As described in Section 4, the proposed method to address the identified need is the construction of a new 345-kV transmission line between the Woburn Substation on Cove Street in Woburn and the Wakefield Junction Substation on Montrose Avenue in Wakefield. This section discusses the systematic route selection process used to select a Preferred Route and a Noticed Alternative Route for the proposed transmission line.

5.1 Overview of Siting Methodology

The route selection procedure was an iterative process involving ongoing consultations with state and municipal officials and representatives, as well as other stakeholder groups. In the course of the analysis, the Companies:

♦ Developed a geographic study area (the “Study Area”);

♦ Identified routing opportunities and constraints;

♦ Identified and screened routes and route variations through engineering review and municipal consultation;

♦ Scored candidate routes based on environmental and constructability criteria; and

♦ Selected a preferred route and noticed alternative based on considerations of cost, reliability, and environmental impacts.

As an initial matter, the Companies identified a Study Area that encompassed possible routes for an underground transmission line between the Woburn and Wakefield Junction Substations. The Study Area and the routing opportunities and constraints within it are described in Section 5.2.

A focused set of route selection guidelines were then applied to identify potential routes within the Study Area:

♦ Direct routes were preferred to more circuitous routes;

♦ Established ROWs (including roadways) should be used where possible and use of private property should be avoided; and

♦ Project costs should be minimized by avoiding routes with complex engineering and construction characteristics.

These guidelines are discussed further in Section 5.3.
Potential routes and route variations were then identified. These routes and route variations are discussed in Section 5.4. The potential routes and route variations were primarily within existing public ways, highways, or private roads; however, the Companies also evaluated three potential route segments that follow railroad ROWs, and one route segment on an overhead transmission line ROW. The Companies also evaluated route segments that would be installed longitudinally within Interstate 93 (“I-93”) and Interstate Route 95 (“I-95”). The process was designed to ensure that no clearly superior route was overlooked.

The potential routes and route variations were screened using recent aerial photos, Massachusetts Geographic Information System (“MassGIS”) data on land use and environmental constraints, and field reconnaissance, as well as information gathered in discussions with municipal and state officials. Routes were screened out if they were clearly inferior on the basis of environmental impact, cost and/or reliability. On the basis of this screening analysis, the universe of potential routes described in Section 5.4 was narrowed to a set of feasible “candidate” routes.

The final step of the route selection process was to evaluate, score, and rank the candidate routes using a set of objective environmental, constructability, and reliability criteria and conceptual cost estimates (see Section 5.5). The Companies used the scoring and ranking process to select the Preferred Route and a geographically distinct Noticed Alternative Route. The Companies also chose to notice two variations to the Preferred Route. The Preferred and Noticed Alternative Routes are compared in detail in Section 6 of this Analysis.

5.2 Identification of Study Area and Initial Development of Routes

5.2.1 Study Area Overview

The Companies began the route selection process by delineating a Study Area that encompassed possible routes for the transmission line between the Woburn and Wakefield Junction Substations (see Figure 5-1). In examining routing opportunities between the two substations, I-95, a six- to eight-lane limited-access highway, presented itself as a natural northern boundary for the Study Area. There are no major north-south linear features to the immediate west or east of the substations, so the Study Area is bounded on the west by Horn Pond and Route 38 (Main Street) in Woburn, and to the east by the Breakheart Reservation in Wakefield/Saugus and Main Street in Saugus. The southern boundary is generally contained by the approximate centers of Winchester and Melrose as well as the Middlesex Fells Reservation. The Study Area was drawn to include major routing opportunities within a reasonable distance of the substations to ensure that no potentially superior routing opportunity was overlooked.
Woburn to Wakefield Line Project

Figure 5-1
Routing Study Area
Several features within the Study Area were major factors in the outcome of the routing analysis. The Study Area encompasses two active passenger railroad ROWs that all routes must cross at some location in order to link the Woburn and Wakefield Junction Substations together. These railroad ROWs are owned by the Massachusetts Bay Transportation Authority ("MBTA"), and both the MBTA/Keolis and Amtrak operate on the tracks. Similarly, all routes must cross I-93 at some location; the I-93 crossing was also a key factor in the routing analysis.

Routing opportunities and routing constraints within the Study Area are described further in Sections 5.2.2 and 5.2.3 below.

5.2.2 Routing Opportunities

After identifying the Study Area, the Companies used United States Geological Survey ("USGS") maps, MassGIS data, aerial photography, and field reconnaissance to identify existing linear corridors that would support a routing of the Project between the substations. Existing routing opportunities identified in the Project area included overhead transmission ROWs, railroad ROWs, and road and highway ROWs.

Opportunities other than municipal roadways identified within the Project area included the following:

- **Woburn Railroad ROW (Cross Street to Green Street):** An inactive 0.65-mile railroad ROW owned by the MBTA that parallels the recently-improved Main Street (Route 38) in Woburn. This ROW has been out of use for over 25 years and is largely overgrown.

- **Future Tri-Community Greenway (Washington Street Woburn to Main Street Stoneham):** An approximately 1.3-mile segment of inactive railroad ROW in Woburn and Stoneham, to be developed as the Tri-Community Greenway, a mixed-use recreational path. Construction of the Tri-Community Greenway is currently planned for 2016. This ROW has been inactive for many years, contains rails or ties for some of its length, contains underground utilities including MWRA water mains in several areas, and is now predominantly under Town of Stoneham and City of Woburn ownership.

- **Wakefield Railroad ROW (Broadway to Salem Street):** An approximately 1-mile section of an inactive MBTA railroad ROW extending north from Wakefield Center. The Town of Wakefield intends to develop this ROW for recreation use; project design is currently 25% complete. This ROW has been inactive for many years, is overgrown, and contains rails and ties intermittently along most of its length.
♦ **NEP ROW:** An existing NEP overhead transmission line ROW located at the eastern extent of the Study Area, oriented north-south and passing immediately by the Wakefield Junction substation. This ROW is approximately 275 feet wide.

♦ **Interstate Highways I-93 and I-95:** The Companies considered routing options within and along the highway layouts of I-93 (between Montvale Avenue and the I-93/I-95 interchange) and I-95 (between the I-93/I-95 interchange and Salem Street in Wakefield (Exit 42)). I-93 and I-95 are heavily traveled limited-access interstate highways controlled and managed by the Massachusetts Department of Transportation (“MassDOT”).

### 5.2.3 Routing Constraints

Any route between Woburn and Wakefield will have to cross a number of north-south barriers, including I-93, the Aberjona River, and active railroad tracks:

♦ **Interstate Highway I-93:** Options for crossing I-93 could include roads that pass beneath the highway (i.e., underpasses), existing tunnels, roads that pass over the highway (i.e., overpasses), and crossings using trenchless techniques where no existing crossing exists. MassDOT has indicated that it would not favor mounting a new line to a bridge that crosses over I-93 unless no other feasible option exists. A trenchless crossing using horizontal directional drilling (“HDD”) or jack-and-bore, while technically feasible, would be very expensive and could have significant impacts to the surrounding community.

♦ **Aberjona River:** The Aberjona River crosses potential routes in multiple locations. Most of these crossings are relatively narrow, and all consist of existing bridges or culverts. Options to cross this feature could include mounting the proposed line to an existing bridge structure or using a trenchless crossing technique to install the line beneath the river.

♦ **Active rail ROWs:** All potential route options will have to cross two active rail ROWs, one in Woburn (the MBTA Lowell Line commuter rail runs on these tracks and the ROW is referred to as the “Lowell Line” herein) and one in Wakefield (the MBTA Haverhill Line commuter rail runs on this railroad and it is referred to as the “Haverhill Line” herein). Structural layouts at potential crossings include overhead trestles (frequently narrow, or built-out with existing utilities), roads passing over the existing tracks, and at-grade crossings where rails are in the street. Options to cross the active rail lines could include mounting to overhead bridges or using a trenchless crossing to install the line beneath the tracks.
5.3 Route Evaluation Guidelines

In evaluating routes, the Companies generally considered the following guidelines to support selection of a route that has the least impact to the human and natural environment, and that is constructible and able to meet reliability requirements at the lowest cost.

(1) Direct routes were preferred to more circuitous routes. Shorter, more direct routes facilitate shorter electric line lengths, require fewer manholes, reduce the number of construction constraints encountered, result in less roadway and traffic disruptions, and generally are less expensive.

(2) Established ROWs should be used and use of private property should be avoided where possible. Using existing ROWs limits the need to acquire property rights and minimize impacts to neighborhoods and existing land uses. Acquisition of additional property rights and use of lands subject to protection under Article 97 were avoided, when possible.

(3) Project costs should be minimized. The total cost of the Project is affected by many factors, including but not limited to: length; number and degree of bends along the route; the need to acquire easements or other forms of property rights (both temporary and permanent); the presence of shallow rock, ledge, or groundwater; land uses and traffic conditions along the route that may affect construction timing; and the number of difficult crossings of features requiring special engineering techniques (i.e., highways and active railroads). Routes with fewer features that may increase overall Project cost were preferred over those with a greater number of such features.

5.4 Routes and Route Variations

The Companies identified potential routes and investigated them to determine if they were capable of meeting the need for the Project. The Companies met frequently with state regulatory agencies, municipal representatives and other stakeholders to discuss potential locations for the Project, and to obtain input and opinions on the proposed routes. This process began in the Fall of 2014, and as of mid-August 2015 included over 45 meetings with agencies, municipalities and other stakeholders (see Section 1 of this Analysis for a chronological list), and resulted in the identification and review of over 20 potential routes and route variations, including many options suggested by Project stakeholders.

In parallel with these consultations, the Companies reviewed potential environmental and human impacts of the routes, assessed constructability, and developed and evaluated routing variations to address specific localized challenges. Based on this analysis, the
Companies selected the most promising routes and route variations for more detailed study and evaluation. Routes or route variations were screened out if they were obviously inferior to other available routes.

The following subsections describe the routing options that were evaluated during the course of the route selection process. These routing options are depicted in Figure 5-2a to 5-2d.

### 5.4.1 Common Access to Woburn Substation and Wakefield Junction Substation

All potential routes share a common access to the Woburn and Wakefield Junction substations. The common access for the Woburn Substation crosses the eastern extent of the substation property and enters Lake Avenue, heading northeast. The segment then turns south onto Pickering Street for approximately 500 feet before turning east onto Border Street for another 500 feet to where it crosses Main Street (Route 38) and enters Cross Street. This common route segment ends less than a tenth of a mile east on Cross Street at the intersection with the Woburn Railroad ROW. The total length of this common route segment is 0.5 miles. The common access to the Woburn Substation is depicted in Figure 5-3.

The Wakefield Junction Substation access begins at the intersection of Montrose Avenue with NEP’s driveway and travels east along 0.17 miles of private driveway. The entrance into the Wakefield Junction Substation is depicted in Figure 5-4. Approaching NEP’s driveway along Montrose Avenue from the north results in a more gradual turning angle, while approaching the driveway from the south requires a sharp turn.

### 5.4.2 Highway Route

At the request of representatives of the Town of Stoneham, the Companies identified a route that runs longitudinally within the interstate highway layout, including both I-93 and I-95 (the “Highway Route”). Starting at the common access to the Woburn Substation, this route would run east on Cross Street, north on Washington Street and east on Montvale Avenue to its intersection with I-93. It would enter the I-93 layout along the eastern side of I-93 between the highway and the Montvale Avenue entrance ramp, and continue north for approximately 1.5 miles along the eastern extent of I-93 to its intersection with I-95. The route would then follow the I-95 exit ramp to access the

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1 The Companies also considered a variation to the Northern Route installed longitudinally within the I-95 layout for approximately one mile between the I-93/I-95 interchange and the Route 28 interchange. Section 5.4.3.1 contains a further description of this route.
Figure 5-2a
Interstate Highway Route, 5 sheet 1 of 4

Eversource Woburn Substation

National Grid Wakefield Junction Substation

Legend
- Common Substation Takeoffs
- Interstate Highway Route

Scale: 1:31,200
1 inch = 2,600 feet

Basemap: 1985/1987 USGS Quadrangles, MassGIS

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division - Data Obtained March 2014

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EverSource National Grid
Common Takeoff from Eversource Woburn Substation

Basemap: 2013 Orthophotography, MassGIS

Legend:
- Common Takeoff from Eversource Woburn Substation

Scale 1:4,800
1 inch = 400 feet

Figure 5-3
Common Takeoff from Eversource Woburn Substation
LEGEND

Common Takeoff from National Grid
Wakefield Junction Substation

Scale 1:4,800
1 inch = 400 feet

National Grid
Wakefield Junction Substation

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Common Takeoff from National Grid Wakefield Junction Substation
southern side of I-95 and run east along I-95 for approximately 5 miles to the Salem Street Wakefield exit (Exit 42). The route would exit the highway layout and travel south on Montrose Avenue to the Wakefield Junction Substation. The total length of the Highway Route is 9.9 miles, 6.5 miles of which are within state highway layout.

The highway layout widths across I-93 and I-95 in this area vary from approximately 225 feet to over 700 feet (at cloverleaf locations), and average approximately 250 feet to 300 feet. I-93 in this stretch has four travel lanes in each direction. There is no usable median between the travel lanes in I-93, which are separated by narrow shoulders and two sets of guardrails. I-95 in this stretch has three travel lanes in each direction. There is likewise no usable median between the travel lanes in I-95, which are separated by narrow shoulders and a concrete barrier. There are no breakdown lanes in most sections and there are tightly-spaced entrance and exit ramps in the relevant sections of I-93 and I-95 being evaluated. There are also significant sections along both I-93 and I-95 where the highway roadside exhibits rock outcrops and ledge, and short sections where the highway is countersunk into bedrock.

MassDOT’s Utility Accommodation Policy on State Highway Right of Way (May 2013) (the “Policy”) regulates utility facilities along, across, over, under or on the right of way of all major highways and other transportation facilities and properties owned or under the jurisdiction of MassDOT, including the fully controlled access highways I-93 and I-95. Longitudinal installations of utilities within fully controlled access highways are specifically prohibited in Chapter 6, Section B(4)(a). Chapter 6, Section B(4)(a) further provides that exceptions may be allowed as specified in Chapter 8.C, but “[w]hen such installations are allowed … the utility facility shall not be installed or serviced by direct access from the fully controlled access roadways or connecting ramps.” Accordingly, the Project would need to be sited between the edge of the paved way and the boundary of the state highway layout, with access that is entirely separate from the highways and their interchanges.

The Companies undertook an analysis of the feasibility of constructing the Project along the Highway Route. The Companies identified a number of technical issues associated with the use of the highway route, including:

♦ Construction of the facility in this location would likely require a new construction access road. The road would require initial clearing of 30 to 40 feet, with 20 to 25 feet kept clear in perpetuity. While there may be sufficient room within the layout for this road in some areas, in other areas the layout narrows significantly;

♦ It is likely that multiple easements would be required from private property owners adjacent to the highway layout to accommodate the access road;
In at least two locations (at the Salem Street Bridge in Woburn and the Hopkins Street Bridge in Reading), bridge abutments leave no room for an access road or the duct bank itself. In these locations, the cables would need to be installed in conduits drilled beneath or through the bridge abutments;

Conditions in the area between the road and the property line are generally unfavorable for construction of an access road and installation of the cable due to extensive ledge and topographical variation. Construction of the road and installation of the cable would require alternately blasting ledge or extensive earth moving to create an evenly graded road;

The presence of sound walls along significant sections of the southern boundary of the I-95 layout further complicates the installation of the access road and the facility;

Trenchless techniques would be required to cross multiple interchanges along the route; and

Construction of the road and installation of the Project would require clearing of relatively thick vegetated buffer between developed residential areas and the highway.

Constructing the Project longitudinally within the highways would substantially increase Project costs, for numerous reasons. First, the Highway Route is at least a mile longer than any of the other route alternatives. Second, construction of a separate access road substantially increases the scope of the Project, creating additional costs even if conditions were favorable for such a road. Third, multiple trenchless crossings would be required at ramp systems and at the two bridge abutments, considerably adding to the cost of the Project. Finally, the Companies would incur the costs of acquiring property rights from MassDOT and other private property owners, and for nighttime construction if required along some or all of the I-93 and I-95.

The Companies also have a number of concerns related to the safe and reliable operation and maintenance of the cables were they to be located within the state highway layout. These include:

Employees and contractors engaged in construction activities, routine maintenance or emergency repair activities along the highway system would be in an unsafe environment due to vehicles traveling at high rates of speed over the adjacent surface;
Construction, routine maintenance and emergency repair along the highway system may also create hazardous traffic conditions, could encourage "rubber necking" and could be distracting to drivers using the highway.

The need for coordination with MassDOT and state police details in the creation of isolated work zones (i.e., setting up jersey barriers etc.) could impact response time in emergency repair situations.

The Companies must keep manholes clear of snow in order to facilitate emergency repairs. This would be particularly difficult if manholes are located along the state highway layout, given the volume of snow that often accumulates off the shoulder of the highway during winter.

Overall, the Companies concluded that use of the I-93 and I-95 highway layouts for 6.5 miles of the Project would add substantially to Project scope, schedule and cost. Although it might reduce temporary construction impacts within central Stoneham and Wakefield in theory, it would create temporary and permanent impacts in areas along I-93 and I-95. Use of the I-93 and I-95 highway layouts could also add to traffic on local roadways during construction due to the anticipated behavior of drivers who would seek to avoid increased traffic on the highways by getting off the highway and using local roads. It would also make the Project more difficult to maintain and repair.

Further, although the Companies assumed for the sake of discussion that MassDOT might provide an exemption from its policy that prohibits this type of installation in fully-controlled access highways, this is not necessarily the case. The MassDOT Policy prohibits installation of utilities within fully controlled highways where, as here, practicable alternatives exist. Chapter 8.C.2.b requires a showing to MassDOT’s satisfaction that “[a]lternate locations are not available or are cost prohibitive from the standpoint of providing efficient utility services.”

For reasons including significant technical challenges, high costs, safety concerns, and limited benefits provided by this route, as well as uncertainty as to whether MassDOT would consider an exemption to its policy prohibiting longitudinal installations, the Companies did not advance this highway route to scoring. However, during the analysis of the highway route, the Companies identified a series of MassDOT and private parcels lying just south of I-95 between the I-93/I-95 interchange that could be used as part of a route for the Project, and that likely would not be subject to the same restrictions as the highway layout itself. These parcels are considered as a variation to the Northern Route in Section 5.4.3.1.
5.4.3 Northern Route and Northern Route Variations

From the common access to the Woburn Substation, the Northern Route travels north on the Woburn Railroad ROW before turning east onto Green Street and then north on Nashua Street, crossing Montvale Avenue, and continuing north on Wood Street to its intersection with Salem Street, all in Woburn.

Upon joining Salem Street, the route turns east, crosses the Lowell Line via a trenchless crossing operation, and follows Salem Street further onto Lynn Street, a dead-end street that ends at the I-93 layout. The route crosses I-93 from this location via a trenchless crossing, joining with North Street on the eastern side of I-93 in Stoneham. This drill may require acquisition of property rights (easements) over a currently undeveloped property on the eastern side of the crossing, between the I-93 layout and North Street and potentially over private property at the eastern end of Lynn Street.

The route follows North Street to the Wakefield town line, where it turns into Prospect Street; from there, the route follows Prospect Street, crossing under the Haverhill Line via a trenchless crossing. The route continues onto Church Street, which it follows to its intersection with Salem Street. The route crosses under the Mill River via trenchless crossing on Salem Street. The route continues on Salem Street and then turns south onto Montrose Avenue, reaching the common access to the Wakefield Junction Substation.

The total length of the Northern Route is 8.66 miles. The Northern Route has a comparatively high degree of curvature and elevation change along the eastern part of the route, and also exhibits narrow road widths in this area. It is longer than other routes; however, it avoids the Main Street/Elm Street/Montvale Avenue area in Stoneham. The Northern Route was retained for detailed evaluation and scoring.

The Northern Route and its variations are shown on Figure 5-2b.

5.4.3.1 Interstate Highway Route Variation

The Interstate Highway Variation of the Northern Route takes advantage of four undeveloped state-owned parcels and one privately owned parcel located just south of the I-95 highway layout between the I-93 and Route 28 ramps in Stoneham. These parcels provide sufficient width to allow the installation of the Project parallel to I-95, with access via Stoneham residential streets rather than the highway.

The Interstate Highway Variation follows the Northern Route through Woburn to the intersection of Salem Street and Cedar Street. At this point, the Interstate Highway Variation turns northeast onto Cedar Street, which it follows until Cedar Street dead-ends at the I-93/I-95 interchange. The variation then crosses the interchange via an HDD operation of over 1,400 feet and enters into the highway layout south of the I-95 layout.
It then crosses through a private property and several adjacent MassDOT properties that lie directly south of the I-95 layout. It skirts the Route 28 interchange ramp and enters the parking lot and access drive of the Stonehill Apartments in Stoneham. It then continues east in a trenchless crossing of Route 28 to the adjacent 99 Restaurant and the 45 South Street Apartments before entering into the public way in Prospect Street, where it rejoins the Northern Route at North Street. The total distance of this route is 8.8 miles, approximately one mile of which is routed adjacent to the highway. In addition to easements from MassDOT, this alternative would require easements from MBTA, private property owners, and potentially other state agencies. The Northern Route with Interstate Highway Variation was retained for detailed evaluation and scoring.

The Interstate Highway Variation is shown on Figure 5-2b.

5.4.3.2 Main Street Woburn Variation

The Main Street Woburn Variation extends from Cross Street north along Main Street (Route 38) in Woburn to the intersection with Green Street. The route then turns east on Green Street where it joins the Northern Route and follows it to the Wakefield Junction Substation. Acquisition of easements across private properties would be required as described in Section 5.4.3 for the Northern Route.

The total length of the Northern Route with Main Street Woburn Variation is 8.44 miles (see Figure 5-2b).

Main Street in Woburn has been recently re-engineered and re-built, and accordingly, the Companies sought to avoid using it as part of Project routing. Because it is possible to avoid Main Street Woburn by using the Woburn Railroad ROW, the Main Street Woburn was not carried forward for evaluation and scoring.

5.4.4 Central Route and Central Route Variations

The Central Route starts on Cross Street at the border of Woburn and Winchester and continues east into Winchester. In Winchester, the route passes beneath elevated active railroad tracks (the Lowell Line), then continues along Cross Street until its intersection with Washington Street. The route follows Washington Street north until it reaches Montvale Avenue. The route travels east along Montvale Avenue under I-93 until its intersection with Main Street in Stoneham. It then continues north on Main Street until its intersection with Elm Street. The route then heads east onto Elm Street, which becomes Albion Street upon entering Wakefield. From this point, the route continues east/northeast to Broadway, following that roadway north, crossing the Haverhill Line tracks at grade and continuing to the Wakefield Railroad ROW. The route continues
north on the Wakefield Railroad ROW to its intersection with Salem Street. The route then turns east on Salem Street and then south onto Montrose Avenue, reaching the common entrance into the Wakefield Junction Substation.

The total length of the Central Route is 8.53 miles. The Central Route was retained for detailed evaluation and scoring.

The Central Route and its variations are shown on Figure 5-2c.

5.4.4.1 Davidson Park Winchester Variation

The Davidson Park Winchester Variation to the Central Route turns north off of Cross Street in Winchester and travels through Davidson Park (owned by the Town of Winchester), Calvary Cemetery (owned by the Catholic Archdiocese of Boston), and onto Central Street in Woburn.

The total length of the Central Route with the Davidson Park Alternative is 7.99 miles. The Davidson Park Winchester Variation is shown on Figure 5-2c.

This variation was considered at the request of Town of Winchester officials. After careful review and a meeting with the Archdiocese representatives to evaluate logistics and restrictions of working within the cemetery, the following challenges with this variation were identified:

♦ Extensive use of private property (Calvary Cemetery) requiring acquisition of easements;

♦ Routing through parkland protected under Article 97 (Davidson Park) and expected to require an easement subject to approval under that program;

♦ Routing through the floodplain, 100-foot buffer zone and Riverfront Area associated with the Aberjona River;

♦ Routing across major MWRA subsurface utilities within Davidson Park;

♦ Potential need for trenchless installation within the cemetery and park; and

♦ Cultural/public sensitivity issues associated with construction within an active cemetery with little available unused space; potential discovery of unmarked remains.

Based on these factors, the Davidson Park Winchester Variation was not advanced for further evaluation and scoring.
5.4.4.2 Forest Street Winchester Variation

The Forest Street Winchester Variation to the Central Route proceeds along Cross Street until its intersection with Forest Street in Winchester. At this point, the route turns north onto Forest Street until its intersection with Washington Street, where it rejoins the Central Route.

The total length of the Central Route with the Forest Street Winchester Variation is 8.43 miles (see Figure 5-2c).

The Forest Street Winchester Variation avoids the Cross Street/Washington Street intersection and reduces the length of the Central Route by 0.1 miles; however, it would be difficult to construct. Because the turn from Cross Street onto Forest Street occurs immediately after crossing the Aberjona River via a trenchless crossing, the conduit and manhole at this location would require a quick rise in elevation and turn to the north. Further, Forest Street is narrow as compared to other roads, and is lined with mature trees along much of its length. Construction through this residential neighborhood would have a high likelihood of damaging the roots of public shade trees and trees on personal property. Further, based on discussion with municipal officials, there are known stormwater drainage issues within this neighborhood, and construction may conflict with infrastructure improvements proposed to address these issues.

Based on these difficulties, the Forest Street Winchester Variation to the Central Route was not advanced for further evaluation and scoring.

5.4.4.3 Tri-Community Greenway Variation

The Tri-Community Greenway Variation follows the Central Route until the intersection of Washington Street with the future Tri-Community Greenway in Woburn. From this point, it proceeds east and north along the future Tri-Community Greenway, crossing under I-93 in an existing tunnel, to its intersection with Central Street in Stoneham. The Tri-Community Greenway Variation then turns north onto Central Street in Stoneham for a block and rejoins the Central Route at Elm Street.

The total length of the Central Route with the Tri-Community Greenway Variation is 8.41 miles (see Figure 5-2c).

The Tri-Community Greenway Variation was considered as a means of avoiding the heavily-trafficked Montvale Avenue in Woburn and Stoneham. However, the Town of Stoneham has consistently opposed the use of the Tri-Community Greenway for this Project, due to concerns that such use would either delay construction of the greenway (possibly resulting in loss of funding) or disturb it very shortly after it is completed. Use of the Tri-Community Greenway ROW would require easements or lease agreements.
from both the City of Woburn and the Town of Stoneham, and potentially the MBTA. In recognition of Stoneham’s concerns, and because the Town has indicated that it would not grant the necessary easements or lease agreements, the Tri-Community Greenway Variation was not advanced for further evaluation and scoring.

5.4.4.4 Cottage Street Stoneham Variation

The Cottage Street Stoneham Variation follows the Central Route to the intersection of Montvale Avenue and Cottage Street in Stoneham. The variation turns north onto Cottage Street until the intersection with William Street, then briefly heads west before turning east onto Elm Street. The route continues east on Elm Street, rejoining the Central Route and following it to the Wakefield Junction Substation.

The total length of the Central Route with Cottage Street Stoneham Variation is 8.55 miles (see Figure 5-2c).

This variation was suggested by the Town of Stoneham as a means of avoiding the busy Montvale Avenue/Main Street intersection. However, the Cottage Street Stoneham Variation would require several sharp bends in quick succession, which is undesirable from a construction and operational perspective due to the potentially damaging effect of compressive stresses on the cable that can occur in association with multiple sharp bends in close proximity to each other. Consequently this variation was not advanced for further evaluation and scoring.

5.4.4.5 Pomeworth Street Stoneham Variation

The Pomeworth Street Variation follows the Central Route to Main Street in Stoneham. The route advances north on Main Street for one block, and then turns east onto Union Street. The route then heads east on Union Street, briefly turns north onto Central Street, and turns east onto Pomeworth Street. From this point, the route continues east to Washington Street, following that roadway north to its intersection with Elm Street, where it rejoins the Central Route to the Wakefield Junction Substation.

The total length of the Central Route with Pomeworth Street is 8.54 miles (see Figure 5-2c).

This variation was suggested by the Town of Stoneham as a means of avoiding the Elm Street/Main Street intersection. It would reduce the use of Main Street and avoid the Elm Street intersection; however, it would instead use relatively narrow streets that likely would need to be closed during construction. Additionally, it would add bends to the route, which is not desirable from a constructability perspective. Ultimately, the
Stoneham Board of Selectmen rejected this route following a May 2015 meeting to review potential routes within the Town. For these reasons, this variation was not advanced for further evaluation and scoring.

### 5.4.4.6 Main Street-Broadway Stoneham Variation

The Main Street-Broadway Stoneham Variation follows the Central Route to Main Street in Stoneham, where the route continues north on Main Street past the Elm Street intersection until its intersection with Broadway. The route then heads east on Broadway, which becomes Mountain Avenue upon entering Wakefield. From this point, the route continues east/northeast on Albion Street, rejoining the Central Route to the Wakefield Junction Substation.

The total length of the Central Route with the Main Street-Broadway Stoneham Variation is 8.91 miles (see Figure 5-2c).

This variation was suggested by the Town of Stoneham as a means of avoiding the Main Street/Elm Street intersection, which is a busy intersection with significant underground utilities. This alternative was not advanced for further evaluation and scoring because it is longer than comparable alternatives and did not produce a significant improvement to the Central Route in regard to traffic or other potential disturbances to the public and local businesses along Main Street.

### 5.4.4.7 New Salem Street Wakefield Variation

The New Salem Street Wakefield Variation follows the Central Route to the point where the Wakefield Railroad ROW intersects New Salem Street in Wakefield. Rather than follow the Wakefield Railroad ROW north to Salem Street, the variation advances northeast along New Salem Street, eventually rejoining the Central Route on Salem Street.

The total length of the Central Route with New Salem Street Wakefield Variation is 8.35 miles (see Figure 5-2c).

The New Salem Street Wakefield Variation provides an in-street alternative to the northern portion of the Wakefield RR ROW, which is elevated, heavily wooded, has numerous encroachments, and is located a few feet from the edge of the Mill River at its northern end. In light of these concerns, the Companies advanced the New Salem Street Variation for scoring and detailed evaluation, and for possible use as an alternative should the use of the northern part of the Wakefield RR ROW prove problematic.
5.4.4.8 Green Street Woburn Variation

The Green Street Woburn Variation of the Central Route begins at the intersection of Cross Street and the Woburn Railroad ROW on the border between Woburn and Winchester and extends north along the ROW before turning east onto Green Street and continuing east on Montvale Avenue. The route follows Montvale Avenue over the Lowell Line on a truss bridge that would be constructed adjacent to the existing railroad crossing on Montvale Avenue, and then rejoins the Central Route. An easement to construct the truss bridge would likely be required from the MBTA and/or the City of Woburn.

The total length of the Central Route with Green Street Woburn Variation is 8.65 miles (see Figure 5-2c). This variation was retained for scoring.

5.4.5 Southern Route and Southern Route Variations

From the common exit at the Woburn Substation, the Southern Route runs east on Cross Street into Winchester. It passes beneath the Lowell Line, elevated at this location, and then the route continues on Cross Street past Davidson Park and passes under the Aberjona River via a trenchless crossing. The route remains on Cross Street until turning north on Washington Street for approximately 725 feet, and then heads east/northeast on Forest Street crossing I-93 via an HDD, and joins Marble Street in Stoneham. Marble Street continues past Main Street (Route 28). Shortly thereafter the route turns north on Summer Street, passing rock outcrops along the east side of that roadway, and then east on Spring Street, where it turns north onto Green Street in Stoneham. Green Street ends at the Stoneham/Wakefield line and heads east along Albion Street, south along North Avenue in Wakefield for a short distance (approximately 315 feet), and then east on West Water Street and Water Street to the intersection with Montrose Avenue. From this intersection, the Southern Route advances slightly over one-half mile before reaching the Wakefield Junction Substation entrance road.

The total length of the Southern Route is 8.01 miles (see Figure 5-2d).

The Southern Route is a comparatively short and direct route. However, there are several significant challenges associated with the Southern Route. The primary challenge is the crossing of I-93 at Marble Street in Stoneham. The Companies first considered crossing on the Marble Street Bridge overpass in Stoneham. However, MassDOT has stated that its utility accommodation policy would not support the use of this bridge without a clear demonstration that there is no viable alternative. Further, the Marble Street Bridge is currently scheduled for replacement by MassDOT in 2021; if it were used, the crossing
would need to be relocated within two to three years of its installation. The I-93 crossing therefore would require an HDD in this location, and potentially the acquisition of easements across private property to accommodate HDD operations.

5.4.5.1 Fallon Road Variation

The Fallon Road Variation of the Southern Route was identified as an alternative method of crossing I-93 at Marble Street in Stoneham (see Figure 5-2d). This variation would extend south from the Southern Route along either Bellevue Avenue or Eugene Drive in Winchester, access the dead-end Fallon Road via an easement of approximately 300 feet across private property, and then advance north on Park Street to re-join the Southern Route at Park Street and Marble Street.

This variation would add approximately 0.53 miles to the Southern Route. In addition, current traffic congestion at the I-93 exit ramps and near-term plans to convert the industrial lands south of Fallon Road to major residential developments were considered and deemed significant enough detractors from this route variation to not advance analysis of its use further.

5.4.5.2 East Street Variation

The East Street Variation follows the Southern Route to the intersection of Spring Street and Green Street in Stoneham. Instead of turning north onto Green Street, the East Street Variation continues on Spring Street and East Street, which becomes Forest Street when it enters Wakefield. In Wakefield, the route continues along Forest Street, crosses the Haverhill Line railroad ROW, and then advances east along Main Street, Oak Street, Old Nahant Road, Farm Street, a short section of Water Street, finally turning north along Montrose Avenue to the Wakefield Junction substation.

The total length of the Southern Route with East Street Variation is 7.99 miles (see Figure 5-2d).

While the East Street Variation of the Southern Route is relatively direct, the crossing of the Haverhill Line is exceptionally problematic. Based on the variation in topography from the east to the west of the railroad, the presence of shallow bedrock/ledge, and the sharp angle(s) of the turns that would be necessary following the crossing, the constructability of this variation cannot be assured. Accordingly, this variation was not advanced for further analysis and scoring.

The Companies considered several additional route variations that generally follow the East Street Variation, but that cross the Haverhill line in different locations. These variations are described in Sections 5.4.5.3 to 5.4.5.6.
5.4.5.3 **Meriam Street Wakefield Variation**

The Meriam Street Wakefield Variation crosses the Haverhill Line on the Laurel Street Bridge, approximately 0.4 miles north of Forest Street. This crossing would require MBTA and MassDOT approval, including the granting of a permanent easement.

The Meriam Street Wakefield Variation follows the East Street Variation to the intersection of Forest Street with Meriam Street in Wakefield. At this point, the variation turns north onto Meriam Street, crosses the Laurel Street Bridge over the active Haverhill Line and then immediately turns south on Main Street and travels back down past Forest Street to Oak Street, where it rejoins the East Street Variation.

The total length of the Southern Route with Meriam Street Wakefield Variation is 8.99 miles (see Figure 5-2d).

Although the Meriam Street Wakefield Variation provides an alternative means of crossing the active Haverhill Line railroad ROW, the sharp double turn associated with the bridge crossing would require the use of two splice vaults in close proximity to each other, which is not desirable from either a constructability or a reliability perspective. As this variation would add length to the route without improving it from either an environmental or a constructability perspective, it was not advanced for further study.

5.4.5.4 **Nahant Street Wakefield Variation**

The Nahant Street Wakefield Variation also uses the Laurel Street Bridge to cross the Haverhill Line. However, after crossing the bridge, this variation heads north on Main Street to its intersection with Nahant Street. The route then travels east on Nahant Street until its intersection with Farm Street, where it rejoins the Southern Route to the Wakefield Junction Substation.

The total length of the Southern Route with the Nahant Street Wakefield Variation is 8.49 miles (see Figure 5-2d).

The use of Nahant Street and the Laurel Street Bridge with subsequent routing heading north on Main Street avoids the extremely challenging Forest Street/Main Street Haverhill Line crossing. However, it would exit onto Farm Street diagonally across from the busy entrance to the Wakefield High School and Northeast Metro Technical High School, without providing a significant improvement from an environmental perspective. Accordingly, this variation was not advanced for further study.
5.4.5.5 Spring Street Wakefield Variation

The Spring Street Wakefield Variation follows the Southern Route with East Street Variation to the intersection of Spring Street with East Street in Stoneham. Rather than continuing onto East Street, this variation follows Spring Street to the southeast and crosses under the active Haverhill Line railroad ROW using trenchless crossing techniques. It then joins Renwick Road for a short distance, then follows Humphrey Street onto Main Street in Wakefield. From Main Street, the route then turns east onto Oak Street, rejoining the Southern Route to the Wakefield Junction Substation.

The total length of the Southern Route with Spring Street Wakefield Variation is 9.31 miles (see Figure 5-2d).

This variation would avoid the Forest Street/Main Street crossing of the railroad ROW. However, it would add approximately one mile to the Southern route, would require the acquisition of an easement over private property to support the trenchless crossing without any offsetting environmental benefit. Accordingly, the Southern Route Spring Street Variation was not advanced for further study.

5.4.5.6 Main Street Wakefield Variation

The Main Street Wakefield Variation follows the Southern Route with East Street Variation to its intersection with Main Street in Wakefield, crossing under the Haverhill Line at the Forest/Main Street intersection. From this point, instead of turning south on Main Street to Oak Street, it advances north on Main Street until its intersection with the Wakefield Railroad ROW. The route travels northeast along a section of the Wakefield Railroad ROW, and then turns east onto Water Street. The route heads east on Water Street before bearing north onto Montrose Avenue to the point of common entrance into Wakefield Junction Substation.

The total length of the Southern Route with the Main Street Wakefield Variation is 8.60 miles (see Figure 5-2d).

The use of Main Street in Wakefield would add approximately 0.37 miles to the Spring Street Variation of the Southern Route and increase work along Main Street in Wakefield without offering significant benefit to the route or avoiding the challenging crossing of the Haverhill Line at Forest Street. Accordingly, this variation was not advanced for further study.
5.4.5.7 NEP ROW Variation

The NEP ROW Variation follows the Southern Route to the intersection of Summer Street and Franklin Street in Stoneham. From this point, it follows Franklin Street into Melrose, crossing the Haverhill Line on Franklin Street in the Melrose Highlands neighborhood. The route continues on Franklin Street until it joins Howard Street in Melrose, then continues on Howard Street until it enters the NEP ROW at the Howard Street substation.

At this point, the transmission line would either continue underground within the NEP ROW, or transition from underground to overhead structures. The route then travels along the ROW for 2.7 miles north through parts of Melrose, Saugus, and Wakefield before reaching the Wakefield Junction Substation on Montrose Avenue.

The total length of the Southern Route with NEP ROW Variation is 8.90 miles (see Figure 5-2d).

The NEP ROW Variation has several significant drawbacks:

- The NEP ROW presently contains the 115-kV F158N and Q169 lines and the 13.8-kV 25W1 line. These lines would need to be rebuilt/relocated in a more compact configuration to allow for installation of a new overhead 345-kV line, adding to the cost and potential environmental impact of the project. The existing structure foundations also would make it extremely difficult to install the Project underground within the ROW.

- If the Project were to continue overhead along the ROW, an above-ground transition station would need to be built at either the Golden Hills Substation, Melrose Substation, or the Wakefield Municipal Substation to transition a 345-kV underground line from underground to overhead, adding to the Project cost.

- The overall route is indirect relative to alternatives, adding ¼ to 1 mile longer than the distance of the underground routes.

Because use of the NEP ROW adds distance and complexity to the Project without offering obvious advantages from an environmental or constructability perspective, this variation was not advanced for further evaluation.
5.5 Analysis of Candidate Routes

5.5.1 Description of Candidate Routes

As described in Section 5.4, the Companies considered and subsequently eliminated a number of route alternatives and related variations in the preliminary stage of the routing analysis, including the Interstate Highway Route and other less-promising variations of the Northern, Central, and Southern Routes. Table 5-1 lists the routes that the Companies retained for further evaluation and scoring. These Candidate Routes are shown on Figure 5-5 and described below.

Table 5-1 Status of Route Selection after Initial Screening

<table>
<thead>
<tr>
<th>Segment</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate Highway Route</td>
<td>Dismissed (see Section 5.4.2)</td>
</tr>
<tr>
<td>Central Route</td>
<td>Retained for scoring</td>
</tr>
<tr>
<td>Central Route with Davidson Park Winchester Variation</td>
<td>Dismissed (see Section 5.4.4.1)</td>
</tr>
<tr>
<td>Central Route with Forest Street Winchester Variation</td>
<td>Dismissed (see Section 5.4.4.2)</td>
</tr>
<tr>
<td>Central Route with Tri-Community Greenway Variation</td>
<td>Dismissed (see Section 5.4.4.3)</td>
</tr>
<tr>
<td>Central Route with Cottage Street Stoneham Variation</td>
<td>Dismissed (see Section 5.4.4.4)</td>
</tr>
<tr>
<td>Central Route with Pomeworth Street Variation</td>
<td>Dismissed (see Section 5.4.4.5)</td>
</tr>
<tr>
<td>Central Route with Main Street-Broadway Stoneham Variation</td>
<td>Dismissed (see Section 5.4.4.6)</td>
</tr>
<tr>
<td>Central Route with New Salem Street Wakefield Variation</td>
<td>Retained for scoring</td>
</tr>
<tr>
<td>Central Route with Green Street Woburn Variation</td>
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</tr>
<tr>
<td>Northern Route</td>
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</tr>
<tr>
<td>Northern Route with Main Street Woburn Variation</td>
<td>Dismissed (see Section 5.4.3.2)</td>
</tr>
<tr>
<td>Southern Route</td>
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</tr>
<tr>
<td>Southern Route with Fallon Road Variation</td>
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</tr>
<tr>
<td>Southern Route with East Street Variation</td>
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<tr>
<td>Southern Route with Spring Street Wakefield Variation</td>
<td>Dismissed (see Section 5.4.5.5)</td>
</tr>
<tr>
<td>Southern Route with Main Street Wakefield Variation</td>
<td>Dismissed (see Section 5.4.5.6)</td>
</tr>
<tr>
<td>Southern Route with NEP ROW Variation</td>
<td>Dismissed (see Section 5.4.5.7)</td>
</tr>
</tbody>
</table>

5.5.1.1 Central Route

As discussed in Section 5.4.4, the Central Route travels in streets through Woburn, Winchester, Stoneham and Wakefield, and incorporates approximately one mile of the currently unused Wakefield Railroad ROW. The Wakefield Railroad ROW is an asset that the Town of Wakefield seeks to convert into a recreation walking/bike path in the future.
This 8.53-mile route would require trenchless crossing techniques in the following locations to avoid impacts to waterways and active railroad tracks: (a) two crossings of the Aberjona River in Winchester; (b) a crossing of the Aberjona River and two crossings of the Sweetwater Brook in Stoneham; and (c) the crossing of the Haverhill Line on Broadway Street and of the Mill River within Salem Street in Wakefield. Each of these crossings could be accomplished using jack-and-bore techniques.

5.5.1.2 Central Route with Green Street Woburn Variation

As discussed in Section 5.4.4.8, the Central Route with Green Street Woburn Variation extends north from the Main Street/Cross Street intersection along the Woburn Railroad ROW for approximately 0.7 miles in Woburn, then turns east onto Green Street and Montvale Avenue before rejoining the Central Route in Stoneham. The Companies are not aware of any near-term recreation or other development plans for the Woburn Railroad ROW. The City of Woburn suggested its use for this Project as an alternative to Main Street (Route 38), which is heavily trafficked, has recently been re-surfaced and has had other engineering/drainage improvements that could be affected by Project construction.

This route would require trenchless crossing techniques in the following locations to avoid impacts to waterways and active railroad tracks: (a) a crossing of the Lowell Line in Woburn; (b) a crossing of the Aberjona River and two crossings of the Sweetwater Brook in Stoneham; and (c) the crossing of the Haverhill Line on Broadway Street and of the Mill River within Salem Street in Wakefield. The water crossings and the crossing of the Haverhill line could be accomplished using jack-and-bore techniques.

However, approximately 700 feet east of the Green Street/Montvale Avenue intersection, the Central Route with Green Street Woburn Variation crosses the Lowell Line on the Montvale Avenue overpass on a new truss bridge that would need to be built parallel to the existing roadway bridge. Alternative means of crossing the Lowell Line were found to be impractical for the following reasons:

♦ There is insufficient room to connect a conduit to the bottom of the bridge due to the headspace between the rails and the bottom of the underpass.

♦ The cable cannot be attached to the outside of the bridge given the existing arrangement of utilities currently attached to the bridge.

♦ A trenchless crossing underneath the bridge and railroad would be difficult due to lack of suitable construction space, sloping topography, and shallow bedrock in this location.
The total route length is 8.65 miles, approximately 0.11 miles longer than the Central Route without the Green Street Woburn Variation.

5.5.1.3 Central Route with New Salem Street Wakefield Variation

As described in Section 5.4.4.7, the Central Route with New Salem Street Variation leaves the Wakefield Railroad ROW at New Salem Street and advances along New Salem Street for approximately 0.75 miles to its intersection with Salem Street, where it rejoins the Central Route. As a result, it uses approximately 0.5 miles of the Wakefield Railroad ROW, as opposed to the 1.0 mile of railroad ROW included in the Central Route.

Trenchless crossings required to construct the Central Route with New Salem Street are similar to those along the Central Route, and include: two crossings of the Aberjona River in Winchester, a crossing of the Aberjona River and two crossings of the Sweetwater Brook in Stoneham, and the crossing of the Haverhill Line on Broadway Street and of the Mill River crossing of New Salem Street in Wakefield. Each of these crossings could be accomplished using jack-and-bore techniques.

The total route length is 8.34 miles, approximately 0.19 miles shorter than the Central Route without the New Salem Street Wakefield Variation.

5.5.1.4 Northern Route

As discussed in Section 5.4.3, the Northern Route travels through Woburn, Stoneham and Wakefield and incorporates approximately 0.7 miles of the Woburn Railroad ROW. Parts of the Northern Route, including Prospect Street, Church Street, and Salem Street have relatively narrow roadway widths.

The Northern Route would require trenchless crossing techniques in the following locations to avoid impacts to waterways and active railroad tracks: (a) crossings beneath the Aberjona River and the Lowell Line in Woburn; (b) a crossing of I-93 between Woburn and Stoneham; (c) crossings of the Aberjona River and Route 28 in Stoneham; and (d) the crossing of the Haverhill Line on Broadway Street and of the Mill River in Wakefield.

Two of these crossings require complex HDD operations. The first is a comparatively long (>500 feet) crossing under I-93, extending from the end of Lynn Street, Woburn (a short residential street) under the highway to Pento Road in Stoneham. Acquisition of easements on private properties on the east side of I-93 would be necessary. HDD operations would be expected to last for approximately three months in close proximity to nearby residences and business, and could potentially be very disruptive to these receptors.
A second HDD operation would be required to cross the active Lowell Line Railroad ROW at Salem Street in Woburn. Salem Street crosses the Lowell Line on a bridge in this location; however, the MassDOT has indicated that the bridge is not available for additional utility crossings. HDD operations would be expected to last for approximately 3 months in this location. In addition, this bridge is proposed for replacement in the near future.

The MWRA is in the early stages of planning to install a major infrastructure improvement project (the Northern Intermediate High Redundant Pipeline) within Prospect Street, overlapping with the Northern Route for approximately 4,300 feet. This project includes the installation of a 48-inch water main to provide redundancy in the regional water supply delivery system. Construction of the project is proposed to begin in the fall of 2016 and end in December 2019. Thus, a significant potential exists for overlapping construction schedules along this portion of the Northern Route. Additionally, because the design for the MWRA project is not yet complete, it is not yet known whether there is room in the relatively narrow Prospect Street for both the MWRA infrastructure and the proposed Project conduit.

5.5.1.5 Northern Route with Highway Variation

The Northern Route with Highway Variation would continue, from Salem Street in Woburn, northeast onto Cedar Street. Cedar Street dead-ends at the I-93/I-95 interchange. The route would cross the interchange by HDD and enter into the highway layout south of the I-95 layout. It would then cross through a private property and several adjacent MassDOT properties located just south of the I-95 highway layout. It would skirt the Route 28 interchange ramp and enter into the parking lot and access drive of Stonehill Apartments. It would continue east in a trenchless crossing of Route 28 to the adjacent 99 Restaurant and the 45 South Street Apartments before entering into the public way in Prospect Street and then rejoining the Northern Route at North Street. The total distance of this route is 8.8 miles, approximately 1.0 mile of which is routed adjacent to the highway.

The Northern Route with Highway Variation would require many of the same crossings as the Northern Route, including the HDD under the Lowell Line. Instead of the Lynn Street Woburn HDD under I-93, there would be a longer HDD under the I-93/I-95 interchange into the area just behind Constitution Road in Stoneham. HDD operations would be expected to take 5 to 6 months in this location.

A new construction access road would be required to support construction of the “cross country” segment of this route, from the exit of the HDD across the I-93/I-95 interchange to the Stonehill Apartments. This segment would require the clearing of a corridor across the vegetated parcels between the residential neighborhoods in Stoneham and I-95.
This route would require a significant number of easements, including:

- MassDOT (2,600 feet)
- Private property (at I-93/I-95) (680 feet)
- Stonehill Apartments (815 feet)
- 99 Restaurant (160 feet)
- 45 North Street Apartments (300 feet)

5.5.1.6 Southern Route

As discussed above, the Southern Route travels in streets through Woburn, Stoneham, and Wakefield. At 8.01 miles, it is a comparatively short and direct route, with substantial variation in road curvature, road width, and topography. The vicinity of Farm Street and Water Street exhibits visible bedrock outcrops, and town representatives have indicated the presence of shallow bedrock and shallow groundwater along West Water and Water Streets in Wakefield.

The Southern Route would require a challenging horizontal directional drill under I-93 at the Marble Street Bridge straddling Winchester and Stoneham. MassDOT has indicated that it would not allow the Project to be attached to the Marble Street Bridge overpass, which is currently scheduled to be replaced in 2021. A HDD crossing would be staged along Forest Street on both the east and west sides of I-93, resulting in traffic disruptions and impacts to neighboring residences during the approximately four-month construction period. Acquisition of easements on private properties would also be necessary.

Trenchless crossings would also be required under the Aberjona River in Winchester on Cross Street, the Mill River on Water Street in Wakefield, and the Haverhill Line on North Avenue in Wakefield.

5.5.2 Environmental and Constructability Analysis

This section discusses the Companies’ comparative analysis of the Candidate Routes based on considerations of human and natural environment impacts and ease of design and construction. Section 5.5.2.1 describes the criteria used in this evaluation. Section 5.5.2.2 describes the ratio scoring methodology used to determine a score for each criterion. Section 5.5.2.3 describes the weight given to each criterion, while Section 5.5.2.4 provides the results of this analysis for each Candidate Route, and for the eastern and western segments of the Central and Southern Routes and their variations.
5.5.2.1 Environmental and Constructability Evaluation Criteria

The Companies used several criteria to evaluate potential environmental impacts and constructability issues for the candidate routes. Because the Study Area lies within an urban environment, most of the relevant impact criteria are associated with the potential for impacts to the human environment.

The following human environmental criteria were included in the routing analysis:

1. Residential land use;
2. Commercial or industrial land uses;
3. Sensitive receptors (hospitals, police/fire stations, elder care, schools and daycare facilities, district courts, places of worship, parkland and cemeteries);
4. Public transit facilities;
5. Historic resources;
6. Traffic congestion; and
7. High-impact crossings (complex, multi-month drilling or bridge construction projects likely to result in high levels of disturbance to the environment, traffic, sensitive receptors, and residential neighborhoods).

The following natural environmental criteria were included in the routing analysis:

1. Wetland buffer zone crossing length;
2. Presence of public shade trees;

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2 Article 97 lands (i.e., lands acquired for conservation purposes and protected under Article 97 of the Amendments to the Massachusetts Constitution, the Public Lands Protection Act) were evaluated along each route using MassGIS data. None of the routes scored in the analysis will have direct impacts to any Article 97-protected land.

3 There is no protected state-listed rare species habitat mapped by the Natural Heritage and Endangered Species Program (“NHESP”) in the immediate vicinity of the routes that were analyzed in the scoring analysis, and no activity is proposed within protected state-listed rare species habitat in any portion of the Project. Similarly, the Companies are not aware of any federally-protected rare species habitat in the immediate vicinity of the routes. Consultation with the applicable agencies will be advanced should any protected species or habitats be encountered during project planning or construction. Because there is no difference in the routes based on the lack of known protected species’ habitats, the Companies excluded protected species and habitats as a criterion in the comparative routing analysis.
3. Location within Areas of Critical Environmental Concern (“ACECs”) or Outstanding Resource Waters (“ORWs”); and

4. Potential to encounter subsurface contamination during construction.

In addition, five evaluation criteria were included relating to engineering and technical aspects of the project:

1. Route length; because short, direct routes are less costly and time consuming to construct;

2. Utility density; considered because increased utility density can slow down construction, increasing the amount of time during which there may be traffic disruption or noise;

3. Route Bends (>30 degree turns based on road centerlines); because sharp turns risk damaging the cable;

4. Street width, because wider streets provide more space for construction equipment while still allowing an open travel lane.

5. Trenchless Crossings, including jack-and-bore (“J&B”) and HDD, operations.

Locations of siting constraints, such as environmentally sensitive areas and human environment factors affecting routing such as fire stations and hospitals are shown in Figure 5-6. Historic resources are shown in Figure 5-7, while locations of Reportable Release Sites are shown in Figure 5-8. A map of sensitive environmental receptors nearby the candidate routes is provided on Figure 5-9. Active railroad, highway, and waterbody crossings are shown on Figure 5-10.

5.5.2.2 Ratio Scoring Methodology

The Companies developed scoring for each of the Candidate Routes, and for the western and eastern segments of the Central and Southern Routes and their variations. For each criterion, the Companies used a ratio scoring technique that rates the route with the highest potential impact as a “1.” Other routes were then assigned a ratio score that represents their comparative relationship to that route. For example, if a hypothetical Route X has the highest potential impact at 10 residential units along the route, and Route Y has 5 residential units along the route, then Route X is assigned a value of “1” for that criterion and Route Y is assigned a value of “0.5.”
Figure 5-9
Sensitive Receptors

Legend

Sensitive Receptors
- Library, School, and/or Daycare
- Medical, Nursing, or Funeral Home
- Place of Worship
- Park/Recreation Area
- Cemetery

Route Segments
- Common Substation Takeoffs
- Central Route
- Central Route Variations
- Northern Route
- Northern Route Variation
- Southern Route

Scale: 1:26,400
1 inch = 2,200 feet
Basemap: 2013 Orthophotography, MassGIS

Data Source: Office of Geographic Information, Massachusetts, Information Technology Division - Data Obtained March 2014

Woburn to Wakefield Line Project

Eversource Woburn Substation

New Salem Street Variation

National Grid Wakefield Junction Substation
Figure 5-10
Railroad, Highway, and Waterbody Crossings

Legend
- Railroad Crossing
- Highway Crossing
- Waterbody Crossing
- High-Impact Crossing (>3 months)

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division - Data Obtained March 2014

Basemap: 2013 Orthophotography, MassGIS

Scale 1:26,400
1 inch = 2,200 feet

Legend:
- MassGIS Data
- USGS Data
- DEP Data
- Route Segments
- Common Substation Takeoffs
- Central Route
- Central Route Variations
- Northern Route
- Northern Route Variation
- Southern Route

Waterbody Crossings:
- Eversource Woburn Substation
- New Salem Street Variation
- Wakefield Junction Substation

Railroad Crossings:
- Woburn to Wakefield Line Project

Highway Crossings:
- Eversource Woburn Substation
- Green Street Variation
- Highway Variation

High-Impact Crossings (>3 months):
- Eversource Woburn Substation
- New Salem Street Variation
- Wakefield Junction Substation

Waterbody Crossings:
- Eversource Woburn Substation
- New Salem Street Variation
- Wakefield Junction Substation

Route Segments:
- Common Substation Takeoffs
- Central Route
- Central Route Variations
- Northern Route
- Northern Route Variation
- Southern Route

Scale 1:26,400
1 inch = 2,200 feet
Basemap: 2013 Orthophotography, MassGIS
Scores for each criterion were added together to get a Raw Score for each Candidate Route. Sources of information used in these evaluations included existing map resources (e.g., MassGIS, USGS topographic maps, aerial photography), the Massachusetts Department of Environmental Protection (“MassDEP”) Massachusetts Contingency Plan (“MCP”) database), and field reconnaissance.

Weights were developed for each scoring criterion to reflect the relative importance of the various criteria. The weights applied to each scoring criterion are presented in Table 5-2. A summary of resulting scores for the entire route (Table 5-3) and route segments (Table 5-4) are provided below. Table 5-5 provides a master scoring spreadsheet and describes both the unweighted score (as discussed in this section) and the weighted score (discussed in Section 5.5.2.3).

**Human Environment Criteria**

**Residential Land Uses**

Residents along a Candidate Route could be subject to temporary traffic disruption, noise, and/or dust. The routes analyzed pass through areas with a great majority of single family homes, with minimal mixed-type neighborhoods or multi-family or apartment complexes. Individual housing units were used to complete the scoring analysis. The number of residences was counted using MassGIS data, aerial photography, municipal records, and/or field verification to determine the number of units along each candidate route. A ratio score was calculated for each candidate route based on the total number of individual residential units determined for each route divided by the highest number of units found along all of the routes.

**Commercial and Industrial Land Uses**

Business and industry along a Candidate Route could be affected by temporary construction impacts such as traffic disruption, noise, and/or dust. The number of commercial and industrial units was counted using MassGIS data, aerial photography, municipal records, and/or field verification to determine the number of units along each candidate route. A ratio score was calculated for each route based on the total number of individual commercial/industrial units determined for each route divided by the highest number of units found along all of the routes.

**Sensitive Receptors**

These types of land uses could be affected by temporary construction impacts such as traffic disruption, property access, noise, and/or dust. This routing criterion included public services such as hospitals, police/fire stations, elder care facilities, schools,
daycare facilities, district courts, churches, parkland, nursing homes, funeral homes, and cemeteries located along a route. The number of sensitive receptor units was determined using MassGIS data, aerial photography, and/or field verification for each candidate route. A ratio score was calculated for each route based on the total number of individual sensitive receptor building units determined for each route divided by the highest number of units found along all of the routes.

Public Transit Facilities

These types of land uses could be affected by temporary construction impacts such as traffic disruption, noise, and/or dust. This evaluation was completed by counting the number of units using MassGIS data, aerial photography, and/or field verification to determine the number of units along each candidate route whose driveways would be intersected. Units were counted for public bus stops or major transportation facilities such as MBTA stations. A ratio score was calculated for each route based on the total number of individual facility units determined for each route divided by the highest number of units found along all of the routes.

Historic and Archaeological Resources

Some of these resources could be affected by temporary construction impacts such as traffic disruption, noise, and/or dust. Evaluation for this criterion consisted of a search of archival records at the Massachusetts Historic Commission (“MHC”) offices to inventory buildings, local historic districts, known archeological sites and National Register-listed individual buildings and districts. The number of historic resources within 500 feet of the route were counted based on the number of buildings, local historic districts, known archaeological sites, and National Register-listed individual buildings and districts included in the Inventory of Historic and Archaeological Assets of the Commonwealth or listed in the State and National Registers of Historic Places along each candidate route. A ratio score was calculated for each route based on the total number of individual historic units determined for each route divided by the highest number of units found along all of the routes.

Potential for Traffic Congestion

The potential for traffic congestion impacts during in-street trench construction was evaluated for each candidate route. Traffic congestion was assessed along existing road segments using information obtained from GIS sources, aerial photography, and field reconnaissance. The following factors were considered: traffic volume, average roadway widths and the number of travel lanes, available on-street parking and road shoulder, the number of intersections along the route, and whether road segments contained bus routes and stops. An overall average score was calculated for each candidate route based on
weighted ratio scoring for four traffic congestion categories: Length and width, Intersections, Road Conditions Affecting Traffic, and Commuter and Public Transportation Routes.

High-Impact Crossings

The Companies recognized the potential for particularly extended (more than three months) and severe construction impacts in locations where the need to cross roads, railroads, or water bodies would require long horizontal directional drills or, in one case, the construction of a new utility bridge, that would be completed over multiple months in close proximity to residences and businesses. These crossings would likely cause a disruption to the public associated with construction noise, visual impacts, traffic, dust generation and the use of road shoulder or parking lot space to support construction. The number of high-impact crossing was identified for each route and a ratio score was calculated by dividing the number of difficult crossings on the route by the greatest number of such crossings required for any route.

Natural Environment Criteria

Public Shade Trees

A field reconnaissance was conducted along each candidate route to count all public shade trees within the public way as defined by MGL Chapter 87, regardless of diameter at breast height or distance from the proposed cable trench. The scoring ratio for this criterion was calculated for each route based on the total number of public shade trees determined for each route divided by the highest number of public shade trees found along any candidate route.

Wetland Resource Areas

This criterion involved reviewing MassGIS data and conducting field reconnaissance to determine the number of local- and state-regulated resource area buffer zones that each candidate route would cross as defined in the Massachusetts Wetlands Protection Act regulations (310 C.M.R. 10.00 et seq.), including the buffer zones of Bordering Vegetated Wetlands, inland Bank, 100-year floodplain (Bordering Land Subject to Flooding), and 200-foot Riverfront Area. The ratio score was calculated based on dividing the total number of resource area buffer zone crossings for each candidate route by the highest number of resource area and/or buffer zone crossings found along all of the routes.
ACECs and ORWs

This criterion evaluated the linear footage of MassGIS-mapped ACECs or ORWs as defined by the Wetlands Protection Act within each candidate route. A ratio score was calculated for each route based on the total linear feet of route segment found within ORWs and ACECs for each route divided by the highest number of linear feet of route segment within these resource areas found along all of the routes.

Potential to Encounter Subsurface Contamination

Trench excavation in urban areas may encounter contaminated soil that can affect worker safety and require special soil management procedures and disposal requirements under federal and state hazardous material regulations. Releases of oil and/or hazardous material to the environment must be reported to the Massachusetts Department of Environmental Protection’s (“MassDEP”) Bureau of Waste Site Cleanup (“BWSC”), in accordance with M.G.L. Chapter 21E and procedures established within the Massachusetts Contingency Plan (“MCP”) (310 C.M.R. 40.0000). MassDEP categorizes Oil or Hazardous Material (“OHM”) sites based on the level of contamination present and the level of remediation completed.

An online search of the MassDEP Waste Site List was performed to determine the potential for each candidate route to encounter subsurface contamination from historical releases or former land development practices. The MassDEP online database was used to collect information on listed MassDEP sites within 500 feet of the candidate routes with a release tracking number. The search included Active Tier Classified Tier I and Tier II sites, Activity and Use Limitation (“AUL”) sites closed with ongoing maintenance conditions, Utility Related Abatement Measure (“URAM”) sites, and Class C temporary solution sites.

Each candidate route was assessed with regard to the number of these active sites located on property parcels within 500 feet of the candidate routes. The raw scores for this criterion were determined based on the total number of these mapped active sites, and the ratio score was calculated by dividing the total found for each individual route by the highest number of these sites found along the candidate routes.
Ease of Construction Criteria

Length

The length of the route determines the overall construction duration; all else being equal, the shorter the route, the shorter the duration of construction and disruption to the public and local businesses. The length of each candidate route in miles was determined using MassGIS and/or aerial photography. A ratio score was calculated for each route based on the total length of the route in miles divided by the length of the longest route.

Existing Utility Density

The number of existing underground pipelines, utility conduits, and features such as manholes and catch basins, and the depth of these facilities in the roadway, affect the available space below grade to physically install the proposed cable and manhole system. Extensive utility density can significantly constrain available space, complicate the construction process, and increase construction duration, traffic disruption, and costs. Utility density along candidate routes was assessed using available subsurface utility records and/or MassGIS data with known facilities obtained from the municipalities and other utility owners. Field reconnaissance was also conducted along the candidate routes to assess the number of observed utility facility features (i.e., utility manhole and vault covers, catch basins) by road segment.

Utility density was evaluated for each street of each route, and a rank of low, medium, or high assigned based on route increments of approximately 1,000 linear feet. A calculated ratio score was based on dividing the total length of medium and high-ranked utility density for each candidate route by the route segment with the greatest length of medium and high-ranked utility density observed along all of the candidate routes.

Route Bends

Bends of greater than nominal angle increase construction difficulty and the risk of cable damage during installation and operation. Sharp turns also necessitate installation of additional manholes to minimize side wall pressure on the cables. The number of bends greater than 30 degrees on each candidate route was determined assuming a route aligned with the center of each road, since detailed engineering plans for the routes was not available at the time of this filing. A ratio score was calculated for each route based on the total number of bends on the route divided by the highest number of bends found along all of the routes.
Street Width

Street width was measured every 1,000 feet along each of the evaluated routes. The ratio score was calculated based on the total length (linear feet) of each route with paved road surfaces less than 30 feet divided by the longest length of sections under 30-feet along all of the routes.

Trenchless Crossings

All Candidate Routes require the crossings of certain features (e.g., railroad ROWs, highways, streams, and rivers) that cannot be crossed via open trench construction without significant impact to the human or natural environment. In most of these instances, the Companies will be required to use trenchless crossing techniques (J&B or HDD). These crossings require greater time and logistical coordination and are more expensive than typical open trench construction. The number of trenchless crossings were counted for each route option, and a ratio score calculated based on dividing the total number of trenchless crossings per route by the count of such crossings on the route with the greatest number on any route.

5.5.2.3 Environmental and Constructability Weighting

The assignment of weights to individual criteria is an important part of the route evaluation process, and ensures that route scoring results reflect the relative importance of individual evaluation criteria. Weighting scores can further illuminate the decision-making process and confirm the appropriateness of the ranking. Table 5-2 defines the weights applied to each evaluation criterion. A triple weight was assigned to four criteria: residential land use, commercial or industrial land uses, high-impact crossings, and potential for traffic congestion. A double weight was given to four additional criteria: sensitive receptors, ACEC/ORW crossings, subsurface utility density, and street width. The remaining criteria were given a weight of 1 (e.g., unweighted).

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4 Additional trenchless crossings may be warranted along the route as a result of utility density or unanticipated subsurface conditions. The need for these additional trenchless operations may be discovered as engineering for the Project is advanced or as unanticipated conditions are encountered in the field once construction is underway. To maintain an “equal playing field” for the routes, crossings that would be discoverable only by detailed survey or excavation were not counted in the scoring (i.e., only clearly visible crossings such as railroad, culvert, or waterway, were counted).
### Table 5-2  Route Evaluation Criteria Weighting Scale

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Assigned Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human Environment Criteria</strong></td>
<td></td>
</tr>
<tr>
<td>Residential Structures</td>
<td>3</td>
</tr>
<tr>
<td>Commercial and Industrial Structures</td>
<td>3</td>
</tr>
<tr>
<td>Sensitive Receptors (hospitals, police/fire stations, elder care, schools, daycare, district courts, churches, parkland/recreation facilities, nursing homes, funeral homes, cemeteries)</td>
<td>2</td>
</tr>
<tr>
<td>Public Transit Facilities</td>
<td>1</td>
</tr>
<tr>
<td>Historic Resources</td>
<td>1</td>
</tr>
<tr>
<td>Potential for Traffic Congestion</td>
<td>3</td>
</tr>
<tr>
<td>High Impact Crossings</td>
<td>3</td>
</tr>
<tr>
<td><strong>Natural Environment Criteria</strong></td>
<td></td>
</tr>
<tr>
<td>Public Shade Trees</td>
<td>1</td>
</tr>
<tr>
<td>Wetland Resource Area and Buffer Zone Crossings</td>
<td>1</td>
</tr>
<tr>
<td>ACECs or ORWs</td>
<td>2</td>
</tr>
<tr>
<td>Potential for Subsurface Contamination</td>
<td>1</td>
</tr>
<tr>
<td><strong>Engineering/Technical Criteria</strong></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>1</td>
</tr>
<tr>
<td>Utility Density</td>
<td>2</td>
</tr>
<tr>
<td>Bends (&gt;30 degree intersections)</td>
<td>1</td>
</tr>
<tr>
<td>Trenchless Crossings</td>
<td>1</td>
</tr>
<tr>
<td>Street Width</td>
<td>2</td>
</tr>
</tbody>
</table>

#### 5.5.2.4  Environmental and Constructability Comparison: Results

The Companies applied the scoring methodology described above to each of the Candidate Routes. The results of this analysis are provided in Table 5-3 below.
Table 5-3  Candidate Route Scoring Summary

<table>
<thead>
<tr>
<th>Candidate Route</th>
<th>Raw Ratio Score</th>
<th>Weighted Ratio Score</th>
<th>Weighted Ratio Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Route</td>
<td>13.2</td>
<td>23.2</td>
<td>6</td>
</tr>
<tr>
<td>Northern Route with Highway Variation</td>
<td>12.3</td>
<td>21.8</td>
<td>5</td>
</tr>
<tr>
<td>Central Route</td>
<td>11.2</td>
<td>18.9</td>
<td>1</td>
</tr>
<tr>
<td>Central Route with Green Street Variation</td>
<td>12.2</td>
<td>21.5</td>
<td>4</td>
</tr>
<tr>
<td>Central Route with New Salem Street Variation</td>
<td>11.5</td>
<td>19.5</td>
<td>2</td>
</tr>
<tr>
<td>Southern Route</td>
<td>11.4</td>
<td>19.7</td>
<td>3</td>
</tr>
</tbody>
</table>

The three Central Routes and the Southern Route share a short common segment on Albion Street in Wakefield. To illuminate whether factors on the western or eastern part of the routes were driving differences in scoring, the Companies developed a second set of scores that compare the western portions of the Central and Southern routes (in Winchester, Woburn and Stoneham) independently of the eastern portions of the routes (in Wakefield). The results of this analysis are provided in Table 5-4, below.

Table 5-4  Scoring Summary for Eastern and Western Route Segments

<table>
<thead>
<tr>
<th>Route Segment</th>
<th>Raw Ratio Score</th>
<th>Weighted Ratio Score</th>
<th>Weighted Ratio Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>West</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern Route West</td>
<td>11.4</td>
<td>20.5</td>
<td>2</td>
</tr>
<tr>
<td>Central Route West</td>
<td>11.2</td>
<td>19.2</td>
<td>1</td>
</tr>
<tr>
<td>Central Route with Green Street (Woburn) Variation</td>
<td>12.2</td>
<td>22.2</td>
<td>3</td>
</tr>
<tr>
<td>East</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Route East</td>
<td>11.1</td>
<td>18.7</td>
<td>1</td>
</tr>
<tr>
<td>Southern Route East</td>
<td>12.0</td>
<td>20.1</td>
<td>3</td>
</tr>
<tr>
<td>Central Route with New Salem Street Variation</td>
<td>11.7</td>
<td>19.7</td>
<td>2</td>
</tr>
</tbody>
</table>

* Data compiled from Table 5-5, Scoring Spreadsheet. Combinations of east and west segments in comparison to Northern Route are summarized in Table 5-4 and provided in more detailed in Table 5-6.
<table>
<thead>
<tr>
<th>CANDIDATE ROUTE</th>
<th>HUMAN ENVIRONMENT CRITERIA</th>
<th>NATURAL ENVIRONMENT CRITERIA</th>
<th>EASE OF CONSTRUCTION CRITERIA</th>
<th>TOTAL SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Residential Land Use</td>
<td>Commercial or Industrial Land Use</td>
<td>Sensitive Receptors</td>
<td>Public Transit Facilities</td>
</tr>
<tr>
<td>Northern Route</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Weighted Score</td>
<td>3.00</td>
<td>1.67</td>
<td>1.41</td>
<td>1.00</td>
</tr>
<tr>
<td>Central Route</td>
<td>0.79</td>
<td>0.89</td>
<td>1.00</td>
<td>0.83</td>
</tr>
<tr>
<td>Weighted Score</td>
<td>2.38</td>
<td>2.66</td>
<td>2.00</td>
<td>0.83</td>
</tr>
<tr>
<td>Southern Route</td>
<td>0.80</td>
<td>0.48</td>
<td>0.71</td>
<td>0.50</td>
</tr>
<tr>
<td>Weighted Score</td>
<td>2.40</td>
<td>1.44</td>
<td>1.41</td>
<td>0.50</td>
</tr>
<tr>
<td>Central Route with Green Street Variation</td>
<td>0.80</td>
<td>1.00</td>
<td>0.71</td>
<td>1.00</td>
</tr>
<tr>
<td>Weighted Score</td>
<td>2.40</td>
<td>3.00</td>
<td>1.41</td>
<td>1.00</td>
</tr>
<tr>
<td>Central Route with New Salem Street Variation</td>
<td>0.76</td>
<td>0.99</td>
<td>1.00</td>
<td>0.83</td>
</tr>
<tr>
<td>Weighted Score</td>
<td>2.27</td>
<td>2.96</td>
<td>2.00</td>
<td>0.83</td>
</tr>
<tr>
<td>Northern Route with Highway Variation</td>
<td>0.81</td>
<td>0.57</td>
<td>0.82</td>
<td>1.00</td>
</tr>
<tr>
<td>Weighted Score</td>
<td>2.43</td>
<td>1.71</td>
<td>1.65</td>
<td>1.00</td>
</tr>
</tbody>
</table>
5.5.3 Cost Comparison

As part of the route selection process, the Companies developed high-level comparative cost estimates for the Candidate Routes and the eastern and western segments of the Central and Southern Routes and variations (see Tables 5-6 and 5-7). These high-level comparative cost estimates are different from the overall Project cost estimates as initially submitted to ISO-NE for purposes of ISO-NE’s needs and solutions studies. The estimates were developed using cost-per-mile estimates for open trench construction in railroad ROWs and in streets, supplemented with generic cost estimates for jack-and-bore crossings and individual estimates for HDD crossings and for the trestle bridge crossing of the Lowell Line on the Central Route with Green Street Variation.

These estimates were developed prior to completion of surveys of existing facilities, engineering, and geotechnical/environmental borings, and they do not include overhead, environmental mitigation or the cost of temporary or permanent easements. Nonetheless, they provide a basic understanding of the likely cost differentials between the various routes. In particular, routes using stretches of railroad ROW, and routes requiring complex crossings, tend to cost more than in-street routes without complex crossings.

Table 5-6 Candidate Route Cost Estimates

<table>
<thead>
<tr>
<th>Candidate Route</th>
<th>Cost Estimate (Millions)</th>
<th>Easements Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Route</td>
<td>$72.6</td>
<td>Approximately 5,500 linear feet on RR ROW (MBTA)</td>
</tr>
<tr>
<td>Central Route with Green Street Woburn</td>
<td>$76.7</td>
<td>Approximately 8,900 linear feet on RR ROW (MBTA)</td>
</tr>
<tr>
<td>Variation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Route with New Salem Street</td>
<td>$69.8</td>
<td>Approximately 2,800 linear feet on RR ROW (MBTA)</td>
</tr>
<tr>
<td>Variation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern Route</td>
<td>$72.0</td>
<td>MassDOT and potentially private property owners for Marble St HDD</td>
</tr>
</tbody>
</table>

As explained in Section 1.7 of this Analysis, the Companies expect to having a planning grade cost estimate (-25%/+25%) developed during the course of this proceeding.

Routes using railroad ROWs or private property would require permanent easements. The HDDs (and possibly some jack-and-bores) would require temporary construction easements for laydown areas.
Table 5-6  Candidate Route Cost Estimates (Continued)

<table>
<thead>
<tr>
<th>Candidate Route</th>
<th>Cost Estimate (Millions)</th>
<th>Easements Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Route</td>
<td>$74.5</td>
<td>• MassDOT and private property owners for I-95 and Lowell Line RR crossings.</td>
</tr>
<tr>
<td>Northern Route with Highway Variation</td>
<td>$77.6</td>
<td>• Approximately 5,000 linear feet easement (state-owned and private properties)</td>
</tr>
</tbody>
</table>

Table 5-7  Cost Estimates – Eastern and Western Route Segments

<table>
<thead>
<tr>
<th>Segment</th>
<th>Cost Estimate (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Segments</td>
<td></td>
</tr>
<tr>
<td>Southern Route West</td>
<td>$45.0</td>
</tr>
<tr>
<td>Central Route West</td>
<td>$43.2</td>
</tr>
<tr>
<td>Central Route with Green Street (Woburn) Variation</td>
<td>$47.3</td>
</tr>
<tr>
<td>Eastern Segments</td>
<td></td>
</tr>
<tr>
<td>Southern Route East</td>
<td>$27.0</td>
</tr>
<tr>
<td>Central Route East</td>
<td>$29.4</td>
</tr>
<tr>
<td>Central Route with New Salem Street Variation</td>
<td>$26.6</td>
</tr>
</tbody>
</table>

5.5.4  Reliability Considerations

The Companies considered whether there was a difference in the Candidate Routes with regard to the reliability of the proposed new line, and determined that there are no meaningful differences in the operating characteristics for the routes under consideration. A new 345-kV transmission line constructed along any of the Candidate Routes would address the thermal and voltage considerations that are identified in Section 3.

5.6  Selection of Preferred and Noticed Alternative Routes

The Companies next performed an overall route comparison. The Companies determined that the ideal route combines low potential for environmental impact with low estimated circuit costs and ease of construction, along with a high degree of reliability. Sections 5.6.1 to 5.6.4 describe the selection of the Preferred Route and Noticed Alternative Route from among the Candidate Routes (see Figure 5-11).
5.6.1 Comparison of Candidate Routes

The Preferred Route was selected by the Companies based on the established environmental evaluation criteria and in consideration of cost, constructability, and municipal and regulatory input. Initially, the Companies compared the six Candidate Routes as a whole, based on scoring and cost, with a qualitative consideration of reliability issues. Cost adders, such as detailed route-by-route evaluation of costs for rock removal, night work, and easement acquisition are not included in the cost estimates presented herein.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Weighted Ratio Score</th>
<th>Weighted Ratio Ranking</th>
<th>Cost Estimate (Millions)</th>
<th>Cost Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Route</td>
<td>18.9</td>
<td>1</td>
<td>$72.6</td>
<td>3</td>
</tr>
<tr>
<td>Route with New Salem Street Variation</td>
<td>19.5</td>
<td>2</td>
<td>$69.8</td>
<td>1</td>
</tr>
<tr>
<td>Southern Route</td>
<td>19.7</td>
<td>3</td>
<td>$72.0</td>
<td>2</td>
</tr>
<tr>
<td>Central Route with Green Street Woburn Variation</td>
<td>21.5</td>
<td>4</td>
<td>$76.7</td>
<td>5</td>
</tr>
<tr>
<td>Northern Route</td>
<td>23.2</td>
<td>6</td>
<td>$74.5</td>
<td>4</td>
</tr>
<tr>
<td>Northern Route with Highway Variation</td>
<td>21.8</td>
<td>5</td>
<td>$77.6</td>
<td>6</td>
</tr>
</tbody>
</table>

As can be seen in Table 5-8, the Northern Route and the Northern Route with Highway Variation are inferior to the Central and Southern Routes. There is also significant uncertainty as to whether these two northern routes could be advanced in a timely fashion, or indeed at all. Both routes overlap the MWRA’s planned water main project for approximately 4,300 feet on North Street and Prospect Street, requiring close coordination with the MWRA and raising concerns that there may not be sufficient room in these narrow streets for both projects. Both routes require the acquisition of rights in private property to cross I-93. In addition, the Highway Variation would require acquisition of rights in one privately-held parcel and four MassDOT parcels south of I-95, as well as the parking lot and access drive of Stonehill Apartments, the 99 Restaurant and the 45 South Street Apartments. Since the Northern Route and the Northern Route with Highway Variation are clearly inferior, the Companies selected the Preferred Route and Noticed Alternative from the four remaining routes.
As can be seen from Table 5-8, these four routes present tradeoffs between environmental impacts and cost. In addition, because all four routes share a short common segment on Albion Street in Wakefield, they could be combined into additional routes that are not shown on Table 5-8. To gain a better understanding of these tradeoffs, and to ensure that no superior route is overlooked, the Companies compared the eastern and western segments of these four routes.

### 5.6.2 Comparison of Western Route Segments

Table 5-9 compares the three western route segments based on cost and scoring. The Central Route West has the best weighted score and the lowest estimated cost. In addition, there are no major outstanding uncertainties regarding the feasibility of this section of the Central Route; all construction is in-road, all crossings can be completed by jack-and-bore techniques, and no private easements are required for construction. Accordingly, the Companies chose the Central Route West as the western portion of their Preferred Route.

The Southern Route West scores better, has a lower estimated cost than the Green Street Variation of the Preferred Route, and does not require the acquisition of ROW easements, which could add to the cost differential. In addition, it has greater geographical diversity from the Central Route West. Therefore, the Companies chose the Southern Route West as the western portion of the Noticed Alternative Route.

### Table 5-9 Comparison – Western Route Segments

<table>
<thead>
<tr>
<th>Segment</th>
<th>Weighted Ratio Score</th>
<th>Weighted Ratio Ranking</th>
<th>Cost Estimate (Millions)</th>
<th>ROW Easements Required</th>
<th>Cost Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Route West</td>
<td>19.2</td>
<td>1</td>
<td>$43.2</td>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td>Southern Route West</td>
<td>20.5</td>
<td>2</td>
<td>$45.0</td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td>Central Route with Green Street (Woburn) Variation</td>
<td>22.2</td>
<td>3</td>
<td>$47.3</td>
<td>0.64 miles</td>
<td>3</td>
</tr>
</tbody>
</table>

### 5.6.3 Comparison of Eastern Route Segments

Table 5-10 compares the three eastern route segments based on cost and scoring. Here, the tradeoffs between cost, environmental impact and constructability are clearly visible. The Central Route East has the best environmental/constructability score, followed by the New Salem Street Variation and Southern Route East. The ranking is reversed with respect to cost.
### Table 5-10  Comparison – Eastern Route Segments

<table>
<thead>
<tr>
<th>Segment</th>
<th>Weighted Ratio Score</th>
<th>Weighted Ratio Ranking</th>
<th>Cost Estimate (Millions)</th>
<th>ROW Easements Required</th>
<th>Cost Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Route East</td>
<td>18.7</td>
<td>1</td>
<td>$29.4</td>
<td>1.04 miles</td>
<td>3</td>
</tr>
<tr>
<td>Central Route East with New Salem Street Variation</td>
<td>19.7</td>
<td>2</td>
<td>$26.6</td>
<td>0.53 miles</td>
<td>1</td>
</tr>
<tr>
<td>Southern Route East</td>
<td>20.1</td>
<td>3</td>
<td>$27.0</td>
<td>None</td>
<td>2</td>
</tr>
</tbody>
</table>

In considering the relative merits of these three route segments, the Companies first compared the Central Route East – with the best environmental score but a higher cost -- to its New Salem Street Variation. The Central Route East would occupy approximately a full mile, rather than half a mile, of the Wakefield Railroad ROW. Using the additional half-mile of railroad ROW increases both Project cost and the risk of encountering encroachments and contaminated soils. Further, the RR ROW runs within a few feet of the Mill River as they both approach Salem Street, making the crossing of the Mill River at Salem Street particularly challenging.

On the other hand, a significant portion of New Salem Street lies within the Mill River watershed and is subject to flooding. The Town of Wakefield also has indicated that the soils along New Salem Street are unstable. Depending on the actual condition of the soils, the Companies might have to build piers to support the Project in this area, increasing Project costs. Unstable soils could also slow construction through the area. Overall, the Companies determined that the Central Route East would be preferable to the New Salem Street Variation.

The Companies then compared the Central Route East with the Southern Route East to determine which would become part of the Preferred Route and which would become part of the Noticed Alternative. The Central Route East has a significantly better environmental and constructability rating, but also a marginally higher cost. In weighing these two options, the Companies also considered the presence of groundwater and granite outcroppings along the Southern Route East, the navigation through which could reduce the cost differential. Overall, the Companies believe that the environmental and constructability attributes of the Central Route East are superior to those of the Southern Route, even considering the potential small cost premium of the Central Route as

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7 Because these two route segments have the majority of their length in common, one could not serve as a Noticed Alternative to the other.
compared to the Southern Route. The Companies therefore chose the Central Route East as the eastern portion of its Preferred Route, and the Southern Route East as the eastern portion of its Noticed Alternative Route.

5.6.4 Identification of Preferred Route, Noticed Alternative Route, and Route Variations

As discussed above, the Preferred Route consists of the western and eastern portion of the Central Route. The Noticed Alternative Route consists of the western and eastern portions of the Southern Route.

In addition to the Preferred and Noticed Alternative Routes, the Companies are noticing two variations to the Preferred Route, as follows:

New Salem (Wakefield) Variation: As discussed above, the Wakefield RR ROW runs within a few feet of the Mill River as they both approach Salem Street on the Central Route, making the crossing of the Mill River at Salem Street particularly challenging. The Companies are noticing the New Salem (Wakefield) Variation to the Preferred Route as a work-around to be used if the use of the northern part of the Wakefield Railroad ROW proves problematic, due either to this crossing or to encroachments and/or contaminated soils.

Green Street (Woburn) Variation: The Preferred Route and Noticed Alternative overlap for the first approximately 2,500 feet along Lake Avenue, Pickering Street, Border Street, and from Cross Street to the Washington Street intersection, a distance of approximately 6,500 feet. Beyond this initial distance of 9,000 feet (and a distance of 1,300 feet along Elm Street in Stoneham), the Preferred Route and Noticed Alternative Route are geographically distinct. In order to provide an additional measure of geographic diversity, the Companies are also noticing the Green Street Woburn Variation to the Preferred Route. While the Companies believe this variation is inferior to the Preferred Route, noticing the variation ensures that, to the greatest degree practical, the Companies have analyzed and noticed geographically distinct routes.

5.7 Conclusion

The route selection process undertaken by the Companies addresses in a comprehensive fashion the Siting Board’s standards applicable to jurisdictional energy facilities. The Companies identified a wide array of candidate routes as potential alternatives to satisfy the Project need, and the Companies’ process was designed to ensure that no clearly superior route was overlooked. The Companies systematically compared possible routes based upon reasonable criteria to evaluate the environmental impacts, cost, and reliability of the identified route alternatives.
The Preferred Route is the highest ranked route evaluated based on environmental and constructability criteria, and will enable the Companies to achieve the best balance between cost, environmental impact, and reliability at the lowest possible cost in accordance with Siting Board precedent. The Companies also have selected a Noticed Alternative Route with an appropriate measure of geographic diversity. Finally, the Companies have selected two variations to the Preferred Route for inclusion in the public notice issued in connection with the review of the Companies’ petition. Section 6 of this Petition compares the Preferred and Noticed Alternative Routes in detail.