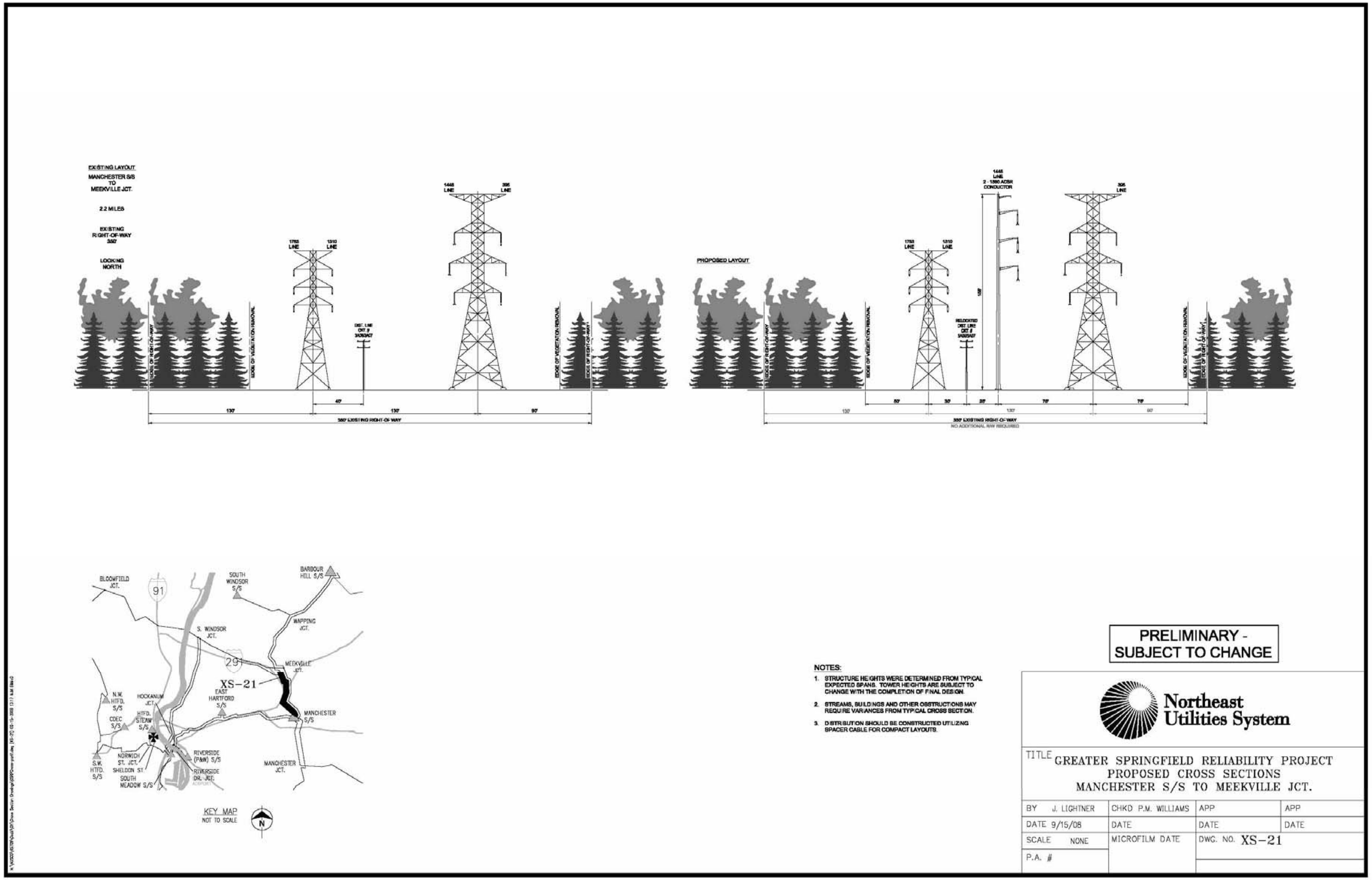

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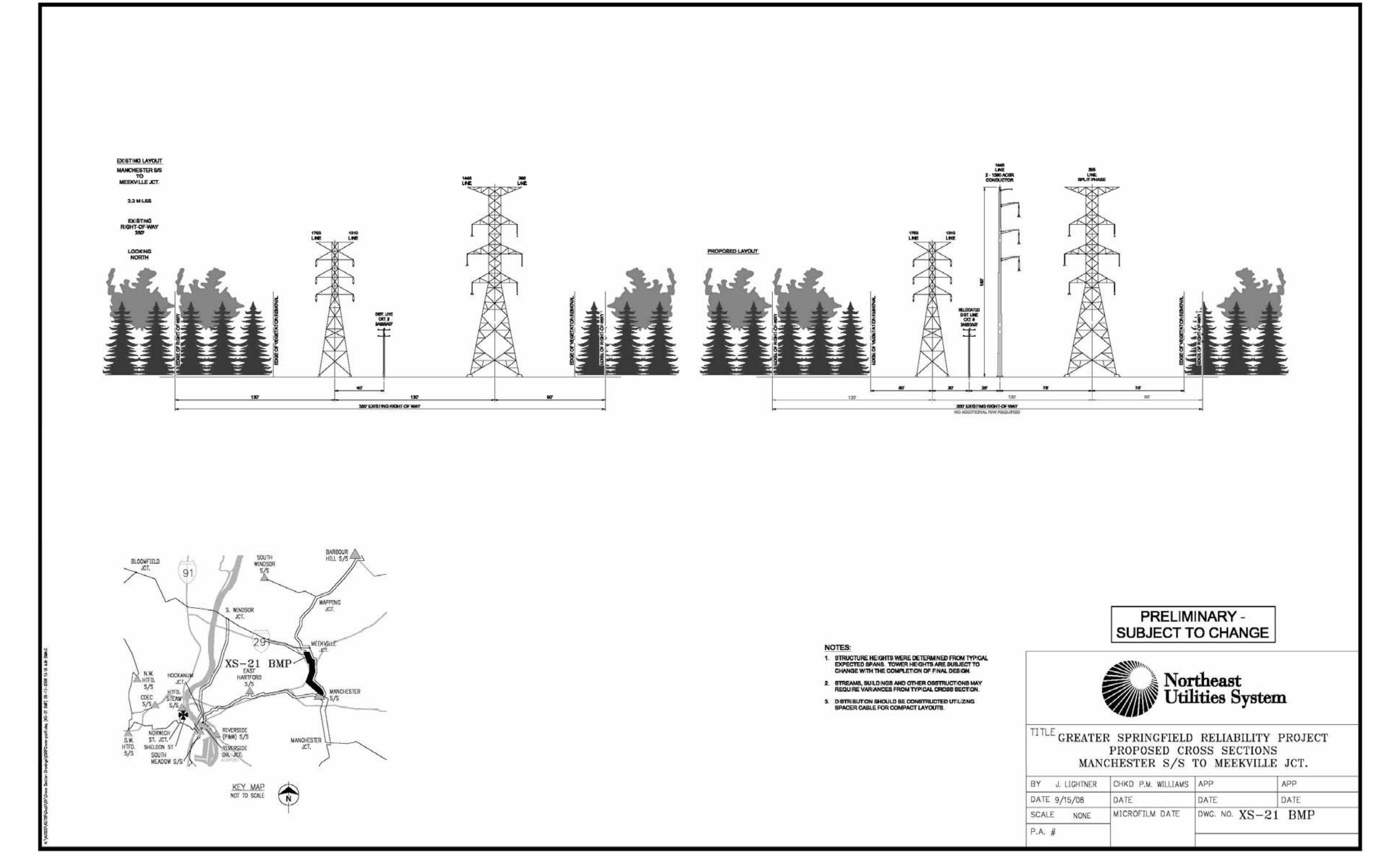
Figure O-19: Cross-Section XS-21 BMP: Manchester Substation to Meekville Junction



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O.4.3.2 Proposed Changes to the Existing Line Configurations and Magnetic Fields

The "Proposed Layout" also shown in Figure O-18 depicts the relocation of the distribution line slightly to the west to allow construction of a new line on steel monopoles between 120 and 190 feet high in the center of the ROW to support the 115-kV circuit #1448 that will be moved from the adjacent lattice-steel towers.

There are no residential "focus areas" adjacent to the MMP ROW but there are three statutory facilities in its vicinity as listed in Table O-10. The levels of EMF measured at the edge of the proposed ROW are also listed in this table.

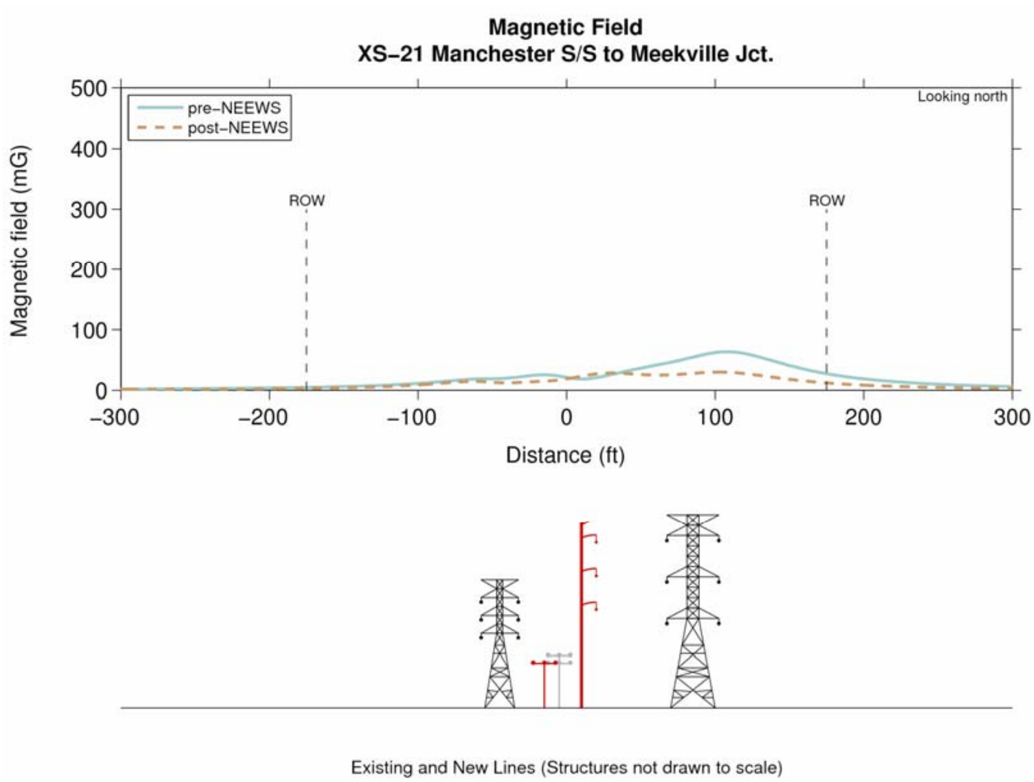
Table O-10: Measured electric and magnetic fields for the Manchester to Meekville Junction Circuit Separation Project (XS-21) in the vicinity of 'Statutory' Facilities

Location Name/Address	Town	Location Label	Cross-Section	Arial Segment #	Magnetic Field (mG)	Electric Field (kV/m)	Distance from CL of new 115-kV circuit (ft)
Manchester – Meekvillle Circuit Separation Project							
Howell Cheney Vocational Training School		SC	XS-21	Manchester Substation to Meekville Jct. Mapsheet 01 of 03	1.8	--	OH - 547
Leber Field/Playground		PG	XS-21	Manchester Substation to Meekville Jct. Mapsheet 01 of 03	5.4 – 7.3**	0.01 – 0.02**	OH - 203
East Catholic High School		SC	XS-21	Manchester Substation to Meekville Jct. Mapsheet 02 of 03	0.3	--	OH-900

-- Shielding by vegetation prevented the collection of measurable electric field levels at this location from existing sources, e.g., distribution lines and service drops.
** Range of measurements taken at this location

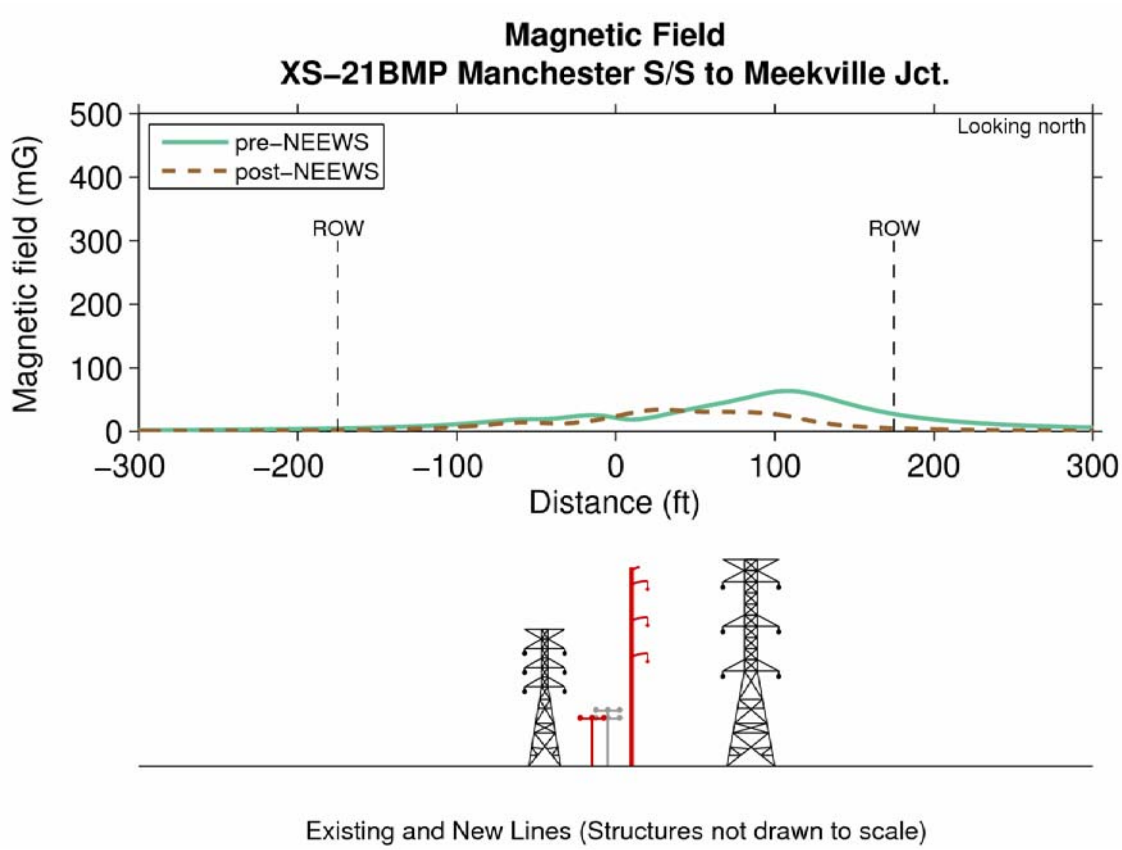
The magnetic fields associated with the existing and proposed configuration of XS-21 at AAL are profiled in Figure O-20.

Figure O-20: Profile XS-21: Manchester Substation to Meekville Junction – Magnetic fields under pre-NEEWS (2012) and post-NEEWS (2017) conditions at AAL



In the Field Management Design Plan (see Appendix O-1), CL&P has evaluated line-design alternatives that would reduce magnetic fields for this project and has recommended that the existing 345-kV line be configured as a split-phase line. The calculated magnetic field profiles for the existing 115-kV lines and with the proposed BMP split- phase configuration option for the proposed line are shown in Figure O-21.

Figure O-21: Profile XS-21 BMP: Manchester Substation to Meekville Junction – Magnetic fields under pre-NEEWS (2012) and post-NEEWS (2017) conditions at AAL



The levels of EMF at the ROW edges for the base line design and this split-phase line design are summarized in Table O-11.

Table O-11: Summary of pre-NEEWS (2012) and post-NEEWS (2017) EMF Levels at the edge of the ROW at annual average loading (AAL) - Manchester to Meekville Junction

Manchester Substation to Meekville Junction				
	Magnetic Field (mG)		**Electric Field (kV/m)**	
Cross Section	**West/North ROW**	**East/South ROW**	**West/North ROW**	**East/South ROW**
XS-21 – Pre	4.8	27.4	0.06	0.15
XS-21 – Post	3.2	12.2	0.07	0.15
XS-21 BMP – Post	2.2	4.9	0.05	0.14

O.5 UPDATE ON THE EMF HEALTH RESEARCH

In its BMP issued on December 14, 2007, the Council recognized the consistent conclusions of "a wide range of public health consensus groups," as well as their own commissioned weight-of-evidence review (p. 4). The Council summarized the current scientific consensus by noting the conclusions of these public health consensus groups, including the most recent review by the World Health Organization (WHO) in 2007 and previously published reviews by the National Institute for Environmental and Health Sciences (NIEHS, 1999), the International Agency for Research on Cancer (IARC, 2002), Australian Radiation Protection and Nuclear Safety Agency (ARPANSA, 2003),[7] the National Radiological Protection Board of Great Britain (NRPB, 2004), and the Health Council of the Netherlands (HCN, 2005). The Council summarized the current scientific consensus as follows: there is limited evidence from epidemiology studies of a statistical association between estimated, average exposures greater than 3 to 4 mG and childhood leukemia; the cumulative research, however, does not indicate that magnetic fields are a cause of childhood leukemia, as animal and other experimental studies do not suggest that magnetic field are carcinogenic. The Council also noted the WHO's recent conclusion with respect to other diseases: "the scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukemia" (BMP, p. 2).

[7] ARPANSA released an updated evaluation of EMF research and a draft standard in 2006, which is largely consistent with those of WHO and other national and international health agencies.

Based on this scientific consensus, the Council concluded that proportional precautionary measures for the siting of new transmission lines include "the use of effective no-cost and low-cost technologies and management techniques on a project-specific basis to reduce MF exposure to the public while allowing for the development of efficient and cost-effective electrical transmission projects" (p. 11). The BMP also stated that the Council will "consider and review evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF" (p. 5).

In support of this provision of the BMP, CL&P commissioned William H. Bailey, Ph.D. and colleagues at Exponent to provide a report that systematically evaluates peer-reviewed research and reviews by scientific panels published from December 14, 2007 through June 16, 2008 to determine if there are new developments that might alter the current scientific consensus as articulated in the Council's 2007 BMP. This report is provided in Appendix O-6. As the Executive Summary of this report states:

> A systematic literature review was performed and epidemiologic and *in vivo* studies published after the WHO report are critically evaluated in this report. These recent studies do not provide evidence to alter the opinion of the WHO and other health and scientific agencies that the research evidence is insufficient to suggest that electric or magnetic fields are a cause of cancer or any other disease process at the levels we encounter in our everyday environment (Appendix O-6, p. 6-1).

O.6 SUMMARY OF ACTIONS DEMONSTRATING CONSISTENCY WITH CSC GUIDELINES

CL&P has provided EMF measurements and calculations, transmission line designs, and an update of EMF research to address the Council's application guidelines and the BMP for a) the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route in GSRP, b) the potential Connecticut portion of the Massachusetts Southern Route Alternative for the 345-kV Ludlow to Agawam Line in GSRP, and c) the Manchester to Meekville Junction Circuit Separation Project.

Section O.4 presents the measured fields and calculated fields that describe the existing, pre-construction conditions at annual average loading (AAL) along the three routes in existing ROWs. Calculated fields at AAL are also presented for proposed base transmission designs that incorporate “no-cost” line configurations and optimized phasing to reduce magnetic fields along the entire route. In addition, calculations of magnetic fields for a “low-cost” alternative overhead delta design are presented that will reduce magnetic fields at the edge of the ROW for a portion of the route from Granby Junction to the Connecticut/Massachusetts state border in GSRP where nearby groupings of homes were identified as a residential “focus area.” Calculations for a “low-cost” alternative split-phase line configuration for the Manchester to Meekville Junction Circuit Separation Project are also presented that will reduce magnetic fields at the edge of the ROW. These alternative designs were derived from analyses presented as part of the Plan (Appendix O-1) and were shown to reduce magnetic fields at the edges of ROWs by 15% or more than achieved by “no-cost” measures incorporated into the base designs.

The magnetic fields associated with underground line variations in the ROW or in streets that would bypass a residential “focus area” adjacent to the Granby Junction – Connecticut/Massachusetts state border section of the GSRP overhead line ROW, and a segment of the Connecticut Portion of the Southern Route Alternative for the 345-kV Ludlow to Agawam Line in Suffield and Enfield are also presented for the consideration of the Council. Additional magnetic field calculations at 25-foot intervals at AAL, PDL, and PDAL loading, and electric field calculations at 25-foot intervals are provided for all base, alternative, and underground designs in Appendices O-3, O-4, and O-5.

Section O.5 presents the conclusions of a summary of current scientific research based upon a systematic review of epidemiologic and *in vivo* research and the consensus conclusions of the WHO status report published since the publication of the BMP in December 2007, which is included in Appendix O-2.

In summary, the data provided in Section O and the related magnetic Field Management Design Plan provided in Appendix O-1 fully comply with the CSC's application guidelines and BMP requirements as summarized in Section O.2 and provide a basis for the determination that the proposed alternatives to the base designs provide an adequate buffer zone in the vicinity of statutory facilities.

O.7 TECHNICAL DESCRIPTION OF PROPOSED AND BEST MANAGEMENT PRACTICE ALTERNATIVE LINE DESIGN

O.7.1 Base Design of Proposed Connecticut Facilities for the GSRP

O.7.1.1 General

The design and appearance of new lines over the 12.0 miles of ROW between North Bloomfield Substation and the Connecticut/Massachusetts state border will be as described in Section I of this application with one exception. A section of ROW in Suffield and East Granby was identified in Section H of the application as an area where alternative underground 345-kV line-routes could be considered. This ROW section is a portion of Segment 2 from Granby Junction to the Connecticut/Massachusetts state border. If build overhead, as CL&P proposes, the line along this section of the ROW would be constructed with a low magnetic field design, consistent with the BMP. In this section, the base H-frame design for the new 345-kV line will be compared to line-design alternatives that would reduce edge-of-ROW magnetic field levels consistent with the BMP.

O.7.1.2 Segment 2 (Granby Junction - CT/MA State Border)

The base design and appearance information for the Segment 2 ROW is as follows:

- Total ROW length is 7.2 miles.
- Existing ROW width is generally 305 feet.
- Existing lattice-steel towers range from 70 to 95 feet in height and support two existing 115-kV circuits.

- None of the existing line structures are to be removed, and the existing double-circuit 115-kV line will continue in use, with the two circuits "bundled" together to operate as a single-circuit. This will be accomplished by bundling the circuit conductors together at approximately 1-mile intervals.
- Additional ROW width would be required for the new 345-kV line construction as follows: approximately an additional 100 feet of width for a distance of approximately 1,000 linear feet between Phelps Road and Mountain Road, and for approximately 400 linear feet east of Ratley Road. At both locations, adjacent land is partially owned by Northeast Utilities.
- Of the 305 feet of existing ROW, approximately 110 feet are currently being maintained for the existing transmission facilities. The new 345-kV would require approximately 205 feet to be maintained; approximately 100 feet of the ROW would remain untouched by the Project
- Structures proposed to support the new 345-kV circuit conductors are: steel- or laminated-wood-pole H-frame structures typically about 90 feet in height with a horizontal configuration of the line conductors, refer to XS-2.
- New line-structure placement is typically near to existing structure locations.
- Segment 2 is not adjacent to any public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds.
- There are numerous residential land uses along Newgate Road, in East Granby and Suffield, and along Phelps Road in Suffield for approximately 3 miles of Segment 2.

O.7.2 Design and Appearance of BMP Alternative (Country Club Lane to Phelps Road)

A BMP design alternative was considered only over the section of Segment 2 between the ROW crossings of Phelps Road in Suffield and the location where Country Club Lane in East Granby comes closest to the ROW. Over this section of ROW, which is approximately 3.2 miles long, a new 345-kV line employing steel-monopole structures with a delta configuration of the line conductors is proposed.

The basis for the selection of this BMP design alternative can be found in the Plan in Appendix O-1. This design alternative will reduce magnetic field levels at the ROW edges consistent with the Council's BMP.

The design and appearance information for this 3.2-mile ROW section within Segment 2 is as follows:

- Total ROW length is 3.2 miles.
- Existing ROW width is generally 305 feet.
- Existing lattice-steel towers range from 70 to 95 feet in height and support two existing 115-kV circuits.
- None of the existing line structures are to be removed, and the existing double-circuit 115-kV line will continue in use, with the two circuits "bundled" together to operate as a single-circuit. This will be accomplished by bundling the circuit conductors together at approximately 1-mile intervals.
- No Additional ROW width would be required for the new 345-kV line construction.
- A new 345-kV line employing steel-monopole structures with a delta configuration of the line conductors is proposed. The typical height of these poles will be 110 feet. The line will be centered 75 feet east of the centerline of the existing 115-kV line.
- New line-structure placement is typically near to existing structure locations.

A 345-kV delta line configuration will reduce magnetic field levels under modeled system average loading conditions by 23% at ROW edges, as compared to the magnetic field levels using the base case H-frame line design. See the Plan in Appendix O-1 and Table O-5 for details.

O.7.3 Base Design Comparison to BMP Design Alternative for a Section of GSRP Segment 2

Table O-12 below summarizes the magnetic field level and cost comparison between the Base Design and the BMP alternative delta line design.

Table O-12: Comparison of Base Design and the BMP Alternative Design

XS-2 Cross Section Configuration	Average Annual Load Case					Cost	
	Maximum Level on ROW (mG)	West ROW Edge		East ROW Edge			
		Level (mG)	Reduction (%)	Level (mG)	Reduction (%)	Section Amount ($)	Project Increase (%)
Base Line Design (H-Frame)	269.2	23.5	-	12.6	-	$11,293,000.00	-
BMP EMF Alternate (Delta)	173.4	17.9	24%	9.8	22%	$13,454,000.00	1.6%

The 345-kV delta line configuration alternative for 3.2 miles in East Granby and Suffield will increase total project cost by about $2.2 million, or about 1.6%, and it will reduce MF levels by an average of 23% at the edges of the ROW (22% on east edge and 24% on west edge). The delta line configuration will require single-pole structures which are taller than the poles of an H-frame structure by 20 to 25 feet typically. However, the delta line configuration is a narrower line than the H-frame line, so a lesser width (by about 10 feet) of vegetation removal will be required on its east side. Also, at angle locations on the line route over these 3.2 miles, the delta line configuration will require either one or two monopoles, whereas the angle structures of an H-frame line would use guyed or self-supporting three-pole structures.

Regardless of the overhead line configuration, many of the construction impacts will remain unchanged. The duration of construction, the size and location of access roads, crane pads, and staging areas will be very similar for both H-Frame structures and delta monopoles. As such impacts to wetlands, wildlife habitats, and other environmental factors will not change significantly by implementing the BMP alternative design for a section of segment 2.

O.7.4 Base Design of the MMP Facilities

O.7.4.1 General

The design and appearance of overhead lines over 2.2 miles of ROW between Manchester Substation and Meekville Junction along which an existing 345-kV circuit and 115-kV circuit will be separated is as described in Section I of this application. However, a section of this ROW was identified in Section H of the Application as an area where a public school and a playground are near the east side of the ROW. This circumstance led CL&P to consider alternative transmission line designs for the MMP pursuant to the Council's BMP. In this section, the base line configuration for the replacement 115-kV line will be compared to line-design alternatives on the ROW that would reduce edge-of-ROW magnetic field levels consistent with the BMP.

In order to separate the 115-kV circuit from the 345-kV circuit along the Manchester to Meekville Junction corridor, a new single-circuit monopole transmission line will need to be constructed within the existing ROW. The separated 115-kV circuit will be rebuilt with a vertical conductor configuration on these new monopoles using 345-kV conductor bundles, conductor spacings and insulation to match the existing 115-kV circuit's 345-kV design capability over much of these 2.2 miles. The existing conditions and proposed base design layout are summarized below:

- A line of existing lattice-steel towers typically 155 feet in height supports one 115-kV circuit and one 345-kV circuit, both of which have 345-kV class insulation, conductor spacings and bundled conductors (with some short exceptions on the 115-kV circuit). To the west of this line, a second line of existing lattice towers with a typical height of 130 feet supports two 115-kV circuits. Existing wood distribution poles on the ROW are approximately 40 feet in height. The ROW width is sufficient to install a new 115-kV overhead line in between the two existing double-circuit transmission lines.
- The existing 115-kV circuit on these double-circuit towers would be replaced on a separate line of steel-monopole structures.
- The total ROW length for the circuit separation is approximately 2.2 miles.
- The existing ROW width is generally 350 feet.
- Structures proposed to support the replacement 115-kV circuit segment are steel monopoles with a typical height of 130 feet, using a vertical configuration of the line conductors. The proposed line location is between the existing lines to minimize additional clearing and other environmental impacts. The proposed new structure heights would be about the same as the

existing lattice towers, ranging between 110 and 175 feet in height, and the new 115-kV line will utilize 345-kV class conductor bundles, insulation and conductor spacings.

- None of the existing transmission lines will be removed; however, throughout this section, approximately four of the existing lattice structures associated with the 115-kV double circuit line will need to be relocated to accommodate the new transmission line. Most of the existing wood distribution poles will need to be relocated to accommodate the new 115-kV overhead line.
- New line structure placements are proposed to be in the vicinity of existing structure locations.
- The additional clearing required would be minimized since the reconstructed line would be placed in between the existing transmission facilities.

O.7.5 Design and Appearance of BMP Alternative for MMP

The most effective way to reduce magnetic field levels at the east edge of the ROW will be to modify the existing 345-kV circuit. By reusing the conductors of the existing 115-kV circuit on the double-circuit line, the 345-kV circuit can be modified to be either a bundled circuit, or with reverse phasing, a split-phase line. Cross-section XS-21 BMP at the end of this section shows the alternative design and appearance. Details on the associated magnetic field calculations and comparisons can be found in the Plan in Appendix O-1. Except for the listed items below, the design and appearance will remain exactly the same as the Base Design for MMP.

- Approximately 3,500 feet of the existing 115-kV circuit on the double-circuit lattice steel tower line will require re-conductoring. Each single conductor would be replaced with a bundled 954-kcmil ACSR conductor bundle.
- Approximately three structures on both ends of the project (six total structures) will require insulation upgrades.

- Connecting conductors would be installed in a few locations to connect the opposite side conductors together for bundled circuit operation. For the split-phase line configuration, these conducting connectors would be changed to tie the top conductors on each side to the bottom conductors on the opposite side.

O.7.6 Base Design Comparison to BMP Design Alternative for the MMP

Table O-13 below summarizes the magnetic field level and cost comparison between the Base Design and the BMP alternative split-phase 345-kV circuit design.

Table O-13: Comparison of base design and split-phase alternative for MMP

XS-21 Cross Section Configuration	Average Annual Load Case					Cost	
	Maximum Level on ROW (mG)	West ROW Edge		East ROW Edge			
		Level (mG)	Reduction (%)	Level (mG)	Reduction (%)	Section Amount ($)	Project Increase (%)
Base Line Design (Vertical)	30.0	3.2	-	12.2	-	13,728,000	-
BMP EMF Alternate (395 Split-Phase)	34.1	2.4	25%	4.8	61%	520,000	3.8%

The edge-of-ROW magnetic field levels, assuming a best phasing of the replacement 115-kV circuit in the base line design, will be lower on both ROW edges than the levels associated with the existing line configuration on this ROW. For the average system loading case, the split-phase 345-kV line design alternative will further reduce the magnetic field levels at the west edge of the ROW by 25%, and levels on the east edge will be further reduced by 61%. The 345-kV split-phase circuit configuration will increase the total project cost by about $520,000 or about 3.8%, but it will reduce MF levels by an average of 43% at the edges of the ROW. CL&P’s Field Management Design Plan recommends using this BMP alternative line design. The split-phase circuit configuration will require modifications to the existing line to upgrade short sections of the former 115-kV circuit conductors for 345-kV use. These modifications are not required for the base line design.

Because the line design and appearance are the same for both the Base Design and BMP design alternative, the construction and visual impacts will remain unchanged. The duration of construction, the size and location of access roads, crane pads, and staging areas will be very similar for both options. As such impacts to wetlands, wildlife habitats, and other environmental resources will not change significantly by implementing the BMP design alternative for the MMP.

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Connecticut Light & Power
The Northeast Utilities System

NEW ENGLAND EAST—WEST SOLUTION

APPENDIX O-1

CL&P'S FIELD MANAGEMENT DESIGN PLAN

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I. INTRODUCTION

This section summarizes an evaluation of engineering measures to reduce magnetic fields at right-of-way (ROW) edges for the new and reconstructed transmission lines that are part of the Greater Springfield Reliability Project (GSRP) and the Manchester to Meekville Junction Circuit Separation Project (MMP) in Connecticut. The goal of this evaluation is to recommend measures that would meet the policy of the Connecticut Siting Council (CSC) for incorporating magnetic field management in the siting and design of new transmission lines as part of its Electric and Magnetic Fields Best Management Practices for the Construction of Electric Transmission Lines in Connecticut, December 14, 2007 (hereinafter referred to as “BMP”). A copy of the BMP is included in Appendix O-2 of the CSC Application.

In compliance with the CSC policy, a Field Management Design Plan (Plan) was developed for the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route and for the MMP. This Plan begins from a design of the proposed overhead transmission line in each case that incorporates standard utility practice to which “no-cost” magnetic field mitigation design features are added (see Section O of the CSC Application). This design is henceforth called the “base line design”. The Plan then examines modified overhead line designs that incorporate low-cost magnetic field mitigation design features at locations where the transmission line routes could be considered by the CSC to be adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds.

The CSC BMP further calls for the incorporation of low-cost modified line designs to reduce magnetic fields at certain locations. A benchmark for additional project spending on these modified designs is up to 4% of the estimated project cost using the base line design, including the cost of the Project’s related substation work. The BMP also specifies that this extra cost allowance should be used on measures that would achieve magnetic field reductions at ROW edges of 15% or more with respect to the levels associated with the base line design. For the proposed GSRP, 4% of the estimated project cost, in Connecticut, is $5.3 million; and for the MMP, 4% of the project cost is $550,000.

The intention of the BMP is to achieve magnetic field reductions using some or all of these 4% allowances. However, the 4% spending guideline and the 15% reduction target are both flexible guidelines. As stated in the CSC BMP, minor increases above the 4% spending guideline and decreases from the 15% reduction guideline may be justifiable in some circumstances. The Council will review CL&P's recommendations in this plan, and then select from CL&P's design alternatives as to the best means to achieve the goals of the BMP.

Section O of the CSC Application also contains information on the pre- and post-NEEWS configurations of the Massachusetts Southern Route Alternative that passes through Suffield and Enfield, Connecticut. The base transmission line design for this area involves the addition of a 345-kV horizontally configured line to an existing ROW. This section contains an existing 115-kV line that is also installed in a horizontal conductor configuration. This Plan does not include line design alternatives for this potential alternative route. The Plan will be amended to address this route segment at a later date, as needed.

Follow-up information on magnetic fields and the FMDP can be obtained by contacting Mr. Robert E. Carberry of Northeast Utilities Services Company at 860-665-6774 and Dr. Gary Ginsberg of the Connecticut Department of Public Health (DPH) at 860-509-7750.

II. GREATER SPRINGFIELD RELIABILITY PROJECT

II.1 PROJECT DESCRIPTION AND BASE LINE DESIGN

In Connecticut, the GSRP consists of constructing a new 345-kV line on an existing ROW between North Bloomfield Substation in Bloomfield, Connecticut and the Connecticut/Massachusetts state border at Agawam, Massachusett. In Connecticut, the project also will require a functional reconfiguration and use of adjacent 115-kV lines within the existing ROW. The 115-kV line reconfiguration will be implemented by de-energizing three existing 115-kV circuit sections from the North Bloomfield Substation to Granby Junction, bundling the conductors on the 115-kV lattice-steel tower line to form one circuit heading northeast from Granby Junction towards Agawam, Massachusetts, and then at Granby Junction, connecting the conductors of this bundled line segment to the 115-kV line conductors heading northwest to a substation in Southwick, Massachusetts. For magnetic field management purposes, the bundling of the conductors on the 115-kV lattice-steel tower line for future operation as a single circuit will incorporate reverse phasing. Together with expected lower current flows over this circuit by comparison with today's use of the two circuits, this 115-kV line will produce lower magnetic fields.

Within Connecticut, the new 345-kV line and the 115-kV line changes will occur primarily on existing right-of-way, but some additional right-of-way will be required for a few individual parcels in Suffield, Connecticut. The existing ROW is typically 305 to 385 feet wide, with sufficient unused width to construct the new 345-kV line on H-Frame structures with the line conductors in a horizontal configuration. A horizontal line configuration is the preferred base line configuration because it allows for lower structure heights (and visual impacts), and is the most economical configuration to build. For the base line configuration, the phasing of the 345-kV line will be selected so that the magnetic field produced by this line and the adjacent 115-kV line is minimized on the westerly ROW edge.

II.2 FOCUS AREAS FOR MAGNETIC FIELD MANAGEMENT

Per the CSC BMP, the focus areas for applications of low-cost magnetic field management designs are those locations where public or private schools, licensed child day-care facilities, public playgrounds, licensed youth camps, or residential areas are adjacent to a proposed new transmission line. For the GSRP, there are no schools, child day-care facilities, playgrounds or youth camps adjacent to the transmission line ROW, but in sections of East Granby and Suffield, numerous residences exist on both the east and west sides of the ROW. Maps are shown in Volumes 9 and 11 of the CSC Application which illustrate the locations of homes along the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route. A 3.2-mile section of the proposed line, from a starting point in East Granby approximately 1.3 miles north of Granby Junction to an end point in Suffield just north of the crossing of Phelps Road, was identified as a “focus area” for BMP consideration. As discussed in Section H of the Application, this section of ROW is near a group of homes that the Council may or may not consider to be a “residential area” within the meaning of the underground presumption of section 16-50i(p) of the Connecticut General Statutes; and CL&P has submitted that the proposed 345-kV line will not be “adjacent to” a “residential area” Nevertheless, as there are more homes along this section of the ROW than exist along other comparable lengths of the Connecticut section of the ROW, it is a logical place for priority attention in this Plan. This section of the route occurs between existing 115-kV line structure numbers 3191 and 3221. The minimum ROW width throughout this section is 305 feet.

II.3 BASE GSRP LINE DESIGN AND ALTERNATIVE GSRP LINE DESIGNS FOR MAGNETIC FIELD REDUCTIONS IN FOCUS AREA

II.3.1 Horizontal Conductor Configuration Using 345-kV H-Frame Line Structures, the Base Line Design

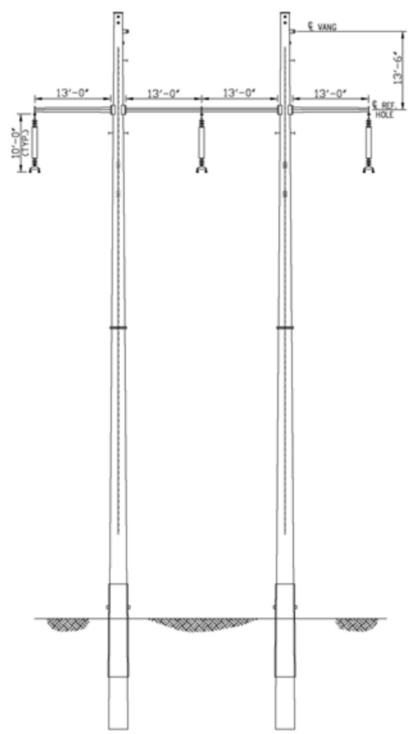
A depiction of a typical 345-kV H-frame line structure is shown in Figure 1. With “no-cost” best circuit phasings in relation to any adjacent lines, this is CL&P’s preferred and base line design for use in all areas where sufficient right-of-way exists. Throughout the ROW in the focus area, the base H-frame line would be centered at 125 feet from the westerly ROW edge. Structure, and therefore conductor, heights can be increased to reduce the magnetic field at both edges of the right-of-way, but only relatively large height increases in this case would achieve the 15% reduction target. Typical 345-kV H-frame line costs for two average structure heights, based upon use of laminated wood poles with direct embedded foundations, are summarized in Table 1.

Table 1: Typical 345-kV H-Frame Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
90' H-Frame	$3,739,000
110' H-Frame	$3,914,000

Note: *Structure Costs are based on (10 structures per mile ((8) tangents and (2) 3-poles structures for H-frames); Conductor costs are based on (2) - 1590-kcmil ACSR "Lapwing"; Costs include labor, material, and hardware*

Figure 1: Tangent H-Frame Structure



II.3.2 345-kV Delta Line Configuration

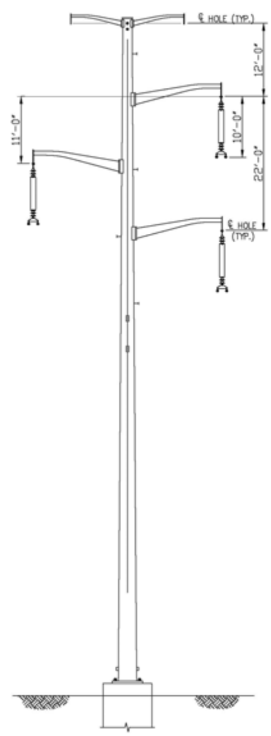
A typical 345-kV delta line structure is shown in Figure 2. Such a line would be constructed using steel monopoles and concrete pier foundations. A delta configuration of the line conductors allows for a narrower line which would lower magnetic field levels at the edges of the ROW in the focus area if constructed on the same centerline as the base case H-frame line. Typical 345-kV delta line costs for two average structure heights can be found in Table 2.

Table 2: Typical 345-kV Delta Line Costs Per Mile

Cost Per Mile	
Structure Description	Total
110' Delta	$4,613,000
130' Delta	$5,241,000

Note: *Structure Costs are based on (10 structures per mile ((8) tangents and (2) 3-poles structures for H-frames); Conductor costs are based on (2) - 1590-kcmil ACSR "Lapwing"; Costs include labor, material, and hardware*

Figure 2: Tangent Delta Structure



II.3.3 345-kV Vertical Line Configuration

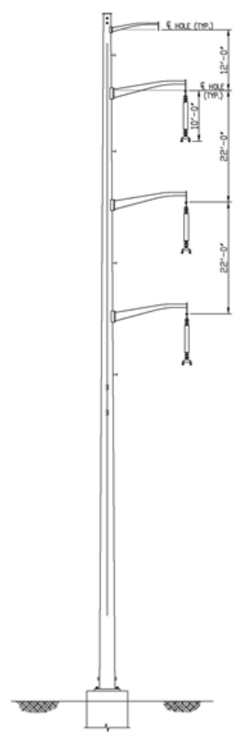
Vertical lines, using structures as shown in Figure 3, are typically constructed on narrower ROWs or where several lines are routed on the same ROW. Such a line would be constructed using steel monopoles and concrete pier foundations. A vertical line configuration is the narrowest possible line configuration, and it produces lower magnetic field levels at the edges of the ROW in the focus area if its conductors are installed over the same centerline as the base case H-frame line. In fact, the magnetic field levels at the ROW edges would be close to those for the delta line configuration. Typical 345-kV vertical line costs for two average structure heights are provided in Table 3.

Table 3: Typical 345-kV Vertical Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
130' Vertical	$5,015,000
150' Vertical	$5,497,000

Note: *Structure Costs are based on (10) structures per mile ((8) tangents, (1) angle, (1) DE); Conductor costs are based on (2) - 1590-kcmil ACSR "Lapwing"; Costs include labor, material, and hardware*

Figure 3: Tangent Vertical Structure



II.3.4 345-kV Split-Phase Line Configuration

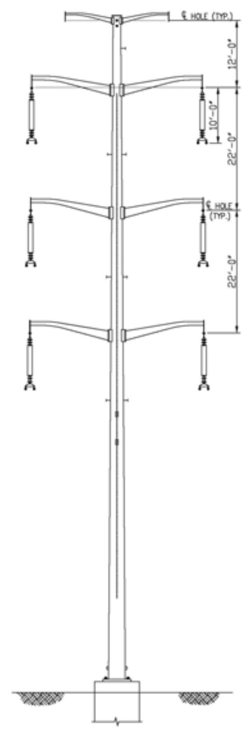
A 345-kV split-phase line configuration, using structures as shown in Figure 4, would employ twice as many line conductors, thus reducing the current in any one conductor by half. This difference, together with reverse phasing of the two sets of line conductors, achieves larger reductions in magnetic field levels at the ROW edges in the focus area than can be achieved by either the delta or vertical line designs. Such a line would be constructed using steel monopoles and concrete pier foundations. Typical 345-kV split-phase line costs for one average structure height are provided in Table 4.

Table 4: Typical 345-kV Split-Phase Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
130' Split-phase	$9,348,000

Note: *Structure Costs are based on (10) structures per mile ((8) tangents, (1) angle, (1) DE); Conductor costs are based on (2) - 1590-kcmil ACSR "Lapwing"; Costs include labor, material, and hardware*

Figure 4: Tangent Split-Phase Structure



II.3.5 345/115-kV Composite Line Configuration

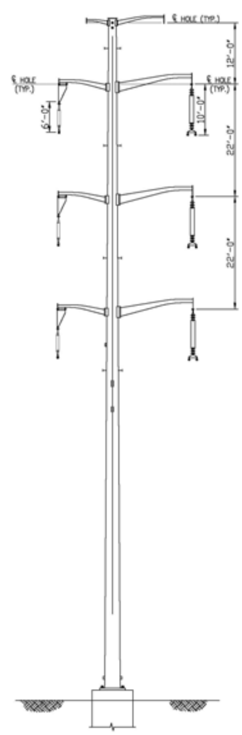
By using a 345/115-kV composite line configuration, shown in Figure 5, the conductors of the two transmission circuits on the ROW can be supported in a vertical configuration on a shared line of structures. If the phasing of the two circuits is optimized, and the 345-kV line conductors are installed on the same centerline as the base case H-frame line, the edge-of-ROW magnetic field levels in the focus area can be reduced to lower levels than a base case 345-kV H-frame line and the existing 115-kV line on adjacent lattice steel towers would produce. By combining the 115-kV circuit on the 345-kV line structures, the nearest line conductors to the westerly ROW edge will be about 50 feet further from this ROW edge than at present. This line configuration would be constructed using steel monopoles with concrete pier foundations. Typical 345/115-kV composite line costs for one average structure height are provided in Table 5.

Table 5: Typical 345-kV Composite Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
130’ Composite	$8,972,000

Note: *Structure Costs are based on (10) structures per mile ((8) tangents, (1) angle, (1) DE); Conductor costs are based on (2) - 1590-kcmil ACSR "Lapwing" for 345-kV and (1) - 1590 kcmil ACSR “Lapwing” for 115-kV; Costs include labor, material, and hardware*

Figure 5: Tangent Composite Structure



II.3.6 Conductor Heights Above Ground

CL&P calculates magnetic fields using typical conductor heights above ground at the middle of cross-country line spans. Wherever conductor heights are higher above ground, magnetic fields will be lower at the ground level on and immediately adjacent to the ROW. Because conductor heights above ground increase between the mid-span points and the line structures, magnetic field levels will be lower at ROW edge locations which are not opposite the mid-span points than CL&P's calculated values. At an extra cost, all of the previously depicted 345-kV line designs can be constructed with additional conductor heights above ground, by increasing the heights of the supporting structures. In this Plan, additional conductor heights above ground of 20 feet were modeled for the base case line design and two alternative line designs.

II.3.7 Conductor Separation

Reducing the separation distance between each of the three conductor bundles of a 345-kV line can reduce magnetic field levels. However, reducing the conductor separations below CL&P's standard separations for each 345-kV line design can reduce reliability and make it unsafe for line workers to perform live-line maintenance. To achieve at least a 15% reduction in magnetic field levels at ROW edges, an H-frame line would have to have its conductor-bundle separation distance reduced from the standard 26 feet to 22 feet. For 345-kV lines, reduced conductor separation will also result in increases in corona-caused noise levels in wet weather. CL&P has evaluated this reduced phase spacing on H-Frame structures and determined it would compromise safe live-line maintenance. As such, CL&P is not considering any use of reduced conductor separations in this Plan.

II.3.8 Passive Loop Shielding

Magnetic field reduction can be achieved over small areas with wire loops installed parallel to overhead lines, for example along a ROW edge. Such loops can be designed such that the magnetic fields produced by currents induced in the loop conductors partially cancel the transmission line magnetic fields resulting in a decreased magnetic field at the edge of ROW. The area of reduced magnetic fields near to passive loops is relatively small, and the additional structures and wires add visual impact. For these reasons, CL&P does not consider passive loop shielding to be a practical field-management tool over the 3.2-mile ROW length in East Granby and Suffield.

II.3.9 Shifting the ROW or Alignments of Lines on a ROW

Under certain circumstances, an entire ROW segment could be shifted to provide additional distance between the new lines and adjacent facilities, thereby reducing magnetic fields at these facilities. This is seldom a practical or low-cost option as it would require purchasing new easements and would result in a proposal of lines on new ROW when the existing ROW could be more than adequate to construct a proposed new line.

Shifting line alignments on a ROW is also seldom a practical magnetic field management option. For a ROW adjacent to residential areas, where there are residences on both sides of the ROW, any shift in line alignment on a ROW usually would reduce magnetic field levels at the residences on one side of the ROW and increase the levels at residences on the other side. Doing this where the ROW is wide enough for a future line addition will make that future line's construction on the ROW difficult without reworking the line shift.

II.4 MAGNETIC FIELD LEVELS PRODUCED BY THE BASE LINE DESIGN AND BMP ALTERNATIVE LINE DESIGNS

CL&P's consultants Exponent calculated magnetic fields for the right-of-way cross-section over the 3.2-mile focus-area ROW section in East Granby and Suffield per recognized industry practice (i.e., typical minimum mid-span clearance of conductors to ground, 1 meter above ground, assumption of flat terrain and balanced currents). These calculations were made at three New England system load levels estimated by CL&P to occur in the year 2017, specifically the annual average load, the annual peak load, and the peak-day average load. Please refer to Section O of the CSC Application for the assumptions that were made in system load-flow modeling to determine the line currents over this ROW section for each of the three load levels.

Table 6 shows the difference in calculated magnetic field levels at the edges of the ROW for the existing conditions and the post-NEEWS conditions with the base case line design.

Table 6: Magnetic Field Comparison, Pre- and Post-NEEWS Configurations on GSRP ROW

XS-2 Cross Section Configuration	Average Annual Load Case		
	Maximum Level on ROW (mG)	West ROW Edge	East ROW Edge
		Level (mG)	Level (mG)
Pre-NEEWS	40.6	8.7	0.1
Post-NEEWS - Base Line Design	269.2	23.5	12.6

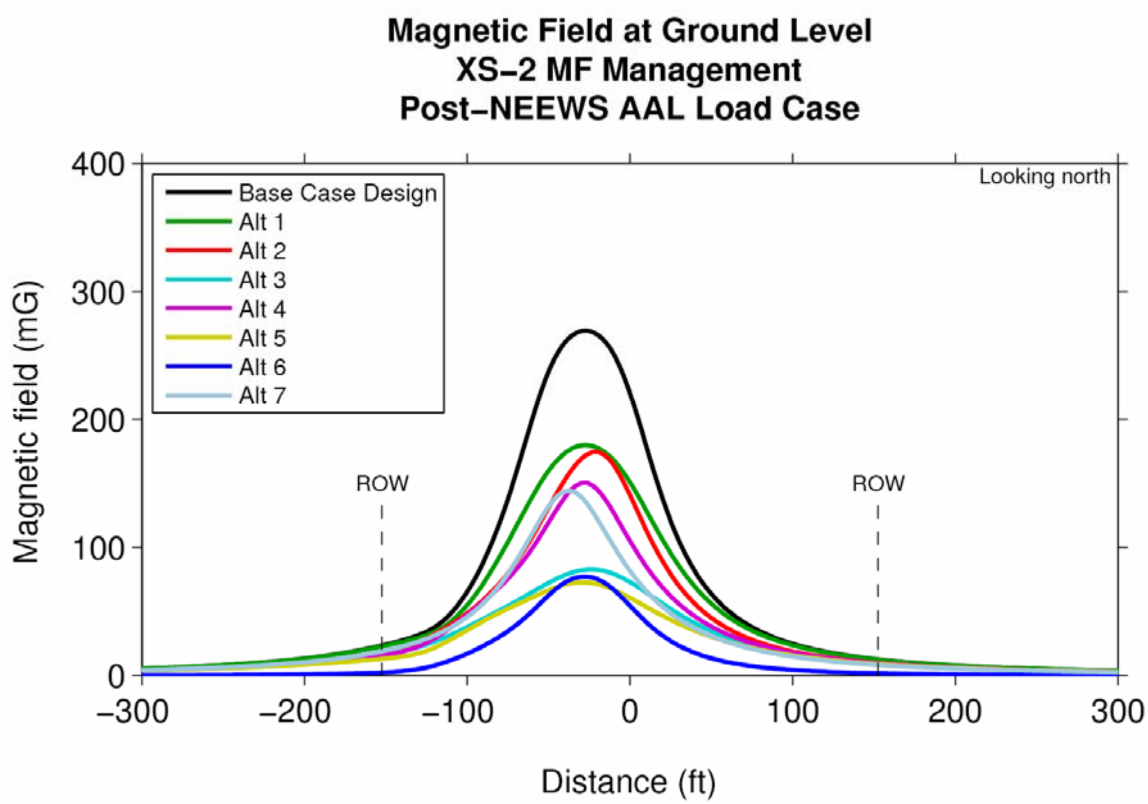
Table 7 shows the calculated edge-of-ROW magnetic field levels along the 3.2-mile ROW segment between 115-kV line structures 3191 and 3221 in cross section 2 between Granby Junction and the Connecticut/Massachusetts border. Relative to the edge-of-ROW magnetic field levels of the base line design, the table also shows the percentages by which these edge-of-ROW magnetic fields would be reduced for seven alternative line designs, and the extra cost associated with each of these line designs.

Table 7: Magnetic Field Management Results for a 3.2-mile Section of the GSRP ROW

XS-2 Cross Section Configuration	Average Annual Load Case					Cost	
	Maximum Level on ROW (mG)	West ROW Edge		East ROW Edge			
		Level (mG)	Reduction (%)	Level (mG)	Reduction (%)	Section Amount ($)	Project Increase (%)
Base Line Design H-Frame	269.8	23.6	-	12.6	-	$11,293,000.00	-
Alt 1 - H-Frame +20 feet	180.0	22.8	3%	12.3	2%	$11,795,000.00	0.4%
Alt 2 - Delta Configuration	173.7	16.9	28%	9.7	23%	$13,454,000.00	1.6%
Alt 3 - Delta +20 feet	82.0	15.1	36%	9.1	28%	$15,303,000.00	3.0%
Alt 4 - Vertical Configuration	150.2	15.8	33%	9.6	24%	$14,794,000.00	2.6%
Alt 5 - Vertical +20 feet	72.5	13.4	43%	9	29%	$16,000,000.00	3.5%
Alt 6 - Split Phase	77.1	2.6	89%	1.9	85%	$24,776,000.00	10.1%
Alt 7 - 345/115-kV Composite	145.2	19.1	19%	8.3	34%	$25,960,000.00	11.0%

Figure 6 provides a graphical representation of the calculated magnetic field levels over the right-of-way cross section for the line segment between existing 115-kV line structures 3191 and 3221, for the annual average load case. This graph includes the base case H-Frame line design and all seven of the design variations considered.

Figure 6: Magnetic Field Profiles for a 3.2-mile Section of the GSRP ROW



The table and figure show that the split-phase 345-kV line configuration will be the most effective at reducing magnetic field levels at the edges of the ROW in the focus area. However, this is the second most expensive alternative and would add costs well above the 4% guideline. The vertical and delta line configurations are also effective in reducing magnetic field levels on both ROW edges about equally, and each could be constructed within the 4% guideline for extra cost. Adding an additional 20 feet of height to either of these two line designs would further reduce magnetic field levels at the ROW edges, but only by a few tenths of a milligauss.

II.5 CL&P RECOMMENDATION FOR THE 3.2-MILE GSRP ROW SEGMENT

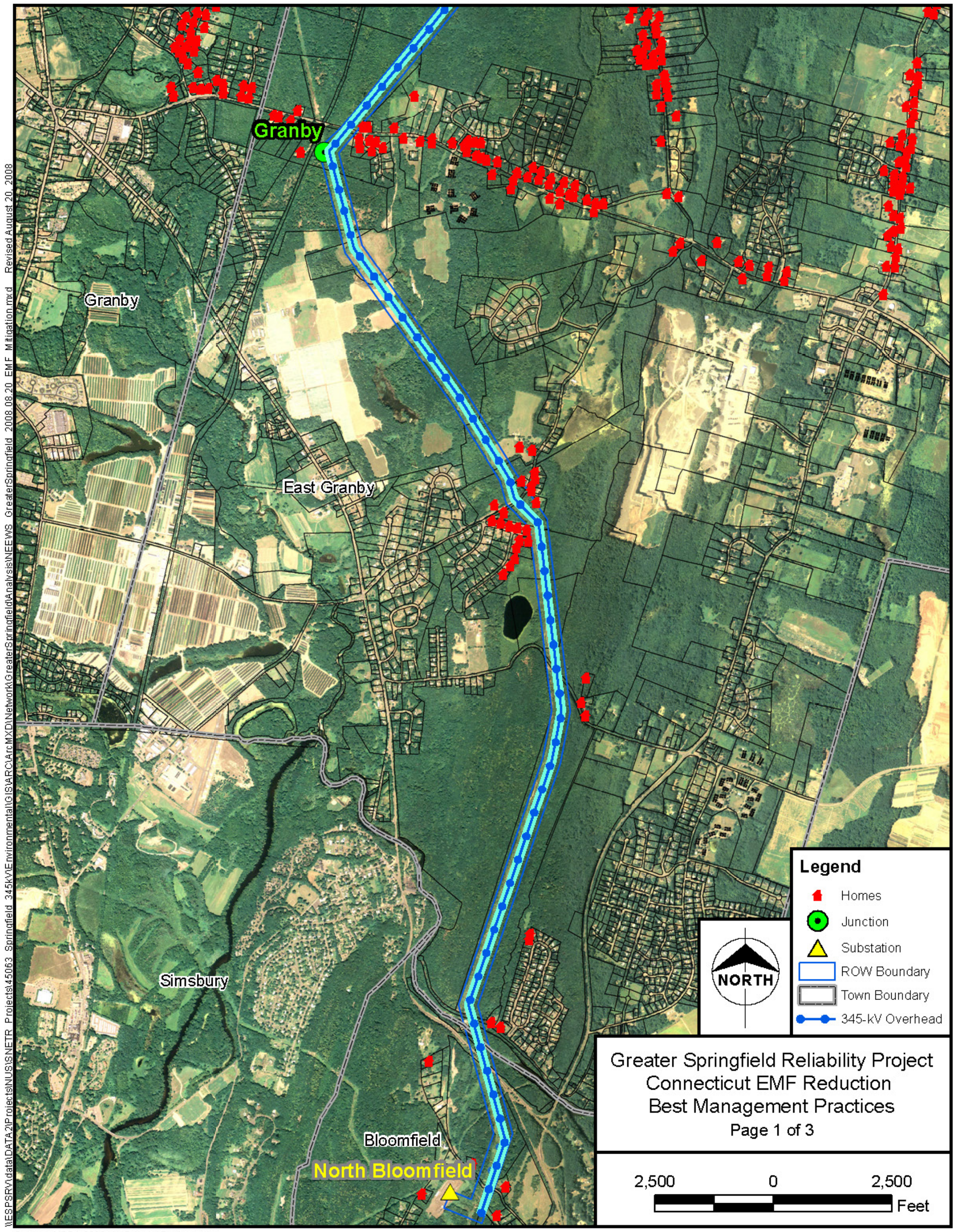
Alternative line designs for magnetic field reductions that cause safety or reliability consequences, do not achieve magnetic field reductions of at least 15% on both edges of the ROW, or that interfere with the ability of the ROW to accept future lines are not recommended. The remaining BMP line design alternatives are the delta, vertical and split-phase line configurations, and each of these could also be built with increased height above ground. The vertical and split-phase line designs are the tallest, so would increase visual impacts. Options using the increased height designs would also increase visual impacts. Constructing the split-phase line design would add costs well above the 4% guideline. The delta line design, at its standard height, presents the best compromise between minimizing line visibility, vegetation removal on the ROW, and achieving magnetic field reductions well above 15%. Therefore, CL&P recommends the delta line design on this ROW segment.

Should the Council in its balancing of impacts and magnetic field mitigation conclude that the base line design or any of the other 345-kV line design alternatives examined in the Plan are preferable, CL&P is prepared to build any of these line designs over the 3.2-mile segment.

II.6 AERIAL MAPS FOR THE CONNECTICUT SECTION OF THE NORTH BLOOMFIELD TO AGAWAM 345-KV LINE ROUTE

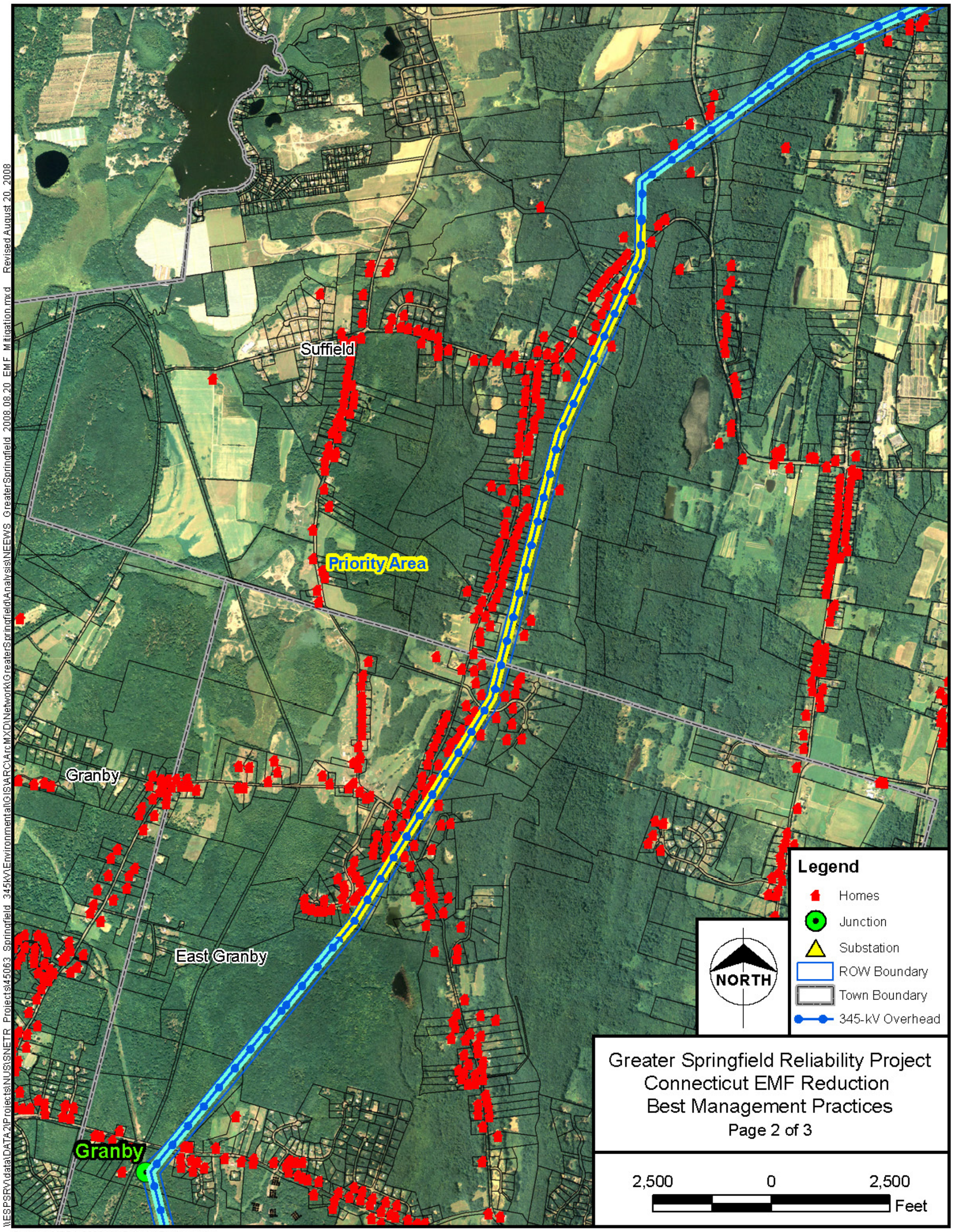
The following are aerial maps of homes in the area near the Connecticut Portion of the North Bloomfield to Agawam 345-kV Line Route.

Figure 7: Aerial Map for Connecticut Portion of North Bloomfield to Agawam 345-kV Line Route, Page 1 of 3



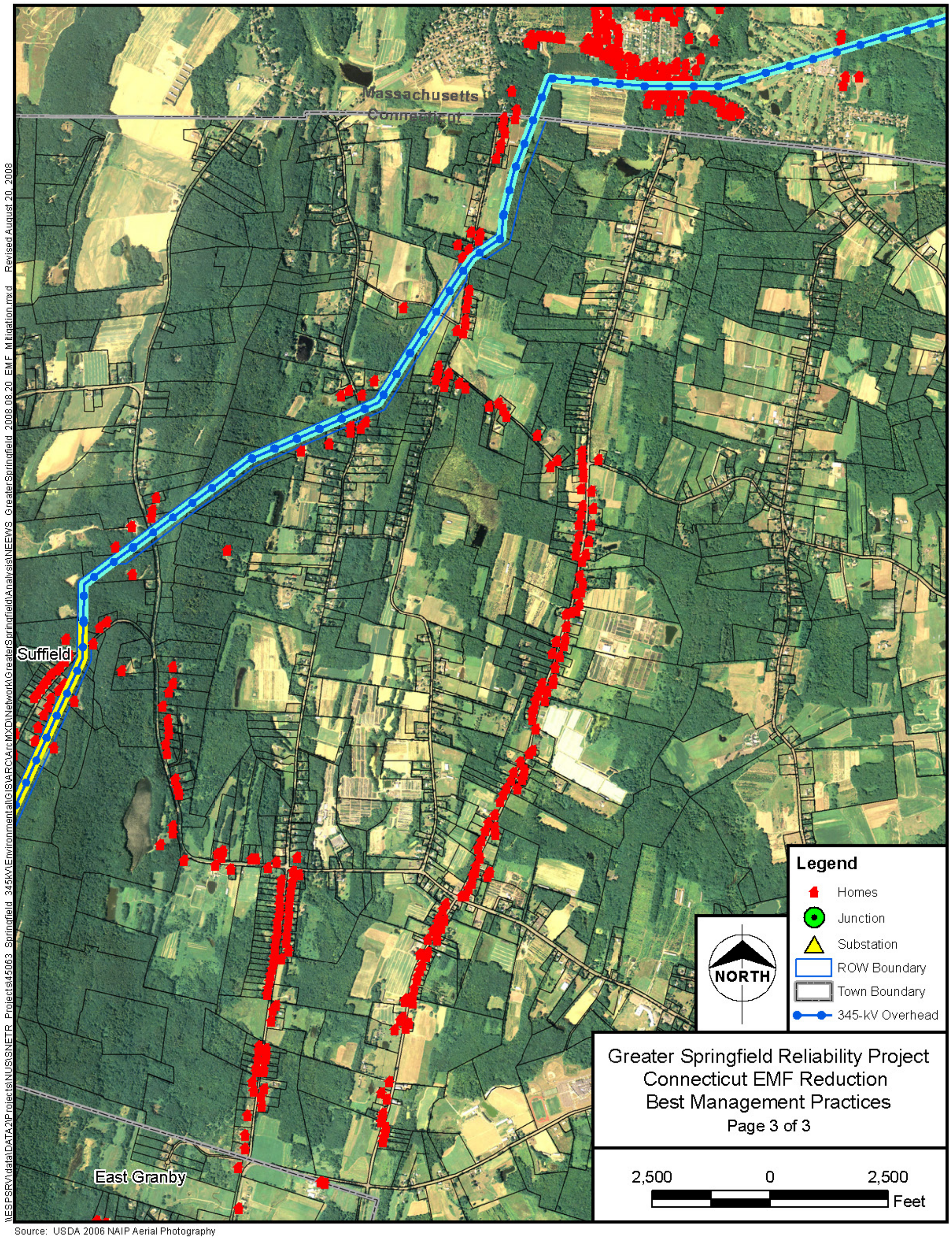
Source: USDA 2006 NAIP Aerial Photography

Figure 8: Aerial Map for Connecticut Section of North Bloomfield to Agawam 345-kV Line Route, Page 2 of 3



Source: USDA 2006 NAIP Aerial Photography

Figure 9: Aerial Map for Connecticut Section of North Bloomfield to Agawam 345-kV Line Route, Page 3 of 3



II.7 CROSS SECTIONS FOR THE CONNECTICUT SECTION OF GSRP

The following cross sections are provided for reference to the various alternate configurations.

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Figure 10: XS-2 Cross Section, Base Configuration

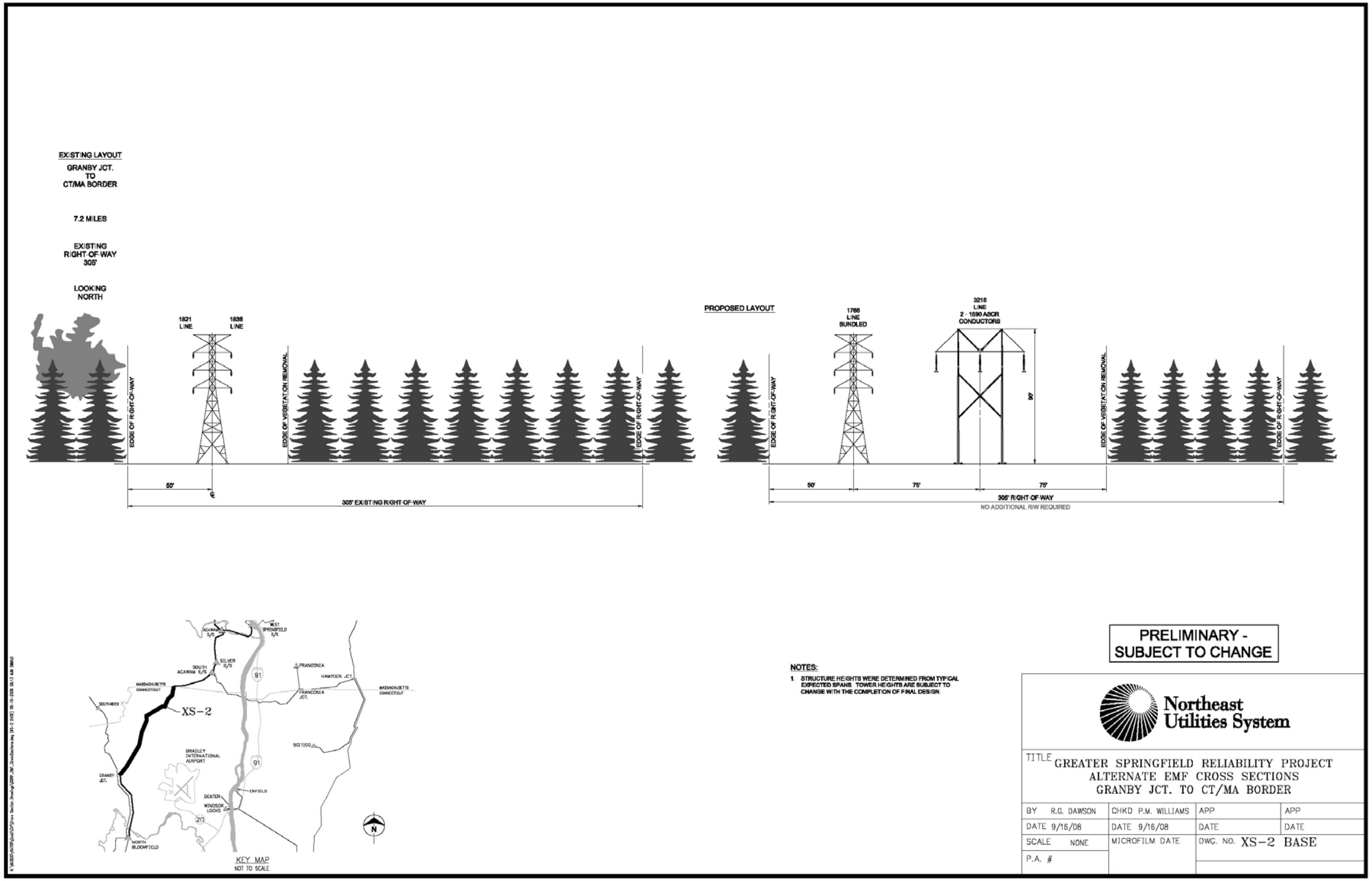

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Figure 11: XS-2 Cross Section, Alternate 1 Configuration

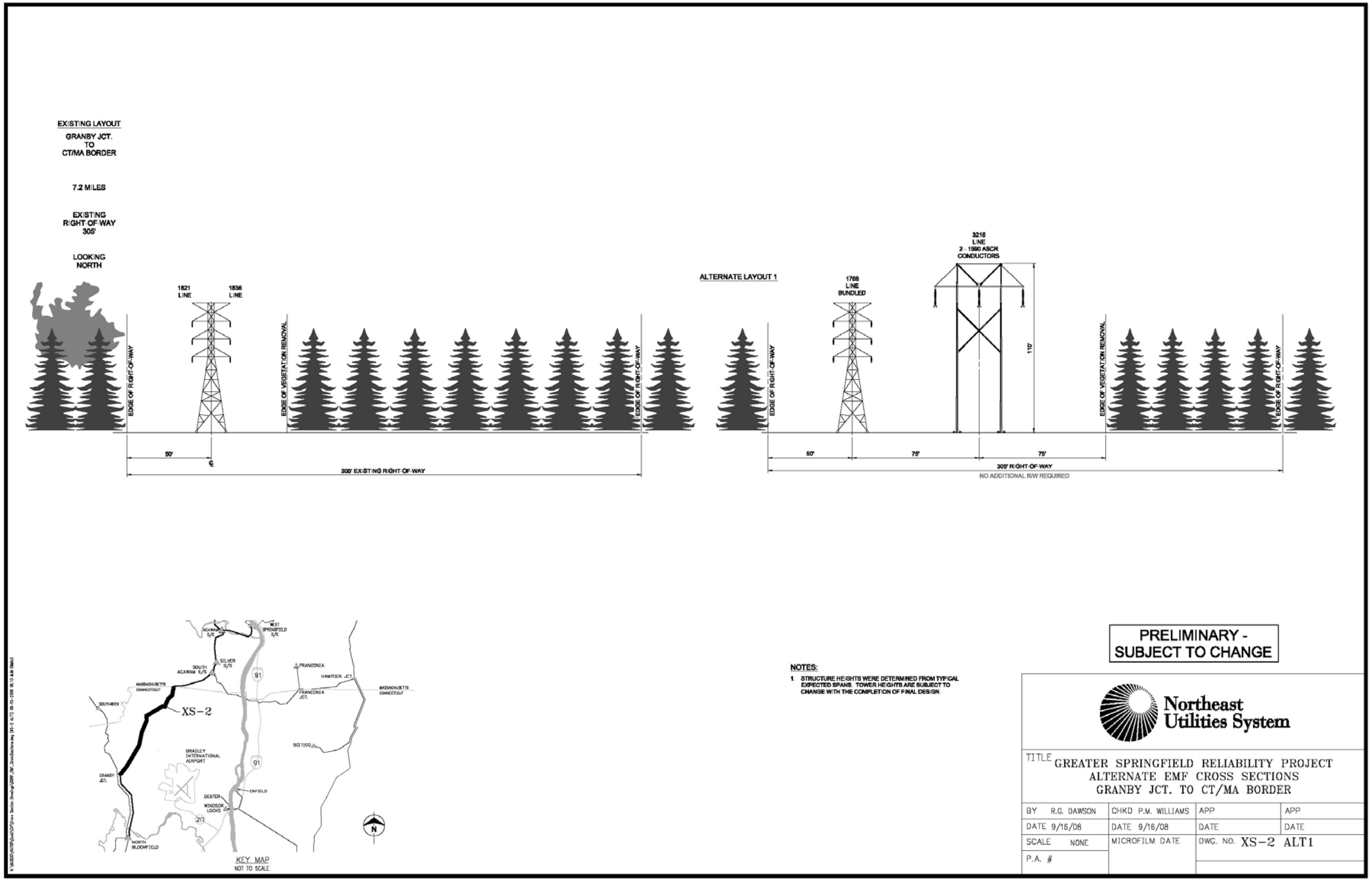

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Figure 12: XS-2 Cross Section, Alternate 2 Configuration

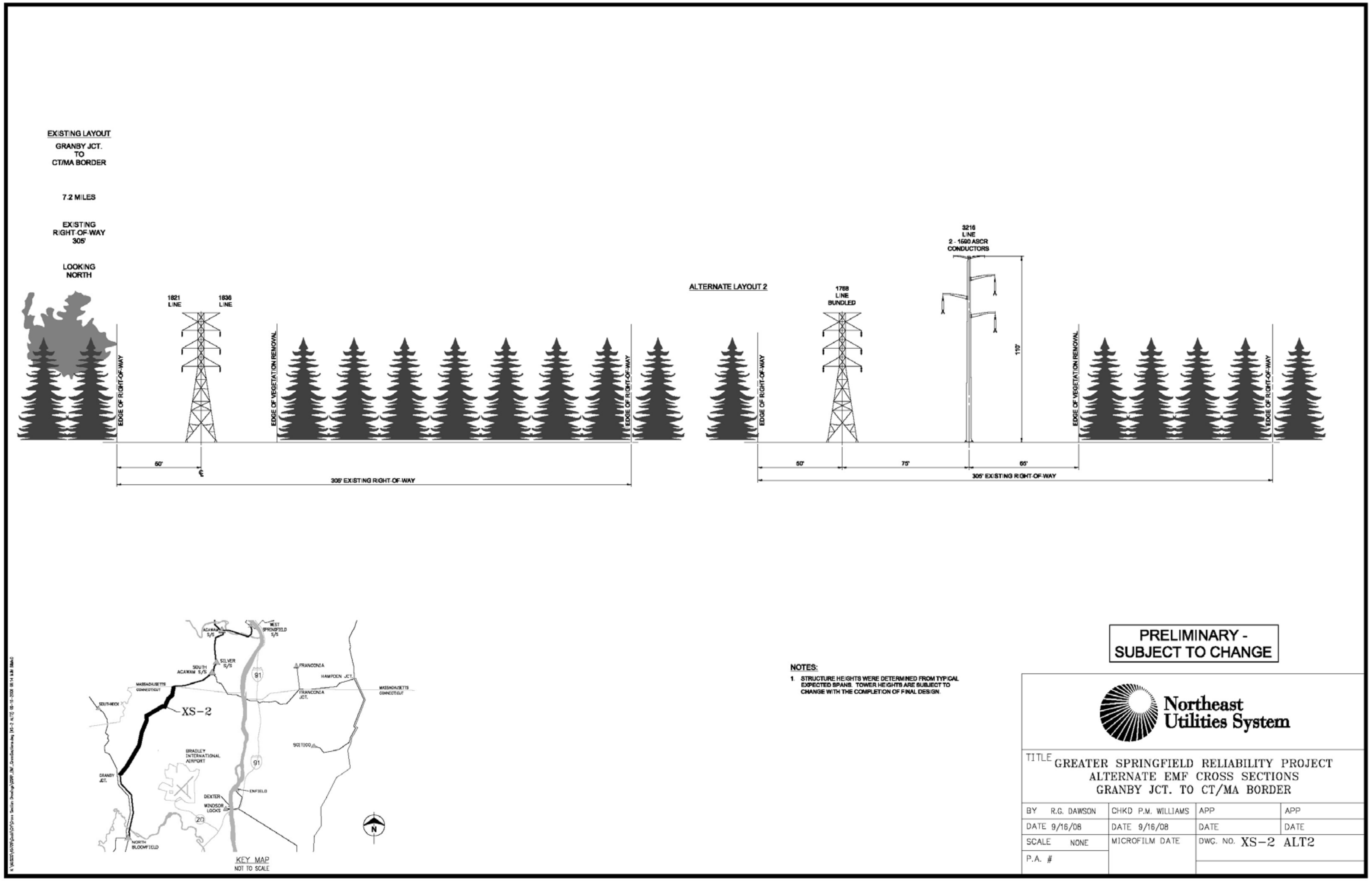

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Figure 13: XS-2 Cross Section, Alternate 3 Configuration

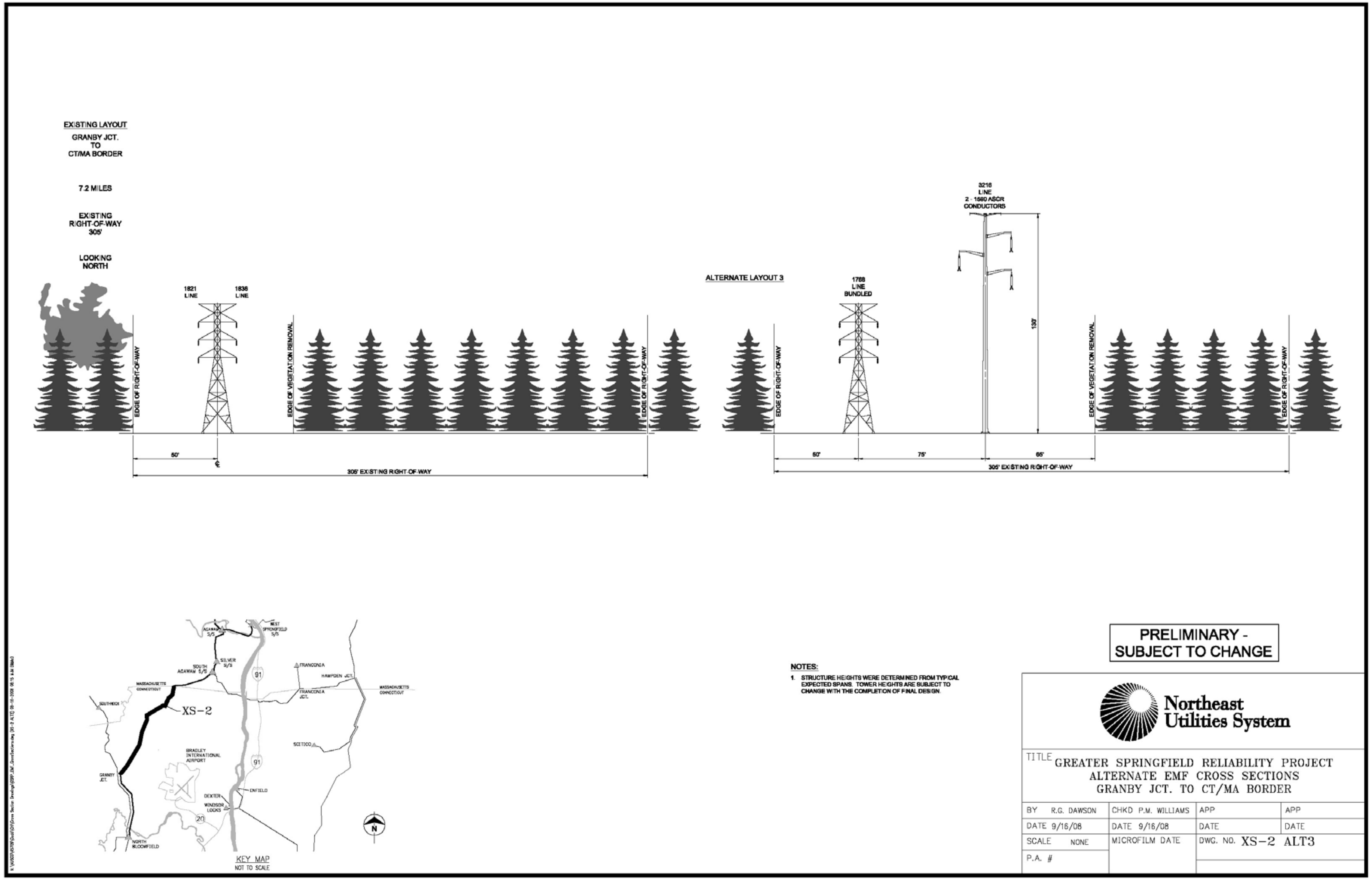

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Figure 14: XS-2 Cross Section, Alternate 4 Configuration

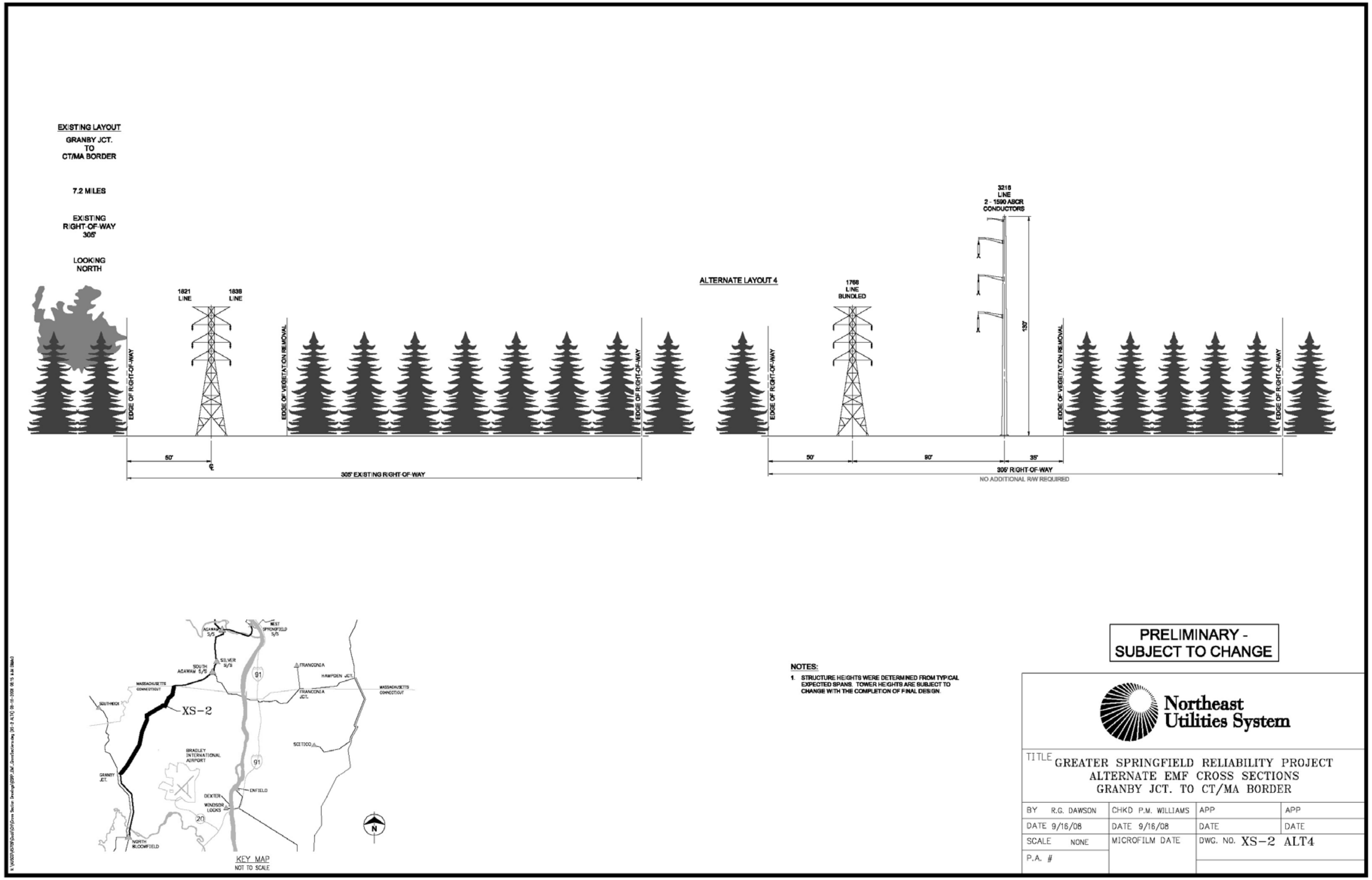

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Figure 15: XS-2 Cross Section, Alternate 5 Configuration

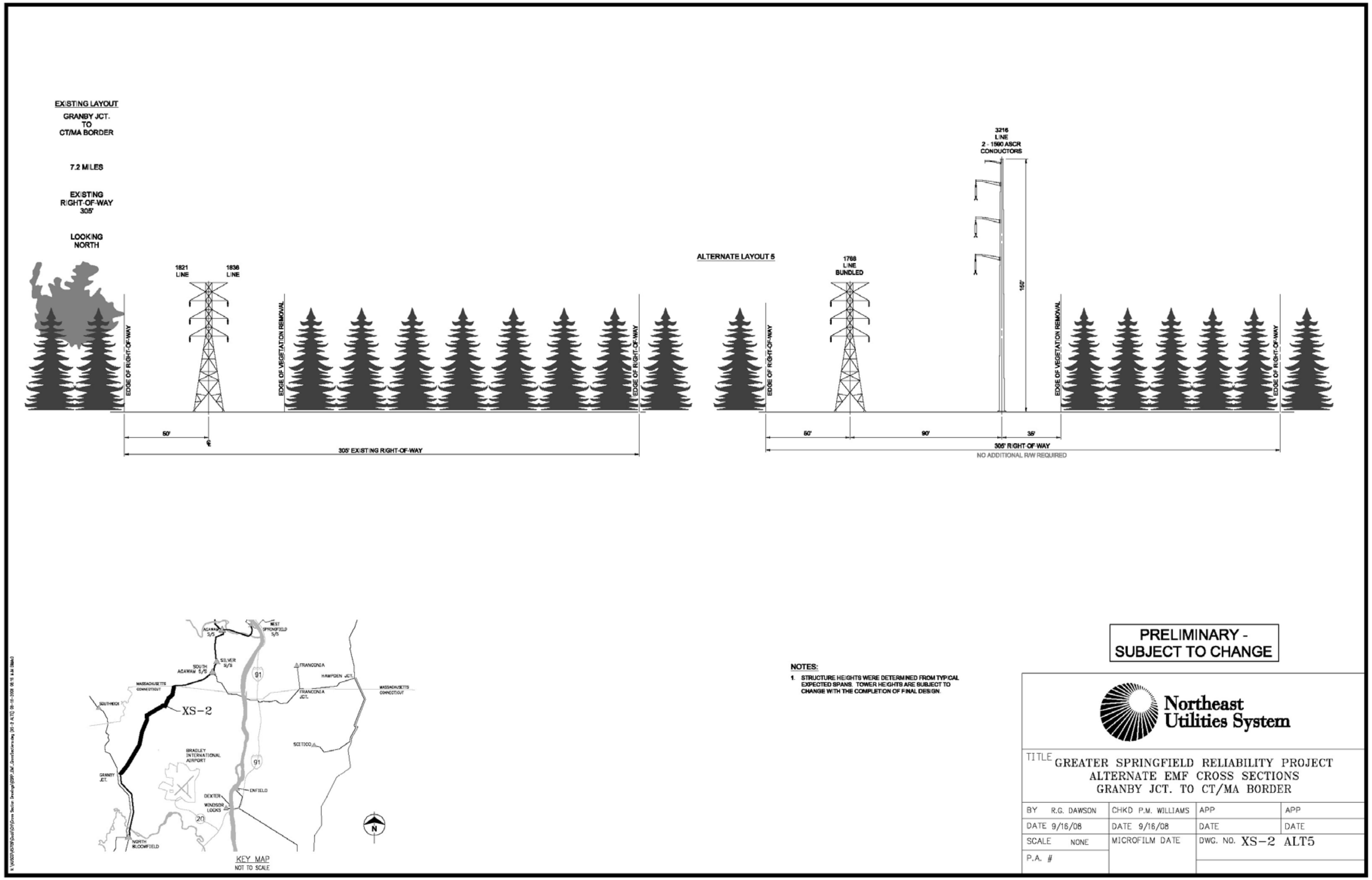

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Figure 16: XS-2 Cross Section, Alternate 6 Configuration

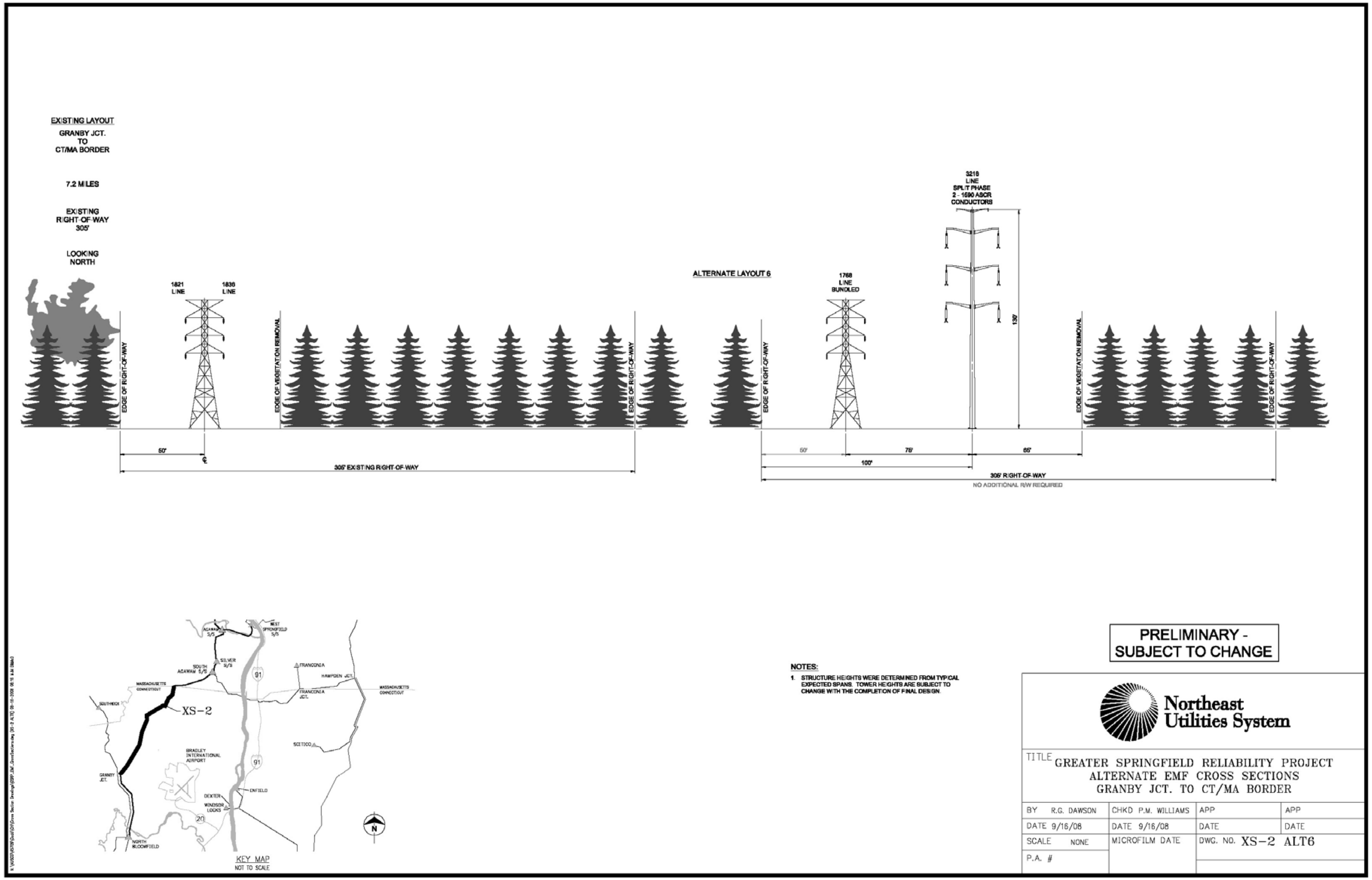

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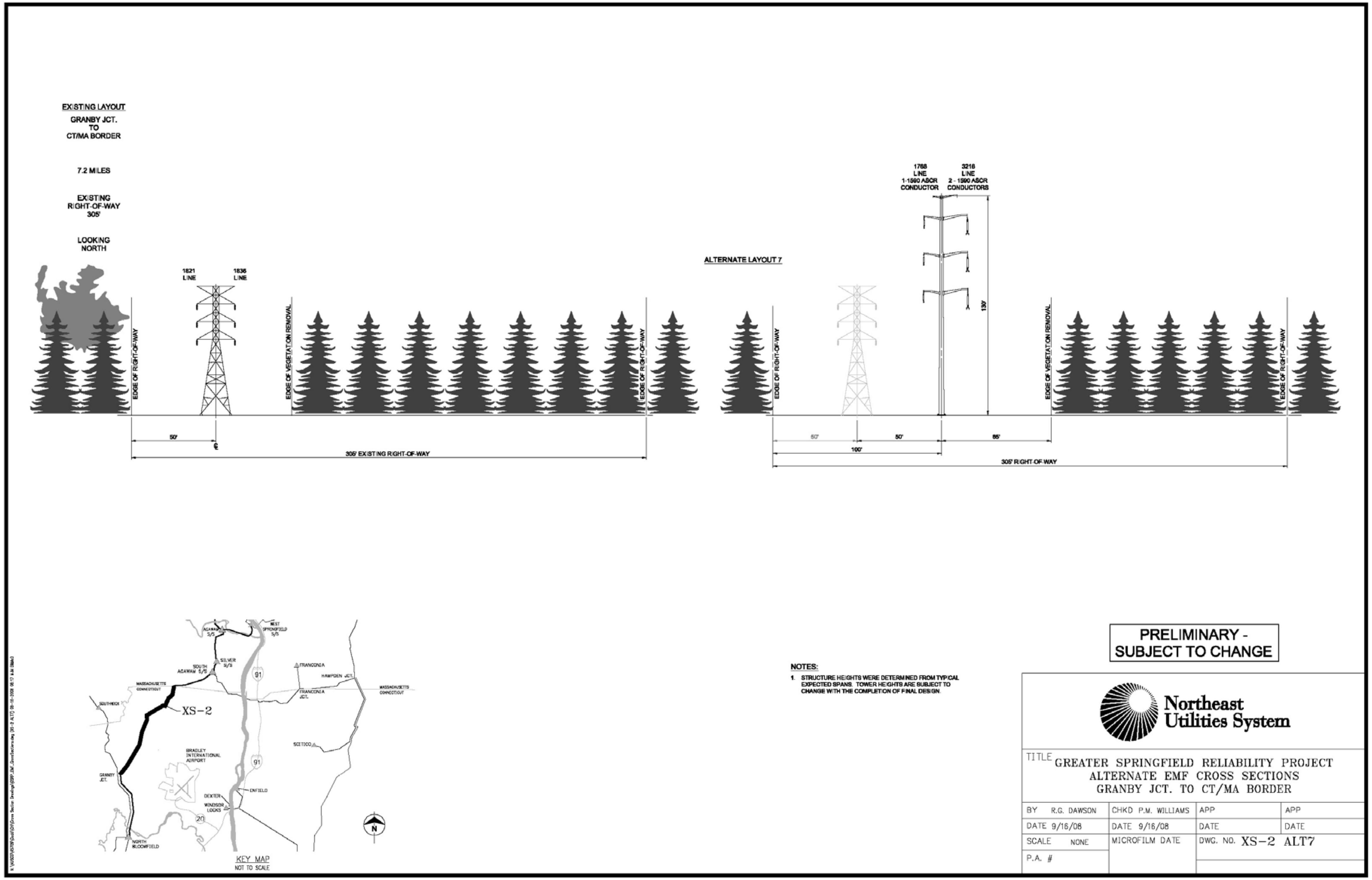
Figure 17: XS-2 Cross Section, Alternate 7 Configuration



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III. MANCHESTER TO MEEKVILLE JUNCTION CIRCUIT SEPARATION PROJECT

III.1 PROJECT DESCRIPTION AND BASE LINE DESIGN

The Manchester to Meekville Junction Circuit Separation Project (MMP) consists of separating a 115-kV circuit and a 345-kV circuit, which are currently installed on shared lattice-steel towers, by replacing the 115-kV circuit on a new line of single-circuit steel monopole structures within the existing ROW. This project requires line work on a 2.2-mile section of the ROW between Manchester Substation and Meekville Junction, a ROW that is approximately 350 feet wide. On this ROW there are currently two lines of double-circuit lattice-steel towers supporting one 345-kV circuit and three 115-kV circuits. Also, a double-circuit distribution line is located between the two transmission lines on portions of this ROW. No ROW expansion is anticipated for the project as the relocated 115-kV circuit can be placed on new monopole structures located between the existing lattice-steel tower lines.

III.2 FOCUS AREAS FOR MAGNETIC FIELD MANAGEMENT

Per the CSC BMP, the focus areas for applications of low-cost magnetic field management designs are those locations where public or private schools, licensed child day-care facilities, public playgrounds, licensed youth camps, or residential areas are adjacent to a proposed new transmission line. For the MMP, there are no youth camps, child day-care facilities, or residential areas adjacent to the transmission line ROW, but one school and one playground are adjacent on the east side. Maps in Volume 9 of the Application illustrate the locations of these facilities along the MMP Line Route.

III.3 BASE MMP LINE DESIGN AND ALTERNATIVE MMP LINE DESIGNS FOR MAGNETIC FIELD REDUCTIONS IN FOCUS AREAS

III.3.1 115-kV Vertical Line Configuration Using 345-kV Class Insulation, Conductor Bundles and Phase Spacings, and Best Circuit Phasing, the Base Line Design

Vertical line structures, as shown in Figure 18, are typically used in areas with narrower ROW widths or where several lines are needed on the same ROW, as is the case for MMP. This type of line would be constructed using steel monopoles on concrete pier foundations. Typical costs for this configuration at two average structure heights are included in Table 8. The base case line design would employ 345-kV class insulation, conductor bundles and phase spacings, as does the majority of the existing 115-kV circuit section it would replace. This design has been considered to provide a method of potentially converting this line to 345-kV at a future date. The base case vertical line design would also employ a no-cost optimal circuit phasing with respect to the existing lines continuing in use, as a magnetic field reduction strategy.

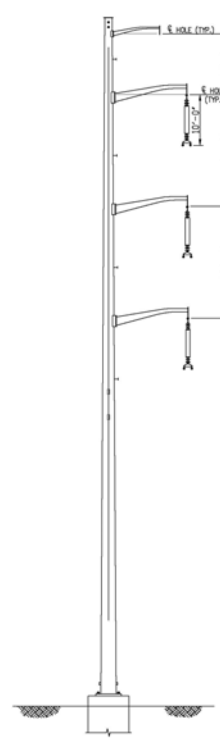
Table 8: Typical Vertical Line Costs Per Span

Cost Per Mile	
Structure Description	**Total**
155' Vertical	$5,497,000

Note: *Structure Costs are based on (10) structures per mile ((8) tangents, (1) angle, (1) DE); Conductor costs are based on (2) - 1590-kcmil ACSR "Lapwing"; Costs include labor, material, and hardware*

*

Figure 18: Tangent Vertical Structure



III.3.2 Modifications to the Existing Line

Separating the 115-kV circuit from the 345-kV line's structures allows an additional opportunity to reduce edge-of-ROW magnetic fields over the entire 2.2-mile MMP route, including opposite to the focus area facilities. This can be accomplished by re-using the former 115-kV circuit conductors on the existing 345-kV line towers to form a bundled 345-kV circuit, and the phasing of the conductors could also be arranged to form a split-phase line configuration.

The bundled circuit configuration of the 345-kV line reduces the current in the existing 345-kV line conductors, which are nearest to the east edge of ROW. This modification alone would reduce the magnetic fields at the east edge-of-ROW. By reverse phasing the bundled circuit conductors to form a split-phase line configuration, magnetic fields will be reduced to a larger degree, and at both ROW edges.

In order to implement the split-phase line configuration, a length of about 3,500 feet of the existing 115-kV line conductors and insulators must be replaced with bundled conductors and 345-kV class insulation. For the split-phase line configuration, conductor ties between the middle conductor bundles and between the opposite-side top and bottom conductor bundles will be required at both ends of the 2.2-mile segment.

III.3.3 Other Line Configurations

The vertical line configuration is the only line design that can be placed in between the existing lattice tower lines and still provide proper electrical clearance to allow for safe operation and maintenance of the line. While there is sufficient room to install a delta line design on the west side of the ROW, positioning a line closer to the west edge of the ROW will increase field levels on that edge of the ROW.

III.3.4 Conductor Heights Above Ground

CL&P calculates magnetic fields using typical conductor heights above ground at the middle of cross-country line spans. Wherever conductor heights are higher above ground (e.g., over I-84), magnetic fields will be lower at the ground level on and immediately adjacent to the ROW. Because conductor heights above ground increase between the mid-span points and the line structures, magnetic field levels will be lower than CL&P's calculated values at ROW edge locations which are not opposite the mid-span points.

III.3.5 Conductor Separation

Reducing the separation distance between each of the three conductor bundles of a 345-kV line can reduce magnetic field levels. However, reducing the conductor separations below CL&P's standard separations for each 345-kV line design can reduce reliability and make it unsafe for line workers to perform live-line maintenance. In this instance, however, the proposed new line could be built with standard 115-kV conductor separations, sacrificing the ability to use this line section at 345 kV in the future. Doing so, however, would minimally affect magnetic field levels at the ROW edges. As such, CL&P is not considering any use of reduced conductor separations in this Plan.

III.3.6 Shifting the ROW or Alignments of Lines on a ROW

Under certain circumstances, an entire ROW could be shifted to provide additional distance between the new lines and adjacent facilities, thereby reducing magnetic fields at these facilities. This is seldom a practical or low-cost option as it would require purchasing new easements and would result in a proposal of lines on new ROW when the existing ROW could be more than adequate to construct a proposed new line.

Shifting line alignments on a ROW is also seldom a practical or low-cost magnetic field management option. Doing this where the ROW is wide enough for a future line addition will make that future line's construction on the ROW difficult without reworking the line shift. This is not a practical option for MMP.

III.3.7 Passive Loop Shielding

Magnetic field reduction can be achieved over small areas with wire loops installed parallel to overhead lines, for example along a ROW edge. Such loops can be designed such that the magnetic fields produced by currents induced in the loop conductors partially cancel the transmission line magnetic fields resulting in a decreased magnetic field at the edge of right-of-way. The area of reduced magnetic fields near to passive loops is relatively small, and the additional structures and wires add visual impact. For these reasons, CL&P does not consider passive loop shielding to be a practical field-management tool over any portion of the 2.2-mile ROW length between Manchester Substation and Meekville Junction.

III.4 MAGNETIC FIELD LEVELS PRODUCED BY THE BASE LINE DESIGN AND ALTERNATIVE LINE DESIGNS

Exponent calculated magnetic fields for the right-of-way cross-section over a 2.2-mile section of the ROW between Manchester Substation and Meekville Junction in Manchester, Connecticut according to recognized industry practice (i.e., typical minimum mid-span clearance of conductors to ground, 1 meter above ground, assumption of flat terrain and balanced currents). These calculations were made at three New England system load levels estimated by CL&P to occur in the year 2017, specifically the annual average load, the annual peak load, and the peak-day average load. Please refer to Section O of the CSC Application for the assumptions that were made in system load-flow modeling to determine the line currents over this ROW section for each of the three load levels.

Table 9 shows the difference in calculated magnetic field levels at the edges of ROW for the existing conditions and the post-NEEWS conditions with the base case line design. The circuit separation and phasing change in this ROW alone reduces the edge of ROW magnetic field levels, by 33% on the westerly edge and by 55% on the easterly edge.

Table 9: Magnetic Field Comparison, Pre- and Post-NEEWS Configurations on MMP ROW

XS-21 Cross Section Configuration	Average Annual Load Case		
	Maximum Level on ROW (mG)	West ROW Edge Level (mG)	East ROW Edge Level (mG)
Pre-NEEWS	62.3	4.8	27.4
Post-NEEWS - Base Line Design	30.0	3.2	12.2

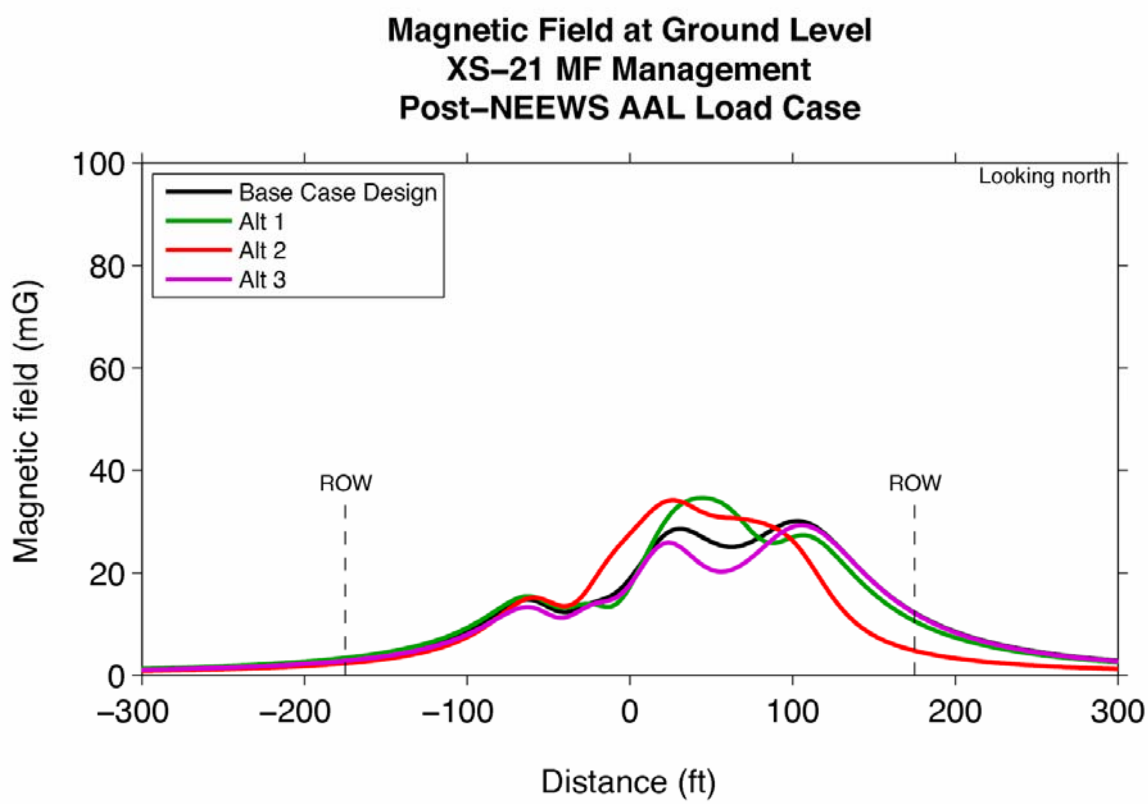
Table 10 shows calculated edge-of-ROW magnetic field levels along the entire 2.2-mile section of the ROW between Manchester Substation and Meekville Junction. Relative to the edge-of-ROW magnetic field levels of the base line design, the table also shows the percentages by which these edge-of-ROW magnetic fields would be reduced for three alternative line designs, and the table shows the extra cost associated with each of these line designs.

Table 10: Magnetic Field Management Results for MMP ROW

XS-21 Cross Section Configuration	Average Annual Load Case					Cost	
	Maximum Level on ROW (mG)	West ROW Edge		East ROW Edge			
		Level (mG)	Reduction (%)	Level (mG)	Reduction (%)	Section Amount ($)	Project Increase (%)
Base Line Design - Vertical	30.0	3.2	-	12.2	-	13,728,000	-
Alt 1 - Vertical +20 feet	29.0	3.1	3%	12.2	0%	3,252,000	23.7%
Alt 2 - 395 Bundled Circuit	34.4	3.4	-6%	10.6	13%	520,000	3.8%
Alt 3 - 395 Split Phase	34.1	2.4	25%	4.8	61%	520,000	3.8%
Alt 4 - 115-kV Design	29.0	2.8	13%	12.1	1%	-2,557,000	-18.6%

Aerial map Figure 7 provides a graphical representation of the calculated magnetic field levels over the right-of-way cross section for the line segment between Manchester Substation and Meekville Junction, for the annual average load case. This graph includes the base line vertical configuration and the four design variations considered

Figure 19: Magnetic Field Profiles for Potential Reduction Section on MMP



The table shows that reconfiguring the existing 345-kV circuit as a split-phase line will be the most effective at reducing magnetic field levels at the edges of the ROW. For the MMP, the cost of this option is within the 4% guideline and provides a reduction greater than 15% at the ROW edges. Reconfiguring the 345-kV circuit into a bundled circuit configuration reduces magnetic field levels on one edge of the ROW but increases levels on the other edge. Again, a split-phase line configuration for the 345-kV circuit will be the most effective method of reducing magnetic field levels at the edges of the ROW.

III.5 CL&P RECOMMENDATION FOR THE 2.2-MILE MMP ROW SEGMENT

Alternative line designs for magnetic field reductions that cause safety or reliability consequences, do not achieve magnetic field reductions of at least 15% on both edges of the ROW, or that interfere with the ability of the ROW to accept future lines will not be recommended. The only remaining line design alternative is the split-phase line configuration of the existing 345-kV line. The split-phase line configuration can be implemented without increases to social or environmental impacts. The existing lattice-steel towers already support a double-circuit line configuration that can be easily modified to a split-phase line configuration by re-conductoring and re-insulating several spans of the existing 115-kV circuit. Therefore, CL&P recommends the existing 345-kV split-phase line design option on this ROW segment.

Should the CSC in its balancing of impacts and mitigation conclude that the base line design or any of the other line design alternatives examined in the Plan are preferable, CL&P is prepared to build any of these line designs over the 2.2-mile segment.

III.6 CROSS SECTIONS FOR THE MMP

The following cross sections are provided for reference to the various alternate configurations.

Figure 20: XS-21 Cross Section, Base Configuration

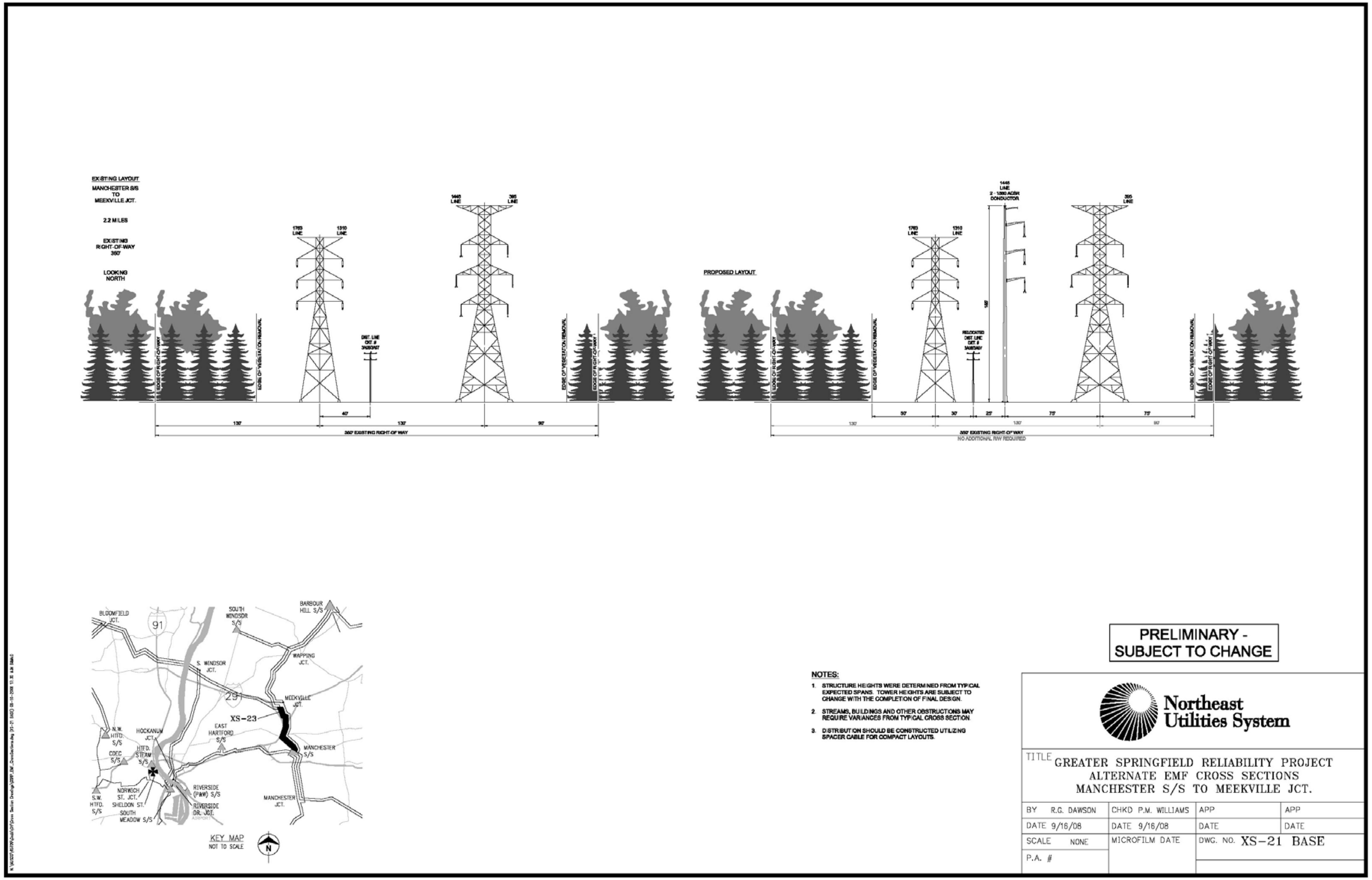


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Figure 21: XS-21 Cross Section, Alternate 1 Configuration

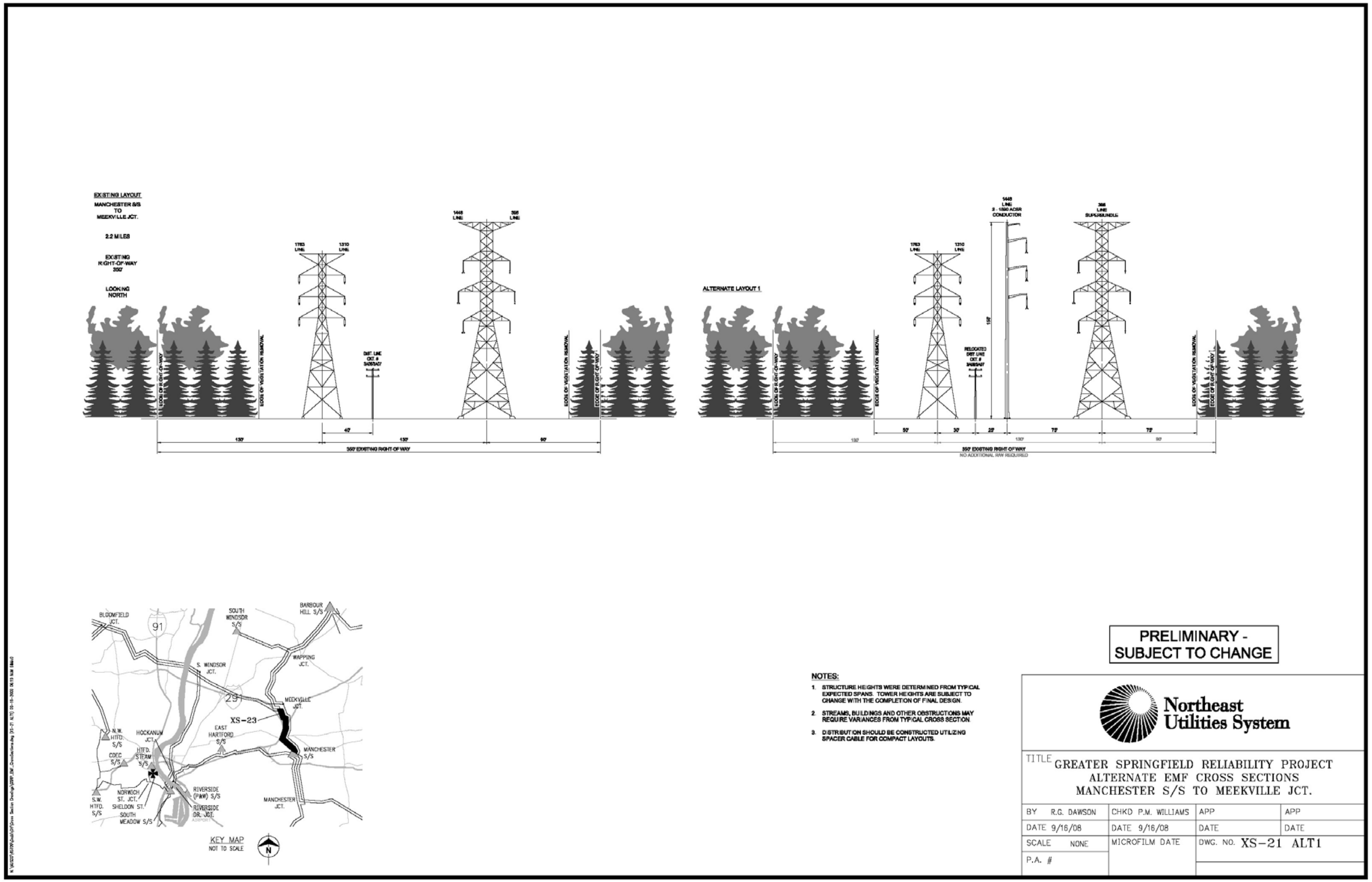

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Figure 22: XS-21 Cross Section, Alternate 2 Configuration

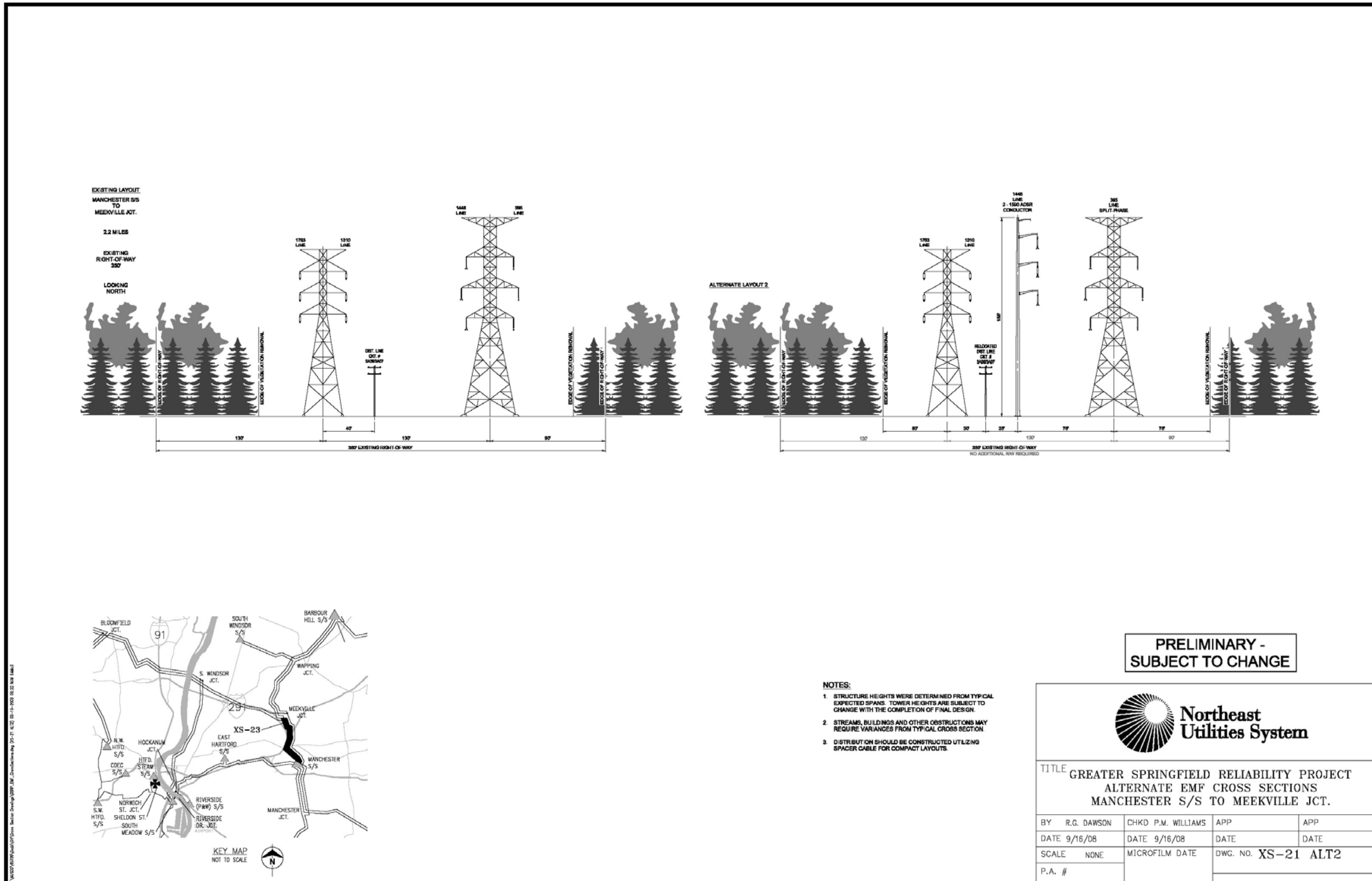

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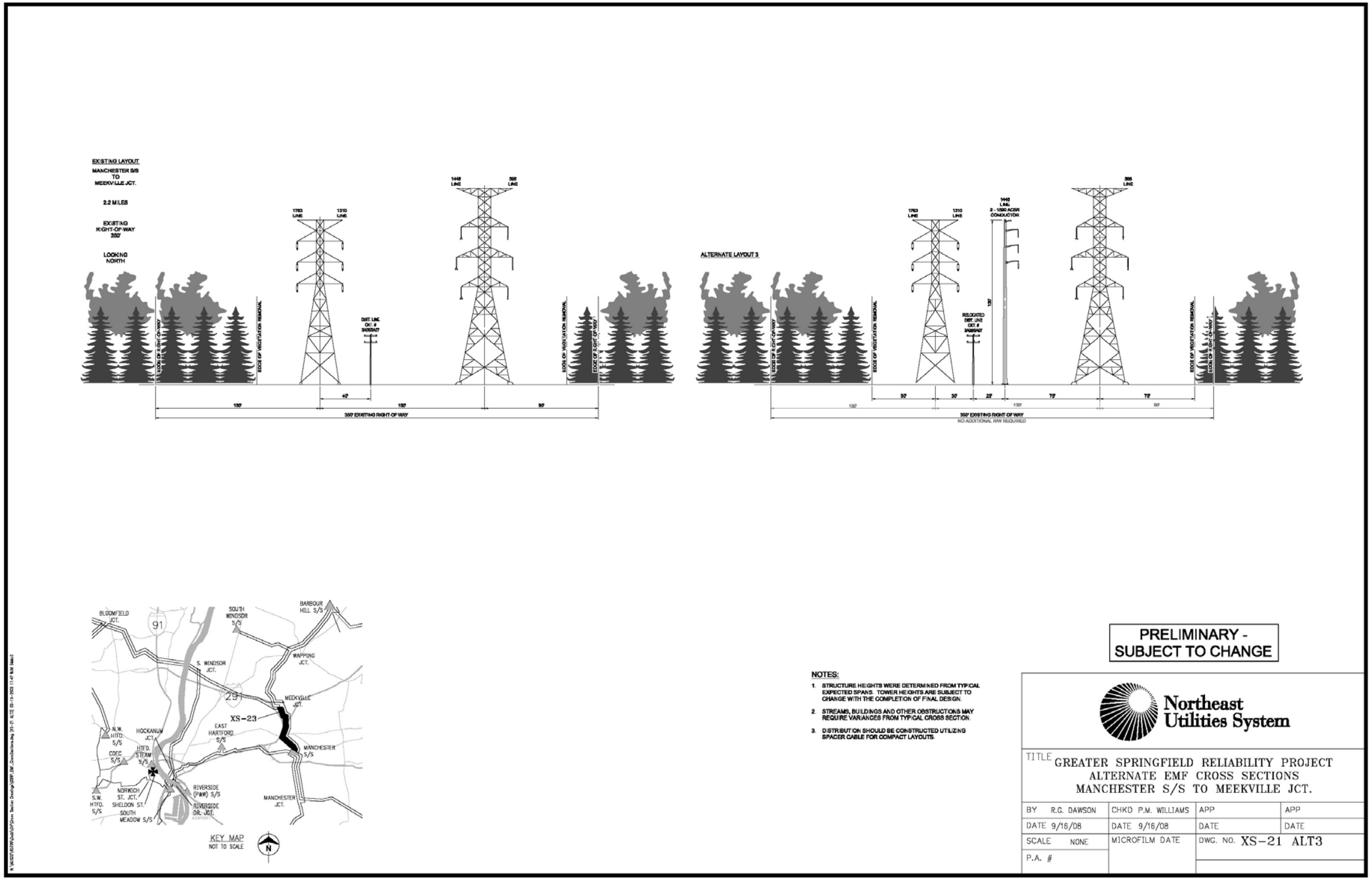
Figure 23: XS-21 Cross Section, Alternate 3 Configuration



APPENDIX O-2

CONNECTICUT SITING COUNCIL'S EMF BEST MANAGEMENT PRACTICES

Electric and Magnetic Field Best Management Practices
For the Construction of Electric Transmission Lines in Connecticut

December 14, 2007

I. Introduction

To address a range of concerns regarding potential health risks from exposure to transmission line electric and magnetic fields (EMF), whether from electric transmission facilities or other sources, the Connecticut Siting Council (Council) (in accordance with Public Act 04-246) issues this policy document "*Best Management Practices for the Construction of Electric Transmission Lines in Connecticut*." It references the latest information regarding scientific knowledge and consensus on EMF health concerns; it also discusses advances in transmission-facility siting and design that can affect public exposure to EMF.

Electric and magnetic fields (EMF) are two forms of energy that surround an electrical device. The strength of an electric field (EF) is proportional to the amount of electric voltage at the source, and decreases rapidly with distance from the source, diminishing even faster when interrupted by conductive materials, such as buildings and vegetation. The level of a magnetic field (MF) is proportional to the amount of electric current (not voltage) at the source, and it, too, decreases rapidly with distance from the source; but magnetic fields are not easily interrupted, as they pass through most materials. EF is often measured in units of kilovolts per meter (kV/m). MF is often measured in units of milligauss (mG).

Transmission lines are common sources of EMF, as are other substantial components of electric power infrastructure, ranging from transformers at substations to the wiring in a home. However, any piece of machinery run by electricity can be a source of EMF: household objects as familiar as electric tools, hair dryers, televisions, computers, refrigerators, and electric ovens.

In the U.S., EMF associated with electric power have a frequency of 60 cycles per second (or 60 Hz). Estimated average background levels of 60-Hz MF in most homes, away from appliances and electrical panels, range from 0.5 to 5.0 mG (NIEHS, 2002). MF near operating appliances such as an oven, fan, hair dryer, television, etc. can range from 10's to 100's of mG. Many passenger trains, trolleys, and subways run on electricity, producing MF: for instance, MF in a Metro-North Railroad car averages about 40-60 mG, increasing to 90-145 mG with acceleration (Bennett Jr., W. 1994). As a point of comparison to these common examples, the Earth itself has an MF of about 570 mG (USGS 2007). Unlike the MF associated with power lines, appliances, or computers, the Earth's MF is steady; in every other respect, however, the Earth's MF has the same characteristics as MF emanating from man-made sources.

Concerns regarding the health effects of EMF arise in the context of electric transmission lines and distribution lines, which produce time-varying EMF, sometimes called extremely-low frequency electric and magnetic fields, or ELF-EMF. As the weight of scientific evidence indicates that exposure to electric fields, beyond levels traditionally established for safety, does not cause adverse health effects, and as safety concerns for electric fields are sufficiently addressed by adherence to the National Electrical Safety Code, as amended, health concerns regarding EMF focus on MF rather than EF.

MF levels in the vicinity of transmission lines are dependent on the flow of electric current through them and fluctuate throughout the day as electrical demand increases and decreases. They can range from about 5 to 150 mG, depending on current load, height of the conductors, separation of the conductors, and distance from the lines. The level of the MF produced by a transmission line decreases with increasing distance from the conductors, becoming indistinguishable from levels found inside or outside homes (exclusive of MF emanating from sources within the home) at a distance of 100 to 300 feet, depending on the design and current loading of the line (NIEHS, 2002).

In Connecticut, existing and proposed transmission lines are designed to carry electric power at voltages of 69, 115, or 345 kilovolts (kV). Distribution lines, i.e. those lines directly servicing the consumer's building, typically operate at voltages below 69 kV and may produce levels of MF similar to those of transmission lines. The purpose of this document is to address engineering practices for proposed electric transmission lines with a design capacity of 69 kV or more and MF health concerns related to these projects, but not other sources of MF.

II. Health Concerns from Power-Line MF

While more than 40 years of scientific research has addressed many questions about EMF, the continuing question of greatest interest to public health agencies is the possibility of an association between time weighted MF exposure and demonstrated health effects. The World Health Organization (WHO) published its latest findings on this question in an Electromagnetic Fields and Public Health fact sheet, June 2007. (http://www.who.int/mediacentre/factsheets/fs322/en/index.html) The fact sheet is based on a review by a WHO Task Group of scientific experts who assessed risks associated with ELF-EMF. As part of this review, the group examined studies related to MF exposure and various health effects, including childhood cancers, cancers in adults, developmental disorders, and neurobehavioral effects, among others. Particular attention was paid to leukemia in children. The Task Group concluded "that scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukemia". (WHO, 2007) For childhood leukemia, WHO concluded recent studies do not alter the existing position taken by the International Agency for Research on Cancer (IARC) in 2002, that ELF-MF is "possibly carcinogenic to humans."

Some epidemiology studies have reported an association between MF and childhood leukemia, while others have not. Two broad statistical analyses of these studies as a pool reported an association with estimated average exposures greater than 3 to 4 mG, but at this level of generalization it is difficult to determine whether the association is significant. In 2005, the National Cancer Institute (NCI) stated, "Among more recent studies, findings have been mixed. Some have found an association; others have not . . . . Currently, researchers conclude that there is limited evidence that magnetic fields from power lines cause childhood leukemia, and that there is inadequate evidence that these magnetic fields cause other cancers in children." The NCI stated further: "Animal studies have not found that magnetic field exposure is associated with increased risk of cancer. The absence of animal data supporting carcinogenicity makes it biologically less likely that magnetic field exposures in humans, at home or at work, are linked to increased cancer risk."

The American Medical Association characterizes the EMF health-effect literature as "inconsistent as to whether a risk exists." The National Institute of Environmental Health Sciences (NIEHS) concluded in 1999 that EMF exposure could not be recognized as "*entirely safe*" due to some statistical evidence of a link with childhood leukemia. Thus, although no public health agency has found that scientific research suggests a causal relationship between EMF and cancer, the NIEHS encourages "inexpensive and safe reductions in exposure" and suggests that the power industry continue its current practice of siting power lines to reduce exposures" rather than regulatory guidelines (NIEHS, 1999, pp. 37-38). In 2002 NIEHS restated that while this evidence was "weak" it was "still sufficient to warrant limited concern" and recommended "continued education on ways of reducing exposures" (NIEHS, 2002, p. 14).

Reviews by other study groups, including IARC (2002), the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (2003), the British National Radiation Protection Board (NRPB) (2004a), and the Health Council of the Netherlands ELF Electromagnetic Fields Committee (2005), are similar to NIEHS and NCI in their uncertainty about reported associations of MF with childhood leukemia. In 2004, the view of the NRPB was:

> "[T]he epidemiological evidence that time-weighted average exposure to power frequency magnetic fields above 0.4 microtesla [4 mG] is associated with a small absolute raised risk of leukemia in children is, at present, an observation for which there is no sound scientific explanation. There is no clear evidence of a carcinogenic effect of ELF EMFS in adults and no plausible biological explanation of the association can be obtained from experiments with animals or from cellular and molecular studies. Alternative explanations for this epidemiological association are possible…Thus: any judgments developed on the assumption that the association is causal would be subject to a very high level of uncertainty." (NRPB, 2004a, p. 15)

Although IARC classified MF as "possibly carcinogenic to humans" based upon pooling of the results from several epidemiologic studies, IARC further stated that the evidence suggesting an association between childhood leukemia and residential MF levels is "limited," with "inadequate" support for a relation to any other cancers. The WHO Task Group concluded "the evidence related to childhood leukemia is not strong enough to be considered causal" (WHO, 2007).

The Connecticut Department of Public Health (DPH) has produced an EMF Health Concerns Fact Sheet (May 2007) that incorporates the conclusions of national and international health panels. The fact sheet states that while "the current scientific evidence provides no definitive answers as to whether EMF exposure can increase health risks, there is enough uncertainty that some people may want to reduce their exposure to EMF."
[http://www.dph.state.ct.us/Publications/brs/eoha/emf_2004.pdf]

In the U.S., there are no state or federal exposure standards for 60-Hz MF based on demonstrated health effects. Nor are there any such standards world-wide. Among those international agencies that provide guidelines for acceptable MF exposure to the general public, the International Commission on Non-Ionizing Radiation Protection established a level of 833 mG, based on an extrapolation from experiments involving transient neural stimulation by MF at much higher exposures. Using a similar approach, the International Committee on Electromagnetic Safety calculated a guideline of 9,040 mG for exposure to workers and the general public (ICNIRP, 1998; ICES/IEEE, 2002). This situation reflects the lack of credible scientific evidence for a causal relationship between MF exposure and adverse health effects.

III. Policy of the Connecticut Siting Council

The Council recognizes that a causal link between power-line MF exposure and demonstrated health effects has not been established, even after much scientific investigation in the U.S. and abroad. Furthermore, the Council recognizes that timely additional research is unlikely to prove the safety of power-line MF to the satisfaction of all. Therefore, the Council will continue its cautious approach to transmission line siting that has guided its Best Management Practices since 1993. This continuing policy is based on the Council's recognition of and agreement with conclusions shared by a wide range of public health consensus groups, and also, in part, on a review which the Council commissioned as to the weight of scientific evidence regarding possible links between power-line MF and adverse health effects. Under this policy, the Council will continue to advocate the use of effective no-cost and low-cost technologies and management techniques on a project-specific basis to reduce MF exposure to the public while allowing for the development of efficient and cost-effective electrical transmission projects. This approach does not imply that MF exposure will be lowered to any specific threshold or exposure limit, nor does it imply MF mitigation will be achieved with no regard to cost.

The Council will develop its precautionary guidelines in conjunction with Section 16-50p(i) of the Connecticut General Statutes, enacted by the General Assembly to call special attention to their concern for children. The Act restricts the siting of overhead 345kV transmission lines in areas where children congregate, subject to technological feasibility. These restrictions cover transmission lines adjacent to "residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds."

Developing Policy Guidelines

One important way the Council seeks to update its Best Management Practices is to integrate policy with specific project development guidelines. In this effort, the Council has reviewed the actions of other states. Most states either have no specific guidelines or have established arbitrary MF levels at the edge of a right-of-way that are not based on any demonstrated health effects. California, however, established a no-cost/low-cost precautionary-based EMF policy in 1993 that was re-affirmed by the California Public Utilities Commission in 2006. California's policy aims to provide significant MF reductions at no cost or low cost, a precautionary approach consistent with the one Connecticut has itself taken since 1993, consistent with the conclusions of the major scientific reviews, and consistent with the policy recommendations of the Connecticut Department of Public Health and the WHO. Moreover, California specifies certain benchmarks integral to its policy. The benchmark for "low-cost/no-cost" is an increase in aggregate project costs of zero to four percent. The benchmark for "significant MF reduction" is an MF reduction of at least 15 percent. With a policy similar to Connecticut's, and concrete benchmarks as well, California offers the Council a useful model in developing policy guidelines.

No-Cost/Low-Cost MF Mitigation

The Council seeks to continue its precautionary policy, in place since 1993, while establishing a standard method to allocate funds for MF mitigation methods. The Council recognizes California's cost allotment strategy as an effective method to achieve MF reduction goals; thus, the Council will follow a similar strategy for no-cost/low-cost MF mitigation.

The Council directs the Applicant to initially develop a Field Management Design Plan that depicts the proposed transmission line project designed according to standard good utility practice and incorporating "no-cost" MF mitigation design features. The Applicant shall then modify the base design by adding low-cost MF mitigation design features specifically where portions of the project are adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds.

The overall cost of low-cost design features are to be calculated at four percent of the initial Field Management Design Plan, including related substations. Best estimates of the total project costs during the Council proceedings should be employed, and the amounts proposed to be incurred for MF mitigation should be excluded. It is important to note that the four percent guideline is not an absolute cap, because the Council does not want to eliminate prematurely a potential measure that might be available and effective but would cost more than the four percent, or exclude arbitrarily an area adjacent to the ROW that might be suitable for MF mitigation. Nor is the four percent an absolute threshold, since the Council wants to encourage the utilities to seek effective field reduction measures costing less than four percent. In general, the Council recognizes that projects can vary widely in the extent of their impacts on statutory facilities, necessitating some variance above and below the four percent figure.

The four percent guideline for low-cost mitigation should aim at a magnetic field reduction of 15 percent or more at the edge of the utility's ROW. This 15 percent reduction should relate specifically to those portions of the project where the expenditures would be made. While experience with transmission projects in Connecticut since 1993 has shown that no-cost/low-cost designs can and do achieve reductions in MF on the order of 15 percent, the 15 percent guideline is no more absolute than the four percent one, nor must the two guidelines be correlated by rote. The nature of guidelines is to be constructive, rather than absolute.

The Council will consider minor increases above the four percent guideline if justified by unique circumstances, but not as a matter of routine. Any cost increases above the four percent guideline should result in mitigation comparably above 15 percent, and the total costs should still remain relatively low.

Undergrounding transmission lines puts MF issues out of sight, but it should not necessarily put them out of mind. With that said, soils and other fill materials do not shield MF, rather, MF is reduced by the underground cable design (refer to page 9 for further information). However, special circumstances may warrant some additional cost in order to achieve further MF mitigation for underground lines. The utilities are encouraged, prior to submitting their application to the Council, to determine whether a project involves such special circumstances. Note that the extra costs of undergrounding done for purposes other than MF mitigation should be counted in the base project cost and not as part of the four percent mitigation spending.

Additionally, the Council notes two general policies it follows in updating its EMF Best Management Practices and conducting other matters within its jurisdiction. One is a policy to support and monitor ongoing study. Accordingly, the Council, during the public hearing process for new transmission line projects, will consider and review evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF. The second is a policy to encourage public participation and education. The Council will continue to conduct public hearings open to all, update its website to contain the latest information regarding MF health effect research, and revise these Best Management Practices to take account of new developments in MF health effect research or in methods for achieving no-cost/low-cost MF mitigation.

The Council will also require that notices of proposed overhead transmission lines provided in utility bill enclosures pursuant to Conn. Gen. Stats. §16-50*l*(b) state the proposed line will meet the Council's Electric and Magnetic Fields Best Management Practices, specifying the design elements planned to reduce magnetic fields. The bill enclosure notice will inform residents how to obtain siting and MF information specific to the proposed line at the Council's website; this information will also be available at each respective town hall. Phone numbers for follow-up information will be made available, including those of DPH, and utility representatives. The project's final post-construction structure and conductor specifications including calculated MF levels shall also be available at the Council's website and each respective town hall.

Finally, we note that Congress has directed the Department of Energy (DOE) periodically to assess congestion along critical transmission paths or corridors and apply special designation to the most significant ones. Additionally, Congress has given the Federal Regulatory Commission supplemental siting authority in DOE designated areas. This means the Council must complete all matters in an expeditious and timely manner. Accordingly, the cooperation of all parties will be of particular importance in fulfilling the policies set forth above.

IV. MF Best Management Practices: Further Management Considerations

The Council's EMF Best Management Practices will apply to the construction of new electric transmission lines in the State, and to modifications of existing lines that require a certificate of environmental compatibility and public need. These practices are intended for use by public service utilities and the Council when considering the installation of such new or modified electric transmission lines. The practices are based on the established Council policy of reducing MF levels at the edge of a right-of-way (ROW), and in areas of particular interest, with no-cost/low-cost designs that do not compromise system reliability or worker safety, or environmental and aesthetic project goals.

Several practical engineering approaches are currently available for reducing MF, and more may be developed as technology advances. In proposing any particular methods of MF mitigation for a given project, the Applicant shall provide a detailed rationale to the Council that supports the proposed MF mitigation measures. The Council has the option to retain a consultant to confirm that the Field Management Design Plan and the proposed MF reduction strategies are consistent with these EMF Best Management Practices.

A. MF Calculations

When preparing a transmission line project, an applicant shall provide design alternatives and calculations of MF for pre-project and post-project conditions, under 1) peak load conditions at the time of the application filing, and 2) projected seasonal maximum 24-hour average current load on the line anticipated within five years after the line is placed into operation. This will allow for an evaluation of how MF levels differ between alternative power line configurations. The intent of requiring various design options is to achieve reduced MF levels when possible through practical design changes. The selection of a specific design will also be affected by other practical factors, such as the cost, system reliability, aesthetics, and environmental quality.

MF values shall be calculated from the ROW centerline out to a distance of 300 feet on each side of the centerline, at intervals of 25 feet, including at the edge of the ROW. In accordance with industry practice, the calculation shall be done at the location of maximum line sag (typically mid-span), and shall provide MF values at 1 meter above ground level, with the assumption of flat terrain and balanced currents. The calculations shall assume "all lines in" and projected load growth five years beyond the time the lines are expected to be put into operation, and shall include changes to the electric system approved by the Council and the Independent System Operator – New England.

As part of this determination, the applicant shall provide the locations of, and anticipated MF levels encompassing, residential areas, private or public schools, licensed child day care facilities, licensed youth camps, or public playgrounds within 300 feet of the proposed transmission line. The Council, at its discretion, may order the field measurement of post-construction MF values in select areas, as appropriate.

B. Buffer Zones and Limits on MF

As enacted by the General Assembly in Section 4 of Public Act No. 04-246, a buffer zone in the context of transmission line siting is deemed, at minimum, to be the distance between the proposed transmission line and the edge of the utility ROW. Buffer zone distances may also be guided by the standards presented in the National Electrical Safety Code (NESC), published by the Institute of Electrical and Electronic Engineers (IEEE). These standards provide for the safe installation, operation, and maintenance of electrical utility lines, including clearance requirements from vegetation, buildings, and other natural and man-made objects that may arise in the ROW. The safety of power-line workers and the general public are considered in the NESC standards. None of these standards include MF limits.

Since 1985, in its reviews of proposed transmission-line facilities, the Massachusetts Energy Facilities Siting Board has used an edge-of-ROW level of 85 mG as a benchmark for comparing different design alternatives. Although a ROW-edge level in excess of this value is not prohibited, it may trigger a more extensive review of alternatives.

In assessing whether a right-of-way provides a sufficient "buffer zone," the Council will emphasize compliance with its own Best Management Practices, but may also take into account approaches of other states, such as those of Florida, Massachusetts, and New York.

A number of states have general MF guidelines that are designed to maintain the 'status quo', i.e., that fields from new transmission lines not exceed those of existing transmission lines. In 1991, the New York Public Service Commission established an interim policy based on limits to MF. It required new high-voltage transmission lines to be designed so that the maximum magnetic fields at the edge of the ROW, one meter above ground, would not exceed 200 mG if the line were to operate at its highest continuous current rating. This 200 mG level represents the maximum calculated magnetic field level for 345 kV lines that were then in operation in New York State.

The Florida Environmental Regulation Commission established a maximum magnetic field limit for new transmission lines and substations in 1989. The MF limits established for the edge of 230-kV to 500-kV transmission line ROWs and the property boundaries for substations ranged from 150 mG to 250 mG, depending on the voltage of the new transmission line and whether an existing 500-kV line was already present.

Although scientific evidence to date does not warrant the establishment of MF exposure limits at the edge of a ROW, the Council will continue to monitor the ways in which states and other jurisdictions determine MF limits on new transmission lines.

C. Engineering Controls that Modify MF Levels

When considering an overhead electric transmission-line application, the Council will expect the applicant to examine the following Engineering Controls to limit MF in publicly accessible areas: distance, height, conductor separation, conductor configuration, optimum phasing, increased voltage, and underground installation. Any design change may also affect the line's impedance, corona discharge, mechanical behavior, system performance, cost, noise levels and visual impact. The Council will consider all of these factors in relation to the MF levels achieved by any particular Engineering Control. Thus, utilities are encouraged to evaluate other possible Engineering Controls that might be applied to the entire line, or just specific segments, depending upon land use, to best minimize MF at a low or no cost.

Consistent with these Best Management Practices and absent line performance and visual impacts, the Council expects that applicants will propose no-cost/low-cost measures to reduce magnetic fields by one or more engineering controls including:

Distance

MF levels from transmission lines (or any electrical source) decrease with distance; thus, increased distance results in lower MF. Horizontal distances can be increased by purchasing wider ROWs, where available. Other distances can be increased in a variety of ways, as described below.

Height of Support Structures

Increasing the vertical distance between the conductors and the edge of the ROW will decrease MF: this can be done by increasing the height of the support structures. The main drawbacks of this approach are an increase in the cost of supporting structures, possible environmental effects from larger foundations, potential detrimental visual effects, and the modest MF reductions achieved (unless the ROW width is unusually narrow).

Conductor Separation

Decreasing the distances between individual phase conductors can reduce MF. Because at any instant in time the sum of the currents in the individual phase conductors is zero, or close to zero, moving the conductors closer together improves their partial cancellation of each other's MF. In other words, the net MF produced by the closer conductors reduces the MF level associated with the line. Placing the conductors closer together has practical limits, however. The distance between the conductors must be sufficient to maintain adequate electric code clearance at all times, and to assure utility employees' safety when working on energized lines. One drawback of a close conductor installation is the need for more support structures per mile (to reduce conductor sway in the wind and sag at mid-span); in turn, costs increase, and so do visual impacts.

Conductor Configuration

The arrangement of conductors influences MF. Conductors arranged in a flat, horizontal pattern at standard clearances generally have greater MF levels than conductors arranged vertically. This is due to the wider spacing between conductors found typically on H-frame structure designs, and to the closer distance between all three conductors and the ground. For single-circuit lines, a compact triangular configuration, called a "delta configuration", generally offers the lowest MF levels. A vertical configuration may cost more and may have increased visual impact. Where the design goal is to minimize MF levels at a specific location within or beyond the ROW, conductor configurations other than vertical or delta may produce equivalent or lower fields.

Optimum Phasing

Optimum phasing applies in situations where more than one circuit exists in an overhead ROW or in a duct bank installed underground. Electric transmission circuits utilize a three-phase system with each phase carried by one conductor, or a bundle of conductors. Optimum phasing reduces MF through partial cancellation. For a ROW with more than two circuits, the phasing arrangement of the conductors of each circuit can generally be optimized to reduce MF levels under typical conditions. The amount of MF cancellation will also vary depending upon the relative loading of each circuit. For transmission lines on the same ROW, optimizing the phasing of the new line with respect to that of existing lines is usually a low-cost method of reducing MF.

MF levels can be reduced for a single circuit line by constructing it as a "split-phase" line with twice as many conductors, and arranging the conductors for optimum cancellation. Disadvantages of the split-phase design include higher cost and increased visual impact.

Increased Voltage

MF are proportional to current, so, for example, replacing a 69-kV line with a 138-kV line, which delivers the same power at half the current, will result in lower MF. This could be an expensive mitigation to address MF alone because it would require the replacement of transformers and substation equipment.

Underground Installation

Burying transmission lines in the earth does not, by itself, provide a shield against MF, since magnetic fields, unlike electric fields, can pass through soil. Instead, certain inherent features of an underground design can reduce MF. The closer proximity of the currents in the wires provides some cancellation of MF, but does not eliminate it entirely. Underground transmission lines are typically three to five feet below ground, a near distance to anyone passing above them, and MF can be quite high directly over the line. MF on either side of an underground line, however, decreases more rapidly with increased distance than the MF from an overhead line.

The greatest reduction in MF can be achieved by "pipe-type" cable installation. This type of cable has all of the wires installed inside a steel pipe, with a pressurized dielectric fluid inside for electrical insulation and cooling. Low MF is achieved through close proximity of the wires, as described above, and through partial shielding provided by the surrounding steel pipe. While this method to reduce MF is effective, system reliability and the environment can be put at risk if the cable is breached and fluid is released.

Lengthy high-voltage underground transmission lines can be problematic due to the operational limits posed by the inherent design. They also can have significantly greater environmental impacts, although visual impacts associated with overhead lines are eliminated. The Council recognizes the operational and reliability concerns associated with current underground technologies and further understands that engineering research regarding the efficiency of operating underground transmission lines is ongoing. Thus, in any new application, the Council may require updates on the feasibility and reliability of the latest technological developments in underground transmission line design.

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APPENDIX O-3

TABULAR SUMMARIES OF MAGNETIC FIELDS AT AAL, APL AND PDAL LOADINGS AND ELECTRIC FIELDS FOR THE PREFERRED NORTHERN ROUTE OF THE GSRP

Table A3-1 AAL

Line Section	Configuration	Magnetic field (mG) at distances relative to ROW centerline (ft)																										
		-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW* edge	ROW* edge
XS-1 North Bloomfield S/S to Granby Jct.	pre-NEEWS	2.1	2.9	4.3	6.9	12.8	28.3	54.0	40.9	33.2	45.4	42.6	14.8	4.2	1.9	1.4	1.1	1.0	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	16.0	0.5
	post-NEEWS	4.3	5.1	6.1	7.5	9.5	12.5	17.3	25.1	28.2	42.7	80.0	157.4	251.4	267.9	201.6	106.0	57.2	34.7	23.2	16.5	12.3	9.6	7.6	6.2	5.2	10.2	13.4
XS-2 Granby Jct. to CT/MA Border	pre-NEEWS	0.3	0.4	0.6	1.0	1.8	3.9	9.6	26.1	40.6	21.5	7.9	3.3	1.6	0.9	0.5	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	8.7	0.1
	post-NEEWS	5.5	6.7	8.2	10.3	13.4	17.8	24.3	34.3	65.5	137.8	237.5	269.2	220.6	120.8	63.8	37.9	24.8	17.5	13.0	10.0	7.9	6.4	5.3	4.5	3.8	23.5	12.6
XS-2BMP Existing Str. 3191 to Existing Str. 3220	post-NEEWS	4.1	4.9	6.0	7.5	9.7	13.1	18.7	29.3	48.7	79.8	131.0	173.4	140.9	79.2	45.1	28.0	18.8	13.4	10.0	7.8	6.2	5.0	4.2	3.5	3.0	17.9	9.8
XS-2UG-ROW Underground in existing ROW	post-NEEWS	0.5	0.6	0.7	0.9	1.2	1.9	3.5	7.3	11.8	42.8	5.4	2.7	1.7	1.2	0.9	0.8	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	3.2	0.5
XS-2UG-STR Underground under streets	post-NEEWS	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.8	1.1	1.4	2.6	41.5	5.6	2.6	1.6	1.2	0.9	0.8	0.6	0.6	0.5	0.4	0.4	0.4	2.6	5.6

* For underground calculations, ± ROW denotes ± 25 ft.

Table A3-2 APL

		Magnetic field (mG) at distances relative to ROW centerline (ft)																										
Line Section	Configuration	-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW* edge	ROW* edge
XS-1 North Bloomfield S/S to Granby Jct.	pre-NEEWS	1.8	2.5	3.6	5.8	10.6	23.2	43.1	31.1	30.5	43.7	42.3	15.5	4.6	2.0	1.3	1.0	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3	13.2	0.5
	post-NEEWS	4.6	5.4	6.5	8.0	10.0	13.2	18.2	26.3	30.1	45.9	85.7	168.5	269.0	286.6	215.6	113.3	61.1	37.1	24.8	17.6	13.2	10.2	8.2	6.7	5.5	10.8	14.3
XS-2 Granby Jct. to CT/MA Border	pre-NEEWS	0.3	0.4	0.6	1.0	1.8	3.9	9.6	26.1	40.7	21.6	7.9	3.3	1.6	0.9	0.5	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	8.7	0.1
	post-NEEWS	5.9	7.1	8.8	11.0	14.2	18.8	25.1	33.6	67.3	146.8	253.2	287.3	235.7	129.1	68.1	40.5	26.6	18.7	13.9	10.7	8.5	6.9	5.7	4.8	4.1	24.4	13.5
XS-2BMP Existing Str. 3191 to Existing Str. 3220	post-NEEWS	4.3	5.2	6.4	8.0	10.4	14.1	20.7	33.7	55.7	87.4	141.2	186.3	151.1	84.8	48.2	29.9	20.1	14.3	10.7	8.3	6.6	5.3	4.4	3.7	3.2	19.8	10.4
XS-2UG-ROW Underground in existing ROW	post-NEEWS	0.6	0.8	0.9	1.3	1.8	3.0	5.5	11.3	17.3	45.6	6.4	3.4	2.1	1.5	1.1	0.9	0.8	0.6	0.6	0.5	0.4	0.4	0.4	0.3	0.3	5.2	0.6
XS-2UG-STR Underground under streets	post-NEEWS	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.8	0.9	1.3	2.9	45.1	5.4	2.5	1.5	1.1	0.9	0.7	0.6	0.5	0.5	0.4	0.4	0.3	2.9	5.4

* For underground calculations, ± ROW denotes ± 25 ft.

Table A3-3 PDAL

Line Section	Configuration	Magnetic field (mG) at distances relative to ROW centerline (ft) -300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW* edge	ROW* edge
XS-1 North Bloomfield S/S to Granby Jct.	pre-NEEWS	1.8	2.5	3.7	5.9	10.8	23.6	44.2	32.5	30.2	41.5	39.0	13.9	4.0	1.8	1.3	1.0	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3	13.4	0.5
	post-NEEWS	4.0	4.7	5.6	6.9	8.8	11.6	16.1	23.8	27.2	39.6	74.0	145.5	232.5	247.8	186.4	98.0	52.9	32.1	21.4	15.3	11.4	8.8	7.1	5.8	4.8	9.5	12.4
XS-2 Granby Jct. to CT/MA Border	pre-NEEWS	0.2	0.3	0.5	0.9	1.7	3.5	8.8	23.9	37.2	19.7	7.2	3.0	1.5	0.8	0.5	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	8.0	0.1
	post-NEEWS	5.1	6.2	7.6	9.6	12.3	16.4	22.0	29.9	58.8	127.0	219.0	248.5	203.9	111.7	58.9	35.0	23.0	16.2	12.0	9.2	7.3	6.0	4.9	4.2	3.5	21.4	11.7
XS-2BMP Existing Str. 3191 to Existing Str. 3220	post-NEEWS	3.7	4.5	5.5	7.0	9.0	12.3	17.9	29.2	47.9	75.2	121.9	161.0	130.6	73.3	41.7	25.9	17.4	12.4	9.3	7.2	5.7	4.6	3.8	3.2	2.8	17.2	9.0
XS-2UG-ROW Underground in existing ROW	post-NEEWS	0.5	0.6	0.8	1.0	1.5	2.4	4.5	9.1	14.0	38.8	5.6	2.9	1.8	1.3	1.0	0.8	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	4.2	0.5
XS-2UG-STR Underground under streets	post-NEEWS	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.7	0.8	1.1	2.5	39.0	4.7	2.1	1.3	1.0	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3	2.5	4.7

* For underground calculations, ± ROW denotes ± 25 ft.

Table A3-4 Electric Fields

Line Section	Configuration	Electric field (kV/m) at distances relative to ROW centerline (ft) -300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW edge	ROW edge
XS-1 North Bloomfield S/S to Granby Jct.	pre-NEEWS	0.03	0.05	0.08	0.15	0.35	0.86	0.70	0.94	0.46	0.68	0.62	0.32	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00
	post-NEEWS	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.08	0.29	1.22	3.91	3.83	3.14	5.07	2.96	1.35	0.68	0.38	0.24	0.16	0.11	0.08	0.06	0.05	0.01	0.18
XS-2 Granby Jct. to CT/MA Border	pre-NEEWS	0.01	0.01	0.01	0.01	0.01	0.01	0.11	0.56	0.55	0.43	0.06	0.01	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00
	post-NEEWS	0.04	0.06	0.07	0.10	0.13	0.16	0.11	0.76	1.20	2.80	4.28	3.00	4.97	3.43	1.55	0.75	0.41	0.24	0.16	0.11	0.08	0.06	0.04	0.03	0.03	0.11	0.15
XS-2BMP Existing Str. 3191 to Existing Str. 3220	post-NEEWS	0.01	0.02	0.03	0.04	0.06	0.08	0.18	0.97	1.72	1.69	2.55	3.14	3.98	1.77	0.85	0.49	0.31	0.21	0.15	0.11	0.08	0.06	0.05	0.04	0.03	0.15	0.14

APPENDIX O-4

TABULAR SUMMARIES OF MAGNETIC FIELDS AT AAL, APL AND PDAL LOADINGS AND ELECTRIC FIELDS FOR THE SOUTHERN ALTERNATIVE ROUTE FOR THE GSRP

Table A4-1 AAL

Line Section	Configuration	Magnetic field (mG) at distances relative to ROW centerline (ft)																									-ROW* edge	ROW* edge
		-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300		
XS-S05 CT Border to CT River	pre-NEEWS	0.4	0.5	0.7	0.9	1.3	2.1	3.8	8.3	17.7	19.2	9.8	4.4	2.4	1.4	1.0	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.1	3.8	0.3
	post-NEEWS	4.0	4.7	5.6	6.7	8.2	10.1	12.5	20.2	65.6	130.3	192.7	268.7	269.7	190.9	97.8	52.8	32.1	21.4	15.2	11.4	8.8	7.0	5.7	4.7	4.0	12.5	15.2
XS-S06 CT River to MA Border	pre-NEEWS	0.6	0.8	0.9	1.2	1.6	2.3	3.4	5.4	8.5	11.8	13.0	11.8	8.5	5.4	3.4	2.3	1.6	1.2	0.9	0.8	0.6	0.5	0.4	0.4	0.3	3.4	0.9
	post-NEEWS	1.8	1.9	2.1	2.2	2.5	3.1	5.0	10.1	21.3	38.0	52.3	61.3	68.9	92.7	142.5	188.7	197.1	168.4	111.2	66.2	41.3	27.6	19.6	14.5	11.2	5.0	111.2
XS-S07 CT Border to MA Border	pre-NEEWS	0.4	0.6	0.7	1.0	1.6	2.6	5.1	11.6	20.1	15.7	7.0	3.4	1.9	1.2	0.8	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.1	0.1	7.0	0.3
	post-NEEWS	4.2	5.0	6.0	7.3	8.9	10.9	14.1	31.5	93.9	150.9	229.1	277.7	248.6	147.9	75.3	42.7	27.1	18.6	13.5	10.2	8.0	6.4	5.3	4.4	3.8	17.3	15.2
XS-S07UG-STR Underground under street	post-NEEWS	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.7	0.9	1.1	1.4	2.6	41.8	5.7	2.6	1.6	1.2	0.9	0.8	0.6	0.6	0.5	0.4	0.4	0.4	2.6	5.7
XS-S07UG-ROW Underground in existing ROW	post-NEEWS	1.0	1.3	1.8	2.6	3.9	6.6	12.7	28.9	49.3	38.0	16.3	7.4	3.8	2.0	1.0	1.3	16.8	8.2	3.4	2.1	1.5	1.2	1.0	0.8	0.7	17.4	4.6

* For underground calculations, ± ROW denotes ± 25 ft.

Table A4-2 APL

Line Section	Configuration	Magnetic field (mG) at distances relative to ROW centerline (ft)																										
		-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW* edge	ROW* edge
XS-S05 CT Border to CT River	pre-NEEWS	0.9	1.2	1.6	2.2	3.2	5.0	9.1	19.7	41.9	45.5	23.3	10.5	5.6	3.4	2.3	1.7	1.2	1.0	0.8	0.6	0.5	0.4	0.4	0.3	0.3	9.1	0.8
	post-NEEWS	4.4	5.1	6.1	7.2	8.7	10.3	12.6	24.8	90.4	168.3	233.0	320.3	320.4	225.5	115.0	61.9	37.5	25.0	17.7	13.2	10.2	8.1	6.6	5.5	4.6	12.6	17.7
XS-S06 CT River to MA Border	pre-NEEWS	1.5	1.8	2.2	2.9	3.9	5.5	8.1	12.7	20.2	28.1	31.0	28.1	20.2	12.7	8.1	5.5	3.9	2.9	2.2	1.8	1.5	1.2	1.0	0.9	0.7	8.1	2.2
	post-NEEWS	1.7	1.8	1.8	2.0	2.4	3.8	7.3	15.4	31.8	55.1	72.8	81.0	86.1	111.7	169.9	224.4	234.2	199.4	131.1	77.7	48.3	32.2	22.8	16.9	13.0	7.3	131.1
XS-S07 CT Border to MA Border	pre-NEEWS	1.0	1.3	1.8	2.5	3.8	6.3	12.1	27.6	47.7	37.4	16.6	8.0	4.6	2.9	2.0	1.5	1.1	0.9	0.7	0.6	0.5	0.4	0.4	0.3	0.3	16.6	0.8
	post-NEEWS	4.7	5.5	6.5	7.8	9.3	11.1	14.7	42.2	127.3	188.5	274.5	330.6	294.6	174.3	88.4	50.0	31.6	21.6	15.7	11.9	9.3	7.5	6.1	5.1	4.3	19.9	17.7
XS-S07UG-STR Underground under street	post-NEEWS	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8	1.0	1.3	1.6	3.0	49.4	6.7	3.1	1.9	1.4	1.1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	3.0	6.7
XS-S07UG-ROW Underground in existing ROW	post-NEEWS	1.3	1.7	2.4	3.4	5.1	8.5	16.5	37.4	63.9	49.4	21.3	9.7	5.1	2.8	1.5	1.7	19.3	9.4	4.0	2.5	1.8	1.4	1.2	1.0	0.8	22.6	5.3

* For underground calculations, ± ROW denotes ± 25 ft.

Table A4-3 PDAL

Line Section	Configuration	Magnetic field (mG) at distances relative to ROW centerline (ft)																										
		-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW* edge	ROW* edge
XS-S05 CT Border to CT River	pre-NEEWS	0.7	0.9	1.2	1.7	2.5	4.0	7.2	15.6	33.2	36.0	18.5	8.3	4.4	2.7	1.8	1.3	1.0	0.8	0.6	0.5	0.4	0.4	0.3	0.3	0.2	7.2	0.6
	post-NEEWS	3.6	4.2	5.0	5.9	7.0	8.2	9.8	21.4	80.9	150.2	203.3	275.8	274.6	193.0	98.3	52.8	32.0	21.3	15.1	11.2	8.7	6.9	5.6	4.7	3.9	9.8	15.1
XS-S06 CT River to MA Border	pre-NEEWS	1.1	1.4	1.8	2.3	3.1	4.3	6.4	10.1	16.0	22.2	24.5	22.2	16.0	10.1	6.4	4.3	3.1	2.3	1.8	1.4	1.1	1.0	0.8	0.7	0.6	6.4	1.8
	post-NEEWS	1.2	1.3	1.3	1.5	2.0	3.5	6.9	14.4	29.3	50.2	66.1	73.4	76.7	97.5	146.7	193.0	200.8	170.8	112.1	66.4	41.2	27.4	19.4	14.3	11.0	6.9	112.1
XS-S07 CT Border to MA Border	pre-NEEWS	0.8	1.0	1.4	2.0	3.0	5.0	9.6	21.9	37.8	29.6	13.2	6.3	3.6	2.3	1.6	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.2	13.2	0.6
	post-NEEWS	3.8	4.5	5.3	6.3	7.4	8.7	11.7	37.4	113.7	167.1	237.7	283.9	252.3	149.1	75.5	42.6	26.9	18.4	13.3	10.1	7.9	6.3	5.2	4.3	3.7	16.7	15.1
XS-S07UG-STR Underground under street	post-NEEWS	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.7	0.9	1.1	1.4	2.6	41.8	5.7	2.6	1.6	1.2	0.9	0.8	0.6	0.6	0.5	0.4	0.4	0.4	2.6	5.7
XS-S07UG-ROW Underground in existing ROW	post-NEEWS	1.5	2.0	2.6	3.7	5.7	9.4	18.2	41.2	70.4	54.5	23.7	10.9	5.8	3.4	2.0	1.8	17.0	7.8	3.5	2.2	1.6	1.3	1.0	0.9	0.8	24.9	4.6

* For underground calculations, ± ROW denotes ± 25 ft.

Table A4-4 Electric fields

Line Section	Configuration	Electric field (kV/m) at distances relative to ROW centerline (ft)																										
		-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW edge	ROW edge
XS-S05 CT Border to CT River	pre-NEEWS	0.01	0.02	0.03	0.04	0.07	0.14	0.31	0.80	1.11	0.89	0.95	0.37	0.16	0.08	0.05	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.31	0.01
	post-NEEWS	0.03	0.04	0.05	0.08	0.12	0.21	0.42	0.96	1.43	0.57	3.49	3.36	3.30	5.02	2.74	1.25	0.63	0.36	0.22	0.15	0.11	0.08	0.06	0.05	0.04	0.42	0.22
XS-S06 CT River to MA Border	pre-NEEWS	0.02	0.03	0.04	0.06	0.10	0.16	0.27	0.48	0.73	0.64	0.38	0.64	0.73	0.48	0.27	0.16	0.10	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.27	0.04
	post-NEEWS	0.03	0.04	0.06	0.08	0.12	0.18	0.30	0.52	0.79	0.73	0.37	0.22	0.59	1.81	3.22	2.54	1.96	3.30	3.08	1.79	0.98	0.57	0.35	0.23	0.16	0.30	3.08
XS-S07 CT Border to MA Border	pre-NEEWS	0.01	0.02	0.03	0.05	0.09	0.19	0.45	1.09	0.65	1.21	0.66	0.26	0.12	0.06	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.66	0.01
	post-NEEWS	0.03	0.04	0.06	0.09	0.15	0.27	0.58	1.29	1.02	1.45	4.27	2.93	4.35	4.24	1.99	0.94	0.50	0.30	0.19	0.13	0.09	0.07	0.05	0.04	0.03	0.81	0.22

APPENDIX O-5

TABULAR SUMMARIES OF MAGNETIC FIELDS AT AAL, APL AND PDAL LOADINGS AND ELECTRIC FIELDS FOR MANCHESTER – MEEKVILLE JUNCTION CIRCUIT SEPARATION PROJECT

Table A5-1 AAL

Line Section	Configuration	Magnetic field (mG) at distances relative to ROW centerline (ft)																									
		-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW* edge	ROW* edge
XS-21 Manchester S/S to Meekville Jct.	pre-NEEWS	2.0	2.3	2.7	3.2	3.9	4.8	6.1	8.1	11.3	16.3	19.1	24.0	21.3	23.3	36.6	48.9	62.3	57.9	40.9	27.4	18.9	13.5	10.0	7.7	6.1	4.8	27.4
	post-NEEWS	1.2	1.4	1.7	2.0	2.5	3.2	4.2	5.9	8.8	13.4	13.3	13.9	18.9	28.2	26.1	26.1	30.0	26.1	18.1	12.2	8.5	6.2	4.6	3.6	2.9	3.2	12.2
XS-21BMP Manchester S/S to Meekville Jct.	post-NEEWS	0.9	1.0	1.2	1.5	1.8	2.4	3.2	4.7	7.5	12.8	14.4	17.2	27.6	34.1	31.2	30.2	26.2	15.1	7.8	4.8	3.3	2.5	1.9	1.5	1.3	2.4	4.8

* For underground calculations, ± ROW denotes ± 25 ft.

Table A5-2 APL

Line Section	Configuration	Magnetic field (mG) at distances relative to ROW centerline (ft)																									
		-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW* edge	ROW* edge
XS-21 Manchester S/S to Meekville Jct.	pre-NEEWS	1.4	1.6	1.8	2.1	2.5	3.0	3.6	4.6	6.4	9.9	15.9	25.8	20.4	26.4	40.6	46.5	50.5	45.5	31.8	21.1	14.4	10.3	7.6	5.9	4.6	3.0	21.1
	post-NEEWS	1.6	1.9	2.1	2.5	2.9	3.4	4.0	4.8	5.8	9.9	23.0	32.5	37.6	44.0	26.2	25.3	39.5	39.4	28.9	19.9	14.0	10.2	7.7	6.0	4.7	3.4	19.9
XS-21BMP Manchester S/S to Meekville Jct.	post-NEEWS	0.8	1.0	1.1	1.3	1.6	1.9	2.4	3.0	4.0	7.3	16.4	23.9	31.7	43.9	36.7	28.4	29.3	21.8	13.2	8.4	5.7	4.1	3.1	2.4	1.9	1.9	8.4

* For underground calculations, ± ROW denotes ± 25 ft.

Table A3-3 PDAL

Line Section	Configuration	Magnetic field (mG) at distances relative to ROW centerline (ft)																										
		-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW* edge	ROW* edge
XS-21 Manchester S/S to Meekville Jct.	pre-NEEWS	1.4	1.5	1.8	2.0	2.4	2.8	3.2	3.8	4.7	7.4	16.2	27.1	22.2	24.2	36.2	41.9	47.6	43.7	31.0	20.8	14.3	10.2	7.6	5.9	4.6	2.8	20.8
	post-NEEWS	1.3	1.5	1.8	2.1	2.4	2.9	3.6	4.4	5.5	7.8	15.3	23.3	28.1	36.0	23.6	19.4	27.4	27.1	20.0	13.9	9.9	7.2	5.5	4.3	3.4	2.9	13.9
XS-21BMP Manchester S/S to Meekville Jct.	post-NEEWS	0.8	0.9	1.1	1.3	1.5	1.9	2.4	3.0	3.9	5.4	10.8	18.7	27.0	37.7	30.8	21.6	20.4	15.0	9.3	6.2	4.3	3.2	2.4	1.9	1.5	1.9	6.2

* For underground calculations, ± ROW denotes ± 25 ft.

Table A3-4 Electric

Line Section	Configuration	Electric field (kV/m) at distances relative to ROW centerline (ft)																										
		-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	-ROW edge	ROW edge
XS-21 Manchester S/S to Meekville Jct.	pre-NEEWS	0.03	0.03	0.04	0.04	0.05	0.06	0.08	0.08	0.09	0.66	1.76	1.10	0.16	0.33	0.57	0.59	1.95	1.62	0.60	0.15	0.08	0.10	0.09	0.08	0.07	0.06	0.15
	post-NEEWS	0.04	0.04	0.05	0.05	0.06	0.07	0.08	0.07	0.06	0.65	1.73	0.95	0.44	1.26	0.95	1.32	2.31	1.69	0.58	0.15	0.15	0.16	0.14	0.12	0.10	0.07	0.15
XS-21BMP Manchester S/S to Meekville Jct.	post-NEEWS	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.10	0.67	1.73	0.96	0.27	0.71	2.99	2.95	2.39	2.02	0.59	0.14	0.08	0.08	0.07	0.06	0.05	0.05	0.14

Connecticut Light & Power
The Northeast Utilities System

NEW ENGLAND EAST–WEST SOLUTION

APPENDIX O-6

EMF AND HEALTH: REVIEW AND UPDATE OF THE SCIENTIFIC RESEARCH
DECEMBER 2007 – JUNE 2008

Exponent®

EMF and Health: Review and Update of the Scientific Research December 2007 – June 2008

EMF and Health:
Review and Update of the Scientific Research December 2007 – June 2008

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Acronyms and Abbreviations

AC	alternating current
AD	Alzheimer's disease
ALL	acute lymphoblastic leukemia
ALS	amyotrophic lateral sclerosis
BMP	Best Management Practices
CI	confidence interval
CSC	Connecticut Siting Council
DC	direct current
DMBA	7,12-dimethylbenz[a]anthracene
ELF	extremely low frequency
EHC	Environmental Health Criteria
EMF	electric and magnetic fields (or electromagnetic fields)
ENU	ethylnitrosourea
FSH	follicle stimulating hormone
G	gauss
GHz	GigaHertz
HCN	Health Council of the Netherlands
Hz	hertz
IARC	International Agency for Research on Cancer
ICNIRP	International Committee on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
LH	luteinizing hormone
mG	milliGauss
NRPB	National Radiation Protection Board of Great Britain
OR	odds ratio
RR	relative risk
SES	socioeconomic status
SSI	Swiss Radiation Protection Authority
TWA	time-weighted average
WHO	World Health Organization

1 Executive Summary

Electric energy is a beneficial and indispensable component of human society. Over the past 30 years, potential health risks associated with the use of electric energy have been studied because of the ubiquitous exposures of populations to fields associated with the transport and use of electricity. This report discusses standard methods for conducting and interpreting health research and provides an up-to-date summary and assessment of current research on EMF and health.

When evaluating if EMF may have an adverse impact on human health, it is important to consider the type and strength of research studies available for evaluation. Human health studies vary in methodological rigor and, therefore, in their capacity to extrapolate findings to the population at large. Furthermore, all studies in three areas of research (epidemiology, *in vivo,* and *in vitro* research) must be evaluated to understand possible health risks.

The World Health Organization (WHO) published a status report on EMF and human health in 2007 critically reviewing the literature to date and taking into account the strength and quality of the individual research studies. The WHO Report provided the following overall conclusions:

> New human, animal, and in vitro studies published since the 2002 IARC Monograph, 2002 [*sic*] do not change the overall classification of ELF as a possible human carcinogen (p. 347).
>
> Acute biological effects [i.e., short-term, transient health effects such as a small shock] have been established for exposure to ELF electric and magnetic fields in the frequency range up to 100 kHz that may have adverse consequences on health. Therefore, exposure limits are needed. International guidelines exist that have addressed this issue. Compliance with these guidelines provides adequate protection. Consistent epidemiological evidence suggests that chronic low-intensity ELF magnetic field exposure is associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted (p. 355).

A systematic literature review was performed and epidemiologic and *in vivo* studies published after the WHO report are evaluated critically in this report. These recent studies do not provide evidence to alter the opinion of the WHO and other health and scientific agencies that the research evidence is insufficient to suggest that electric or magnetic fields are a cause of cancer or any other disease process at the levels we encounter in our everyday environment.

2 Introduction

In response to public concerns regarding electric and magnetic fields (EMF) and health, the Connecticut Siting Council (CSC) released precautionary measures related to the construction of electric transmission lines in Connecticut on December 14, 2007. The CSC's Best Management Practices (BMP) policy document is founded on the recognition of consistent conclusions by "a wide range of public health consensus groups," as well as their own commissioned weight-of-evidence review (p. 4). The CSC summarized the current scientific consensus by noting the conclusions of these public health consensus groups, including the most recent review by the World Health Organization (WHO) and previously published reviews by the National Institute for Environmental and Health Sciences (NIEHS, 1999), the International Agency for Research on Cancer (IARC, 2002), ARPANSA (2003), the National Radiological Protection Board of Great Britain (NRPB, 2004), and the Health Council of Netherlands (HCN, 2005). The CSC summarized the current scientific consensus as follows: there is limited evidence from epidemiology studies of a statistical association between estimated, average exposures greater than 3-4 milligauss (mG) and childhood leukemia; the cumulative research, however, does not indicate that magnetic fields are a cause of childhood leukemia, as animal and other experimental studies do not suggest that magnetic field are carcinogenic. The CSC also noted the WHO's recent conclusion with respect to other diseases: "the scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukemia" (p. 2).

Based on this scientific consensus, the CSC concluded that proportional precautionary measures for the siting of new transmission lines include "the use of effective no-cost and low-cost technologies and management techniques on a project-specific basis to reduce MF exposure to the public while allowing for the development of efficient and cost-effective electrical transmission projects" (p. 11). The BMP also stated that the CSC will "consider and review evidence of any new developments in scientific research addressing MF [magnetic fields] and public health effects or changes in scientific consensus group positions regarding MF" (p. 5). This report supports this activity by providing a review of recently published studies and reviews, and describing if and how these recent developments affect the current scientific consensus regarding the possible health effects of EMF.

The current report systematically evaluates peer-reviewed research and reviews by scientific panels published from December 14, 2007 through June 16, 2008 to determine if there are new developments that alter the current scientific consensus as articulated in the CSC's 2007 BMP.[1] During this six-month timeframe, approximately 10 relevant scientific studies were published and 1 scientific organization issued an evaluation of the scientific evidence.

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[1] As noted by the ICNIRP, IARC and WHO, there has been no consistent or strong evidence to explain how EMF exposure could affect biological processes in cells and tissues. In addition, as described in Section 3.2 below, such data are supplementary to epidemiology and whole animal studies, and are not directly used by health agencies to assess risk to human health. For that reason, this review only systematically addresses epidemiology studies and *in vivo* studies and relies largely on reviews and the conclusions of scientific panels with regard to studies of mechanism.

For reference, Section 3 provides a brief background on methods used for conducting and evaluating scientific research. Section 4 briefly summarizes the methods and conclusions of the weight-of-evidence review on EMF by the WHO, and Section 5 summarizes the recent literature and reviews that have been published since the time of the WHO report based on a systematic review of the literature.

3 Evaluation of Human Health Studies

The scientific process entails looking at *all* the evidence on a particular issue in a systematic and thorough manner to see if the overall data presents a logically coherent and consistent picture. This is often referred to as a weight-of-evidence review, in which all studies are considered together, giving more weight to studies of higher quality and using an established analytic framework to arrive at a conclusion about a possible causal relationship. Two steps precede a weight-of-evidence evaluation: a systematic review to identify the relevant literature and an evaluation of each study to determine its strengths and weaknesses. The following sections discuss important considerations in the evaluation of human health studies of EMF, including exposure considerations, study design, methods for estimating risk, bias, and the process of causal inference.

EMF exposure considerations

To fully characterize any exposure, it is necessary to consider the nature, dose, and timing of exposure. The nature of exposure relates to the specifics of that exposure (e.g., 60-Hz or 50-Hz and AC or direct current [DC] magnetic fields), including the ways in which persons may be exposed (e.g., occupationally or non-occupationally). While there are many different characteristics of magnetic fields (such as direction, polarization and harmonic content), these characteristics are typically not considered in the exposure assessment in epidemiologic studies. The dose of the exposure is the amount of the biologically relevant aspect of the exposure in tissue. Dose can be measured as the accumulated dose or as an exposure rate. The *biological dose* of exposure in tissue is correlated to exposure outside the body as the available dose and the encountered dose. The *available dose* of EMF is the maximum amount that a nearby source could emit. The encountered dose is less than or equal to the available dose. The amount of exposure that might possibly influence tissues in humans (i.e., the biological dose) is less than or equal to the amount of EMF that is available and encountered. Ultimately, it is this biological dose that has the potential, if any, to influence disease risk. The hierarchical nature of these dose categories is illustrated in Figure 2-1. The biological dose often cannot be measured, and most research studies measure the available or encountered dose.

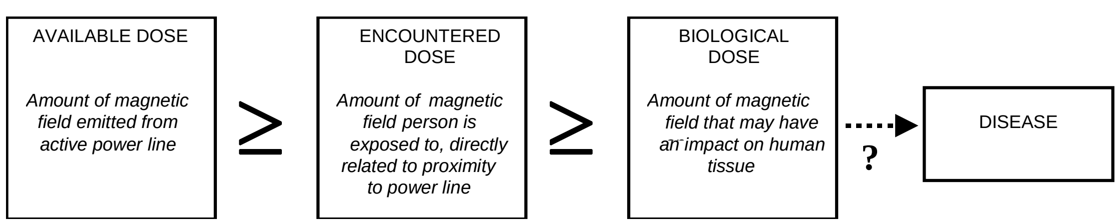

Figure 4-1. Relationship between dose categories, with an EMF-related example

(Source: Modified from Armstrong, White and Saracci, 2000, p. 12)

Time of exposure is characterized as: (1) when the exposure first begins, (2) when, if at all, the exposure ends, and (3) whether the exposure is continuous or occurs intermittently. Aspects to consider further when evaluating time of exposure are the duration of the exposure and whether there is a critical time window (i.e., an etiologically relevant exposure period) for the disease. This is particularly important for diseases that may have a long latency period between the start of the disease and when the disease is detected, e.g., cancer. For example, if scientists hypothesize that a particular childhood cancer is the result of prenatal exposures (e.g., maternal drinking habits), then the child's exposure history after birth is not relevant when considering disease etiology.

Dose and time are usually considered jointly to create summary exposure measures. Three common joint dose-time measures are: peak exposure, cumulative exposure, and average exposure. These measures can be considered just during the etiologically relevant time period or in terms of total lifetime exposure. Since it is often not known what the critical time window is for most diseases, these summary exposure measurements are often evaluated as: peak lifetime exposure, cumulative lifetime exposure, and average lifetime exposure. Most studies of EMF have made calculations or taken measurements over a 24-hour or 48-hour period to be used as an *estimate* of average lifetime exposure, and some occupational studies have also used job-exposure matrices to estimate a cumulative or peak exposure, or both

Another important consideration of EMF exposure is whether it has been measured directly or indirectly. For example, personal exposure to magnetic fields can be measured directly when an individual is wearing a device that records the amount of magnetic field encountered at frequent intervals (see example of the output of this device in Figure P-1). EMF can be estimated indirectly by assigning an estimated amount of EMF exposure to an individual based on calculations considering nearby power installations or a person's job title. For example, a relative estimate of exposure could be assigned to all machine operators based on historical information on the magnitude of the magnetic field produced by the machine. Indirect measurements are not as accurate as direct measurements because they do not contain information specific to that person or the exposure situation. In the example of machine operators, the indirect measurement may not account for how much time any one individual spends working at that machine or any potential variability in magnetic fields produced by the machines over time, in addition to residential magnetic field exposures.

Types of health research studies

Prior to presenting the summary of research findings related to EMF and health, an overview of design aspects of health research studies is provided to aid in the interpretation of these studies. Research studies can be broadly classified into two groups: 1) epidemiologic observations of people, which are not experimental, and 2) experimental studies on animals, humans, cells and tissues in laboratory settings. Epidemiologic studies investigate how disease is distributed in populations and what factors influence or determine this disease distribution (Gordis, 2000). Epidemiologic studies attempt to establish causes for human disease while observing people as they go about their normal, daily lives. Such studies are designed to quantify and evaluate the associations between reported exposures to environmental factors and disease.

The most common types of epidemiologic studies in the EMF literature are case-control and cohort studies. In case-control studies, people with and without the disease of interest are identified and potential causative exposures are evaluated. Often, people are interviewed or their personal records (e.g., medical records or employment records) are reviewed in order establish the exposure history for each individual. The exposure histories are then compared between the diseased and non-diseased populations to determine whether any statistically significant differences in exposure histories exist. In cohort studies, on the other hand, individuals within a defined cohort of people (e.g., all persons working at a factory) are classified as exposed or non-exposed and followed over time for the incidence of disease. Researchers then compare disease incidence in the exposed and non-exposed groups.

Experimental studies are designed to test specific hypotheses under controlled conditions and are vital to assessing cause-and-effect relationships. An example of a human experimental study relevant to this area of research would be studies that measure the impact of magnetic field exposure on acute biological responses in humans, such as hormone levels. These studies are conducted in laboratories under controlled conditions. *In vivo* and *in vitro* experimental studies are also conducted under controlled conditions in laboratories. *In vivo* studies expose laboratory animals to very high levels of a chemical or physical agent to determine whether exposed animals develop cancer or other effects at higher rates than unexposed animals, while attempting to control other factors that could possibly affect disease rates (e.g., diet, genetics, etc.). *In vitro* studies of isolated cells and tissues are also important because they can help scientists understand biological responses as they relate to the same exposure in intact humans and animals. The results of experimental studies of animals, and particularly those of isolated tissues or cells, however, may not always be directly extrapolated to human populations. In the case of *in vitro* studies, the responses of cells and tissues outside the body may not reflect the response of those same cells if maintained in a living system, so their relevance cannot be assumed. Therefore, it is both necessary and desirable that agents that could present a potential health threat be explored by both epidemiologic and experimental studies.

Both of these approaches – epidemiologic and experimental laboratory studies – have been used to evaluate whether exposure to EMF has any adverse effects on human health. Epidemiologic studies are valuable because they are conducted in human populations, but they are limited by their non-experimental design and usual retrospective nature. In epidemiologic studies of EMF, for example, researchers cannot control the amount of individual exposure to EMF, how exposure occurs over time, the contribution of different field sources, or individual behaviors that could affect disease risk, such as diet. In valid risk assessments of EMF, epidemiologic studies have been considered alongside experimental studies of laboratory animals, while studies of isolated tissues and cells are generally acknowledged as being less relevant.

Estimating risk

Epidemiologists measure the statistical association between factors and disease in order to estimate "risk." Risk is a multi-faceted term that includes several related components, beyond just a simple statistical association. This brief summary of risk is included to provide a foundation for understanding and interpreting statistical associations in epidemiologic studies as risk estimates.

Two common types of risk estimates are absolute risk and relative risk (RR). Absolute risk, also known as incidence, is the amount of new disease that occurs in a given period of time. For example, the absolute risk of invasive childhood cancer in children ages 0-19 years for 2004 was 14.8 per 100,000 children (Ries et al., 2007). RRs are calculated to evaluate whether a particular exposure (EMF, diet, genetics, race, etc.) is associated with a disease outcome. This is calculated by looking at the absolute risk in one group relative to a comparison group. For example, white children in the 0-19 year age range had an estimated absolute risk of childhood cancer of 15.4 per 100,000 in 2004, and African American children had an estimated absolute risk of 13.3 per 100,000 in the same year. By dividing the absolute risk of white children by the absolute risk of African American children, we obtain a RR of 1.16. This RR estimate can be interpreted to mean that white children have a childhood cancer risk that is 16% greater than the risk of African American children. Additional statistical analysis is needed to evaluate whether this association is statistically significant.

It is important to understand that risk is estimated differently from cohort and case-control studies because of the way the studies are designed. Traditional cohort studies can provide a direct estimate of RR, while case-control studies can only provide indirect estimates of RR, called odds ratios (OR). For this reason, among others, cohort studies usually provide more reliable estimates of the risk associated with particular exposures.

Thus, the association between a particular disease and exposure is measured quantitatively in an epidemiology study as either the RR (cohort studies) or OR (case-control studies) estimate. The general interpretation of a risk estimate equal to 1.0 is that the exposure is not associated with an increased incidence of the disease. If the risk estimate is greater than 1.0, the inference is that the exposure is associated with an increased incidence of the disease. On the other hand, if the risk estimate is less than 1.0, the inference is that the exposure is associated with a reduced incidence of the disease. The magnitude of the risk estimate is often referred to as its strength (i.e., strong vs. weak).

Statistical significance

Statistical significance testing provides an idea of whether or not a statistical association is caused by chance alone, i.e., is the association likely to be observed this way upon repeated testing or is it simply a chance occurrence. The terms “statistically significant” or “statistically significant association” are used in epidemiologic studies to describe the tendency of the level of exposure and the occurrence of disease to be linked, with chance as an unlikely explanation. Statistically significant associations, however, are not automatically an indication of cause-and-effect, because the interpretation of statistical associations depends on many other factors associated with the design and conduct of the study, including, for example, how the data were collected and the size of the study.

Confidence intervals (CI) are typically reported along with RR and OR values. A CI is a range of values for an estimate of effect that has a specified probability (e.g., 95%) of including the “true” estimate of effect. A 95% CI indicates that, if the study were conducted a very large number of times, 95% of the measured estimates would be within the upper and lower confidence limits.

The range of the CI is also important for interpreting estimated associations, including the precision and statistical significance of the association. A very wide CI indicates great uncertainty in the value of the "true" risk estimate. This is usually due to a small number of observations. A narrow CI provides more certainty about where the "true" RR estimate lies. Another way of interpreting the CI is as follows: if the 95% CI does not include 1.0, the probability of an association being due to chance alone is 5% or lower and the result is considered statistically significant, as discussed above.

Meta-analysis

In scientific research, the results of smaller studies may be difficult to distinguish from normal, random variation, particularly in sub-group analyses for high exposure levels. Meta-analysis is an analytic technique that combines the published results from a group of studies into one summary result. A pooled analysis, on the other hand, combines the raw, individual-level data from the original studies and analyzes the data from the studies altogether. These methods are valuable because they increase the number of individuals in the analysis, which allows for a more robust and stable estimate of association. Meta- and pooled analyses are also an important tool for qualitatively synthesizing the results of a large group of studies.

The disadvantage of meta- and pooled analyses is that they can convey a false sense of consistency across studies if *only* the combined estimate of effect is considered (Rothman and Greenland, 1998). These analyses typically combine data from studies with different study populations, methods for measuring and defining exposure, and disease definitions. This is particularly true for analyses that combine data from case-control studies, which often use very different methods for the selection of cases and controls and exposure assessment. Therefore, in addition to the synthesis or combining of data, meta- and pooled analyses should be used to understand what factors cause the results of the studies to vary (publication date, study design, possibility of selection bias, etc.), and how these factors affect the associations calculated from the data of all the studies combined (Rothman and Greenland, 1998).

Meta- and pooled analyses are a valuable technique in epidemiology; however, in addition to calculating a summary relative risk, they should follow standard techniques (Stroup et al., 2001) and analyze the factors that contribute to any heterogeneity between the studies.

Bias in epidemiologic studies

One key reason that results of epidemiologic studies cannot directly provide evidence for cause-and-effect is the presence of bias. Bias is defined as "any systematic error in the design, conduct or analysis of a study that results in a mistaken estimate of an exposure's effect on the risk of disease" (Gordis, 2000, p. 204). In other words, sources of bias are factors or research situations that can mask a true association or create an association that does not exist. As a result, the extent of bias, as well as its types and sources, are important considerations in the interpretation of epidemiologic studies. Since it is not possible to fully control human populations, perfectly measure their exposures, control for the effects of all other risk factors, etc., bias will exist in some form in all epidemiologic studies of human health.

One important source of bias occurs when two groups differ in ways other than just the variable of interest. An example of this is the relationship between diet and exercise. People who exercise more may tend to also consume healthier diets. Consider an example of a researcher whose study finds that people who exercise have a lower risk of diabetes compared to people who do not exercise. If the researcher does not control for the impact of diet, it is not possible to say with certainty that the lower risk of diabetes is due to exercise and not a healthier diet.

Cause vs. association and evaluating evidence regarding causal associations

Epidemiologic studies can help suggest risk factors that may contribute to a disease risk, but they are not used as the sole basis for drawing inferences about cause-and-effect relationships. Since epidemiologists do not have control over the many other factors to which people are exposed (e.g., genetics, pollution, infections, etc.) and diseases can be caused by a complex interaction of many factors, the results of epidemiologic studies must be interpreted with caution. A single epidemiologic study is rarely unequivocally supportive or non-supportive of causation; rather, a weight is assigned to the study based on the validity of its methods.

In 1964, the Surgeon General of the United States published a landmark report on smoking-related diseases (U.S. Department of Health, Education and Welfare, 1964). As part of this report, nine criteria for evaluating epidemiology studies (along with experimental data) for causality were outlined. In a more recent version of this report, these criteria have been reorganized into seven criteria. In the earlier version, coherence, plausibility, and analogy were considered as distinct items, but are now summarized together because they have been treated in practice as essentially reflecting one concept (Department of Health and Human Services, 2004). Table 2-1 provides a listing and brief description of each of the criterion.

Table 4-1. Criteria for evaluating whether an association is causal

Criteria	Description
Consistency	Repeated observation of an association between exposure and disease in multiple studies of adequate statistical power, in different populations, and at different times.
Strength of the association	The larger (stronger) the magnitude and statistical strength of an association is between exposure and disease, the less likely such an effect is the result of chance or unmeasured confounding.
Specificity	The exposure is the single (or one of a few) cause of disease.
Temporality	The exposure occurs prior to the onset of disease.
Coherence, plausibility, and analogy	The association cannot violate known scientific principles and the association must be consistent with experimentally demonstrated biologic mechanisms.
Biologic gradient	This is also known as a dose-response relationship, i.e., the observation that the stronger or greater the exposure is, the stronger or greater the effect.
Experiment	Observations that result from situations in which natural conditions imitate experimental conditions. Also stated as a change in disease outcome in response to a non-experimental change in exposure patterns in population.

(Source: Department of Health and Human Services, 2004)

The criteria were meant to be applied to statistically significant associations that have been observed in the epidemiologic literature, i.e., if no statistically significant association has been observed for an exposure then the criteria are not relevant. It is important to note that these criteria were not intended to serve as a checklist; rather, they were intended to serve as a guide in evaluating associations for causal inference. Theoretically, it is possible for an exposure to meet all seven criteria, but still not be deemed a causal factor. Also, no one criterion can provide indisputable evidence for causation, nor can any one criterion, save temporality, rule out causation.

In summary, the judicious consideration of the above criteria are useful in assessing epidemiologic studies, but they cannot be used as the sole basis for drawing inferences about cause-and-effect relationships. In line with the criteria of "coherence, plausibility, and analogy," epidemiologic studies are considered along with *in vitro* and *in vivo* studies in a comprehensive review. Epidemiologic support for causality is usually based on high-quality studies reporting consistent results across many different populations and study designs that are supported by the experimental data collected from *in vitro* and *in vivo* studies.

Biological response vs. disease in human health

When interpreting research studies, it is important to distinguish between a reported biological response and an indicator of disease. This is relevant because exposure to EMF may elicit a biological response that is simply a normal response to environmental conditions. This response, however, may not be a disease, cause a disease, or be otherwise harmful. There are many exposures or factors encountered in day-to-day life that elicit a biological response, but the response is neither harmful nor a cause of disease. For example, when an individual walks from a dark room indoors to a sunny day outdoors, the pupils of the eye naturally constrict to limit the amount of light passing into the eye. This constriction of the pupil is considered a biological response to the change in light conditions. Pupil constriction, however, is neither a disease itself, nor is it known to cause disease.

4 The WHO 2007 Report: Methods and Conclusions

The CSC cited the conclusions of the WHO report published in June 2007 as representing the current scientific consensus on EMF and health at the time. The report and its conclusions, therefore, are described briefly here. Following the description of the WHO report below, a summary of research published since the CSC's release of its BMP in December 2007 is provided (Section 5) as an update to the CSC on recent scientific developments.

The WHO is a scientific organization within the United Nations system whose mandate includes providing leadership on global health matters, shaping the health research agenda, and setting norms and standards. The WHO established the International EMF Project in 1996, in response to public concerns about exposures to EMF and possible adverse health outcomes. The project's membership includes 8 international organizations, 8 collaborating institutions and over 54 national authorities. The overall purpose of the Project is to assess health and environmental effects of exposure to static and time varying fields in the frequency range 0-300 GigaHertz (GHz). A key objective of the Project was to evaluate the scientific literature and make a status report on health effects to be used as the basis for a coherent international response, including the identification of important research gaps and the development of internationally acceptable standards for EMF exposure.

The WHO published a Monograph in June 2007 as part of the WHO's Environmental Health Criteria (EHC) Programme summarizing health research in the extremely low frequency (ELF) range. The Monograph used standard scientific procedures, as outlined in its Preamble and described above in 3, to conduct the review. The Task Group responsible for the report's overall conclusions consisted of 21 scientists from around the world with expertise in a wide range of disciplines. The Task Group relied on the conclusions of previous weight-of-evidence reviews,[2] where possible, and (with regard to cancer) mainly focused on evaluating studies published after an IARC review in 2002.

The WHO Task Group and IARC use specific terms to describe the strength of the evidence in support of causality. *Sufficient evidence of carcinogenicity* is assigned to a body of epidemiologic research if a positive association has been observed in studies in which chance, bias and confounding can be ruled out with reasonable confidence. *Limited evidence of carcinogenicity* describes a body of epidemiologic research where the findings are inconsistent or there are outstanding questions about study design or other methodological issues that preclude making strong conclusions. *Inadequate evidence of carcinogenicity* describes a body of epidemiologic research where it is unclear whether the data is supportive or unsupportive of causation because there is a lack of data or there are major quantitative or qualitative issues. A similar classification system is used for carcinogenicity in experimental animals and mechanistic data.

[2]The term "weight-of-evidence review" is used in this report to denote a systematic review process by a multidisciplinary, scientific panel involving experimental and epidemiologic research to arrive at conclusions about possible health risks. The WHO Monograph on EMF does not specifically describe their report as a weight-of-evidence review. Rather, they describe conducting a health risk assessment. A health risk assessment differs from a weight-of-evidence review in that it also incorporates an exposure and exposure-response assessment.

The WHO also used the IARC method for categorizing exposures based on their likely carcinogenicity. Categories include (from highest to lowest risk): carcinogenic to humans, probably carcinogenic to humans, possibly carcinogenic to humans, unclassifiable, and probably not carcinogenic to humans. These categories are intentionally meant to err on the side of caution, giving more weight to the possibility that the exposure is truly carcinogenic and less weight to the possibility that the exposure is not carcinogenic. The category "possibly carcinogenic to humans" denotes exposures for which there is limited evidence of carcinogenicity in epidemiology studies and less than sufficient evidence of carcinogenicity in studies of experimental animals.

The WHO report provided the following overall conclusions:

> New human, animal, and in vitro studies published since the 2002 IARC Monograph, 2002 [*sic*] do not change the overall classification of ELF as a possible human carcinogen (p. 347).
>
> Acute biological effects [i.e., short-term, transient health effects such as a small shock] have been established for exposure to ELF electric and magnetic fields in the frequency range up to 100 kHz that may have adverse consequences on health. Therefore, exposure limits are needed. International guidelines exist that have addressed this issue. Compliance with these guidelines provides adequate protection. Consistent epidemiological evidence suggests that chronic low-intensity ELF magnetic field exposure is associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted (p. 355, WHO, 2007).

With regard to specific diseases, the WHO concluded the following:

Childhood cancers. The WHO report paid particular attention to childhood leukemia because the most consistent epidemiologic association in the area of EMF and health research has been reported between this disease and time-weighted average (TWA) exposure to high, magnetic field levels; it is this association (as reported in two pooled analyses of the available studies, Ahlbom et al., 2000 and Greenland et al., 2000) which provided limited epidemiologic evidence and resulted in the classification of magnetic fields as possibly carcinogenic by the IARC in 2002.

The WHO report systematically evaluated several factors that might be partially, or fully, responsible for the consistent association, including: chance, misclassification of magnetic field exposure, confounding from hypothesized or unknown risk factors, and selection bias. The authors concluded that chance is an unlikely explanation since the pooled analyses had a larger sample size and decreased variability; control selection bias is probably occurring in these studies and would result in an overestimate of the true association, but would not explain the entire observed association; it is less likely that confounding is occurring, although the possibility that some yet-to-be identified confounder is responsible for the association cannot be fully excluded; and, finally, exposure misclassification would likely result in an underestimate of the true association, although it is not entirely clear. The WHO concluded that reconciling the epidemiologic data on childhood leukemia and the negative (i.e., no hazard or risk observed) experimental findings through innovative research is currently the highest priority in the field of ELF-EMF research. Given that few children are expected to have average magnetic field exposures greater than 3-4 mG, however, the WHO stated that the public health impact of magnetic fields on childhood leukemia would likely be minimal, if the association was determined to be causal.

Breast cancer. The WHO concluded that recently published studies on breast cancer and EMF exposure were higher in quality compared with previous studies, and, for that reason, provide strong support to previous consensus statements that magnetic field exposure does not influence the risk of breast cancer. In summary, the WHO stated "[w]ith these [recent] studies, the evidence for an association between ELF magnetic field exposure and the risk of female breast cancer is weakened considerably and does not support an association of this kind" (p. 9, WHO, 2007). The WHO recommended no further research with respect to breast cancer and magnetic field exposure.

Adult leukemia and brain cancer. The WHO concluded, "In the case of adult brain cancer and leukaemia, the new studies published after the IARC monograph do not change the conclusion that the overall evidence for an association between ELF [EMF] and the risk of these disease remains inadequate" (p. 307, WHO, 2007). The WHO panel recommended updating the existing cohorts of occupationally exposed individuals in Europe and pooling the epidemiologic data on brain cancer and adult leukemia to confirm the absence of an association.

In vivo research on carcinogenesis. The WHO described four large-scale, long-term studies of rodents exposed to magnetic fields over the course of their lifetime that did not report increases in any type of cancer (Mandeville et al., 1997; Yasui et al., 1997; McCormick et al., 1999; Boorman et al., 2001a,b). The WHO stated that no directly relevant animal model for childhood acute lymphoblastic leukemia (ALL) currently exists; however, some animals develop a type of lymphoma similar to childhood ALL. The WHO stated that studies exposing transgenic mice predisposed to this lymphoma to power-frequency magnetic fields have not reported an increased incidence of lymphoma associated with exposure (Harris et al., 1998; McCormick et al., 1998; Sommer and Lerchel 2004; Sommer and Lerchl, 2006).

Other studies have investigated whether exposure to magnetic fields can promote cancer or act as a co-carcinogen used known cancer-causing agents, such as ionizing radiation, ultraviolet radiation or chemicals like 7,12-dimethylbenz[a]anthracene (DMBA). No effects were observed for studies on chemically-induced pre-neoplastic liver lesions, leukemia/lymphoma, skin tumors, or brain tumors; however, the incidence of chemically-induced mammary tumors was increased with magnetic field exposure in a series of German experiments, suggesting that magnetic field exposure increased the proliferation of mammary tumor cells (Löscher et al., 1993, 1994, 1997; Mevissen et al., 1993a,b, 1996a,b, 1998; Baum et al., 1995; Löscher and Mevissen, 1995). These results were not replicated in a subsequent series of experiments in a US laboratory (Anderson et al., 1999; Boorman et al.1999a,b; NTP, 1999), possibly due to differences in experimental protocol and the species strain (Fedrowitz et al., 2004).

In summary, the WHO concluded with respect to *in vivo* research, "[t]here is no evidence that ELF exposure alone causes tumours. The evidence that ELF field exposure can enhance tumour development in combination with carcinogens is inadequate" (p. 10, WHO, 2007). Recommendations for future research included the development of a rodent model for childhood ALL and the continued investigation of whether magnetic fields can act as a co-carcinogen.

Reproductive effects. The WHO concluded that, overall, the body of research does not suggest that maternal or paternal exposures to ELF-EMF cause adverse reproductive outcomes. The evidence from epidemiologic studies on miscarriage was described as inadequate, and further research on this possible association was recommended, although low priority was given to this recommendation

Neurodegenerative diseases. The WHO reported that the majority of studies have reported associations between occupational magnetic field exposure and mortality from Alzheimer's disease (AD) and amyotrophic lateral sclerosis (ALS), although the design and methods of these studies were relatively weak (e.g., disease status was based on death certificate data, exposure was based on incomplete occupational information from census data, and there was no control for confounding factors). The WHO concluded that there is inadequate data in support of an association between magnetic fields and AD or ALS. The panel highly recommended that further studies be conducted in this area, particularly studies where the association between magnetic fields and ALS is estimated while controlling for the possible confounding effect of electric shocks.

5 Recently Published Literature (December 2007 – June 2008)

The following sections provide a summary of epidemiologic and *in vivo* studies published December 14, 2007 through June 16, 2008, to evaluate whether the findings of these recent studies alter the conclusions published by the WHO in their 2007 report. This update is pursuant to the request of the CSC to monitor the EMF literature on an ongoing basis.

A structured literature search was conducted using PubMed, a search engine provided by the National Library of Medicine and the National Institutes of Health that includes over 15 million up-to-date citations from MEDLINE and other life science journals for biomedical articles dating back to the 1950s (http://www.pubmed.gov). A well-defined search strategy was used to identify literature published December 14, 2007 through June 16, 2008. All fields (title, abstract, etc.) were searched for a term that referenced the exposure of interest (EMF, magnetic fields, electric fields, or electromagnetic) *and* the outcome of interest: cancer (cancer, leukemia, lymphoma, carcinogenesis), neurodegenerative disease (neurodegenerative disease, Alzheimer's disease, amyotrophic lateral sclerosis, or Lou Gehrig's disease), cardiovascular effects (cardiovascular or heart rate), reproductive outcomes (miscarriage, reproduction or development), or suicide/depression. An epidemiologist reviewed the titles and abstracts of these publications for inclusion. Only peer-reviewed, epidemiologic studies, meta-analyses, human experimental studies, or *in vivo* studies of 50/60-Hz alternating current (AC) ELF-EMF and health effects were included.

One epidemiologic study (Mezei et al., 2008a), three meta-analyses (Garcia et al., 2008; Kheifets et al., 2008; Mezei et al., 2008b), and five *in vivo* studies (Al-Akhras 2008; Chung et al., 2008; Fedrowitz and Löscher, 2008; Fu et al., 2008; Liu et al., 2008; Negishi et al., 2008) were identified. One review authored by a scientific organization, the Swedish Radiation Protection Authority, was identified.[3]

Childhood cancers

A statistical association can represent a true causal relationship between the identified exposure and disease, or may simply be an artifact of an error in the study's design or conduct. In the absence of experimental data to explain a true causal relationship, the WHO identified several possible errors that may explain the observed statistical association between childhood leukemia and magnetic field exposure, including chance, the misclassification of the true magnetic field exposure in the study subjects due to poor exposure assessment methods, uncontrolled confounding of hypothesized or unknown risk factors, and control selection bias. The reviewers concluded that control selection bias was a likely factor in observed statistical association, resulting in an overestimate of the true association. Control selection bias occurs when there are differences in study participation between the case and control groups that are dependent on the

[3] In March 2008, Ahlbom et al. published a brief summary of the 2007 opinion of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) related to the possible effects of EMF on health. This summary is not reviewed further in this report because it provides no update to the conclusions expressed in the full review published in March 2007.

exposure of interest. In other words, the purpose of a control group is to describe the population from which the cases arose (i.e., the source population); if controls are self-selecting into the study for reasons associated with the exposure of interest, the participating controls do not represent the underlying exposure prevalence of the source population.

In studies of EMF, if controls with lower socioeconomic status (SES) or higher residential mobility are less likely to participate in the study than cases with the same characteristics and lower SES and higher residential mobility are associated with higher magnetic field exposures (as has been suggested), the prevalence of high magnetic field exposure in the participating control group will be an underestimate of the true exposure prevalence in the source population. The result is that the ratio of the odds of exposure in the cases to the odds of exposure in the controls (i.e., the OR) will be an overestimate of the true association.

Two recently published studies by Mezei and colleagues attempted to address the role that selection bias may have played in the observed association. In the first study, Mezei et al. (2008a) evaluated the possible role of control selection bias in a previously published Canadian case-control study of magnetic field exposure and childhood leukemia (McBride et al., 1999). The authors compared controls that chose not to participate in the study (first-choice nonparticipant controls) with controls that participated in the study (non-first-choice participant controls) to determine whether first-choice nonparticipant controls have lower SES or different urban/rural status or wire coding characteristics than non-first-choice participant controls. The authors observed that the first-choice nonparticipant controls had a lower socioeconomic status than the non-first-choice participant controls, and lower socioeconomic status was associated with higher wire-code categories. The authors also observed an attenuation of the association between childhood leukemia and wire-code category when the ideal control group was used (OR=1.6 vs. 1.3); however, this difference was not consistent across the various wire-coding and exposure categorization schemes. Thus, the study suggested that control selection bias was operating to some extent, although the authors noted the inherent problems associated with estimating magnetic field exposure using wire codes as a proxy and, therefore, concluded, "the role of selection bias cannot entirely be dismissed on the basis of these results alone."

The WHO report stated the following with regard to control selection bias:

> Another argument against selection bias is that there is a lack of consistent association in studies of childhood brain tumours and residential magnetic fields. Many of the leukaemia studies included in the pooled analysis examined brain tumours as well and there is no reason to think that selection bias will affect one outcome and not the other. However, brain tumour studies have generally been smaller and some of lower quality; and a pooled analysis of brain tumour studies is yet to be conducted. (p. 272)

Mezei et al. (2008b) is a meta-analysis of studies on childhood brain tumors and residential magnetic field exposure. The primary goal of the analysis was to combine inconsistent results from previous studies to see if an association existed with larger sample sizes, and secondarily to assess whether pooled results are consistent with the pooled results from childhood leukemia studies. Thirteen epidemiologic studies were identified that used various proxies of magnetic field exposure (distance, wire codes, calculated magnetic fields, and measured magnetic fields). For all of the exposure proxies considered, the combined effect estimate was close to 1.0 and not statistically significant, indicating no association between magnetic field exposure and childhood brain tumors. The exception was a meta-analysis of five studies with information on childhood brain tumors and calculated or measured magnetic fields greater than 3-4 mG; the combined OR was elevated but not statistically significant (OR=1.68, 95% CI=0.83-3.43). The authors suggested two explanations for this elevated OR. First, they stated that an increased risk of childhood brain tumors could not be excluded at high exposure levels (i.e., >3-4 mG). They also stated that the similarity of this result to the findings of the pooled analyses of childhood leukemia studies for exposures greater than 3-4 mG suggests that control selection bias is operating in both analyses.

Overall, the authors concluded that the analysis did not find a significant increase in childhood brain cancer risk using various proxies of residential exposure to magnetic fields. This strengthens previous weight-of-evidence conclusions that there is no significant association between magnetic fields and childhood brain tumors and provides further evidence for some effect of control selection bias in the observed associations with childhood leukemia and magnetic fields.

Adult cancers

As recommended by the WHO in 2005, Kheifets et al. (2008) conducted an update of two previously published meta-analyses of occupational EMF exposure and adult leukemia and brain cancer that had reported small increases in risk for both cancer types. Kheifets et al. (2008) collected relevant publications of occupational EMF exposure and adult leukemia and brain cancer and calculated summary risk estimates using various schemes to weight and categorize the study data. The analysis followed standard methods for meta-analysis of observational epidemiologic data, including a clearly defined search strategy, a thorough examination of heterogeneity through sensitivity analysis and meta-regression, a systematic evaluation of study quality, and an assessment of publication bias (Stroup et al., 2001). The authors reported a small and statistically significant increase of leukemia and brain cancer in relation to the highest estimate of magnetic field exposure in the individual studies. For brain cancer, 20 recent studies were added to the pre-1993 group of 28 studies. A weak, statistically significant association was estimated across the entire group of studies (OR=1.14, 95% CI=1.07, 1.22). For leukemia, 21 recent studies were added to the pre-1993 group of 35 studies. A weak, statistically significant association was estimated across the entire group of studies (OR=1.16, 95% CI=1.11, 1.22).

Several findings, however, suggested that magnetic field exposure is not responsible for the observed associations with leukemia and brain cancer, including that there is no consistent pattern among leukemia subtypes when the past and new meta-analyses were compared. In addition, for brain cancer, the present meta-analysis reports a weaker estimated association than the previous meta-analysis, whereas a stronger association would be expected should a true risk exist since the quality of studies has increased over time. Thus, the authors concluded, “the lack of a clear pattern of EMF exposure and outcome risk does not support a hypothesis that these exposures are responsible for the observed excess risk” (p. 677). This meta-analysis does not change the WHO classification of adult leukemia/lymphoma data as inadequate.

Neurodegenerative diseases

Garcia et al. (2008) conducted a systematic review and meta-analysis of studies of occupational EMF exposure and AD published through April 2006. The authors identified 14 epidemiologic studies with information on the risk of AD related to occupational exposure to ELF-EMF; the WHO considered the majority of these studies in their 2007 review. A statistically significant association between AD and occupational EMF exposure was observed for both case-control and cohort studies (OR =2.03, 95% CI=1.38-3.00 and RR =1.62, 95% CI=1.16-2.27, respectively), although statistical testing showed that the results from the individual studies were so different that the authors cautioned against the validity of the combined results. While some subgroup analyses had statistically significant increased risks and were not significantly heterogeneous between studies, the findings were contradictory between study design types (e.g., elevated pooled risk estimates were reported for *men* in cohort studies and elevated pooled risk estimates were reported for *women* in case-control studies). The authors found no exposure-response patterns and publication bias was apparent. The authors concluded that the analysis suggests an association between AD and occupational magnetic field exposure, but noted the numerous limitations associated with these studies, including the difficulty of assessing EMF exposure during the appropriate time period, case ascertainment issues due to diagnostic difficulties, and differences in control selection.

In a commentary that accompanied this publication, Röösli stated, "In view of the large statistical heterogeneity and the observed publication bias, I doubt that these pooled effect estimates are meaningful and they should be considered with caution" (p. 342, Röösli, 2008). Röösli discussed the difficulty of assessing long-term ELF-MF exposure among AD patients solely based on their recollection or the recollection of their friends and relatives from proxy respondents. He also noted that differentiating between AD and dementia requires "considerable diagnostic effort," and studies that you use death certificates to ascertain cases are likely not catching a large number of cases. Despite these limitations and the heterogeneity between the studies, he stated that it is "unlikely" that the heterogeneity of the study results can be fully attributed to methodological issues and the question of whether magnetic field exposure is related to AD remains.

The WHO stated that there is inadequate data in support of an association between magnetic field exposure and AD or ALS; the recent meta-analysis confirmed that the associations reported in studies of AD are highly inconsistent and the studies have many limitations. The conclusion that there is inadequate epidemiologic data with regard to magnetic field exposure and AD/ALS remains. Further studies are required to address these study design limitations. Röösli recommended a cohort study with systematic disease screening, prospective collection of exposure information, and the collection of residential and occupational magnetic field exposure.

Recent *in vivo* studies of carcinogenesis

Recent research on EMF and the production of tumors includes three studies that exposed laboratory animals to high levels of magnetic fields for long periods of time to observe them for the occurrence of cancer (Chung et al., 2008; Fedrowitz and Löscher, 2008; Negishi et al., 2008). In view of the available evidence that magnetic field exposure *alone* does not increase the occurrence of cancer, animals were exposed first to a chemical known to initiate cancer and then to magnetic fields in recent studies. The research question is whether EMF can promote, or enhance, the growth of cancer in these animals. Specific exposures frequently used to initiate cancer include ionizing radiation and chemicals such as ethylnitrosourea (ENU) and DMBA; ENU is known to induce brain cancers in animal exposed *in utero* (before birth) and DMBA is known to induce breast cancer in animals.

Chung et al. (2008) examined the possible role of 60-Hz magnetic fields in promoting brain tumors initiated by injecting ENU *in utero*. Following ENU exposure *in utero*, the offspring were divided into a sham exposure group (0 mG) and three magnetic-field exposure groups: 50 mG, 833 mG, and 5,000 mG. The rats were exposed for 21 hours each day from the age of 4 weeks to the age of 32 or 42 weeks. Rats exposed to ENU developed brain tumors, but those rats exposed to magnetic fields did not have more tumors than the rats not exposed to magnetic fields; this was true for all levels of magnetic-field exposure. Overall, the authors concluded that this study provides no evidence that 60-Hz magnetic field exposures up to 5,000 mG promoted tumor development in rats predisposed for tumors of the nervous system.

A series of experiments from a German laboratory had suggested that magnetic fields promote the development of mammary tumors, as discussed in Section 4. These results, however, were not replicated in a subsequent series of experiments in a US laboratory, with findings from the German laboratory suggesting that the discrepancy was possibly due to differences in experimental protocol and the species strain. In the most recent study from this German laboratory, the researchers exposed DMBA-treated Fischer 344 rats to either high levels of magnetic fields (1,000 mG) or no exposure for 26 weeks and reported that the incidence of breast cancers was significantly elevated in the group exposed to magnetic fields after initiation with DMBA (Fedrowitz and Löscher, 2008). The details of the results were not wholly consistent across tumor sites. Thus, while the series of experiments from the German laboratory continue to suggest that magnetic fields promote mammary tumorigenesis, questions still remain regarding the relevance of species differences.

To study the effect of magnetic field exposure on promoting lymphoma/lymphatic leukemia, researchers studied a strain of mice known to develop these cancers after treatment with DMBA (Negishi et al., 2008). After DMBA treatment, the mice were exposed to 50-Hz magnetic fields of 0, 70, 700, or 3,500 mG for 22 hours per day for 30 weeks and observed daily for the development of lymphoma/lymphatic leukemia. The authors reported that the percentage of mice with lymphoma/lymphatic leukemia was not higher in the MF-exposed groups, compared to the sham-exposed group. The authors concluded, "these data provide no evidence to support the hypothesis that power frequency MFs [magnetic fields] is a significant risk factor for hematopoietic neoplasia" (p. 29).

The WHO concluded, "There is no evidence that ELF exposure alone causes tumours. The evidence that ELF field exposure can enhance tumour development in combination with carcinogens is inadequate." The recent studies by Fedrowitz and Löscher (2008), Negishi et al. (2008) and Chung et al. (2008) do not alter this conclusion.

Other recent *in vivo* studies

Al-Ahkras (2008) examined the effect of 50-Hz sinusoidal magnetic fields on sex hormones and organ weights among female, adult rats. Twelve rats were exposed to 50-Hz, 250 mG magnetic fields for 18 weeks and an additional 12 rats were sham-exposed. The exposed rats were housed with the unexposed rats for 12 weeks post-exposure, before all rats were sacrificed. Hormone concentrations were measured during (6, 12, 18 weeks) and after (6 and 12 weeks) magnetic field exposure. Body, ovarian, and uterine weights were measured at sacrifice.

The differences between exposed and unexposed rats were not consistent across measures or test times. Among the exposed rats, follicle stimulating hormone (FSH) concentrations were significantly lower at 6 weeks (but not 12 or 18 weeks), luteinizing hormone (LH) concentrations were significantly lower at 6, 12 and 18 weeks, progesterone concentrations were significantly lower at 12 weeks (but not 6 or 18), and estrogen concentrations were significantly lower at 12 weeks (but not 6 or 18). Estrogen levels were significantly lower 12 weeks after magnetic-field exposure ended, but there was no difference after six weeks. The author provided no explanation as to the inconsistency in the observed findings, e.g., significantly decreased FSH levels at 6 weeks, but not 12 or 18 weeks.

After sacrifice, average ovarian weights were less in the exposed rats compared to the control rats. No differences were observed in total body weight or uterine weight. The author concluded that long-term exposure to 50-Hz, 250 mG magnetic fields had inhibitory effects on female sex hormones in this study, which were partly reversible after removal of the field.

Two studies focused on the acquisition and performance of spatial tasks, which was an area of research reviewed by the WHO Task Group. Fu et al. (2008) reported that neither 7 days nor 25 days of exposure to 25-Hz (6,000 mG) or 50-Hz (10,100 mG) magnetic fields affected locomotor activity, but 25 days of exposure to the 10,100 mG magnetic field did reduce recognition of the novel arm of a Y-maze. In contrast, Liu et al. (2008a) report that four weeks of exposure to a 20,000 mG, 50-Hz magnetic field for 1 or 4 hours per day improved the performance of rats in a water maze, suggesting an improvement in long-term memory without any effect on short-term memory.

The difficulty in the interpretation of these and other studies of rodent learning and memory by another report by Liu et al. (2008b) who reported that 4 hours per day of exposure to 20,000 mG for 25 days (but not 1 hour per day) increased behaviors suggestive of increased anxiety in maze and other tests. Depending upon the nature and severity of the tasks in such studies, increased anxiety either might facilitate or hinder task performance. It is also important to consider that the well-known phenomenon reported in a variety of species that a change in the physiological or environmental context – such as stimuli associated with magnetic field or other related factors between learning and retention testing – may hinder performance on memory tasks (Overton, 1991).

Recently published reviews by scientific organizations

Since December 2007, one scientific organization, the Swedish Radiation Protection Authority (SSI), has published a review of EMF and health research (SSI, 2008). This review is highlighted because emphasis should be placed on the conclusions of reviews by expert panels organized by reputable scientific organizations. These panels follow standard, scientific methods and consist of individuals with the appropriate expertise.[4]

The SSI appointed an international, independent expert group of eight scientists. Using other major scientific reviews as a starting point, this expert group evaluates recent studies in consecutive annual reports with the goal of providing an ongoing health risk assessment. Each annual report focuses on several, key health topics; the 2008 report focused on epidemiologic studies of childhood leukemia and cardiovascular disease and experimental data related to genotoxic effects. An additional component of the 2008 report included an overview of recently published reviews, including a large section on the conclusions of the most recent weight-of-evidence review by the WHO.

The overall conclusion of the SSI report was that research published during the year 2007 does not alter the conclusion that ELF magnetic fields should be classified as a possible carcinogen. The SSI noted some *in vitro* and *in vivo* studies from 2007 reporting genotoxic effects at very high magnetic field exposure levels, but stated that the results require replication and are of unknown significance to human exposures at much lower exposure levels. The SSI also noted findings from epidemiologic studies testing new hypotheses related to magnetic fields and childhood leukemia that require further study. In addition, the expert group reviewed studies related to the hypothesis that magnetic fields increase the risk for cardiac arrhythmia-related conditions and acute myocardial infarction, concluding that studies do not support this hypothesis.

The SSI concluded, "[f]or power frequency fields the previous assessment by IARC remains unchanged, namely that ELF magnetic fields are a possible human carcinogen. WHO recommends in its ELF Environmental Health Criteria document … that implementing very low cost precautionary procedures to reduce exposure is reasonable and warranted" (p. 54).

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[4] Two reviews were not considered because they were not published by a scientific organization: an online report by an *ad hoc* group of 14 individuals to "assess scientific evidence on health impacts from electromagnetic radiation below current public exposure limits" (The BioInitiative Working Group, 2007; Hardell and Sage, 2008) and a review of research related to breast cancer and EMF published by the advocacy group Breast Cancer Fund (Breast Cancer Fund, 2008).

6 Summary

A few epidemiologic and *in vivo* studies have been published on EMF and health since the CSC considered the weight-of-the-evidence in December 2007. Overall, the meta-analyses of childhood brain cancer and adult leukemias were well conducted and provided valuable information, while the meta-analysis by Garcia et al. (2008) simply confirmed the variability and limitations inherent in the studies of AD and occupational EMF exposure. Mezei et al. (2008a,b) confirmed that selection bias may play some role in the observed association between childhood leukemia and magnetic fields, although it is not clear to what extent. Recent *in vivo* studies on carcinogenesis confirm the lack of experimental data supporting a hazard associated with magnetic field exposure.

Thus, the weak statistical association between high, average magnetic fields and childhood leukemia remains largely unexplained and unsupported by the experimental data. The current body of research supports the conclusion that there is no association between magnetic fields and adult leukemia/lymphoma, brain cancer and breast cancer. Although the current body of evidence does not provide strong evidence in support of a causal relationship, further research is required on AD and ALS to clarify the association observed in occupational studies.

In conclusion, the recent studies do not provide evidence to alter the conclusion that the entire body of research suggests that EMFs are not the cause of cancer or any other disease process at the levels we encounter in our everyday environment.

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U.S. Department of Health and Human Services. *The Health Consequences of Smoking: A Report to the Surgeon General*. Washington: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, 2004.

World Health Organization (WHO). Environmental Health Criteria 238: Extremely Low Frequency (ELF) Fields. WHO, Geneva, Switzerland, ISBN 978-92-4-157238-5, 2007.

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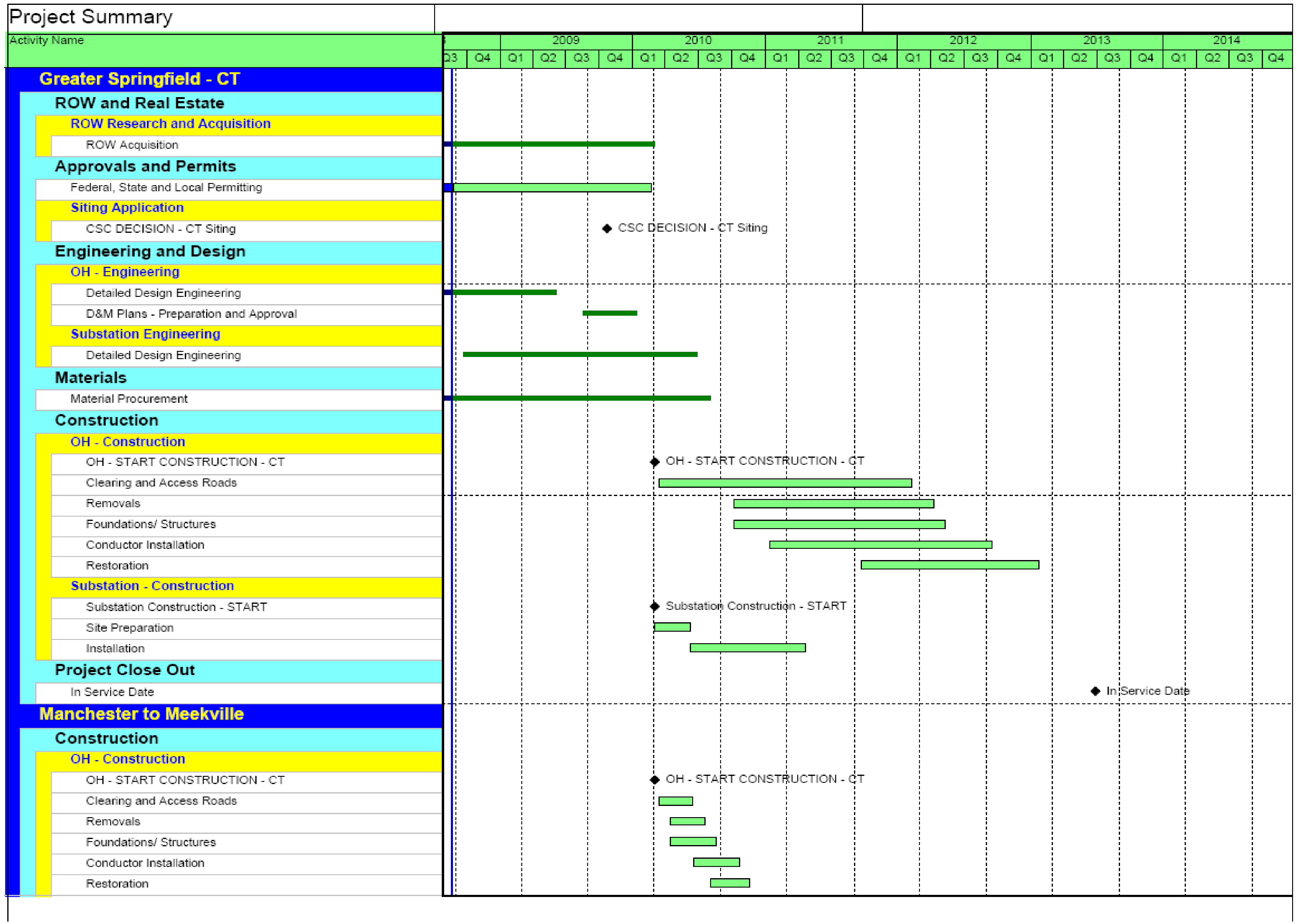
SECTION P

PROJECT SCHEDULE

P. Project Schedule



SECTION Q

AGENCY CONSULTATIONS

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Q. AGENCY CONSULTATIONS

Q.1 AGENCY CONSULTATIONS PRIOR TO FILING APPLICATION

As part of the planning process for the Greater Springfield Reliability Project and the Manchester to Meekville Junction Circuit Separation Project, the CL&P has consulted with various federal, state, and local agencies, in order to provide agency representatives with information about the projects and to solicit agency input. Table Q-1 (List of Federal, State and Local Agency Consultations) lists the agencies that CL&P has contacted or received comments from to date. Agency responses concerning the projects are included in Volume 4.

Table Q-1: List of Federal, State, and Local Agency Consultations

Agency	Date	Agency Contact
Federal		
U.S. Army Corps of Engineers, New England District	10/24/07 4/9/08 5/30/08	Susan Lee Michael Sheehan Michael Elliot Dave Keddell Paul Minkin Paul Sargent
U.S. Department of Interior - Fish & Wildlife Service	11/8/07 5/14/08	Anthony P. Tur
State		
Department of Environmental Protection	3/26/08	Da
Department of Environmental Protection – Franklin Wildlife Management Area	3/10/08 4/24/08	Julie Victoria
Department of Environmental Protection - Natural/Diversity Database	3/17/08 4/4/08 11/15/08	Dawn M. McKay Julie Victoria
Historical Commission	2/8/08	Karen Senich
Local		
Town of Bloomfield – Planning and Zoning	8/28/08 9/2/08	Thomas B. Hooper
Town of Bloomfield – Inland and Wetland Commission	8/18/08 8/28/08	David Castaldi
Suffield Conservation Commission	7/22/08	Barbara Chain Arthur Christenson

Q.2 ADDITIONAL AGENCY APPROVALS

In addition to a Certificate from the Council, the projects would require various permits and approvals from other agencies. At the federal level, the projects must comply with the Clean Water Act (CWA), the Rivers and Harbors Act, Coastal Zone Management Act, and National Historic Preservation Act. Similarly, at the state level, along with compliance with the Council's regulations (as established by PUESA), the Project must conform to the Connecticut Coastal Management Act, Inland Wetlands and Watercourses Act, and Tidal Wetlands Act. Table Q-2 *(Possible Permits, Reviews and Approvals for the GSRP and MMP)* summarizes the possible permits and approvals for the proposed Project.

Table Q-2: Possible Permits, Reviews and Approvals for the GSRP and MMP

Agency	Certificate, Permit, Review, Approval or Confirmation	Activity Regulated
Federal		
U.S. Army Corps of Engineers	Section 10 Rivers and Harbors Act; Section 404 CWA	Discharge of dredge or fill material into waters of the U.S. (wetlands or watercourses), installation of transmission line across navigable waterbodies
U.S. Fish and Wildlife Service	Coordinates with Corps regarding endangered or threatened upland species; provides input to Corps permit application review	Construction or operation activities that may affect federally-listed endangered or threatened species
National Marine Fisheries Service	Coordinates with Corps regarding endangered or threatened marine species and essential fish habitat; provides input to Corps permit application review	Construction or operation activities that may affect federally-listed endangered or threatened marine species or essential fish habitat
U.S. Environmental Protection Agency	Provides input to Corps permit application review	Construction or operation activities that may affect water, air, or other resources

Agency	Certificate, Permit, Review, Approval or Confirmation	Activity Regulated
State		
Connecticut Siting Council	Certificate of Environmental Compatibility and Public Need Development & Management Plan approval prior to construction	General transmission line need, construction, environmental compatibility and operation
Department of Environmental Protection	Coastal Zone Consistency Certificate	Determination that Project is consistent with state coastal zone management policies and objectives
	401 Water Quality Certificate	Conformance to Section 401 of the CWA
	General Permits	Storm Water Management and other activities as they may apply
	Structures, Dredge and Fill Permit Tidal Wetlands Permit	Underground crossings of tidal waterbodies
Connecticut Historical Commission	Approval of proposed Project as consistent with the National Historic Preservation Act; comments during Council process	Construction and operation activities that may affect archaeological or historic resources.
Department of Agriculture, Bureau of Aquaculture	Comments during Council and DEP review processes regarding issues pertaining to commercial shell fishing	Activities that may affect tidal or tidally-influenced waters that support shellfish resources
Department of Public Utility Control	Approval pursuant to C.G.S. Section 16-243	Method & Manner of Construction Approval to Energize
Local		
Town of Bloomfield Zoning Commission (North Bloomfield Substation)	Location review pursuant to C.G.S. Section 16-50x(d)	Location Review
Town of Bloomfield Inland Wetlands Commission (North Bloomfield Substation)	Location review pursuant to C.G.S. Section 16-50x(d)	Location Review

SECTION R

DIRECTORY OF APPLICATION GUIDE

R. DIRECTORY OF APPLICATION GUIDE

The following table provides references to indicate where information requested in the Council's application guide is located in this Application.

Table R-1: Cross-Reference Between Council's Guide and This Application

APPLICATION GUIDE FOR TERRESTRIAL ELECTRIC TRANSMISSION LINE FACILITY DATED AUGUST, 2007	
CSC Guide	**The Companies' Application**
I. Pre-Application Process (General Status § 16-50*l* (e)) Applicants shall consult General Statutes §§ 16-50g through 16-50aa and Sections 16-50j-1 through 16-50z-4 of the Regulations of Connecticut State Agencies to assure complete compliance with the requirements of those sections.	Volume 1, Section II
II. Quality, Form and Filing Requirements (Regs. Conn. State Agencies § 16-50j-12)	This section details filing mechanics: there are no corresponding sections in the application.
III. Application Filing Fees (General Statutes § 16-50l (a) and Regs. Of Conn. State Agencies § 16-50v-la) All application fees shall be paid to the Council at the time an application is filed with the Council. Municipal participation fee.	Volume 1, Section IV
IV. Proof of Service (General Status § 16-50*l* (b)) Each application shall be accompanied by proof of service of such application on: A. The chief elected official, the zoning commission, planning commission, the planning and zoning commissions, and the conservation and wetlands commissions of the site municipality and any adjoining municipality having a boundary not more than 2500 feet from the facility; B. The regional planning agency that encompasses the route municipalities; C. The State Attorney General; D. Each member of the Legislature in whose district the facility is proposed; E. Any federal agency, department, commission, or instrumentality which has jurisdiction over the proposed facility; and	Volume 1, Section V

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CSC Guide	**The Companies' Application**
F. The state departments of Environmental Protection, Public Health, Public Utility Control, Economic and Community Development, and Transportation; the Council on Environmental Quality; the Office of Policy and Management; and the State Historic Preservation Officer (SHPO).	
V. Notice to Community Organizations The applicant shall use reasonable efforts to provide notice of the application on the following: A. Affected community groups including Chambers of Commerce, land trusts, environmental groups, trail organizations, historic preservation groups, advocacy groups for the protection of Long Island Sound, and river protection organizations within the watershed affected by the proposed facility that have been identified by municipality where the facility is proposed to be located or that have registered with the Council to be provided notice; and B. Any affected water company within the watershed affected by the proposed facility.	Volume 1, Section VI
VI. Notice in Utility Bills (General Statutes § 16-50*l* (b)) For electric transmission facilities, notice shall also be provided to each electric company customer in the municipality where the facility is proposed on a separate enclosure with each customer's monthly bill.	Volume 1, Section VII
VII. Contents of Application (General Statutes § 16-501 (a) (1)) An application for a Certificate for the construction of a transmission line facility should include or be accompanied by the following:	
A. A brief description of the proposed facility, including location relative to affected municipalities and location relative to adjacent streets.	Volume 1, Section I (E)
B. A statement of the purpose for which the application is being made.	Volume 1, Section I (A)
C. A statement describing the statutory authority for such application.	Volume 1, Section I (B)
D. The exact legal name of each person seeking the authorization or relief and the address or principal place of business of each such person. If any applicant is a corporation, trust association, or other organized group, it shall also give the state under the laws of which it was created or organized.	Volume 1, Section I (C)
E. The name, title, address, and telephone number of the attorney or other person to whom	Volume 1, Section I (D)

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correspondence or communications in regard to the application are to be addressed. Notice, orders, and other papers may be served upon the person so named, and such service shall be deemed to be service to the applicant.	
F. An Executive Summary providing an overview description of the proposal, and any transmission line facility and routing alternatives.	Volume 1, Section I (Executive Summary)
G. A statement and full explanation of why the proposed transmission line is needed and how the transmission line would conform to a long-range plan for expansion of utility service in the state and interconnected utility systems that would serve the public need for adequate, reliable, and economic service, including:	Volume 1, Section I (F)
1. A description and documentation of the existing system and its limitations;	Volume 1, Section I (F.2 and F.5)
2. Justification for the proposed in-service date;	Volume 1, Section I (F.6)
3. The estimated length of time the existing system is judged to be adequate with and without the proposed transmission line;	Volume 1, Section I (F)
4. Identification of system alternatives with the advantages and disadvantages of each; and	Volume 1, Section I (G)
5. If applicable, identification of the facility in the forecast of loads and resources pursuant to General Statutes § 16-50r.	Volume 1, Section I (F.3);
6. The extent to which the facility shall be located overhead, pursuant to General Statutes § 16-50p(a)(3)(D) and 16-5*l*(a)(A)	Volume 1, Section (H)
7. An impact assessment of any electromagnetic field to be produced by proposed transmission line, pursuant to General Statutes § 16-5*l*(a)(A)	Volume 1, Section I (O)
For Sections H – J: All applications shall include the following information for property within the proposed project area, including access roads and the proposed ROW. To the extent that the Applicant does not own, lease or otherwise have access to property within the proposed project areas, the Applicant shall exert due diligence to seek permission to gain access. Due diligence shall be established by the submission of (1) Certified Mailing receipts for letters sent to the owner or owners of record requesting access to the property; and (2) an affidavit from the Applicant stating that it was not provided access to the property. In the absence of permission to access, the Applicant shall make visual inspections to document existing conditions from public ROW, existing utility ROW and/or from other accessible properties within or surrounding the proposed project area.	Proposed routes predominately follows CL&P's existing ROWs, or is aligned along public roadways or in other areas that are visible from public locations.
H. A narrative description of the proposed transmission	Volume 1, Section I (L); Volumes 2

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line including:	(Environmental – Wetlands) and 4 (Environmental) and Volumes 9, and 11 (Aerial Photographs) for all of the following.
Existing Conditions 1. The ecological communities of the wetlands, watercourses and upland systems and their functional significance, including but not limited to:	Volume 1, Section I (L)
a. Floral associations;	Volume 1, Section I (L.1.2, L.1.3, L.2.2 and L.2.3) and Volume 2 (Environmental – Wetlands)
b. Inventory of wildlife habitat with observed and expected wildlife users;	Volume 1, Section I (L.1.3 and L.2.3); Volume 4 (Report entitled "Inventory of Vernal Pools and Amphibian Breeding Habitats Along the Connecticut Portion of the GSSRP" by ENSR)
c. Species of Special Concern and rare or endangered species, including their habitats;	Volume 1, Section I (L.1.3.6 and L.2.3.6)
d. Inventory of breeding birds and their habitats;	Volume 1, Section I (L.1.3.5 and L.2.3.5); Volume 4 (Report Entitled "Inventory of Potential Breeding Bird Species and Habitats Along the Connecticut Portions of Greater Springfield Reliability Project")
e. Riparian environments and buffer vegetation; and	Volume 1, Section I (L.1.2, L.1.3, L.2.2 and L.2.3) and Volume 2 (Environmental – Wetlands)
f. Fishery habitat and cold water fisheries.	Volume 1, Section I (L.1.3.3 and L.2.3.3)
2. Existing infrastructure (where applicable)	Volume 1, Section I (I.1 and I.2)
a. Existing ROW boundaries;	Volume 9 (Aerial Photographs - 400 Scale), Volume 11 (Aerial Photographs - 100 Scale), Volume 1, Section I (I.1.2 and I.1.3) and Volume 10 (Typical Cross-Sections and Photo Simulations)
b. Components of existing transmission line; and	Volume 1, Section I (F.2, I.1.5); Volume 8 (Photographs); Volume 10 (Typical Cross-Sections and Photo Simulations)
c. Other improvements within existing and proposed right-of-way	Volume 11 (Aerial Photographs - 100 Scale)
Proposed Conditions 1. Itemized estimated costs;	Volume 1, Section I (I.4)
2. Conductor sizes and specifications;	Volume 1, Section I (I.1.1 and I.2.1)
3. Overhead structure design, appearance, and heights, if any,	Volume 1, Section I (I.1.2 and I.2.2); Volume 8 (Photographs along Proposed Route), Volume 10 (Typical Cross-Sections and Plan & Profile Drawings)
4. Length of line;	Volume 1, Section I (I.4.1)
5. Terminal points;	Volume 1, Section I (I.4)
6. Initial and design voltages and capacities;	Volume 1, Section I (I.1.2, I.2.2, and I.4.3)
7. Rights-of-way and access way acquisition;	Volume 1, Section I (I.3.3)
8. Areas of disturbance (temporary and permanent)	Volume 1, Section I (J, K, M)
9. Proposed construction staging areas, conductor	Volume 1, Section I (J)

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pulling sites, material marshaling yards and construction field offices.	
10. Proposed access roads and opportunities for alternative access;	Volume 1, Section I (I.4.3 and J.1.4) and Volume 11 (Aerial Photographs - 100 Scale)
11. Proposed structure location envelopes;	Volume 1, Section I (I.4.4) and Volume 11 (Aerial Photographs - 100 Scale)
12. Proposed blasting, grading, and changes to drainage;	Volume 1, Section I (J.1.9 and N.1.9)
13. Substation connections;	Volume 1, Section I (J.1.9 and N.1.9); Volume 7 (Substation Drawings)
14. Service areas;	Volume 1, Section I (I.4.6)
15. Construction methods and difficulties; and	Volume 1, Section I (J)
16. For an electric transmission line, a description of the life-cycle costs of the proposed transmission line and alternative facilities, including overhead and underground lines, including all capital and operating costs, and other associated effects that can be calculated for development and operation of the specified transmission line and alternative lines over their expected operational lives.	Volume 1, Section I (I.5)
I. Area Description - A proposed route map, and maps or aerial photographs at a suitable scale (one inch = 400 feet to 2,000 feet) showing the ROWs and the proximity of the following:	
1. Settled areas; schools and daycare centers; hospitals; and group homes;	Volume 9 (Aerial Photographs - 400 Scale)
2. Forests and parks; recreational areas; scenic areas; historic areas; and areas of archaeological interest;	Volume 9 (Aerial Photographs - 400 Scale)
3. Areas regulated under the Inland Wetlands and Watercourses Act and Coastal Zone Management Act, unless provided under Section J;	Volume 9 (Aerial Photographs - 400 Scale) Volume 11 (Aerial Photographs - 100 Scale)
4. Areas regulated under the Tidal Wetlands Act, unless provided under Section J;	Volume 9 (Aerial Photographs - 400 Scale)
5. Public water supplies;	Volume 9 (Aerial Photographs - 400 Scale)
6. Hunting or wildlife management areas;	Volume 9, Aerial Photographs (400 Scale)
7. Existing transmission lines within one mile of the route;	Volume 1, Section I (F.2.1, Figure F-2); Volume 9 (Aerial Photographs - 100 Scale)
8. Depth to bedrock map (USGS Series), and;	Volume 9 (USGS Maps)
9. Vegetative communities.	Volume 9 (Aerial Photographs - 400 Scale); Volume 10 (Plan & Profile Drawings) Volume 11 (Aerial Photographs - 100 Scale)
J. Proposed Route Description - Proposed route plans at a scale no smaller than 1"=100 feet, except as otherwise required, showing existing conditions and certain proposed transmission line changes, expanding upon the narrative descriptions in Section H.	Volume 11 (Aerial Photographs - 100 Scale)

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Existing Conditions	
a. Identification of existing and proposed ROW boundaries;	Volume 11 (Aerial Photographs - 100 Scale)
b. Location of any existing transmission line structures and accessways;	Volume 11 (Aerial Photographs - 100 Scale)
c. Contour mapping at two-foot intervals;	Volume 11 (Aerial Photographs - 100 Scale)
d. Inland and tidal wetlands boundaries, vernal pools, and intermittent and perennial watercourses, as determined in the field, unless existing mapping is adequate, with a 50 foot buffer shown for wetlands and a 100 foot buffer shown for vernal pools and watercourses.	Volume 11 (Aerial Photographs - 100 Scale)
e. Coastal Management Zone boundaries;	Volume 11 (Aerial Photographs - 100 Scale)
f. 100-year flood plain boundaries as identified by the Federal Emergency Management Agency;	Volume 11 (Aerial Photographs - 100 Scale)
g. Locations of protected and special concern species;	See Volume 1, Section I (L.1.3 and L.2.3) for narrative description. Locations of protected and special concern species not included on maps to protect species.
h. Areas susceptible to soil erosion;	Volume 11 (Aerial Photographs - 100 Scale)
i. Habitat for protected and special concern species, including those represented by the DEP Natural Diversity Data Base (confidential data provided in an appropriate manner);	Volume 1, Section I (L.1.3 and L.2.3)
j. Fishery habitat and cold water fisheries.	Volume 1 (L.1.3.3 and L.2.3.3) Volume 9 (Aerial Photographs - 400 Scale) Volume 11, (Aerial Photographs - 100 Scale)
(All maps shall identify the location(s) of source information.)	
2. Changes to existing conditions for the proposed transmission line: a. Additional Rights-of-way width required, if any;	Volumes 11 (Aerial Photographs - 100 Scale); Volume 10, Cross Sections
b. Anticipated transmission line structure location envelopes;	Volume 11 (Aerial Photographs - 100 Scale)
c. Anticipated areas of disturbance (temporary and permanent);	Volume 11 (Aerial Photographs - 100 Scale); Volume 10 (Typical Cross Sections and Photo Simulation)
d. Where any anticipated area of disturbance overlaps a wetland or a wetland buffer boundary;	Volume 11 (Aerial Photographs - 100 Scale)
e. Anticipated area of disturbance for material staging and conductor pulling sites;	Volume 11 (Aerial Photographs - 100 Scale); Volume 9 (Aerial Photographs - 400 Scale), Volume 1, Section I (K)

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f. Anticipated access roads and opportunities for alternative access;	Volume 11 (Aerial Photographs - 100 Scale); Volume 9 (Aerial Photographs - 400 Scale)
g. Substation connections;	Volume 11 (Aerial Photographs - 100 Scale); Volume 7 (Substation Drawings)
h. Other sensitive areas requiring special attention.	Volume 11 (Aerial Photographs - 100 Scale)
K. A description of the impact the proposed transmission line and its construction would have on the environment, ecology, and scenic, historic, and recreational values, including effects on:	Volume 1, Section I (N)
1. Public health and safety; Conn. Gen. Stat. § 16-50p. Proposed and existing routes of underground and overhead lines in proximity to residential areas, schools, day care facilities, camps, playgrounds and industrial areas.	Volume 1, Section I (K)
2. Local, state, and federal land use plans including energy security;	Volume 1, Section I (N.1.4)
3. Existing and future development;	Volume 1, Section I (N.1.4)
4. Road crossings;	Volume 11 (Aerial Photographs - 100 Scale); Volume 9 (Aerial Photographs - 400 Scale); Volume 1, Section I (N.1.5)
5. Wetlands, vernal pools, and watercourses within existing or expanded right-of-way, access roads and other disturbed areas; relationship of these features to adjacent uplands; their values and function assessment;	Volume 1, Section I (N.1.2); Volume 2 (Reports by ENSR entitled "Wetland and Waterways Description Report" and "Supplemental Wetland and Waterways Description Report"). See also, Volume 4.
6. Water quality on the right-of-way, and down slope areas including pollution transport and risks from insulating oils;	Volume 1, Section I (J and N.1.2)
7. Wildlife and vegetation, including rare and endangered species, and species of special concern, with documentation by the Department of Environmental Protection Natural Diversity Data Base;	Volume 1, Section I (N.1.3)
8. Open space and protected areas;	Volume 1, Section I (N.1.4)
9. Water supply areas;	Volume 1, Section I (N.1.2)
10. Archaeological and historic resources, with documentation by the State Historic Preservation Officer; and	Volume 1, Section I (N.1.6); Volume 3 (Environmental – Cultural Resources)
11. Other environmental concerns identified by the applicant, the Council, or any public agency.	Volume 1, Section I (L and N)
L. Mapping/plans with an associated description explaining mitigation measures for the proposed transmission line including:	
1. Construction techniques designed specifically to minimize adverse effects on natural areas and sensitive areas;	Volume 1, Section I (J, N); Volume 7 (Substation Drawings); Volume 11(Aerial Photographs - 100 Scale)
2. Special routing or design features made	Volume 1, Section I (H, I, N)

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specifically to avoid or minimize adverse effects on natural areas and sensitive areas;	
3. Justification for maintaining retired or unused facilities on the ROWs if removal is not planned;	Volume 1, Section I (I)
4. Methods to prevent and discourage unauthorized use of the ROWs;	Volume 1, Section I (N)
5. Establishment of vegetation proposed near residential, recreational, and scenic areas and at road crossings, waterways, ridgelines, and areas where the line would be exposed to view;	Volume 1, Section I (J.1.8)
6. Methods for preservation of vegetation for wildlife habitat and screening;	Volume 1, Section I (N.1.3)
7. Methods for mitigating or restoring impacted wildlife habitat, wetlands, and watercourses; and	Volume 1, Section I (N.1.2 and N.1.3)
8. Erosion and sedimentation controls and methodology.	Volume 1, Section I (J.1.1), (N.1.1)
M. Safety and reliability information, including: 1. Provisions for emergency operations and shutdowns; and	Volume 1, Section I (K)
2. Fire suppression technology.	Volume 1, Section I (K)
N. Justification that the location of the proposed transmission line would not pose an undue safety or health hazard to persons or property along the area traversed by the proposed transmission line including:	Volume 1, Section I (O)
1. Measurements of existing electric and magnetic fields (EMF) at the boundaries of adjacent schools, daycare facilities, playgrounds, and hospitals, with extrapolated calculations of exposure levels during expected normal and peak normal line loading;	Volume 1, Section I (O)
2. Calculations of expected EMF levels at the above listed locations that would occur during normal and peak normal operation of the transmission line; and	Volume 1, Section I (O)
3. A statement describing consistency with the Council's "Best Management Practices for Electric and Magnetic Fields", as amended.	Volume 1, Section I (O)
P. A schedule of proposed program for ROW or property acquisitions, construction, rehabilitation, testing and operation.	Volume 1, Section I (P)
Q. Transmission Line Alternatives. Provide narrative descriptions generally addressing the same items required for the proposed transmission line (Section H).	Volume 1, Section I (H, I.3, I.4, I.5, M, N.2, N.3 and O.4.2)
R. A justification for adoption of the route selected	Volume 1, Section I (H, I)

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including a comparison with alternative routes which are environmentally, technically, and economically practicable. For electric transmission lines. Provide a justification of overhead portions, if any, including comparative cost studies and a comparative analysis of effects described in Section K for under grounding. Within 60 days of filing, the applicant shall provide supplemental information for the Council to make a reasonable comparison between the Applicant's proposed route and any reasonable alternative route recommended by the site municipalities pursuant to C.G.S. Section 16-501.	
S. Identification of each federal, state, regional, district and municipal agency with which proposed route reviews have been undertaken or will be undertaken, a copy of each written agency position on such route, and a schedule for obtaining approvals not yet received.	Volume 1, Section I (Q) and Volume 4 (Agency Correspondence)
T. Bulk filing of municipal zoning, planning, planning and zoning, conservation and inland/wetland regulations and bylaws.	Volume 1, Section I (T)
U. Such information any department or agency of the state exercising environmental controls may, by regulation, require.	Volume 1, Section I (Q)
V. Such information the applicant may consider relevant.	Application
X. The applicant shall submit into the record the full text of the terms of any agreement, and a statement of any consideration therefore, if not contained in such agreement, entered into by the applicant and any party to the certification proceeding, or any third party, in connection with the construction or operation of the facility. This provision shall not require the public disclosure of proprietary information of trade secrets. Please note that all documents, including but not limited to maps, must be dates. If the document date is unavailable, the date the document was obtained shall be provided. If a map includes a key table(s) a matching source list/table, appropriately organized, shall also be included.	

SECTIONS II - VIII

- **QUANTITY, FORM, AND FILING REQUIREMENTS**
- **APPLICATION FILING FEES**
- **PROOF OF SERVICE**
- **NOTICE TO COMMUNITY ORGANIZATIONS**
- **PUBLIC NOTICE**
- **NOTICE IN UTILITY BILLS**
- **NOTICE OF OWNERS OF PROPERTY ABUTTING SUBSTATION AND SWITCHING STATION SITES**
- **GLOSSARY**

II. QUANTITY, FORM, AND FILING REQUIREMENTS

(Regs., Conn. State Agencies § 16-50j-12)

A. As requested by the Council, CL&P is furnishing to the Council an original and 35 paper copies of the Application, as well as electronic copies of the Application.

B. CL&P requests administrative notice of the following Council docket records, generic hearings or statements prepared by the Council as a result of generic hearings, and other pertinent documents.

CSC Application, Findings of Fact, Opinion and Decision and Order Docket No. 272 - The Connecticut Light and Power Company and The United Illuminating Company application for a Certificate of Environmental Compatibility and Public Need for the Construction of New 345-kV Electric Transmission Line and Associated Facilities Between Scovill Rock Switching Station in Middletown and Norwalk Substation in Norwalk

Connecticut Guidelines for Soil Erosion and Sediment Control 2002

Connecticut General Statutes Section 16-243 and Sections 16-11-134, and 135 of the Regulations of Connecticut State Agencies (and by reference, the National Electrical Safety Code ANSI C2, 2007 Edition)

CSC, "Review of the Ten Year Forecast of Connecticut Electric Loads and Resources 2008 – 2017" (when issued in final form)

CSC, "Review of the Ten Year Forecast of Connecticut Electric Loads and Resources 2007 – 2016"

CSC, "Review of the Ten Year Forecast of Connecticut Electric Loads and Resources 2006 – 2015"

CSC, "Life Cycle 2007 – Life Cycle Costs of Electric Transmission Lines"

Letter dated April 13, 2007 addressed to Derek Phelps from Roger Zaklukiewicz (re: Life Cycle 2007)

CSC, "EMF Best Management Practices for the Construction of Electric Transmission Lines in Connecticut", December 14, 2007

Gradient Corp., "Current Status of Scientific Research, Consensus, and Regulation re: Potential Health Effects of Power Line EMF", January 2006

National Electrical Safety Code ANSI C2, 2007 Edition

United States Code, 33 USC Sections 10 and 404, Army Corps of Engineers

ISO-NE, “2008-2017 Forecast Report of Capacity, Energy, Loads &Transmission (CELT)”, April 2008

ISO-NE, “2007 Regional System Plan”, October 18, 2007

ISO-NE, “2006 Regional System Plan”, October 26, 2006

ISO-NE, “Regional System Plan (RSPO5)”, Approved 10/20/2005

ISO-NE, Southern New England Transmission Reliability, “Report 1 - Need Analysis”, January 2008

ISO-NE, New England East-West Solutions, Report 2 Options Analysis (Formerly-Southern New England Transmission Reliability) Report 2 Options Analysis (June 2008)

ISO-NE, “Planning Procedure No. 3 (PP-3) Reliability Standards for the New England Area Bulk Power Supply System”, October 13, 2006

ISO-NE, “Planning FERC Electric Tariff No. 3 Open Access Transmission Tariff - Attachment K Regional”, December 7, 2007

Northeast Power Coordinating Council, “Document A-02 - Basic Criteria for Design and Operation of Interconnected Power Systems”, revised May 6, 2004

Northeast Power Coordinating Council, “Document A-05 - Bulk Power System Protection Criteria”, revised November 14, 2002

New England Energy Alliance, “Electricity Transmission Infrastructure Development in New England Value through Reliability, Economic and Environmental Benefits” -Polestar Communications & Strategic Analysis, December 2007

World Health Organization, “Electromagnetic Field and Public Health Exposure to Extremely Low Frequency Fields - Fact sheet #322”, June 2007

CT Department of Public Health, Environmental Health Section Environmental & Occupational Health Assessment Program, Electric and Magnetic Fields (EMF): Health Concerns – Fact Sheet

National Institute of Environmental Health Science, National Institutes of Health, Electric and Magnetic Fields Associated with the Use of Electric Power – June 2002

Connecticut Energy Advisory Board, “2007 Energy Plan for Connecticut”, Approved February 6, 2007

C. This Application is presented based on the Council's August 2007 Application Guide for Terrestrial Electric Transmission Line Facilitates to assist applicant in filing for a Certificate from the Council for the construction of an electric or fuel transmission line as defined in Connecticut General Statutes § 16-50i (a) (1) and (2).

CL&P also consulted Connecticut General Statutes §§ 16-50g through 16-50aa and Sections 16-50j-1 through 16-50z-4 of the Regulations of Connecticut State Agencies in preparing this Application.

CL&P has provided a reference table which acts as a directory between the Council's Application Guide and this Application. Table R-1 in Section R provides a summary of the application guide and identifies the corresponding section of the Application where the information is addressed.

<u>Pre-Application Process</u> (General Statutes § *16-50l* (e))

CL&P met with representatives of each of the affected municipalities prior to distribution of the MCF. On June 16, 2008, the MCF was distributed to the Chief Elected Official of each of these municipalities, thereby commencing the municipal consultation period. During this time, the CL&P sought input from the public and local government representatives on the primary route under consideration and alternative routes as presented in the MCF.

III. APPLICATION FILING FEES

(Regs., Conn. State Agencies § 16-50v-la)

The filing fee for this application is determined by the following schedule:

Estimated Construction Cost		Fee
Up to	$5,000,000	0.05% or $1,000.00, whichever is greater
Above	$5,000,000	0.1% or $25,000.00, whichever is less

Based on this schedule and the estimated construction cost for the Projects presented in Section ES.10 and ES.11, a check for the filing fee in the amount of $25,000 payable to the Council accompanies the Application. CL&P understands that additional assessments may be made for expenses in excess of the filing fee, and that fees in excess of the Council's actual costs will be refunded to CL&P.

Pursuant to Conn. Gen. Stat §16-50*l*(a)(3*)*, CL&P also encloses two separate checks, each in the amount of $25,000 payable to the Council for the municipal participation fees (one with respect to the Connecticut portion of the Greater Springfield Reliability Project and one for the Manchester to Meekville Junction Circuit Separation Project.)

IV. PROOF OF SERVICE

(General Statutes § 16-50*l* (b))

This application was served on the following:

A. The chief elected official, the zoning commission, planning commission, the planning and zoning commissions, and the conservation and wetlands commissions of the site municipality and any adjoining municipality having a boundary not more than 2,500 feet from the facility;

B. The regional planning agency that encompasses the route municipalities;

C. The State Attorney General;

D. Each member of the Legislature in whose district the facility is proposed;

E. Any federal agency which has jurisdiction over the proposed facility; and

F. The State Departments of Environmental Protection, Public Health, Public Utility Control, Economic and Community Development, and Transportation; the Council on Environmental Quality; and the Office of Policy and Management.

Attachments to the cover letter accompanying the filing of this Application to the Council include the transmittal memos sent to these officials and agencies as well as a copy of the Service List and an affidavit attesting that appropriate service was made.

V. NOTICE TO COMMUNITY ORGANIZATIONS

The applicant made reasonable efforts to provide notice of the Application on the following:

A. Affected community groups including Chambers of Commerce, land trusts, environmental groups, trail organizations, historic preservation groups, advocacy groups for the protection of Long Island Sound, and river protection organizations within the watershed affected by the proposed facility that have been identified by a municipality where the facility is proposed to be located or that have registered with the Council to be provided notice; and

B. Any affected water company within the watershed affected by the proposed facility.

Attachments to the cover letter accompanying the filing of this Application to the Council include a listing of the community groups and water companies to whom notice of the Application is being provided as well as the transmittal memo sent to these organizations and an affidavit that such notice was given.

VI. PUBLIC NOTICE

(General Statues § 16-50*l* (b))

Notice of the application was published at least twice prior to the filing of the Application in newspapers having general circulation in the site municipalities. The notice included the name of the applicant, the date of filing, and a summary of the Application. The notice was published in not less than ten point type. Affidavits of publication are attached to the cover letter accompanying the filing of this Application to the Council.

VII. NOTICE IN UTILITY BILLS

(General Statutes § 16-50*l* (b))

Notice of the proposed Projects was provided to each CL&P customer located within the municipalities of the proposed and alternative routes on a separate enclosure with each customer's monthly bill for one or more months prior to the filing of the Application with the Council. This included all CL&P customers in the towns of Bloomfield, East Granby, Enfield, Manchester, and Suffield.

An affidavit attesting to delivery of the bill insert and a copy of the actual insert itself are attached to the cover letter accompanying the filing of this Application to the Council.

VIII. NOTICE TO OWNERS OF PROPERTY ABUTTING SUBSTATION AND SWITCHING STATION SITES

Notice of the proposed modifications to the North Bloomfield Substation in Bloomfield, Connecticut was provided to abutters of the Substation, via certified mail, return receipt requested. An Affidavit regarding this notice is attached to the cover letter accompanying the filing of this Application to the Council.

Glossary

115-kV: 115 kilovolts or 115,000 volts

345-kV: 345 kilovolts or 345,000 volts

AC (alternating current): An electric current which reverses its direction of flow periodically. (In the United States this occurs 60 times a second-60 cycles or 60 Hertz.) This is the type of current supplied to homes and business.

ACSR: Aluminum Conductor, Steel Reinforced, a common type of overhead conductor.

AIS: Air-insulated Substation

Ampere: (Amp): A unit measure for the flow (current) of electricity. A typical home service capability (i.e., size) is 100 amps; 200 amps is required for homes with electric heat.

Arrester: Protects lines, transformers and equipment from lightning and other voltage surges by carrying the charge to ground. Arresters serve the same purpose as a safety valve on a steam boiler.

Auxiliary Transformers: Equipment installed at substations to provide voltage or current information for relaying and/or metering purposes.

BLSF: Bordering Land Subject to Flooding.

Bundle (circuit): Two or more parallel 3-conductor circuits joined together to operate as one single circuit.

Bundle (conductor): Two or more phase conductors or cables joined together to operate as a single phase of a circuit.

Cable: A fully insulated conductor usually installed underground but in some circumstances can be installed overhead.

CELT: ISO-NE, Forecast Report of Capacity, Energy, Loads and Transmission

Certificate: Certificate of Environmental Compatibility and Public Need

Circuit: A system of conductors (three conductors or three bundles of conductors) through which an electrical current is intended to flow and which may be supported above ground by transmission structures or placed underground.

Circuit Breaker: A switch that automatically disconnects power to the circuit in the event of a fault condition. Located in substations. Performs the same function as a circuit breaker in a home.

C&LM: Conservation and Load Management.

Conductor: A metallic wire, busbar, rod, tube or cable which serves as a path for electric current flow.

Conduit: Pipes, usually PVC plastic, typically encased in concrete, for housing underground power cables.

CEAB: Connecticut Energy Advisory Board

Contingency: The unexpected failure or outage of a system component, such as a generator, transmission line, circuit breaker, switch or other electrical element

Conversion: Change made to an existing transmission line for use at a higher voltage, sometimes requiring the installation of more insulators. (Lines are sometimes pre-built for future operation at the higher voltage.)

CONVEX: Connecticut Valley Electric Exchange.

Corona: A luminous discharge due to ionization of the air surrounding conductors, hardware, accessories, or insulators caused by a voltage gradient exceeding a certain critical value. Surface irregularities such as stranding, nicks, scratches, and semiconducting or insulating protrusions are usual corona sites, and weather has a pronounced influence on the occurrence and characteristics of overhead power-line corona.

Council: Connecticut Siting Council

CT DEP: Connecticut Department of Environmental Protection

dBA: Decibel, on the A-weighted scale.

DC: (direct current): Electricity that flows continuously in one direction. A battery produces DC power.

DBH: Diameter breast height

Deadend Structure: is a line structure that is designed to have the capacity to hold the lateral strain of the conductor in one direction

Demand: The total amount of electricity required at any given time by an electric supplier's customers.

DG: Distributed Generation. Refers to modular electric generation or storage, located near the point of electric use, and generally involves the use of small generators located close to electric demand sources, to decrease end-users' electric purchases and to reduce the need for electricity generated by large, centrally-located power plants and power transport to load centers on transmission lines.

Distribution: Line, system. The facilities that transport electrical energy from the transmission system to the customer.

Disconnect Switch: Equipment installed to isolate circuit breakers, transmission lines or other equipment for maintenance or sectionalizing purposes.

DPU: (Massachusetts) Department of Public Utilities (formerly Department of Telecommunications and Energy)

DRP: Demand-response program.

DRSP: Demand-response service provider

Duct: Pipe or tubular runway for underground power cables (see also Conduit).

Duct Bank: A group of ducts or conduit usually encased in concrete in a trench.

EFSB: Energy Facilities Siting Board (Massachusetts)

Electric Field: Produced by voltage applied to conductors and equipment. The electric field is expressed in measurement units of volts per meter (V/m) or kilovolts per meter (kV/m); 1 kV/m is equal to 1,000 V/m.

Electric Transmission: The facilities (69 kV+) that transport electrical energy from generating plants to distribution substations.

EMF: Electric and magnetic fields.

ENE: Eastern New England

EPA: United States Environmental Protection Agency

Fault: A failure (short circuit) or interruption in an electrical circuit.

FCM: Forward Capacity Market

FEMA: Federal Emergency Management Agency

FERC: Federal Energy Regulatory Commission

G: Gauss; 1G = 1,000 mG (milligauss); the unit of measure for magnetic fields.

GIL: Gas-Insulated Transmission Line using sulfur hexafluoride gas (SF_6).

GIS: Gas-Insulated Substation

GSRP: Greater Springfield Reliability Project

Ground Wire: Cable/wire used to connect wires and metallic structure parts to the earth. Sometimes used to describe the lightning shield wire.

HDD: Horizontal directional drill

H-frame Structure: A wood or steel structure constructed of two upright poles with a horizontal cross-arm and bracings.

HPFF Pipe Cable System: High-pressure fluid-filled; a type of underground transmission line.

HPGF Pipe Cable System: High-pressure gas-filled, a type of underground transmission line.

Hz: Hertz, a measure of alternating current frequency; one cycle/second.

Impedance: The combined resistance and reactance of the line or piece of electrical equipment which determines the current flow when an alternating voltage is applied

ISO-NE: Independent System Operator New England, Inc. New England's independent system operator.

kcmil: 1,000 circular mils, approximately 0.0008 sq. in.

kV: kilovolt, equals 1,000 volts

kV/m: Electric field unit of measurement (kilovolts/meter)

Lattice-type Structure: Transmission or substation structure constructed of lightweight steel members.

Lightning Shield Wire: Electric cable located to prevent lightning from striking transmission circuit conductors.

Line: A series of overhead transmission structures which support one or more circuits; or in the case of underground construction, a duct bank housing one or more cable circuits.

LMP: Locational marginal pricing

Load: Amount of power delivered as required at any point or points in the system. Load is created by the power demands of customers' equipment (residential, commercial, industrial).

Load Pocket: A load area that has insufficient transmission import capacity and must rely on out-of-merit order local generation.

LOLE: Loss of Load Expectation; a measure of bulk-power system reliability.

LPFF: Low-pressure fluid-filled; a type of self-contained fluid filled (SCFF) underground transmission line.

LPP: Laminated paper-polypropylene; a type of cable insulation.

Magnetic Field: Produced by the flow of electric currents; however, unlike electric fields, most materials do not readily block magnetic fields. The level of a magnetic field is commonly expressed as magnetic flux density in units called gauss (G), or in milligauss (mG), where 1 G = 1,000 mG.

Magnetic Flux Density: See Magnetic Field

Manhole: See Splice Vault

MHG: Material Handling Guidelines

mG: milligauss (see Magnetic Field)

MMP: Manchester to Meekville Junction Circuit Separation Project

MVA: (Megavolt Ampere) Measure of electrical capacity equal to the product of the voltage times the current times the square root of 3. Electrical equipment capacities are sometimes stated in MVA.

MVAR: (Megavolt Ampere Reactive) Measure of reactive power.

MW(s): (Megawatt(s)) Megawatt equals 1 million watts, measure of the work electricity can do.

MWh: per megawatt hour

NEEWS: New England East – West Solution

NEPOOL: New England Power Pool

NERC: North American Electric Reliability Council

NESC: National Electrical Safety Code

NPCC: Northeast Power Coordinating Council

NRCS: Natural Resources Conservation Service (United States Department of Agriculture)

NRHP: National Register of Historic Places

OH (Overhead): Electrical facilities installed above the surface of the earth.

Phases: Transmission (and some distribution) AC circuits are comprised of three phases that have a voltage differential between them.

Pothead: See Terminator

Protection/Control Equipment: Devices used to detect faults, transients and other disturbances in the electrical system in the shortest possible time. They are customized or controlled per an entity's operational requirements.

PSI: Pounds per square inch

Reactive Power: The portion of electricity that establishes and sustains the electric and magnetic fields of alternating-current lines and equipment owing to their inductive and capacitive characteristics. Reactive power is provided by generators, synchronous condensers, and capacitors, absorbed by reactive loads, and directly influences electric system voltage. Shunt capacitor and reactor capacities are usually stated in MVAR.

Rebuild: Replacement of an existing overhead transmission line with new structures and conductors generally along the same route as the replaced line.

Reconductor: Replacement of existing conductors with new conductors, but with little if any replacement or modification of existing structures.

RGGI: Regional Greenhouse Gas Initiative

Reinforcement: Any of a number of approaches to improve the capacity of the transmission system, including rebuild, reconductor, conversion and bundling methods.

Right-of-way: ROW; corridor

RFP: Request for Proposal

RPS: Renewable Portfolio Standards

RSP: Regional System Plan prepared annually by ISO-NE.

RTE: Rare, threatened and endangered.

SCADA: Supervisory Control and Data Acquisition

SCFF Cable System: Self-contained fluid-filled hollow-core cable; a type of underground transmission line used primarily for submarine installations.

Series Reactor: A device used for introducing impedance into an electrical circuit, the principal element of which is inductive reactance.

SEMA/RI: Southeastern Massachusetts and Rhode Island area

SF_6: Sulfur hexafluoride, an insulating gas used in GIS substations and circuit breakers.

Shield Wire: See Lightning Shield Wire

SHPO: State Historic Preservation Office

Shunt Reactor: An electrical reactive power device primarily used to compensate for reactive power demands by high voltage underground transmission cables.

Splice: A device to connect together the ends of bare conductor or insulated cable.

Splice Vault: A buried concrete enclosure where underground cable ends are spliced and cable-sheath bonding and grounding is installed.

SNE: Southern New England

S/S (Substation): A fenced-in yard containing switches, transformers, line-terminal structures, and other equipment enclosures and structures. Adjustments of voltage, monitoring of circuits and other service functions take place in this installation.

Steel Lattice Tower: See Lattice-Type Structure

Steel Monopole Structure: Transmission structure consisting of a single tubular steel column with horizontal arms to support insulators and conductors.

Step-down Transformer: See Transformer

Step-up Transformer: See Transformer

Switchgear: General term covering electrical switching and interrupting devices. Device used to close or open, or both, one or more electric circuits.

Stormwater Pollution Control Plan: Is a sediment and erosion control plan that also describes all the construction site operator's activities to prevent stormwater contamination, control sedimentation and erosion, and comply with the requirements of the Clean Water Act

SWCT: southwest quadrant of the state

Terminal Points: The substation or switching station at which a transmission line terminates.

Terminal Structure: Structure typically within a substation that ends a section of transmission line.

Terminator: A flared pot-shaped insulated fitting used to connect underground cables to overhead lines.

Transformer: A device used to transform voltage levels to facilitate the efficient transfer of power from the generating plant to the customer. A step-up transformer increases the voltage while a step-down transformer decreases it.

Transmission Line: Any line operating at 69,000 or more volts.

UG (Underground): Electrical facilities installed below the surface of the earth.

Upgrade: See Reinforcement

USACE: United States Army Corps of Engineers (New England District)

USFWS: United States Fish and Wildlife Service

USGS: United States Geological Survey (U.S. Department of the Interior).

VAR: Volt-ampere reactive power. The unit of measure for reactive power.

Vault: See Splice Vault.

V/m: volts per meter, kilovolt per meter: 1,000 V/m = 1 kVm; electric field measurement

Voltage: A measure of the push or force that transmits energy.

Watercourse: Rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs, and all other bodies of water, natural or artificial, public or private.

Wetland: is an area of land consisting of soil that is saturated with moisture, such as a swamp, marsh, or bog

WMA: Wildlife Management Area

XLPE: Cross-linked polyethylene (solid dielectric) insulation for transmission cables.