Southern Rhode Island 115 kV Transmission Project

Warwick, East Greenwich, North Kingstown, Exeter, South Kingstown & Charlestown, Rhode Island

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Glossary

AAC	All Aluminum Conductor
ACI	American Concrete Institute
ACOE	Army Corps of Engineers
ACSR	Aluminum Conductor Steel Reinforced
AFUDC	Allowance for Funds Used During Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASSF	Areas Subject to Storm Flowage
B&V	Black & Veatch Corporation
BMPs	Best Management Practices
C&LM	Conservation and Load Management
CAAA	Clean Air Act Amendments
CO	Carbon Monoxide
Companies	The National Grid Companies, including The Narragansett Electric Company
CPWRR	Cumulative Present Worth Revenue Requirements
DSM	Demand Side Management
dBA	Sound Amplitude in A-weighted Decibels
EDP	Engineering Department Procedures
EDP-GEN	Engineering Department Procedures – General
EDP-PLN	Engineering Department Procedures – Planning
EDR	Environmental Design & Research, P.C.
EFSB	Energy Facility Siting Board
EHS	Extra High Strength

EMF	Electric and Magnetic Fields
EPA	Environmental Protection Agency
EPR	Ethylene Propylene Rubber
FACTS	Flexible AC Transmission System
FDC	Feeder Design Criteria
FEMA	Federal Emergency Management Agency
GWh	Gigawatt Hours
HAP	Hunt-Annaquatucket/Pettaquamscutt
HPFF	High Pressure Fluid Filled
IEEE	Institute of Electrical and Electronic Engineers
ISO-NE	Independent System Operator – New England
K	Erodibility Factor
kcmil	Thousand Circular Mils (measure of conductor area)
kV	Kilovolt
LDPE	Low Density Polyethylene
mG	Milligauss
MSL	Mean Sea Level
MVA	Megavolt Amp (apparent power or the magnitude of the sum of the average real power and the reactive power)
MVAr	Megavolt Amp Reactive (reactive power or the power associated with inductive or capacitive elements)
MW	Megawatt (average real power or rate of energy flow)
MWh	Megawatt Hours
NA	Non-attainment
NAAQS	National Ambient Air Quality Standards
Narragansett	The Narragansett Electric Company
NEES	New England Electric System
NEPOOL	New England Power Pool
NERC	North American Electric Reliability Council
NESC	National Electrical Safety Code

NOx	Oxides of Nitrogen
NPCC	Northeast Power Coordinating Council
NPV	Net Present Value
O_3	Ozone
PAL	Public Archaeology Lab, Inc.
PGP	Programmatic General Permit
PLC	Programmable Logic Control
Project	Southern Rhode Island Transmission Projects
PSA	Power Supply Area
psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride
RIDEM	Rhode Island Department of Environmental Management
RIDOT	Rhode Island Department of Transportation
RIEDC	Rhode Island Economic Development Corporation
RIGIS	Rhode Island Geographic Information System
RIGL	Rhode Island General Laws
RIHPHC	Rhode Island Historic Preservation and Heritage Commission
RINHP	Rhode Island Natural Heritage Program
RIPDES	Rhode Island Pollutant Discharge Elimination System
RMS	Root Mean Square
ROW	Right-of-Way
SECT	Southeast Connecticut
SIP	State Implementation Plan
SN	Summer Normal
SPP	Statewide Planning Program
SPS	Special Protection System
SRI	Southern Rhode Island
SWRI	Southwest Rhode Island
TDR	Targeted Demand Response

TMDL	Total Maximum Daily Load
URI	University of Rhode Island
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
VHB	Vanasse Hangen Brustlin, Inc.
VOC	Volatile Organic Compounds
XLPE	Cross Linked Polyethylene

1.0 Introduction

1.1 Report Preparation and Responsibilities

This Environmental Report will support applications to the Rhode Island Energy Facility Siting Board ("EFSB") and other agencies in connection with the Southern Rhode Island Transmission Project ("the Project"). The Report has been prepared by The Narragansett Electric Company (Narragansett) and the other National Grid Companies (collectively "the Companies") under the direction of David J. Beron P.E., Project Manager for the Project. Numerous employees of the Companies, including planners and engineers, contributed to the report. The description of the affected natural and social environments, and impact analyses were prepared by Vanasse Hangen Brustlin, Inc. (VHB) and other consultants to the Companies including the Public Archaeology Lab, Inc. (PAL for cultural resources), Environmental Design & Research, P.C. (EDR for visual resources), Exponent, Inc. (for analysis of health effects of electric and magnetic fields (EMF)) and Black & Veatch Corporation (B&V for engineering, design, noise and EMF calculations).

1.2 Compliance with EFSB Requirements

Compliance with the requirements of Rule 1.6 of the EFSB Rules of Practice and Procedure (the "EFSB Rules") is addressed in the Notice of Intent Application which is filed with the EFSB herewith.

2.0 Executive Summary

2.1 Introduction

This Environmental Report has been prepared in support of an application to the EFSB for construction of jurisdictional facilities and for submission with other applications. The Environmental Report has been prepared in accordance with the EFSB Rules to provide information on the potential impacts of the electric transmission system improvements proposed by the applicant. The following report details the Project, discusses the alternatives to the Project which were considered and analyzed, highlights the specific natural and social features which have been assessed for the evaluation of impacts, discusses potential impacts and presents a mitigation plan for potential impacts associated with the construction of the Project.

The Purpose and Need for the Project is detailed in Section 3 of this Environmental Report, and includes all studies and forecasts regarding the need for the proposed transmission system improvements. Section 4 provides a detailed description of each of the components of the Project, and also discusses construction practices, Right-of-Way (ROW) maintenance practices, EMF, safety and public health considerations, estimated project costs, and anticipated project schedule. An analysis of alternatives to the Project, together with reasons for the rejection of each alternative, is presented in Section 5 of this report. A detailed description of all environmental and social characteristics within and immediately surrounding the proposed project locations is included as Sections 6 and 7, respectively. Section 8 of this report identifies the impacts of the Project on the natural and social environments both on and off site. Section 9 summarizes proposed mitigation measures which when implemented will effectively offset impacts associated with the Project. Finally, Section 10 lists the federal, state, and local government agencies which may exercise licensing authority and from which Narragansett may be required to obtain approvals prior to constructing the Project.

2.2 Project Description and Proposed Action

Narragansett is proposing to perform a series of electric transmission system improvements in order to continue to provide reliable electric supply to the southern Rhode Island area. The Project will expand and significantly reinforce the existing transmission system in southern Rhode Island. A new 115 kV transmission line and a new 115-12.47 kV substation will be constructed, existing 115 kV transmission lines will be reconductored, and an existing substation will be expanded and modified. Figure 2-1[1] provides an overview of the Project location and Figure 2-2 (sheets 1 through 9) provides more detail as to the Project alignment. Table 2-1 provides a brief description of each component of the proposed Project.

Table 2-1: Project Description

Project Component	Length (miles)	Towns	Proposed Action
L-190 Reconductoring	5.3	Warwick, East Greenwich and North Kingstown	Reconductor the existing L-190 115 kV transmission line from Kent County Substation to the Old Baptist Road Tap Point.
L-190 Extension	12.3	East Greenwich, North Kingstown, Exeter, and South Kingstown	Construct new L-190 115 kV transmission line extension on existing ROW from the Old Baptist Road Tap Point to the West Kingston Substation.
1870N Reconductoring	4.3	South Kingstown and Charlestown	Reconductor the existing 1870N 115 kV transmission line from the West Kingston Substation to the Kenyon Substation.
1870 Reconductoring	3.9	Charlestown	Reconductor the existing 1870 115 kV transmission line from the Kenyon Substation to the Wood River Substation.
Tower Hill Tap Lines Construction	0.75	North Kingstown	Construct two new 115 kV transmission tap lines on existing ROW between the existing G-185S ROW and new Tower Hill Substation.
Tower Hill Substation Construction	—	North Kingstown	Construct a new 115-12.47 kV low-profile substation in the vicinity of Tower Hill Road to be supplied by the new 115 kV transmission tap lines.
West Kingston Substation Expansion	—	South Kingstown	Upgrade existing 115 kV equipment, add new 115 kV equipment and expand the existing 115 kV switchyard to accommodate the new L-190 115 kV transmission line extension.

2.3 Purpose and Need

The purpose of the transmission system improvements is to enable Narragansett to continue to provide reliable electric supply to the southern Rhode Island area. The Project will improve the reliability of electric supply to the area by increasing the loading capability of the transmission system and maintaining acceptable voltages in southern Rhode Island consistent with the Companies' planning guidelines.

2.4 Alternatives

An analysis was undertaken to evaluate the feasibility of alternatives to the proposed transmission system improvements. Narragansett evaluated multiple alternatives

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1 All figures are bound separately as Volume 2.

including the "No-Build" alternative, alternatives using the existing ROW, alternative overhead routes, underground transmission alternatives, alternative system improvements, and alternative technologies. Feasibility assessments, cost considerations, reliability assessments, and impact assessments were used to evaluate the alternatives. The results of the analysis confirm that the proposed Project will address the reliability issues in the most cost-effective manner while minimizing impacts to the social and natural environments.

2.5 Summary of Environmental Effects and Mitigation

The proposed Project will be constructed in a manner that minimizes the potential for adverse environmental impacts. Design and construction mitigation measures will ensure that construction related environmental impacts are minimized. The Project will have minimal impact on the geologic, soil, surface water, and wetland resources of the Project area. VHB has undertaken an inventory of the Project ROW as requested by the Rhode Island Natural Heritage Program (RINHP). VHB has submitted the findings to RINHP, and will coordinate with RINHP to ensure that any rare, threatened or endangered species identified are not adversely affected by the Project.

Transmission line and substation construction and expansion may cause a small loss of excavated soil due to water and wind erosion. This may result in minor siltation of water bodies and wetlands. However, these impacts will be short-term and localized. To ensure that these impacts are minimized, standard Best Management Practices (BMPs) such as the installation of erosion control devices (i.e., hay bales and silt fence) and the re-establishment of vegetation will be employed to minimize wetland and water quality impacts.

Construction of the Project will result in impacts to wetland resources caused by vegetation clearing, and the placement of fill required for pole structure construction. The design of the Project has been developed to reduce wetland impacts through avoidance, minimization and compensation. Approximately 710 square feet of wetland will be altered and approximately 61 acres of tree clearing will result from the L-190 transmission line extension. Approximately 160 square feet of wetland will be altered and approximately five acres of tree clearing will result for the Tower Hill Tap Lines and Substation. Narragansett will prepare a mitigation plan which will provide compensatory flood storage for lost flood storage volume and compensation for impacts to wetlands if required for U.S. Army Corps of Engineers Section 404 permitting. In addition to these mitigation measures, Narragansett will retain the services of an environmental monitor throughout the entire construction phase of the Project. The purpose of the environmental monitor will be to ensure compliance with all applicable federal, state, and local permit conditions and to maintain strict adherence to Narragansett construction practices.

2.6 Summary of Social Effects and Mitigation

Based on the location of the Project, the greatest potential for social impact is the interaction of construction and maintenance on current and future land uses. Because the Project is located within an established ROW, it will not require, nor will it lead to, long-term residential or business disruption. Temporary construction impacts primarily related to construction traffic and equipment operation are expected to be minor. The construction and rehabilitation of the 115 kV transmission lines and the substation construction and expansion will not adversely impact the overall social and economic condition of the Project areas.

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2.6.1 Cultural Resources

There are no known significant historic or archaeological sites, or recorded historic properties that would be impacted by the proposed Project. In areas that have been assessed as potentially archaeologically sensitive, appropriate investigations will be undertaken prior to any excavation so that archaeological resources are not inadvertently disturbed.

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2.6.2 Visual Resources

The visual analyses performed for the Project indicate that the proposed transmission facilities will have limited visibility, will not significantly increase visibility of the existing facilities, and will not significantly impact the visual/aesthetic character of the study area. The viewshed analysis indicates that potential visibility of the proposed line is almost identical to that of the existing line, and largely confined within a half-mile radius of the existing line (i.e. the Project study area). Line-of-sight cross section analysis indicates that existing vegetation, structures, and topography will be effective in screening views of the proposed line from most locations within and adjacent to the study area (including visually sensitive sites). Field review confirmed the results of the cross section analysis and revealed that views of the existing line are largely restricted to road crossings, open fields and some newer residential subdivisions within 0.5 mile of the transmission line corridor. Evaluation of the Landscape Similarity Zones (LSZ) within the study area indicated that the visual quality of landscape components within these zones are generally considered average, and that none of the zones possess the high quality features that would define them as Preservation Class landscapes. The Visual Impact Assessment (VIA) conducted for the Project indicated that adverse visual impacts of the proposed facilities are modest and do not exceed the threshold of allowable impact defined in the Study methodology for any LSZ within the study area. This is largely attributable to the construction of the proposed project adjacent to an existing transmission line, and the effective screening provided in most views by existing vegetation.

2.6.3 Noise

In order to evaluate noise impacts associated with the Project, Narragansett conducted ambient sound level surveys at the West Kingston Substation and the proposed Tower Hill Substation site. Based on the survey results, existing sound levels at the West Kingston Substation ranged from 29 to 44 dBA during the daytime and 28 to 42 dBA at night. These very quiet to quiet levels are consistent with bird calls and a light breeze outdoors and an average residence indoors. At the Tower Hill Substation site, sound levels ranged between 40 to 49 dBA during the day and 31 to 47 dBA at night. These slightly higher levels can be equated to typical office sound levels.

At the West Kingston Substation, no additional sound generating equipment will be installed as part of the Project; therefore no additional noise will be generated at the substation. Since the Tower Hill Substation will introduce new sound generating equipment, Narragansett modeled future sound levels with the substation in place. The model evaluated the substation equipment: transformers, transformer cooling fans, and control house air conditioning units. The equipment was modeled as operating at extreme overload conditions, which is a situation unlikely to occur but was used as a worst case scenario. The results of the model indicated that sound pressure levels generated under this condition would range between 28 and 35 dBA. When considered in conjunction with existing background sound levels, predicted sound level increases would range from 2 dBA at the closest residence at Pinecrest Drive to 4 dBA at residences south and east of the site. These nominal increases lead Narragansett to conclude that the Project will not significantly affect noise levels at receptor sites.

Under normal operating conditions, transmission lines do not typically generate appreciable noise levels.

2.6.4 Electric and Magnetic Fields

Electric and magnetic fields were calculated for the 2006 and 2017 timeframes using projected typical and summer peak load levels. Field levels were calculated at the edges of the ROW. These post-construction field levels were compared with field levels calculated for the existing arrangement of electric lines on the ROW under predicted 2006 typical and summer peak loads. The results of this comparison showed that after the Project is completed the magnetic fields at both edges of the ROW will be lower in the three segments between Old Baptist Road Tap Point and West Kingston Substation under both 2006 typical and peak loads. In these segments of the ROW, the fields will generally remain lower than present levels under projected typical and peak 2017 loads although the fields in a few segments will be nominally higher than present levels. The results of the EMF calculations are presented in Sections 7.8 and 8.16 of this report.

The magnetic fields at the edge of ROW between West Kingston Substation and Wood River Substation will be higher after the reconductoring of the 1870N and 1870 lines since they will carry more current and there will continue to be only a single 115 kV transmission line on these segments of the ROW. In 2017 these fields will generally be somewhat higher than 2006 post-construction levels.

The Tower Hill Tap ROW presently is occupied by a 34.5 kV distribution line, although current does not normally flow through this line since it is used only in the event of a contingency. Upon completion of the Project, there will also be two 115 kV transmission lines on the ROW. Electric and magnetic fields will increase over existing conditions.

2.7 Conclusion

Completion of the Project as proposed by Narragansett will address the electric reliability needs of the southern Rhode Island area in a cost-effective manner which minimizes environmental and social impacts. Mitigation will be provided for all impacts to state and federal regulated wetland resources. Impacts to rare, threatened or endangered species will be avoided through close coordination with the RINHP. Similarly, impacts to cultural resources will be avoided through investigation and coordination with the Rhode Island Historical Preservation and Heritage Commission (RIHPHC).

To the extent that impacts can not be avoided, they will be addressed through mitigation techniques as discussed in Section 9 of this report.

3.0 Purpose and Need

Narragansett[2] strives to provide all customers with reliable electric service at the lowest possible cost while minimizing adverse environmental effects.

Transmission planning studies are done to determine what facilities are needed to supply adequate electric power to Narragansett's customers. The need for the proposed 115 kV transmission line from the Old Baptist Road Tap Point in North Kingstown to the West Kingston Substation in South Kingstown and additional reconductoring and substation improvements was identified by transmission planning studies.

Distribution planning studies are conducted to identify needs of the low voltage distribution system and to recommend solutions to provide adequate, reliable and economic service to customers in specific geographic areas. A distribution study conducted by Narragansett, more fully described later in this report, identified the need for the proposed Tower Hill Substation and related facilities in North Kingstown.

The purpose of the proposed Project is to enable Narragansett to continue to provide reliable electric supply to the southern Rhode Island area. The Project will improve the reliability of electric supply to the area by increasing the loading capability of the transmission system and maintaining acceptable voltages in southern Rhode Island consistent with the Companies' planning guidelines. The system improvements will also improve reliability for the Connecticut transmission system.

3.1 Reliability

All National Grid transmission facilities in New England are designed in accordance with the reliability criteria contained in the latest version of the National Grid Transmission Planning Guide (April 2004) (Transmission Planning Guide). The guide is consistent with the ISO New England (ISO-NE) and New England Power Pool

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2 The Narragansett Electric Company, a subsidiary of National Grid USA, is an electricity distribution and transmission company serving approximately 465,000 customers in 38 Rhode Island communities. National Grid USA is a public utility holding company. Other subsidiaries of National Grid USA include operating companies such as New England Power Company, Massachusetts Electric Company, Nantucket Electric Company, Granite State Electric Company (in New Hampshire), and Niagara Mohawk Power Corporation (in New York), as well as National Grid USA Service Company, Inc. which provides services such as engineering, facilities construction and accounting.

(NEPOOL) standards, and the Northeast Power Coordinating Council (NPCC) criteria.

These criteria are followed so that transmission system facility loadings remain within system capabilities and transmission equipment is kept within a reasonable range of voltages for foreseeable contingencies, including the loss of a single element such as a transmission line or substation transformer. The loading capabilities are determined using maximum allowable equipment temperatures as criteria. The allowable temperatures are established by manufacturer's design, American National Standards Institute (ANSI) and other national standards, known material properties, or, in the case of a transmission line, the design basis of the line. The range of allowable voltage is established by manufacturer's design, and ANSI and other standards. The transmission system is designed to meet these deterministic criteria to promote the reliability and efficiency of electric service on the bulk power system and also with the intent of providing an acceptable level of reliability to the customers.

Transmission planning studies identified reliability concerns under summer peak load conditions in the southern Rhode Island area. The transmission supply to the southern Rhode Island area did not meet the reliability criteria as described in the Transmission Planning Guide. The reliability concerns included both thermal and voltage violations of the criteria in the event of a contingency such as the loss of a transmission system component.

3.2 Planning Studies

The following sections describe how transmission and distribution planning studies are conducted.

3.2.1 Transmission Planning Studies

The potential low voltage problems in southern Rhode Island and the need to increase thermal loading capability to the southern Rhode Island area were identified by transmission planning studies. This section discusses in general how these studies are conducted.

Transmission planning studies are undertaken to determine what facilities are needed to maintain reliable electric power to specific geographic areas throughout the transmission system. The criteria and standards defined in the Transmission Planning Guide are used to assess the reliability of the system.

To begin a transmission planning study, the geographic area whose electric supply is to be examined is determined as well as the length of time the study will cover.

Studies commonly look 10 to 15 years into the future. Using electric load forecasts for the chosen time period and the chosen geographic area, along with a computer model of the existing electrical system, "load flow" analyses are performed. These load flow analyses are used to determine how the existing system reacts to future load levels under normal and single contingency conditions. Thermal loadings are evaluated using the criteria provided in the Transmission Planning Guide. The thermal ratings of each element in the system are determined such that maximum use can be made of the equipment without damage or undue loss of equipment life.

The load flows are analyzed to determine whether any piece of equipment is carrying more electric current than the equipment is rated for based on the assumed ambient conditions. Voltage levels are checked to determine that they are within appropriate ranges. The effect of future loads is reviewed. System stability, grounding, fault current levels, operability, and ability to maintain the system are also considered.

After identifying problems that could occur on the electrical system under future electrical loads or contingency situations, alternative plans are developed to deal with them. Typically these plans call for replacing existing equipment or adding facilities to the electric system. The plans are developed and evaluated based on the Transmission Planning Guide and other standards (e.g., NEPOOL and NPCC), equipment standards and specifications, relaying practices, operational and maintenance considerations, safety, environmental impacts, and economics. The evaluation of alternatives leads to a recommended plan that is summarized in a report.

Planning studies may consider a planning horizon up to 15 years into the future. In such a study, the proposed upgrades in the near term receive the most focus and the upgrades at the latter end of the planning horizon are used to evaluate the robustness of the near term plan from both a technical and economic perspective. The objective is to avoid building facilities that do not fit into the long term needs of the system. This approach can sometimes result in increased costs in the near term to prepare for future expansion, in order to provide for the best possible utilization of resources over the life of the system facilities. The recommendations at the latter end of the planning horizon are reviewed again prior to construction. Some of the events that can change a plan upon review are:

™ Significant change in load forecast or actual load growth.
™ Changes that affect the ability to implement the recommendations.
™ Other changes in the system.

Either the schedule or the substance of a plan is modified if a review shows that change is warranted.

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3.2.2 Distribution Planning Studies

Distribution planning studies are conducted to identify needs of the distribution system and to recommend solutions to provide adequate, reliable and economic service to customers in specific geographic areas. National Grid has developed Engineering Department Procedures (EDPs) which outline how area supply and distribution planning studies should be conducted. EDP-PLN-1 is entitled "Guide for Area Supply and Distribution Planning" and EDP-PLN-2 is entitled "System Planning – General."

Prior to beginning a distribution planning study, the specific geographic area for the study is identified along with the length of time the study will cover. Typically studies cover a 10 to 15 year time frame.

Power Supply Area (PSA) forecasts, published by the National Grid USA Service Company Planning and Financial Analysis Department, are used to project annual loads in the Study Area for the study period. To complement the PSA load growth forecasts, the Study Area historical annual load growth rate is calculated and anticipated large spot loads are identified. Taking all these variables into consideration, a projected annual load growth rate is developed for the Study Area.

Once the geographic area and load forecast are identified, a diagnostic analysis is performed to identify existing and anticipated problems. Computer load flow models are often utilized to determine if voltage regulation and supply line loading is within acceptable limits.

The next stage of a study is to develop plans to resolve any identified area problems. In the development of plans, the supply and distribution design criteria are applied to:

™ Prevent equipment loading from exceeding its thermal capabilities.
™ Maintain voltage regulation within acceptable limits.
™ Ensure that service reliability criteria are not violated for loss of any single element in the system.

Plans that are found to be technically or economically infeasible are screened out and not fully developed. Viable plans are further developed and their costs are estimated. Each viable plan undergoes a rigorous analysis to ensure it is technically sound and that it resolves the area problems for the length of the study period.

The final stage of a study is to review and refine overall plan costs and performance, and to select a preferred plan. An environmental impact assessment and a transmission system impact review are performed for each plan. The net present value (NPV) of each plan is calculated. A sensitivity analysis is performed to determine if changes in expected load growth or other factors would have a significant impact on which plan has the lowest NPV. If the plans have different impacts on reliability, power quality, or the environment, these differences are evaluated prior to making the final recommendation on a preferred plan. The recommended plan is chosen based upon cost, reliability, power quality, environmental impact, and other factors.

3.3 Need Description

Prior to the mid-1990s, the load in the southern Rhode Island area was primarily served from a single 115 kV transmission line that is tied to the transmission network at Montville Substation in Connecticut at one end and Kent County Substation in Rhode Island at the other end. The Wood River, Kenyon, and West Kingston Substations were all directly served by this line. The Old Baptist Road and Davisville Substations were served by a radial 115 kV line, which was tapped directly off this line. The original 115 kV line consists of the following line segments:

- G-185S line from Kent County Substation to West Kingston Substation, approximately 17.5 miles in length and a four mile radial tap line to the Old Baptist Road and Davisville Substations.
- 1870N line from West Kingston Substation to Kenyon Substation, approximately 4.3 miles in length.
- 1870 line from Kenyon Substation to Wood River Substation, approximately 3.9 miles in length.
- 1870S line from Wood River Substation to Mystic Substation, approximately 16.1 miles in length[3].
- 1280 line from Mystic Substation to Montville Substation via Buddington Substation, approximately 16 miles in length.

Figure 3-1 is a map of the southern Rhode Island and southeastern Connecticut area showing these existing line segments. Figure 3-2 depicts the One-Line diagram of the electrical transmission system in the southern Rhode Island area.

Prior to the mid-1990s, if the radial tap line serving Old Baptist Road and Davisville Substations had been damaged and unable to carry electricity, both substations would have been without a source of electricity until repairs could be made. At the time, Narragansett had a "firming" policy that requires the electric supply be firm for any contiguous area with a peak load of 30 megawatts (MW) or more. The firming

3 The 1870S transmission line was split in summer 2005 with the construction of the Shunock Substation in Connecticut. The line from Wood River Substation to Shunock Substation is approximately 8.5 miles. The line from Shunock Substation to Mystic Substation is approximately 7.6 miles. The Shunock to Mystic line segment in Connecticut will be redesignated as the 1465 transmission line.

policy required that an alternative supply be available to serve such a load. As the load grew, the original transmission line no longer met the firming policy at Old Baptist Road and Davisville Substations.

In addition, one of the requirements of the system design is to be able to serve the load between Montville and Kent County Substations from either end in the event of the loss of any single line segment. With load growth throughout the southern Rhode Island area, the transmission system minimum acceptable voltages could not be maintained during such a contingency.

To address this situation, Narragansett built the L-190 line from Kent County Substation to the Davisville and Old Baptist Road Substations. The L-190 transmission line was designed to provide primary service to roughly half the load at the Davisville and Old Baptist Road Substations and an alternate supply for the remainder of the load served by these Substations. The Wood River, Kenyon, and West Kingston Substations, and roughly half of the load of the Davisville and Old Baptist Road Substations continue to be served by the single 115 kV line. When the L-190 line is out of service, the entire load is served by the original 115 kV line.

As load has continued to grow, the existing transmission system is reaching the limits of its ability to continue to provide reliable service to the southern Rhode Island area. The 2007 demand for southwest Rhode Island and southeastern Connecticut is forecast to be 308 MW[4]. The immediate reliability concerns occur when the load has to be served from only one end of the line, resulting in voltages dropping below acceptable levels. Under forecasted 2006 load levels and contingency conditions, the existing line is also exposed to loading above the thermal capabilities of the existing conductors. The planning study must consider and address both problems. Further, the actual loads have grown at a rate that has exceeded the forecast for the area. As a result, the need to develop the next solution for the southern Rhode Island area is immediate.

3.4 Planning Studies Related to the Southern Rhode Island Area

The following sections summarize the studies that have addressed the southern Rhode Island area and recommended the construction of the new 115 kV L-190 transmission line extension from the Old Baptist Road Tap Point to the West Kingston Substation, and the reconductoring of other 115 kV transmission lines in southern Rhode Island. In addition, section 3.4.3 summarizes the distribution planning study which recommends building a new substation to be supplied by the new 115 kV transmission line extension.

4 The 2007 SWRI + SECT load consists of the forecasted loads at Davisville, Old Baptist Road, West Kingston, Kenyon, Wood River Substations in Rhode Island and at Shunock and Mystic Substations in Connecticut for the year 2007 using load growth provided in the 2003 PSA Forecast. The SWRI area loads were modeled with extreme weather peak load plus spot loads.

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3.4.1 March and November 1992 Reviews

A 1987 study recommended the construction of the L-190 transmission line from Kent County Substation to the Old Baptist Road Tap Point. The March and November 1992 reports reviewed the need for the new line in light of the actual and forecasted loads. These reports confirmed that this segment of the L-190 transmission line should be constructed and suggested that the line would need to be extended from the Old Baptist Road Tap Point to the West Kingston Substation around the end of the 15 year study horizon, in 2005.

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3.4.2 Southwest Rhode Island Transmission Supply Study (October 2003)

The following two sections summarize the October 2003 Southwest Rhode Island Transmission Supply Study (the "October 2003 Transmission Study" which is attached as Appendix A) which recommended the southern Rhode Island transmission improvements which are the subject of this application. Section 3.4.2.1, below, summarizes the part of the October 2003 Transmission Study that recommended the L-190 reinforcements to address reliability in southern Rhode Island. This section also summarizes the other alternatives to the L-190 reinforcements that were considered.

Section 3.4.2.2 summarizes the 1870N and 1870 reconductorings which are recommended to remove a Special Protection System (SPS) that exists on the 1870S line. The interest in removing the SPS and the need for additional upgrades is common to all the alternatives summarized in Section 3.4.2.1.

3.4.2.1 L-190 Extension and L-190 Reconductoring

The October 2003 Transmission Study identified the need for additional reinforcement in the southern Rhode Island area to address low voltage violations and line loading violations. Under peak load conditions and the loss of the G-185S transmission line from Kent County Substation to West Kingston Substation, load flow analyses revealed that the remaining 115 kV supply from Connecticut did not adequately maintain voltages within the voltage criteria of the Transmission Planning Guide. The voltage concerns were immediate and to address them in the short term Narragansett installed seven distribution capacitor banks. In addition to the voltage violations, the study also identified line loading violations. Under peak load conditions and the loss of the 1280 line from Montville, Connecticut to Mystic, Connecticut, the loading on the G-185S transmission line from the Old Baptist Road Tap Point to the West Kingston Substation exceeded the thermal rating of the line.

The October 2003 Transmission Study considered four alternatives to address the low voltages and thermal overloads.

Alternative 1, the recommended alternative, consisted of the following:

- Extending the L-190 115 kV line from the Old Baptist Road Tap Point to the West Kingston Substation, a distance of 12.3 miles, including rebuilding the West Kingston 115 kV Substation to tie in the L-190 line extension.
- Reconductoring the L-190 line from the Kent County Substation to the Old Baptist Road Tap Point with 1113 and 1590 kcmil ACSR conductors by the time the L-190 extension is complete. With L-190 tied in at West Kingston Substation, overloads were observed on the L-190 line from Kent County Substation to Old Baptist Road Tap Point for contingencies that include the loss of G-185S line. The 795 kcmil AAC conductor was observed to overload immediately and the 795 kcmil ACSR conductor was observed to overload by the year 2010. Reconductoring both sections of the line at the same time will reduce the construction and engineering costs.
- Reconductoring the G-185S line from the Kent County Substation to the Old Baptist Road Tap Point with 1113 kcmil ACSR conductor and 1590 kcmil ACSR conductor by 2012[5]. The G-185S line from Kent County Substation to the Old Baptist Road Tap Point is observed to overload for the loss of the L-190 line by the year 2012 (SWRI+SECT= 334 MW[6]).

The recommended alternative assumed the seven distribution capacitor banks that were installed in 2003 to be part of the total plan. The recommended alternative shows adequate performance out to the end of the study period, which looked out to the year 2020. The recommended alternative was the least cost alternative. The total estimated capital cost as of October, 2004 was $14.6 million.

Alternative 2 consisted of the following:

- Installing six (6), 10 MVAr 115 kV capacitors at the Kenyon Substation to address the immediate voltage concern for loss of line G-185S.
- Reconductoring of the G-185S line with 795 kcmil ACSR conductor to address the thermal overload of line G-185S from Old Baptist Road Tap Point to West Kingston for the loss of line 1280 to be completed by the year 2006.
- Reconductoring the G-185S from the Kent County Substation to the Old Baptist Road Tap Point by 2008 based on the 2003 load forecast.

5 This project will be the subject of a future EFSB application.

6 The year 2012 SWRI + SECT load consists of the forecasted loads at Davisville, Old Baptist Road, West Kingston, Kenyon, Wood River Substations in Rhode Island and at Shunock and Mystic Substations in Connecticut for the year 2012 using load growth provided in the 2003 PSA Forecast. The SWRI area loads were modeled with extreme weather peak load plus spot loads.

- Additional reinforcement of the transmission system, such as the extension of the L-190 line from Old Baptist Road Tap Point to West Kingston Substation by 2016, was required within the study horizon, and included for purposes of the economic evaluation.

Alternative 2 performed adequately. However, this alternative would create a more complicated system to operate and it did not perform as well technically as the recommended alternative, Alternative 1. Alternative 2 was also a higher cost alternative than the recommended alternative. The total estimated capital cost of Alternative 2 was $15.7 million.

Alternative 3 consisted of the following:

- Installing a 60 MVAr capacity Flexible AC Transmission System (FACTS) device at the Kenyon Substation to address the immediate voltage concern for loss of line G-185S.
- Reconductoring of the G-185S line with 795 kcmil ACSR conductor to address the thermal overload of line G-185S from Old Baptist Road Tap Point to West Kingston Substation for the loss of line 1280 to be completed by the year 2006.
- Reconductoring the G-185S from the Kent County Substation to the Old Baptist Road Tap Point by 2008 based on the 2003 load forecast.
- Additional reinforcement of the transmission system, such as the extension of the L-190 line from Old Baptist Road Tap Point to West Kingston Substation by 2016 was required within the study horizon, and was included for purposes of the economic evaluation.

Alternative 3 performed adequately. However, this alternative did not perform as well technically as the recommended alternative, Alternative 1. Alternative 3 was also a higher cost alternative than the recommended alternative. The total estimated capital cost of Alternative 3 was $19.9 million.

Alternative 4 consisted of the following:

- Building a 345 kV line with 2-1590 kcmil ACSR bundled conductor from the Kent County Substation to the Northeast Utilities Montville Substation in Connecticut, a total of approximately 51 miles.
- Tapping a 345-115 kV autotransformer along the 345 kV line to provide a mid-line source to the 115 kV line between Kent County Substation and Montville Substation.

Alternative 4 provided a significant increase in capability for the transmission in the area, but it was also much more expensive than the other alternatives. The total estimated capital cost of Alternative 4 was $108.1 million.

After a thorough evaluation of Alternatives 1 through 4, the October 2003 Transmission Study recommended Alternative 1 as the preferred plan to address the transmission planning needs of the southern Rhode Island area.

3.4.2.2 1870N and 1870 Reconductoring

In addition to the evaluation of Alternatives 1 through 4, additional studies were completed to determine the necessary upgrades to remove an SPS that currently exists on the 1870S line from the Wood River Substation to the Shunock Substation in Connecticut. An SPS is a protection system designed to detect abnormal system conditions, and take corrective action other than the isolation of faulted elements. Such action may include changes in load, generation, or system configuration to maintain system stability, acceptable voltages or power flows[7].

The 1870 SPS was originally installed as an emergency short term measure to allow higher Connecticut import capability to address reliability concerns related to generation outages in Connecticut. Without the SPS, the G-185S/1870/1280 115 kV transmission path limits Connecticut import capability following tripping of the 345 kV transmission path between Sherman Road Substation and Card Street Substation. The SPS opens the G-185S/1870/1280 transmission path at Wood River Substation or Shunock Substation to prevent overloading the G-185S line from Kent County Substation to West Kingston Substation.

With the proposed extension and tie in of the L-190 transmission line to West Kingston Substation, the G-185S transmission line will no longer overload on the loss of a 345 kV line into Connecticut. However, once the L-190 extension is complete, the 1870N transmission line from West Kingston Substation to Kenyon Substation and the 1870 transmission line from Kenyon Substation to Wood River Substation will continue to overload for loss of a Connecticut 345 kV line.

To avoid this overload, the 1870 SPS could be set to approximately 130 MVA to protect for the overload of the 1870N transmission line. However, the SPS was only intended to be an emergency short term measure for Connecticut generation deficiency. In order to provide a long term solution, it is proposed to reconductor the 1870N transmission line with 1113 kcmil ACSR and to reconductor the 1870 transmission line with 1113 kcmil ACSR and remove the SPS.

The operation of the 1870 SPS results in the separation of the 115 kV systems between Wood River Substation and Shunock Substation and exposes these areas to loss of load for the next contingency. Eliminating the 1870 SPS will remove the reliability exposure that both southeast Connecticut and southern Rhode Island are exposed to if the 1870 SPS operates.

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7 "Special Protection Systems," NPCC Reference Manual Revision 16, NPCC, 2003.

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3.4.3 South County East Area Supply and Distribution Study (October 2004)

To identify and address distribution supply issues, a distribution planning study was conducted for southern Rhode Island. The October 2004 study was entitled "South County East Area Supply and Distribution Study" (the "October 2004 Distribution Study" which is attached as Appendix B). The study encompassed the towns of North Kingstown, South Kingstown, Narragansett and sections of East Greenwich, West Greenwich, Exeter, Richmond and Charlestown. The study was initiated to address local feeder, transformer and distribution supply line loading issues, to provide supply and distribution capacity to serve projected load growth in the Study Area through the year 2013, and to address existing reliability issues.

The study identified a number of supply and distribution problems in the Study Area. Problems include loading at West Kingston and Peacedale Substations, loading on the 34.5 kV supply lines to Lafayette and Bonnet Substations, heavily loaded area distribution feeders and a number of Feeder Design Criteria (FDC) violations. Assuming no new facilities are added, the major problems in the Study Area consist of the following:

- In 2004, six of the nineteen distribution feeders in the Study Area were projected to exceed the FDC of 20 MWh interruption for a single contingency and four feeders were projected to have un-served load (i.e., black outs) for the duration of an outage.
- In 2005, the projected summer peak load at Peacedale Substation is 30.9 MW. The transformers have a summer emergency rating of 27.2 MVA. The projected load on these transformers is above the summer emergency rating for loss of a Peacedale transformer or one of the two supply lines on peak. To prevent the transformers from being loaded beyond their emergency rating, auto transfer will be disabled during summer peak at this substation until additional capacity is added. As a result, upon the loss of a transformer or supply line, load served by the affected element of the substation would be dropped until manual switching occurs or repairs are made.
- In 2005, the projected peak contingency load on the Kent County 3312 supply line section feeding Lafayette Substation and Bostitch and backing up Hunt River Substation and Brown & Sharpe is 26.2 MW. The 3312 supply line section is limited by 2/0 copper conductors with a summer emergency rating of 21.8 MVA. For loss of the Davisville 84T3 supply line, the projected peak load on the 3312 supply line section is projected to exceed the summer emergency rating. To prevent the 3312 supply line section from being loaded beyond its emergency rating, auto transfer will be disabled at Hunt River Substation during summer peak until additional capacity is added.

- In 2007, the projected summer peak load at West Kingston Substation is 75 MW. For loss of either a West Kingston transformer or the West Kingston 3307 supply line feeding Peacedale and Wakefield Substations approximately 20 MW of load is automatically transferred to the Davisville Substation. Despite the load transfer to Davisville Substation, load on the West Kingston T1 transformer is still projected to exceed its summer emergency rating.
- In 2010, for loss of a West Kingston transformer or the 3307 supply line to Wakefield and Bonnet Substations approximately 22 MW of load is transferred to the Davisville 84T3 supply line. The 84T3 line section backing up Bonnet Substation and a portion of the Wakefield Substation load is limited by 2/0 copper conductors with a summer emergency rating of 21.8 MVA. This load transfer will exceed the summer emergency rating of the 84T3 line section.
- In 2005, one distribution feeder in the Study Area is projected to exceed 100 percent of its summer normal (SN) rating and an additional six feeders are projected to exceed 90 percent of their SN rating. By 2013, twelve feeders are projected to exceed 100 percent of their SN rating.

The October 2004 Distribution Study determined that it will be necessary to add supply and distribution capacity to address existing and future thermal and reliability needs for the area. To provide the capacity, the study recommended the development of a new 115-12.47 kV substation at Tower Hill Road in North Kingstown, on a site owned by Narragansett adjacent to an existing ROW. The 115 kV transmission system would be extended approximately 3/4 of a mile from the existing G-185S ROW to the proposed Tower Hill Substation site along an existing ROW. The substation would be initially equipped with a single transformer and three regulated feeders. The ultimate layout of the substation would provide for two transformers and eight regulated feeders. The location of the proposed Tower Hill Substation and the tap lines that will serve it are depicted on Figure 2-2, sheet 4 of 9.

3.5 Conclusions

The October 2003 Transmission Study examined the transmission needs of the southern Rhode Island area. Based on cost and technical performance, Alternative 1 is preferred to address the southern Rhode Island transmission system needs. This alternative extends the existing 115 kV L-190 line from the Old Baptist Road Tap Point to West Kingston Substation and reconductors the existing L-190 transmission line from Kent County Substation to Old Baptist Road Tap Point. The preferred alternative also includes reconductoring the G-185S transmission line from Kent County Substation to the Old Baptist Road Tap Point by 2012, although not part of the Project.

Reconductoring of the 1870N and the 1870 transmission lines as part of the Project will increase the reliability of the transmission system. Once 1870N (West Kingston to Kenyon) and 1870 (Kenyon to Wood River) are reconductored, the 1870 SPS can be removed. These proposed upgrades and the removal of the 1870 SPS will maintain the Connecticut import capability and remove the reliability exposure that both southern Rhode Island and southeast Connecticut are exposed to if the 1870 SPS operates.

The October 2004 Distribution Study examined the distribution supply needs of southern Rhode Island. To increase distribution supply capability, the Study recommended construction of a new substation at Tower Hill Road in North Kingstown which will be supplied by 115 kV tap lines from the G-185S ROW.

4.0 Proposed Action and Project Descriptions

4.1 Introduction

Narragansett is proposing to construct a new 115 kV transmission line on an existing ROW between the Old Baptist Road Tap Point and the West Kingston Substation, passing through East Greenwich, North Kingstown, Exeter, and South Kingstown. Narragansett is also proposing to reconductor existing transmission lines in the City of Warwick, and the Towns of East Greenwich, North Kingstown, South Kingstown, and Charlestown. Reconductoring involves replacing the conductors of existing transmission lines with new larger conductors which are capable of carrying more power. In many cases it will be necessary to replace existing pole structures as part of the reconductoring projects. Narragansett is also proposing to construct a new 115-12.47 kV substation and transmission tap lines to the new substation in the Town of North Kingstown, and proposing to expand and modify an existing substation in the Town of South Kingstown. In order to meet the electrical needs of the southern Rhode Island area identified in Section 3, all of the component projects must be completed.

In this section of the Environmental Report, the overall scope of the Project is identified, and the individual projects and facilities comprising the Project are described. This section of the report also details Narragansett's construction and ROW maintenance practices, calculated EMF levels, safety and public health considerations, estimated Project costs, and the anticipated schedule for the Project.

The following Table 4-1 provides information on each component of the proposed Project.

Table 4-1: Project Description

Project Component	Length (miles)	Towns	Proposed Action
L-190 Reconductoring	5.3	Warwick, East Greenwich and North Kingstown	Reconductor the existing L-190 115 kV transmission line from Kent County Substation to the Old Baptist Road Tap Point.
L-190 Extension	12.3	East Greenwich, North Kingstown, Exeter, and South Kingstown	Construct new L-190 115 kV transmission line extension on existing ROW from the Old Baptist Road Tap Point to the West Kingston Substation.
1870N Reconductoring	4.3	South Kingstown and Charlestown	Reconductor the existing 1870N 115 kV transmission line from the West Kingston Substation to the Kenyon Substation.
1870 Reconductoring	3.9	Charlestown	Reconductor the existing 1870 115 kV transmission line from the Kenyon Substation to the Wood River Substation.
Tower Hill Tap Lines Construction	0.75	North Kingstown	Construct two new 115 kV transmission tap lines on existing ROW between the existing G-185S ROW and new Tower Hill Substation.
Tower Hill Substation Construction	—	North Kingstown	Construct a new 115-12.47 kV low-profile substation in the vicinity of Tower Hill Road to be supplied by the new 115 kV transmission tap lines.
West Kingston Substation Expansion	—	South Kingstown	Upgrade existing 115 kV equipment, add new 115 kV equipment and expand the existing 115 kV switchyard to accommodate the new L-190 115 kV transmission line extension.

4.2 Overall Scope of the Proposed Action

The Project will expand and significantly reinforce the existing transmission system in southern Rhode Island. A new 115 kV transmission line, two new tap lines and a new 115-12.47 kV substation will be constructed, existing 115 kV transmission lines will be reconductored, and an existing substation will be expanded and modified.

The proposed transmission system improvements will provide an additional 115 kV supply from the north to Narragansett's existing West Kingston Substation. This will be accomplished by extending the L-190 115 kV transmission line approximately 12.3 miles from its existing terminus at the Old Baptist Road Tap Point in East Greenwich to the West Kingston Substation, located in South Kingstown. To accept this new supply line, the existing West Kingston Substation will be expanded and modified through equipment additions.

The proposed transmission system additions also include the construction of a new 115-12.47 kV substation in the vicinity of Tower Hill Road in North Kingstown. This proposed substation will be served by two new 115 kV transmission tap lines, each approximately 0.75 miles in length originating from the existing G-185S ROW.

Lastly, the proposed transmission system reinforcements include the reconductoring of three existing 115 kV transmission lines in the southern Rhode Island area: the L-190 transmission line from the Kent County Substation in Warwick to the Old Baptist Road Tap Point in East Greenwich, the 1870N transmission line from the West Kingston Substation in South Kingstown to the Kenyon Substation in Charlestown, and the 1870 transmission line from the Kenyon Substation to the Wood River Substation in Charlestown.

The individual projects comprising the Project are described in more detail in the following sections. The locations and routes of the proposed transmission system additions and reinforcements are shown on Figure 2-1.

4.3 Description of the Projects

The following sections of this report provide a detailed description of the components of the proposed Project.

4.3.1 Reconductor 5.3 Miles of Existing L-190 115 kV Transmission Line from Kent County Substation to the Old Baptist Road Tap Point

Narragansett proposes to reconductor its existing L-190 115kV transmission line which runs a distance of approximately 5.3 miles between the Kent County Substation and the Old Baptist Road Tap Point. The transmission line is located in an existing 300-foot wide ROW held by Narragansett since the 1960s and which contains the L-190 115 kV transmission line, the G-185S 115 kV transmission line, and a 34.5 kV subtransmission line. The L-190 transmission line originates at the Kent County Substation located on Cowesett Road in Warwick and extends south through Warwick, through a portion of East Greenwich, into North Kingstown, and then back into East Greenwich to its southern terminus at the Old Baptist Road Tap Point (see Figure 4-1).

The 5.3 mile portion of the L-190 transmission line which is proposed to be reconductored contains 2.0 miles of single-circuit structures, and 3.3 miles of double-circuit structures. The single-circuit segments of this transmission line are supported predominantly by wood pole structures with a few exceptions. The first two structures outside of the Kent County Substation are single-circuit Y-Frame steel structures and the two structures spanning the Hunt River are single-circuit steel H-frame structures. The remaining 3.3 miles of the L-190 transmission line consist of double-circuit steel pole davit arm structures, which support both the L-190 transmission line and the adjacent G-185S transmission line.

To support the proposed reconductoring of the L-190 transmission line, it has been determined that the existing single-circuit wood structures will need to be replaced to provide the necessary strength and ground clearances required for the new, larger conductors. Additionally, two existing wood H-frame structures will be removed and replaced with steel structures to support new loadbreak switches which are proposed to be installed at the Old Baptist Road Tap Point. All of the existing single-circuit steel structures and all of the existing double-circuit steel structures of the L-190 transmission line have been analyzed and found to be adequate to support the proposed new conductors, and will therefore remain in place.

As a result, the scope of the proposed L-190 transmission line reconductoring project consists of replacing a total of 21 structures along the 5.3 mile route, and replacing the existing conductors and shield wires of the transmission line. The existing 795 kcmil AAC and ACSR conductors will be replaced with new 1113 and 1590 kcmil ACSR conductors, and the existing shield wires will be replaced with new 3/8-inch EHS steel shield wires. Existing insulators on all structures will be replaced with new 10-disc insulator strings. Tree trimming and "danger" tree removal will be performed along the existing ROW in conjunction with the transmission line reconductoring projects, but no new areas of tree clearing are proposed as part of this work. The proposed modifications will not significantly change the appearance of the existing facility.

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4.3.2 Construct New 12.3 Mile Extension of L-190 115 kV Transmission Line from the Old Baptist Road Tap Point to the West Kingston Substation

Narragansett proposes to construct a new extension of the L-190 115kV transmission line from its existing terminus at the Old Baptist Road Tap Point in East Greenwich a distance of approximately 12.3 miles to the existing West Kingston Substation in South Kingstown[8]. The new L-190 transmission line extension will be constructed within an existing ROW held by Narragansett since the 1960s, and will pass through portions of East Greenwich, North Kingstown, Exeter and South Kingstown. The route of the new L-190 transmission line extension is illustrated on Figure 4-2. From Old Baptist Road Tap Point to the Tower Hill Tap Point, the existing ROW is 300 feet wide and presently contains the G-185S 115 kV transmission line and a 34.5 kV subtransmission line. South of the Tower Hill Tap Point the existing ROW is 200 feet wide and contains only the G-185S transmission line.

The new L-190 transmission line extension will be constructed to the west of and adjacent to the existing lines on the ROW. In the segment of the ROW north of the Tower Hill Tap Point, the new L-190 transmission line extension will be constructed

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8 Post construction, the new L-190 line extension will be re-designated as the G-185S, and the existing G-185S from the Old Baptist Road Tap Point to West Kingston Substation will be designated as the L-190 transmission line.

73 feet west of the centerline of the existing G-185S transmission line as illustrated in Figure 4-3. In the segment of the ROW which is south of Tower Hill Tap Point, the new L-190 transmission line extension will be constructed 40 feet west of the G-185S centerline as illustrated in Figure 4-4.

The new L-190 transmission line extension will be constructed primarily with single-shaft steel pole davit arm structures supporting conductors in a delta configuration with one shield wire as shown in Figure 4-5. Other structure types will be required to support line angle and dead-end locations, or to hold loadbreak switches proposed as part of the transmission line facility. Whenever possible, new structures will be placed adjacent to existing structures of the G-185S transmission line.

Preliminary design indicates that a total of 148 structures will be required to support the new transmission line. Of the 148 structures, 128 will be single-shaft steel pole davit arm structures which are directly-embedded in the ground. The remaining 20 structures will also be steel pole structures, but will be set upon reinforced concrete caisson foundations to support the structural loads caused by line angles, deadend locations or the mounting of three loadbreak switches proposed in the transmission line. Pile foundations will be required to support structures located in unsuitable soil conditions. A total of 10 of the 128 direct embedment structures will require steel piling for installation. The steel pile foundations were selected in order to reduce impacts in regulated wetland areas. The conductors of the new L-190 transmission line extension will be 795 kcmil 54/7 ACSR “Condor” cable, and the new shield wire will be 3/8-inch EHS steel wire. Tree clearing will be required to create room for the new transmission line along the ROW. As shown on Figures 4-3 and 4-4, the width of required tree clearing varies from 34 to 65 feet, and totals approximately 61 acres of required tree removal along the 12.3-mile corridor.

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4.3.3 Reconductor 4.3 Miles of Existing 1870N 115 kV Transmission Line from the West Kingston Substation to the Kenyon Substation

Narragansett proposes to reconductor its existing 1870N 115kV transmission line which runs a distance of approximately 4.3 miles between the West Kingston Substation in South Kingstown and the Kenyon Substation located in Charlestown (see Figure 4-6). The transmission line runs along an existing 125 foot wide ROW held by Narragansett since the 1960s.

The 1870N transmission line consists of wood pole structures, primarily of an H-frame configuration. A significant number of the major components of the 1870N Transmission line are original and have been in service for approximately 40 years. As a result of transmission line age and changes in National Electrical Safety Code (NESC) loading criteria, it has been determined that 50 out of 57 of the existing transmission line structures will need to be replaced to provide the necessary strength and ground clearances required for the new, larger conductors. Due to their location in unsuitable soil conditions, 10 of the structures will be installed on new pile foundations, and the remainder will be directly-embedded.

All of the existing 795 kcmil AAC conductors of the 1870N transmission line will be replaced with new 1113 kcmil, 54/19 ACSR "Finch" conductors. The two existing shield wires of the transmission line will be replaced with new 3/8-inch EHS steel wires. Existing insulators on all structures will be replaced with new 10-disc insulator strings. As described in Section 4.3.1, vegetation maintenance will occur as part of this reconductoring project. The proposed modifications will not significantly change the appearance of the existing facility.

4.3.4 Reconductor 3.9 Miles of Existing 1870 115 kV Transmission Line from the Kenyon Substation to the Wood River Substation

Narragansett proposes to reconductor its existing 1870 115kV transmission line which runs a distance of approximately 3.9 miles between the Kenyon Substation in Charlestown and the Wood River Substation, also located in Charlestown (see Figure 4-7). The transmission line runs along an existing 125-foot wide ROW held by Narragansett since the 1960s.

The 1870 transmission line consists of wood pole structures, primarily of an H-frame configuration. A significant number of the major components of the 1870 transmission line are original and have been in service for approximately 40 years. As a result of transmission line age and changes in NESC loading criteria, it has been determined that 45 out of the 49 total transmission line structures will need to be replaced to provide the necessary strength and ground clearances required for the new, larger conductors.

All of the existing 795 kcmil AAC conductors of the 1870 transmission line will be replaced with new 1113 kcmil, 54/19 ACSR "Finch" conductors. The two existing shield wires of the transmission line will be replaced with new 3/8-inch EHS steel wires. Existing insulators on all structures will be replaced with new 10-disc insulator strings. As described in Section 4.3.1, vegetation maintenance will occur as part of this reconductoring project. The proposed modifications will not significantly change the appearance of the existing facility.

4.3.5 Expansion and Modifications at West Kingston Substation

The L-190 transmission line extension will increase transmission capacity into the West Kingston Substation which will require the upgrade of the existing 115kV equipment at the substation. The transmission line addition also requires that the existing 115kV switchyard be expanded to accommodate the new L-190 115kV transmission line position within the substation.

The West Kingston site currently consists of two separate fenced areas: a 34.5 kV yard and a 115 kV yard. In order to accommodate the new L-190 line, these two yards will be combined.

Significant yard grading will be required due to elevation differences at the site between the two yards. An access drive to adjacent RIDEM property will be relocated.

The existing oil circuit breakers and disconnect switches will be removed and replaced with new gas circuit breakers and new disconnect switches. A new gas circuit breaker with disconnect switches will be installed to support the new L-190 line.

The existing airbreak switches located outside the substation fenced area on transmission lines G-185S and 1870N will be removed. New motor operated airbreak switches will be placed on new steel deadend structures for both G-185S and the new L-190 transmission lines inside the expanded substation fence line. The 1870N transmission line requires a motor operated loadbreak switch which will also be placed on a new steel deadend structure inside the expanded substation fence line.

Figure 4-8 depicts the existing conditions and the proposed layout of the West Kingston Substation.

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4.3.6 Construct New Tower Hill Substation and Two New 115 kV Tap Lines

Narragansett proposes to construct a new 115-12.47 kV low-profile substation on a 13-acre parcel owned by Narragansett west of Tower Hill Road in North Kingstown. This proposed substation will be supplied by two new parallel 115 kV transmission tap lines, each approximately 0.75 miles in length, which will originate from the existing G-185S ROW and will be built on an existing Narragansett power line ROW.

The substation will be a standard 115 kV low profile substation as shown on the layout drawing, Figure 4-9. The ultimate layout of the Tower Hill Substation will include the following:

™ Two 115kV steel pole dead-end structures.
™ One 115 kV gas circuit breaker.
™ Two 115kV circuit switchers.
™ Two new 115-12.47kV 55 MVA power transformers.
™ A 36 foot by 14 foot control house.

™ Eight bays of low profile bus structures, 15 kV class circuit breakers, switches, voltage regulators, insulators, and buses.
™ Two 7.2 MVAr capacitor banks.
™ Miscellaneous substation equipment.

The new substation will be constructed within a fenced area approximately 150 feet by 255 feet. It will be located at the westerly side of property owned by Narragansett. A new driveway will be constructed to the substation from Tower Hill Road, a distance of approximately 800 feet. Duct banks to accommodate the 12.47 kV feeder cables will be installed underground along the driveway. The duct banks will be extended underground along Tower Hill Road to provide a connection to the existing overhead distribution system at West Allenton Road.

To supply the new Tower Hill Substation, Narragansett proposes to construct two new 115 kV transmission tap lines. Each of the new 115 kV transmission tap lines will be approximately 0.75 miles long, and will originate from the west, ultimately tapping the existing G-185S transmission line and the new L-190 transmission line extension as their sources as shown on Figure 4-2. These new transmission tap lines will be constructed along an existing ROW held by Narragansett since the 1960s, and which presently contains a 34.5 kV subtransmission line. The two new 115 kV transmission tap lines will be constructed parallel with and adjacent to the existing 34.5 kV subtransmission line, as illustrated in Figure 4-10. The existing 34.5 kV line will remain as is.

Preliminary design indicates that a total of seven structures will be required to support each of the new transmission tap lines. The new transmission tap lines will be constructed with single-shaft steel pole davit arm structures supporting conductors in a delta configuration with one shield wire. The conductors of the two new transmission tap lines will be 795 kcmil 54/7 ACSR "Condor" cable, and the new shield wires will be 3/8-inch EHS steel wire.

Tree clearing will be required to create room for the new transmission tap lines along the ROW. As shown on Figure 4-10, the width of required tree clearing varies from 103 feet to 108 feet along the ROW, and totals approximately five acres of required tree removal.

4.4 Construction Practices

The proposed transmission system improvements will be constructed using conventional overhead electric powerline and substation construction techniques. Hours of construction will be restricted in accordance with local requirements.

The transmission line work will be constructed in a progression of activities which will normally proceed as follows:

1. ROW clearing and BMP installation.
2. Access road construction and maintenance.
3. Installation of foundations and pole structures.
4. Conductor and shield wire installation.
5. Restoration of the ROW.

Each of these transmission line construction activities is described in the following sections. Substation construction activities are described in Section 4.4.6.

Narragansett will retain the services of an environmental monitor throughout the entire construction phase of the Project. The purpose of the environmental monitor will be to perform site inspections, ensure compliance with all applicable federal, state, and local permit conditions, and to maintain strict adherence to Narragansett policies.

4.4.1 ROW Clearing and Erosion Control Installation

Trees within portions of the ROW must be cleared to provide adequate clearance to electrical conductors and access for construction and maintenance of the transmission line and substation facilities. Initial clearing operations will include the removal of all tall growing woody species within the required portions of the ROW. The clearing will be performed in a manner which will maximize conservation of natural resources, and minimize soil disturbance and erosion.

Prior to clearing, the boundaries of wetlands will be clearly marked to prohibit unauthorized vehicular encroachment into wetland areas. Tall growing trees will be cut close to the ground leaving the stumps and roots in place, except where grading is required for access road construction or at structure sites. The clearing will be performed so that low-growing vegetation will be preserved wherever possible. The clearing and maintenance methods will encourage the growth of low-growing shrubs, ferns, wildflowers and grasses, thus helping to stabilize the cleared areas against erosion and providing a degree of natural vegetation control. Cleared trees will be chipped and removed from the site.

Where the ROW crosses an improved road, vegetative buffers will be left across the ROW where practicable to screen the view of the transmission lines. These buffers will be selectively cleared, leaving as much of the existing vegetation intact as possible. Larger trees within the buffer area may be topped or pruned to provide adequate conductor clearance, or will be removed where topping or pruning is not practical.

Special clearing methods will be used in environmentally sensitive areas such as wetlands. Where possible, cut trees will be removed from wetland areas then chipped and removed from the Project site. In certain wetlands where soft organic substrates exist and where attempting to remove felled trees would adversely impact the wetland, cut trees will be limbed and left to decompose in place. Where the ROW crosses streams and brooks, vegetation along the stream bank will be selectively cut using standard forestry equipment. Care will be taken to minimize the disturbance of soils and potential for project related erosion.

Equipment typically used during the ROW clearing phase of construction will include motorized tree shears, log skidders, chippers, and chain saws. Pickup trucks will be used to transport work crews and handheld equipment to work sites. Box trailers will be used to remove wood chips from work sites. Grading equipment such as a bulldozer may be used to prepare a level work area on which to set equipment for the clearing operation. Low-bed trailers will be used to transport tracked equipment which cannot be operated on public roads, from a staging area to the work site.

Following the ROW clearing activities, proper erosion control devices, such as hay bales and siltation fencing, will be installed in accordance with approved plans and permit requirements. The installation of these erosion control devices will be supervised by Narragansett's environmental monitor. The devices will function to mitigate construction-related erosion and sedimentation, and will also serve as a physical boundary to delineate resource areas and to contain construction activities within approved areas.

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4.4.2 Access Road Construction and Maintenance

Access roads are required to provide the ability to construct, inspect and maintain the existing and proposed transmission line facilities. For the projects involving the reconductoring of existing transmission lines, existing access roads are suitable in a majority of the areas. In some cases, existing access roads will require maintenance or upgrading to support the proposed construction activities. In areas of new transmission line construction, the establishment of new access roads will be required in some cases, and would be performed in conjunction with the tree clearing activities. In all cases, maximum feasible use will be made of existing access roads along the ROW.

Any new access roads will be located to minimize disturbance to environmentally sensitive areas and to abutters along the ROW. New access roads will be established over native soils wherever possible to minimize impact to the soil structure and to limit the amount of imported fill material. Access roads will follow the existing contours of the land as closely as possible, and, where practical, will avoid severe slope conditions. Roads will be constructed to avoid altering existing drainage patterns.

Special consideration will be given to construction of access roads within or adjacent to environmentally sensitive areas in order to minimize the potential impacts associated with construction. If it is necessary to grade soil in archaeologically sensitive areas, Narragansett will conduct an investigation of archaeological resources in accordance with a plan that has been pre-approved by the RIHPHC prior to installing the access road.

Access across wetland areas and streams, where upland access is not available, will be accomplished by the temporary placement of swamp mats. Swamp mats consist of timbers which are bolted together and placed over wetland areas so as to distribute equipment loads and minimize disturbance to the wetland and soil substrates. Such temporary swamp mat access roads will be removed following completion of construction.

Any access road construction will be carried out in compliance with the conditions and approvals of the appropriate federal and state regulatory agencies. Exposed soils on access roads will be wetted and stabilized as necessary to suppress dust generation. Crushed stone aprons will be used at all access road entrances to public roadways to clean the tires of construction vehicles and minimize the migration of soils off site.

Equipment typically used during the installation and maintenance of access roads will include dump trucks used to transport fill materials to work sites, and bulldozers, backhoes and graders which will be used to place fill materials or make cuts to achieve the proper access road profile. Hand held equipment such as shovels and picks will be used to make minor refinements to road surfaces. Cranes will be used to place swamp mats in locations where temporary access across wetland areas is proposed. Throughout the Project, pick-up trucks will be used to transport crews and hand held equipment to work sites. Low-bed trailers will be used to transport tracked equipment which cannot be operated on public roadways to the work site.

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4.4.3 Installation of Foundations and Pole Structures

Installation of foundations and pole structures will include excavation for the foundation or pole structure, setting the structure, and backfilling the excavation. Grading may be required at some structure locations to provide a level work surface for construction equipment and crews. Where structures are located in archaeologically sensitive areas, Narragansett will conduct an investigation for archaeological resources in accordance with a RIHPHC-approved plan prior to any site preparation or excavation.

If rock is encountered during excavation, rock removal can generally be accomplished by means of rock drilling. In the case of excavations for larger and deeper foundations, rock blasting could be necessary. If rock blasting is required, charges will be kept to the minimum required to break up the rock. Heavy mats will be used to contain the blast materials. Blasting activities will be performed in strict adherence to federal, state, and local regulations.

Direct embedment structures will require excavations ranging from approximately 10 to 15 feet in depth and three to six feet in diameter. Excavated material will be placed next to the excavation. Steel casings may be used to support the sides of deeper excavations. Once the structure has been properly positioned and plumbed within the hole, the excavation will be backfilled with the native soil or clean gravel, and tamped to provide structural integrity. Following the backfilling operation, any remaining excavation spoils will be spread over upland areas or removed from the site.

Dewatering may be necessary during excavations for structures near wetland areas. If there is adequate vegetation in upland areas to function as a filter medium, the water generally will be discharged to the vegetated land surface. Where vegetation is absent or where slope prohibits, the water will be pumped into a hay bale or silt fence settling basin which will be located in an upland area. The pump intake will not be allowed to rest on the bottom of the excavation throughout dewatering. The basin and all accumulated sediment will be removed following dewatering operations and the area will be seeded and mulched.

As previously discussed, some of the proposed transmission line structures will require reinforced concrete caisson foundations. Such foundations typically range from 15 to 30 feet in depth, and five to seven feet in diameter. Generally, steel casings will be used to support the sides of foundation excavations. Following the completion of foundation construction, excavated soil, clean gravel or concrete will be used to backfill around the foundation. The transmission structures are then erected upon the completed foundations. Any remaining excavation spoils are then spread over upland areas or removed from the site.

As previously described, some of the transmission line structures will require the support of steel or wood pilings, due to their location in unsuitable soil conditions. In such cases, temporary swamp mat access roads will be constructed out to the structure locations, and a pile-driver will be used to install the supporting piles. The pole structure will then be erected and secured to the pile system.

Equipment typically used during the installation of foundations and pole structures will include excavating equipment such as backhoes and clam shell diggers, rock drills and concrete trucks. Cranes will be used to erect structures. Hand held equipment including shovels and vibratory tampers will be used during the backfilling of foundations and pole structures. Dump trucks will be used to remove excavation spoils from the work site if necessary. A pile-driver will be used to install piles where required. Tracked equipment which cannot be operated on public roadways will be transported to the work site by means of a low-bed trailer.

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4.4.4 Conductor and Shield Wire Installation

Following the erection of transmission structures, insulators will be installed on the structures. Shield wires and conductors will then be installed using stringing blocks and tensioning equipment. The tensioning equipment is used to pull the conductors through the stringing blocks and to achieve the desired sag and tension condition. During the stringing operation, temporary guard structures or boom trucks will be placed at road and highway crossings, and at crossings of existing utility lines to ensure the public safety and the continued operation of other utility equipment. To minimize any additional disturbance to soils and vegetation, existing access roads will be used to the fullest extent possible in the placement of tensioning equipment.

The equipment which typically will be used during the conductor and shield wire installation operation includes puller-tensioners, conductor reel stands, and platform cranes. The booms of small cranes and bucket trucks may be used as guard structures during the stringing operation to prevent the conductors from falling across roads or other utility lines. Pickup trucks will be used to transport work crews and small materials to work sites.

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4.4.5 Restoration of the ROW

Restoration efforts, including final grading and installation of permanent erosion control devices, will be completed following the construction operations. All construction debris will be removed from the Project site and properly disposed of. All disturbed areas around structures and other graded locations will be seeded with an appropriate conservation seed mixture and mulched to stabilize the soils. Temporary erosion control devices will be removed following the stabilization of disturbed areas. Pre-existing drainage patterns, ditches, roads, walls, and fences will generally be restored to their former condition. Where authorized by property owners, permanent gates and access road blocks will be installed at key locations to inhibit access onto the ROW by unauthorized persons or vehicles.

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4.4.6 Substation Construction

The construction of the new Tower Hill Substation and the West Kingston Substation modifications would be accomplished using standard site development and substation construction techniques. The parcel on which the new Tower Hill Substation is to be constructed is essentially a cleared field. The lot is fairly level so there will be a minimal amount of earthwork. Organic soils will be removed and replaced with gravel fill to form a stable base for the substation equipment and access driveway. The majority of the organic material will be kept on site to create landscape berm features. The existing 34.5 kV transmission line traversing the site will remain in its present location.

The Tower Hill and West Kingston substation yards will be surfaced with a 6-inch thick layer of 3/4-inch crushed stone and surrounded by chain link security fences. Within the fenced in yards, concrete foundations will be constructed to support the various electrical equipment and pole structures. Most of the foundations are shallow with the exception of the transformers and structures that receive the transmission lines into the substation. If dewatering for these foundations is required, the water will be pumped into temporary hay bale settlement basins. At Tower Hill Substation, spill prevention control and countermeasure requirements will be addressed by the construction of a containment system around the transformers.

At both substations, the access driveway will be paved. Disturbed areas outside the substation fences and driveways will be re-vegetated.

Conventional construction equipment, such as backhoes, dump trucks, concrete trucks, equipment delivery trucks and cranes, will be used during the substation construction at Tower Hill and West Kingston Substations.

4.4.7 Environmental Compliance and Monitoring

Throughout the entire construction process, Narragansett will retain the services of an environmental monitor. The primary responsibility of the monitor will be to enforce compliance with all federal, state and local permit requirements and Narragansett company policies. At regular intervals and during periods of prolonged precipitation, the monitor will inspect all locations to determine that the environmental controls are functioning properly and to make recommendations for correction or maintenance, as necessary. In addition to retaining the services of an environmental monitor, Narragansett will require the construction contractor to designate an individual to be responsible for the daily inspection and upkeep of environmental controls. This person will also be responsible for providing direction to the other members of the construction crew regarding matters such as wetland access and appropriate work methods. Additionally, all construction personnel will be briefed on project environmental issues and obligations prior to the start of construction. Regular construction progress meetings will reinforce the contractor's awareness of these issues.

4.4.8 Construction Traffic

Construction-related traffic will occur over the proposed 12-month construction period. Access to the ROW for construction equipment will be gained from public roadways crossing the ROW in various locations along the route. Because each of the construction tasks will occur at different times and locations over the course of the construction, traffic will be intermittent at these entry roadways. Traffic will consist of various vehicle types ranging from pick-up trucks to heavy construction equipment.

Narragansett's contractor will coordinate closely with the Rhode Island Department of Transportation (RIDOT) to develop acceptable traffic management plans for work within state highways. Narragansett will coordinate with local authorities for work on local streets and roads. At locations where construction equipment must be staged in a public way, the contractor will follow a pre-approved work zone traffic control plan.

4.5 ROW Maintenance

As is the present case, vegetation along the ROW will continue to be managed 1) to provide clearance between vegetation and electrical conductors and supporting structures so that safe, reliable delivery of power to consumers is assured, and 2) to provide access for necessary inspection, repair and maintenance of the facility. All vegetation maintenance is carried out in strict accordance with National Grid's "*ROW Vegetation Management Policies and Procedures*" and the requirements of the Rhode Island Department of Environmental Management (RIDEM) Division of Agriculture as well as federal regulations as administered by the Environmental Protection Agency.

Vegetation maintenance of the ROW will continue to be accomplished using selective application of herbicides and by hand and mechanical cutting. Herbicides will continue to be applied by licensed applicators to select target species. Herbicides are never applied in areas of standing water or within designated protective buffer areas associated with wells, surface waters, and agricultural areas.

Narragansett currently utilizes a four- to five-year vegetation maintenance cycle on its transmission rights-of-way. Narragansett's ROW vegetation maintenance practices encourage the growth of low-growing shrubs and other vegetation which provides a degree of natural vegetation control. Vegetation maintenance of the ROW under and adjacent to the transmission lines will be accomplished with methods identical to those currently used in maintaining vegetation along the existing ROW.

4.6 Safety and Public Health Considerations

Narragansett will design, build and maintain the facilities for the proposed Project so that the health and safety of the public are protected. This will be accomplished through adherence to all federal, state and local regulations, and industry standards and guidelines established for protection of the public. Specifically, the proposed project will be designed, built and maintained in accordance with the NESC [9]. The facilities will be designed in accordance with sound engineering practices using established design codes and guides published by, among others, the Institute of Electrical and Electronic Engineers (IEEE), the American Society of Civil Engineers (ASCE), the American Concrete Institute (ACI), and the ANSI. Practices which will be used to protect the public during construction will include, but not be limited to, establishing traffic control plans for construction traffic on busy streets to maintain safe driving conditions, restricting public access to potentially hazardous work areas, and use of temporary guard structures at road and electric line crossings to prevent accidental contact with the conductor during installation.

Following construction of the facilities, all transmission structures and substation facilities will be clearly marked with warning signs to alert the public of potential hazards if climbed or entered. Trespassing on the ROW will be inhibited by the installation of gates and/or barriers at entrances from public roads.

A discussion of the current status of the health research relevant to exposure to EMF is attached as Appendix C. This report was prepared by Exponent, Inc.

4.7 Estimated Project Costs

Narragansett prepared study grade estimates of the costs associated with the proposed Project. Study estimates are prepared prior to detailed engineering and are prepared in accordance with National Grid USA Service Company Inc. Engineering Department Procedure EDP-GEN-2 entitled "Project Estimating Guide." Study grade estimates are prepared using historical cost data, data from similar projects, and other stated assumptions of the project engineer. The accuracy of study estimates is expected to be ± 25 percent. Estimated costs include costs of materials, labor and equipment, escalation, and Allowance for Funds Used During Construction (AFUDC). The estimated capital costs associated with the proposed Project are presented in Table 4-2.

Annual operation and maintenance activities for transmission lines include periodic ROW vegetation management, helicopter patrol, and miscellaneous route inspections. Since the ROW has an existing line on it, any increase in operation and maintenance costs will be nominal.

9 The NESC is an American National Standards Institute (ANSI) standard which covers basic provisions for safeguarding of persons from hazards arising from the installation, operation, or maintenance of 1) conductors and equipment in electrical supply stations, and 2) overhead and underground electric supply and communication lines. It also includes work rules for the construction, maintenance, and operation of electric supply and communication lines and equipment.

Substation operation and maintenance activities include periodic visual and operational inspections, thermo-vision inspection, yard maintenance, snow removal, and equipment maintenance. The estimated annual operation and maintenance costs for the Tower Hill Substation are $11,000.

Table 4-2: Estimated Project Costs

Project Components	Estimated Cost
Reconductor 5.3 Miles of Existing L-190 115 kV Transmission Line from Kent County Substation to the Old Baptist Road Tap Point	$1,900,000
Construct New 12.3 Mile Extension of L-190 115 kV Transmission Line from the Old Baptist Road Tap Point to the West Kingston Substation	$6,200,000
Reconductor 4.3 Miles of Existing 1870N 115 kV Transmission Line from the West Kingston Substation to the Kenyon Substation	$3,100,000
Reconductor 3.9 Miles of Existing 1870 115 kV Transmission Line from the Kenyon Substation to the Wood River Substation	$2,200,000
Construct Two New 0.75 Mile Tap Lines to Tower Hill Substation	$1,850,000
Construct New Tower Hill Substation	$7,000,000
Expand and Modify West Kingston Substation	$2,600,000
Equipment additions at Kent County Substation	$100,000
Equipment additions at Kenyon Substation	$100,000
Equipment additions at Wood River Substation	$50,000
TOTAL ESTIMATED PROJECT COST[10]	$25,100,000

4.8 Project Schedule

Narragansett anticipates starting construction of the facilities in the third quarter of 2006, and placing the facilities in service in the second quarter of 2007. This schedule is based on time duration estimates of project permitting, detailed engineering, materials acquisition, and construction. A schedule of major project tasks is shown in Figure 4-11.

10 ISO New England has approved regional cost recovery for the transmission lines and substation work, not including Tower Hill Substation and associated tap lines, as proposed, pursuant to Section 2 of Schedule 12C of Part II of the ISO New England Inc. Open Access Transmission Tariff and ISO Planning Procedure 4.

5.0 Alternatives to the Proposed Action

An important goal in the planning and development of the proposed electric transmission system improvements was to ensure that the solutions selected to meet the electrical system needs were the most appropriate in terms of cost and reliability, and that environmental impacts are minimized to the fullest extent possible. Analyses were undertaken to evaluate the feasibility of alternatives to the Project to ensure these objectives were met.

The alternatives analysis is presented in this section of the report. The alternatives analysis was performed in accordance with the EFSB criteria, which requires an analysis of alternatives to the Project, reasons for the applicant's rejection of those alternatives, and estimates of facility costs for each alternative considered. In Narragansett's alternatives analysis, a variety of alternative types were evaluated, including the "No-Build" alternative, alternative overhead routes for the L-190 transmission line extension, overhead alternatives utilizing the existing ROW, underground transmission line alternatives, alternative system improvements, alternative technologies, and alternative substation sites. Some of the alternatives were rejected based on feasibility assessments, or the inability of the alternative to address the identified system needs. Other alternatives which were found to be feasible and capable of addressing the identified need were further examined on the basis of estimated costs, operability, impact assessments and reliability assessments. The proposed action was found to best balance the EFSB's criteria of cost, reliability, and minimization of impacts to the human and natural environment.

5.1 No-Build Alternative – L-190 Transmission Line Extension

As detailed in Section 3.0 of this report, the proposed transmission system improvements are required to satisfy the transmission planning criteria of National Grid, the ISO-NE and NEPOOL, and NPCC. Due to existing and projected electricity demand levels in the southern Rhode Island area, these planning criteria require that the proposed transmission system improvements be completed to provide reliable electric supply to the areas served by the West Kingston Substation, the Kenyon Substation, the Wood River Substation, and the proposed Tower Hill Substation.

However, the regulations of the EFSB require examination of the "No-Build" alternative; that is, alternatives that do not require the building of the proposed 115 kV transmission line from the Old Baptist Road Tap Point to the West Kingston Substation.

There are three "No-Build" alternatives – 1) Demand Side Management (DSM) or Distributed Generation (DG), 2) Alternative 2 of the October 2003 Transmission Study that includes reconductoring G-185S and installing 115 kV capacitors, and 3) Alternative 3 of the October 2003 Transmission Study that includes reconductoring G-185S and installing a FACTS device. Alternatives 2 and 3 would ultimately require a significant upgrade such as the L-190 transmission line extension.

The first "No-Build" alternative is one that reduces the existing and projected demands on the existing transmission system. Such programs are referred to as DSM programs. This alternative could also include new technologies such as DG. The first "No-Build" alternative has been rejected because it is not a viable alternative as is discussed in Section 5.6.

The second "No-Build" alternative considered is Alternative 2 of the October 2003 Transmission Study which addresses thermal line loadings with a reconductoring of G-185S and maintains voltages with the installation of 115 kV capacitors as described in Section 3.4 of this report. This option was not chosen because it is more costly and would not perform as well as the proposed L-190 transmission line extension and thus would provide lower quality of service. This option would also create a more complicated system to operate.

The third "No-Build" alternative considered is Alternative 3 of the October 2003 Transmission Study which addresses thermal line loadings with a reconductoring of G-185S and maintains voltages with the installation of a FACTS device as described in Section 3.4 of this report. This option was not chosen because it is more costly and would not perform as well as the L-190 transmission line extension and thus would provide lower quality of service.

In conclusion, the first "No-Build" alternative is not a viable alternative to the Proposed Action, and the second and third "No-Build" alternatives are more expensive, technically inferior alternatives to the construction of the proposed transmission line extension.

5.2 Alternative Overhead Routes for the L-190 Transmission Line Extension

The geographic area in the vicinity of the proposed L-190 transmission line extension is variable with areas of hilly topography generally associated with glacial till and more level or gently rolling topography associated with glacial outwash. The Project

ROW crosses freshwater wetlands including swamps, marshes and watercourses. Development in the Project vicinity contains a mix of residential, commercial, and industrial land uses that is generally denser in the northern portions and sparser in the southern portions. Because of the development in the area and the time and expense associated with acquiring new ROW, Narragansett has selected the existing transmission line ROW between the Old Baptist Road Tap Point and the West Kingston Substation as the route of the proposed L-190 transmission line extension. To verify that no viable alternative overhead routes exist between the Old Baptist Road Tap Point and the West Kingston Substation, Narragansett examined the general vicinity for possible alternatives to the proposed route on the existing ROW.

5.2.1 Railroad ROW

In examining the Project area, Narragansett recognized that the Amtrak railroad ROW passes nearby both the Old Baptist Road Tap Point and the West Kingston Substation. As a result, Narragansett assessed the viability of using the railroad ROW as an alternative route to construct the L-190 transmission line extension. Through contact with Amtrak and research, Narragansett determined that the use of the railroad ROW as an alternative route was problematic for a variety of reasons.

Due to train traffic and schedules, the permissible hours of construction along the tracks would be severely restricted, and construction would only be allowed between the hours of 12:00 a.m. and 4:00 a.m., making the construction of the proposed transmission line impractical. Access restrictions due to train traffic and schedules would also make emergency or routine maintenance of the transmission line excessively difficult. High-speed train traffic would pose safety risks to workers constructing or maintaining the proposed transmission line. Similarly, Amtrak's electric catenary which powers the trains would be located beneath and adjacent to the proposed transmission line, and would pose a safety risk to workers constructing or maintaining the transmission line.

The need to purchase the rights and easements needed to install the transmission line along Amtrak's corridor would add to the cost of the proposed transmission line, and would also significantly extend the schedule for completing the required transmission system improvements.

For these reasons, Narragansett determined that using the railroad ROW as an alternative route for L-190 transmission line extension was not a viable alternative.

5.2.2 Acquire New ROW

Because a relatively direct route for the L-190 transmission line extension already exists on an established ROW, and because of residential and commercial development in the area, Narragansett concluded that establishing a new ROW was not viable. Pursuing the acquisition of new ROW would add significantly to the cost of the proposed Project and would likely result in the displacement of some residences and businesses. Developing a new ROW would not serve to minimize the environmental or social impacts of the Project, as the EFSB criteria require. Lastly, attempting to secure a new ROW between the Old Baptist Road Tap Point and the West Kingston Substation would substantially delay the Project. For these reasons, Narragansett determined that buying a new ROW route for the L-190 transmission line extension was not a feasible alternative.

5.2.3 Use of Public Streets and Highways

Another alternative route is the use of public streets and highways for the proposed L-190 transmission line extension. Narragansett generally requires a ROW 80 to 100 feet wide for a 115 kV transmission line. While transmission lines are constructed along public highways in some areas of the United States, Narragansett has never done so. In addition, this alternative would render the new transmission line very visible along the heavily traveled roadways. Since there is a viable alternative, this option was rejected.

5.3 Overhead Alternatives Using the Existing ROW

Within the existing Narragansett ROW, there were still several alternative configurations for constructing the L-190 transmission line extension that were considered. Narragansett examined several different types of structures which could be used to support the transmission line conductors. Narragansett examined these possible alternatives in detail to determine the advantages and disadvantages of each, as compared to the proposed option of installing the L-190 transmission line extension on single-shaft steel pole davit arm structures. By developing preliminary designs for several alternatives, Narragansett was able to accurately assess their impacts on project cost, reliability, visibility of the structures, EMF levels, wetlands, and the level of disturbance caused by construction. The following sections describe the alternatives considered and their advantages and disadvantages.

5.3.1 Construct L-190 Transmission Line Extension Using H-frame Structures

As proposed, the new L-190 transmission line extension will use single-shaft steel pole davit arm structures to support the conductors in a delta configuration along with one shield wire (refer to Figure 4-5). As an alternative, Narragansett evaluated using H-frame structures to support the new wires. H-frame structures consist of two pole shafts connected with a horizontal crossarm from which the conductors are suspended. A shield wire is carried at the top of each of the pole shafts. Narragansett created and evaluated a preliminary design for the H-frame alternative. The H-frame structure alternative was determined to have the following advantages and disadvantages relative to the proposed davit arm structure:

- H-frame structures would be 14 feet lower than davit arm structures on average, and as such would be marginally less visible in terms of their height.
- H-frame structures and davit arm structures would be relatively comparable in terms of their allowable span lengths, and as such, both designs would utilize approximately the same number of structures along the transmission line route.
- H-frame structures and davit arm structures are comparable in terms of their structural reliability.
- H-frame structures and davit arm structures are comparable in terms of their electrical reliability and performance.
- H-frame structures would have a wider configuration than davit arm structures, utilizing more room on the ROW and necessitating somewhat more tree removal than the proposed davit arm structures.
- H-frame structures would increase the installed cost of the new L-190 transmission line extension by $1.5 million (or about 25 percent) over the proposed davit arm configuration.
- Because H-frame structures consist of two poles, they would approximately double the required excavation and soil disturbance for installation as compared to the use of davit arm structures.

After considering the relative advantages and disadvantages of utilizing H-frame structures, Narragansett concluded that utilizing davit arm structures for constructing the new L-190 transmission line extension offered more advantages, created fewer impacts, and was a more cost-effective solution.

5.3.2 Construct L-190 Transmission Line Extension Using Double-Circuit Davit Arm Structures

As an alternative to constructing the new L-190 transmission line extension using single-shaft steel pole davit arm structures, Narragansett also evaluated utilizing a double-circuit structure to carry both the proposed L-190 transmission line extension and the existing G-185S transmission line. To achieve this, two new circuits would be constructed on a common single-shaft steel structure, and the existing G-185S transmission line would be removed from its present location. Narragansett created and evaluated a preliminary design for the double-circuit structure alternative; it was determined that the double-circuit structure alternative had the following advantages and disadvantages relative to the proposed davit arm structure:

™ Depending where it was located on the ROW, a double-circuit configuration could potentially require less tree clearing than would be necessary to add an additional single-circuit structure to the ROW.

™ Double-circuit structures and single-circuit davit arm structures would be relatively comparable in terms of their allowable span lengths, and as such, both designs would utilize approximately the same number of structures along the transmission line route.

™ Double-circuit structures and single-circuit davit arm structures would be comparable in terms of their structural reliability.

™ Double-circuit structures would be inferior to single-circuit davit arm structures in terms of their electrical reliability and performance. Common mode failure of double-circuit structures can result in loss of both lines. Double-circuit structures would increase the risk of a lightning strike or single transmission line fault causing both 115 kV transmission lines on the ROW to be interrupted. Loss of both lines would consequently result in a temporary loss of all load at substations tapped directly off these lines. These would include the Old Baptist Road, Davisville, Tower Hill, and West Kingston Substations.

™ Each double-circuit structure would require a reinforced concrete caisson foundation, as opposed to the single-circuit davit arm line which will only require concrete foundations at points of line angle and deadend locations. The additional foundations required for the double-circuit alternative would significantly increase the excavation and soil disturbance required for installation, and would increase the potential for impacts to environmental resources.

™ Double-circuit structures would be nine feet taller than single-circuit davit arm structures on average, and as such would be marginally more visible.

™ The larger and heavier steel structures required for a double-circuit transmission line, together with the need to get concrete trucks to each foundation location along the transmission line route, would significantly increase the level of access road improvements required for the Project, and the impacts associated with those improvements.

™ Double-circuit structures would increase the installed cost of the new L-190 transmission line extension by $8.2 million (or about 137 percent) over the proposed single-circuit davit arm configuration.

™ Constructing a double-circuit transmission line would unnecessarily remove, retire and replace the existing G-185S transmission line which is functioning adequately and is an established transmission source to the southern Rhode Island area.

After considering the relative advantages and disadvantages of utilizing double-circuit structures, Narragansett concluded that utilizing single-circuit davit arm structures for constructing the new L-190 transmission line extension offered more advantages, created fewer impacts, and was a much more cost-effective solution.

5.4 Underground Transmission Alternative

Narragansett considered an underground transmission line as an alternative to the proposed overhead L-190 transmission line extension. In its analysis, Narragansett identified and evaluated several possible routes, and developed a preferred route for the underground transmission line alternative. Cost estimates, reliability assessments, and impact assessments were developed for the underground alternative and compared with the proposed overhead alternative.

Underground relocation of the existing transmission lines is not a feasible or economical alternative to the proposed reconductoring projects so it was not evaluated.

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5.4.1 Description of Underground Alternative Routes

Narragansett considered three routes between the required end points, Old Baptist Road Tap Point and the West Kingston Substation. The routes included use of the Amtrak railroad corridor, use of the existing overhead ROW, and use of the public roadway network. In addition to connecting the endpoints, the underground route also would have to provide a means to serve the proposed Tower Hill Substation. The underground routes are depicted on Figure 5-1.

In the case of the Amtrak Corridor and the existing overhead ROW, the routes are well defined by the existing land uses. In the case of the public roadway network, there is some flexibility in route selection. The public roadway route was selected to be a reasonably direct connection between Old Baptist Road Tap Point and West Kingston Substation, passing by the site of the proposed Tower Hill Substation.

The routes are discussed in more detail in the following sections.

5.4.1.1 Amtrak Railroad Corridor

As shown on Figure 5-1, the Amtrak Corridor crosses the existing Old Baptist Road Tap near the Old Baptist Road Substation, and passes close to the West Kingston Substation, which is approximately 11.6 miles to the south. This corridor is a segment of the mainline Amtrak Northeast Corridor between Boston and New York City. There are two tracks within the corridor, and the corridor is electrified with an overhead catenary system which powers the electric trains. The catenary system is supported by closely spaced steel pole structures on both sides of the tracks.

There are a number of disadvantages with the Amtrak Corridor for an underground alternative:

- The existing multiple tracks and dense network of catenary support towers leave little room for installation of underground transmission facilities.
- Because it is a mainline railroad corridor, Amtrak would impose severe physical and time restrictions on installation of underground facilities. The initial indication from Amtrak is that installation would only be allowed between midnight and 4AM. With the required set-up and break-down time on the tracks, this would translate into a 2 to 3 hour work window per day, severely hampering installation progress and increasing project cost and duration.
- Access for maintenance and emergency repairs would be similarly restricted in the future.
- The presence of high speed train traffic and an electrified catenary along the corridor would pose a safety risk to workers during construction and maintenance of the line.
- The Amtrak Corridor does not pass by the site selected for the Tower Hill Substation. The nearest approach of the railroad to Tower Hill is 1.8 miles away. It would be necessary for the underground cables to leave the Amtrak Corridor and traverse the roadway network to get to Tower Hill Substation, and then return to the Amtrak Corridor by the same or different roads. This would make the overall cable length approximately 15.2 miles.
- The need to acquire property rights from Amtrak would increase project costs and increase implementation timeframes.

On a screening level, the significant construction and operational constraints associated with the Amtrak Corridor made the route unsuitable for underground installation, and the route was not developed further as an alternative.

5.4.1.2 Existing Overhead ROW Route

Installing an underground transmission line along the existing overhead transmission ROW between the Old Baptist Road Tap Point and the West Kingston Substation was examined. The route along the overhead ROW is approximately 12.3 miles. It would be necessary to install cable from the overhead ROW to the Tower Hill Substation and back, consisting of 1.5 miles of cable. This would make the underground route 13.8 miles.

There are a number of disadvantages with the use of the overhead ROW corridor for an underground transmission line:

- A significant portion of the overhead ROW is wetlands or wetland buffer zone.

With overhead construction, excavation primarily occurs at the tower locations, and it is possible in many cases to span wetlands and other sensitive areas. With underground construction, it is necessary to trench the entire route, or to use trenchless techniques such as directional drilling, which would create additional design, construction and economic issues. Underground construction techniques, therefore, would cause an increase in short and long term impacts to wetland resources.

™ There is a lake crossing (Secret Lake), and a number of stream crossings along the overhead ROW. Again, it is possible to span these areas with overhead lines, but special construction techniques would be necessary to install an underground line in these areas.

™ 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 underground line than for an overhead line.

™ In areas where the ROW is not owned in fee, Narragansett does not necessarily have rights to install underground lines.

The significant construction, operational and environmental constraints associated with the overhead transmission ROW corridor made the route unsuitable for underground installation, and therefore the route was dismissed as an alternative.

5.4.1.3 Public Roadway Network

An underground route was developed using the existing public roadway network. As illustrated on Figure 5-1, the route would originate along the Old Baptist Road Tap, near the existing Old Baptist Road Substation. It would either traverse Devil's Foot Road or the existing Old Baptist Road Tap ROW a short distance to Route 1. The route would proceed south on Route 1 to the Tower Hill Substation. The cable would enter and exit the Tower Hill Substation. Upon exiting the Tower Hill Substation, the route would continue south on Route 1 to Shermantown Road. The route would proceed west and south on Shermantown Road, south on Slocum Road, west on Stony Fort Road, south on North Road adjacent to the University of Rhode Island, west on Route 138, southwest on Liberty Lane, and south on Great Neck Road to the West Kingston Substation. The total distance is approximately 15 miles.

An underground route in the public roadway network does not pose the same construction and operational difficulties of the Amtrak alternative. Similarly, it would not have the environmental impacts of the existing overhead ROW route. However, the use of the public roadway network would create significant temporary impacts to the public during construction of the underground duct line system. Of the three underground routing possibilities examined, the use of the public roadway network was the most feasible. The roadway network option was used to develop the underground alternative to the proposed overhead line.

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5.4.2 Underground Cable Technology Assessment

At 115 kV, there are two underground cable technologies that were assessed for an underground alternative to the overhead L-190 transmission line extension. These are high pressure fluid filled (HPFF) pipe type cable and solid dielectric cable. A brief description of each follows.

5.4.2.1 High Pressure Fluid Filled Pipe Type

HPFF pipe type cable consists of three single core paper-insulated liquid-impregnated cables. Metallic tapes and "skid wires" are added to the insulated cables for shielding and mechanical protection. The cables are installed in a coated steel pipe. The steel pipe is filled with a synthetic dielectric fluid, which is pressurized to approximately 200 pounds per square inch (psi). Pressurizing equipment, consisting of pumps, reservoirs, and associated controls, are required at one or both terminal ends of the cable.

The HPFF pipe type cable system offers several advantages as compared to a solid dielectric cable system:

™ Long and successful experience record dating from 1930s, with extensive use in the United States.
™ Historically, very high reliability.
™ Steel pipe provides mechanical protection and compact circuit installation, accommodates three large-diameter cables, and allows for relatively long cable pulls.
™ Successful commercial operation at voltages from 69 kV through 345 kV.

Disadvantages of HPFF pipe type cable as compared to solid dielectric cable include:

™ Installation and maintenance of a cathodic protection system is required since the steel pipe is susceptible to corrosion.
™ The use of dielectric fluid presents possible environmental concerns.
™ Installation and maintenance of a pressurization system is needed at one or more of the terminal locations.
™ Additional pressurization systems are required for route lengths exceeding 10 to 12 miles.
™ A highly reliable auxiliary power supply is needed for the liquid pressurization system.
™ A communication system is needed for the liquid pressurization system alarms.
™ Relatively long repair times and complex procedures are necessary in the event of faults on the cable system.
™ Higher charging current requires devices such as shunt reactors or other voltage compensation at the terminals.

5.4.2.2 Solid Dielectric Cable

Solid Dielectric Cable consists of a conductor insulated with an extruded solid material. At 115 kV, the insulation can be either a plastic material known as XLPE, or a rubber material known as Ethylene Propylene Rubber (EPR). Additional layers are added to the insulated cables for shielding and mechanical protection.

Solid dielectric cables are typically installed in a duct line consisting of several polyvinyl chloride (PVC) conduits encased in concrete. Manholes are required at approximately 1,500 to 2,000 foot intervals to allow for splicing of the cables.

In comparison with HPFF pipe type cables, solid dielectric cables exhibit the following advantages:

- No pressurization system is required.
- Absence of dielectric fluid eliminates potential fire and environmental concerns.
- In most cases, less monitoring, control, and remote communication systems are required.
- Shorter repair time compared to HPFF pipe type systems.
- The system has lower operation and maintenance requirements.
- Lower charging current as compared to HPFF pipe type systems, thus relatively lower requirements for shunt reactors or other compensating devices.

Solid dielectric cable systems have the following disadvantages in comparison to HPFF cable systems.

- Manhole requirements are doubled for two parallel circuit configurations when compared to HPFF.
- Induced sheath voltages and losses normally require mitigation.
- Cable sheath surge voltage limiters are subject to failure and may cause undesirable grounding of the cable sheath.

5.4.2.3 Ampacity Requirements

The ampacity requirements for the underground transmission line alternative were determined through loadflow analysis and are presented in Table 5-1.

Table 5-1: Ampacity Requirements of the Underground Alternative

	MVA	Amps
Normal Operating Condition @ 90˚ C	225	1,130
24 Hr Emergency Condition @ 105˚ C	320	1,607

Ampacity calculations were completed for HPFF pipe type and XLPE cable systems. Normal and emergency ampacities were satisfied with a 3,000 kcmil copper solid dielectric insulated cable. For pipe type cables, it was determined that two parallel cables, each consisting of 1,250 kcmil copper conductors were necessary to satisfy ampacity requirements.

5.4.2.4 Underground Cable Technology Assessment Conclusion

A HPFF pipe type cable system would require two cables to satisfy ampacity requirements, while ampacity requirements would be satisfied with a single solid dielectric cable. Costs for the two-cable HPFF pipe type system would exceed the costs for the single solid dielectric system. The HPFF pipe type system would require at least two pressurizing plants, with the associated operating and maintenance requirements. There would be approximately 250,000 gallons of dielectric fluid in the HPFF pipe type system, as opposed to essentially no fluid in the solid dielectric system.

The HPFF pipe type system was evaluated as less suitable than solid dielectric cable for the southern Rhode Island transmission line for cost, operational, and potential environmental concerns. For these reasons, a cable system using solid dielectric technology was developed as the preferred underground alternative for this application.

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5.4.3 Description of Underground Construction

The solid dielectric underground transmission line alternative would consist of three insulated conductors installed in a duct and manhole system. The duct line would consist of nine six-inch PVC conduits encased in concrete. A typical trench cross-section is shown on Figure 5-2. Cables would be installed one cable per duct, between manholes spaced at 1,500 to 2,000 feet.

A typical trench design would be three feet wide and 5.5 feet deep. The design depth would be 2.5 feet to the top of the duct line concrete encasement. In addition to the power conductors, the duct line would contain a neutral cable for shield grounding, and fiber optic cables which would be used for the communication and relaying requirements of the transmission system. Spare conduits would be installed with the original installation to allow for installation of additional power conductors, should power flow requirements change in the future.
At the terminal ends, the cables would rise above ground through riser structures and would be terminated in the substation yard. An overhead to underground transition station, similar to a small substation, would be required at the Davisville Tap. The Tower Hill Substation would require two sets of cable terminations for the incoming and outgoing lines. The West Kingston Substation would be modified to accept an underground supply.

The typical construction progression for an underground installation would begin with the installation of precast concrete manholes. Excavation of the required trench would then commence. The PVC conduit would arrive in ten or twenty foot lengths and would be installed in the trench to form the duct bank. The assembled duct bank would be encased with concrete. The remaining backfill would be native soil or clean gravel. Roadways would be temporarily repaved as the construction progressed. Barriers and steel plates would be used along the trench route to provide protection and access ways for vehicles and pedestrians as necessary.

Once the manholes and duct lines were installed, the remaining construction activities would be confined to the terminals and manhole locations. These activities would consist of installing the cables in the conduits, splicing the cables at each manhole location and final testing. The ROW and streets would be restored following completion of construction.

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5.4.4 Underground Alternative Costs

Narragansett prepared study grade estimates of the underground transmission line alternative. The estimated capital costs associated with the underground alternative are as follows:

Table 5-2: Underground Alternative – L-190 Transmission Line Extension from Old Baptist Road Tap Point to West Kingston Substation – Estimated Cost

	Estimated Cost
Transmission	
Install a 15 mile 115 kV underground transmission line, from a transition station on the Old Baptist Road/Davisville Tap to Tower Hill Substation to West Kingston Substation (via roadway network)	$70,200,000
Reconductor 1.1 miles of the existing overhead 115 kV transmission line from Old Baptist Road Tap Point to proposed transition station	$600,000
Substation	
Davisville Transition Station	$800,000
Tower Hill Substation (Cable related modifications only)	$350,000
West Kingston Substation (Cable related modifications only)	$450,000
Total Capital Cost of Underground Alternative	$72,400,000

Source: The Narragansett Electric Company/Black & Veatch Corporation

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5.4.5 Underground Operational Issues

In addition to the significantly higher costs, there are a number of system and operational issues associated with underground transmission lines. These include:

™ Lengthy Outage Repair Times

When an overhead transmission line experiences an outage, it can typically be repaired within 24 to 48 hours. In the case of a failure of an underground transmission cable, repair times can be in the range of 100 to 300 hours or more. The extended outage times for underground cables expose the remainder of the transmission system to emergency loadings for longer periods of time. There is also increased exposure to loss of another transmission segment, with possible loss of load, during the extended underground outage.

™ Effect on Reclosing

Many faults on overhead lines are temporary in nature. Often it is possible to "reclose" (re-energize) an overhead line after a temporary fault, and return the line to service with only a brief interruption. Faults on underground transmission cables are almost never temporary, and the cable must remain out of service until the problem is diagnosed and repairs can be completed.

™ Capacitance

Underground cables have significantly higher capacitance than overhead lines, meaning that it takes reactive power (MVArs) to "charge up" the cable before the cable can transmit real power (MWs). This has several ramifications.

® Part of the cable's capacity is used up by the charging current, so larger conductors are needed to transmit the equivalent amount of power.

® Capacitance can create voltage control problems, meaning that the voltage can get too high when the transmission system is at light load. If the L-190 transmission line extension were placed underground between the Old Baptist Road Tap Point and the West Kingston Substation, there would be approximately 27 MVAr of charging. Loadflow analysis indicates that the transmission system can absorb this much line charging in this area, but the transmission system would be near the outer limit of acceptable voltage performance. If any additional underground line extensions were to be added in the area, voltage performance could become unacceptable, necessitating the installation of compensating devices, such as shunt reactors.

® Cable capacitance causes higher switching transient voltages on the system (voltage "spikes" during switching). This can damage other system components, may trigger the need to replace surge arresters throughout the area, and complicates future system expansions.

™ Cable Reactance

The underground cable would have a significantly lower series reactance than the overhead lines that would operate in parallel with the cable. What this means is that there would be an unequal split of the power flow between the overhead line and the underground cable, with the underground cable "hogging" the load. Under certain loading conditions, the underground cable could be operating at its thermal limit, while the overhead line would be operating well below its limit. This limits operating flexibility on the transmission system.

In order to better balance the load between the cable and the overhead line and the rest of the 115 kV system, it may be necessary to install series reactors at the terminal station(s) at an additional cost. These are non-typical transmission hardware components, and add a further level of complexity to the system.

™ Ratings

It is often difficult to match overhead line ratings with underground cables. It is also more difficult to upgrade ratings on underground lines should that become necessary in the future.

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5.4.6 Comparison of Underground and Overhead Alternatives

Underground and overhead transmission alternatives were compared on the basis of meeting the identified need, reliability, estimated costs and environmental considerations.

5.4.6.1 Meeting the Identified Need

Both the underground and overhead transmission alternatives would meet the identified need of providing a connection between the Old Baptist Road Tap Point and the West Kingston Substation, as well as providing a supply to the Tower Hill Substation. Both alternatives could be built with adequate capacity to meet present and future projected loads. However, it would take approximately 24 months longer to put the underground transmission lines alternative into service, due to longer engineering, licensing, material procurement and construction durations. As previously noted, the need for transmission system reinforcement is immediate, due to faster than projected load growth. Since the overhead alternative is anticipated to take months less to put into service, it will meet the identified need much sooner.

5.4.6.2 Reliability

The reliability performance characteristics of typical overhead and underground transmission lines differ. Unplanned interruptions of underground transmission lines are relatively infrequent. However, when an interruption does occur on an underground line, it takes a relatively long time to get the line back into service. In contrast, an overhead line can typically be returned to service much more quickly than an underground line.

The proposed project will add a second 115 kV connection between the Old Baptist Road Tap Point and the West Kingston Substation, and would create two supplies to the Tower Hill Substation. Because there would be two supplies to Tower Hill, and three supplies into West Kingston Substation, an unplanned interruption would occur only when there are overlapping interruptions of two or more circuits.

5.4.6.3 Environmental Considerations

The potential environmental impacts associated with the overhead and underground alternatives were compared. A complete discussion of the potential impacts associated with the proposed overhead alternative can be found in Section 8.0 of this report.

The overhead line will be constructed in an existing overhead ROW. Construction techniques would be used that would minimize effects on the natural environment for the overhead alternative. Disturbed areas would be allowed to revegetate with low growing plant species, similar to existing vegetation within the cleared portions of the ROW.

In the case of the underground alternative, the majority of the construction would occur within existing roadways. Assuming an on-road route, most of the environmental effects would be to the "manmade" environment, and would primarily occur during the construction of the lines. These would include significant temporary effects on traffic during conduit and cable installation. Other construction related impacts would include temporary increases in noise from construction vehicles.

Where the roadway route would pass through buffer areas adjacent to wetlands, proper construction techniques such as use of hay bales or other sedimentation barriers would be employed to protect those areas.

With the exception of transition station sites, there would be no visual impact with an underground line. Both the overhead and underground proposals would have little or no long term environmental effects.

5.4.6.4 Electric and Magnetic Fields

Underground cables are equipped with metallic shielding, and essentially have no external electric fields.

The underground lines would produce magnetic fields. Magnetic fields were calculated for the underground alternative. For an underground cable installed in public roads, the "edge of ROW" is not clearly defined, since the cable could be installed anywhere within the roadway alignment, and since road widths vary. Calculations were made one meter above grade directly over the cable trench. The normal peak load would be different in the line segments on either side of the Tower Hill Substation, so calculations are provided for both segments. Anticipated normal peak loads in 2006 and 2017 were used in calculations. Peak magnetic fields are summarized in Table 5-3. The magnetic fields drop off rapidly as distance from the cables increases.

Table 5-3: Magnetic Fields (mG) from Underground Alternative, Normal Peak Loading

Segment	2006	2017
Old Baptist Road Tap to Tower Hill Substation	136	138
Tower Hill Substation to West Kingston Substation	110	121

Source: Black & Veatch Corporation
Note: One Meter Above Grade Directly Over Cable

5.4.6.5 Economic Comparison of Overhead and Underground Alternatives

A comparison of facility construction costs for the underground and overhead transmission alternatives was performed. Estimated capital costs in 2005 dollars of the proposed overhead transmission project are presented in section 4.8 and the estimated capital costs of the underground alternative are presented in section 5.4.4.

Performing the L-190 extension as an underground line adds approximately 60 million dollars of additional construction costs to the overall Project cost. An economic comparison of the overhead and underground alternatives is shown in Table 5-4.

Table 5-4: Facility Construction Cost Comparison – Proposed Project and Underground L-190 Extension Alternative

Project Segments	Project as Proposed (L190 Line Extension Overhead) Estimated Cost	Underground Alternative for L190 Extension Estimated Cost
Reconductor 5.3 Miles of Existing L-190 115 kV overhead Transmission Line from Kent County Substation to the Old Baptist Road Tap Point	$1,900,000	$2,900,000
Construct New 12.3 Mile overhead extension of L-190 115 kV Transmission Line from the Old Baptist Road Tap Point to the West Kingston Substation	$6,200,000	NA
Construct New 15 mile underground cable system from Davisville Tap to West Kingston Substation, including reconductoring of part of the Davisville Tap, a transition station on the Davisville Tap, cable connections at Tower Hill Substation, and underground termination at West Kingston Substation.	NA	$72,400,000
Reconductor 4.3 Miles of Existing 1870N overhead 115 kV Transmission Line from the West Kingston Substation to the Kenyon Substation	$3,100,000	$3,100,000
Reconductor 3.9 Miles of Existing 1870 overhead 115 kV Transmission Line from the Kenyon Substation to the Wood River Substation	$2,200,000	$2,200,000
Construct New 0.75 Mile Overhead Tap Lines to Tower Hill Substation (two lines on preferred plan, one on alternate plan)	$1,850,000	900,000
Construct New Tower Hill Substation	$7,000,000	$7,000,000
Expand and Modify West Kingston Substation	$2,600,000	$2,600,000
Equipment additions at Kent County Substation	$100,000	$100,000
Equipment additions at Kenyon Substation	$100,000	$100,000
Equipment additions at Wood River Substation	$50,000	$50,000
TOTAL ESTIMATED PROJECT COST	$25,100,000	$91,350,000

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5.4.7 Conclusions

Both the overhead and underground alternatives would meet the identified needs of the Project and have virtually the same effects on reliability. Generally, the underground alternative on the public roadway network would have fewer environmental impacts than the preferred overhead alternative. There would, however, be greater temporary impacts to the public during construction. The significantly higher cost and the operational issues make the underground alternative much less preferred than the overhead alternative.

5.5 Alternative Sources of Supply

The preceding sections addressed reinforcing the southern Rhode Island area from the north with a supply from Kent County Substation in Warwick. As part of its alternative analysis, Narragansett identified two other electrical sources that are within a reasonable distance of the southern Rhode Island area. These include a source from the east (Aquidneck Island) and a source from the west (Connecticut). The following sections summarize the alternatives that were considered using these potential sources.

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5.5.1 Connection from Aquidneck Island

Geographically, there is a possible source to the southern Rhode Island area from the Aquidneck Island area to the east. Analysis was performed to determine if connecting the West Kingston Substation to Aquidneck Island via a 115 kV line would be a feasible alternative to the L-190 transmission line extension. This alternative is depicted in Figure 5-3.

Three variations of the Aquidneck Island alternative were considered. Each of these variations would include the installation of a new 115 kV transmission line between West Kingston Substation and Aquidneck Island.

In order to address the immediate voltage concerns, these variations also include a "common" short term solution of installing seven capacitor banks at the Kenyon, Wood River, and West Kingston Substations.

The variations relate to how the interconnection from the new common 115 kV transmission line is made to the rest of the transmission system on Aquidneck Island.

The 115 kV transmission line for Variation A and B would consist of the following segments:

- An overhead 115 kV transmission line following the existing ROW and the Tower Hill Tap ROW from West Kingston Substation to Rome Point at the shore in North Kingstown (approximately 12.0 miles).
- Underground cable from the termination of the overhead line to the shore (0.2 miles).
- A submarine 115 kV cable under the West Passage of Narragansett Bay (2.0 miles).
- Underground 115 kV cable across Jamestown (3.3 miles).

- Submarine 115kV cable under the East Passage of Narragansett Bay to a landfall in Newport (2.0 miles).
- Underground 115 kV cable from the landfall in Newport to Gate 2 Substation (0.9 miles).

All three variations would depend on two sections of submarine transmission cable under the West and East passages of Narragansett Bay. Repair times for submarine transmission cables typically exceed a month. This is a primary concern with any of the Aquidneck Island options. Each variation is discussed separately, below.

Variation A – Connection to Gate 2 Substation 69 kV System

Under Variation A, the following equipment would be installed:

- The 115 kV line from West Kingston Substation to Gate 2 Substation, as previously described.
- The common distribution station capacitor banks at the Kenyon, Wood River, and West Kingston Substations.
- At Gate 2 Substation, a new 115-69 kV substation to connect the new 115 kV line to the existing 69 kV system.
- At West Kingston Substation, a 115 kV circuit breaker to connect the Aquidneck Island connection to the 115 kV system.

A preliminary loadflow analysis revealed that Variation A had poor technical performance. Transmission system voltages were found to be unacceptable. Under certain contingencies, the system was found to be near voltage collapse. This variation was dropped from further consideration for these reasons.

Variation B – Convert 69 kV lines between Gate 2 and Dexter Substations to 115 kV

Under Variation B, the following project components would be installed:

- The 115 kV line between West Kingston Substation and Gate 2 Substation, as previously described.
- The common distribution station capacitor banks at the Kenyon, Wood River, and West Kingston Substations.
- The existing overhead 69 kV lines (61, 62 and 63) would be converted to 115 kV operation from Gate 2 Substation in Newport to Dexter Substation in Portsmouth.
- The existing 69 – 23 kV and 69 – 13 kV transformers at Gate 2, Navy, and Jepson Substations would be reconstructed for 115-23 kV and 115 – 13 kV operation, and the existing Dexter Substation would be reconstructed as a 115 kV switch yard.

A loadflow analysis of this option revealed that other transmission components in southern Rhode Island and on Aquidneck Island would become overloaded, and would require reinforcement. These included:

- Reconductoring the L14 line between the Tiverton Tap and Dexter Substation.
- Reconductoring the M13 line between the Tiverton Tap and Bent Substation.
- Reconductoring G-185S, 1870N and 1870 transmission lines in southern Rhode Island.

The total capital cost of Variation B was estimated to be $83 million.

Preliminary loadflow analysis revealed that Variation B would provide adequate technical performance. However, it would be significantly more expensive than the preferred alternative. Further, the amount of time required to build the 115 kV line from West Kingston Substation to Gate 2 Substation, and to install the additional upgrades, would be significantly longer than the timing to extend L-190 and associated upgrades. This variation would result in a delay in meeting the area's immediate need.

This variation would not remove the need to upgrade the G-185S. The reconductoring of 1870N and 1870 lines would still be required to remove the need for the 1870 SPS. Loadflow analysis suggests that the L-190 extension would still benefit the southern Rhode Island area.

This variation would also have the extended outage exposure of submarine transmission cables.

Based on the cost, timing, reliability, maintenance and potential environmental impacts of Variation B, this plan is not preferred in comparison to the proposed overhead L-190 transmission line extension.

Variation C – Extend 115 kV to Jepson Substation

Under Variation C, the following project components would be installed:

- A 115 kV line between West Kingston Substation and Jepson Substation include the following segments:
  - An overhead 115 kV transmission line from West Kingston Substation to the shore in North Kingstown (approximately 12.0 miles).
  - Underground cable from the termination of the overhead line to the shore (0.2 miles).
  - A submarine 115 kV cable under the West Passage of Narragansett Bay (2.0 miles).
  - Underground 115 kV cable across Jamestown (2.3 miles).

   - ® Submarine 115kV cable under the East Passage of Narragansett Bay to a landfall in Middletown (3.2 miles).
   - ® Underground 115 kV cable from the Middletown landfall to Jepson Substation (2.9 miles).

- ™ The common distribution station capacitor banks at the Kenyon, Wood River, and West Kingston Substations.
- ™ At Jepson Substation, a new 115-69 kV substation would be constructed to connect the 115 kV to the 69 kV, and the existing Dexter Substation would be reconstructed as a 115 kV switch yard.
- ™ The 61 and 62 overhead lines from Jepson Substation to Dexter Substation would be converted from 69kV to 115 kV.

As with Variation B, loadflow analysis of Variation C revealed that other transmission components in southern Rhode Island and on Aquidneck Island would become overloaded, and would require reinforcement. These included:

- ™ Reconductoring the L14 line between Tiverton Tap and Dexter Substation
- ™ Reconductoring the M13 line between Tiverton Tap and Bent Substation
- ™ Reconductoring G-185S, 1870N and 1870 transmission lines in southern Rhode Island.

The total capital cost of Variation C is estimated to be $79 million.

Preliminary loadflow analysis revealed that Variation C would provide adequate technical performance. However, as with Variation B, Variation C is significantly more expensive than the preferred alternative. Further, the amount of time required to build the 115 kV line from West Kingston Substation to Jepson Substation, and to install the additional upgrades, would be significantly longer than the timing to extend L-190 and associated upgrades. This variation would result in a delay in meeting the area's immediate need.

This variation would not remove the need to upgrade the G-185S. The reconductoring of 1870N and 1870 lines would still be required to remove the need for the 1870 SPS. Loadflow analysis suggests that the L-190 extension would still benefit the southern Rhode Island area.

This variation would also have the extended outage exposure of submarine transmission cables.

Based on the cost, timing, reliability, maintenance, and potential environmental impacts of Variation C, this plan is not preferred in comparison to the proposed overhead L-190 transmission line extension.

In summary, all of the Aquidneck Island options were inferior to the preferred plan in meeting the identified needs in a cost effective manner which minimizes projected-related impacts.

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5.5.2 Upgrades in Connecticut

The L-190 transmission line extension project is a reinforcement to the southern Rhode Island area that is sourced from the north. The southern Rhode Island area is also presently sourced from the west by the existing connection of the 115 kV line from Montville Substation in Connecticut. The October 2003 Transmission Study identified the need for additional reinforcement in the southern Rhode Island area to address low voltage violations and line loading violations as discussed in Section 3.4.2.1. Under peak load conditions and the loss of the G-185S transmission line from Kent County Substation to West Kingston Substation, it was observed that the remaining 115 kV supply from Connecticut did not adequately maintain voltages within the voltage criteria of the Transmission Planning Guide. In addition to the voltage violations, the study also identified line loading violations. Under peak load conditions and the loss of the 1280 transmission line from Montville Substation to Mystic Substation in Connecticut, the loading on the G-185S transmission line from the Old Baptist Road Tap Point to the West Kingston Substation exceeded the thermal equipment rating of the line.

A possible solution that would address the inadequate voltage support and the thermal loading issues is the construction of a second line in Connecticut from Montville Substation to Mystic Substation in parallel with the existing 1280 transmission line. The 1280 transmission line is 16 miles in length from Montville Substation to the Mystic Substation. This includes a tap to the Buddington Substation in Connecticut. A second line from Montville Substation to Mystic Substation would provide adequate voltage support on loss of G-185S and would eliminate the thermal overload on G-185S under the loss of 1280. It would require a number of years to build such a line. In order to address the immediate voltage concerns, this alternative included a short term solution of installing seven distribution station capacitor banks at the Kenyon, Wood River, and West Kingston Substations in the preliminary analysis.

The alternative of constructing a second 115 kV line in Connecticut would ultimately benefit the southeast Connecticut area more than the southern Rhode Island area. The system voltages would be adequately maintained in Connecticut in the longer term more than they would be in southern Rhode Island. In the long term, reliability concerns would return to the southern Rhode Island area and a reinforcement such as the L-190 extension would still be required to meet the growing load demand in southern Rhode Island. In addition, the second 115 kV line in Connecticut does not address the 1870 SPS. The reconductoring of the G-185S, 1870N and 1870 transmission lines would still be required to remove the need for the 1870 SPS.

Connecticut upgrades would only defer, not eliminate, the need for the Project. Based on this, technical performance and other considerations, the alternative of upgrading the Connecticut transmission system was rejected in favor of the L-190 transmission line extension.

5.6 Alternative Technologies

Alternative technologies that reduce the existing and projected demands on the existing transmission system were also considered in Narragansett's alternative analysis. The alternatives considered were DG and DSM. The following sections summarize these alternatives.

5.6.1 Distributed Generation

DG generally means small generators of kW to multi-MW size installed at a customer's point of use. Distributed Generation has a number of different uses, including emergency or backup power, peak shaving, premium power for critical loads, and combined heat and power[11]. Generation supply in New England is based on a competitive market model, which relies on the premise that if generation is a viable solution to market needs, then the market will respond to the needs. If, however, the market does not respond, as it has not in the case of the southern Rhode Island area, then transmission providers have an obligation to provide any transmission upgrades required to maintain reliable service to the system. Thus Narragansett Electric cannot rely on DG as an alternative to the Project.

5.6.2 Demand Side Management

DSM programs have been in use in Rhode Island for many years. They are geared toward reducing overall energy usage at customer facilities, and are funded with a state-mandated system benefits charge. Even with the many projects funded this way, Narragansett's peak load and energy requirements continue to grow. Existing customers add electric devices and appliances or increase their use of existing electrical equipment, and new customers are added to the service area continuously. Narragansett's DSM programs encourage energy efficient equipment and energy efficient new construction. These programs can only defer, not eliminate, the need for new investments in the transmission system in the state. Narragansett's load forecasts incorporate these expected load and energy reductions due to DSM programs. The need for the proposed transmission system improvements still exists

11 "Demand Response, Quick-Start, and Distributed Generation", Regional Transmission Expansion Plan (RTEP03), ISO New England, Inc. 2003

due to overall load growth in excess of what these programs have historically been able to accomplish.

As part of a larger effort to gauge how customer-side load management efforts can assist in managing load on the Company's transmission and distribution systems, the Company will conduct a targeted demand response (TDR) project in the area which the proposed transmission upgrades will serve. TDR involves enrolling customers in the area to shed load upon request by the Company during emergency loading events in exchange for an economic incentive. This effort will be conducted to provide some load relief in the event of delays in the proposed Project. Using this TDR approach is a new concept and not fully tested or proven. There are concerns relative to the amount of potential load shed available, as well as how often customers are willing to shed load.

Assuming sufficient load can be contracted to maintain a reliable supply to the area, each ensuing year would require additional load to be contracted for the TDR project. The amount of load that needs to be contracted would need to be at least equal to the growth in load in the area. The ability to contract TDR likely will become quickly saturated due to the fact consumers typically see greater value in receiving enough electrical service for their business and comfort needs versus the value in forgoing this additional service by being asked to interrupt their business processes. In addition, the number of hours in which the system is exposed to having to call on TDR resources would also increase as time goes on. As a result, it is likely that operating reliably with a dependence on TDR over an extended period of time may not be possible. With Narragansett's multi-year understanding of the existing DSM programs and the fact that a TDR program is still largely untested, the Company believes they are best suited as stop-gap measures rather than a long term alternative solution to the needs of the southern Rhode Island area.

Consequently, Narragansett is pursuing a TDR/DSM Program in the West Kingston area in preparation for having it available for short term operating relief in the event the Project, as proposed in this report, is not completed on schedule.

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5.6.3 Alternative Voltages

5.6.3.1 345 kV

In the October 2003 Transmission Study a 345 kV alternative was also considered and identified as Alternative 4 in the Study. This alternative is discussed in detail in Section 3.4.2 and was rejected because of its significantly higher cost as compared to the proposed alternative.

5.6.3.2 34.5 kV

To delay the need for the proposed L-190 transmission line extension to West Kingston Substation, an alternative plan was considered that would transfer approximately 70 MW of southern Rhode Island load to a source outside southern Rhode Island through additions to the 34.5 kV subtransmission system. The nearest source outside southern Rhode Island with adequate capacity would be the Kent County Substation. A new 115-34.5 kV substation with three 34.5 kV circuits, supplied by the L-190 and the G-185S transmission lines was considered at the Kent County Substation site. Two new 34.5 kV circuits would supply Bonnet and Wakefield Substations while a third new 34.5 kV circuit would supply Lafayette Substation and URI. Bonnet and Wakefield Substations are located approximately 18 miles and 22.5 miles, respectively, from Kent County Substation. Lafayette Substation and URI are located approximately nine miles and 16 miles, respectively, from Kent County Substation.

This plan would require approximately 45 miles of 795 ACSR 34.5 kV construction on transmission ROWs, 15 miles on supply line ROWs and eight miles along State Route 1A.

The two 34.5 kV lines from Kent County Substation would have to supply approximately 20 MW of load at Bonnet Substation and 30 MW of load at Wakefield Substation. For the contingency loss of a supply line to Bonnet and Wakefield Substations, the remaining supply line would have to support the entire 50 MW of load. Under a contingency condition, there could be voltage reliability concerns at both Bonnet and Wakefield Substations. To ensure voltage stability, load may have to be reconnected in small increments.

A significant portion of the 34.5 kV supply line construction between Bonnet and Wakefield Substations would be through wetlands, with associated potential impact and limited accessibility for construction, operation and maintenance. This alternative would also require major construction along Route 1A in North Kingstown and Narragansett, and would have significant temporary impacts to traffic flow along this route. A voltage stability study would also be required to confirm that voltage can be maintained at Bonnet and Wakefield Substations for the contingency loss of a supply line. The cost of the 34.5 kV alternative is summarized in Table 5-5.

Table 5-5: Estimated 34.5kV Alternative Costs

Type of Investment	Estimated Cost
Transmission	$5,000,000
Substation	$15,000,000
Distribution Supply Line	$56,000,000
Distribution	$2,000,000
Total Investment	$78,000,000

Due to the estimated cost of this plan, the technical challenges and the environmental impact, the 34.5 kV supply alternative is not a viable alternative to the proposed L-190 transmission line extension.

5.7 Alternatives to Tower Hill Substation

The October 2004 Distribution Study identified two alternatives for addressing the existing and projected needs of the study area through 2013. The study area is shown in Figure 2 of the October 2004 Distribution Study (Appendix B) and the service areas of the existing distribution substations are shown in Figure 5-4 of this report. The first alternative is a new 115-12.47 kV substation (identified as the Tower Hill Substation in this Environmental Report). The second alternative includes conversion of the existing Lafayette Substation, the rebuilding of the Peacedale Substation, expansion of Wakefield Substation, and substantial reinforcements to the overhead distribution system. This section of the Environmental Report also discusses a No-Build Alternative and alternative sites for the recommended new substation.

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5.7.1 No-Build Alternative

The October 2004 Distribution Study reviewed existing facilities in an area that serves approximately 50,000 customers with a 2003 peak load of 131 MW. The study indicated several overload possibilities of the existing facilities and projected an additional 41 MW of load growth over its 10 year planning horizon (2004 to 2013). The October 2004 Distribution Study reviewed the existing facilities serving the customers in the study area and identified the following problems:

™ Substation Loadings

® Peacedale Substation is a 34.5-12.47 kV distribution substation built in the 1970's. The projected 2004 summer peak load is 29.1 MW or 107 percent of one of the station's two transformers. Loss of one transformer or one of the 34.5 kV supply lines into the station would overload the remaining transformer.

- West Kingston Substation is a 115-34.5 kV transmission substation with a projected 2007 summer peak load of 75 MW. The substation is designed to automatically transfer 18 MW of load to Davisville Substation in the event of the loss of one of the station's two transformers. In 2007, the remaining transformer at West Kingston is projected to exceed its summer emergency rating after loss of one transformer and load transfer to Davisville Substation.

- 34.5 kV Distribution Supply Lines
  - In 2010 loss of one of the 34.5 kV distribution supply lines from West Kingston Substation that normally supplies the Wakefield and Bonnet substations would overload the 84T3 line that serves as a backup supply to these substations. This would result in load shedding of approximately 22 MW, leaving customers without power until repairs are completed. Such an outage could last from a few hours to a day or more and affect thousands of customers.
  - Similarly, loss of the 84T3 line in 2005 is projected to overload the 3312 supply line into Lafayette and Bostitch. This line also serves as backup to Hunt River Substation and Brown & Sharpe. This would result in load shedding of approximately 24 MW, leaving customers without power until repairs are completed.

- Overloaded Distribution Feeders
  - In 2006, two distribution feeders are projected to exceed 100 percent of their summer normal (SN) rating and an additional five (5) feeders are projected to exceed 90 percent of their SN rating. By 2013, twelve (12) of the nineteen (19) feeders in the study area are projected to exceed 100 percent of their SN rating.

In conclusion, the No-Build Alternative would result in near term equipment overloads at two substations and on several overhead supply and distribution lines. In addition, the existing capacity supplying the study area would not be able to adequately support load growth and new customers. Therefore the No-Build Alternative is not considered a feasible alternative to the recommended plan.

5.7.2 Conversion and Upgrades to Existing Facilities Alternative

One of the alternatives reviewed in the October 2004 Distribution Study included converting the existing 34.5–12.47 kV Lafayette Substation to a 115-12.47 kV substation, rebuilding Peacedale Substation, expanding Wakefield Substation and expanding the 34.5 kV supply system. This alternative, which is described in detail in Section 5.3 of the October 2004 Distribution Study (Appendix B), has the following disadvantages compared to the recommended plan:

™ Although either alternative can meet the 2013 projected load growth of 41 MW, the subsequent phases of this alternative to serve future load will be more expensive than the recommended alternative. This is due to the location of Lafayette Substation relative to the load center, and the limits of the 34.5 kV distribution supply system from West Kingston Substation. The major load centers are located in the Peacedale, Wakefield and Bonnet Substation areas and at URI. These load centers are beyond the reach of Lafayette Substation feeders and would have to be supplied by the 34.5 kV distribution supply system from West Kingston Substation. The recommended alternative has the flexibility to relieve Lafayette, Peacedale, Wakefield and Bonnet Substation areas. Distribution feeders can be installed along the local road network with minimal double circuiting or extensive underground work, creating a more reliable and cost-effective system.

™ This alternative could ultimately add only 47 MW of capacity into the system. This capacity would be utilized within the study period thereby requiring investments in new facilities to serve additional load beyond 2013. In comparison, the recommended alternative can ultimately add approximately 85 MW of capacity into the system which could serve new customers well beyond the study period.

™ In March 2005, URI announced a major expansion to their campus in Kingston. This expansion was not anticipated in the October 2004 Distribution Study and is not incorporated in the study's load projections. URI is supplied by the 34.5 kV distribution supply system from the West Kingston Substation. At full build out, the 34.5 kV distribution supply system from West Kingston Substation is limited to 72.8 MW by the overhead supply lines. Significant load growth at URI will utilize all available capacity of the 34.5 kV supply system. Without Tower Hill Road Substation, a new investment will be required to relieve the 34.5 kV supply system before the end of the study period.

™ The cost of this alternative which would add only 47 MW of capacity to the system is $9,800,000 which is $2,600,000 (36 percent) more than the recommended plan which would add 85 MW of capacity to the system.

Based on this analysis, the alternative of converting and upgrading existing facilities is not recommended. The recommended alternative provides more capacity and greater flexibility to serve future loads that can be expected beyond the study period. In addition, the estimated cost of the recommended plan is less than this alternative of converting and upgrading the existing facilities.

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5.7.3 Alternative Sites for the Proposed Substation

The recommended plan is the construction of a new substation on property owned by Narragansett west of Tower Hill Road. Narragansett evaluated a number of other potential substation sites in the Tower Hill Road vicinity.

5.7.3.1 Substation Siting Criteria

Potential substation sites are evaluated using the following criteria:

- An ability to tap the G-185S and proposed L-190 transmission lines. A site that is not adjacent to the supply lines or a transmission line ROW would make siting a substation impractical due to the requirement for obtaining the land rights necessary for extending transmission lines to the site.
- A location in the general vicinity of the load center which is served by the Lafayette, Old Baptist Road, West Kingston, Peacedale, Bonnet and Wakefield Substations as depicted on Figure 5-4. This allows efficient distribution of electricity, minimizes outage risks, minimizes distribution costs and is consistent with reliability and design criteria established by National Grid.
- A lot size and shape sufficient to allow construction of a substation. Generally a 115-12.47 kV substation requires a minimum of approximately four acres, depending on physical constraints such as slopes, wetlands and access considerations.
- Environmental constraints and impacts including visual considerations related to the site.
- The cost of developing the substation and associated facilities.

Six alternative sites for the proposed substation were reviewed against the above criteria. The alternative sites are Tower Hill East, Indian Corner Road, the Transmission Line Tap Point, Oak Hill Road Town Well Site, Route 4 Town Well Site and the RIDOT Property (Route 4 at West Allenton Road). The locations of these sites are shown on Figure 5-5. A summary of the important characteristics of each site follows.

5.7.3.2 Tower Hill East (Assessor's Plat 71, Lots 11, 20 and 21)

The site contains approximately 62 acres located on the east side of Tower Hill Road. It is approximately one mile from the transmission supply lines, but is located along an existing electric ROW. The site is owned by Narragansett and is currently crossed by a 34.5 kV sub-transmission line.

- The transmission tap lines would be approximately 6,000 feet long from the existing 115 kV transmission corridor. Distribution getaways would run along Tower Hill Road to serve the load, as with the preferred site.
- Much of the Tower Hill East site is wetlands although there are wooded upland areas adjacent to the cemetery that could be cleared for a substation. Grading may impact some wetlands and 100 year floodplain.
- The substation driveway may require wetlands disturbance and filling to access the site.
- The site is zoned rural residential with a zone 2 groundwater protection overlay district. Substations are allowed by Special Use Permit in this zone.

The longer transmission tap lines and survey, additional earthwork, wetlands mitigation and tree clearing would increase costs by approximately $1.8 million over the preferred alternative.

5.7.3.3 Indian Corner Road (Assessor's Plat 77, Lot 3)

This site is on the G-185S/L-190 transmission line corridor. The land is open space and is owned by the Town of North Kingstown. It contains approximately 62 acres and has frontage on Indian Corner Road.

- The substation supply lines would tap directly from the existing and proposed transmission lines adjacent to the site. Distribution getaways would run underground along Indian Corner Road and West Allenton Road for a significant distance to avoid overhead double circuiting, substantially increasing the cost over the preferred alternative.
- The land is zoned as Open Space with a groundwater protection overlay district and includes Donald Downs Park and Liscio Field. Substations are prohibited in the open space zone.

Due to the zoning restrictions and cost of distribution, this site is not considered a practical alternative to the proposed substation site.

5.7.3.4 Transmission Line Tap Point (Assessor's Plat 75, Lots 7 and 9)

This site consists of two landlocked parcels owned by Narragansett and containing approximately 14.2 acres. The site is directly adjacent to the G-185S/ L-190 transmission line corridor.

- The majority of the site is encumbered by wetlands. The zoning is residential with a groundwater protection overlay district. Substations are allowed by Special Use Permit in this zone.
- Due to the expanse of wetlands at this site, siting a substation would be very difficult. Because the site is landlocked, access would need to be developed along the Narragansett ROW to a local street, most likely Tower Hill Road. The length of the driveway would also impact wetlands and significantly increase distribution costs.

Due to the wetlands, access and cost issues, this site is not considered a practical alternative to the proposed substation site.

5.7.3.5 Oak Hill Road Town Well Site (Assessor's Plat 83, Lot 6)

This site, located south of Oak Hill Road and east of Route 4, is Town-owned land that contains three town wells. Each well has a 400-foot protective radius. The transmission line ROW traverses the property. The two parcels making up the water department site are zoned Rural Residential and Public Use. Both parcels are in the Zone 1 Groundwater Protection Overlay.

- The site is large enough for a substation. The area near the old DPW garage would be a likely location for the substation.
- The substation would be directly up gradient of the town wells within the Zone 1 recharge area. Groundwater flows from west to east across the substation site towards the town wells. The North Kingstown Water Department, in consultation with the Rhode Island Department of Health would have to approve the substation use on this site.
- A new access road must be constructed off Oak Hill Road. The existing water department access road could not be used because it is within the 400-foot protective radius of the wells. In addition security of the wellheads is a priority of the Water Department. A new driveway would run along the transmission ROW from Oak Hill Road. Wetlands within the Groundwater Protection Zone 1 would be impacted.
- The Water Department property would require a subdivision to create a legal parcel for Narragansett Electric. Substations are allowed by special use permit.

™ Distribution feeders would need to be constructed underground for a distance of 8600 feet along Route 4 and West Allenton Road. RIDOT would need to approve this construction and compare it to other alternative sites for the substation.

™ Distribution feeders would cross a fairly large stream flowing under Route 4 toward the wells. This crossing has not been designed and may impact costs.

™ Faults on underground feeders are more difficult to identify and repair resulting in longer and more costly outages.

™ Site investigation and possible remediation would be required for the former DPW garage area. The cost of such work has not been determined.

™ The lengthy underground distribution system and subdivision survey, possible removal of DPW garage, wetlands mitigation and tree clearing would increase costs by approximately $3.3 million over the preferred alternative and would significantly add to the time required to complete the needed electrical improvements.

Due to the proximity of the town wells, wetlands impacts and substantial increase in cost, this site is not considered a practical alternative to the proposed substation site.

5.7.3.6 Route 4 Town Well Site (Assessor's Plat 76, Lot 88)

This site, located west of Route 4 and north of the existing transmission line ROW, is Town owned land that contains one town well. The well has a 400-foot protective radius.

™ The transmission line ROW traverses the southern portion of property, outside of the 400 foot radius. The parcel of interest is zoned Rural Residential and is in a Zone 1 Groundwater Protection Overlay.

™ Development of this parcel is restricted by the following language in the deed conveying the property to the Town: "the use of the premises hereby conveyed shall be restricted in perpetuity to conservation purposes for public drinking water protection pursuant to Rhode Island General Laws section 46-15.3." Removal of this restriction would require, at a minimum, agreement of the Town and the former owner of the property. Sale of the property to Narragansett would require approval of the town at a general or special election pursuant to section 314 of the North Kingstown Charter.

™ Most of the area is wetland. There is a wooded upland area that would need to be cleared for a substation.

™ The substation would be within the Zone 1 recharge area. The North Kingstown Water Department, in consultation with the Department of Health would have to approve the substation use on this site.

- Access to the site is severely restricted. The existing water department access driveway off Route 4 would not be allowed for substation access because it is within the 400-foot protective radius. In addition security of the wellhead is a priority of the Water Department. There is no access to the site from West Allenton Road. Consequently, a new access road must be constructed off Route 4. Because this is a limited access section of Route 4, it is unlikely that RIDOT would approve access if there were other feasible alternatives.

- A driveway from Route 4 would require significant wetlands filling within the Groundwater Protection Zone 1 of the well and within the 100 year floodplain.

- Water department property would require a subdivision to create a legal parcel for Narragansett Electric.

- Distribution feeders would need to be constructed underground along Route 4 and West Allenton Road. RIDOT would need to approve this construction and compare it against other alternative sites for the substation.

- Underground feeders are less desirable from an outage repair perspective. Faults are more difficult to identify and repair resulting in longer and more costly outages.

- The lengthy underground distribution system and subdivision survey, additional earthwork, wetlands mitigation and tree clearing would increase costs by approximately $1.8 million over the preferred alternative and would significantly add to the time needed to complete the needed electrical improvements.

Narragansett has also examined a parcel it owns which is located adjacent to the Route 4 Town Well Site (Assessor's Plat No. 75, Lot 8). This Narragansett property is not subject to development restrictions and it would not be necessary to subdivide it for use as a substation. However, the other constraints discussed above would also be constraints to the use of the Narragansett parcel for the substation.

Due to the lack of access, proximity to the town well and potential wetlands impacts, these sites are not considered preferable to the proposed substation site.

5.7.3.7 RIDOT Property (Route 4 at West Allenton Rd)

This parcel which is located west of Route 4 at West Allenton Road was purchased by RIDOT for future safety improvements to the Route 4 and West Allenton Road intersection. RIDOT anticipates that the intersection improvements will occur within five or six years.

- Preliminary highway design suggests that there is no excess land beyond that needed by RIDOT for intersection improvements.

™ Since the land was purchased with federal funding, it is not possible for RIDOT to sell any excess land to a private party but must follow a procedure which includes offering the property back to the original owner.

™ There is not an existing ROW from the existing transmission line ROW to the site for the transmission tap lines into the substation. The land between the transmission line right of way and the site is developed so it would be very difficult if not impossible to secure new ROW for overhead tap lines.

Because of unavailability of the lot and the difficulty in obtaining a ROW for the tap lines, this site was rejected as a feasible alternative at a screening level.

5.7.3.8 Comparison of Alternative Sites

The following table provides a qualitative comparison of the alternatives to the recommended substation site off Tower Hill Road.

Table 5-6: Comparison of Alternative Substation Sites

Criteria	Tower Hill East	Oak Hill Road Town Well Site	Route 4 Town Well Site	RIDOT Property	Indian Corner Road	Transmission Line Tap Point
Environmental Impacts	Greater	Greater*	Greater	Similar	Greater	Greater *
Visibility	Similar	Less	Less	Greater	Similar	Less
Permitting	Similar	More Difficult	More Difficult	More Difficult	More Difficult *	More Difficult *
Acquisition Costs	Owned	Higher	Higher**	Unavailable*	Higher	Owned
Transmission Costs	Higher	Lower	Lower	Higher*	Lower	Lower
Substation Costs	Higher	Higher	Higher	Higher	Higher	Higher
Distribution Costs	Similar	Higher*	Higher	Higher	Higher	Higher

* Significant factors that make use of the site for substation infeasible.
**There would be no acquisition cost for the Narragansett-owned parcel adjacent to the Route 4 Town Well Site.

Based on this analysis, each of the alternative sites for the substation was found to be inferior to the proposed site. As such, the site on the west side of Tower Hill Road is recommended for the proposed substation.

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5.7.4 Alternative Configurations for the Tower Hill Tap Lines

As explained in section 4.3.6 and shown on figure 4-10, Narragansett proposes to build tap lines from the existing G-185S ROW to the new Tower Hill Substation on an existing 300-foot wide right of way that is presently occupied by a 34.5 kV sub-transmission line. Narragansett's preferred configuration and standard construction is single-shaft steel pole davit arm structures supporting three conductors in a delta configuration with one shield wire.

Narragansett has examined two alternative overhead configurations and an underground configuration for the tap lines as discussed below.

The first overhead configuration ("Alternative A" on figure 5-6) would arrange the tap lines in a horizontal configuration on two wood pole H-frame structures. This configuration is wider than the proposed configuration and would result in slightly more tree clearing (approximately 5 feet) but would also result in shorter typical structure heights (57 feet versus 71 feet for the proposed configuration). As shown in figure 5-6, the magnetic field levels at the south edge of the right of way under this alternative would be slightly higher than with the proposed configuration.

The second overhead configuration would arrange the transmission lines on single pole davit arm structures in a vertical configuration with the wires inboard of the poles. This configuration, which may require the use of concrete foundations for the structures, would reduce the amount of tree clearing required on the south edge of the right of way (approximately 20 feet less than with the proposed alternative) but would result in taller poles (80 feet rather than 71 feet with the proposed configuration). The magnetic field levels at the south edge of the right of way would be marginally lower with this configuration than with the proposed configuration.

In order to construct the Tower Hill Tap Lines underground, it would be necessary to construct a transition station (similar to a substation) at the proposed tap point on the transmission line ROW (east of Route 4) and construct an underground manhole and duct system for the underground cables from that point to the substation site. The tap point and the route of the tap lines include substantial areas of wetlands. It would be very difficult or impossible to obtain a RIDEM wetlands permit to construct the transmission station in, and underground cables through, these wetlands. In addition, constructing the tap lines underground would cost five to eight times more than the overhead tap lines as proposed. Locating the transition station away from the wetland and selecting a different route to the substation would add length and cost to the underground alternative for the Tower Hill Tap Lines. Thus from both an environmental and economic standpoint, constructing the tap lines underground is not a practical alternative.

5.8 Summary of Alternatives and Conclusions

In the development of the Project and selection of the preferred alternative, Narragansett developed and evaluated a variety of alternatives to the proposed action. Alternatives to the construction of the extension of the L-190 line included various No-Build alternatives, alternative overhead routes, alternative overhead configurations within the existing ROW, underground alternatives including various routes and cable types, alternative supplies and alternative technologies to alleviate the power supply deficiency identified in the October 2003 Transmission Study. Narragansett also considered alternative sites and tap line configurations to the proposed Tower Hill Substation.

The No-Build alternatives to the L-190 line extension included (1) implementing DSM or DG technologies, (2) reconductoring the G-185S line and installing new 115 kV capacitors, and (3) reconductoring the G-185S line and installing a FACTS device. These No-Build alternatives were dismissed due to impracticality (DSM/DG), complication of the transmission system, and reduced quality of service, respectively. As such, the No-Build alternatives were not considered to be viable.

In addition to the preferred alternative within the existing overhead ROW, three alternative overhead routes were evaluated: utilizing the Amtrak railroad ROW, purchase of new overhead ROW, and use of public streets and highways. These alternatives were concluded to be infeasible due to the need to locate and acquire new overhead ROW which is known to be a lengthy and expensive process (all alternatives), the difficulty of construction during a restricted time window (Amtrak alternative), and increased visual impact to the public at large (public roadway alternative). Thus these overhead alternatives were not considered to be preferable to the proposed action of constructing the new line within overhead ROW already controlled by Narragansett and already occupied by an existing transmission line.

Three overhead configurations were also considered within the existing ROW. These are: steel single pole davit arm construction, H-frame construction, and double circuit davit arm construction. Of these configurations, steel single pole davit arm construction for the L-190 transmission line extension was determined to be preferred due to environmental and cost considerations.

Various underground alternatives were considered. These included route alternatives using the Amtrak ROW, the existing overhead ROW, and the public roadway network. The public roadway network was determined to be the most viable underground alternative for constructability, maintainability, and environmental impact. Two underground cable technologies were considered: HPFF pipe type and solid dielectric. In developing an underground alternative, solid dielectric cable was found to be preferred for this application for environmental and operational factors, and cost. However, compared to the preferred overhead plan, the underground alternative was rejected due to significantly higher construction costs, negative operational issues, and ramifications on future expansion. Furthermore, the underground alternative was considered unsuitable to meet the Project purpose due to longer construction time frame which would not satisfy the present need.

Alternative sources of power and alternative technologies which were considered include an Aquidneck Island connection, potential upgrades in Connecticut, DSM/DG, and alternative voltages (345 kV and 34.5 kV). These alternatives were dismissed based on schedule, reliability, system operation, ROW availability, cost, and environmental issues.

Following an evaluation of the relative merits and short comings of the various transmission alternatives, the proposed action of constructing an overhead single circuit davit arm transmission line within the existing ROW was determined to be preferable to the other alternatives.

Alternatives to the proposed Tower Hill Substation included No-Build, conversion of Lafayette Substation to 115 kV, and development of other sites. These alternatives were considered inferior based on inability to meet the need (No-Build), cost and lack of long term flexibility to meet load growth (Lafayette Substation), and siting constraints (other sites). For these reasons, Narragansett has selected the Tower Hill Substation site as the preferred alternative. Finally, Narragansett has reviewed several alternative configurations for the Tower Hill Tap Lines. The proposed configuration (single pole davit arm structures) represents a balance among structure height, amount of tree clearing required and environmental impacts.

6.0 Description of Affected Natural Environment

This section of the Report describes the existing natural environment that may be affected by the proposed project, both within and surrounding the 115 kV transmission line ROW and substation sites. As required by the Rules and Regulations of the Energy Facility Siting Board, a detailed description of all environmental characteristics within and immediately surrounding the proposed Project has been prepared. The following section describes the specific natural features which have been assessed for the evaluation of impacts and the preparation of a mitigation plan. Information pertaining to existing site conditions has been obtained through available published resource information, the Rhode Island Geographic Information System (RIGIS) database, various state and local agencies, and field investigations of the Project site.

6.1 Project Study Area

A project Study Area was established to accurately assess the existing environment within and immediately surrounding the transmission line ROW. This Study Area consists of a 5,000 foot wide corridor centered on the existing transmission line ROW (refer to Figure 6-1)[12]. The boundaries of this corridor were determined to allow for a detailed inventory of existing conditions within and adjacent to the ROW.

6.2 Climate and Weather

The Rhode Island weather is largely influenced by the moderating effect of the Atlantic Ocean. In winter the average temperature is 30 degrees Fahrenheit (F) and the average daily minimum temperature is 20 degrees F. In the summer the average temperature is 70 degrees F and the average daily maximum temperature is 80 degrees F. Of the total annual precipitation of 49 inches, 22 inches or 45 percent usually falls in April through September. Average seasonal snowfall is 36 inches (Rector, 1981).

12 The figures cited in this chapter consist of five sheets covering the entire ROW from Kent County Substation to Wood River Substation.

6.3 Geology

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6.3.1 Bedrock Geology

The Project is located entirely within the Seaboard Lowland section of the New England physiographic province. This region consists of two areas of contrasting topography and bedrock: an upland region underlain by igneous and metamorphic rocks, and a lowland region underlain by downfolded sedimentary rocks known as the Narragansett Basin (Quinn, 1952).

In the vicinity of the Kent County Substation, the proposed transmission line Project is located within the upland region. This area is occupied by a Devoian age geologic formation. The bedrock of this area is classified as the Scituate Igneous Suite. This rock is characterized as granite, volcaniclastic rocks, alkali, feldspar, granite, monzonite, and granodiorite. The majority of the Project is located within this formation.

Where the transmission line crosses Frenchtown Road in East Greenwich and south to the crossing at Indian Corner Road in North Kingstown, the bedrock geologic formation is of Pennsylvanian age and belongs to the Narragansett Bay Group. This bedrock is a Rhode Island formation typically consisting of irregularly interbedded sandstone, conglomerate and shale with some beds of meta-anthracite.

From Indian Corner Road west to Carolina Back Road near Saw Mill Pond in Charlestown, the Rhode Island formation gives way to a third geologic formation crossed by the Project, referred to as the Esmond Igneous Suite. This rock is characterized by augen, granite, and gneiss. Small outcrops of metasedimentary, metaclastic rocks are present east of Shannock Road in Charlestown.

In the vicinity of Saw Mill Pond to Cedar Swamp in Charlestown, the bedrock geologic formation is of late Proterozoic age and belongs to the Sterling Igneous Suite. This rock is characterized as alaskite gneiss, a fine to medium grained leucocratic granite gneiss.

West of Cedar Swamp a sixth geologic formation is crossed by the transmission line Project. This bedrock geologic formation is from the Permian Age and belongs to the Narragansett Pier Plutonic Suite. The rock is characterized as medium-grained equigranular subsolvus granite, with lesser grandiorite and quartz monzonite.

The depth of bedrock varies throughout the extent of the Study Area. Numerous rock outcrops are present in the northern portions of the transmission line ROW north of Interstate 95 and in the vicinity of Major Potter Road. Within the southern portions of the Study Area, bedrock is at greater depths due to the presence of deep glacial outwash deposits.

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6.3.2 Surficial Geology

The present landscape of the Project area, as with much of the northeastern United States, was formed by the actions of the continental glacier of the Wisconsin glacial age, approximately 15,000 years ago. Many dynamic land forming processes occurred during this geologic event to produce the landforms and surficial geologic deposits within the Project area. Similar to the bedrock geologic deposits, the surficial geologic deposits within the transmission line ROW can be divided into two topographic areas – the higher, more rugged area to the north covered chiefly by till, and the lower, flatter area to the south covered by outwash deposits (Smith, 1955). Glacial till is material carried by and deposited directly by glacial ice with little or no reworking by running water. Therefore, this material shows little sorting, and stones are only poorly rounded. Glacial till is nonstratified glacial drift consisting of clay, silt, sand, stones and boulders transported and deposited by glacial ice. In contrast, outwash was deposited by the abundant meltwater which flowed from the shrinking glacier. This material is typically composed of well rounded stones and contains sorted silt, sand and gravel. Glacial outwash is common in valleys on landforms known as valley trains, outwash terraces, eskers, kame terraces, kames, and outwash fans or deltas. The boundary between these areas of till and outwash is often characterized by an abrupt change in slope. Surficial geologic characteristics of the Project corridor are depicted in Figure 6-2.

The upland till plains are the most extensive example of glacial till in Rhode Island. The till is derived mostly from granite, schist, and gneiss rock. Glacial stones and boulders are commonly scattered on the surface of these plains, and bedrock outcrops are present in some areas. Much of the till is relatively loose and unconsolidated. Some areas, however, were compacted, leaving deposits of dense material, or "hard pan," that is difficult to penetrate with a hand shovel.

The Narragansett till plains make up the area immediately around Narragansett Bay. This area is covered by glacial till derived from sedimentary rock, shale, sandstone, conglomerate, and, in a few places, coal. This till is generally compacted, dark gray to olive-colored, and finer textured than the till derived from granitic rock. The area has few bedrock outcrops, and most of the landforms are drumloidal, smoothed by the over-riding glacier.

Outwash deposits are widespread in small, scattered areas and broad, level plains. The outwash consists of particles of gravel, sand, silt, and to a lesser extent clay that were deposited in irregular layers by glacial meltwater as the water moved toward the sea. Some of the larger deposits of outwash in the Study Area are along the Pawcatuck River and in Warwick. Significant areas of outwash are located in almost every town and city in the State. Some of these outwash areas are capped with windblown deposits of silt.

6.3.3 Geological Hazards

Geological hazards such as earthquake and fault zones that could have negative impacts on transmission line or substation construction are not evident in the Study Area. Historically, seismic activity in the northeastern United States is the result of rebound in the earth's crust depressed by ice loading during the Pleistocine glacial event. These events are non-tectonic and do not usually result in vertical movement along faults. This rebound may cause moderate to very strong ground shaking locally and some horizontal movement, but this can be regarded as minimal for the design life of the Project.

6.3.4 Sand and Gravel Mining

Geologic deposits in the vicinity of the transmission line ROW that had been operated for sand and gravel mining are now inactive. The former gravel pit along the transmission line ROW located on the north side of Route 102 (Ten Rod Road) in North Kingstown which is partially within the ROW is now the Wickford Junction Shopping Plaza. A former gravel pit located within the ROW east of Route 4 in the vicinity of Secret Lake is now used by the Town of North Kingstown. A gravel pit north of Frenchtown Road (Route 402) in East Greenwich is inactive due to the relocation of Route 403.

6.4 Soils

Detailed information concerning the physical properties, classification, agricultural suitability and erodibility of soils in the vicinity of the Study Area are presented in this section. Descriptions of soil types identified within the Project area were obtained from the Soil Survey of Rhode Island (Rector, 1981), and from on-site investigations conducted by VHB The survey delineates map units that may consist of one or more soil series and/or miscellaneous non-soil areas that are closely and continuously associated on the landscape. In addition to the named series, map units include specific phase information that describes the texture and stoniness of the soil surface and the slope class. A total of twenty-seven (27) named soil series have been mapped within the Study Area. Table 6-1 lists the characteristics of the forty-five soil phases (lower taxonomic units than series) found within the Study Area. Figure 6-3 depicts soil classes grouped by drainage class and erodibility hazard.

Table 6-1: Characteristics of Soil Phases within the Study Area

Soil Map Unit Symbol	Soil Phase	Drainage Class	Percent Slope
Aa	Adrian muck	Vpd	0
AfB	Agawam fine sandy loam	wd	3-8
BhA	Bridgehampton silt loam	mwd	0-3
BhB	Bridgehampton silt loam	mwd	3-8
BmA	Bridgehampton silt loam, till substratum	wd-mwd	0-3
BmB	Bridgehampton silt loam, till substratum	wd-mwd	3-8
BoC	Bridgehampton – Charlton complex	wd-mwd	3-5
BnB	Bridgehampton – Charlton complex	wd-mwd	0-8
BnC	Bridgehampton – Charlton complex	wd-mwd	8-15
Co	Carlisle muck	vpd	0
CdB	Canton & Charlton fine sandy loam	wd	3-8
CeC	Canton & Charlton fine sandy loam	wd	3-5
ChB	Canton & Charlton v. fine sandy loam	wd	3-8
ChC	Canton & Charlton v. stony fine sandy loams	wd	8-15
EfA	Enfield silt loam	wd	0-3
EfB	Enfield silt loam	wd	3-8
HkA	Hinckley gravelly sandy loam	ed	0-3
HkC	Hinckley gravelly sandy loam	ed	Rolling
HkD	Hinckley gravelly sandy loam	ed	Hilly
HnC	Hinckley-Enfield complex	ed-wd	Rolling
MmA	Merrimac sandy loam	swed	0-3
MmB	Merrimac sandy loam	swed	3-8
NbB	Narragansett v. stony silt loam	wd	0-8
PaA	Paxton fine sandy loam	wd	0-3
PaB	Paxton fine sandy loam	wd	3-8
PbB	Paxton v. stony fine sandy loam	wd	0-8
Pg	Pits, gravel	ed-swed	Variable
QoC	Quonset gravelly sandy loam	ed	Rolling
RbB	Rainbow v. stony silt loam	mwd	0-8
Rc	Raypol silt loam	pd	--
Rf	Ridgebury, Whitman & Leicester ex. stony fine sandy loam	pd-vpd	--
Ru	Rumney fine sandy loam	pd	--
Sb	Scarboro mucky sandy loam	vpd	--
ScA	Scio silt loam	mwd	0-3
Ss	Sudbury sandy loam	mwd	--
SuB	Sutton v. stony fine sandy loam	mwd	0-8

Table 6-1: Characteristics of Soil Phases within the Study Area (Continued)

Soil Map Unit Symbol	Soil Phase	Drainage Class	Percent Slope
Tb	Tisbury silt loam	mwd	--
UD	Udorthents – urban land complex	mwd-ed	Variable
W	Water	--	0
Wa	Walpole sandy loam	pd	--
WcB	Wapping v. stony silt loam	mwd	0-8
WgA	Windsor loamy sand	ed	0-3
WgB	Windsor loamy sand	ed	3-8
WhB	Woodbridge fine sandy loam	mwd	3-8
WoB	Woodbridge v. stony fine sandy loam	mwd	0-8

Notes:
ed = excessively drained
wd = well drained
mwd – moderately well drained
swed = somewhat excessively drained
pd = poorly drained (hydric)
vpd = very poorly drained (hydric)
8-15 percent slope = highly erodable

Source: Soil Survey of Rhode Island (Rector, 1981)

6.4.1 Soil Series

The soil series detailed in the following subsections have been identified within the Study Area. The classification follows that published in the Soil Survey of Rhode Island (Rector, 1981).

6.4.1.1 Adrian Series

The Adrian series is classified as sand or sandy-skeletal, mixed, euic, mesic, Terric Medisaprists. These very poorly drained soils formed in organic material derived from herbaceous plants and are underlain by sand and gravel. The soils are in depressions and small drainageways of glacial till uplands and outwash plains.

6.4.1.2 Agawam Series

The Agawam series is classified as coarse-loamy over sandy or sandy-skeletal, mixed, mesic Typic Dystrochrepts. These well drained soils formed in glaciofluvial deposits derived mainly from schist, gneiss, and phyllite. The soils are on terraces and outwash plains.

6.4.1.3 Bridgehampton Series

The Bridgehampton series is classified as coarse-silty, mixed, mesic Typic Dystrochrepts. These well drained to moderately well drained soils have formed in outwash and glacial till deposits derived mainly from schist, gneiss, and phyllite. These soils have thick mantles of windblown silt and fine sand. The soils are on glacial till uplands and outwash terraces.

6.4.1.4 Bridgehampton and Charlton Series

The Bridgehampton series is classified as coarse-silty, mixed, mesic Typic Dystrochrepts. These well drained to moderately well drained soils formed in outwash and glacial till deposits derived mainly from schist, gneiss, and phyllite with thick mantles of windblown silt and fine sand. The Charlton series consists of coarse-loamy, mixed mesic Typic Dystrochrepts. These well drained soils formed in friable glacial till deposits derived mainly from schist and gneiss. Because these series are similar they are grouped and mapped together as a single complex.

6.4.1.5 Carlisle Series

The Carlisle series is classified as euic, mesic Typic Medisaprists. These very poorly drained soils are formed in deep organic deposits in depressions in outwash plains, till plains, and moraines.

6.4.1.6 Canton and Charlton Series

The Canton series is classified as coarse-loamy over sandy or sandy skeletal, mixed, mesic Typic Dystrocrept. These well drained soils formed in glacial till derived mainly from schist and gneiss. The similar Charlton series is classified as coarse-loamy, mixed, mesic Typic Dystrochrepts. These soils were also formed in glacial till derived mainly from schist and gneiss. Charlton soils have a finer textured substratum than Canton soils. Because these series are similar they are grouped and mapped together as an association.

6.4.1.7 Enfield Series

The Enfield series is classified as coarse-silty over sandy or sandy-skeletal, mixed, mesic Typic Dystrochrepts. These well drained soils are formed in silt mantled outwash deposits derived mainly from schist, gneiss, and phyllite. These soils are on terraces and outwash plains.

6.4.1.8 Hinckley Series

The Hinckley series is classified as sandy-skeletal, mixed, mesic Typic Udorthents. These excessively drained soils are formed in glaciofluvial deposits derived mainly from schist and gneiss. The soils are on terraces, outwash plains, and recessional moraines.

6.4.1.9 Hinckley and Enfield Series

The Hinckley series is classified as sandy-skeletal, mixed, mesic Typic Udorthents. These excessively drained soils are formed in glaciofluvial deposits derived mainly from schist and gneiss. The Enfield series is classified as coarse-silty over sandy or sandy-skeletal, mixed, mesic Typic Dysrochrepts. These well drained soils are formed in silt mantled outwash deposits derived mainly from schist, gneiss, and phyllite. These soils are grouped and mapped together as an association.

6.4.1.10 Merrimac Series

The Merrimac series is classified as sandy, mixed mesic Typic Dystrochrepts. These somewhat excessively drained soils are formed in outwash deposits derived from schist, gneiss, and phyllite. The soils are on outwash plains and terraces.

6.4.1.11 Narragansett Series

The Narragansett series is classified as coarse-loamy, mixed, mesic Typic Dystrochrepts. These well drained soils are formed in glacial till derived mainly from schist, gneiss, and phyllite. The soils are on side slopes and crests of glacial till upland hills. The soil surface ranges from non-stony to extremely stony.

6.4.1.12 Paxton Series

The Paxton series is classified as coarse-loamy, mixed, mesic Typic Fragiochrepts. These well drained soils are formed in compact glacial till derived mainly from gneiss and schist. They are on side slopes and crests of glacial till upland hills and drumlins. The soil surface ranges from non-stony to extremely stony.

6.4.1.13 Quonset Series

The Quonset series is classified as sandy-skeletal, mixed, mesic Typic Udorthents. These excessively drained soils are formed in glaciofluvial deposits derived mainly from phyllite, shale, schist, and gneiss. These soils are on terraces and outwash plains.

6.4.1.14 Rainbow Series

The Rainbow series is classified as coarse-loamy, mixed, mesic Typic Fragiochrepts. These moderately well drained soils are formed in silt mantled compact glacial till derived mainly from schist, gneiss, and granite. The soils are on drumlins and glacial till plains. The soil surface ranges from non-stony to very stony.

6.4.1.15 Raypol Series

The Raypol series is classified as coarse-loamy over sandy or sandy-skeletal, mixed, acid, mesic Aeric Haplaquepts. These poorly drained soils formed in windblown or water-deposited silts derived mainly from schist, gneiss, and shale. The soils are in depressions mainly on terraces and outwash plains.

6.4.1.16 Ridgebury, Whitman and Leicester Series

The Ridgebury, Whitman and Leicester series are commonly grouped together as one soil complex due to their similar properties. However, they are distinct series with individual classifications. The Ridgebury series is classified as coarse-loamy, mixed, mesic Aeric Fragiaquepts, the Whitman series is classified as coarse-loamy, mixed, mesic Humic Fragiaquepts and the Leicester series is classified as coarse-loamy, mixed, acid, mesic Aeric Haplaquepts. Ridgebury and Leicester soils are poorly drained and Whitman soils are very poorly drained. Whitman and Ridgebury soils have a dense till layer within one meter of the soil surface. These soils are formed in loamy glacial till derived mainly from schist, gneiss and granite. These soils are in depressions, drainageways in glacial till uplands, and nearly level areas of glacial upland hills and drumlins.

6.4.1.17 Rumney Series

The Rumney series is classified as coarse-loamy, mixed, nonacid, mesic Aeric Fluvaquents. These poorly drained soils are formed in recent alluvium derived mainly from granite, gneiss, and schist. The soils are on flood plains.

6.4.1.18 Scarboro Series

The Scarboro series is classified as sandy, mixed, mesic Histic Humaquepts. These very poorly drained soils have thin organic surfaces over sand deposits derived mainly from schist, gneiss, and shale. The soils are in depressions and drainageways in outwash plains and terraces.

6.4.1.19 Scio Series

The Scio series is classified as coarse-silty, mixed, mesic Aquic Dystrochrepts. These moderately well drained soils are formed in silt mantled glacial till derived mainly from schist, gneiss, and phyllite. The soils are on side slopes and crests of glacial upland hills, and in depressions in terraces and outwash plains.

6.4.1.20 Sudbury Series

The Sudbury series is classified as sandy, mixed, mesic Aquic Dystrochrepts. These moderately well drained soils are formed in glaciofluvial deposits derived mainly from schist and gneiss. These soils are on terraces and outwash plains.

6.4.1.21 Sutton Series

The Sutton series is classified as coarse-loamy, mixed, mesic Aquic Dystrochrepts. These moderately well drained soils are formed in glacial till derived mainly from schist, gneiss and granite. The soils are on side slopes and in depressions of upland hills. The soil surface ranges from non-stony to extremely stony.

6.4.1.22 Tisbury Series

The Tisbury series is classified as coarse—silty over sandy or sandy-skeletal, mixed, mesic Aquic Dystrochrepts. These moderately well drained soils are formed in glaciofluvial deposits derived mainly from schist, gneiss, and granite. The soils are on outwash terraces.

6.4.1.23 Udorthents Series

Udorthents are moderately well drained to excessively drained soils that have been cut, filled, or eroded. The areas have had more than two feet of the upper part of the original soil removed or have more than two feet of fill on top of the original soil. Udorthents are extremely variable in texture. They are on glacial till plains and gravelly outwash terraces.

6.4.1.24 Walpole Series

The Walpole series is classified as sandy, mixed, mesic Aeric Haplaquepts. These poorly drained soils are formed in glaciofluvial deposits derived mainly from schist, gneiss, and granite. The soils are in depressions and drainageways.

6.4.1.25 Wapping Series

The Wapping series is classified as coarse-loamy, mixed, mesic Aquic Dystrochrepts. These moderately well drained soils are formed in silt mantled glacial till. The soils are on side slopes or in depressions of glaciated uplands.

6.4.1.26 Windsor Series

The Windsor series is classified as mixed, mesic Typic Udipsamments. These excessively drained soils are formed in glaciofluvial deposits and Pleistocene dunes derived mainly from schist, gneiss, and phyllite. The soils are on terraces, outwash plains, kames, and eskers.

6.4.1.27 Woodbridge Series

The Woodbridge series is classified as coarse-loamy, mixed, mesic Typic Fragiochrepts. These moderately well drained soils are formed in glacial till derived mainly from schist, gneiss, and phyllite. The soils are on lower slopes and crests of upland hills and drumlins.

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6.4.2 Prime Farmland Soils

Prime farmland, as defined by the United States Department of Agriculture (USDA), is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when it is treated and managed using acceptable farming methods.

Rhode Island recognizes thirty-five prime farmland soils. The proposed Project will cross thirteen prime farmland soil units as listed in Table 6-2.

Table 6-2: USDA Prime Farmland Soils within the Study Area

Soil Map Unit Symbol	Name	Percent Slope
AfB	Agawam fine sandy loam	3 to 8
BhA	Bridgehampton silt loam	0 to 3
BmA	Bridgehampton silt loam, till substratum	0 to 3
CdB	Canton and Charlton fine sandy loams	3 to 8
EfA	Enfield silt loam	0 to 3
MmA	Merrimac sandy loam	0 to 3
MmB	Merrimac sandy loam	3 to 8
PaA	Paxton fine sandy loam	0 to 3
PaB	Paxton fine sandy loam	3 to 8
ScA	Scio silt loam	0 to 3
Ss	Sudbury sandy loam	0 to 3
Tb	Tisbury silt loam	0 to 3
WhB	Woodbridge fine sandy loam	3 to 8

Prime farmland soils could be utilized as cropland, pastureland, rangeland, forestland, or other land. Urbanized land and water are exempt from consideration as prime farmland. Within the Study Area, prime farmland soils exist on land occupied by cleared ROW, forestland, turf and roads. At the present time, turf farms in the vicinity of Indian Corner Road, Slocum Road, Yawgoo Valley Road and Kingston Road (Route 138) are being commercially managed. A hayfield in the vicinity of the proposed Tower Hill Substation and transmission line tap is located in prime farmland soils.

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6.4.3 Farmland of Statewide Importance

Farmland of statewide importance is land, in addition to prime farmland, that is of statewide importance for the production of food, feed, fiber, forage and oilseed crops. Generally, farmlands of statewide importance include those lands that do not meet the requirements to be considered prime farmland, yet they economically produce high yield of crops when treated and managed with modern farming methods. Some may produce as high a yield as prime farmland if conditions are favorable.

The State of Rhode Island has expanded its definition of farmland of statewide importance to include all prime farmland areas. Therefore, in Rhode Island, all prime farmland soils are also designated as farmland of statewide importance, however, all soils designated as farmland of statewide importance are not prime farmland.

Table 6-3 lists soil units designated as farmland soils of statewide importance that are found within the Study Area.

Table 6-3: Farmland Soils of Statewide Importance within the Study Area

Soil Map Unit Symbol	Name	Percent Slope
BhB	Bridgehampton silt loam	3 to 8
BmB	Bridgehampton silt loam, till substratum	3 to 8
EfB	Enfield silt loam	3 to 8
HkA	Hinckley gravelly sandy loam	0 to 3
HkC	Hinckley gravelly sandy loam	Rolling
HnC	Hinckley-Enfield complex	Rolling
QoC	Quonset gravelly sandy loam	Rolling
Rc	Raypol silt loam	0 to 5
Ru	Rumney fine sandy loam	0 to 3
Wa	Walpole sandy loam	0 to 8
WgA	Windsor loamy sand	0 to 3
WgB	Windsor loamy sand	3 to 8

Source: Soil Survey of Rhode Island (Rector, 1981).

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6.4.4 Erosive Soils

The erodibility of a soil is dependent upon the slope of the land occupied by the soil and the texture of the soil. Soils are given an erodibility factor (K), which is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values in Rhode Island range from 0.10 to 0.64 and vary throughout the depth of the soil profile with changes in soil texture. Very poorly drained soils and certain floodplain soils usually occupy areas with little or no slope. Therefore, these soils are not subject to erosion under normal conditions and are not given an erodibility factor. Soil map units described as strongly sloping or rolling may include areas with slopes greater than eight percent and soil map units with moderate erosion hazard are listed in Table 6-4.

Table 6-4: Project Area Soil Mapping Units with Potential Steep Slopes

Soil Map Unit Symbol	Soil Phase	Percent Slope	Surface K Values
BnC	Bridgehampton – Charlton complex	8-15	0.49
ChC	Canton & Charlton v. stony fine sandy loams	8-15	0.17
HkC	Hinckley gravelly sandy loam	Rolling	0.17
HkD	Hinckley gravelly sandy loam	Hilly	0.17
HnC	Hinckley-Enfield complex	Rolling	0.17/0.49
QoC	Quonset gravelly sandy loam	Rolling	0.17

Source: Soil Survey of Rhode Island (Rector, 1981).

6.5 Surface Water

The proposed Project lies within the Narragansett Bay drainage basin and the Pawcatuck River drainage basin of Rhode Island.

A drainage basin is the area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel (Dunne and Leopold, 1978), and is synonymous with watershed. Within the Narragansett Bay drainage basin and the Pawcatuck River drainage basin are numerous subordinate watersheds associated with river systems. The Narragansett Bay Basin includes the system of waterways that discharge into the Atlantic Ocean between Point Judith in Narragansett and Sakonnet Point in Little Compton. The Narragansett Bay Basin also comprises the watershed tributaries to Narragansett Bay and the small waterways that flow into the Atlantic Ocean from Sakonnet Point east.

The waters of the State of Rhode Island (meaning all surface water and groundwater of the State) are assigned a Use Class which is defined by the most sensitive, and therefore governing, uses which it is intended to protect. Waters are classified according to specific physical, chemical and biological criteria which establish parameters of minimum water quality necessary to support the water Use Classification. The water quality classification of the major surface waters within the Study Area are identified in the descriptions of the water courses that follow. Classification and use of all water courses within the Study Area are presented in Table 6-5.

The northern portion of the Project area is drained by waterways which generally flow to the east and southeast into Narragansett Bay. The southern portion of the Project area drains south and southwest towards the Atlantic Ocean and Little Narragansett Bay via the Pawcatuck River. Figure 6-4 depicts surface waters within the Study Area.

Pursuant to the requirements of Section 305(b) of the Federal Clean Water Act, waterbodies which are determined to be not supporting their designated uses in whole or in part are considered impaired, and placed on the Clean Water Act, Section 303(d) List of Impaired Waters where they are prioritized and scheduled for restoration. The causes of impairment are those pollutants or other stressors that contribute to the actual or threatened impairment of designated uses in a waterbody. Causes include chemical contaminants, physical parameters, and biological parameters. Sources of impairment are not determined until a total maximum daily load (TMDL) assessment is conducted on a waterbody. Nine impaired waters are associated with the Study Area: Maskerchugg River, Frenchtown Brook, Fry Brook, Belleville Ponds, Hunt River, Chipuxet River, Chickasheen Brook, Cedar Swamp Brook, and Pawcatuck River.

Table 6-5: Surface Water Resources within the Study Area

Water Body Name	Town	Approximate Location	Use Classification	Present Water Quality
Maskerchugg River	Warwick/E. Greenwich	5,200 feet north of Division Street	B	Impaired
Tributary to the Maskerchugg River	Warwick	1,300 feet north of Division Street	B	Compliant
Tributary to the West Branch of the Maskerchugg River	East Greenwich	2,200 feet south of Division Street	B	Impaired
Tributary to Hunt River	East Greenwich	2,150 feet north of Frenchtown Road	A	Compliant
Fry Brook	E. Greenwich	1,320 feet north of Frenchtown Road	B	Impaired
Frenchtown Brook	E. Greenwich	890 feet south of Frenchtown Road	(A)	Impaired
Hunt River	E. Greenwich	2,600 feet south of Frenchtown Road	A	Impaired
Hunt River	E. Greenwich/ N. Kingstown	4,200 feet south of Frenchtown Road	A	Impaired
Hunt River	E. Greenwich/N. Kingstown	5,630 feet south of Frenchtown Road	A	Impaired
Hunt River	East Greenwich	800 feet northeast of South Road	A	Impaired
Hunt River	N. Kingstown	800 feet north of Stony Lane	A	Impaired
Tributary to Belleville Pond	N. Kingstown	650 feet north of Lafayette Road	B	Compliant
Belleville Ponds	N. Kingstown	1,500 feet east of Route 4	B	Impaired
Oak Hill Pond and Tributary	N. Kingstown	200 feet east of Route 4	B	Compliant
Secret Lake	N. Kingstown	800 feet east of Route 4	B	Compliant
Tributary to Secret Lake	N. Kingstown	600 feet north of Route 4	B	Compliant
Kettle Hole Pond	N. Kingstown	2,150 feet north of Indian Corner Road	B	Compliant
Tributary to Chipuxet River	N. Kingstown	6,750 feet northeast of Slocum Road	A	Impaired
Tributary to Chipuxet River	N. Kingstown	4,300 feet northeast of Slocum Road	A	Impaired
Tributary to Chipuxet River	N. Kingstown	3,000 feet northeast of Slocum Road	A	Impaired
Tributary to Chipuxet River	Exeter	Crosses Slocum Road	A	Impaired
Chipuxet River	Exeter	3,600 feet south of Yawgoo Valley Road	B	Impaired
Tributary to Chickasheen Brook	S. Kingstown	1,500 feet northeast of Waites Corner Road	A	Compliant
Tributary to Chickasheen Brook	S. Kingstown	2,200 feet north of Liberty Lane	A	Compliant
Chickasheen Brook	S. Kingstown	400 feet south of Liberty Lane	A	Impaired
Pawcatuck River	S. Kingstown/ Charlestown/ Richmond	3,000 feet northeast of Biscuit City Road	B	Impaired
Great Swamp	Richmond, S. Kingstown,	South of Great Neck Road	B	Compliant
Pasquiset Brook	Charlestown	1,150 west of Maple Lake Farm Road	A	Compliant
Saw Mill Pond	Charlestown	600 feet south of Old Mill Road	B	Compliant
Cedar Swamp Brook	Charlestown	950 feet west of King's Factory Road	B	Impaired

Classification	Use
A	Public drinking water supply, no treatment.
B	Public drinking water supply with appropriate treatment; agricultural uses; bathing, other primary contact recreational activities; fish and wildlife habitat.
C	Boating, other secondary contact recreational activities; fish and wildlife habitat; industrial processes and cooling.
( )	Small streams tributary to Class A waters are considered Class A; small streams which are not otherwise designated are assumed to be Class B based on Rhode Island's Water Quality Standards criteria.

Source: R.I. Department of Environmental Management. Water Quality Regulations (June 2000).
R.I. Department of Environmental Management. State of Rhode Island and Providence Plantations 2004 Section 305(b) State of the State's Waters Report

Table 6-6: Impaired Surface Water Resources within the Study Area

Water Body	Impairment	Group
Maskerchugg River	Lead (Pb), Cadmium (Cd), Copper (Cu) levels	2
Frenchtown Brook	Pathogens	2
Fry Brook	Pathogens	5
Hunt River	Pathogens	5
Chipuxet River	Biodiversity Impact, Cadmium (Cd), Lead (Pb)	2
Belleville Ponds	Phosphorous Content	2
Chickasheen Brook	Noxious Aquatic Plants (native) and phosphorous	1
Cedar Swamp Brook	Pathogens, Low DO and Iron (Fe) content	2
Pawcatuck River	Unknown Toxicity and Biodiversity impacts	2

Group	Explanation
1	Waters are not meeting Rhode Island Water Quality Standards and TMDL development is currently underway.
2	Waters are not meeting Rhode Island Water Quality Standards and TMDL development is planned for the future.
5	A TMDL or a control action functionally equivalent to a TMDL, has been developed for these waterbodies. Implementation is underway which will result in attainment of the standards. However, the standard will not be met within the next two years. For control actions functionally equivalent to a TMDL, a determination must be made that the identified impairment is caused by the source(s) to be controlled.

Source: R.I. Department of Environmental Management. State of Rhode Island 2002 303(d) List of Impaired Waters, Final March 2003.

6.5.1 Greenwich Bay Watershed

The Greenwich Bay watershed is 26 square miles within the City of Warwick and the Towns of East Greenwich and West Warwick. It contains five protected coves and nine tributary streams. The Greenwich Bay watershed is a vitally important environmental, recreational and economic resource for the City of Warwick. Nearly half of the watershed is residential land, with another 20 percent being forested. The watershed discharges to Greenwich Bay which is an estuary.

6.5.2 Maskerchugg River Watershed

The Maskerchugg River drains in an area of approximately six square miles and is located within portions of East Greenwich and Warwick. Although there are several unnamed intermittent and perennial streams within this watershed, there is only one named tributary, Dark Entry Brook, which lies outside of the Project study area. This watercourse originates on the west side of Drum Rock Hill, approximately one half mile east of the Kent County Substation, and flows south to its confluence with the Maskerchugg River at Bleachery Pond. Elevations within the Maskerchugg River watershed range from sea level at the drainage outlet at Greenwich Cove to 350 feet above sea level on Spencer Hill. The river has an average gradient of one percent, although the slope is greater near its headwaters along the south side of Cowesett Road. The Maskerchugg River is a RIDEM Use Class B waterway.

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6.5.3 Hunt River Watershed

The Hunt River drains a 23 square mile area within the Town of East Greenwich and portions of the municipalities of North Kingstown, West Greenwich, Warwick and Exeter. With an average gradient of nine feet per mile, the main stream slowly meanders through coastal lowlands to the dam at Forge Road where it meets tidal water approximately four river miles downstream from the ROW. The major tributaries to the Hunt River include Sandhill Brook, Scrabbletown Brook, Mawney Brook, Frenchtown Brook, and Fry Brook. Of these, only Frenchtown Brook and Fry Brook are located within the ROW.

With the exception of Sandhill Brook, these tributaries originate in the hilly and forested glacial till uplands. Sandhill Brook, like the Hunt River, has little gradient and runs northeasterly through coastal lowlands.

Elevations within the Hunt River watershed begin at sea level at Forge Road in North Kingstown and extend to more than 470 feet above sea level near the headwaters of Frenchtown Brook at Hopkins Hill in West Greenwich. All of the ponds on the Hunt River appear to be man-made, although small natural ponded areas may have existed before alterations. The average annual runoff, as measured at the Forge Road United States Geological Survey (U.S.G.S.) gauging station, is about 27 million gallons a day, however, the river may discharge as little as eight million gallons a day for extended periods. The Hunt River is identified by the Rhode Island Department of Environmental Management (RIDEM) as a Class A waterbody from its head waters to Frenchtown Road. From this point to Forge Road the river has a Class B use designation.

The two major tributaries to the Hunt River located within the Project are Frenchtown Brook and Fry Brook. The following is a brief description of the characteristics of each tributary.

6.5.3.1 Frenchtown Brook

Frenchtown Brook originates within hilly glacial till in the eastern portion of West Greenwich and meanders eastward for approximately five miles before reaching the Hunt River approximately 600 feet north of Frenchtown Road. The RIDEM has classified Frenchtown Brook as a Use Class A waterbody. Class A waters are suitable for public water supply without any prior treatment. Frenchtown Brook is used for fishing and is periodically stocked. A fish ladder has been constructed within the brook west of State Route 4 to promote access to spawning areas by alewife and other anadromous fish.

6.5.3.2 Fry Brook

Fry Brook originates approximately 4,000 feet west of Bartons Corner in the Town of East Greenwich and passes through a variety of land uses including woodlands, agriculture fields, and urban areas. For part of its three-mile length, Fry Brook flows adjacent to Route 2, receiving additional input from several small tributaries which originate west of Route 2. Fry Brook provides habitat for brook trout and is considered a valuable tributary to the Hunt River. The portion of Fry Brook which crosses the project Study Area is classified by the RIDEM as Use Class B waters, however, this segment is listed as impaired in the 303(d) list published in 2002.

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6.5.4 Annaquatucket River Watershed

Consisting of approximately 4,700 acres, the Annaquatucket basin covers nearly all of North Kingstown. It discharges into the Narragansett Bay at Bissel Cove. The Annaquatucket watershed supplies drinking water (through groundwater aquifers) to the communities of Narragansett, North Kingstown, and occasionally Jamestown. Land use within the watershed includes industrial, agricultural, commercial/retail and residential. The Annaquatucket River is assigned a Use Class B by the RIDEM.

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6.5.5 Pawcatuck River Watershed

The Pawcatuck River Watershed stretches across the southwestern border of Rhode Island into southeastern Connecticut. It includes all or portions of Charlestown, Coventry, Exeter, Hopkinton, North Kingstown, Richmond, South Kingstown, Westerly, and West Greenwich. The entire watershed covers an area of nearly 300 square miles. The Pawcatuck River Watershed contains a small percentage of commercial/retail uses. Overall, 65 percent of the land in this watershed remains undeveloped, including management areas, conservation easements, and private and public land trust holdings. The Pawcatuck River is a RIDEM use Class B waterway.

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6.5.6 Floodplain

The 100-year floodplain represents the extent of flooding that would result during a storm event having a one percent chance of occurring per year. Based on available Federal Emergency Management Agency (FEMA) mapping for the towns within the Study Area, the Project will cross several areas of designated 100-year (Zone A) frequency floodplain. These areas include the floodplain of the Hunt River, Frenchtown Brook, Fry Brook, Maskerchugg River, Secret Lake, Kettle Hole Pond, Chipuxet River, Chickasheen Brook, Great Swamp, Pawcatuck River, Pasquiset River, and Cedar Swamp Brook. The unnamed watercourses may also contain 100-year floodplain though not mapped by FEMA.

6.6 Groundwater

The presence and availability of groundwater resources is a direct function of the geologic deposits in the area. Within the portion of the Study Area overlying deep stratified drift deposits, groundwater resources have the highest potential yield and quality, and thus are given the highest classification (Class GAA). These groundwater resources are presumed suitable for public drinking water use without prior treatment. Approximately 43 percent of the Project is located within areas classified as GAA by the RIDEM, Groundwater Division. The remaining 57 percent of the Project is located within areas classified as GA. Groundwater classified GA is also presumed suitable for public or private drinking water use without prior treatment, however, the potential yield of this resource is less than that of Class GAA due to the nature of the surrounding geologic deposits (glacial till and bedrock). Both GAA and GA classes are subject to the same groundwater quality standards and preventative action limits for organic and inorganic chemicals, microbiological substances and radionuclides. Groundwater resources within the Study Area are depicted at Figure 6-4.

The RIDEM Office of Water Resources has identified and mapped several areas of groundwater non-attainment within the Study Area. Non-attainment areas are areas where groundwater is known or presumed to be out of compliance with the standards for the assigned classification. The goal for this groundwater is restoration to a quality consistent with the classification. The areas designated non-attainment are site-specific locations of facilities or activities such as leaking underground storage tanks, landfills, chemical spills, and road salt storage areas that have caused groundwater contamination.

Class GB groundwaters are areas where groundwater may not be suitable for drinking water supply without prior treatment based on the potential for degraded quality resulting from overlying land usage. Class GC groundwater is known to be unsuitable for drinking water use due to waste disposal practices such as landfills. Class GB and GC areas are served by a public water supply. These groundwater resources do not occur within the Study Area.

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6.6.1 Sole Source Aquifers

The major groundwater resources identified within the Study Area are the Hunt-Annaquatucket/Pettaquamscutt (HAP), the Pawcatuck Basin Aquifer System and the overlapping area of the two systems. The United States Environmental Protection Agency has designated the HAP and the Pawcatuck Basin as Sole Source Aquifers. The HAP River Aquifer is the primary source of groundwater for public use in Warwick, East Greenwich and part of North Kingstown. Within the Study Area, the Pawcatuck Basin is the primary source of groundwater for public use in southwestern North Kingstown, Exeter, South Kingstown, and Charlestown. The purpose of sole source aquifer designation is to manage land use practices within the aquifer recharge area to protect groundwater quality. The portion of the Project that lies within the recharge area begins in the vicinity of the East Greenwich High School and extends south to the vicinity of the West Kingstown Substation. There are a few breaks in the recharge zone east of where the transmission line crosses Slocum Road. The recharge zone then extends just west of Biscuit City Road and continues in a westerly direction to Cedar Swamp. There is a break in the recharge zone where the transmission line crosses Carolina Back Road. Sole source aquifers are depicted on Figure 6-4.

6.7 Vegetation

The Study Area contains a variety of vegetative cover types typical of southern New England. These types include oak/pine forest, old field and managed lawn. This section of the report focuses on upland communities. Wetland communities are discussed in Section 6.8 of the report.

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6.7.1 Oak/Pine Forest Community

The forested habitats located within the Study Area are dominated by an oak/pine canopy. Although these woodlands appear similar throughout, differences in the tree and shrub communities occur between sites. Precipitation and aspect are important factors in determining what vegetation a particular site will support. Hilltops and south facing slopes are often deficient in the amount of soil moisture available to the plant community. In summer, when the moisture requirements of plants are highest, hilltops become substantially drier than sites farther down slope. The trees growing on hilltops, therefore, are smaller and more widely spaced and are a different species composition than those on more favorable sites, and are more tolerant of dry conditions. Red oak (with mixtures of other oaks) and white pine generally occur on outwash soils and sandy till hills in the Study Area. Oak/pine forest also occurs on shallow-to-bedrock nutrient poor soils in the vicinity of the ROW.

Common associates of the hilltop oak/pine forests in the vicinity of the transmission line ROW include black (*Quercus velutina*) scarlet (*Q. coccinea*), and white (*Q. alba*) oaks as well as aspen (*Populus sp*.) and gray birch (*Betula populifolia*). The shrub/sapling understory includes such species as black cherry (*Prunus serotina*), lowbush blueberry (*Vaccinium angustifolium*) and greenbrier (*Smilax rotundifolia*). Sheep laurel (*Kalmia angustifolia*) and sweet fern (*Comptonia peregrina*) occasionally occur under oak stands with canopy openings on rocky slopes. Herbaceous species include bracken fern (*Pteridium aquilinum*), tree clubmoss (*Lycopodium obscurum*) and hayscented fern (*Dennstaedtia punctilobula*). These hilltop communities occur where excessively drained soils predominate, and on hilltops throughout the Study Area.

There is an increase in the diversity within plant communities on midslopes compared with dry hilltops. The increase in soil moisture produces this greater diversity in trees, shrubs and herbs. Midslope tree species in addition to oaks include black birch (*Betula lenta*), white ash (*Fraxinus americana*), American beech (*Fagus grandifolia*) and several species of hickory (*Carya* sp.). Shrubs include witch hazel (*Hamamelis virginiana*), sassafras (*Sassafras albidum*) and ironwood (*Carpinus caroliniana*). Greenbrier and poison ivy (*Toxicodendron radicans*) are also common in this community. Common groundcover species include tree clubmoss and wintergreen (*Gaultheria procumbens*). Midslope oak/pine communities occur on cool north facing slopes and adjacent to forested wetlands on the uncleared portion of the ROW.

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6.7.2 Old Field Community

Vegetation within the cleared portions of the ROW is typically representative of an old field successional community. Old field communities are established through the process of natural succession from cleared land to mature forest. Within the cleared ROW, periodic vegetation management has favored the establishment and persistence of grasses and herbs. Over time, pioneer woody plant species including gray birch, black cherry, sumac (*Rhus sp.*) and eastern red cedar (*Juniperus virginiana*) have become established.

Within the cleared portions of the ROW, vegetation varies considerably. On dry hilltops, little bluestem (*Schizachyrium scoparium*), round-head bushclover (*Lespedeza capitata*), staghorn sumac (*Rhus typhina*) and eastern red cedar are common. On the mid-slope, greenbrier and blackberry (*Rubus* sp.) form dense, impenetrable thickets. Numerous herbs including goldenrod (*Solidago* sp.), aster (*Aster* sp.), pokeweed (*Phytolacca americana*), and mullein (*Verbascum thapsus*) are also common.

■

6.7.3 Managed Lawn

Portions of the cleared ROW are managed residential lawn. Typically these areas consist of a continuous grass cover which may include Kentucky bluegrass, red fescue, clover, and plaintains. Ornamental shrubs may also occur within these areas. Within some portions of these areas on the ROW, there exist small residential gardens.

■

6.7.4 Agricultural Areas

Based on the existing land use mapping obtained from the RIGIS, the proposed route will cross land of agricultural use. This agricultural land includes an open field located immediately north of East Greenwich High School adjacent to Avenger Drive and turf farms in the vicinity of Indian Corner Road, Slocum Road, Yawgoo Valley

Road, Waites Corner Road and Route 138. A hayfield is located in the vicinity of the proposed Tower Hill Substation.

6.8 Wetlands

Wetlands have been identified as resources potentially providing ecological functions and societal values. Wetlands are characterized by three criteria including the (i) presence of undrained hydric soils, (ii) a prevalence (>50 percent) of hydrophytic vegetation, and (iii) wetland hydrology, soils that are saturated near the surface or flooded by shallow water during at least a portion of the growing season.

6.8.1 Study Area Wetlands

State-regulated freshwater wetlands and/or streams have been identified and delineated within the ROW. Figure 6-5 depicts wetland resources within the Project Study Area. Field methodology for the delineation of State-regulated resource areas was based upon vegetative composition, presence of hydric soils and evidence of wetland hydrology. Based on the provisions of the Rhode Island Fresh Water Wetlands Act and Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act (RIDEM 1998) (the "Rules"), state-regulated fresh water wetlands include swamps, marshes, bogs, forested or shrub wetlands, emergent plant communities and other areas dominated by wetland vegetation and showing wetland hydrology. Swamps are defined as wetlands dominated by woody species and are three acres in size, or greater. Marshes are wetlands dominated by emergent species and are one acre or greater in size. Bogs are wetlands dominated by "bog" species and generally support sphagnum moss. Bogs have no minimum size criteria. Emergent wetlands communities are areas similar to marshes in vegetation composition; however, there is no size criterion. Forested and shrub wetlands are similar to swamps, but do not meet the three acre size criteria.

The upland area within 50 feet of the edge of a swamp, marsh or bog is regulated as the 50-foot Perimeter Wetland under the Rules. Emergent wetland communities, forested wetlands and shrub wetlands do not merit a 50-foot Perimeter Wetland.

In addition to these vegetated wetland communities, Rhode Island also regulates activities in and around streams and open waterbodies which include rivers, ponds, and Areas Subject to Storm Flowage (ASSF). A river is any perennial stream indicated as a blue line on a USGS topographic map. If the river is less than 10 feet wide, the area within 100 feet of each bank is regulated as 100 foot Riverbank Wetland. If the river is greater than 10 feet wide, the area within 200 feet of each bank is regulated as 200 foot Riverbank Wetland.

A pond is an area of open standing or slow moving water present for six or more months during the year and at least one quarter acre in size. Ponds have a 50 foot Perimeter Wetland associated with the boundary. An ASSF is defined as any body of flowing water as identified by a scoured channel or change in vegetative composition or density that conveys storm runoff into or out of a wetland.

Vegetation community types and their dominant plant species located within the existing transmission line ROW are described below.

6.8.1.1 Pond

A pond is a water body that is at least one-quarter acre in size, with open standing or slowly moving water present for at least six months a year. The boundary of a pond is determined by the extent of water which is delineated and surveyed. Ponds located within the Study Area are Belleville Pond, Oak Hill Pond, Secret Lake, Kettle Hole Pond, Hundred Acre Pond, Barber Pond, Maple Lake, and Saw Mill Pond.

6.8.1.2 Pond/Swamp Complex

Pond/Swamp complexes are dominated by open water typical of a pond with fringing sapling/shrubs comprised of red maple, sweet pepperbush (*Clethra alnifolia*), winterberry (*Ilex verticillata*), meadowsweet (*Spiraea alba*), highbush blueberry, swamp azalea (*Rhododendron viscosum*), and common greenbrier. Four Pond/Swamp complexes are present within the ROW.

6.8.1.3 Swamp

Swamps are defined as areas at least three acres in size, dominated by woody vegetation, where groundwater is at or near the ground surface for a significant part of the growing season. A 50-foot perimeter wetland is applied to swamps. Shrub swamps are areas dominated by broad-leaved deciduous shrubs and have an emergent herbaceous layer. Dominant species include sweet pepperbush, highbush blueberry, winterberry, and swamp azalea. Other species occurring in these swamps include arrowwood (*Viburnum dentatum*), and silky dogwood (*Cornus amomum*). Drier portions of shrub swamps are often densely overgrown with wild grape (*Vitus labrusca*) and greenbrier. Common species in the herbaceous layer include cinnamon fern, sensitive fern (*Onoclea sensibilis*), poison ivy (*Toxicodendron radicans*), and dewberry (*Rubus hispidus*). Although some wetlands on the ROW are composed entirely of shrub swamp, in most wetlands the shrub swamp occurs in areas where the wetland crosses the managed portion of the ROW. Thirty-six shrub swamps are present within the Project ROW.

Forested swamps mainly occur on the edges of the managed ROW where the shrub swamps are present. Vegetation in a forested swamp is comprised of red maple, willow (*Salix* sp.), black gum (*Nyssa sylvatica*), alder (*Alnus* sp.), silky dogwood, sweet pepperbush, winterberry, swamp azalea, cinnamon fern, common reed (*Phragmites* sp.), and peat moss (*Sphagnum* spp.).

6.8.1.4 Marsh

Marshes are wetlands at least one acre in size where water is generally above the surface of the substrate and where the vegetation is dominated by emergent herbaceous species. Marshes are the dominant cover type in several large wetlands within the ROW. Marsh vegetation is typically dominated by broad-leaved cattail (*Typha latifolia*) and tussock sedge (*Carex stricta*), with lesser amounts of common reed, sensitive fern, marsh fern (*Thelypteris palustris*), soft rush (*Juncus effusus*), and woolgrass (*Scirpus cyperinus*). Five Marshes/Marsh Complexes are present within the Project ROW.

6.8.1.5 River

A River is a body of water designated as a perennial stream by the US Geologic Survey (a blue line stream on a USGS topographic map). Rivers located within the Study Area are the Maskerchugg River, Hunt River, Chipuxet River, and the Pawcatuck River.

6.8.1.6 Stream/Intermittent Stream

A stream is any flowing body of water or watercourse other than a river which flows during sufficient periods of the year to develop and maintain defined channels. Such watercourses carry groundwater discharge and/or surface runoff. Such watercourses may not have flowing water during extended dry periods but may contain isolated pools or standing water. Streams and intermittent streams within the Study Area are the Fry Brook, Frenchtown Brook, Chickasheen Brook, Pasquiset Brook, Cedar Swamp Brook, and other unnamed tributaries associated with these waterways. The ROW crosses twenty-four streams/intermittent streams.

6.8.1.7 Emergent Plant Communities

Emergent plant communities within the Project ROW wetlands are characterized by cattail, bulrush (*Scirpus pungens*), blue joint (*Calamagrostis canadensis*), woolgrass (*Scirpus cyperinus*), meadowsweet, Joe-Pye weed (*Eupatorium dubium*), sensitive fern (*Onoclea sensibilis*), soft rush, and reed canary grass (*Phalaris arundinacea*). Twenty emergent plant communities were identified within the ROW.

6.8.1.8 Shrub/Forested Wetland

Shrub wetlands in the transmission line ROW are dominated by highbush blueberry, sweet pepper bush, arrowwood, spicebush, winterberry, greenbrier and cinnamon fern with minor amounts of skunk cabbage and poison ivy. Some wetlands on the ROW are composed entirely of shrub wetland. In some wetlands the shrub wetland occurs in areas where the wetland crosses the managed portion of the ROW or fringes around surface water areas. Thirteen shrub wetlands are present within the ROW.

Forested wetlands occur at the edge of the maintained ROW where most shrub wetlands are present. Vegetation includes red maple, yellow birch (*Betula alleghaniensis*) and ash with an understory generally consisting of vegetation mentioned previously in the shrub wetland.

6.8.1.9 Floodplain

A floodplain is the land area adjacent to a river or stream or other body of flowing water which is, on the average, likely to be covered with flood waters resulting from a 100-year frequency storm event as mapped by FEMA. These areas within the ROW include the Hunt River, Frenchtown Brook, Fry Brook, Maskerchugg River, Secret Lake, Kettle Hole Pond, Chipuxet River, Chickasheen Brook, Great Swamp, Pawcatuck River, Pasquiset River, and Cedar Swamp Brook. The unnamed watercourses may also contain 100-year floodplain though they are not mapped.

6.8.1.10 Area Subject to Storm Flowage

ASSFs are channel areas and water courses which carry storm, surface, groundwater discharge or drainage waters out of, into, and/or connect freshwater wetlands or coastal wetlands. ASSFs are recognized by evidence of scouring and/or a marked change in vegetative density and/or composition. Two ASSFs were identified within the ROW.

6.8.1.11 Special Aquatic Site

An area subject to flooding is a contained basin that lacks a permanent above ground outlet. It fills with water with the rising water table of fall and winter or with the meltwater and runoff of winter and spring snow and rain. Special aquatic sites contain water for a few months in the spring and early summer. Three special aquatic sites were identified within the ROW.

6.9 Wildlife

As previously described, the proposed transmission Project passes through a variety of aquatic and terrestrial habitats. The wildlife assemblages present within the Study Area vary according to habitat characteristics. An overall list of wildlife species expected to occur within the transmission line ROW was compiled. This list encompasses the major habitats encountered within the ROW. It should be noted that individual species may not occur in one particular area as opposed to another, but may be found in the general area of the transmission line. A list of amphibian, reptiles, birds and mammals expected to occur within a given habitat are provided in Table 6-7. This information is based on geographical distribution and habitat preferences as described in New England Wildlife: Habitat, Natural History and Distribution (DeGraaf and Rudis, 1983).

Table 6-7: Expected and Observed Wildlife Species

	Terrestrial Habitats		Aquatic Habitats					
	Oak/Pine Forest	Old Field	Bog	Shallow Marsh	Shrub Swamp	Forested Wetland	River	Stream
AMPHIBIANS AND REPTILES								
Spotted Salamander	X				X	X		
Red Spotted Newt	X				X			
Northern Dusky Salamander	X							
Redback Salamander	X		X			X		
Northern Two-Lined Salamander	X		X			X	X	X
Eastern American Toad	X	X		X	X	X		
Fowler's Toad	X					X		
Northern Spring Peeper				X	X	X		
Gray Tree Frog	X		X		X	X		
Bullfrog				X	X	X		
Green Frog				X	X	X	X	X
Wood Frog	X		X	X	X	X		X
Pickerel Frog	X		X			X		X
Common Snapping Turtle	X	X	X	X		X	X	X
Stinkpot		X						
Spotted Turtle		X	X	X	X			
Eastern Box Turtle	X	X				X		
Eastern Painted Turtle						X		
Northern Water Snake			X		X	X	X	
Northern Brown Snake	X				X	X		
Eastern Garter Snake	X	O	X		X	X		
Northern Ringneck Snake	X					X		
Northern Black Racer	X	X			X	X		
Eastern Smooth Green Snake		X			X			
Eastern Milk Snake	X		X			X		
BIRDS								
Green Backed Heron				X		X	X	X
Wood Duck				X		X	X	
American Black Duck			X	X		X		
Sharp-shinned Hawk	X	X				X		
Red-shouldered Hawk	X				X			
Red-tailed Hawk	O	O				X		
Rough-legged Hawk		X	X					
American Kestrel		X						
Ring-necked Pheasant		X						
Ruffed Grouse	X	X				X		
American Woodcock	X	X			O			
Morning Dove	X	X						
Eastern Screech-Owl	X			X		X		

Legend:
X = expected to occur
O = observed by VHB. Spring 2005

Table 6-7: Expected and Observed Wildlife Species (Continued)

	Terrestrial Habitats		Aquatic Habitats					
	Oak/Pine Forest	Old Field	Bog	Shallow Marsh	Shrub Swamp	Forested Wetland	River	Stream
Great Horned Owl	X	X				X		
Barred Owl	X					X	X	X
Whip-poor-will	X	X				X		
Ruby-throated Hummingbird		X				X		
Downy Woodpecker	X					X		
Hairy Woodpecker	X					X		
Northern Flicker	X					X		
Eastern Wood-Pewee	X					X		
Alder Flycatcher				X				
Willow Flycatcher		X						
Least Flycatcher	X					X		
Eastern Phoebe	X					X		
Great Crested Flycatcher	X							
Eastern Kingbird		X				X		
Tree Swallow		X		X				
Blue Jay	O	O				O		
American Crow	X	X						
Black-capped Chickadee	O	O						
Tufted Titmouse	O					X		
Red-breasted Nuthatch	X		X			X		
White-breasted Nuthatch	X					X		
Brown Creeper	X		X			X		
Carolina Wren	X	X						
House Wren	X	X				X		
Blue-gray Gnatcatcher	X	X			X	X		
Eastern Bluebird	X	X						
Veery	X					X		
Hermit Thrush	X	X	X		X	X		
Wood Thrush	X					X		
American Robin	O	O	X		X	X		
Gray Catbird		O	X		O			
Northern Mockingbird		X						
Brown Thrasher	X	X						
Cedar Waxwing	X	X			X			
Northern Shrike		X						
European Starling		X						
Yellow-throated Vireo	X					X		
Warbling Vireo	X					X		
Red-eyed Vireo	X					X		
Blue-winged Warbler		X			X			
Nashville Warbler	X		X		X			
Yellow Warbler	X	X			X			

Legend:
X = expected to occur
O = observed by VHB. Spring 2005

Table 6-7: Expected and Observed Wildlife Species (Continued)

	Terrestrial Habitats		Aquatic Habitats					
	Oak/Pine Forest	Old Field	Bog	Shallow Marsh	Shrub Swamp	Forested Wetland	River	Stream
Chestnut-sided Warbler		X			X			
Yellow-rumped Warbler	X	X			X	X		
Black-throated Green Warbler	X					X		
Pine Warbler	X							
Prairie Warbler		X						
Black & White Warbler	X		X			X		
American Redstart	X					X		
Ovenbird	X					X		
Northern Waterthrush	X		X		X	X	X	X
Common Yellowthroat	X	X	X	X	X	X		
Canada Warbler	X		X		X	X		
Scarlet Tanager	X					X		
Northern Cardinal		O			X		X	X
Rose-breasted Grosbeak	X	X				X		
Indigo Bunting	X	X						
Rufous-sided Towhee	X	X						
Chipping Sparrow	X							
Fox Sparrow	X	X			X			
Song Sparrow	X	X			X			
Tree Sparrow		X			X			
Swamp Sparrow			X	X	X			
Field Sparrow		X						
Red-winged Blackbird			X	X	X			
Common Grackle	X		X	X	X			
Brown-headed Cowbird	X					X		
Northern Oriole	X					X		
Purple Finch	X							
House Finch	X							
American Goldfinch			X	X	X	X		
House Sparrow		X						
MAMMALS								
Virginia Opossum	X	X		X	X	X		
Masked Shrew	X	X	X	X	X	X		
Northern Short-tailed Shrew	X	X	X	X	X	X		
Hairy-tailed Mole	X	X				X		
Eastern Mole		X				X		
Star-nosed Mole			X	X	X		X	X
Little Brown Myotis	X	X	X	X	X	X	X	X
Keen's Myotis	X	X	X	X	X	X	X	X
Silver-haired Bat		X	X	X	X		X	X
Eastern Pipistrelle	X	X	X	X	X	X	X	X

Legend:
X = expected to occur
O = observed by VHB. Spring 2005

Table 6-7: Expected and Observed Wildlife Species (Continued)

	Terrestrial Habitats		Aquatic Habitats					
	Oak/Pine Forest	Old Field	Bog	Shallow Marsh	Shrub Swamp	Forested Wetland	River	Stream
Big Brown Bat	X	X	X	X	X	X	X	X
Eastern Cottontail		O		X				
Snowshoe Hare	X		X			X		
Eastern Chipmunk	O	O				X		
Woodchuck	X	X						
Gray Squirrel	X	O				X		
Red Squirrel						X		
Southern Flying Squirrel	X							
White-footed Mouse	X	X	X		X	X		
Southern Red-backed Vole	X	X	X		X	X		
Meadow Vole		X	X	X	X			
Woodland Vole	X	X				X		
Muskrat			X	X	X		X	X
House Mouse		X						
Meadow Jumping Mouse		X	X	X				
Red Fox	X	X			X	X		
Gray Fox	X	X			X	X		
Raccoon	X	X	X	X	X	X		
Ermine	X	X			X	X		
Mink	X	X	X	X	X	X	X	X
Striped Skunk	X	X			X	X		
White-tailed Deer	O	O			X	X		

Legend:
X = expected to occur
O = observed by VHB. Spring 2005

Source: New England Wildlife: Habitat, Natural History and Distribution, United States Department of Agriculture, General Technical Report Ne-108, 1983.

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6.9.1 Fisheries

The RIDEM Division of Fish and Wildlife conducted fish surveys in Rhode Island's streams and ponds between 1993 and 2002. Table 6-8 summarizes the fish that were found in major waterways and waterbodies associated with the Project Study Area. Data were not available for Oak Hill, Saw Mill, and Kettle Hole Ponds. Electro-fishing was the primary sampling method used, though trap nets, seine hauls and gill nets were used where the waterways were not accessible with the electro-fishing boat.

Table 6-8: Fish Survey Results

	WATERWAYS/WATERBODIES										
	Maskerchugg River	Hunt River	Frenchtown Brook	Fry Brook	Belleville Pond	Secret Lake	Chipuxet River	Chickasheen Brook	Pawcatuck River	Pasquiset Brook	Cedar Swamp Brook
FISH											
Alewife		X			X				X		
American Eel	X	X	X	X	X	X	X	X	X	X	X
American Shad									X		
Atlantic Menhaden									X		
Atlantic Salmon		X	X						X		
Atlantic Silverside									X		
Banded Killifish									X		
Banded Sunfish		X					X			X	X
Black Crappie					X	X			X		
Blueback Herring		X							X		
Bluefish											
Bluegill		X	X		X	X	X		X		X
Bridle Shiner									X		
Brook Trout	X		X	X			X	X	X		
Brown Bullhead	X	X			X	X	X	X	X		
Brown Trout		X							X		
Chain Pickerel		X			X	X	X	X	X	X	X
Creek Chubsucker							X				
Crevalle Jack									X		
Fallfish								X	X		
Gizzard Shad									X		
Golden Shiner	X	X			X	X			X		
Hickory Shad									X		
Hogchoker									X		
Largemouth Bass		X	X		X	X	X	X	X		
Longnose Dace		X	X								
Naked Goby									X		
Northern Searobin									X		
Northern Kingfish									X		
Pumpkinseed	X	X	X		X	X	X	X	X		
Rainbow Smelt									X		
Rainbow Trout									X		
Redbreast Sunfish									X		
Redfin Pickerel	X	X	X				X	X	X	X	X
Striped Bass									X		

Table 6-8: Fish Survey Results (Continued)

	WATERWAYS/WATERBODIES										
	Maskerchugg River	Hunt River	Frenchtown Brook	Fry Brook	Belleville Pond	Secret Lake	Chipuxet River	Chickasheen Brook	Pawcatuck River	Pasquiset Brook	Cedar Swamp Brook
Swamp Darter		X						X			
Tessellated Darter								X	X	X	
Weakfish									X		
White Catfish									X		
White Perch					X				X		
White Sucker		X	X	X			X	X	X		
Winter Flounder									X		
Yellow Perch					X	X	X	X	X	X	

Legend:
X = Reported as present in Fish Surveys

Source: Rhode Island Department of Environmental Management, Division of Fish and Wildlife "A Preliminary Summary of Fish Surveys That Were Conducted in Rhode Island's Streams and Ponds Between 1993 and 2002, "Alan D. Libby, May 2004.

6.9.2 Rare and Endangered Species

The U.S. Fish and Wildlife Service has reviewed its files for Federally endangered species and has found that no Federally listed or proposed, threatened and endangered species are known to occur in the Project area.

The Rhode Island Natural Heritage Program (RINHP) has reviewed its database for endangered species and has noted that a new inventory of the Project alignment needs to be conducted because the RINHP records are out of date. Narragansett has agreed to conduct the requested inventories during the 2005 growing season. The work will be carried out in close coordination with the RINHP, including developing a methodology for their review and approval, as well as obtaining a collector's permit from the RIDEM Fish and Wildlife program. The RIDEM Freshwater Wetlands permitting regulations require that Narragansett coordinate with RINHP and obtain their concurrence that the Project as proposed will be carried out in a manner that is protective of any rare, threatened or endangered species that are identified within the ROW.

6.10 Air Quality

The National Ambient Air Quality Standards (NAAQS) were established by the Federal Clean Air Act Amendments (CAAA), and are designed to protect both public health and welfare. Air quality analyses for projects that may impact motor vehicular traffic are required to evaluate their impact on ozone (O_3) and carbon monoxide (CO).

Rhode Island developed a State Implementation Plan (SIP) in 1982 to comply with the 1977 CAAA requirements for O_3 and CO. While Rhode Island's 1982 SIP uses the term hydrocarbons, current CAAA policy requires the use of volatile organic compounds (VOCs). VOCs include all reactive hydrocarbons. However, the terms "hydrocarbons" and "VOCs" are used interchangeably.

While three pollutants (CO, NOx, and VOCs) play a role in O_3 formation, EPA determined in 1980 that SIPs must require the reduction of VOCs as the most effective strategy to achieve the O_3 standard. The 1990 CAAA now require that states update their SIPs to evaluate the impact of reducing all three pollutants.

Currently, the entire State of Rhode Island is classified as a non-attainment area for O_3. Rhode Island's ability to attain the one-hour NAAQS standard by 2007 is contingent on the implementation of the NOx SIP call and the Federal on-road and non-road mobile source emissions reductions programs.

7.0 Description of Affected Social Environment

The EFSB Rules require a detailed description of all environmental characteristics of the proposed site including the physical and social environment on and off site. The proposed Project is located within an existing ROW and parcels of land owned by Narragansett in the Towns of East Greenwich, North Kingstown, Exeter, South Kingstown, Charlestown and the City of Warwick. For the purpose of the following discussion, the Study Area is defined as the City of Warwick and the Towns of East Greenwich, North Kingstown, South Kingstown, Charlestown, and Exeter located in central and southern Rhode Island.

As per sections 45-22.2-2 et seq. of the Rhode Island General Laws, all cities and towns are required to adopt and periodically update Local Comprehensive Land Use Plans. In compliance with these requirements, the cities and towns are in the process of completing their local Plans. Due in part to the timing of the update, local municipalities have relied on available 1990 Census data to prepare various sections of the Plans. At this time, 2000 Census data is available and has been incorporated into this report for use as current information to more accurately assess current conditions in each Town.

7.1 Population Trends

The population within the Study Area increased steadily between 1980 and 2000 as shown in Table 7-1. The project area can be characterized as being a mix of urban and suburban areas with a 2000 population that accounted for 15.9 percent of the total State population.

Table 7-1: Project Area Population Trends, 1980-2000

Area	1980	1990	2000	Change 1980-1990 Absolute	Change 1980-1990 Percent	Change 1990-2000 Absolute	Change 1990-2000 Percent
State of Rhode Island	947,154	1,003,464	1,048,319	56,310	5.9%	44,855	4.5%
Project Area*	148,939	157,648	166,907	8,709	5.8%	9,259	5.9%
Percent of State	15.7%	15.7%	15.9%				
Warwick	87,123	85,427	85,808	(1,696)	(1.9)%	381	0.4%
East Greenwich	10,211	11,865	12,948	1,654	16.2%	1,083	9.1%
North Kingstown	21,938	23,786	26,326	1,848	8.4%	2,540	10.7%
Exeter	4,453	5,461	6,045	1,008	22.6%	584	10.7%
South Kingstown	20,414	24,631	27,921	4,217	20.7%	3,290	13.3%
Charlestown	4,800	6,478	7,859	1,678	35.0%	1,381	21.3%

Notes:
* Towns of East Greenwich, Charlestown, Exeter, North Kingstown, South Kingstown, and the City of Warwick.
( ) Negative
Source: U.S. Department of Commerce, Rhode Island Census, 2000

The Project area has experienced a higher percentage of population growth over the census period from 1990 to 2000 than the State as a whole.

According to the Rhode Island Statewide Planning projections, the population of the Project area will exhibit a continuation of growth with an average projected annual growth of approximately 575 people from 2000 to 2020 (see Table 7-2). The rate of growth for the Project area is expected to outpace the rate of growth for the State of Rhode Island as a whole.

Table 7-2: Project Area Population Projections, 2000-2020

Area	2000	2020*	Change in Population Absolute	Change in Population Percent
State of Rhode Island	1,048,319	1,111,464	63,145	6.0%
Project Area	166,907	178,370	11,463	6.9%
Percent of State Population	15.9%	16.0%		
Warwick	85,808	85,235	(573)	(0.7)%
East Greenwich	12,948	14,656	1,708	13.2%
North Kingstown	26,326	29,065	2,739	10.4%
Exeter	6,045	7,039	994	16.4%
South Kingstown	27,921	32,607	4,686	16.8%
Charlestown	7,859	9,768	1,909	24.3%

Notes:
* 2020 Population Projections based on the 2000 Census information
( ) Negative
Source: U.S. Bureau of the Census, 2000
Rhode Island Statewide Planning Program, 2004.

7.2 Employment Overview and Labor Force

Recent population growth, urbanization, and a substantial commuter-based population have produced greater demands for and a wider selection of trades and services. According to the Rhode Island Economic Development Corporation (RIEDC), Rhode Island as a whole has enormous growth potential in the health and life science industry due to the emerging biotechnology companies. The financial services sector is extremely important to Rhode Island employing over 33,000 individuals. Many manufacturers that invest in technologies and workforce training to compete in the global market have corporate or divisional headquarters in Rhode Island.

Labor force and employment trends are shown in Table 7-3.

Table 7-3: Labor Force and Employment Estimates, 1990-2000

	Warwick	East Greenwich	North Kingstown	Exeter	South Kingstown	Charlestown	State
2000							
Labor Force	45,926	6,443	14,422	3,500	15,003	4,232	530,590
Employment	44,058	6,106	13,899	3,311	13,689	4,129	500,731
Unemployment	1,868	337	523	189	1,314	103	29,859
Unemployment Rate	4.1%	5.2%	3.6%	5.4%	8.8%	2.4%	5.6%
1990							
Labor Force	46,294	6,318	12,937	2,826	12,630	3,370	522,603
Employment	43,769	6,061	12,359	2,695	11,962	3,204	487,913
Unemployment	2,525	257	578	131	668	166	34,690
Unemployment Rate	5.5%	4.1%	4.5%	4.6%	5.3%	4.9%	6.6%
Increase in Total Employment	289	45	1,540	616	1,727	925	12,818

Source: U.S. Department of Commerce, Bureau of the Census, 1990, 2000.
Rhode Island Statewide Planning.

Historically, the leading employment sectors in the Project area are manufacturing and retail trades (see Table 7-4). Recently, however, there has been a general shift from manufacturing employment to services which includes education, health and social services.

The educational, health and social service sector is the largest source of employment in the Study Area. The manufacturing and retail trade sectors ranked second in the Study Area. As the economy of the region shifts from a manufacturing-based economy to a service and trade-based economy the number of manufacturing jobs is expected to decrease. These three categories are predicted to continue to make up the largest employers in the future.

Table 7-4: Employment by Industry, 2000

	Warwick 2000	East Greenwich 2000	North Kingstown 2000	Exeter 2000	South Kingstown 2000	Charlestown 2000	Project Area 2000	Total
Agricultural, Forestry, Fishing and Hunting, and Mining	174	36	88	82	267	104	751	0.9%
Construction	2,262	217	731	292	729	473	4,704	5.5%
Manufacturing	6,530	821	1,776	321	1,152	637	11,237	13.2%
Wholesale Trade	1,590	243	491	135	395	49	2,903	3.4%
Retail Trade	5,784	629	1,830	336	1,253	498	10,330	12.1%
Transportation and Warehousing, and Utilities	2,348	134	416	190	419	125	3,632	4.3%
Information	1,162	105	365	72	327	29	2,060	2.4%
Finance, Insurance, Real Estate, and Rental and Leasing	3,835	653	1,004	216	838	158	6,704	7.9%
Professional, Scientific, Management, Administrative, and Waste Management	3,249	691	1,155	421	1,131	253	6,900	8.1%
Educational, Health and Social Services	9,556	1,659	3,660	690	4,342	872	20,779	24.4%
Arts, Entertainment, Recreation, Accommodation and Food Service	3,412	417	1,039	200	1,457	519	7,044	8.3%
Other Services (Except Public Administration)	2,214	183	551	105	697	212	3,962	4.6%
Public Administration	1,942	318	793	251	682	200	4,186	4.9%
Total	44,058	6,106	13,899	3,311	13,689	4,129	85,192	100%

Note: Industry data for 1990 and 2000 are not comparable due to changes in the classification system by industry.
Source: Rhode Island Statewide Planning.
U.S. Department of Commerce, Bureau of the Census, 2000.

7.3 Land Use

This section describes existing and future land use within the Study Area. The scope of this discussion will address those features which might be affected by the Project.

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7.3.1 Project Area Land Use

As depicted in Figure 7-1, several dominant land use patterns are evident within the Project area. These generalized land use patterns include residential, commercial and industrial development, agricultural uses, and water-dependent uses. Growth in the Study Area over the past two decades has been strongly influenced by its geographic location in southern Rhode Island.

The major land use located within the affected municipalities is single-family residential development in varying densities. In recent years, residential subdivisions have been the predominant land use which has alleviated development pressures and formed new throughways, thereby breaking up large parcels of open agricultural land. Large lot subdivisions are a recent trend that will likely continue as the Study Area changes from a primarily rural economy to a major suburban community.

Commercial and industrial development is primarily focused along Route 2 (South County Trail), portions of Route 4 and portions of Route 102 (Ten Rod Road). Most of the commercial growth is characterized by a mixture of uses including car dealers, restaurants, mini-storage, and shopping malls. Industrial development is primarily located along Route 2 and consists of now inactive sand and gravel operations, textiles and manufacturing, and publishing.

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7.3.2 Land Use Along the Transmission Line Corridor

The northern terminus of the Project is located south of Cowesett Road at the Kent County Substation in the City of Warwick. From the Kent County Substation, the Warwick section of the ROW runs south and generally parallel to and west of Interstate 95. The route crosses the Maskerchugg River and continues south through woodlands until reaching the intersection of Major Potter and Green Bush Roads. The ROW crosses over Major Potter Road and turns southwest, crossing woodlands before reaching Interstate 95. Continuing southwest, the ROW crosses Interstate 95, and runs for approximately 1,500 feet through forested, residential and wetland areas before reaching Division Street, the boundary between Warwick and East Greenwich.

After crossing Division Street into East Greenwich, the ROW heads south paralleling Route 4 on the east for approximately 2.8 miles, crosses Middle Road, and continues south, passing residential areas and the East Greenwich High School. Continuing south and paralleling Route 4, the ROW crosses a former gravel operation that is the site of a new highway interchange before reaching Frenchtown Road.

After crossing over Frenchtown Road, the ROW continues south, paralleling Route 4 for approximately 1,000 feet, crossing Davisville Road (Route 403) and entering the Audubon property associated with the Hunt River. The Audubon property, located in the Towns of East Greenwich and North Kingstown, comprises over 100 acres of wildlife preserve. The ROW crosses into the Audubon property and runs south for approximately 5,400 feet to the Old Baptist Road Tap Point in the Town of East Greenwich. This portion of the ROW crosses forested upland areas and the Hunt River wetland complex. The L-190 transmission line extension will extend from the Old Baptist Road Tap Point south to the West Kingston Substation.

After crossing Old Baptist Road, the ROW continues south crossing forested areas, wetland, and commercial areas before reaching Route 102. South of Route 102 the ROW continues in a southerly direction through forested areas and reaching an Amtrak railway crossing. From the railroad, the ROW crosses Lafayette Road and continues in a south easterly direction toward the southwest portion of Secret Lake. This portion of the route passes through shrubland, forested upland areas, open space, gravel pits, residential areas, and crosses surface water areas.

The proposed Tower Hill Tap will extend on existing ROW approximately 3,000 feet east from the vicinity of G-185S Structure 174 north of Allenton Road to the western side of Tower Hill Road passing through residential, forested and wetland areas. The Tower Hill Substation is proposed on land owned by Narragansett with residences, commercial uses, and open space abutting.

The ROW continues south through forested areas from the Tower Hill Road Tap point approximately 500 feet then turns southwest and crosses Route 4. From Route 4 the ROW continues southwest through forested and wetland areas and along the southern edge of Kettle Hole Pond before turning south.

From Kettle Hole Pond, the ROW passes areas of open space, forest and recreation before crossing Indian Corner Road. Then it continues south approximately 2,800 feet through forested, wetland, and agricultural areas. The ROW then turns westward and continues approximately 6,000 feet where it crosses Slocum Road, the division between North Kingstown and Exeter. This portion of the route crosses shrubland, forest, wetland areas associated with streams and residential areas.

Continuing west in Exeter, the ROW passes through residential, agricultural, and forested areas and crosses Yawgoo Valley Road. It then continues west through forested and agricultural areas where it crosses the Amtrak Railroad at a second location. From the railroad, the ROW continues in a south westerly direction through agricultural, forested, open space, and wetland areas to Wolf Rocks Road.

South of Wolf Rocks Road, the ROW crosses into South Kingstown, and continues west to Waites Corner Road and on to Kingstown Road (Route 138). This portion of the ROW passes through agricultural, wetland, forested, and residential areas. From Route 138, the ROW continues south through forested areas to Liberty Lane. After crossing Liberty Lane, the ROW continues south across the Chickasheen Brook and through forested and wetland areas to the third Amtrak railroad crossing associated with the Project. The ROW then continues south to the West Kingston Substation passing through forested, agricultural, and residential areas.

From the West Kingston Substation, the transmission line ROW continues generally in a southwesterly direction through agricultural, wetland, and forested areas, until it crosses Biscuit City Road. This portion of the ROW crosses wetland and forested areas associated with the Great Swamp Wildlife Reservation, agricultural areas, the Pawcatuck River, and some residential areas in the vicinity of Biscuit City Road.

South of Biscuit City Road the ROW passes through forested and residential areas, crossing Maple Lake Farm Road, Shannock Road and Botka Drive before it reaches the Kenyon Substation in Charlestown. This area contains residential, forested and wetland areas including Pasquiset Brook.

West of Kenyon Substation, the ROW passes through a residential, forested and wetland areas crossing Route 2 and Route 112 (Carolina Back Road). From Route 112, the route continues to the southern Project terminus at the Wood River Substation. This portion of the Project passes through residential, forested, wetland, and agricultural areas, crosses the Narragansett Trail and King's Factory Road, as well as crossing Cedar Swamp Brook.

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7.3.3 Open Space and Recreation

Several areas of open space, including recreational areas, are present within the Project Study Area. These include the Audubon Hunt River Preserve and the Davisville Memorial Refuge off Davisville Road, Belleville Pond area (Ryan Park) between Lafayette Road and Oak Hill Road, the Great Swamp Wildlife Management Area off Great Neck Road and the Pawcatuck River. These open space resources provide year round opportunities for hiking, canoeing and nature study, as well as seasonal opportunity for fishing and hunting.

Established recreational areas within the Study Area include the East Greenwich High School Athletic Complex, Feurer Park located off of Lafayette Road, Ryan Park in the vicinity of Belleville Pond, and Liscio Field located in Donald Downs Park in North Kingstown. These facilities include running tracks, football and baseball fields. The Woodland Greens Golf Course is located between South Road and Old Baptist Road in North Kingstown and the southeastern portion of East Greenwich. In Exeter, the Yawgoo Valley Ski Area provides skiing opportunities in winter and water slides in the summer. Further south at Route 138 in South Kingstown, the West Kingston Park provides a playground and baseball fields.

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7.3.4 Future Land Use

In order to assess future land use, an analysis of current zoning was undertaken. Typically, towns and cities manage future growth through zoning regulations which provide a degree of control over a community. The majority of the Study Area is zoned farming, forested or residential in varying densities. Specifically, the route crosses low density residential areas within the Study Area in the Towns of Exeter, South Kingstown and Charlestown. High density residential areas within the Study Area include the City of Warwick and the Towns of East Greenwich and North Kingstown. More specifically, these areas are located west of Route 4 between Division Street and Frenchtown Road in East Greenwich and in the vicinity of Old Baptist Road, Lafayette Road and West Allenton Road in North Kingstown.

Forested land within the existing ROW in the Towns of Exeter, South Kingstown and Charlestown can be used for future residential development in accordance with the town zoning ordinances. Agricultural land within the Study Area consists of an open field located immediately north of East Greenwich High School and turf farms in the vicinity of Indian Corner Road and Slocum Road in North Kingstown, and Yawgoo Valley Road, Waites Corner Road and Route 138 in South Kingstown which are being commercially farmed. Portions of the Study Area are located within the Hunt River Preserve in North Kingstown, the Great Swamp in South Kingstown, and Cedar Swamp in Charlestown.

The Comprehensive Plans for the Town of Charlestown adopted by the Council on January 13, 1992 and the Town of Exeter approved March 3, 2004 do not mention utility transmission line construction. Policy 3.4 of South Kingstown's Comprehensive Plan prepared by Edwards and Kelcey March 29, 2004 states that "the Town will minimize development along existing or future utility transmission lines, which simply connect high-density areas."

The Town of North Kingstown requires that utilities must be compatible with local character and construction of underground utilities with redevelopment and reconstruction of roads preferred. There is no mention of electric transmission facilities in the Comprehensive Plan adopted by North Kingstown Town Council on July 9, 2001.

According to the City of Warwick Comprehensive Plans as approved December 20, 2002 regarding park facility improvements, District 7 in the vicinity of Duchess Street noted concern over the presence of transmission lines. They would ultimately like a new park site. The proposed project will not be located in the vicinity of Duchess Street.

The Town of East Greenwich Comprehensive Plan was amended and codified June 23, 2003 by Ordinance No. 735, but does not address transmission lines.

7.4 Visual Resources

The visual quality of a place is determined by the perceived aesthetic value of the available views as influenced by the topography, vegetation, and land use. The Narragansett ROW extends 25.8 miles through multiple towns in Rhode Island. The topography of the study area as a whole is characterized by gently rolling hills and valleys in the northern portion of the corridor with level plains in the central and southern regions. The elevation ranges from 20 feet to 320 feet above sea level with the greatest viewing distances offered across the open field and agricultural landscape of the central region of the study area. Land uses (landscape similarity zones) within the study area include suburban residential, commercial, rural residential, agricultural undeveloped forestland and transportation. The forest vegetation is primarily an Oak-Hickory community intermixed with white pine/red pine forest. The mature forest vegetation typically occurs in large intact blocks that provide a strong sense of enclosure and screening along streets and surrounding residential neighborhoods.

Visually sensitive resources within the study area include multiple historic sites listed by the RIHPHC. Additionally, the study area is characterized by numerous public recreational and natural areas that are protected and managed by the RIDEM. Designated scenic areas within the study area include the South County Trail (Route 2) and other travel corridors that traverse attractive New England and southern Rhode Island landscapes.

Areas of intensive land use in the study area are also considered visually sensitive due to the number of potential viewers. These areas include residential neighborhoods, commercial districts and transportation corridors. Specific viewer groups within the study area include commuters and through-travelers, local residents, business employees, and recreational users.

A more detailed characterization of the visual aspects of the Study Area is contained in the visual assessment conducted by EDR, which is filed with this report.

7.5 Noise

7.5.1 Introduction[13]

Environmental sound levels are quantified by a variety of parameters and metrics. This section introduces general concepts and terminology related to acoustics and environmental noise.

Sound energy is physically characterized by amplitude and frequency. Sound amplitude is measured in decibels (dB) as the logarithmic ratio of a sound pressure to a reference sound pressure which corresponds to the typical threshold of human hearing. Generally, the average listener considers a 1 dB change in a constant broadband noise “imperceptible” and a 3 dB change "just barely perceptible". Similarly, a 5 dB change is generally considered "clearly noticeable" and a 10 dB change is generally considered a doubling (or halving) of the apparent loudness.

13 This introduction including Table 7-5 is taken from Chapter 2 of the Environmental Noise Assessment for the Tower Hill Substation prepared by Black & Veatch Corporation.

Frequency is measured in hertz (Hz), which is the number of cycles per second. The typical human ear can hear frequencies ranging from approximately 20 Hz to 20,000 Hz. Typically, the human ear is most sensitive to sounds in the middle frequencies (1,000 to 8,000 Hz) and is less sensitive to sounds in the low and high frequencies. As such, the A-weighting scale was developed to simulate the frequency response of the human ear to sounds at typical environmental levels. The A-weighting scale emphasizes sounds in the middle frequencies and de-emphasizes sounds in the low and high frequencies. Any sound level to which the A-weighting scale has been applied is expressed in A-weighted decibels, dBA. For reference, the A-weighted sound pressure levels associated with some common noise sources are shown in Table 7-5.

Table 7-5: Typical Sound Pressure Levels Associated with Common Noise Sources

Sound Pressure Level (dBA)	Subjective Evaluation	Environment	
		Outdoor	Indoor
140	Deafening	Jet aircraft at 75 ft	
130	Threshold of pain	Jet aircraft takeoff at 300 ft	
120	Threshold of feeling	Elevated train	Rock band concert
110	Extremely Loud	Jet flyover at 1000 ft	Inside propeller plane
100	Very Loud	Motorcycle at 25 ft, auto horn at 10 ft, crowd noise at football game	
90	Very Loud	Propeller plane flyover at 1000 ft, noisy urban street	Full symphony or band, food blender, noisy factory
80	Moderately Loud	Diesel truck (40 mph) at 50 ft	Inside auto at high speed, garbage disposal, dishwasher
70	Loud	B-757 cabin during flight	Close conversation, vacuum cleaner, electric typewriter
60	Moderate	Air-conditioner condenser at 15 ft, near highway traffic	General office
50	Quiet		Private office
40	Quiet	Farm field with light breeze, birdcalls, soft stereo music in residence	Bedroom, average residence (without t.v. and stereo)
30	Very quiet	Quiet residential neighborhood	
20	Very Quiet	Rustling leaves	Quiet theater, whisper
10	Just audible		Human breathing
0	Threshold of hearing		

Source: Adapted from Architectural Acoustics, M. David Egan, 1988 and Architectural Graphic Standards, Ramsey and Sleeper, 1994.

Noise in the environment is constantly fluctuating, such as when a car drives by, a dog barks, or a plane passes overhead. Several noise metrics have been developed to quantify fluctuating noise levels. These metrics include the equivalent-continuous sound level and the exceedance sound levels.

The equivalent-continuous sound level, L_{eq}, is the level of a hypothetical steady sound that has the equivalent sound energy as the actual fluctuating sound over a given time duration. For example, L_{eq}(1h) is the equivalent-continuous sound level measured over a one-hour period and provides and indication of the average (mean) sound energy over the one-hour period.

The exceedance sound level, L_x, is the sound level exceeded "x" percent of the sampling period and is referred to as a statistical sound level. The most common L_x values are L_{90}, L_{50}, and L_{10}. L_{90} is the sound level exceeded 90 percent of the sampling period. L_{90} is referred to as the residual sound level because it measures the background sound level without the influence of loud, transient noise sources (ANSI S12.9). L_{50} is the sound level exceeded 50 percent of the sampling period or the median sound level. L_{10} is the sound level exceeded 10 percent of the sampling period. L_{10} is often referred to as the intrusive sound level because it measures the occasional louder noises.

The variation between the L_{90}, L_{50} and L_{10} sound levels can provide an indication of the variability and distribution of the noise environment. If the noise environment were perfectly steady, all values would be identical. A large variation between the values would indicate a large range of sound levels within the environment. For instance, measurements near a roadway with frequent passing vehicles would cause a large variation in the statistical sound levels.

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7.5.2 West Kingston Substation

In order to characterize the existing acoustical environment surrounding the existing West Kingston Substation site, an ambient sound level survey was conducted. The existing acoustical environment around the substation site is typical of semi-rural areas. The primary sources of noise include natural sounds, substation noise, and occasional vehicular traffic.

The ambient sound level survey was conducted on May 11 and 12, 2005 to characterize the existing acoustical environment at nearby noise sensitive receptors. The ambient sound level survey procedure was based on general industry test standards including ANSI S12.9, ANSI S12.18, and ANSI S1.13. In order to effectively quantify and qualify the existing daily sound levels, the ambient survey included both continuous monitoring and short-term measurements. The sound level survey was conducted at two locations near the Project site. These locations were selected to capture acoustical environments representative of the nearby noise-sensitive receptors.

Based on the survey results, the existing background sound levels at the substation site ranged from 29 dBA to 44 dBA during daytime hours and from 28 dBA to 42 dBA during nighttime hours.

7.5.3 Tower Hill Substation

In order to characterize the existing acoustical environment surrounding the proposed Tower Hill Substation site, an ambient sound level survey was conducted. The existing acoustical environment within the areas surrounding the substation site is typical of residential areas with moderate traffic flows. The primary sources of noise include vehicular traffic and natural sounds.

The ambient sound level survey was conducted on May 11 - 12, 2005 to characterize the existing acoustical environment at nearby noise sensitive receptors. The ambient sound level survey procedure was based on general industry test standards including ANSI S12.9, ANSI S12.18, and ANSI S1.13. In order to effectively quantify and qualify the existing daily sound levels, the ambient survey included both continuous monitoring and short-term measurements. The sound level survey was conducted at two locations near the proposed project site. These locations were selected to capture acoustical environments representative of the nearby noise-sensitive receptors.

Based on the survey results, the existing background sound levels at the substation site ranged from 40 dBA to 49 dBA during daytime hours and from 31 dBA to 47 dBA during nighttime hours.

7.6 Cultural Resources

The PAL conducted a Phase I(a/b) reconnaissance archaeological survey consisting of archival research and a project site walkover investigation to assess the potential for pre-contact, contact, and post-contact period cultural resources to be present within the existing ROW. As a result of the survey, the ROW has been stratified into zones of high, moderate, and low archaeological sensitivity, relative to the probability that potentially significant cultural resources can be expected to be (or have been) located within those zones. Further consideration of cultural resources was recommended for area-specific construction and construction-related impacts within the identified zones of high and moderate archeological sensitivity.

Zones of high and moderate archaeological sensitivity were identified in sections of the ROW that have not been substantially disturbed and are situated in attractive environmental settings (elevated terrain, well-drained soils, within 500 meters of a source of water) and/or are within or proximate to identified cultural resources. Poorly drained areas (wetlands) and sections of the existing ROW substantially disturbed through activities such as sand and gravel mining were identified as zones of low sensitivity.

7.7 Transportation

The transportation needs of the Study Area are served by a network of U.S., State and local roads and highways. The primary transportation artery in the Study Area running north/south is Interstate 95, which crosses the northern portion of the Study Area. State highway systems within the Study Area that serve the suburban and rural areas include Route 4, Route 2, Route 403, Route 102, Route 112, and Route 138. The ROW crosses thirty-four roadways. Local roads within the Study Area will be used by construction vehicles to gain access along the ROW. The ROW crosses the Amtrak Northeast Corridor mainline in three locations.

7.8 Electric and Magnetic Fields

EMF is a term used to describe electric and magnetic fields that are created by electric voltage (electric field) and electric current (magnetic field). Power frequency EMF is a natural consequence of electrical circuits, and can be either directly measured using the appropriate measuring instruments or calculated using appropriate information.

Electric fields are present whenever voltage exists on a wire, and are not dependent on current. The magnitude of the electric field is primarily a function of the configuration and operating voltage of the line and decreases with the distance from the source (line). The electric field can be shielded (i.e., the strength can be reduced) by any conducting surface, such as trees, fences, walls, buildings, and most types of structures. The strength of an electric field is measured in volts per meter (V/m) or kilovolts per meter (kV/m).

Magnetic fields are present whenever current flows in a conductor, and are not dependent on the voltage present on the conductor. The strength of these fields also decreases with distance from the source. However, unlike electric fields, most common materials have little shielding effect on magnetic fields.

The magnetic field strength is a function of both the current on the conductor and the design of the system. Magnetic fields are measured in units called Gauss. However, for the low levels normally encountered during daily activities, the field strength is expressed in a much smaller unit, the milliGauss (mG), which is one thousandth of a Gauss.

Power frequency EMFs are present wherever electricity is used. This includes not only utility transmission lines, distribution lines, and substations, but also the building wiring in homes, offices, and schools, and in the appliances and machinery used in these locations. Magnetic field intensities from these sources can range from below 1 mG to above 1,000 mG (1 Gauss).

Narragansett, like all North American electric utilities, supplies electricity at 60-Hz. The electric and magnetic fields discussed below are 60-Hz electric and magnetic fields.

Electric and magnetic fields were calculated for each of the segments of the ROW as it exists today using typical and summer peak load levels for the year 2006 with a computer program named ENVIRO[14]. (The ENVIRO program's calculation of magnetic field strength was verified in a number of tests, including the study done for the state's Committee to Study the Potential Health Effects of EMF Emanating from High Voltage Transmission Lines.) The voltages stay nominally constant throughout the year, so electric field strength at the edge of a ROW does not change except for small change with the height of the conductors. Table 7-6 shows electric field levels at the edge of the ROW for the six transmission line segments. Tables 7-7 and 7-8 show the existing magnetic field (RMS Resultant) levels under typical and peak loads.

Table 7-6: Electric Field Strengths (kV/m) at Edge of ROW Under Existing Conditions (2006)

Line Segment	West Edge	East Edge
L-190 - Extension - Old Baptist Road Tap Point to Lafayette Substation	<0.01	0.42
L-190 - Extension - Lafayette Substation to Tower Hill Tap	<0.01	0.42
L-190 - Extension - Tower Hill Tap to West Kingston Substation	0.02	0.41
Tower Hill Tap Lines	<0.01*	0.02**
1870N - West Kingston Substation to Kenyon Substation	0.42	0.25
1870 - Kenyon Substation to Wood River Substation	0.42	0.25

Source: Black & Veatch Corporation, 2005
* South Edge
** North Edge

14 ENVIRO, Version 3.52, is part of the Transmission Line Workstation (EMF workstation™ Version 2.51) computer program. The ENVIRO program enables utility engineers to calculate magnetic and electric fields, audible noise, and maximum conductor voltage gradients in complex transmission line systems. TL workstation was prepared by the Electric Power Research Institute, Inc. (EPRI). Copyright© July 31, 1997 Electric Power Research Institute, Inc.

Table 7-7: Existing Magnetic Field Strengths (mG) at Edge of ROW under Typical Load Conditions (2006)

Line/segment	West Edge	East Edge
L-190 - Extension - Old Baptist Road Tap Point to Lafayette Substation	1.1	20.6
L-190 - Extension - Lafayette Substation to Tower Hill Tap	1.0	20.0
L-190 - Extension - Tower Hill Tap to West Kingston Substation	2.7	25.0
1870N - West Kingston Substation to Kenyon Substation	8.2	24.2
1870 - Kenyon Substation to Wood River Substation	4.5	28.4

Source: Black & Veatch Corporation

Table 7-8: Existing Magnetic Field Strengths (mG) at Edge of ROW under Peak Load Conditions (2006)

Line segment	West Edge	East Edge
L-190 - Extension - Old Baptist Road Tap Point to Lafayette Substation	2.4	46.0
L-190 - Extension - Lafayette Substation to Tower Hill Tap	2.4	46.0
L-190 - Extension - Tower Hill Tap to West Kingston Substation	5.9	45.0
1870N - West Kingston Substation to Kenyon Substation	28.4	31.8
1870 - Kenyon Substation to Wood River Substation	23.5	43.6

Source: Black & Veatch Corporation

8.0 Impact Analysis

This chapter presents an analysis of the potential impacts of the Project on existing environmental and social conditions within the Study Area. As with any construction project, potential adverse impacts can be associated with the construction, operation or maintenance of an electric transmission line or substation. These impacts have been minimized by the careful location of structures, facilities and access roads, and by the adoption of numerous mitigation practices.

This project will be constructed in a manner that minimizes the potential for adverse environmental impacts. A monitoring program will be conducted by Narragansett to ensure that the Project is constructed in compliance with all relevant licenses and permits and all applicable federal, state and local laws and regulations. Design and construction mitigation measures will ensure that construction related environmental impacts are minimized.

8.1 Geology

The Project will have negligible impact on the bedrock and surficial geologic resources of the Project area. The northern portion of the Project consists of ablation till with pockets of lodgment till and organic deposits associated with wetland areas. Glacial outwash deposits make up the majority of the soils in the vicinity of the Hunt River south to Indian Corner Road in North Kingstown. Organic deposits and sections of urban land are scattered throughout this area. South of Indian Corner Road to Liberty Lane in South Kingstown, several areas of ablation till and glacial outwash are crossed. The Great Swamp in South Kingstown consists of lodgment till and deep organic deposits. Areas of ablation till and glacial outwash are crossed south of the Great Swamp, as are areas of alluvial and organic deposits along Pasquiset Brook and Cedar Swamp Brook.

Due to the depth of these deposits, bedrock is not expected to be encountered during excavation for poles in this area. If bedrock is encountered at or below the surface and it is sufficiently stable and unfractured, the pole structure may be anchored directly to the bedrock which will serve as the footing for the structure. If the bedrock is inadequate as a pole footing, it will be drilled or blasted to the required depth and a concrete footing will be prepared, or the pole set and backfilled with clean granular material.

If required, blasting activities will be performed with strict adherence to relevant local, state and federal regulations. Proper safeguards will be taken to protect personnel and property in the area. Charges will be kept to the minimum required to break up the rock. Mats of heavy steel mesh or other material will be used to prevent the scattering of rock and debris.

The Project includes limited grading activities. Proposed grading is restricted to the proposed Tower Hill Substation site and the West Kingston Substation expansion. Grading will be necessary to create a level site for construction, as well as to provide appropriate spill prevention controls and countermeasures.

8.2 Soils

Construction activities which expose unprotected soils have the potential to increase natural erosion and sedimentation rates. Soil compaction and decreased infiltration rates may result from equipment operations. To minimize these impacts, standard construction techniques and BMPs such as the installation of hay bales and siltation fencing, the re-establishment of vegetation and dust control measures, will be employed to minimize any short- or long-term effects due to construction activity. These devices will be inspected by Narragansett's Environmental Monitor frequently during construction and repaired or replaced if necessary. Narragansett will develop and implement a Storm Water Pollution Prevention Plan (SWPPP) which will detail BMPs and inspection protocols.

Excess soil from excavation at pole structures in uplands will be spread around the poles and stabilized to prevent migration to wetland areas. Excess material excavated from pole structure locations in wetlands will be disposed of at upland sites. Topsoil will then be spread over the excess excavated subsoil material to promote rapid revegetation.

Highly erodable soils are encountered within the transmission line ROW, however, on all slopes greater than eight percent which are above sensitive areas, disturbed soils will be stabilized with hay or chipped brush mulch to prevent the migration of sediments.

The transmission line ROW crosses several areas of prime farmland soils. These areas are currently occupied by residential and transportation land uses and active turf farms in the vicinity of Indian Corner Road, Slocum Road, Yawgoo Valley Road, Waites Corner Road, and Route 138. A hayfield in the vicinity of the proposed Tower Hill Substation and transmission line tap is also located in prime farmland soils. The Project will displace prime farmland soils only at new pole locations and at the Tower Hill Substation site.

8.3 Surface Water

Any impact of the Project upon surface watercourses will be minor and temporary. Construction activities temporarily increase risks for erosion and sedimentation that may temporarily degrade existing water quality; however, appropriate BMPs will be implemented and maintained to effectively control sediment. In addition, construction equipment will not cross rivers and streams along the construction corridor without the use of temporary mat bridges or other crossing structures. Emphasis has been placed on utilizing existing gravel roadways within the ROW and seeking access points that avoid crossing wetlands and surface waters.

The major surface water features within the transmission line ROW include the Maskerchugg River, the Hunt River, Frenchtown Brook, Fry Brook, Belleville Pond, Oak Hill Pond, Saw Mill Pond, Secret Lake, Kettle Hole Pond, Chipuxet River, Chickasheen Brook, Great Swamp, Pawcatuck River, Pasquiset Brook, Cedar Swamp Brook, and the unnamed perennial watercourses. Swamp mats will be used to access structure locations within or adjacent to surface water features as conditions warrant. Access to most structure locations adjacent to these watercourses will be provided without impacting the channels either by using alternate upland access on the ROW or by spanning the areas using temporary wooden mats during construction. Sedimentation and erosion within these watercourses will be minimized through the implementation of BMPs prior to construction activities.

Potential impacts to surface waters if sediment transport is not controlled include increased sedimentation (locally and downstream) and subsequent alterations of benthic substrates, decreases in primary production and dissolved oxygen concentrations, releases of toxic substances and/or nutrients from sediments, and destruction of benthic invertebrates. Erosion and sedimentation controls will effectively minimize the potential for this situation to occur. The implementation and maintenance of stringent erosion and sedimentation control BMPs will limit the levels of project related sedimentation and will minimize adverse impacts to surface waters.

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8.3.1 Water Quality

The primary potential impact to water quality from any major construction project is the increase in turbidity of surface waters in the vicinity of construction resulting from soil erosion and sedimentation from the disturbed site. A second potential impact is the spillage of petroleum or other chemical products near waterways. Disturbance to previously undisturbed areas on the ROW will be minimized through the use of existing roadways. Overhead transmission line construction requires only a minimal disturbance of soil for pole footing excavation. Further, equipment will not be refueled or maintained near wetland or surface water resources. Therefore, it is anticipated that any adverse impacts to water resources resulting from construction of the proposed transmission line will be negligible.

The removal of vegetation prior to construction may result in increased erosion potential so that slightly higher than normal sediment yields may be delivered to area streams and wetlands during a heavy rainfall. However, these short-term impacts should be minor as a result of the relatively small area to be disturbed, the use of selective clearing within 25 feet of streams, the implementation of erosion control measures and the short duration of construction activities. In addition, a detailed Erosion Control Plan will be designed and implemented which will confine sediment within the immediate construction area and minimize impacts to downstream areas.

8.3.2 Hydrology

Some minor, temporary impacts to surface drainage can be expected during construction and maintenance of the transmission lines. These impacts will be associated with access road improvements and installation of the pole structures. Following construction, the topography within the work corridor will generally be restored to its pre-construction contours with the exception of structure pads and permanent access roads.

The hydrology of surface waters will not be significantly affected during or after construction since temporary wooden mat bridges will be constructed across some stream channels to allow for the passage of construction equipment without disturbing the stream or its channel substrate. These bridges will be removed following construction. A slightly higher rate of storm water runoff may result from the clearing of vegetation which would otherwise function to absorb some of the precipitation and slow the rate of runoff. These impacts will be short-term because vegetative cover will quickly reestablish in the construction corridor following construction.

8.3.3 Floodplain

Available FEMA mapping of the Project area indicates that the 100-year floodplain is associated with the Hunt River, Frenchtown Brook, Fry Brook, Maskerchugg River, Secret Lake, Kettle Hole Pond, Chipuxet River, Chickasheen Brook, Great Swamp, Pawcatuck River, Pasquiset River and Cedar Swamp Brook. The 100-year floodplain represents the extent of flooding that would result during a storm event having a one percent chance of occurring per year. The unnamed watercourses within the Study Area may also contain 100-year floodplains, though un-mapped by FEMA.

Permanent impacts to floodplain will occur at structures 116-118, 122-128, 131, 173, 174, 192, 193, and 258 on the L-190 Line, and totals approximately 240 square feet of permanent disturbance. In accordance with state and local regulations, Narragansett is providing incremental floodplain compensation as close as practicable to each impact.

8.4 Groundwater

Issues related to development within a water resources overlay district include potential impacts related to storage of hazardous materials, reduction in groundwater recharge or degradation of groundwater resources due to discharges of regulated materials. Normal operation of the proposed transmission and substation facilities includes proper storage and handling of hazardous and regulated materials, and development of contingency plans in the event of a spill of such materials. Normal facility operation does not include discharges of any substances to groundwater.

8.4.1 Transmission Lines

Potential impacts to groundwater resources within the transmission line ROW as a result of construction activity will be negligible. Equipment used for the construction of the transmission line will be properly maintained and operated to reduce the chances of spill occurrences of petroleum products. Refueling of equipment will be conducted in upland areas. Within primary groundwater recharge areas, special safeguards will be implemented to assure the protection of groundwater resources. Refueling equipment will be required to carry spill containment and prevention devices (i.e., absorbent pads, clean up rags, five gallon containers, absorbent material, etc.) at all times. In addition, maintenance equipment and replacement parts for construction equipment will be on hand to repair failures and stop a spill in the event of equipment malfunction. Following construction, the normal operation and maintenance of the transmission line facility will pose no threat to groundwater resources.

8.4.2 Substation

Two 115-12.47 kV transformers are proposed to be installed at the Tower Hill Substation. Each transformer is filled with approximately 6,000 gallons of mineral oil dielectric fluid (MODF) for insulation and cooling. Although MODF is not listed as a hazardous material, it is hydrocarbon based and therefore warrants special attention.

The proposed substation will not involve storage of hazardous materials but does require installation of batteries to provide power in the event of an emergency. The acid contained in the batteries is a hazardous material. The batteries will be installed inside the control house within a containment berm.

In accordance with Environmental Protection Agency (EPA) spill prevention control and countermeasures (SPCC) requirements (Title 40 CFR Part 112), containment must be provided to prevent spills from reaching navigable waters. The proposed transformers will be supported on concrete foundations with a secondary containment system. Secondary containment systems will be designed in conformance with guidelines developed by National Grid which are in use throughout the Companies' service territory.

The EPA regulations require that substation transformers containing oil based liquids must have secondary containment for the entire contents of the unit plus sufficient freeboard to allow for precipitation. At the Tower Hill Substation each transformer will be surrounded by a containment system sized to contain at least 125 percent of its MODF volume. Other electrical equipment such as the regulators and breakers contain much smaller amounts of MODF. Any potential leak from these will be trapped in the crushed stone surface.

As required by EPA, an SPCC Plan will be prepared for the Tower Hill Substation upon completion of construction. Due to their critical role, Narragansett Electric performs regular inspections and maintenance of its substations. In addition if a leak was to occur, the substation is alarmed to notify Narragansett's 24 hour a day trouble center to dispatch a crew to address the problem.

Due to their unique construction, substations typically do not generate large increases in storm water runoff. Substations yards are constructed with well drained gravel to create a near level pad and surfaced with a layer of crushed stone. After storm events, the crushed stone surface and underlying gravel will cause rainfall to infiltrate and prevent standing water. Impervious surfaces are limited to the concrete equipment foundations, access driveway and control house roof. Runoff from these areas will sheet into the crushed stone and infiltrate into the soil.

8.5 Vegetation

The primary impacts to vegetation will occur along the alignment of the proposed L-190 transmission line extension, the Tower Hill Tap lines, and in and around the substation sites. The clearing of vegetation will consist of cutting trees and saplings within 50 feet of the proposed transmission line alignment. This will result in a variable amount of clearing that is required depending on the existing tree line. Clearing along the L-190 extension alignment will vary from 34 feet to 65 feet. North of the Tower Hill Tap Point, a width of 127 feet of existing vegetation will be left in place along the west side of the ROW. South of the Tower Hill Tap Point, a width of 55 feet of existing vegetation will be left in place along the west side of the ROW. Clearing along the Tower Hill Tap alignment will vary from 103 feet to 108 feet, leaving a width of 94 feet of existing vegetation along the south side of the ROW. Approximately 61 acres of existing vegetation will be cleared for the Project.

Woody species with a mature height over 10 feet will be removed. Low growing vegetation will be preserved wherever possible. Following construction, disturbed areas in the vicinity of the pole structures will be seeded and mulched.

A well managed ROW is required to maintain the reliability of the transmission system. Following construction, vegetation management is necessary to prevent trees and other tall woody species from growing into or falling into the lines. Dense woody vegetation also restricts visual and physical access which is necessary for inspection, repair and maintenance of the transmission lines.

Narragansett manages vegetation on its ROWs through integrated procedures combining removal of danger trees, hand cutting, targeted herbicide use, mowing, selective trimming and side trimming. Three methods of targeted herbicide treatments are utilized: basal application, cut stump treatment, and foliar application.

The appropriate method of vegetation management is chosen by a Narragansett forester or arborist. The typical maintenance cycle for this ROW is five years, although occasionally site specific conditions may require a shorter cycle. All state permits necessary for any vegetation management operation are obtained prior to the initiation of management procedures.

8.6 Wetlands

Construction of the Project will result in temporary and permanent impacts to wetland resources. The following sections describe the impacts associated with construction of the Project including vegetation clearing, excavation for pole structures and access road construction.

8.6.1 Clearing and Vegetation Management

Approximately 23 acres of vegetation clearing will occur within wetland and state regulated buffer areas to facilitate construction and maintenance of the proposed transmission line. Appropriate erosion and sediment control measures will minimize impacts to wetlands from adjacent disturbed areas.

8.6.2 Access Roads

Following the delineation of wetland boundaries within the 26.5 mile transmission line ROW, a site inspection was conducted to determine access to pole structures which would minimize impacts to wetland areas. Access road locations have been chosen to avoid wetlands completely, to cross wetlands at previously impacted locations or to traverse the edge of the wetland. Temporary crossings using timber mats will be used where possible.

No permanent access roads will be constructed within wetland areas for this Project.

8.6.3 Structures

Under the current design of the proposed transmission facilities, engineering and safety requirements necessitate the placement of 41 pole structures within state and federally regulated wetland areas and 16 pole structures within state-regulated 100-year floodplain. The only fill needed for structures is any backfill required around the pole embedment. This would amount to approximately four cubic yards of crushed rock per structure. To mitigate this impact, Narragansett is providing incremental floodplain compensation.

8.7 Wildlife

The removal of mature trees in forested areas within the ROW may affect wildlife species composition by favoring species that prefer emergent/shrub habitat to those that inhabit forested communities. During construction, temporary displacement of wildlife may occur due to the presence of clearing and construction equipment. However, the ability of the area to provide wildlife habitat will not be adversely affected following construction. Conversely, a study conducted by Nickerson and Thibodeau (1984) of three ROWs in Massachusetts indicated an increase in wildlife utilization, especially avian species, following clearing of the ROWs. The study attributed this increase in wildlife usage to the conversion of forested areas into both wetland and upland shrub and emergent plant communities, and provided edge effect feeding, nesting and cover habitat for various species. The ROWs also serve as open corridors connecting non-contiguous natural areas.

Wildlife currently utilizing the forested edge of the cleared ROW may be impacted by the construction of the Project. Larger, more mobile species, typically large mammals, will leave the construction area and may be temporarily impacted by displacement and disruption of breeding cycles. Some avifauna will also be temporarily displaced, possibly impacting breeding and nesting activities depending on the time of year. Smaller and less mobile animals such as small mammals and herpetofauna may be killed during vegetation clearing and the transmission line construction. The species impacted during the construction of the transmission line are expected to be limited in number. Effects will be localized to the immediate area of construction around structure locations and along existing access roads. Following construction, wildlife are expected to return and re-colonize the ROW.

Impacts to sensitive habitats of rare, threatened or endangered species will be avoided through close coordination with the RINHP which will involve a detailed ROW inventory, and discussion on avoidance and mitigation of potential impacts. RINHP approval of the Project methodology is required as a condition of the RIDEM Freshwater Wetlands permit process.

8.8 Social and Economic Impacts

Based on the proposed location of the Project, the greatest potential for social impact is the interaction of construction and maintenance on current and future land uses abutting the ROW.

8.8.1 Social Impacts

The Project will enable Narragansett to continue to provide reliable electric services to homes, business and industry in the southern Rhode Island area. The proposed Project does not require nor will it lead to residential or business disruption. Temporary construction impacts, primarily related to construction traffic and equipment operation are expected to be minor; however, the Project will not adversely impact the overall social and economic condition of the Project area. As described in Section 4.0, the proposed transmission line will be located entirely within an existing ROW presently occupied by other electric lines. Therefore, the Project will not require the acquisition of property to install the transmission line or disrupt orderly planned development, thus avoiding adverse impacts.

8.8.2 Population

Project construction and maintenance will have no impact on the population but will improve existing electrical service reliability to the population of the southern Rhode Island area. It also will provide the capability to serve residential, commercial and industrial developments planned for the future.

8.8.3 Employment

The construction of the transmission line may have minor beneficial effects on the area economy by creating new jobs for the construction period. Project expenditures may also have a small spin-off impact as funds are recirculated and respent within the local economy.

By meeting the current and projected demands for increased power in the area, the construction of the Project will support the state's effort to stimulate additional growth and economic activity in the region.

8.9 Land Use and Recreation

The following discussion addresses the compatibility of the proposed transmission line with various land uses along the proposed route.

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8.9.1 Land Use

Land use impacts can be separated into short-term and long-term impacts. Short-term land use impacts may occur during the construction phase of the proposed project. Impacts associated with the construction phase of the Project will be temporary, and most present land uses within the existing ROW could resume following construction. Narragansett will provide notification of the intended construction plan and schedule to affected abutters so that the effect of any temporary disruptions may be minimized.

The Project is proposed entirely within an existing ROW and on land owned by Narragansett, which are already occupied by electric facilities. The development of the new transmission lines within the existing ROW will be consistent with the established land use and therefore will not present long-term land use impacts. Proposed modifications to the West Kingston Substation are consistent with the present uses of the site. The development of the Tower Hill Substation will occupy less than two acres of a 13 acre parcel of land owned by Narragansett that presently contains a sub-transmission line. As part of the substation development, Narragansett will construct vegetated berms and provide other landscaping to reduce the impact of the substation. Generally, existing land uses within the existing transmission line ROW will be allowed to continue following construction.

8.9.1.1 Residential

A number of residential areas are located in proximity to the ROW and substation sites. In many locations, existing vegetation will continue to provide visual screening of the facilities from residences. Because the proposed transmission lines and substation will occupy areas dedicated to use for electrical facilities, the Project will not displace any existing residential uses, nor will it affect any future development proposals.

8.9.1.2 Agriculture

The proposed Project crosses a number of areas which are presently in agricultural use. Impacts to agricultural uses will occur as a result of the proposed L-190 extension, Tower Hill Tap lines and Tower Hill Substation, but will be limited to the footprints of the transmission line structures, access roads and substation.

8.9.1.3 Business

The proposed route will cross several business areas. These businesses include commercial, retail, office, and agricultural uses. Normal operations will not be adversely affected by the Project. No displacement of business will result from the Project.

8.9.1.4 Institutions

East Greenwich High School is the only public institutional facility located along the proposed route. The school is located approximately midway between Frenchtown Road and Middle Road. The existing transmission lines are visible from the High School. The proposed work in this location (reconductoring) will have no impact on existing land uses in the vicinity of the High School.

8.9.2 Recreation

No existing recreational uses will be displaced by the Project.

Impacts to existing parks and recreational areas from the proposed electric transmission line will be minimal and short-term. Since the Project is located within an existing electric transmission line ROW, potential long-term impacts will be avoided.

8.9.3 Consistency with Local Planning

As documented in the Purpose and Need section of this report, there is a clear need for improving the electrical reliability to the area. The Towns of East Greenwich, North Kingstown, Exeter, South Kingstown and Charlestown, and the City of Warwick have Comprehensive Plans which describe the local viewpoint regarding future development and growth in each community. Each municipality's Comprehensive Plan was evaluated with regard to expressed town-wide goals. The proposed project was then evaluated for consistency with the local planning initiatives in each community.

Because the proposed Project will use existing ROW, it will not alter existing land use patterns and will not adversely impact future planned development. The Project will provide an adequate supply of electricity for the growth and development envisioned by the Comprehensive Plans of the communities in southern Rhode Island.

8.10 Visual Resources

The VIA procedures used in the study conducted by EDR, which is filed with this report, were based in methodology developed by the ACOE. The VIA utilized several evaluation techniques, including: viewshed analysis, line of sight cross-sections, field evaluation, computer-assisted visual simulations, and the evaluation of the Project's visual impact by a panel of landscape architects. This comprehensive analysis evaluated the effect of the proposed Project on the aesthetic character/resources of the study area.

The viewshed analysis mapping determined the potential visibility of the existing and proposed transmission structures from locations inside and outside the study boundary. This is a "worst-case" analysis, in that the screening effect of vegetation and built structures is not considered. Viewshed mapping revealed there is very little change in potential structure visibility with the proposed project in place.

Cross-section analysis more accurately accounts for the screening effect of vegetation and structures in the study area. Six cross-sections were prepared to illustrate potential project visibility. The cross-section locations were chosen to include visually sensitive areas (i.e., trails, water bodies, historic and recreational sites) within and adjacent to the study area. As a whole, the cross-sections demonstrate that the extensive forest vegetation and undulating topography within the area will effectively screen views of the proposed project from most locations.

Field verification was conducted after the viewshed mapping and cross-section studies to more accurately evaluate potential visibility of the proposed transmission facilities from ground-level vantage points. This fieldwork confirmed that the visibility of the existing transmission line is limited in the northern portion of the study area due to the hill and valley topography and the dense forest vegetation surrounding most public roads and areas of development. Longer distance views are generally confined to the central and southern portions of the study area. Throughout the study area visibility of the existing transmission line is largely limited to locations where the transmission line crosses existing roads or is in proximity to cleared yards in recently developed residential areas.

A selection of photos from the fieldwork was assembled into a package representing the six landscape similarity zones found in the study area. The photos were then presented to a panel of registered landscape architects. Using the Visual Resource Management Classification System (MCS) developed by the ACOE the panel evaluated each LSZ to determine the degree and nature of acceptable visual change in each landscape. The panel of landscape architects also evaluated the visual impact of the proposed project using the ACOE VIA methodology. This evaluation methodology involves rating the visual quality of representative viewpoints with and without the project in place. On this project eight viewpoints were selected to represent the full range of LSZ and viewer groups within the study area. The difference between the ratings of the existing and proposed view is the basis for evaluation of the project related visual change. Impact ratings were then compared to the sensitivity of the LSZ, as determined by their MCS classification, and used to determine the type and level of mitigation, if any, that would be appropriate.

Utilizing the procedure described above, no visual impact was noted in four of the eight viewpoints. In these instances, visual change with the project in place was either imperceptible or did not significantly alter the character of the vegetation, landform, land use, or user activity in the view. Some level of adverse visual impact was noted in the remaining viewpoints. In views of the proposed transmission line, some impact was noted due to the new structures' contrast in line, color, form, and/or scale with existing elements in the landscape. However, adverse impact was generally confined to near foreground views where existing screening was lacking and/or proposed ROW clearing was obvious. The most significant adverse impacts were noted in those views where the contrast between the new structures and existing land use (including the existing H-frame structures) was most obvious. However, in no case did the level of adverse visual impact come close to exceeding the threshold of allowable impact for any LSZ within the Project study area. Consequently, the VIA analysis suggests that no additional actions/project modifications are necessary to mitigate adverse visual impact.

8.11 Noise

8.11.1 West Kingston Substation

The environmental noise emissions associated with the proposed substation expansion were qualitatively addressed in order to evaluate the potential future noise impacts on the neighboring properties. However as no additional sound-generating equipment is to be installed, there will be no change to the noise generated by the substation.

8.11.2 Tower Hill Substation

The environmental noise emissions associated with the proposed substation were modeled in order to evaluate the potential future noise impacts on the neighboring properties. These noise emissions were modeled in accordance with ISO 9613 using noise prediction software (CadnaA version 3.4.109). The model simulated the outdoor propagation of sound from each noise source and accounted for sound wave divergence, atmospheric and ground sound absorption, sound directivity, and sound attenuation due to interceding barriers and topography.

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 unlikely that all these sources would ever be operating simultaneously because this would represent an extreme overload condition on the system. However, this scenario was evaluated as a worst case condition.

The sound pressure levels under this scenario at the nearest noise sensitive receptors due to substation operation range from approximately 28 dBA to 35 dBA.

In order to evaluate the potential impacts of the noise on the neighboring noise sensitive receptors resulting from substation operation, the predicted facility sound levels were compared to the measured background sound levels. The potential noise impacts on surrounding properties resulting form substation operations is summarized in the following table.

Table 8-1: Predicted Future Background Sound Levels During Operation

Noise Receptor Locations		Measured Hourly Background Sound Level (L_{90}), dBA		Predicted Facility Sound Level, dBA[4]	Future Background Sound Level with Facility, dBA		Future Background Sound Level Increase Due to Facility, dBA	
NML	Description	min[1] (nighttime)	max[2] (daytime)		min[1]	max[2]	min[1]	max[2]
1	Nearest residences west of the project site, near 89 Pinecrest Drive	31	47	28	33	47	2	0
2	Residences located south of the project site near the intersection of West Allenton Road and Girard Lane	33	49	31	35	49	2	0
A[3]	Residences located south of the project site and east of NML 2	33	49	35	37	49	4	0

Source: Black & Veatch Corporation, 2005.
Notes:
1 During the quietest measured background noise
2 During loudest measured background noise
3 Assumes ambient sound level data collected for NML 2 is generally representative of Location A
4 Based on full load operation and max cooling

There will be no noise impact from the substation on neighboring properties during daytime conditions. During nighttime conditions, a 2 dBA to 4 dBA increase is estimated assuming the extreme conditions described above. These levels are considered just above the threshold of hearing.

Given the low predicted sound levels under a worst case operating condition, it is concluded that the substation will not impact neighboring properties.

8.11.3 Transmission Line

The proposed transmission line will not generate an audible sound level under normal operating conditions. As a result, the existing ambient noise levels will not be altered by the proposed transmission line.

8.11.4 Construction Noise

Temporary noise impacts will occur during construction of the Project. Proper mufflers will be required to control noise levels generated by construction equipment. Hours of construction will comply with applicable local requirements.

8.12 Transportation

The construction related traffic increase will be small relative to total traffic volume on public roads in the area. In addition, it will be intermittent, temporary, and will cease once the project is completed. The addition of this traffic for the limited periods of time is not expected to result in any additional congestion or change in operating conditions along any of the roadways along the ROW.

Narragansett's contractor will coordinate closely with RIDOT to develop acceptable traffic management plans for work within state highway rights-of-way. At all locations where access to the ROW intersects a public way, the contractor will follow a pre-approved work zone traffic control plan. Although traffic entering and exiting the ROW at these locations is expected to be small, vehicles entering and exiting the site will do so safely and with minimal disruption to traffic along the public way. Following construction, traffic activity will be minimal and will occur only when the ROW or transmission lines have to be maintained. As a result, the construction and operation of the transmission line will have minimal impact on the traffic of the surrounding area roadways.

Narragansett will coordinate construction in the vicinity of the Amtrak Northeast Corridor with Amtrak operational and safety personnel.

8.13 Cultural Resources

The Phase I (a/b) archaeological survey conducted by PAL resulted in the identification of zones of high, moderate, and low archaeological sensitivity, relative to the probability that potentially significant cultural resources can be expected within these zones. In accordance with the PAL's recommendations for sensitive locations, Narragansett will conduct further Phase I(c) intensive archaeological survey at specific construction sites within zones of high and moderate sensitivity. As recommended by PAL, the investigations will be conducted prior to construction at proposed structures, access road cut locations, and ancillary work or equipment storage areas involving soil disturbance in archaeologically sensitive zones. The investigations will consist of excavating five test pits at structure locations; one central test pit will be located at the pole site and four test pits will be arrayed in the cardinal directions five meters from the central test pit. A set of five test pits will also be excavated at each access road cut and at each designated work and/or equipment storage area. Depending on the configuration of each area, test pits will be placed either along a linear transect or within an array configuration. Each pit will be dug in ten centimeter levels with all soils sifted through a ¼-inch screen. Any recovered cultural materials will be collected by test pit and level. Soil profiles of each test pit will be recorded, describing the color and texture of the associated stratum of any recovered artifacts.

If archaeological materials or potential historic properties are discovered, Narragansett will conduct additional investigations at the Phase II archaeological site examination level to determine the spatial extent of the resource. Once this is established, Narragansett will, if possible, relocate or redesign the structure, access road, or work/storage area to avoid the resource. In the unlikely event that the resource cannot be avoided, Narragansett will work closely with the RIHPHC to develop a strategy of mitigation. Any identified properties will be documented and all recovered cultural materials will be processed and cataloged in accordance with RIHPHC procedures, and accepted professional standards.

8.14 Air Quality

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8.14.1 Construction Impacts

Exposed soils will be wetted and stabilized as necessary to suppress dust generation, and crushed stone aprons will be used at all access road entrances to public roadways, consequently fugitive dust emissions will be low. In addition, minimal quantities of earth will be moved or disturbed during construction. Therefore, any impacts from fugitive dust particles will be of short duration and localized.

Due to the transitory nature of the construction, air quality in the Study Area will not be significantly affected by construction along the ROW. Emissions produced by the operation of construction machinery (nitrogen oxides, sulfur oxides, carbon monoxide, and particulate matter) are short-term and not generally considered significant.

8.14.2 Project Impacts

In part, air quality is a function of area wide emissions of O_3 precursors (CO, NOx, and VOCs) from the change in daily traffic volumes along lengths of area roadways. The Project will not change traffic and emissions parameters, nor affect the travel characteristics of the vehicles traveling in East Greenwich, North Kingstown, Exeter, South Kingstown, Charlestown, and Warwick, Rhode Island. Therefore, the mobile source emissions will not be changed due to the proposed project.

8.15 Safety and Public Health

Narragansett substations are locked and enclosed with chain link fence topped with barbed wire to prevent unauthorized entry. Transformers and other equipment which use MODF are provided with secondary containment systems to prevent the release of the MODF in the event of a leak. MODF levels are continuously monitored and alarmed by protective systems.

Because the proposed facilities will be designed, built and maintained in accordance with the standards and codes as described in Section 4.7, the public health and safety will be protected.

A discussion of the current status of the health research related to exposure to EMFs is attached in Appendix C. This report was prepared by Exponent Health Sciences.

8.16 Electric and Magnetic Fields

The projected electric and magnetic fields at the edges of the ROW after completion of the Project were calculated using the computer program ENVIRO and compared to pre-construction values.

Electric field levels, which are a function of voltage and line configuration, are shown in Table 8-2 for the segments of the transmission lines both prior to and after construction. The reconductoring of existing lines and the construction of the new L-190 line will have only a small effect on electric field levels at the edges of ROW.

Table 8-2: Pre- and Post-Construction Electric Field Levels (kV/m)

Line segment	2006 Pre-construction		2006 Post-construction	
	West	East	West	East
L-190 - Old Baptist Road Tap Point to Lafayette Substation	<0.01	0.42	0.02	0.47
L-190 - Lafayette Substation to Tower Hill Tap	<0.01	0.42	0.02	0.47
L-190 - Tower Hill Tap to West Kingston Substation	0.02	0.41	0.07	0.32
Tower Hill Tap Lines	<0.01*	0.02**	0.03*	0.04**
1870N - West Kingston Substation to Kenyon Substation	0.42	0.25	0.47	0.27
1870 - Kenyon Substation to Wood River Substation	0.42	0.25	0.47	0.27

Source: Black & Veatch Corporation
* South Edge
** North Edge

The magnetic field (RMS Resultant) levels were calculated for the segments of the ROW for typical and peak loads, before and immediately after construction in 2006, and in 2017, and are shown in Tables 8-3 and 8-4.

Table 8-3: Pre- and Post-Construction Magnetic Field Levels (mG) – Typical Loading

Line Segment	2006 Pre-construction		2006 Post-construction		2017 Post-construction*	
	West	East	West	East	West	East
L-190 - Old Baptist Road Tap Point to Lafayette Substation	1.1	20.6	0.9	13.8	1.3	20.0
L-190 - Lafayette Substation to Tower Hill Tap	1.0	20.0	0.9	13.4	1.2	19.6
L-190 - Tower Hill Tap to West Kingston Substation	2.7	25.0	2.2	10.6	3.2	13.3
Tower Hill Tap Lines	—	—	1.6**	2.9***	0.4**	0.7***
1870N - West Kingston Substation to Kenyon Substation	8.2	24.2	11.1	25.6	16.4	32.4
1870 - Kenyon Substation to Wood River Substation	4.5	28.4	6.5	29.4	11.2	41.5

Source: Black & Veatch Corporation
* The year 2017 was selected to predict EMF levels at 10 years post-construction, based on Narragansett's current load growth projection for the Southern Rhode Island region. It should be noted, however, that actual flows on the facilities increase and decrease in response to customer load demands, so that even if the proposed Southern Rhode Island Transmission Project was not constructed, EMF levels would continue to rise through time as customer demand and power flow increases on the existing lines. As such, EMF levels would naturally rise over the pre-construction levels specified above.
** South Edge
*** North Edge

Table 8-4: Pre- and Post-Construction Magnetic Field Levels (mG) – Peak Loading

	2006 Pre-construction		2006 Post-construction		2017 Post-construction*	
Line Segment	West	East	West	East	West	East
L-190 - Old Baptist Road Tap Point to Lafayette Substation	2.4	46.0	2.0	31.9	2.1	33.7
L-190 - Lafayette Substation to Tower Hill Tap	2.4	46.0	1.9	31.4	2.0	33.0
L-190 - Tower Hill Tap to West Kingston Substation	5.9	45.0	5.1	24.8	5.4	23.0
Tower Hill Tap Lines	—	—	3.5**	6.2***	0.6**	1.0***
1870N - West Kingston Substation to Kenyon Substation	28.4	31.8	35.4	35.5	31.9	38.6
1870 - Kenyon Substation to Wood River Substation	23.5	43.6	30.3	47.2	26.8	59.0

Source: Black & Veatch Corporation

* The year 2017 was selected to predict EMF levels at 10 years post-construction, based on Narragansett's current load growth projection for the Southern Rhode Island region. It should be noted, however, that actual flows on the facilities increase and decrease in response to customer load demands, so that even if the proposed Southern Rhode Island Transmission Project was not constructed, EMF levels would continue to rise through time as customer demand and power flow increases on the existing lines. As such, EMF levels would naturally rise over the pre-construction levels specified above.

** South Edge

*** North Edge

In designing the Project, Narragansett has optimized the configuration of the new line to maximize the cancellation effect of the magnetic fields from the two parallel 115 kV transmission lines. In the segment where the new L-190 line will be constructed, the magnetic field levels will decrease from preconstruction values when the new line is placed into operation as a result of cancellation.

Where the 1870 and 1870N lines are to be reconductored, the magnetic field values at the edges of ROW will increase since there is no cancellation from a second 115 kV line.

Calculated magnetic field levels at the property line of the proposed Tower Hill Substation site are generally 1.5 mG or less except where the transmission tap lines enter the property and where the distribution feeders leave the property.

The electric and magnetic field levels from the existing and proposed facilities are well below recommended limits for public exposure published by the International Committee on Electromagnetic Safety and the International Committee on Nonionizing Radiation Protection. No national scientific or public health agency has determined that exposure to field levels below these recommended limits pose any health hazard. A more detailed discussion of standards and research on electric and magnetic fields is included in Appendix C.

9.0 Mitigation Measures

Mitigation measures will effectively minimize Project impacts on the natural and social environment. Mitigation measures have been designed for the Project to minimize impacts associated with each phase of construction. Many of these measures are standard proven procedures that Narragansett incorporates in all transmission line and substation construction projects. Others are site specific measures designed to meet the needs of this particular Project. These measures are described in the following sections.

9.1 Design Phase

In order to reduce the impacts associated with the construction and operation of the transmission line facility, Narragansett has incorporated design measures to minimize the impacts of the Project. These measures include alignment, design, pole structure locations and use of existing access roads where possible, which have resulted in the avoidance and minimization of residential and wetland impacts, and soil disturbance. Residential impacts are minimized by locating the proposed electric transmission line in the existing ROW. The design and construction of the proposed electric transmission line incorporates measures which minimize impacts to wetlands and other natural features within the ROW. One hundred twenty three of the 164 proposed transmission line structures have been located outside of wetland areas. Further, a wetland mitigation plan, which includes the implementation of BMPs (i.e., hay bales, silt fence, vegetation management, etc.) during and following construction, to minimize impacts associated with the proposed project, will be filed with the wetlands application for the Project.

The following sections detail the various measures that were implemented in the design phase of the Project to reduce impacts to the natural and social environment.

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9.1.1 Mitigation of Natural Resource Impacts

The design of the transmission lines and substations has been developed to reduce wetland impacts through avoidance, minimization, and compensation. Consequently, unavoidable wetland impacts associated with the construction of pole structures for the Project have been limited to approximately 80 cubic yards of permanent wetland disturbance due to filling. Mitigation for these alterations of wetland must be provided in order to comply with federal wetland regulations.

The RIDEM requires compensation for any loss of 100-year flood storage. In accordance with these requirements, Narragansett will provide floodplain compensation for fills related to structure placement. Erosion controls will be installed along the perimeter of the excavation area to avoid sedimentation of the adjacent wetlands. Following excavation, the disturbed area will be seeded and mulched.

Potential short-term and long-term impacts to wildlife will be mitigated. Wildlife impacts in the short term will be mitigated by limiting ground disturbances to pole structure and access road locations, and restoring and/or stabilizing areas immediately following construction. Vehicle and equipment traffic will be limited to established access roads as much as practical. Long-term mitigation efforts will include minimizing permanent wetland disturbance and maintaining wetland functions following construction.

Overall, the proposed mitigation plan has been designed to minimize impacts to environmental resources resulting from the proposed project.

9.1.1.1 Transmission Line

Adverse project-related wetland impacts were avoided and minimized to the maximum extent practicable through the Project design process. The result is the least environmentally damaging practical alternative.

A preliminary site investigation was conducted by Narragansett following the wetland boundary delineation to make siting adjustments to the preliminary transmission line layout which will minimize wetland impacts. The proposed pole structure locations were reviewed to ensure that impacts to the natural environment during construction would be minimal. This preliminary site investigation resulted in limiting wetland crossings to those which are necessary for the construction and maintenance of the line.

9.1.1.2 Access Roads

As a further mitigating measure, proposed access routes have been situated to cross streams and wetlands at the narrowest practical point to minimize disturbance. Each of the proposed access ways through wetlands was thoroughly scrutinized for consistency with the Rhode Island Freshwater Wetland Rules and will not be a random, unnecessary, or undesirable alteration of a freshwater wetland. Each location was selected to traverse the wetland fringe or a previously disturbed area within the wetland. No permanent roads will be built in the wetland areas for this Project.

9.1.2 Mitigation of Social Resource Impacts

In addition to avoiding and minimizing impacts to the natural environment within the Project ROW, several design practices have been incorporated to minimize or avoid impacts to the surrounding social environment. To minimize impacts to adjacent residences and undisturbed areas, Narragansett will locate the Project within an existing ROW parallel to existing electric lines. Narragansett also proposes to locate new pole structures opposite existing structures, where feasible, to minimize the potential for visual impact. Vegetation clearing will be limited so that a visual buffer between residences and the Project is maintained where possible. At the proposed Tower Hill Substation site an earthen berm and landscaping are proposed to provide additional visual screening.

9.2 Construction Phase

Narragansett will implement several measures during construction which will minimize impacts to the environment. These include the use of existing access roads and structure pads where possible, installation of erosion and sedimentation controls, supervision and inspection of construction activities within resource areas by an environmental monitor and minimization of disturbed areas. The following section details various mitigation measures which will be implemented to minimize construction related impacts.

9.2.1 Mitigation of Natural Resource Impacts

Given the engineering constraints for the L-190 transmission line extension in the design of the facility it was necessary to site:

- Thirteen new structures within the Hunt River wetland complex south of the Old Baptist Road Tap Point;
- Three pole structures within the Secret Lake wetland complex;
- One pole structure within the Kettle Hole Pond wetland complex;
- Two pole structures within the beaver impoundment associated with the Chickasheen Brook; and
- Two pole structures within other unnamed wetland complexes.

For the Tower Hill transmission tap line it was necessary to site:

- Six pole structures within the Secret Lake wetland complex; and
- Two pole structures within a shrub swamp/marsh complex.

Access to the structures will be provided by utilizing swamp mats from the existing maintained portion of the ROW, where possible. Construction access will be limited to the existing structure location and proposed access route, and will be lined with erosion and sedimentation control BMPs. Following erection of the structure, each area will be restored.

With construction of the existing transmission lines in the 1960s, access roads were established within portions of the ROW. During construction of the Project, vehicles will utilize these existing access roads where practical to minimize disturbance within the ROW.

Clearing and vegetation management operations will be confined to the ROW. Excavated soils will be stockpiled and spread in approved soil areas well outside all biological wetland areas in such a manner that general drainage patterns will not be affected. Clearing adjacent to wetland areas is of particular concern due to the potential for erosion, and therefore, specific mitigation measures will be implemented to minimize this potential. These measures will include the installation of hay bale diversion berms across the slope to intercept storm water runoff which will be directed through hay bales or silt fence to remove suspended sediment. These structures will be maintained until vegetative cover is re-established. In addition, silt fence or hay bales will be installed across disturbed slopes adjacent to wetland areas in accordance with an erosion and sediment control plan.

Selective clearing will be performed adjacent to all stream crossings. A 25-foot buffer area will be established on both sides of the stream to prevent erosion and siltation within the stream channel. Woody species with a mature height greater than 10 feet will be hand cut. Trees and shrubs with a mature height of less than 10 feet will remain undisturbed. Where possible, existing vegetation will be retained at all road crossings and areas subject to public view to maintain a visual buffer to the ROW. In some areas such as the Tower Hill Substation site, landscape plantings will be utilized to provide visual screening.

Stream crossings will be located perpendicular to the channel to the extent possible to reduce the crossing length and reduce the potential for disturbance to the water body. Design and implementation of all stream crossing structures (i.e., temporary mat bridges) will comply with standards and specifications as outlined in the "Rhode Island Soil Erosion and Sediment Control Handbook." Pole structures have been located to minimize the number of temporary and permanent stream crossings. Temporary access is used where the substrate is sufficiently firm or level to support equipment without creating a disturbance to the soil substrate.

9.2.1.1 Erosion and Sedimentation Control

Erosion and sediment control devices will be installed along the perimeter of identified wetland resource areas prior to the onset of soil disturbance activities to ensure that spoil piles and other disturbed soil areas are confined and do not result in downslope sedimentation of sensitive areas. Woody species with a mature height greater than 10 feet will be cleared within specified portions of the ROW. Low growing tree species, shrubs and grasses will only be mowed along access roads and at pole locations. To avoid disturbing the root mat, tree stumps will be left in place except at structure locations and within access roads. Erosion control will be inspected on a daily basis and maintained or replaced as necessary.

Dewatering may be necessary during excavations for pole structures adjacent to wetland areas. If there is adequate vegetation in upland areas to function as a filter medium, the water generally will be discharged to the vegetated land surface. Where vegetation is absent or where slope prohibits, water will be pumped into a hay bale or silt fence settling basin which will be located in approved areas outside wetland resource areas. The pump intake hose will not be allowed to set on the bottom of the excavation throughout dewatering. The basin and all accumulated sediment will be removed following dewatering operations and the area will be seeded and mulched.

9.2.1.2 Supervision and Monitoring

Throughout the entire construction process, Narragansett will retain the services of an environmental monitor. The primary responsibility of the monitor will be to oversee construction activities including the installation and maintenance of erosion and sedimentation controls, on a routine basis to ensure compliance with all federal and state permit requirements, Narragansett company policies and other commitments. The environmental monitor will be a trained environmental scientist responsible for supervising construction activities relative to environmental issues. The environmental monitor will be experienced in the erosion control techniques described in this report and will have an understanding of wetland resources to be protected.

During periods of prolonged precipitation, the monitor will inspect all locations to confirm that the environmental controls are functioning properly. In addition to retaining the services of an environmental monitor, Narragansett will require the contractor to designate an individual to be responsible for the daily inspection and upkeep of environmental controls. This person will also be responsible for providing direction to the other members of the construction crew regarding matters of wetland access and appropriate work methods. Additionally, all construction personnel will be briefed on project environmental compliance issues and obligations prior to the start of construction. Regular construction progress meetings will provide the opportunity to reinforce the contractor's awareness of these issues.

9.2.2 Mitigation of Social Resource Impacts

Narragansett will minimize social resource impacts during construction by incorporating several standard mitigation measures. By use of an established transmission line ROW rather than creating a new ROW, the potential for disruption due to construction activities will be limited to an area already dedicated to transmission line uses. Construction generated noise will be limited by the use of mufflers on all construction equipment and by limiting construction activities to the hours specified in the local ordinances. Dust will be controlled by wetting and stabilizing access road surfaces, as necessary, and by maintaining crushed stone aprons at the intersections of access roads with paved roads. By notifying abutters of planned construction activities before and during construction of the line, Narragansett will minimize the potential for disturbance from the construction.

Some short term impacts are unavoidable, even though they have been minimized. By carrying out the construction of the line in a timely fashion, Narragansett will keep these impacts to a minimum. The construction of the new lines in the existing ROW may cause some temporary disturbance to the abutting property owners.

Narragansett will prepare a traffic management plan which will minimize impacts associated with increased construction traffic on local roadways.

If archaeological materials or properties are discovered during construction, Narragansett will respond as described in Section 8.13 of this report.

9.3 Post-Construction Phase

Following the completion of construction, Narragansett uses standard mitigation measures on all transmission line construction projects to minimize the impacts of projects on the natural and social environment. These measures include revegetation and stabilization of disturbed soils, ROW vegetation management practices and vegetation screening maintenance at road crossings and in sensitive areas. Other measures are used on a site specific basis. Narragansett will implement the following standard and site specific mitigation measures for the proposed project.

9.3.1 Mitigation of Natural Resource Impacts

Restoration efforts, including final grading and installation of permanent erosion control devices, and seeding of disturbed areas, will be completed following construction. Construction debris will be removed from the Project site and disposed of at an appropriate landfill. Pre-existing drainage patterns, ditches, roads, fences, and stone walls will be restored to their former condition, where appropriate.

Permanent slope breakers and erosion control devices will be installed in areas where the disturbed soil has the potential to impact wetland resource areas.

Vegetation maintenance of the ROW will be accomplished with methods identical to those currently used in maintaining vegetation along the existing lines on the ROW. Narragansett's ROW vegetation maintenance practices encourage the growth of low-growing shrubs and other vegetation which provides a degree of natural vegetation control. In addition to reducing the need to remove tall growing tree species from the ROW, the vegetation maintained on the ROW inhibits erosion.

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9.3.2 Mitigation of Social Resource Impacts

With the exception of the Tower Hill Tap lines and Substation, upon completion of the Project, magnetic field levels at the edges of the ROW adjacent to existing residences will be substantially lower than they are at present.

Where possible, Narragansett will limit access to the ROW by installing permanent gates and barriers where access roads enter the ROW from public ways. Select areas, including the Tower Hill Substation site, will be visually screened with landscaping and/or grading.

10.0 Permit Requirements

10.1 Permit and Other Regulations

Narragansett must obtain permits under the following state, local and federal statutes and regulations prior to the construction of the Project.

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10.1.1 State Permits

10.1.1.1 EFSB License

The Project will require a license to construct a major energy facility from the EFSB pursuant to Rhode Island General Laws ("R.I.G.L.") Sec. 42-98-1 et seq.

10.1.1.2 RIDEM Freshwater Wetlands Permit

The Project will require a freshwater wetlands permit from RIDEM pursuant to R.I.G.L. Sec. 2-1-18 et seq. for alteration of freshwater wetlands in connection with the construction of certain structures and access roads.

10.1.1.3 RIPDES Storm Water Discharge Associated with Construction Activities

The Project will require a permit from RIDEM for approval of storm water discharge associated with construction activities pursuant to Rule 31 of the Rhode Island Pollutant Discharge Elimination System ("RIPDES") Regulations. It is expected that the Project will qualify for authorization under the General Permit.

10.1.1.4 Water Quality Certification

The Project will need a water quality certification from RIDEM under Section 401 of the Clean Water Act.

10.1.1.5 RIDOT Permits

The Project will require freeway and highway utility permits from the RIDOT for the installation of wires across freeways and state highways pursuant to R.I.G.L. Chapters 10 and 8 of Title 24. The project will also require a physical alteration permit for access to state highways from the ROW pursuant to R.I.G.L. Chapter 8 of Title 24.

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10.1.2 Local Permits

10.1.2.1 Zoning

The Project will require the following zoning relief:

Warwick

According to the Warwick Zoning Official, no zoning relief is required for the reconductoring work.

East Greenwich

According to the East Greenwich Town Solicitor, no zoning relief is required for either the reconductoring or the extension of the L-190 transmission line in East Greenwich.

North Kingstown

In North Kingstown, a Special Use Permit will be required for the substation because it will be located in the RR and VR zoning districts. North Kingstown Zoning Ordinance, Article III. A Special Use Permit will be required for the transmission lines located in the RR, NR, OS and PL zoning districts. North Kingstown Zoning Ordinance, Article III. A Use Variance will be required for the transmission lines in the VR and PB zoning districts. North Kingstown Zoning Ordinance, Article III. In addition, development plan review is necessary because portions of the Project are located in the Groundwater recharge and wellhead protection and overlay districts, the Special Flood Hazard Overlay District and the Steep slope overlay district. North Kingstown Zoning Ordinance, Section 21-186, Section 21-188 and Section 21-185.

Exeter

Zoning Ordinance, Table 2.4 and Section 1.3(3.F). Exeter's zoning ordinance requires a Special Use Permit for the L-190 extension in Exeter and for development within the Groundwater Protection Overlay District. Exeter Zoning Ordinance, Table 2.4 and Sections 1.3(3.F) and 7.5. The Project will require a dimensional variance to exceed the 40 foot height limitation. Exeter Zoning Ordinance, Table 2.4.2 and Section 1.3(3.E). Development plan review is required because the Project will require a special use permit and dimensional variance. Exeter Zoning Ordinance, Section 2.5.1(D)(1).

South Kingstown

The Project is allowed as of right in South Kingstown. South Kingstown Zoning Ordinance, Section 301. Portions of the Project in South Kingstown are located in the Groundwater Protection Overlay District; uses permitted in the underlying zoning district are permitted in the Groundwater Protection Overlay District provided they comply with the Groundwater Protection Overlay District regulations, which the Project will do. South Kingstown Zoning Ordinance, Section 102(c) and Section 602.

Charlestown

A dimensional variance will be needed to increase the existing structure heights. Charlestown Zoning Ordinance, Sections 218-32(C), 218-24(D) and 218-26. The Project must satisfy the construction standards for the Groundwater Protection Overlay District. Charlestown Zoning Ordinance, Section 218-36.

10.1.2.2 Erosion and Sediment Control

Erosion and sediment control plans must be submitted and approved as follows.

Warwick

An erosion and sediment control permit must be obtained from the building official for any development project that requires a building permit. The Project will not require a building permit. Warwick Code Section 68-3(a)(1). The Code exempts (1) development projects where less than one-half acre is to be disturbed during one planting season, which disturbance of soil is not within 100 feet of any watercourse, and has no slope greater than ten percent, and where, in the opinion of the building official, no soil erosion will occur; (2) An excavation which exhibits all of the following characteristics: (a) Is less than four feet in vertical depth at its deepest point measured from the average elevation of the natural ground surface; (b) Does not result in a total displacement of more than 100 cubic yards of material on any lot, land parcel, or subdivision; (c) Has no slopes steeper than ten feet vertical in 100 feet horizontal or approximately ten percent; and (d) Has all disturbed surface areas promptly and effectively protected to prevent soil erosion and sedimentation from occurring, including seeding and/or sodding; provided that all disturbed surface areas which will be exposed for a period of time in excess of 30 days shall be covered with a suitable temporary protective ground cover until permanent ground cover is in place. Warwick Code Section 68-4(b).

East Greenwich

Determination of applicability filed with Building Official to determine if erosion and sediment control plan must be filed. East Greenwich Code – Land Disturbing Activities – Section 9-61 through 9-99. If an erosion and sediment control plan is necessary, the Building Official shall approve, approve with conditions or disapprove such erosion and sediment control plan. East Greenwich Code – Land Disturbing Activities – Section 9-98.

North Kingstown

Soil erosion and sediment control plans must be filed in North Kingstown for the portions of the Project that are located within the Groundwater Protection Overlay District. North Kingstown Zoning Ordinance, Section 21-186(g).

Exeter

There is no requirement for the submission of a separate erosion and sediment control plan in Exeter. Exeter's Land Development/Subdivision Regulations governing erosions and sediment control standards do not apply to the Project. Exeter Code – Land Development/Subdivision Regulations, Appendix B, Section II.

South Kingstown

If the proposal is for construction "of any new principal or accessory structure or any expansion of an existing … structure for any use which exceeds 1000 square feet in ground coverage," the permit application shall include a "soil erosion and sediment control plan" consistent with the guidelines set forth in the current Rhode Island Soil Erosion and Sediment Control Handbook. South Kingstown Zoning Ordinance, Section 901(F). Construction of the new L-190 transmission line extension will involve the installation of 33 new structures in South Kingstown. Based on a typical structure footprint diameter of five feet, the 1000-square foot ground coverage threshold will not be exceeded. Thus a Soil Erosion and Sediment Control application will not be required in accordance with the South Kingstown Zoning Ordinance.

Charlestown

Soil erosion and sediment control plan is required for any application that requires Development Plan Review and the activity will disturb more than one-half acre of land. Charlestown Zoning Ordinance, Section 218-77(A). The Project will not require Development Plan Review (see Section 10.1.2.1, above.) Project activities in Charlestown are limited to the replacement of 95 H-frame structures. These pole replacements are anticipated to result in approximately 19,000 square feet of soil disturbance. Since neither Development Plan Review, nor soil disturbance exceeding one-half acre are anticipated, a soil erosion and sediment control plan is not required per the Charlestown Zoning Ordinance.

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10.1.3 Federal Permits

The project will require an ACOE Section 404 Permit for the filling of wetlands in connection with the construction of the structures in wetlands, clearing in wetlands, and the construction of certain temporary access roads.

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