Thruway Authority | New York State Department of Transportation | Metro-North Railroad | TAPPAN ZEE BRIDGE/I-287 ENVIRONMENTAL REVIEW

New York State Department of Transportation
New York State Thruway Authority
Metropolitan Transportation Authority/Metro-North Railroad

Tappan Zee Bridge/I-287 Corridor Project

DRAFT

Transit Alignment Options Report

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TAPPAN ZEE BRIDGE/I-287
ENVIRONMENTAL REVIEW

TRANSIT ALIGNMENT OPTIONS REPORT

PREPARED BY

This report was prepared for NYSDOT, MTA/MNR and NYSTA by AECOM and Ove Arup and Partners Consulting Engineers.

Subconsultants: No subconsultants participated in the preparation of this report.

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Description of Work Performed by Firm:
Prepared Transit Alignment Options Report, including development of options, and conducted all supporting transportation and environmental analyses.

Date

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Description of Work Performed by Firm:
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Executive Summary

The Project Sponsors – the New York State Department of Transportation (NYSDOT), the New York State Thruway Authority (NYSTA), and Metro-North Railroad (an agency of the Metropolitan Transportation Authority [MTA]) – in cooperation with the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) as co-lead agencies, are preparing an Environmental Impact Statement (EIS) for the Tappan Zee Bridge/I-287 Corridor Project in Rockland and Westchester Counties, New York (NY).

One of the key steps in preparation of the EIS is the development and refinement of alternatives. As this project has transit, bridge, and highway elements, the process of defining the alternatives is documented in a number of studies by the Project Sponsors including this *Transit Alignment Options Report*. This process is presented on Figure S-1, which shows the parallel development of the studies leading to the development of the EIS alternatives.

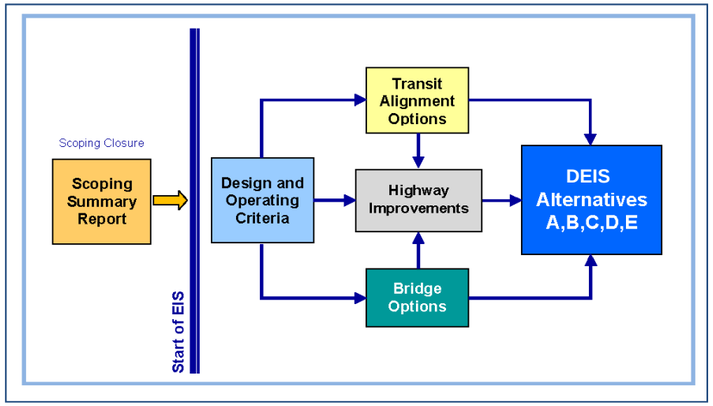

Figure S-1 Alternatives Development Roadmap

The transit modes, their termini, and general EIS alternatives were developed in the *Transit Mode Selection Report*. At the completion of that report, many of those alternatives had reasonable transit alignment options that needed further study. The purpose of this report is to evaluate those transit alignment options in Rockland and Westchester Counties (Figure S-3) in order to define the four build alternatives that will be further analyzed in the EIS. Based on this analysis, the transit alignment options that best support the Purpose and Need of the project have been recommended to be carried forward in the EIS as transit elements of the build alternatives.

Following completion of the analysis documented in this report and the reports related to the highway and bridge options, the EIS will be developed in accordance with the Revised Notice of Intent (issued February 14, 2008) using a tiered process to facilitate decision-making. The tiering approach allows an assessment of site specific impacts, costs, and mitigation measures in a Tier 2 highway and bridge analysis, while simultaneously considering broad overall corridor issues in a Tier 1 transit analysis of general alignment and logical termini of the proposed modes.

The EIS build alternatives include several common elements, namely, a replacement bridge that will accommodate transit, highway improvements in Rockland County, and CRT from Suffern to Tarrytown with a direct connection to the Metro-North Hudson Line for service to Grand Central Terminal (GCT). While full-corridor BRT is a common element of all build alternatives, the alternatives do differ in the type of BRT guideway that would be implemented.

- **Exclusive busway** – a barrier-separated system only accessible to buses. Exclusive busways are being evaluated for both Rockland and Westchester Counties
- **Exclusive bus lane** – a dedicated lane for buses only on a local arterial with no physical barrier separation. Exclusive bus lanes are being evaluated in Westchester County
- **Shared-use lanes (HOV/HOT)** – buses operate in lanes shared with other vehicles. For this project BRT would operate in the high occupancy vehicle/high occupancy toll (HOV/HOT) lanes in the Thruway median that are being evaluated in Rockland County

The five DEIS alternatives are as follows (Figure S-2):

- **Alternative A – No Build –** A No Build Alternative will be analyzed in the EIS consistent with National Environmental Policy Act (NEPA) requirements.
- **Alternative B – Full-Corridor Busway and Rockland CRT** – Alternative B would provide BRT service between Suffern, N.Y and Port Chester, NY, in an exclusive busway, and CRT service in Rockland County.
- **Alternative C – Busway in Rockland, Bus Lanes in Westchester, and Rockland CRT** – Alternative C would provide BRT service between Suffern and Port Chester via a BRT exclusive busway in Rockland County and BRT exclusive bus lanes in Westchester County, as well as provide CRT service in Rockland County.
- **Alternative D – HOV/HOT Lanes in Rockland, Busway in Westchester, and Rockland CRT** – Alternative D would provide BRT service between Suffern and Port Chester, via BRT in shared-use HOV/HOT lanes in Rockland County and BRT in an exclusive busway in Westchester County, as well as provide CRT service in Rockland County.
- **Alternative E – HOV/HOT Lanes in Rockland, Bus Lanes in Westchester, and Rockland CRT** – Alternative E would provide BRT service between Suffern and Port Chester via BRT in shared-use HOV/HOT lanes in Rockland County and BRT in exclusive bus lanes in Westchester County, as well as provide CRT service in Rockland County.

The transit alignment option recommendations presented in this report reflect a balanced consideration of engineering design, cost-effectiveness, optimized transit performance, and minimized environmental impacts. The evaluation of these options considered the following criteria with a focus on major differentiators:

- **Engineering:** engineering design, operations and maintenance, and constructability.
- **Capital Cost (2012$):** cost of material, labor and equipment, plus escalation, markups and soft costs.
- **Transportation:** travel time, traffic network changes, and transportation system integration.
- **Environmental:** land use and potential for transit oriented development (TOD), displacements and acquisitions, wetlands, aquifers and floodplains, parklands, historic and archaeological resources, Hudson River ecosystems, noise, and visual impacts.

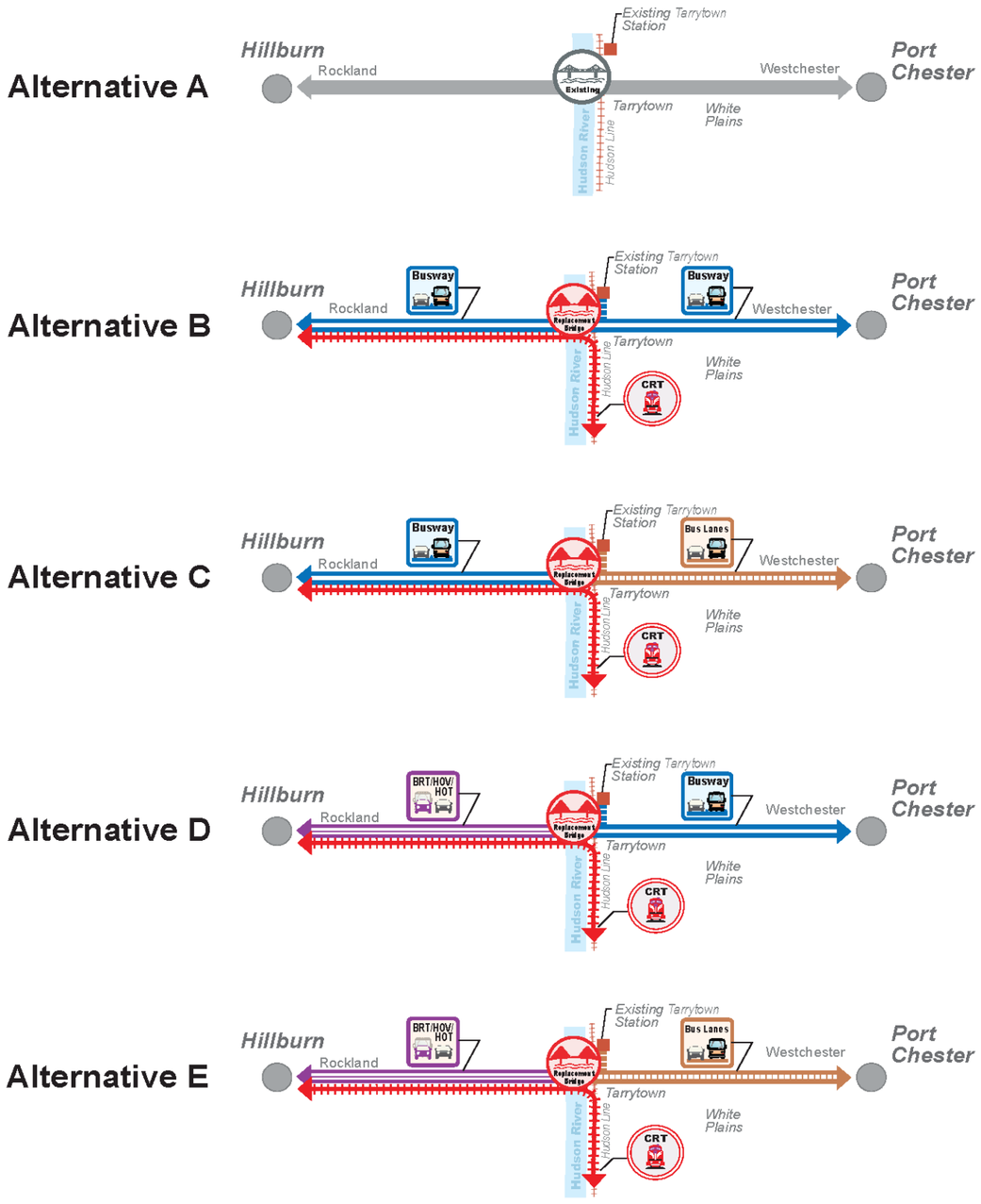

Table S-2 Overview Build Alternatives

COMMUTER RAIL TRANSIT - (All Build Alternatives)

The CRT alignment travels from the Village of Hillburn across Rockland County and over the replacement Tappan Zee Bridge to its connection with the Metro-North Hudson Line in Tarrytown providing direct service to GCT. This route is common to all EIS build alternatives. The CRT alignment options that have been evaluated are listed below:

- **Suffern to Airmont:** CRT in the Piermont Line right-of-way (ROW) or adjacent to Wayne Avenue.
- **Airmont to Monsey:** CRT over or under Airmont Road from the Piermont Line ROW.
- **Monsey to West Nyack:** CRT alignment in the median or on the south side of the Thruway.
- **Clarkstown and Orangetown:** CRT over or under the CSX West Shore Line.
- **Tarrytown**: Tunnel (land side) or trestle (waterside) options for the CRT connection to the Hudson Line.

Suffern to Airmont - CRT in the Piermont Line Right-of-Way or Wayne Avenue

The western terminus of the CRT alignment is at the connection to the Metro-North Port Jervis Line at the proposed Hillburn Station. Two options were evaluated for the approximate 3-mile segment between the Hillburn Station and Airmont Road at Interchange 14B.

- **Piermont Line Right-of Way:** The alignment would begin just north of 4th Street in Hillburn with a two-track connection to the Port Jervis Line. The alignment would head south following the existing Piermont Line diversion from the Port Jervis Line. The CRT would remain in the Piermont ROW and continue east to Airmont Road.

- **Wayne Avenue:** The alignment for the Wayne Avenue Option would also begin just north of 4th Street in Hillburn with a two-track connection to the Port Jervis Line. The alignment deviates from the Piermont Line ROW turning east and placing it north of Wayne Avenue and parallel with the south side of the Thruway. It would then enter the Thruway ROW and continue east to Airmont Road.

The environmental criterion of displacements and acquisitions was the leading factor for recommending the Piermont Line Option to be advanced into the EIS. The Wayne Avenue Option would result in the displacement of a combined total of 70 businesses and dwelling units compared to three displacements for the Piermont Line Option and had no advantages over the Piermont Line Option. There were also two advantages of the Piermont Line Option that reinforced its recommendation: an overall reduced length of high grades and $170 million less in capital costs.

Airmont to Monsey - CRT Over- or Under-Airmont Road

The CRT vertical alignment at Airmont Road could span over Airmont Road or cross under it to provide grade separation at Airmont Road in the 1.6 mile segment from Airmont to Monsey:

- **Over-Airmont Road:** To maintain CRT grade separation at Airmont Road the CRT alignment would pass over Airmont Road on a viaduct. The CRT being elevated over Airmont Road also facilitates the steep climb east to Monsey.

- **Under-Airmont Road:** An alignment option under Airmont Road, which also provides grade separation, was assessed due to the potential visual impacts of the viaduct passing over Airmont Road.

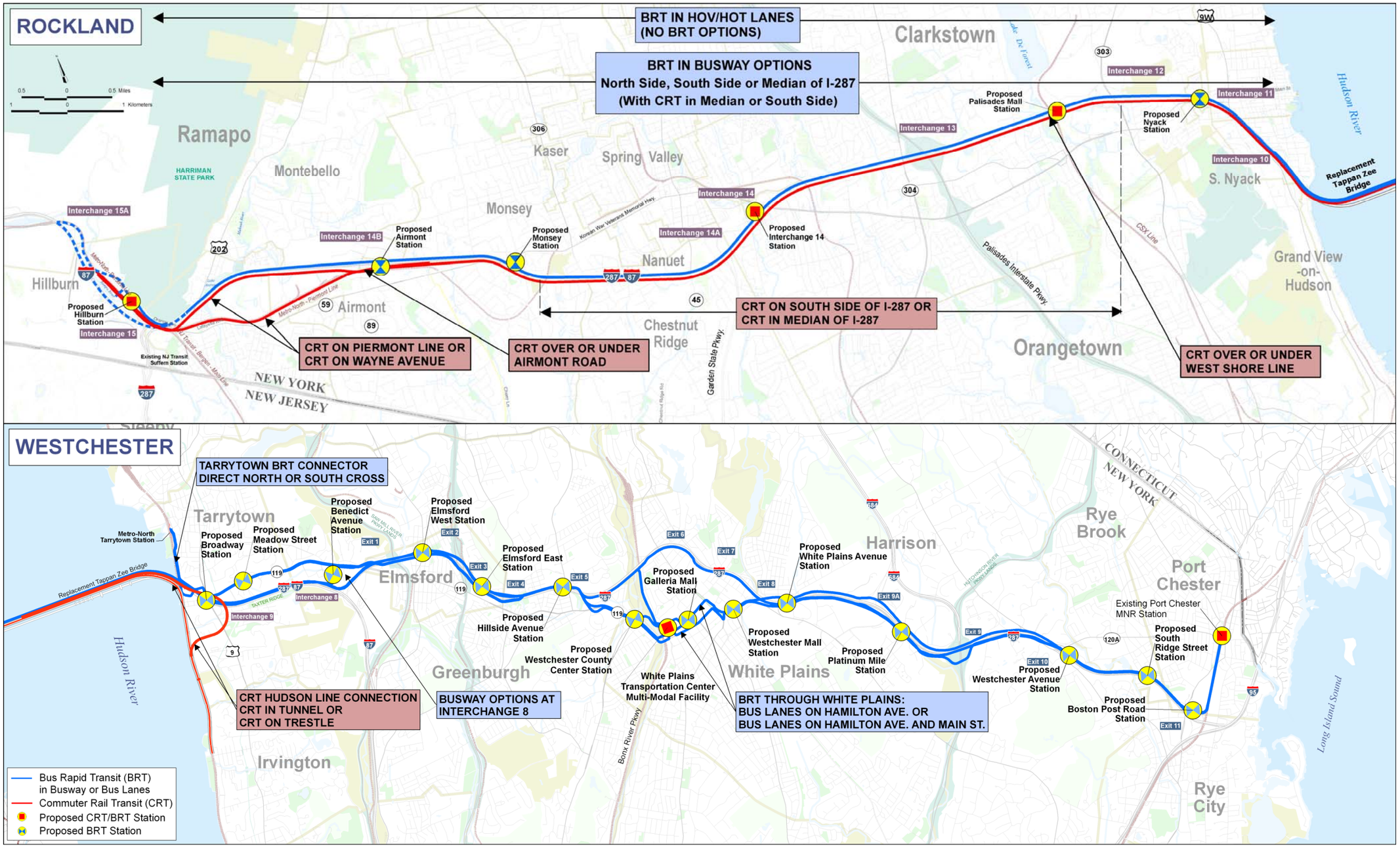

Figure S-3 Transit Alignment Options

The Over-Airmont Road Option is recommended for advancement into the EIS based on the engineering and cost criteria. The CRT alignment in the Under-Airmont Road Option would be below grade from Hemion Road to East Saddle River Road while the Over-Airmont Road Option alignment would be substantially at or near the Thruway grade except for the retained cut crossing under Route 59 in Monsey. Thus, the infrastructure necessary for the Under-Airmont Road Option is substantially more complex and more costly than the Over-Airmont Road Option. The complexity of the Under-Airmont Road Option lengthens its construction duration by 1 to 2 years. The capital cost estimates for the Under- and Over-Airmont Road options would be $2.29 billion and $1.30 billion, respectively, a difference of nearly $1 billion.

Monsey to West Nyack - CRT in the Median or on the South Side of the Thruway

In the Monsey-to-West Nyack area, the CRT alignment is in the median or on the south side of the Thruway. The study area for these options follows the Thruway ROW for a distance of approximately 8 miles from Monsey to Interchange 11 in Nyack. In this same area the BRT would operate either in HOV/HOT lanes, in the Thruway median, or in a busway built in the median, on the north or south sides of the Thruway. The two CRT alignment options are:

- **Median:** The CRT alignment would be constructed within the median of a widened Thruway.
- **South**: The CRT alignment would be built along the south side of the Thruway.

For both options the CRT alignment between the corridor's high point in Monsey and its low point at the Hackensack River Valley would require tunnels, retained cuts and long viaducts because current CRT equipment cannot achieve the steep Thruway grades in this hilly terrain. This segment of the CRT alignment would include two of the three CRT stations in Rockland County: Interchange 14 and Palisades Mall.

The South Option is recommended for advancement into the EIS based on engineering and cost criteria. In general, the South Option has more advantages than the Median Option. The South Option reduces potential interference between CRT and highway operations and maintenance activities during both normal and emergency conditions. It also minimizes construction complexity and duration by 4 to 5 years, facilitates construction from available land with adjacent access, and simplifies construction of the proposed elevated CRT station at the Palisades Mall.

The estimated capital cost of the Median Option ranges from $6.52 billion with a north side busway to $7.36 billion with BRT in HOV/HOT lanes. The estimated capital cost for the South Option ranges from $4.95 billion with a north side busway to $5.23 billion with BRT in HOV/HOT lanes. The cost differential between the CRT Median and the South Option with BRT in HOV/HOT lanes is $2.13 billion. The cost differential between the CRT Median Option and the South Option with a north side busway is $1.57 billion.

Clarkstown and Orangetown - CRT Over/Under West Shore Line

The CRT alignment that would cross the Hackensack River Valley cannot follow the 3-percent highway grade. Therefore, it would need to be on long viaduct that spans over the valley and the West Shore Line (WSL), or the alignment could be at Thruway grade beneath the WSL and continue east and west from this point. Since the vertical alignments of Median and South Options in this area are similar, the focus on the evaluation of the Under- and Over WSL Options is made without specific reference to the CRT Median or South options:

- **Over West Shore Line**: The CRT alignment that crosses the Hackensack River Valley would be on a viaduct (7,600 feet long) that spans over the WSL.

- **Under West Shore Line**: This alignment option was developed to avoid the long viaduct; it would run at Thruway grade beneath the WSL.

The Over-WSL Option is recommended for advancement into the EIS based on engineering, cost, transportation, and environmental criteria. The primary engineering differentiator is the extent of deep retained cuts and long tunnels between Interchanges 14A and 12 required for the Under-WSL Option, versus the use of a long viaduct over the Hackensack River Valley for the Over-WSL Option. While both options are feasible in terms of engineering, there are a number of important negative infrastructure implications for the Under-WSL Option including the need to lower Strawtown Road by up to 15 feet, provide for drainage and flood control particularly in the area around the Hackensack River, and the need to divert a number of existing watercourses that cross beneath the Thruway. The capital cost estimates for the Over- and Under-WSL Options are $2.0 and $2.69 billion (2012$), respectively, a difference of $690 million.

Considering the transportation criteria, the Under-WSL Option would require relocating the proposed Interchange 14 Station to the west of the proposed location. This would create connectivity and access problems at the new location because it would be removed from the existing local bus routes and the proposed feeder buses in the BRT service plan. The proposed location at Interchange 14 in the Over-WSL Option provides superior connectivity and access.

From an environmental perspective, the Over-WSL Option would have visual impacts due to the CRT viaduct. However, the Under-WSL Option provides a poor Interchange 14 CRT station location with respect to potential TOD. It also has the potential for significant impacts to watercourses and floodplains, and would result in direct impacts to the recommended Strawtown Road Historic District, which would experience visual impacts with the over WSL Option.

Tarrytown - CRT Hudson Line Connection

The CRT connection from the replacement Tappan Zee Bridge to Metro-North's Hudson Line occurs in Westchester County in the Village of Tarrytown. There are two alignment options under consideration for the Hudson Line Connection: a waterside option (Trestle) and a landside option (Tunnel).

- **Tunnel**: Several tunnel alignment options were considered and eliminated. The Tunnel Option that was selected for further evaluation was a 40-mph alignment with a six-track junction to the Hudson Line tracks. The Tunnel Option would descend from the bridge and enter into a mined tunnel, which would pass under the intersection of Routes 9 and 119, turn south into a 45-mph curve that would pass west of Broadway and along the eastern edge of the Kraft property. The alignment would then pass through the Requa House property into a reverse curve to enter under the Hudson Line tracks outside of Lyndhurst.

- **Trestle:** Several trestle alignment options were considered and eliminated. The Trestle Option that was selected for further evaluation was a 45-mph south alignment with a six-track junction to the Hudson Line. It would proceed from the south side of the replacement bridge, descending from the main span. The trestle would reach existing track grade in front of New County Park, approximately 600-feet south of Lyndhurst.

The Tunnel Option is recommended for advancement into the EIS for several reasons. There are no significant engineering differentiators between the Tunnel and Trestle Options; however, a possible future extension of the CRT into Westchester would be precluded with the Trestle Option since it would require an interlocking on the replacement Tappan Zee Bridge. This is considered highly undesirable because of the difficulty in maintaining and operating an interlocking on a bridge structure.

With respect to transportation connectivity, the Tunnel Option allows for the future construction of a cross-Westchester CRT system and a possible future Tappan Zee Station, whereas they would be precluded with the Trestle Option because the required interlocking would have to be on the bridge.

There were a number of differentiators with respect to the environmental criteria, some favoring the Tunnel Option and some favoring the Trestle Option. The most significant differentiating criterion is the major new visual element added by the Trestle Option to the scenic Hudson River viewshed, resulting in major visual impacts to Lyndhurst, (a National Historic Landmark), the RiverWalk trail, and waterfront property in the Van Wart/Paulding Avenue neighborhood in Tarrytown.

The capital cost estimate for the tunnel is $1.34 billion and the cost for the trestle is $263 million. There is a difference of approximately $1 billion which has led to the recommendation that tunnel alignments be studied further in the EIS in an effort to reduce the tunnel cost.

ROCKLAND BUS RAPID TRANSIT

BRT in HOV/HOT Lanes

Alternatives D and E include HOV/HOT lanes as the guideway for BRT in Rockland County. The HOV/HOT lanes would be located in the Thruway median with a lane in each direction. The CRT alignment would be built along the south side of the Thruway and independent of the highway.

There are no alignment options for BRT operating in HOV/HOT lanes, as the lanes would only be constructed in the median of the Thruway. Due to the physical constraints in the Suffern area, the HOV/HOT lanes would begin and end east of Interchange 15. Rather than include a westbound lane drop before Interchange 15, the westbound HOV/HOT lane would be extended as a general purpose lane for approximately two-thirds of a mile, where the existing Thruway expands from three to four lanes and then widens to five lanes within Interchange 15.

The HOV/HOT alignment would be built as a widening of the existing highway pavement; therefore, the profile and alignment would be that of the existing Thruway. However, the BRT profile would diverge from the HOV/HOT lanes for access to and from BRT station locations. As a result, the width of the Thruway would expand at the station areas for exclusive BRT ramps (Texas-Ts) to be built to provide access to off-line stations. There are six proposed BRT stations in Rockland County: Hillburn, Airmont Road, Monsey, Interchange 14, Palisades Mall, and Nyack. Hillburn, Interchange 14 & Palisades Mall are also Intermodal Stations with the CRT

BRT in Busway

A dedicated BRT busway with CRT in Rockland County is included in Alternatives B and C as an alternative to BRT in HOV/HOT lanes. The busway alignment extends from the proposed Hillburn Station to the Tappan Zee Bridge, primarily within the Thruway ROW. The busway options would place the BRT stations “in-line” directly along the busway. Unlike the HOV/HOT lane alignment which has no options, a series of busway alignment options was evaluated: north side, median, and south side of the Thruway. The median alignment did not meet fundamental BRT performance, land use, engineering and cost criteria requirements and was eliminated, resulting in the comparison between the north and south side options.

- **North Side:** This option parallels the Thruway alignment along its north side both horizontally and vertically, except at the interchanges where the BRT profile would cross under or over the interchange ramps. The CRT would be constructed independently along the south side. The Busway North Option is noteworthy because there is sufficient area adjacent to the north side of the highway to fit the two-lane busway; therefore no change to the existing Thruway pavement is required.

- **South Side**: This option parallels the Thruway alignment along its south side both horizontally and vertically in a similar manner as the Busway North Option. The CRT alignment would be built adjacent to the busway thus creating a transit corridor along the south side of the Thruway. The busway would be located adjacent to the Thruway because it could be built as an extension of the existing pavement, thus simplifying construction; however with the CRT alignment also on the south side there is insufficient area to fit both modes within the Thruway ROW. As a result the Busway South Option requires the Thruway to be reconstructed and shifted to the north.

The Busway North Option is recommended for advancement into the EIS based on engineering, cost, transportation, and environmental criteria. The main differentiator between the Busway North and South Options is the extent of Thruway modifications required to implement the alignment. For the North Option, no major change to the existing Thruway pavement footprint would be required, whereas the Busway South Option would require the Thruway to be shifted north and reconstructed prior to construction of the busway. Thus, for the Busway North Option construction staging would be simpler resulting in shorter duration. These differences are reflected in the capital cost estimates. The capital cost estimates of the Busway North and Busway South Options that include CRT on the south side are $7.08 billion and $7.54 billion, respectively, a cost difference of $500 million.

The Busway North Option also provides better transportation connectivity because of its more suitable locations for the proposed BRT stations in Rockland County. The key environmental criteria with the Busway North Option is that there would be 18 less displaced residential units and six less displaced businesses compared to the Busway South Option.

WESTCHESTER BUS RAPID TRANSIT

BRT Connector to Tarrytown Station

The Tarrytown BRT Connector provides a direct BRT guideway for both the Bus Lanes and Busway alternatives from the replacement Tappan Zee Bridge to the existing Metro-North Tarrytown Station, a distance of approximately 2/3-mile. The option study area focuses on the Westchester County landing of the Tappan Zee Bridge and the developments to the north and south. The elevation difference between the bridge touchdown and the Hudson Line tracks requires the BRT connector to descend from the bridge on structure with a steep profile. Four alignment options were initially evaluated. Two were eliminated resulting in the final evaluation between:

- **North Direct:** From the north side of the touchdown this alignment option would turn west and pass under the relocated Interchange 9 on-ramp in a deep cut and continue along the north edge of the bridge and be on structure with 7-percent grade as it descends to the east side of the Hudson line.

- **South Cross:** The alignment would be in a tunnel under the toll plaza. It would then be on a structure on the south side of the touchdown area and then turn north and under the Tappan Zee Bridge approach and descend until it reaches grade with the Hudson line.

The South Cross Option is recommended for advancement into the EIS based on engineering and environmental criteria. Both options would be similar in terms of grades and overall profile and each would work with the proposed bridge configuration options. However, the South Cross Option offers a number of advantages from a constructability perspective. Both options would have visual impacts. However, the North Direct Option would have a more notable

impact to residences at Tappan Landing, where the BRT is on structure. The South Cross Option also features a BRT on structure in this segment, but at a lower elevation with less visual impact.

WESTCHESTER BUS LANES

Tarrytown to White Plains

The Bus Lane alignment from the replacement bridge in Westchester County would continue east in dedicated lanes on Route 119 (White Plains Road). At Interchange 8 the alignment would transition into a busway adjacent to the south side of I-287 through Elmsford/Greenburgh. At Exit 5 the alignment would turn south and split into dedicated lanes on Route 119 (Tarrytown Road) as it approaches downtown White Plains. Along this alignment there are seven proposed BRT stations: Broadway, Meadow Street, Benedict Avenue, Elmsford West, Elmsford East, Hillside Avenue and Westchester County Center. There are no bus lane alignment options in this area.

Downtown White Plains

From Route 119 the Bus Lane alternative would use dedicated lanes on Main Street and Hamilton Avenue as entry and exit routes into and out of the White Plains Central Business District. East of its connection to the White Plains Transportation Center (WPTC), there are a number of alignment options to travel the one mile through downtown. After an analysis of all the reasonable routes, the two most effective bus lane alignment options were evaluated in downtown White Plains:

- **Hamilton Avenue**: BRT buses would operate in exclusive lanes in a bi-directional manner.
- **Hamilton Avenue and Main Street**: BRT buses would operate in exclusive lanes, westbound on Hamilton Avenue and eastbound on Main Street.

Bus lanes on Hamilton Avenue are recommended for advancement into the EIS based on transportation criteria. Providing two-way BRT service along Hamilton Avenue would have less impact on downtown White Plains street and intersection operations than the Hamilton Avenue/Main Street route. Three BRT stations are proposed in downtown White Plains: WPTC, Galleria Mall and Westchester Mall. The BRT bus routing through downtown White Plains and final station locations will be subject to further study in the Tier 2 transit analysis for this project.

East of White Plains

East of downtown White Plains the bus lanes would be split on Westchester Avenue and run in the direction of travel. Just west of Exit 10 the bus lanes would be combined on the north side of I-287 and continue as a busway to just north of the I-95 interchange. East of this station, the alignment would turn north along the west side of the New Haven Line ROW to access the eastern BRT terminus at the existing Metro-North Port Chester Station. There are six proposed BRT stations along this alignment: White Plains Avenue, Platinum Mile, Westchester Avenue, South Ridge Street, Boston Post Road and Port Chester. There are no bus lane alignment options in this area.

WESTCHESTER BUSWAY

Tarrytown to Interchange 8

The Busway alignment off the replacement bridge would connect directly to the Tarrytown Connector and the proposed Broadway Station. East of the station the alignment would pass under South Broadway and continue in an exclusive busway adjacent to the north side of I-287. At Interchange 8 the alignment had two options.

Busway Options at Interchange 8

Two alignment options were evaluated in the vicinity of Interchange 8:

- **Benedict Avenue:** Before reaching Interchange 8 this option would turn north out of the I-287 ROW, transition to grade and continue into the office park area and meet Route 119. The proposed Benedict Avenue BRT Station would be located in the office park area and within walking distance to the local Bee-Line services on Route 119.
- **I-287 ROW:** This option would maintain the alignment along the north side of Interchange 8 at grade, with the proposed station located on the alignment at the rear of the commercial properties abutting the interchange.

The Benedict Avenue Option is recommended for advancement into the EIS based on transportation and environmental criteria. The Benedict Avenue Option would provide better overall accessibility to the office parks and better station visibility compared to the I-287 Option. It would also provide better access for transfers to Bee-Line buses running along Route 119. While both options would require takings and/or easements for the alignment and station, the Benedict Avenue Option has flexibility as to how the alignment would travel north to Route 119 for a best fit within the office parks and the optimal station location.

Interchange 8 to White Plains

East of the Benedict Avenue Station the busway would continue east on Route 119 for a short distance then transition to an exclusive busway and follow the north side of I-287 through Elmsford/Greenburgh. After Exit 5 the alignment would turn south onto Route 119 and approach downtown White Plains. From the replacement Tappan Zee Bridge to White Plains there are six proposed BRT stations in the Busway Alternative service plan: Broadway, Benedict Avenue, Elmsford West, Elmsford East, Hillside Avenue and Westchester County Center. There are no bus lane alignment options in this area.

Downtown White Plains

There are two possible access routes into downtown White Plains from the west. The Bus Lane alternative uses dedicated lanes on Route 119 and then the Main Street and Hamilton Avenue bridges to enter downtown. In the Busway alternative the dedicated lanes on Route 119 would turn east at the Westchester County Center and cross the Bronx River Parkway (and the environmentally sensitive Bronx River Parkway Reservation), and approach the Metro-North Harlem Line embankment. A new underpass beneath the Harlem Line tracks would bring the BRT to the station at the White Plains Transportation Center (WPTC).

Previous concepts for the busway alignment considered continuing the busway viaduct along the I-287 ROW east of Exit 5 and utilizing the ROW of the Harlem Line to approach the White Plains central business district from the west and north. This concept was removed from further consideration because of ROW and environmental impacts.

Previous concepts for the busway alignment also considered a dedicated busway on I-287 that would bypass downtown White Plain. This concept was eliminated because of the significant ROW impacts and the low projected use of this alignment by the proposed BRT services. Instead, new entry and exit ramps from the busway to I-287 for both BRT alternatives would be provided to allow buses to bypass White Plains in mixed traffic.

As in the Bus Lane alternative, bi-directional exclusive bus lanes on Hamilton Avenue through downtown White Plains are recommended for advancement into the EIS for the Busway alternative. The BRT stations in downtown White Plains would also be those proposed for the Bus Lane alternative.

East of White Plains

East of downtown White Plains the busway alignment would enter the I-287 ROW between the eastbound I-287 travel lanes and Westchester Avenue on a separate guideway. The alignment would mostly be on a viaduct to clear the bridges over I-287. Just before Exit 10 the busway would cross over I-287 to reach the north side of I-287 and would continue along this alignment in the same manner as the Bus Lane alternative until it reaches the eastern BRT terminus at the Metro-North Port Chester Station. Proposed BRT stations would be located at White Plains Avenue, Platinum Mile, Westchester Avenue, Ridge Street, Boston Post Road and Port Chester. There are no busway alignment options in this area.

EIS ALTERNATIVES

The five EIS alternatives are as follows:

- **Alternative A –** No Build
- **Alternative B –** Full-Corridor Busway and Rockland CRT
- **Alternative C –** Busway in Rockland, Bus Lanes in Westchester, and Rockland CRT
- **Alternative D –** HOV/HOT Lanes in Rockland, Busway in Westchester, and Rockland CRT
- **Alternative E –** HOV/HOT Lanes in Rockland, Bus Lanes in Westchester, and Rockland CRT

Each of the four build alternatives would contain common elements, which include a replacement Tappan Zee Bridge, highway improvements, and CRT in Rockland County. Based on the evaluations and recommendations included in this report the transit alignments for each of the build alternatives are fully defined. Table S-1 lists the recommended transit alignment options for the CRT and BRT for Alternatives B, C D and E.

Table S-1

Transit Alignment Options Recommended for the Build Alternatives

Recommended Option	Alternative			
	B	C	D	E
Commuter Rail Transit				
CRT in the Piermont Line ROW	✓	✓	✓	✓
CRT over Airmont Road	✓	✓	✓	✓
CRT on the south side of the Thruway	✓	✓	✓	✓
CRT over the West Shore Line	✓	✓	✓	✓
CRT Hudson Line Connection in a tunnel	✓	✓	✓	✓
Bus Rapid Transit				
BRT Busway on north side of Thruway	✓	✓		
BRT South Cross Connection to Tarrytown Station	✓	✓	✓	✓
BRT bi-directional bus lanes on Hamilton Avenue	✓	✓	✓	✓
BRT Benedict Avenue busway alignment at Interchange 8	✓		✓	


environment

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List of Acronyms and Abbreviations

AA	Alternatives Analysis
AASHTO	American Association of State Highway and Transportation Officials
ACHP	Advisory Council on Historic Preservation
AGT	Automated Guideway Transit
APE	Area of Potential Effect
APTA	American Public Transportation Association
ARC	Access to the Region's Core
AREMA	American Railway Engineering and Maintenance-of-Way Association
AVL	Automated Vehicle Locator
BPM	Best Practice Model
BRT	Bus Rapid Transit
BTU	British Thermal Unit
CBD	Central Business District
CCTV	Closed-Circuit Television
CO	Carbon Monoxide
CO_2	Carbon Dioxide
ConnDOT	Connecticut Department of Transportation
CRT	Commuter Rail Transit
CSI	Construction Specifications Institute
DEIS	Draft Environmental Impact Statement
DMU	Diesel Multiple Unit
EIS	Environmental Impact Statement
EMU	Electric Multiple Unit
FHWA	Federal Highway Administration
FRA	Federal Rail Administration
FTA	Federal Transit Administration
GCT	Grand Central Terminal
GIS	Geographic Information System
GPS	Global Positioning System
GSP	Garden State Parkway
HAJ	Household Auto-Journey
HOT	High-Occupancy Toll
HOV	High-Occupancy Vehicle
HOV+3	High-Occupancy Vehicle-3
ITS	Intelligent Transportation System
LRT	Light Rail Transit
MDSC	Mode Destination Stops Choice
MPO	Metropolitan Planning Organization
MTA	Metropolitan Transportation Authority
µm	micrometer
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NJT	New Jersey Transit
NO_x	Nitrogen Oxides
NOI	Notice of Intent
NRE	National Register Eligible
NRL	National Register Listed
NYC	New York City
NYMTC	New York Metropolitan Transportation Council
NYCT	New York City Transit
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
NYSHPO	New York State Historic Preservation Office
NYSM	New York State Museum
NYSTA	New York State Thruway Authority
O_3	Ozone
PAP	Pre-Assignment Processor
Pb	Lead
PM	Particulate Matter
PM_{10}	Particulate Matter with Diameters up to 10 µm
$PM_{2.5}$	Particulate Matter with Diameters up to 2.5 µm
ROD	Record of Decision
ROI	Return on Investment
ROW	Right of Way
RRT	Rail Rapid Transit
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SAWG	Stakeholder Advisory Working Group
SEQRA	New York State Environmental Quality Review Act
SHPA	State Historic Preservation Act
SHPO	State Historic Preservation Office
SO_2	Sulfur Dioxide
SOV	Single-Occupant Vehicle
TAOR	Transit Alignment Options Report
TDM/TSM	Transportation Demand Management/Transportation Systems Management
TIP	Transportation Improvement Program
TMSR	Transit Mode Selection Report
TOD	Transit-Oriented Development
TOR	Transport of Rockland
USEPA	US Environmental Protection Agency
VMT	Vehicle Miles Traveled
WPTC	White Plains Transportation Center

1 Introduction

The Project Sponsors – the New York State Department of Transportation (NYSDOT), the New York State Thruway Authority (NYSTA), and Metro-North Railroad (an agency of the Metropolitan Transportation Authority [MTA]) – in cooperation with the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) as co-lead agencies, are preparing an Environmental Impact Statement (EIS) for the Tappan Zee Bridge/I-287 Corridor Project in Rockland and Westchester Counties, New York (NY).

One of the key steps in preparation of the EIS is the development and refinement of alternatives. As this project has transit, bridge, and highway elements, the process of defining the alternatives is documented in a number of studies by the Project Sponsors:

- *Transit Alignment Options Report* (TAOR) (this report).
- *Highway Improvements Report* (presents the evaluation of potential highway options such as climbing lanes).
- *Bridge Options Development Report* (presents the evaluation of single-level and dual-level bridge designs).

This process is presented on Figure 1-1, which shows the parallel development of the studies leading to the development of the EIS alternatives. Early in the process, project scoping provided a forum for the public to provide comments and feedback on the Project Purpose and Need, potential alternatives, and environmental analysis being considered in the EIS. Scoping was closed in Spring 2009.

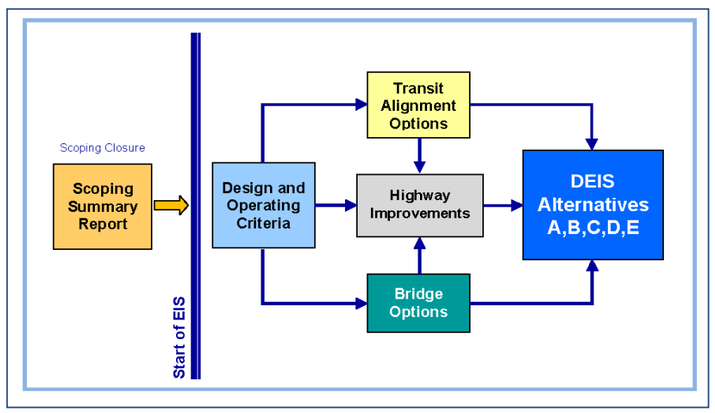


Figure 1-1 Alternatives Development Roadmap

1.1 Project Purpose and Need

As articulated during scoping, the Purpose and Need for the Tappan Zee Bridge/I-287 Corridor Project builds on the problems and deficiencies in the corridor, and more accurately states the basis for identifying and selecting solutions to effectively and efficiently address those needs, while respecting the natural and human environment.

Several transportation improvements, including improved mobility, transit options, and safety, are needed to meet the growing travel demands of the corridor. Travelers in the corridor experience significant delays due to congestion, as corridor facilities often operate near capacity, particularly in the vicinity of the Tappan Zee Bridge. Rockland County is one of the fastest-growing communities in the Metropolitan Region, and Westchester County is experiencing employment growth in areas around White Plains and the Platinum Mile. The Tappan Zee Bridge and the corridor provide an important link between these communities and to the overall regional transportation network. In addition to the capacity constraints of the corridor, the Tappan Zee Bridge is aging and in need of a regular and extensive maintenance program. As the region grows, travel demand will increase on this already-strained roadway network.

Based on these considerations, the Project Purpose and Need is to:

- Preserve the river crossing as a vital link in the regional and national transportation network.
- Provide a river crossing that has structural integrity, meets current design criteria and standards, and accommodates transit.
- Improve highway safety, mobility, and capacity throughout the corridor.
- Improve transit mobility and capacity throughout the corridor and travel connections to the existing north-south and east-west transit network.

Project goals and objectives were also developed to indicate how the project will address the Purpose and Need. Objectives are used to measure progress in the attainment of goals. Project alternatives developed to respond to the Purpose and Need are evaluated by how well they meet the goals (e.g., Improve Mobility) by determining their likely performance against various objectives (e.g., reduce traffic congestion, improve travel times, etc.). All levels of evaluation conducted throughout the development of the EIS will be consistent with the Purpose and Need and the project's goals and objectives.

1.2 Purpose of this Report

This report evaluates and screens a group of reasonable transit alignment options to define the build alternatives that will be further analyzed in the EIS. The options are evaluated and screened using a set of criteria consistent with the Purpose and Need and goals and objectives of the project. As such, the analysis reflects a balanced consideration of engineering design, cost, optimized transit performance, and minimized environmental impacts. Based on this analysis, the transit alignment options with the fewest impacts that best support the Purpose and Need of the project are recommended to be carried forward in the EIS as transit elements of the build alternatives, while those options with comparatively greater impacts are recommended to be screened from further consideration in the EIS.

The study area for this report consists of a linear 30-mile corridor that extends from the I-87/I-287 Interchange in Rockland County to the I-287/I-95 Interchange in Westchester County and includes the Tappan Zee Bridge (Figure S-2). It is consistent with the study area presented in the *Scoping Report* and the *Transit Mode Selection Report*. The corridor is an important part of a regional transportation system, and transportation implications extend beyond the immediate roadway system to Poughkeepsie in Dutchess County to the north, Stamford, Connecticut to the east, the five New York City boroughs to the south, and parts of Orange County, New York, and Bergen County, New Jersey to the west.

Following completion of the analysis and screening process documented in this report, the Highway Improvement Report and Bridge Technical Papers, the EIS will be developed in accordance with the Revised Notice of Intent (issued February 14, 2008) using a tiered process to facilitate decision-making. The scope of analysis in each tier – Tier 2 highway and bridge and Tier 1 transit – will be appropriate to the level of detail necessary to make informed decisions regarding the alternatives, and will incorporate input received from the public and reviewing agencies. The tiering approach allows an assessment of site specific impacts, costs, and mitigation measures in a Tier 2 highway and bridge analysis, while simultaneously considering broad overall corridor issues in a Tier 1 transit analysis of general alignment and logical termini of the proposed modes. The intent of the Project Sponsors and FHWA and FTA is for the Tier 2 highway and bridge and Tier 1 transit analyses to be developed concurrently in order to maximize multimodal solutions.

A future Tier 2 transit environmental process will build upon the Tier 1 transit analysis and the Tier 2 bridge and highway analysis. During the future Tier 2 transit environmental analysis, the work completed during the Tier 1 transit analysis will be further refined and decisions advanced based upon more detailed engineering design. The Tier 2 transit analysis will focus in greater detail on specific elements of the transit system such as station locations and site plans, vehicle types, and storage facilities with respect to site specific impacts and mitigation measures.

1.3 Environmental Impact Statement Alternatives

Based on the results of the *Transit Mode Selection Report* (May 2009) (TMSR) and the *Alternatives Analysis for Rehabilitation and Replacement of the Tappan Zee Bridge Report* (March 2009), the No Build Alternative (Alternative A) and four build alternatives (Alternatives B through E) will be carried forward into the draft EIS (DEIS). More detailed analysis and public outreach conducted during the EIS development will be considered and lead to recommendation of a preferred alternative.

The EIS build alternatives include several common elements, namely, a replacement bridge that will accommodate transit, highway improvements in Rockland County (e.g., climbing lanes), and CRT from Suffern to Tarrytown with a direct connection to the Metro-North Hudson Line for service to Grand Central Terminal. While full-corridor BRT is a common element of all build alternatives, the alternatives do differ in the type of BRT guideway that would be implemented. Two different BRT guideways are under study for each county:

- **Exclusive busway** – a barrier-separated system only accessible to buses. Exclusive busways are being evaluated for both Rockland and Westchester Counties (Photo 1-1).
- **Exclusive bus lane** – a dedicated lane for buses only on a local arterial with no physical barrier separation. Exclusive bus lanes are being evaluated in Westchester County (Photo 1-2).
- **Shared-use lanes** – buses operate in lanes shared with other vehicles. For this project BRT would operate in the high occupancy vehicle/high occupancy toll (HOV/HOT) lanes in the Thruway median that are being evaluated in Rockland County (Photo 1-3).

The five DEIS alternatives are as follows (Table 1-1):

- **Alternative A – No Build –** A No Build Alternative will be analyzed in the EIS consistent with National Environmental Policy Act (NEPA) requirements. The key components of the No Build Alternative are continuous maintenance of the bridge structure and highway to avoid unacceptable levels of deterioration that would lead to operational and safety deficiencies. The No Build Alternative also incorporates the proposed projects listed in the latest Transportation Improvement Program (TIP). The 2008-2012 TIP was adopted by the New York Metropolitan Transportation Council (NYMTC) on October 29, 2007 and approved by the federal agencies December 10, 2007. This 5-year program runs from October 1, 2007 through September 30, 2012. The TIP includes those projects contained within the fiscally constrained portion of the Long Range Transportation Plan (LRTP) for the region.
- **Alternative B – Full-Corridor Busway and Rockland CRT** – Alternative B would provide BRT service between Suffern and Port Chester in a busway, and CRT service in Rockland County.
- **Alternative C – Busway/Bus Lanes and Rockland CRT** – Alternative C would provide BRT service between Suffern and Port Chester via a BRT busway in Rockland County and BRT bus lanes in Westchester County, as well as provide CRT service in Rockland County.

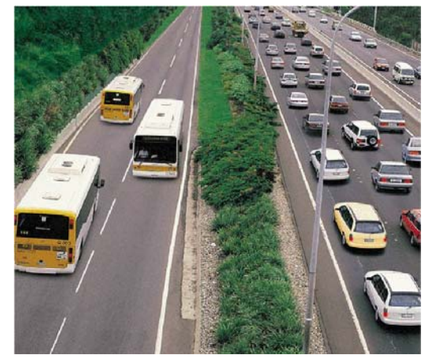


Photo 1-1 Exclusive Busway

Photo 1-2 Exclusive Bus Lane

Photo 1-3 Shared-Use Lanes (HOV/HOT)

- **Alternative D – HOV/HOT/Busway and Rockland CRT** – Alternative D would provide BRT service between Suffern and Port Chester, via BRT in HOV/HOT lanes in Rockland County and BRT in a busway in Westchester County, as well as provide CRT service in Rockland County.
- **Alternative E – HOV/HOT/Bus Lanes and Rockland CRT** – Alternative E would provide BRT service between Suffern and Port Chester via BRT in HOV/HOT lanes in Rockland County and BRT in bus lanes in Westchester County, as well as provide CRT service in Rockland County.

Table 1-1

Key Elements of the Build Alternatives

Alternative	BRT in Rockland County		BRT in Westchester County		CRT in Rockland County*	Replacement Bridge	Highway Improvements in Rockland County
	Busway	HOV/ HOT Lanes	Busway	Bus Lanes			
B	✓		✓		✓	✓	✓
C	✓			✓	✓	✓	✓
D		✓	✓		✓	✓	✓
E		✓		✓	✓	✓	✓
Note*: CRT also includes a short section in Westchester County connecting to the Metro-North Hudson Line.							

1.4 Transit Alignment Options

The transit modes and logical termini that were developed in the TMSR are consistent with those presented in this report. However, many of the alternatives in the TMSR had transit alignment options that needed further study. The options that are evaluated further in this report include (Figure 1-2):

- CRT in the Piermont Line right-of-way (ROW), or on Wayne Avenue (south side of the Thruway), from Suffern to Airmont Road).
- CRT Piermont Line over or under Airmont Road.
- CRT in the median or on the south side of the Thruway, (from Monsey to just east of the Palisades Mall).
- CRT over or under the West Shore Line.
- CRT Hudson Line connection in a tunnel or on a trestle.
- BRT busway in the Thruway median, north, or south sides.
- BRT connection to the existing Tarrytown Station (direct north or south cross).
- BRT bus routes in White Plains (Hamilton Avenue and Hamilton Avenue/Main Street).
- BRT busway options at I-287 Interchange 8.

1.4.1 Evaluation Criteria

The evaluation of these options considered the engineering, cost, transportation, and environmental criteria presented in Table 1-2, with a focus on major differentiators and criteria are not weighted. These are the general evaluation criteria that were outlined in the project scoping update documents. Construction impacts, as well as indirect and cumulative impacts, were considered but were determined not to be differentiators. Thus, for the most part the analysis focused on direct impacts. Direct, indirect, cumulative, and construction impacts will be addressed in detail in the EIS. Similarly, relative costs for operations and maintenance of modes and costs of property acquisition were not considered differentiators in the option evaluations, and therefore not included in the capital cost estimates. However, the number of property acquisitions has been considered.

The evaluation process for both BRT and CRT alignment options considered transit system connectivity and integration. The evaluation also included a discussion of each alignment option's impact on the existing highway configuration. The result of this process is that the transit elements of the alternatives to be analyzed in the EIS are fully defined with respect to mode, alignment, and logical termini.

Table 1-2

Transit Alignment Option Evaluation Criteria

Evaluation Criteria		Description
Engineering	Engineering Design	Horizontal alignment, vertical alignment, clearances, connection to existing system.
	Operations & Maintenance	Operations and maintenance, including impacts to existing infrastructure, redundancy, and safety.
	Constructability	Construction activities, schedule. Duration and construction risk.
Cost	Capital Costs (2012 $)	Material, labor, and equipment costs (including location, market escalation, etc.) and markups for (1) design and construction contingencies, (2) contractors general conditions, insurance, overhead, and profit), and (3) soft costs such as design, permitting, and agency staff.
Transportation	Travel Time	Travel time in minutes.
	Traffic Network Changes	Permanent impacts to road networks, road closures and/or realignments required.
	Transportation System Integration	Ease of connections/transfers between local bus services and new systems; ease of intermodal connections/transfers; ease of feeder-bus access to new BRT system.
Environmental	Land Use / Potential for Transit-Oriented Development (TOD)	Direct impacts related to consistency with land use and TOD potential at stations assessed.
	Displacements and Acquisitions	Direct impacts measured in number of structures displaced or acquired. (Permanent subsurface easements are not considered because they were not expected to be differentiators between options.)
	Wetlands	Direct impacts measured in acres.
	Aquifers and Floodplains	Impacts to aquifers and floodplains.
	Parklands	Direct impacts measured in acres.
	Historic and Archaeological Resources	Direct impacts to historic and archeological resources.
	Hudson River Ecosystems	Direct impacts measured in acres.
	Noise	Direct impacts based on likely perceptible changes in noise levels.
	Visual	Impacts to visual resources.

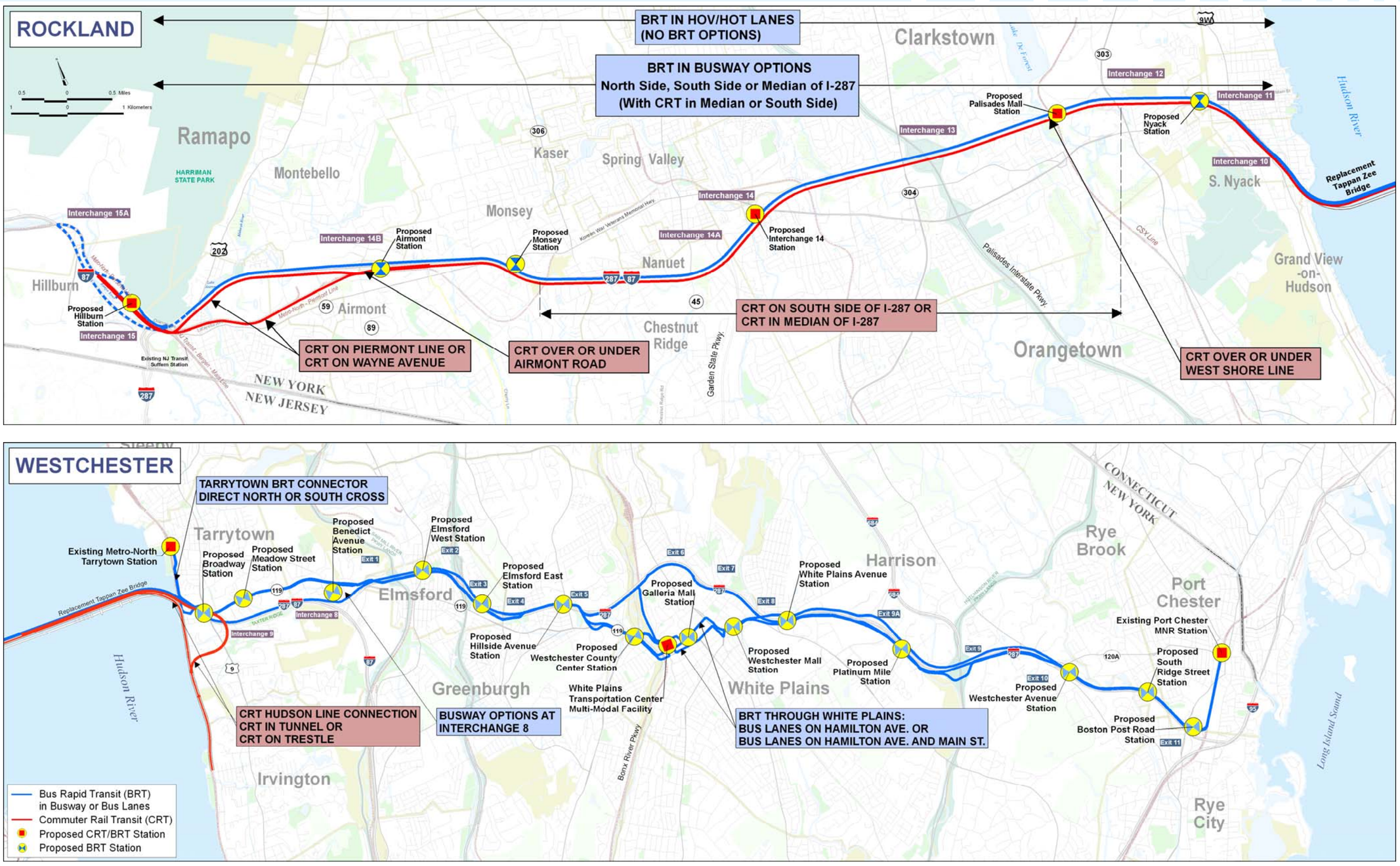


Figure 1-2 Transit Alignment Options

1.5 Transit Systems

1.5.1 Bus Rapid Transit

The key elements of a BRT system include a service plan, guideways, vehicles, stations, branding, and the use of intelligent transportation system (ITS) technologies to create an integrated system. This information is presented in detail in the TMSR.

A central objective of the BRT concept is to eliminate or reduce transfers and provide direct service to key destinations. Traditional bus service planning focuses on efficient routing that can lead to adverse effects, such as long travel times, long distances to access service, extensive transfers, and lack of coordination between bus route planning and land use planning. BRT is intended to address these shortcomings. For example, local or feeder routes are given access to the BRT guideway, eliminating the need to transfer. Development of BRT stations is coordinated with surrounding development. Multi-modal stations provide convenient locations to transfer between modes and routes and can be integrated into major development projects, such as business parks and shopping centers, enhancing the potential for transit oriented development (TOD).

BRT routes typically operate along a main trunk line. Stations are similar to rail stations, with level boarding from the platform, and rapid boarding systems, such as multiple doors. BRT also utilizes ITS technology, transit-signal priority, convenient and rapid fare collection, and close integration with land use to enhance the bus system's performance.

BRT systems feature:

- Simple and understandable route layouts.
- Convenient transfers.
- Branded service to help distinguish it from local bus service.
- Station locations coordinated with land use plans.
- Service to major activity centers.
- Frequent trunk line service.
- Feeder buses routed onto the BRT guideway.

BRT systems can operate on different types of guideways as described earlier. Typical BRT guideway cross-sections are shown on Figure 1-3.

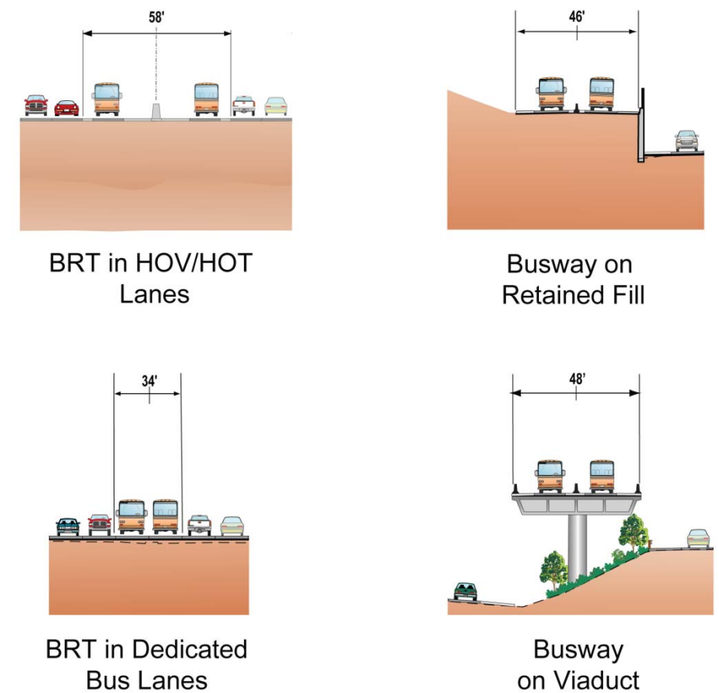


Figure 1-3 Typical BRT Cross-Sections

1.5.2 Commuter Rail Transit

The key elements of a CRT system include a service plan, guideways, vehicles, stations, and the use of intelligent transportation system (ITS) technologies to create an integrated system. This information is presented in detail in the TMSR.

CRT systems operate as integrated services, with central controls that monitor system operations. Because CRT systems operate in exclusive guideways, they are able to operate at high speeds, with longer trains that allow higher passenger capacities than other transit services. CRT systems are primarily designed for longer-distance trips than other transit modes and have fewer stations. Commuter services often have both local and express services. Typical peak-hour CRT headways of 30 minutes are common, although some lines operate on headways as short as 15 minutes. Where CRT systems have tight headways, it is not uncommon for a varied station stop pattern (zone service), whereby not all trains stop at each station.

CRT systems feature:

- Long station spacing (typically over 2 miles).
- Guideways largely limited to exclusive ROWs.
- Long trains (four to 10 cars).
- High top speeds (90 mph or more).

- Convenient transfers.
- Station locations coordinated with land use plans.
- On-board fare collection (although other methods are currently being utilized or evaluated).
- High passenger capacity.
- Signal system.

CRT alignments are preferably constructed at the existing surface grades. Where a surface alignment is not possible, the guideway may need to be placed below grade in a cut section or on an elevated structure. CRT systems are typically designed to avoid gradients in excess of 1.5 percent in general and 2 percent for short sections. Since this is not always possible without raising or lowering the guideway relative to the natural grade of a potential alignment, this requirement results in the need for retained cuts and fills, viaducts and tunnels. Each of these options requires more space than an at-grade guideway, and each costs substantially more to construct and maintain than an at-grade guideway. Figure 1-4 shows typical guideway cross-sections for CRT.

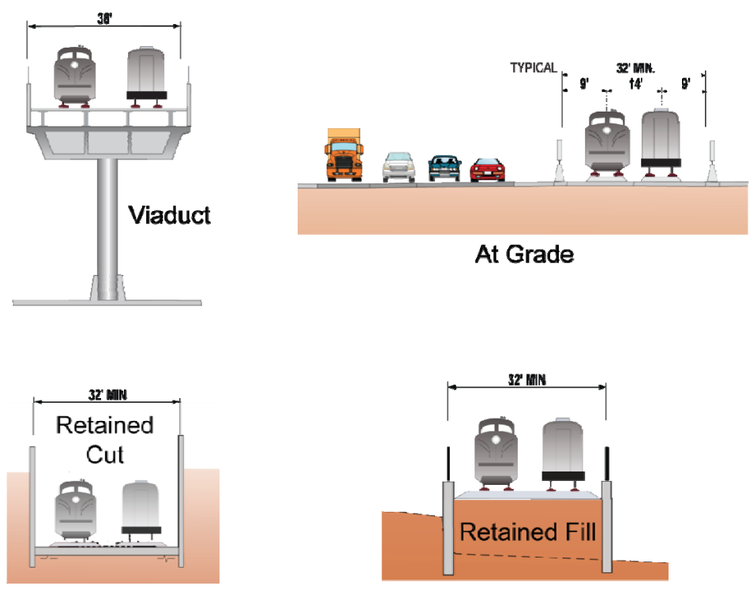


Figure 1-4 Typical CRT Cross-Sections

While options are available to overcome vertical alignment constraints, there are limited solutions to horizontal alignment constraints. Horizontal curves are desired on flat terrain. Walls and fill may be required to provide adequate length to accommodate the gentle curves needed for commuter rail systems. A consequence of tight curves is that it may cause decreased train speed and wheel squeal, both undesirable qualities. Tight curves also increase maintenance costs due to increased rail wear, which increases maintenance costs. Track can be superelevated (i.e., elevated or banked on curves to allow trains to operate on curves at higher speeds) to alleviate some of the impact of curves on speed and passenger comfort, but this introduces additional maintenance costs.

1.6 Service Plans

Proposed BRT and CRT service plans have been developed for the project (Appendix A). As part of the TMSR, coordination was performed with the bus operators in both Rockland and Westchester counties to establish the seventeen proposed bus routes included. The service plans include routes, frequencies, fares, stop locations, and termini. The service plans are conceptual for transportation system modeling and EIS analysis and will be further refined for Tier 2 transit. All proposed transit services will be fully integrated with local transit services and bus feeder routes to optimize ridership and mobility. The proposed BRT and CRT stations identified in the service plans are listed in Table 1-3.

Table 1-3

Proposed CRT and BRT Stations

CRT Stations in Rockland County	BRT Stations in Rockland County	BRT Stations in Westchester County	
Hillburn	Hillburn	Broadway	Galleria Mall
	Airmont	Meadow Street*	Westchester Mall
	Monsey	Benedict Avenue	White Plains Avenue
Interchange 14	Interchange 14	Elmsford West	Platinum Mile
Palisades Mall	Palisades Mall	Elmsford East	Westchester Avenue
	Nyack	Hillside Avenue	South Ridge Street
		Westchester County Center	Boston Post Road
		White Plains Transportation Center	Port Chester

* Meadow Street BRT Station is not included in Westchester County busway alternatives.

1.6.1 Bus Rapid Transit

There are a total of 17 proposed bus routes in the proposed BRT service plan (Appendix A). Only one BRT bus route (T) would operate along the entire length of the BRT trunk line in the I-287 corridor. Although Route B also operates along the entire corridor, it would not stop at the proposed BRT stations in White Plains. The other BRT feeder routes operate along various segments of the BRT trunk line, but travel off the trunk line to provide collection/distribution functions in designated areas. This feature of the BRT service plan allows the opportunity to provide a direct "one-seat ride" between a greater number of locations.

Certain proposed BRT bus routes would replace and enhance existing bus services:

- Route A would replace the current Orange-Westchester Link (OWL) bus service.
- Routes C and E would replace existing Tappan Zee Express services operated by Transit of Rockland (TOR).
- Routes L, M, N and O would replace Bee-Line Routes 11, 62, 21 and 77, respectively.
- Route P would replace the I-Bus service operated by Connecticut Transit (CT Transit).

1.6.2 Commuter Rail Transit

The proposed CRT service plan (Appendix A) has three new services in the I-287 Corridor:

- **Hillburn to Grand Central Terminal** - Line G would provide service between the proposed Hillburn Station and Grand Central Terminal via the Hudson Line. This service would utilize electric multiple-unit trainsets

and would stop at both the proposed Interchange 14 and Palisades Mall Stations. The service would operate every 15 minutes during the peak hour in the peak direction. Hourly service would be provided during the off-peak periods as well as in the off-peak direction during the peak periods.

- **Harriman to Grand Central Terminal –** Line F would operate between Harriman on the Port Jervis Line and Grand Central Terminal. These trains would also serve the Tuxedo and Sloatsburg Stations on the Port Jervis Line as well as the proposed Hillburn Station; however, east of Hillburn these trains would operate as an express service along the new CRT alignment and would not stop at the proposed Interchange 14 and Palisades Mall Stations. This service would not utilize electric multiple-unit trainsets, as the third rail electrification system would not extend to areas north of the proposed Hillburn Station. Instead, Metro-North would utilize dual mode locomotives that provide motive power for trains comprised of coaches that are not electric multiple-unit cars.

  These dual mode locomotives can utilize the third rail and operate as electric locomotives for travel between Hillburn and Grand Central Terminal, and then operate as diesel-powered locomotives to provide service between Harriman and Hillburn. The Harriman to Grand Central Terminal service is proposed to operate every 15 minutes during the peak hour in the peak direction. Service would be provided during the off-peak periods as well as in the off-peak direction during the peak periods.

- **Port Jervis to Grand Central Terminal -** Line E would operate between Port Jervis and Grand Central Terminal. During the peak periods and in the peak direction of travel these trains would serve the Otisville, Middletown, Campbell Hall, Salisbury Mills, and Harriman Stations on the Port Jervis Line; however, south of Harriman these trains would operate as an express service along the new CRT alignment. Therefore, they would not stop at the existing Tuxedo and Sloatsburg Stations or at the proposed Hillburn, Interchange 14, and Palisades Mall Stations.

  During the off-peak periods – as well as in the off-peak direction during the peak periods – these trains would stop at the existing Tuxedo and Sloatsburg Stations, and at the proposed Hillburn, Interchange 14, and Palisades Mall Stations. Similar to the Line F service, this service would not be able to utilize electric multiple-unit trainsets, and would utilize "dual mode" locomotives. The Port Jervis to Grand Central Terminal service would operate every 30 minutes during the peak hour in the peak direction Hourly service would be provided during the off-peak periods as well as in the off-peak direction during the peak periods.

1.7 Design Criteria

The design criteria for the proposed BRT and CRT systems are presented in Appendix A and have been used in the development of the BRT and CRT alignment options:

- BRT geometric design criteria are provided for the three proposed alignments that will be developed in the EIS (Appendix A): BRT in HOV/HOT lanes in the Thruway median; busways outside the I-87/I-287 ROW; and bus lanes on existing arterials. Many of the design criteria correspond to the requirements cited in Chapters 2, 5, and 24 of NYSDOT Highway Design Manual (HDM) and other sources referenced. These criteria will serve as the governing standards by which the geometric characteristics of the BRT alignments developed for the EIS alternatives will be assessed.

- CRT guideways are confined to exclusive ROWs primarily for safety and to permit higher operating speeds. The desirable space to accommodate a set of two commuter rail tracks at-grade is dependent upon track spacing and horizontal clearance from track centers. Greater width would be required at stations where platforms require additional width. Geometric design criteria to be used in the EIS for evaluation of new commuter rail lines are included in Appendix A.

Any design element falling short of its minimum or exceeding its maximum criterion will be categorized as non-standard, and a formal justification would be prepared and approved before it can be integrated into the corridor.

1.8 Stakeholder Coordination

The Project Sponsors are committed to maintaining an open and transparent public and agency coordination program throughout the environmental review process. A comprehensive public participation process has been carried out throughout the study and has included briefings, meetings, an up-to-date project Web site, and community outreach centers in Tarrytown and Nyack where the public may drop in to speak to project staff members, see maps and displays, and review materials. Public involvement activities have been conducted under the guidance of and with the participation of the FHWA and FTA.

In addition, with regard to preparation of the TAOR, the public outreach process included Stakeholders' Advisory Working Groups (SAWGs) meetings focused on the transit alignment options; small working meetings with officials from potentially affected towns and villages across the corridor; community working meetings geared to the general public; and meetings with environmental justice communities, as described below.

1.8.1 Stakeholders' Advisory Working Groups

Starting in spring 2007, members of the public and community representatives have participated in the project's four SAWGs, which focus on traffic and transit, environment, land use, and bridge-design issues. A fifth SAWG, focusing on finance, began in 2009. The SAWGs are designed to exchange information and ideas and solicit community feedback. All aspects of the transit alignment options were described in detail at joint meetings of the Land Use and Traffic and Transit SAWGs. These meetings included:

- March 11, 2009 - DEIS Alternatives from the TMSR.
- May 5, 2009 - Transit Alignment Options Work Plan.
- June 10, 2009 - Monsey to West Nyack CRT Options.
- July 30, 2009 - Westchester Busway/Bus Lane Options - Tarrytown to White Plains.
- August 27, 2009 - Busway and Bus Lane Alignment Options through White Plains.
- October 1, 2009 - Busway Alignment Options along I-287 in Rockland County.
- January 27, 2010 – Westchester Busway/Bus Lane Alignments East of White Plains.

1.8.2 Community Working Meetings

An extensive set of small, hands-on working meetings was conducted with representatives of villages and towns across the project corridor to describe the transit alignment options in their respective communities, to solicit their input, and to encourage questions and discussion. Replacement bridge configuration options were also presented. Attendees at the meetings included mayors and supervisors, board members, local planners and engineers, representatives of the relevant county's planning agency, and other village or town staff. In addition to taking a detailed look at the BRT and CRT alignments, the meetings included a brief overview of the process to screen the alignment options, BRT and CRT service plans, and possible locations of transit stations. Engineering plans, area maps, typical cross sections and other materials were rolled out on tables for participants. The locations and dates of the meetings were as follows:

Chestnut Ridge	September 15, 2009	Town of Ramapo	October 15, 2009
Elmsford	September 22, 2009	Montebello	October 19, 2009
Airmont	September 24, 2009	Port Chester	October 20, 2009
South Nyack	September 24, 2009	Tarrytown	October 20, 2009
Harrison	September 30, 2009	Rye Brook	October 21, 2009
Town of Orangetown	October 8, 2009	White Plains	October 22, 2009
Town of Clarkstown	October 13, 2009	Greenburgh	October 23, 2009
Spring Valley	October 14, 2009	Irvington	October 28, 2009
Hillburn	October 14, 2009	Nyack	November 16, 2009
Suffern	October 14, 2009	Rye City	November 21, 2009

1.8.3 Public Working Meetings

Five large, informal meetings were held to present the transit alignment options to the public. Each meeting focused on the transit alignment options through a particular geographical area. Project team members were on hand to explain boards and displays, as well engineering plans, on the transit alignment options and bridge configurations, to answer individual questions, and to address concerns. Members of the public were asked to give their feedback, either by speaking to project staff or filling in comment forms. Handouts in English and Spanish describing the alignments and other materials were available.

- Ramapo – November 10, 2009 at Spring Valley High School.
- Clarkstown – November 12, 2009 at Palisades Center.
- Orangetown – November 18, 2009 at Nyack High School.
- Greenburgh/City of White Plains – December 1, 2009 at Greenburgh Library.
- White Plains/Harrison/Rye/Port Chester – December 9, 2009 at Port Chester Senior Community Center.

The Consulting Parties were invited to these meetings and individual meetings were also held with the staff of two National Historic Landmark properties (Lyndhurst and Sunnyside).

1.8.4 Environmental Justice Community Meetings

Executive order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low--Income Populations*, requires consideration of whether a proposed federal action would disproportionately affect minority or low-income groups. EO 12898 also requires federal agencies to ensure adequate public participation from communities with substantial minority and/or low-income populations. To this end, the Project Sponsors, FHWA, and FTA conducted two transit alignment option meetings with environmental justice (EJ) community representatives. In addition to issuing a notification of the meeting to the project's extensive mailing list of EJ representatives and groups, the project team:

- Distributed fliers in English and Spanish to churches, community centers, and other key locations in identified minority and low-income communities in the corridor.
- Made phone calls and sent fax and email reminders about the meetings.
- Posted notifications in community calendars in local newspapers throughout the corridor.
- Prepared handouts, a newsletter, and comment forms in English and Spanish that were available at the meetings.

The following meetings were held:

- Westchester County - December 3, 2009 at the New York Power Authority (NYPA) Building.
- Rockland County - December 10, 2009 at Palisades Center.

1.9 Report Organization

The advancement of transit alignment options for BRT and CRT are in some cases mutually dependent, particularly in Rockland County. In addition, the CRT system has more critical design constraints (the major one being grades). Thus, the remainder of the report is organized, as follows:

- **Chapter 2: Rockland and Westchester Counties – CRT Alignment** – this chapter presents the CRT alignment options in both counties. The CRT options discussed in detail in this chapter are independent of BRT.
- **Chapter 3: Rockland County – BRT in HOV/HOT Lanes with CRT Alignment** – this chapter describes the BRT in HOV/HOT lanes with CRT alignment in Rockland County.
- **Chapter 4: Rockland County – BRT in Busway with CRT Alignment** – this chapter describes the BRT in busway options with CRT alignment in Rockland County.
- **Chapter 5: Westchester County – BRT in Bus Lanes** – this chapter describes the BRT in bus lanes alignment and the bus lane options in Westchester County.
- **Chapter 6: Westchester County – BRT in Busway** – this chapter describes the BRT in busway alignment and busway options in Westchester County.
- **Chapter 7: Description of EIS Alternatives** – this chapter presents the transit alignment recommendations for the four build alternatives to be carried into the EIS based on the results of Chapters 2 to 6.

2 Rockland and Westchester Counties – CRT Alignment (All Build Alternatives)

This chapter presents the development and evaluation of the CRT alignment options from Hillburn, NY to a direct connection to the Metro-North Hudson Line south of the existing Tarrytown Station, NY for service to Grand Central Terminal (GCT) in Manhattan. This route is common to all DEIS build alternatives. The CRT alignment options being evaluated are shown on Figure 2-1 and are listed below:

- **Suffern to Airmont:**
  - CRT and BRT combined in the Piermont Line right-of-way (ROW).
  - CRT in the Piermont Line ROW.
  - CRT adjacent to Wayne Avenue on the south side of the Thruway.
- **Airmont to Monsey:** CRT over or under Airmont Road from the Piermont Line ROW.
- **Monsey to West Nyack:** CRT alignment in the median or on the south side of the Thruway.
- **Clarkstown and Orangetown:** CRT over or under the CSX West Shore Line.
- **Tarrytown**: Tunnel (land side) or trestle (waterside) options for the CRT connection to the Hudson Line.

2.1 Suffern to Airmont

The study area in Suffern (Figure 2-2) begins just north of the intersection of the 4th Street Bridge and Orange Avenue (Route 59) in the Village of Hillburn, NY. It continues under the Thruway at Interchange 15, through the Villages of Suffern and Airmont, across Interchange 14B (Airmont Road), to about ½ mile east of where Route 59 crosses the Thruway in Monsey (hereafter referred to as the Monsey Hill). This is a distance of 4.6 miles with an elevation difference of 308 feet from the low point at the Mahwah River to the top of the Monsey Hill. Area characteristics and features that warranted consideration in the development and evaluation of options included:

- Existing rail facilities, including the Norfolk Southern and NJ Transit Yard, Metro-North's Port Jervis line (leased from Norfolk Southern), and Metro-North's Piermont Line.
- Water courses including the Ramapo River, the Mahwah River, and Lake Antrim.
- Well fields and the sole-source aquifer south of Interchange 15 and west of Route 59.
- Harriman State Park, which includes the steep rock face on the north side of the Thruway at Interchange 15.
- Existing freight service on the Piermont Line with existing railroad sidings that serve warehouses east of Hemion Road and one location east of Airmont Road.
- Complex infrastructure at Interchange 15.
- Downtown Suffern's residential and commercial development, which is adjacent to both the Thruway and the Metro-North Piermont Line.
- National Register-listed, eligible, or recommended eligible historic properties in the Village of Suffern.

2.1.1 Proposed Transit Operations

The western terminus of the cross-Rockland CRT alignment would be at the proposed Hillburn Station. The proposed station complex would be constructed along the existing Metro-North's Port Jervis Line at 4th Street and Orange Avenue (Route 59) and may include a storage yard and park-and-ride facilities.

This station would serve as an intermodal transportation center with transfers between proposed CRT and BRT services and existing local bus service (Figure 2-3). In addition, with its direct connection to Metro-North's Port Jervis Line, the Hillburn Station could provide transfer service to NJ Transit's Main-Bergen Line. The proposed station would also provide transfer capability for riders from New Jersey to the proposed cross-Rockland CRT service and cross-corridor BRT service. This would be accomplished by the extension of service from the existing NJ Transit Suffern Station to the proposed Hillburn Station.

The proposed Hillburn Station would also serve as the western terminus of the proposed BRT trunk line (Route T) and the origin of proposed feeder Routes B and C. The existing local Transit of Rockland (TOR) Route 93 could easily serve the Hillburn Station, and both the TOR Route 59 and the Monsey Loop 3 could be extended from their current terminals in Suffern at Hallet Place to the Hillburn Station, thus allowing for greater intermodal connectivity. Shuttle service and/or new feeder routes could be established to better connect downtown Suffern to the Hillburn Station as the need arises.

2.1.2 CRT and BRT Busway in the Piermont Line ROW

The existing Piermont Line (built in 1841 as the Erie Railroad) originally connected Suffern to Ramapo. It now functions as a single-track freight line with infrequent service to a number of commercial facilities between Suffern and Airmont. The Piermont Line is currently abandoned east of Spook Rock Road to Spring Valley.

An analysis was conducted to determine the feasibility of constructing both CRT and BRT in the Piermont Line ROW from Suffern to Airmont Road. Area features that warranted consideration in the development and evaluation of this option included:

- Existing Piermont Line ROW (typically 66-feet wide, but narrows to about 40 feet at Dunnigan Drive near Airmont Road.)
- Proximity of buildings to the Piermont Line ROW, especially in downtown Suffern.
- Complex Thruway infrastructure at Interchange 15.
- Hemion Road Thruway overbridge.
- Interchange 14B and Airmont Road.
- Existing freight service and railroad sidings on the Piermont Line.

The CRT and BRT busway alignments would be built side by side in the Piermont Line ROW with similar profiles. This is desirable for two reasons: (1) maintaining similar profiles would enable both systems to operate without grade crossings, thereby increasing safety and operational reliability, and (2) the construction would be simplified by reducing the number of retaining walls required.

Figure 2-1 CRT Options in Rockland and Westchester Counties

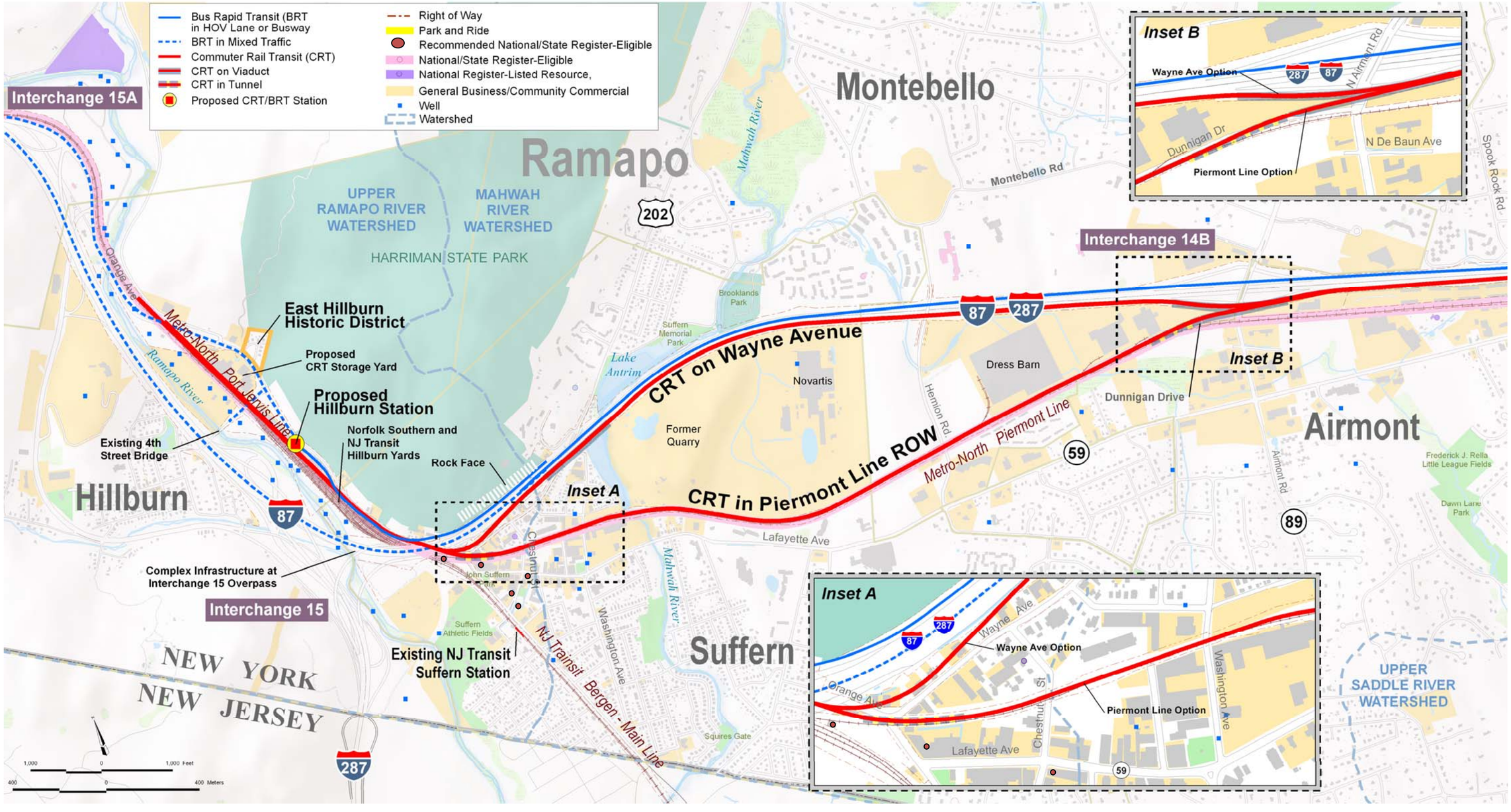


Figure 2-2 Suffern Area Key CRT Alignment Considerations

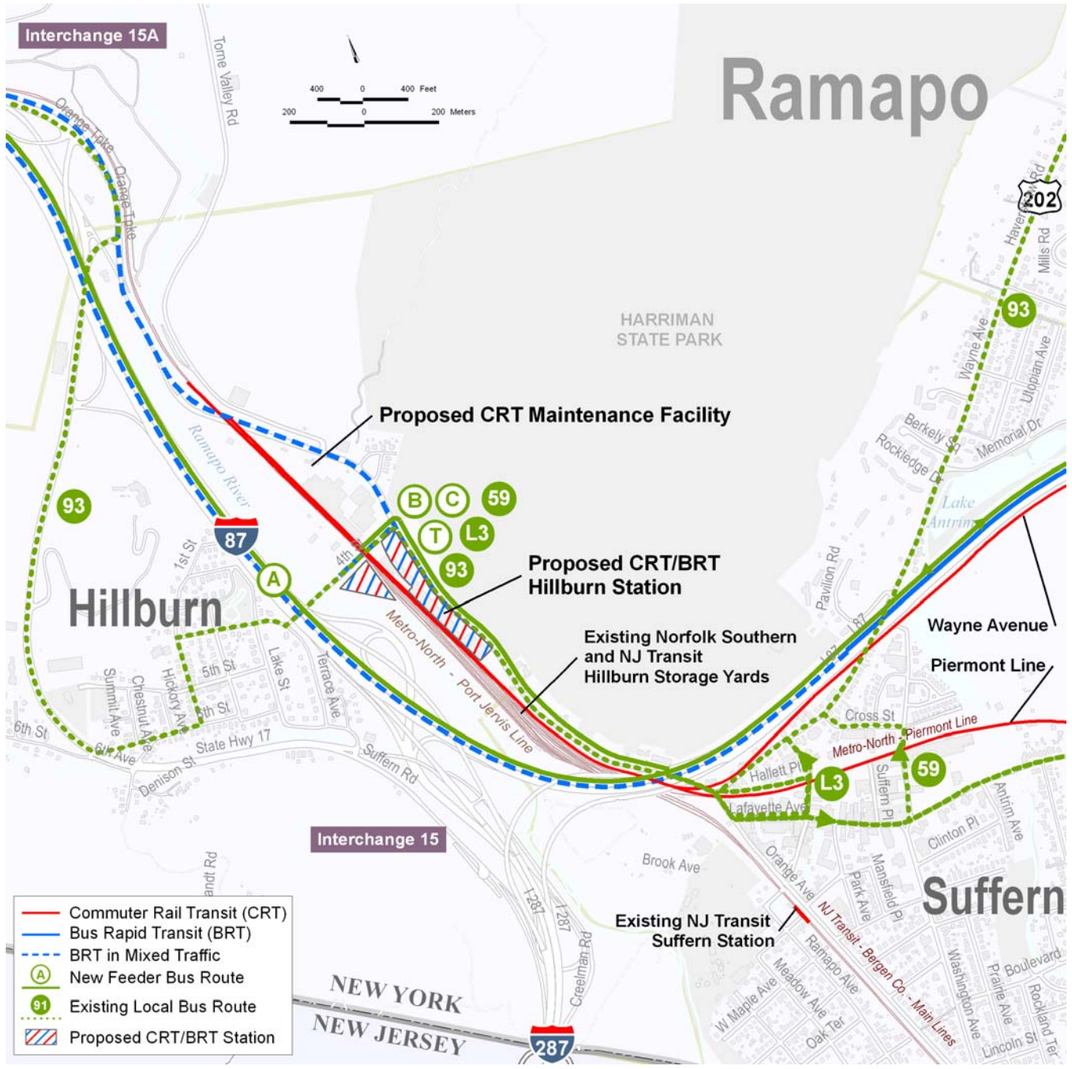


Figure 2-3 Hillburn Station Connectivity Diagram

Although the CRT and BRT busway profiles would be similar for the majority of the alignment, they would vary at the western end of this area. The CRT alignment in downtown Suffern would be in a tunnel under Route 59 and be grade separated at Chestnut Street and Washington Avenue with the alignment in a retained cut section. For the busway alignment the width constraints imposed by the Port Jervis Line tracks and the Interchange 15 pier arrangements prevent a direct busway connection to the Hillburn Station. As a result the busway alignment would terminate at the Route 59 intersection and would continue in mixed traffic for about ½ mile on Route 59 to access the Hillburn Station.

Other alignment accommodations would occur in certain areas, such as the horizontal curve over the Mahwah River. In this area commercial and residential development is heavier on the south side, therefore, the CRT alignment would be shifted north by approximately 27 feet to fit the BRT busway on the south side and minimize ROW impacts. In addition, the CRT alignment near Hemion Road would shift southward to allow the reconstruction of the freight tracks and sidings, and Dunnigan Drive, which also parallels the existing warehouses.

Locating the typical BRT and CRT alignments adjacent to each other would require an approximate 84-foot wide section (Figure 2-4), which exceeds the typical ROW width of 66 feet. This would result in approximately 5 acres of acquisitions and 11 residential/commercial displacements (seven commercial buildings in Suffern, three residential homes east of the Mahwah River, and a small office building at Hemion Road). The impacts due to the displacements would be greater and therefore, this option should be eliminated.

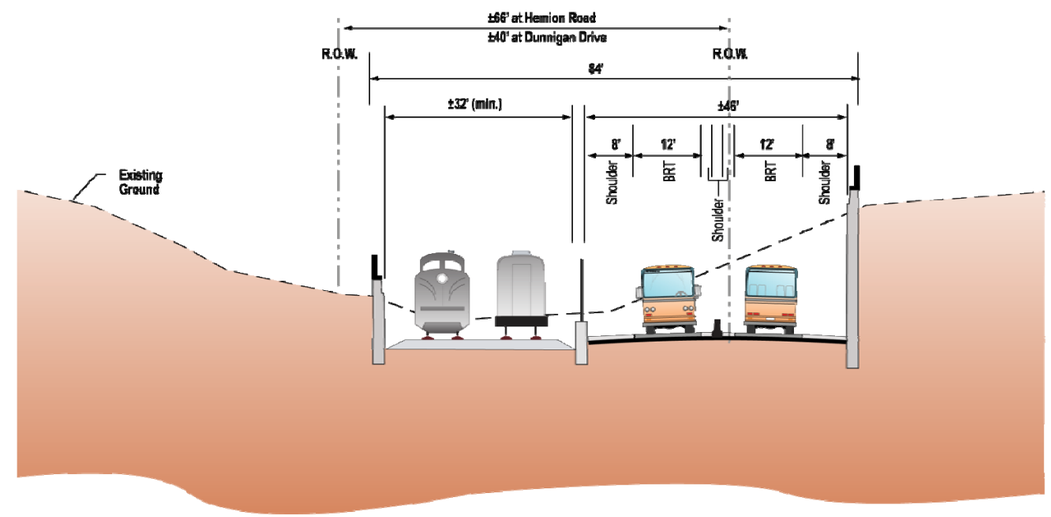


Figure 2-4 CRT and BRT Busway in the Piermont Line ROW
Typical Cross-Section West of the Mahwah River

2.1.3 CRT in the Piermont Line ROW

The alignment for CRT in the Piermont Line ROW would begin just north of 4th Street in Hillburn with a two-track connection to the Port Jervis Line. The alignment would head south following the existing Piermont Line diversion from the Port Jervis Line and descend in a short tunnel under Route 59 to maintain grade separation in downtown Suffern. The CRT would remain in the Piermont ROW transitioning to an open cut section under Chestnut Street and Washington Avenue. Engineering features of the alignment along the existing Piermont Line ROW are shown on Figure 2-5, and a typical cross-section is shown on Figure 2-6.

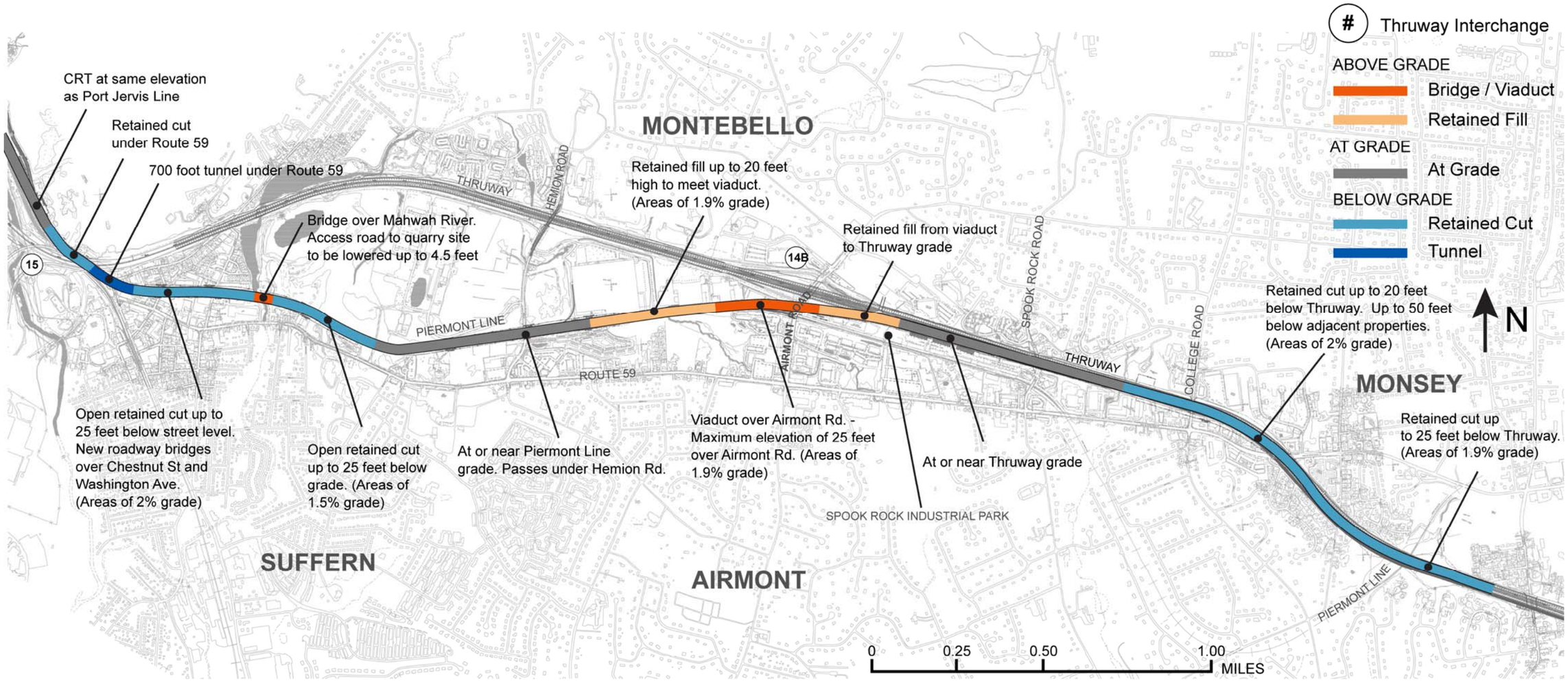


Figure 2-5 CRT in the Piermont Line ROW Over Airmont Road – Engineering Features

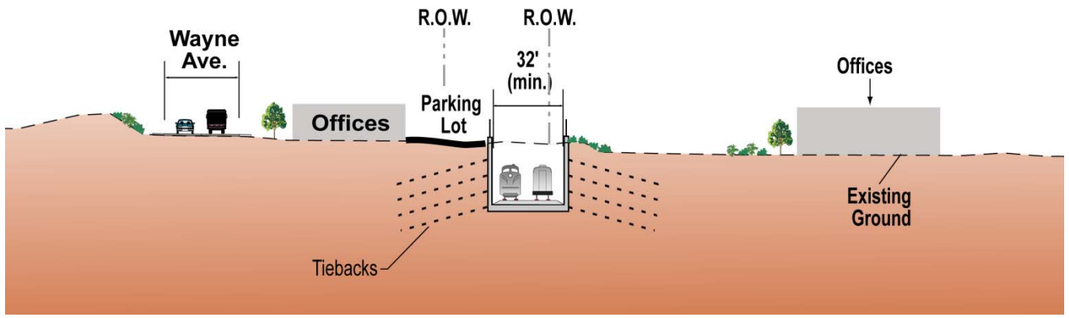


Figure 2-6 CRT in the Piermont Line ROW
Typical Cross-Section at Washington Avenue (View Looking East)

The profile must rise from the retained cut section under Washington Avenue to cross over the Mahwah River above the 100-year flood elevation. East of this crossing the alignment follows the existing Piermont Line profile as it passes beneath Hemion Road. The CRT alignment would then depart from the Piermont Line ROW in a northeasterly direction as it approaches Interchange 14B and Airmont Road. A 1,500-foot long viaduct is required for the alignment to transition from the Piermont Line ROW to the Thruway ROW, crossing above Dunnigan Drive, the Piermont freight line, and Airmont Road.

There are three existing railroad sidings on the Piermont Line that must be maintained as they provide service to facilities along Dunnigan Drive. A third track would be constructed parallel to the proposed CRT alignment to maintain the freight service when CRT is implemented. The third track would begin just east of Hemion Road and would proceed at-grade, parallel and north of the proposed CRT alignment. The freight track would continue east at-grade from the Dunnigan Drive sidings and would cross under the CRT viaduct to tie back into the existing Piermont Line ROW west of Airmont Road.

The CRT alignment would continue eastward to Spook Rock Road along the south side of the Thruway. As the alignment approaches College Road, the CRT profile would continue on a 2-percent grade in retained cut to reach the area where Route 59 crosses the Thruway in Monsey. Monsey Hill is the highest point of the Thruway in Rockland County at elevation 618 feet.

2.1.4 CRT on Wayne Avenue

The alignment for the Wayne Avenue Option would also begin just north of 4th Street in Hillburn with a direct connection to the Port Jervis Line. The alignment would deviate from the Piermont Line ROW in a retained fill to pass under Interchange 15 (Photo 2-1) and cross over Route 59. (The CRT alignment from Hillburn would pass through Area A in Photo 2-1.) Route 59 would be lowered 4 feet at the south fascia of Interchange 15 to maintain CRT vertical clearance above Route 59 and below Interchange 15.

It would then turn east on a horizontal curvature of D = 8.81 degrees (radius = 650 feet) placing it north of Wayne Avenue and parallel with the south side of the Thruway. It would then enter the Thruway ROW and continue east to Airmont Road. A 1,600-foot long viaduct would be required for the alignment to cross over Airmont Road and into the Thruway ROW. A typical cross-section is shown on Figure 2-7 and features of the alignment are shown on Figure 2-8.

The alignment would cross over the Mahwah River on a 1,000-foot long viaduct and would then proceed east under Hemion Road. Another viaduct would be needed as the alignment approaches Interchange 14B in order to cross over Airmont Road with grades up to 2 percent. It would then continue in a retained fill east of Airmont Road to meet the Thruway grade and then climbs to the Monsey Hill.

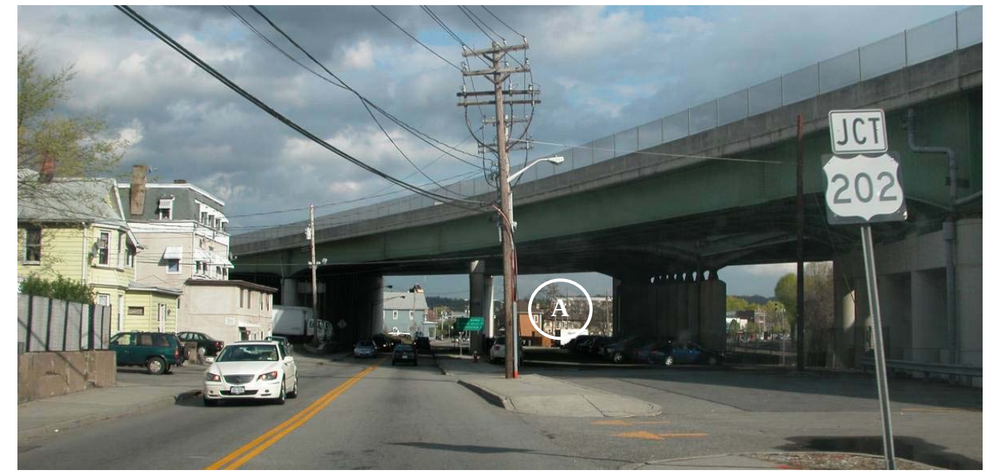


Photo 2-1 CRT alignment would pass through Area A and beneath Interchange 15
Looking South from Route 59 towards Suffern.

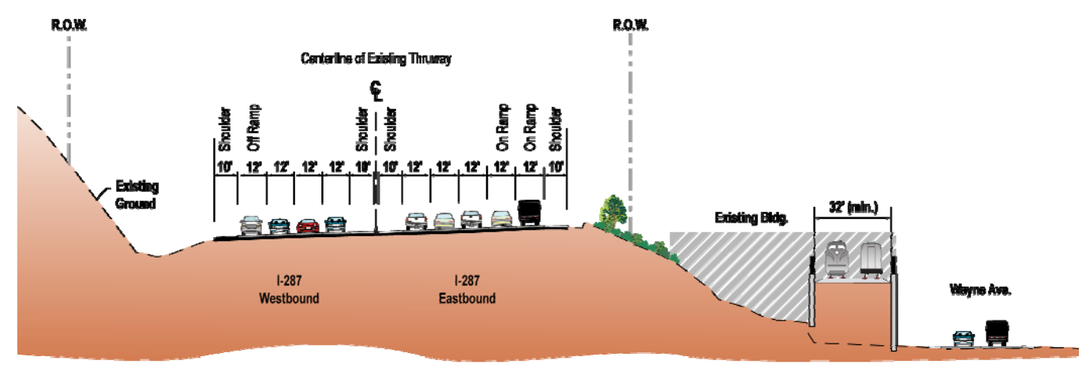


Figure 2-7 CRT Adjacent to Wayne Avenue
Typical Cross-Section in Downtown Suffern

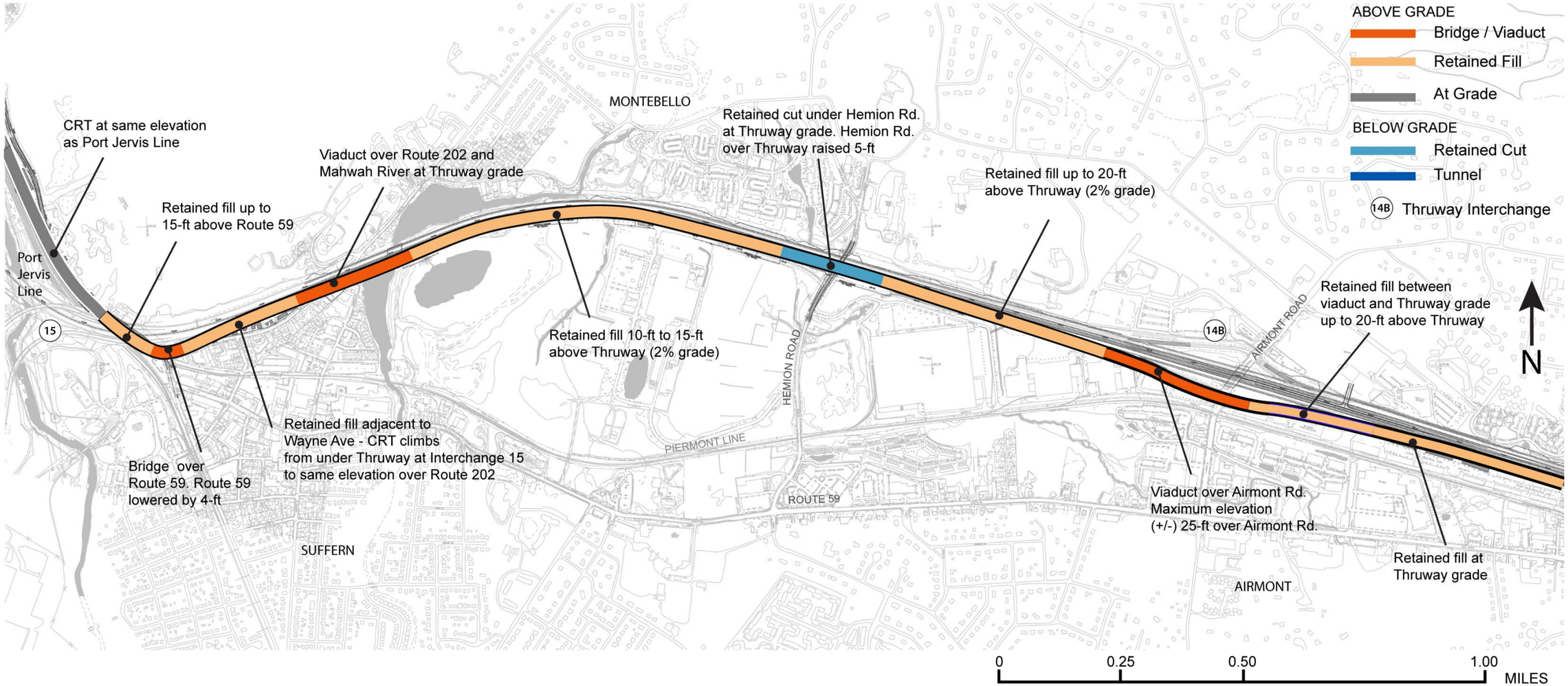


Figure 2-8 CRT on Wayne Avenue – Engineering Features

2.1.5 Evaluation Results

The engineering evaluation of the options is presented below.

2.1.5.1 Engineering

The alignments are approximately the same length (14,000 feet) for both the Piermont Line and Wayne Avenue Options, measured from the southern end of the possible Hillburn Station platform to Airmont Road.

Engineering Design (CRT Vertical Alignment)

The Piermont Line Option would require considerable modifications to the existing freight line alignment in order to accommodate the added width, grade, and connectivity of the two proposed CRT tracks. Modifications would include:

- Replacing the single freight track arrangement with a two-track arrangement.
- Lowering the existing track alignment into a cut-and-cover tunnel and retained cut sections to avoid at-grade crossings.
- Raising the alignment to cross over Airmont Road.
- Creating a 3,000-foot section of three tracks to separate the CRT from the freight track near Airmont Road.

In addition to the vertical constraints at Washington Avenue and Hemion Road, these modifications would result in an average grade of 1.4 percent over a length of 12,000 feet from the lowest to the highest track elevations. The alignment would also include a short distance (720 feet) at a grade of 2 percent near Washington Avenue to climb over the Mahwah River and a long distance (3,600 feet) at a grade of 1.9 percent east of Hemion Road to rise and span over Airmont Road.

The Wayne Avenue Option would require Route 59 to be lowered 4 feet at Interchange 15 to maintain CRT vertical clearance below Interchange 15 and above Route 59. East of Interchange 15 the alignment would provide two new tracks adjacent to the existing Thruway roadway. The alignment would be the same length as the Piermont Line Option. However, there would be a longer distance of 2 percent grade (6,100 feet) due to the combination of the Thruway grade east of the Mahwah River, the vertical constraint of the bridge carrying Hemion Road over the Thruway, and the need for the CRT alignment to climb over Airmont Road.

Engineering Design (CRT Horizontal Alignment)

The maximum allowable design speed for CRT based on the project's design criteria would be 90 mph, where conditions allow. This speed would not be achieved on either alignment due to the horizontal curvature through the Suffern area for both options.

The Piermont Line Option would have a horizontal curvature of D = 5.73° (radius = 1,000 feet) and a grade of 0.69 percent in the area under the Interchange 15 ramps (with a corresponding maximum allowable speed of 45 mph). This combination of low grade and low radius is not expected to affect train performance.

The Wayne Avenue Option would have a horizontal curvature of D = 8.81° degrees (radius = 650 feet). It would also be located along the alignment under the Interchange 15 ramps. This radius corresponds to an allowable maximum speed of 35 mph. A rail grade of 2.0 percent for a length of 500 feet would exist at this location. The combination of the minimum radius with high grades would be undesirable, but would be necessary to traverse the constraints in the area.

Tunnels

The Piermont Line Option requires a 700-foot long tunnel passing under the intersection of Route 59 and Wayne Avenue. No ventilation buildings would be necessary for this length of tunnel. However, emergency and safety equipment would be necessary. Additionally, a pump station would be necessary to drain the tunnel and section in retained cut through downtown Suffern. The Wayne Avenue Option does not require a tunnel.

Engineering Design (Drainage)

The New York State Department of Environmental Conservation (NYSDEC) general permit governing stormwater runoff (GP-0-10-001) requires both options to implement best management practices to control stormwater quality and quantity. The total volume and flow of additional stormwater runoff to be managed for the Piermont Line Option may be somewhat smaller due to the contribution of the existing trackbed to current stormwater flows. However, the difference in stormwater runoff volumes and flow between the two options would be minimal. Accordingly, stormwater management requirements are not considered a differentiator between the options.

Operations and Maintenance

The key CRT operating considerations in this area include maintaining the existing Piermont Line sidings to commercial facilities; sharing the tracks with existing freight operators; and integrating with NJ Transit operations for the connection to the Port Jervis Line and a possible track turnout for a future extension of their service to the CRT Hillburn Station. Both the Piermont Line and Wayne Avenue Options would accommodate these operating requirements. However, freight service on the Piermont Line would need to be scheduled outside the peak commuting hours and be integrated with the CRT schedule.

The Wayne Avenue Option would present CRT maintenance issues associated with the tight horizontal curvature as the alignment turns beneath Interchange 15. The horizontal curvature of D = 8.81° (radius = 650 feet) of this option would result in quicker wear of the track rails. Thus, the tracks would need to be replaced more frequently.

Existing Thruway operations would not be affected by either option. However, future modifications to the Thruway would be constrained between Interchanges 15 and 14B by the Wayne Avenue Option, as CRT would be present along the southern edge of the highway alignment.

Constructability

The Piermont Line Option requires three distinct construction activity zones:

- **Hillburn Station to Interchange 15 –** construction would generally be at-grade. Relocation of Route 59 by about 25 feet to the east would be required. Construction access would be along Route 59.

- **Route 59 to the Mahwah River** – construction would generally be in a cut and adjacent to residential and commercial buildings in downtown Suffern. Construction access would be from local streets. Extensive tie-backs for the deep retaining walls under the existing adjacent properties would be required. Alternating closures of Chestnut Street and Washington Avenue would be required to maintain local traffic circulation. Extensive utility relocations would be anticipated.

- **Mahwah River to Airmont Road** - this area includes retained cut, at-grade, and viaduct sections, with access either from local roads, Route 59, or Dunnigan Drive. Access along the work site would be greatly simplified by the presence of the existing Piermont Line, as construction would likely occur with little or no disruption

to existing traffic patterns. Partial closure of the Hemion Road Bridge over the Piermont Line tracks would also be required.

The Wayne Avenue Option also requires three distinct construction activity zones:

- **Hillburn Station to Interchange 15** - construction would generally be similar to that of the Piermont Line Option.

- **Route 59 and along Wayne Avenue** - activities would include the demolition of the existing structures on the north side of Wayne Avenue and construction of foundations for bridge piers and extensive retaining walls. Access to the construction area would be from Wayne Avenue. Partial closure of Route 59 would be required for the construction of the rail overpass.

- **Wayne Avenue to Airmont Road** - activities would include the construction of two viaducts and extended at-grade or near-grade sections, with construction access from the Thruway. Reconstruction of the Thruway pavement adjacent to the CRT tracks and its drainage would be required. Shifting the eastbound lanes and closing the adjacent shoulder would be some of the temporary construction measures implemented to facilitate CRT construction. Partial closure of the Hemion Road Bridge over the Thruway would also be required.

Both the Piermont Line and Wayne Avenue Options would need special construction measures to ensure that no temporary or permanent infiltration of the sole source aquifer in the Suffern area occurs.

Overall, both options would have extensive construction requirements; therefore, constructability would not be a differentiator between the options.

2.1.5.2 Cost

The capital cost estimates for the Wayne Avenue and Piermont Line Options are $1.47 billion and $1.30 billion (2012$), respectively. The extent of the estimate is the 6-mile segment from north of the 4th Street Bridge, which includes the maintenance yard and the proposed Hillburn Station to East Saddle River Road. The estimate includes the costs of the CRT infrastructure, systems, and trackwork. It also includes modifications/reconstruction of Thruway overbridges, pavement, and drainage systems, and all local street improvements that would be necessary to accommodate CRT. Costs associated with BRT Busway or HOV/HOT lanes and transit rolling stock and equipment are not included in the estimate. The approximate 12% cost differential between these options is not considered a differentiator.

2.1.5.3 Transportation

There are no major differentiators between the options in terms of either travel time or transportation system integration. Traffic network changes are not applicable in terms of a proposed CRT alignment, as the railroad would be grade-separated.

2.1.5.4 Environment

The results of the environmental evaluation for the Piermont Line and Wayne Avenue Options are:

- **Land Use/Potential for TOD**. There is no proposed CRT station in this study area east of Hillburn for either option. Thus, land use and TOD are not considered differentiators.

- **Displacements and Acquisitions**. The Piermont Line Option would have three potential displacements (two commercial structures with two businesses and one residential structure with one dwelling unit). The Wayne Avenue Option would have 16 potential displacements (four mixed-use with four businesses and 29 dwelling units; two commercial structures with two businesses; eight residential structures housing 35 dwelling units and two residential ancillary structures). Displacements and acquisitions are considered a differentiator based on the greater number of overall displacements of the Wayne Avenue Option compared to the Piermont Line ROW Option.

- **Wetlands.** The Piermont Line Option requires the crossing of the Mahwah River (a Class A water body) and construction near rivers and wetlands. This alignment would affect 1.7 acres of wetlands. The Wayne Avenue Option would entail a longer crossing of the Mahwah River, construction near rivers and wetlands, and affect 1.9 acres of wetlands. Also, the construction activities associated with the Wayne Avenue Option would result in increased disturbance to the Mahwah River. Wetlands are not considered a differentiator between the options.

- **Aquifers and Floodplains**. Under both options, the presence of a sole-source aquifer (Ramapo Valley) would require US Environmental Protection Agency (USEPA) approval and may require special runoff controls if a potential to contaminate the aquifer is identified. This is not considered a differentiator. Under the Piermont Line Option, the tunnel is immediately adjacent to an existing mapped floodplain that may require special engineering features such as flood walls, but this is not considered a differentiator.

- **Parklands.** Neither option alignment would impact parklands in the study area. Parklands are not considered a differentiator.

- **Historic Resources.** The Piermont Line Option would directly impact three historic architectural resources in Suffern:

  - National Register-Eligible (NRE) NY & Erie RR Co. Alignment (Piermont Line) (reconstruction).
  - National Register-Listed (NRL) US Post Office-Suffern (subsurface easement).
  - Recommended NRE Lafayette Avenue Cluster (possible partial acquisition associated with cut-and-cover tunnel).

  In comparison, the Wayne Avenue Option would directly impact by its displacement one historic architectural resource (recommended NRE resource at 36 Wayne Avenue). Thus, the Piermont Line Option would have fewer direct impacts to historic architectural resources than the Wayne Avenue Option as an actual displacement would occur under the Wayne Avenue Option, but not under the Piermont Line Option. Historic resources are not considered a differentiator.

- **Archaeological Resources**. Phase 1A assessments (literature review) for both options determined the potential for archaeological sensitivity (southern Piermont Line ROW and backyards on Wayne Avenue). Phase 1B intensive walkover surveys are in progress for both these alignment options. Archaeological resources are not considered a differentiator since most archaeological resources can be mitigated before construction is initiated.

- **Hudson River Ecosystems.** These options would not impact the Hudson River. Hudson River ecosystems are not considered a differentiator.

- **Noise**. The operation of CRT in the Piermont Line ROW and on Wayne Avenue would both result in a perceptible increase in noise levels for those residential areas adjacent to the CRT alignment. However, the Wayne Avenue noise increase would be somewhat masked by the noise level of the adjacent Thruway traffic. Along the Piermont Line east of the Mahwah River there are low existing ambient background noise levels.

Therefore the potential noise increase above existing levels would be greater for the Piermont Line Option than for the Wayne Avenue Option. Noise is considered a differentiator.

- **Visual**. The Piermont Line Option would be in a tunnel and a cut section through downtown Suffern. There would be little if any sight lines into the cut section from properties adjacent to the alignment. In addition there would be a protective fence further blocking views into the cut section. The Wayne Avenue Option in downtown Suffern would include a highly visible viaduct over Route 59 and a long retained fill adjacent to Wayne Avenue which would be visible to the residences on the south side of Wayne Avenue.

  Where the Piermont Line Option approaches Airmont Road on the long viaduct there will be notable visual impacts to the residential complex along the south side of the ROW. The Wayne Avenue Option would also include a viaduct; however it would be 200 to 400 feet north of the Piermont Line Option and a commercial property is between the two alignments. Thus the visual impacts are greatly reduced.

  Since both options have notable visual impacts, visual impacts are not considered a differentiator.

2.1.6 Transit Alignment Recommendation

The evaluation of the Wayne Avenue and Piermont Line Options in the 2.5 mile area between Suffern and Airmont is summarized in Table 2-1. The Piermont Line Option is recommended for advancement into the EIS as an element of Alternatives B, C, D, and E based on the following criteria differentiators:

- **Engineering.** The Wayne Avenue Option would have sharper horizontal curvature and 6,100 feet of high grades compared to 4,300 feet for the Piermont Line Option. Both options would have approximately the same extent of construction. The Piermont Line Option would require the temporary closure of the existing freight line and the alternating closures of Washington Avenue and Chestnut Street during construction. The Wayne Avenue Option would require temporary lane shifts and the closure of the outside shoulder along the Thruway between Interchange 15 and Airmont Road; however three lanes of through traffic would be maintained during construction.

- **Environment**. The environmental differentiators are:

  - Displacements and Acquisitions: The Wayne Avenue Option would displace 16 structures that have a combined total of 70 displaced businesses and dwelling units compared to only three structures for the Piermont Line Option. The magnitude of the Wayne Avenue Option displacements is the leading consideration for recommending the Piermont Line Option.

  - Noise: The operation of CRT in the Piermont Line ROW and on Wayne Avenue would both result in a perceptible increase in noise levels for those residential areas adjacent to the CRT alignment. However, the potential noise increase above the low existing levels along the Piermont Line would be considered a differentiator compared to the noise increase from the Wayne Avenue Option since that increase would be mostly masked by highway traffic noise. Although the Wayne Avenue Option is preferable based on this criterion, it is not sufficient to outweigh the overall advantages of the Piermont Line Option.

Table 2-1

CRT in Piermont Line ROW and Wayne Avenue Options

Criteria	CRT in Piermont Line ROW	CRT on Wayne Avenue
Engineering		
Engineering Design (CRT Vertical Alignment	4,300 feet of high grades	6,100 feet of high grades
Engineering Design (CRT Horizontal Alignment	D = 5.73° degrees (radius = 1,000 feet) allowable maximum speed of 45 mph	Horizontal Curve D = 8.81° degrees (radius = 650 feet) (allowable maximum speed of 35 mph)
Tunnels	Requires a tunnel	No tunnel
Engineering Design (Drainage)	Not a differentiator.	Not a differentiator.
Operations and Maintenance	Not a differentiator.	Not a differentiator.
Constructability	Not a differentiator.	Not a differentiator.
Cost		
Capital Costs (2012 $)	Not a differentiator.	Not a differentiator.
Transportation		
Travel Time	Not a differentiator.	Not a differentiator.
Traffic Network Changes	Not a differentiator.	Not a differentiator.
Transportation System Integration	Not a differentiator.	Not a differentiator.
Environment		
Land Use / Potential for TOD	Not a differentiator.	Not a differentiator.
Displacements and Acquisitions	Structures (3 total): 2 commercial (2 businesses); 1 residential (1 dwelling unit).	Structures (16 total): 4 Mixed-Use (4 businesses and 29 dwelling units) 2 Commercial (2 businesses); 8 residential (35 dwelling units); 2 residential ancillary building.
Wetlands	Not a differentiator.	Not a differentiator.
Aquifers and Floodplains	Not a differentiator.	Not a differentiator.
Parklands	Not a differentiator.	Not a differentiator.
Historic Resources	Not a differentiator.	Not a differentiator.
Archaeological Resources	Not a differentiator.	Not a differentiator.
Hudson River Ecosystems	Not a differentiator.	Not a differentiator.
Noise	Operation of CRT would result in a perceptible increase in noise levels in an area where existing noise levels are low.	Operation of CRT would result in a perceptible increase in noise levels. However, this increase would be masked by highway traffic noise.
Visual	Not a differentiator.	Not a differentiator.

2.2 Airmont to Monsey

In the previous analysis of the Piermont Line and Wayne Avenue Options, the CRT vertical alignment at Airmont Road was presented as passing over Airmont Road on a viaduct because crossing over Airmont Road facilitates the long steep climb for CRT east to the Monsey Hill. An alignment option under Airmont Road was also assessed due to the potential visual impacts of the viaduct passing over Airmont Road (Figure 2-9). Although the Piermont Line Option was used in the analysis of the over and under Airmont Road alignment options, an analysis that would have used the Wayne Avenue Option instead would have resulted in the much the same alignment impacts east of Airmont Road as was determined using the Piermont Line Option.

2.2.1 Description of Alignment Options

The alignments for the Over- and Under-Airmont Road Options are the same from Hillburn to Hemion Road (Figures 2-5 and 2-9). The Over-Airmont Road Option would cross over Airmont Road on a 1,500-feet long viaduct and follow the Thruway grade for close to a mile before entering a retained cut section followed by a short tunnel to reach the top of and pass through the Monsey Hill.

The Under-Airmont Road profile would differ from the Over-Airmont Road Option just west of Hemion Road dropping to pass under the relocated Piermont freight line and Dunnigan Drive. This would require raising Dunnigan Drive and the freight line by 8 feet. Additionally, the siding located closest to Airmont Road would need to be raised, which would require modifications to the commercial building access road if the siding is to remain active. The Under-Airmont Road profile would begin to climb after Dunnigan Drive, pass under Spook Rock Road and then enter a tunnel west of College Road that would extend to east of the Monsey Hill.

2.2.2 Evaluation Results

This subchapter presents the evaluation results for the Over- and Under-Airmont Road options.

2.2.2.1 Engineering

The engineering evaluation of the options is presented below.

Engineering Design

The comparison of engineering criteria is based on the 18,500-foot long segment of the Thruway from Hemion Road to east of the Monsey Hill. Neither option can reach the top of this hill at the same grade as the Thruway because of the high Thruway grades in the approach to the top of the hill – up to 3 percent. Consequently, both are in tunnels, but at different depths. From the top of the hill to East Saddle River Road both options have almost the same alignments with no differentiators.

The differences between the two options occur between Hemion Road and the top of the Monsey Hill (Figure 2-10), a distance of 2.55 miles. The differences are primarily associated with the length of higher grades, and the long extent of tunnel and retaining-wall construction in the Under-Airmont Road Option.

The extent of structures required in the Under-Airmont Road Option is considerably greater than that of the Over-Airmont Road Option. Rock cuts and associated retaining walls extend continuously from Airmont Road to Route 59 in the Under-Airmont Road Option, but are required only for short distances for the Over-Airmont Road Option.

The average Thruway grade from Hemion Road to the top of the Monsey Hill is 1.55 percent (a difference in elevation of 210 feet over 13,500 feet). However, this average grade cannot be achieved in a straight line because of the constraints represented by the existing bridge carrying Airmont Road over the Thruway and the Thruway bridge over Spook Rock Road. As a result, it is necessary to increase or decrease the grades to cross over or pass under the constraints.

Over-Airmont Road Option

In the Over-Airmont Road Option, the grade from Hemion Road to Airmont Road is increased to 1.9 percent for a length of 3,600 feet to elevate CRT to cross over Airmont Road. The grades are 1.5 percent or less for the remainder of the alignment, although the long length (5,900 feet) at 1.5 percent from Airmont to the tunnel under the Monsey Hill is notable.

Under-Airmont Road Option

In the Under-Airmont Road Option, the grade from Hemion Road to Airmont Road is below 1.5 percent, as a result of the relatively flat 800-feet long tunnel under Dunnigan Drive, Airmont Road, and the existing freight line. Full ventilation and fire-control facilities would be required for this tunnel. Once under Airmont Road, the CRT alignment would remain in deep cut or tunnel to the top of the Monsey Hill and beyond with the following grades:

- **Airmont Road to Spook Rock Road** - a 1.6-percent profile for 2,850 feet would be necessary to pass just under Spook Rock Road. This segment would not be in tunnel but would be in deep cut with walls up to 45-feet deep on the north side of the CRT to support the Thruway and up to 24-feet high on the south side to support the existing ground and five of the industrial buildings within the Spook Rock Industrial Park.
- **Spook Rock Road to the top of the Monsey Hill** –the alignment would be in a tunnel with a grade of 1.7 percent for a length of 4,020 feet. Tunneling under the Monsey Hill would be necessary based on the depth of the CRT relative to the elevations of the existing grades and the Thruway (Table 2-2). Because the CRT alignment is covered in tunnel, a higher maximum grade of up to 2% is allowable. A flatter grade could be used, but it would result in a longer and deeper tunnel at the Monsey Hill.

Overall both option alignments have sustained lengths of high grades through the study area; therefore this criterion is not considered a differentiator.

Operations and Maintenance

Key CRT operations and maintenance considerations common to both options are:

- Both options utilize the Piermont Line ROW and, therefore, would have the same impact on freight service. Provision would be included in both options to maintain the existing sidings, and for the continued operation of the freight line once construction is completed.
- Both options would utilize the same horizontal corridor on the southern edge of the Thruway and would have similar impacts to Thruway operations, including access restrictions to overbridges during inspections, routine maintenance and bridge repairs.

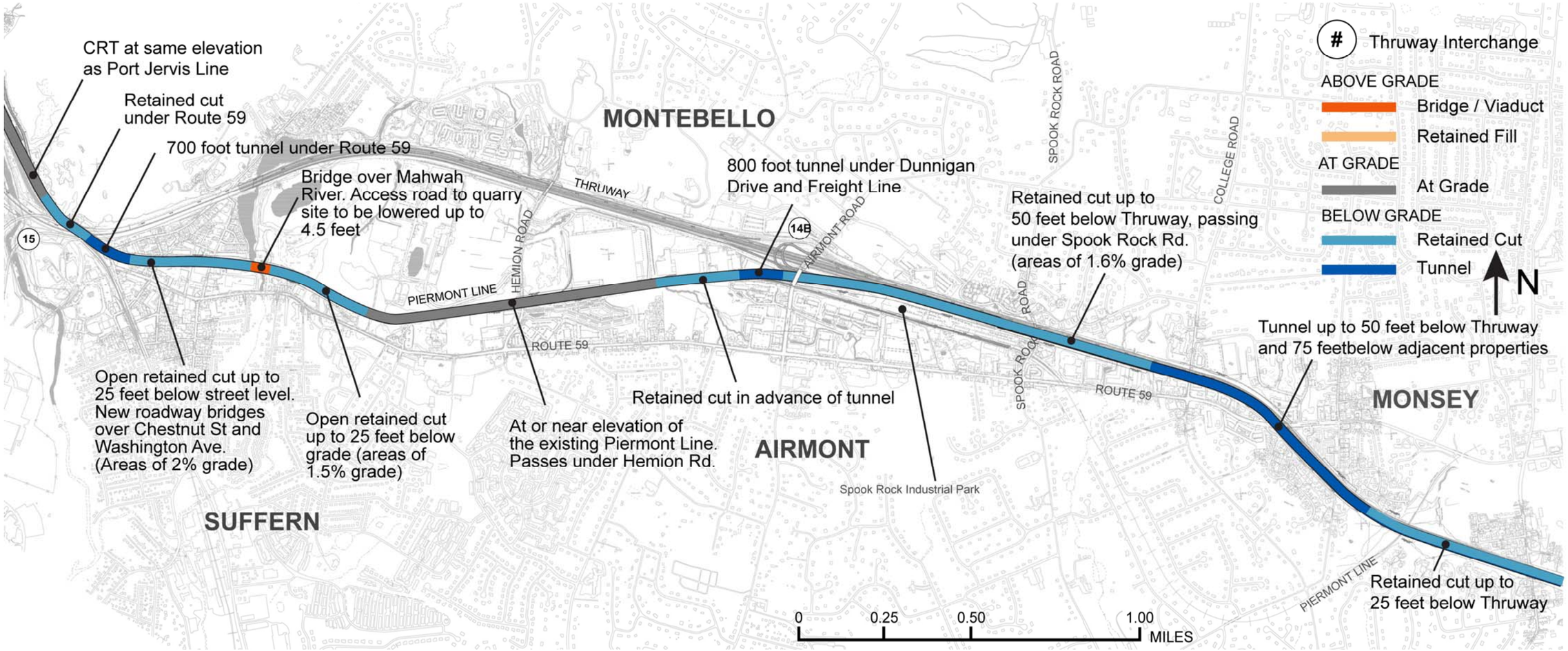


Figure 2-9 CRT in the Piermont Line ROW Under Airmont Road – Engineering Features

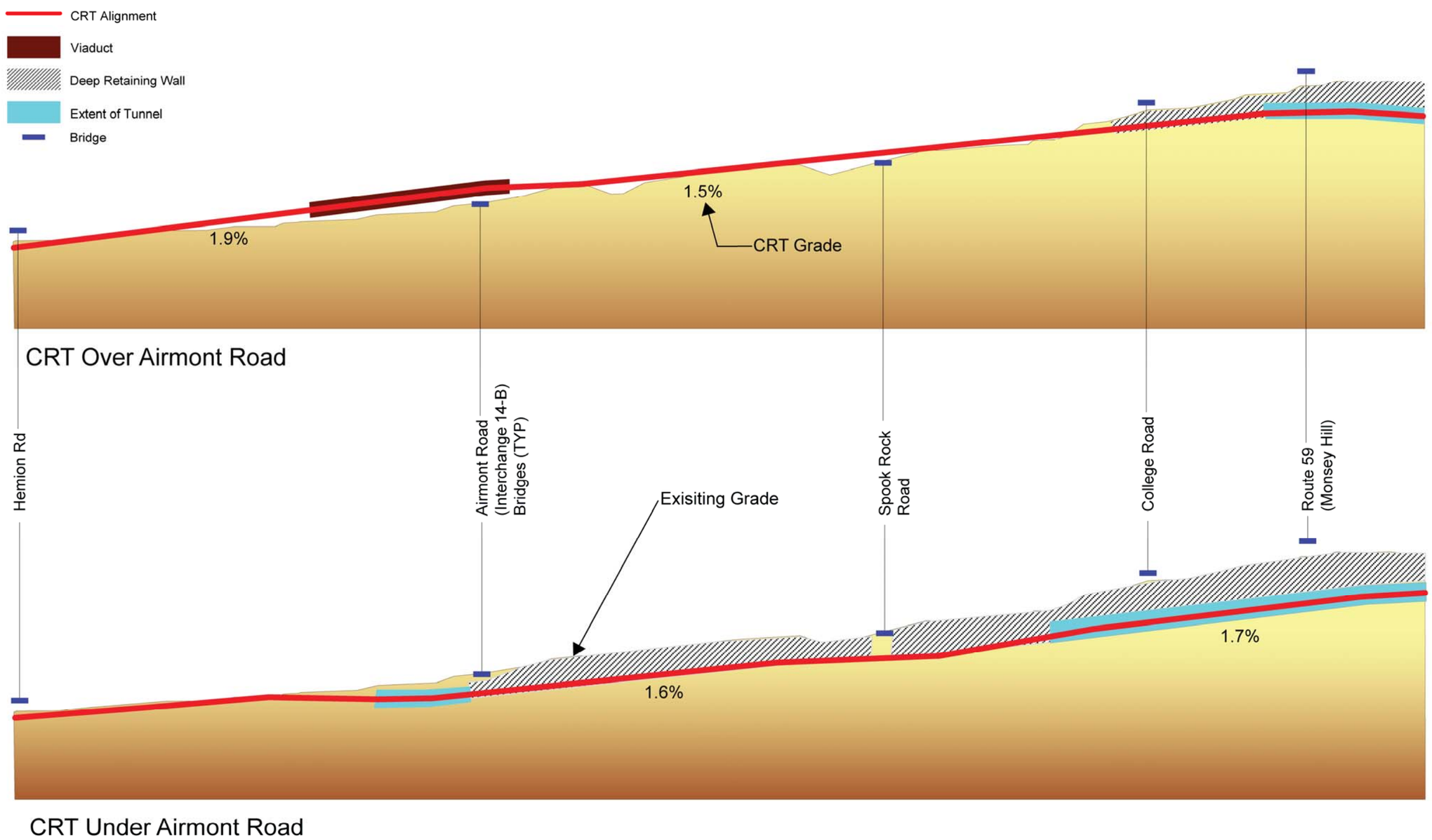


Figure 2-10 Profile of CRT Options Over and Under Airmont Road

Table 2-2

CRT Elevation Differences Adjacent to the Thruway and General Ground to the South

Location	Stationing	CRT Over Airmont Road Elevations (feet)					CRT Under Airmont Road Elevations (feet)			
		Thruway	Rail	Adjacent Ground to the South	CRT Elevation Difference [1,2]		Rail	Adjacent Ground to the South	CRT Elevation Difference [1,2]	
					Relative to Thruway on North Side of CRT	Relative to Ground on South Side of CRT			Relative to Thruway on North Side of CRT	Relative to Ground on South Side of CRT
	1	2	3	4	5	6	7	8	9	10
Hemion Road	190	NA	375	410	NA	-35	375	400	Same as Over-Airmont Road option	
Intermediate Location	225	NA	440	420	NA	+20	400	420	NA	-20
Airmont Road	235	430	458	438	+28	+20	409	438	-11	-30
West end of Spook Rock Industrial Park	250	470	470	452	0	+20	428	452	-42	-24
East end of Spook Rock Industrial Park	275	510	509	480	0	+29	463	480	-47	-17
Spook Rock Road	278	512	512	490	0	+22	463	490	-49	-27
Intermediate Location	295	540	533	538	-7	-5	490	538	-50	-48
College Road	310	575	558	590	-17	-30	514	590	-61	-76
Route 59	325	610	570	620	-40	-50	545	620	-65	-75
Monsey Heights Road Adjacent to Schwartz Memorial Park	340	605	550	610	-55	-60	548	610	-57	-62
Schwartz Memorial Park and Watercourse	345	585	545	520	-40	+25 above valley floor	Same as Over-Airmont Road Option			
Piermont Line	350	572	535	570	-35	-35	Same as Over-Airmont Road Option			
Krashes Court -100 foot valley below Thruway	355	550	530	450	-20	+80 above valley floor	Same as Over-Airmont Road Option			
Algonquin Circular	365	530	515	530	-15	-15	Same as Over-Airmont Road Option			
Saddle River Road	375	503	503	480	0	+23 above side road	Same as Over-Airmont Road Option			

Notes:
1. A '+' sign indicates the CRT is above ground.
2. A '-'sign indicates that CRT is below ground.

Differentiating operations and maintenance considerations are the three vent buildings associated with the two tunnels in the Under-Airmont Road Option, (one near Airmont Road and two near the top of the hill at Route 59). There are no vent buildings in the Over-Airmont Road Option. Operating and maintaining the tunnel vent buildings would be a requirement only of the Under Airmont Option, but this would not be so significant as to be a differentiator between the options.

Constructability

Differentiators between the two options are associated with the type, scale, and duration of construction. In general, construction impacts would be more adverse with the Under-Airmont Road Option due to the long lengths of underground construction. For example, at Spook Rock Road, construction activities associated with the Over-Airmont Road Option involve only an extension of the existing area of fill (up to 22-feet high) that originally formed the Thruway (Figure 2-11). However, in the Under-Airmont Road Option, deep excavation and extensive new retaining walls on both sides of the proposed CRT are required. The north retaining wall, which would support the Thruway, would be 49 feet high at Spook Rock Road, with heights reaching 65 feet elsewhere (Table 2-2, column 9). The retaining wall on the south side supporting the CRT would be 27-feet high at Spook Rock Road but would be as high as 76 feet at College Road (Table 2-2, column 10).

These retaining walls are required to support generally soft material to the west of College Road, but are in rock to the east. This rock is generally of good quality, but would require local rock nailing and containment to ensure rock slope stability. Wall types that limit subsidence are required because of the presence of approximately 10 commercial buildings adjacent to the south retaining walls. As a consequence, walls would be thick with extensive temporary supports during construction to control movements, resulting in higher construction costs and longer construction duration.

Both options are in a retained cut section east of College Road. Thus, they would be constructed from the Thruway using mining methods or excavation with retaining walls. For the Under-Airmont Road Option, which is the deeper of the two options in this area, it may be possible to construct the deepest sections as tunnels (with access from shafts located on each side of the Monsey Hill). However, further detailed geotechnical investigation would be required to confirm viability.

The construction duration for the Under-Airmont Road Option would be 2 to 3 years, compared to 1 to 2 years for the Over-Airmont Road Option, due to the extent of deep retaining walls and the complexity of construction.

The differences in construction complexity, (lengths of deep retaining walls and tunnels), construction risk and duration between the over and under Airmont Road options would include constructability as a major differentiator.

2.2.2.2 Cost

The capital cost estimates for the Under- and Over-Airmont Road options would be $2.29 billion and $1.30 billion (2012$), respectively. The extent of the estimate is the 6-mile segment from north of the 4th Street Bridge, which includes the proposed maintenance yard and Hillburn Station, to East Saddle River Road. The estimate includes the costs of the CRT infrastructure, systems, and trackwork. It also includes modifications/reconstruction of Thruway overbridges, pavement, and drainage systems, and all local street improvements that would be necessary to accommodate CRT. Costs associated with BRT Busway or HOV/HOT lanes and transit rolling stock and equipment are not included in the estimate. The large cost differential between these options (75 percent) is considered a differentiator.

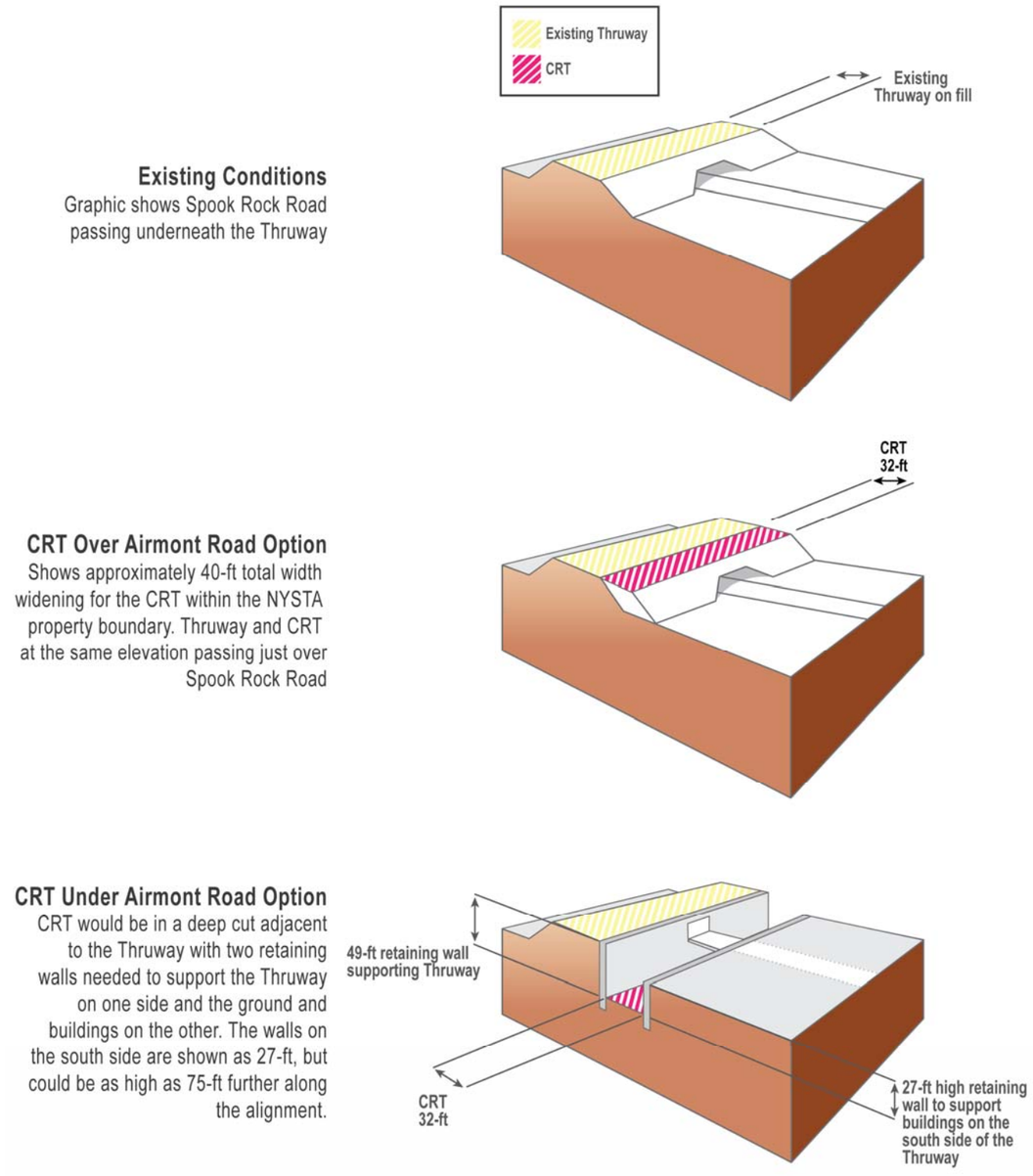


Figure 2-11 Comparison of Construction Activities at Spook Rock Road

2.2.2.3 Transportation

There is no significant difference in terms of travel time or transit system integration between the two options. Neither option would result in permanent traffic network changes in the study area. Transportation criteria are not considered differentiators.

2.2.2.4 Environment

The results of the environmental evaluation for the CRT Over- and Under Airmont Road Options are:

- **Land Use/Potential for TOD**. There are no differentiating land use impacts between the two options. There is no CRT station in this area. Land use and TOD are not considered differentiators.
- **Displacements and Acquisitions**. Both options would result in three commercial displacements at the Spook Rock Industrial Park with the BRT in HOV/HOT lanes alternatives. Neither option would result in property displacements with busway alternatives. Displacements and acquisitions are not considered a differentiator.
- **Wetlands**. The Over- and Under-Airmont Road Options would impact 1.71 and 2.03 acres of wetlands, respectively. Neither option would result in disturbance to a New York State Department of Environmental Conservation (NYSDEC) Class II wetland. Wetlands are not considered a differentiator.
- **Aquifers and Floodplains**. There are none in this area. Aquifers and floodplains are not considered a differentiator.
- **Parklands**. Both the Under and Over Airmont Road Options would require a taking from the Lillian G. and Frank J. Schwartz Memorial Park when these options are evaluated with the BRT in HOV/HOT lane alternative. The impact would be a sliver taking of 400 linear feet amounting to 0.11 acre. However, this taking would not be required with the BRT in a Busway alternative because the full-build footprint of the busway alignment in this area is not as wide as with the HOV/HOT alignment. Since this park impact is not directly associated with the over or under Airmont Road option alignments, Parklands are not considered a differentiator.
- **Historic Resources**. There are none in this area. Historic resources are not considered a differentiator.
- **Archaeological Resources**. There are none in this area. Archaeological resources are not considered a differentiator.
- **Hudson River Ecosystems.** The options would not impact the Hudson River. Hudson River ecosystems are not considered a differentiator.
- **Noise**. There would be an increase in noise under both options, however there would be a greater increase with the Over-Airmont Road Option by comparison since the Under-Airmont Road alignment is always in tunnel or below grade. However, the potential noise increase under either option is not anticipated to be perceptible because the increase in noise would be masked by the existing highway traffic noise. Therefore noise is not considered a differentiator.
- **Visual**. The Over-Airmont Road Option would result in visual impacts due to the CRT viaduct near residential-use sight lines. Conversely, only moderate visual impacts from the vent buildings and access shafts are anticipated in the Under-Airmont Road Option, and specifically to those properties adjacent to these facilities. Otherwise the Under-Airmont Option would cause minimal visual impacts. Based on the notable impacts of viaduct in the Over-Airmont Road Option visual impacts are considered a differentiator.

2.2.3 Transit Alignment Recommendation

The evaluation of the Over-Airmont Road and Under-Airmont Road Options in the 3.5 mile area between Airmont and Monsey is summarized in Table 2-3. The Over-Airmont Road Option is recommended for advancement into the EIS as an element of Alternatives B, C, D, and E based on the following criteria differentiators:

- **Engineering -** The CRT in the Under-Airmont Road Option alignment would be below grade from Hemion Road to East Saddle River Road because of the tunnel required to pass under Dunnigan Drive and the steep grade of the Thruway from Airmont Road to beyond the top of the Monsey Hill. This differs substantially from the Over-Airmont Road Option alignment, in which there are long alignment segments that are at the same grade as the Thruway. As a result, the infrastructure necessary to construct and maintain the Under-Airmont Road Option is substantially more complex than the Over-Airmont Road Option. The greater construction complexity of the Under-Airmont Road Option lengthens its construction duration by 1 to 2 years compared to the Over-Airmont Road Option.
- **Cost –** The capital cost estimates for the Under- and Over-Airmont Road options would be $2.29 billion and $1.30 billion (2012$), respectively, a difference of nearly $1 billion.
- **Environment -** The only environmental criterion considered a differentiator between the options is the visual impacts of the Over-Airmont Road Option to residences directly adjacent to the viaduct that crosses Airmont Road.

Table 2-3

Suffern Area: CRT Over/Under Airmont Road Options From The Piermont Line

Criteria	Piermont Line Over Airmont Road	Piermont Line Under Airmont Road
Engineering		
Engineering Design	Not a differentiator.	Not a differentiator.
Operations and Maintenance	Not a differentiator.	Not a differentiator.
Constructability	• Construction adjacent to Thruway would require 3,000 feet of retaining walls up to 25 feet deep to support the Thruway and adjacent properties.	• Partial closure of Airmont Road required for tunnel construction; number of lanes reduced during construction. • Cut and cover adjacent to Thruway would require 6,000 feet of retaining walls and 5,000 feet of tunnel from Airmont Road to the Monsey Hill. • Longer construction duration (1 to 2 years). • Construction adjacent to the Thruway requires shifting lanes and loss of shoulder.
Cost		
Capital Cost	$1.30 billion	$2.29 billion
Transportation		
Travel Time	Not a differentiator.	Not a differentiator.
Traffic Network Changes	Not a differentiator.	Not a differentiator.
Transportation System Integration	Not a differentiator.	Not a differentiator.
Environment		
Land Use / Potential for TOD	Not a differentiator.	Not a differentiator.
Displacements and Acquisitions	Not a differentiator.	Not a differentiator.
Wetlands	Not a differentiator.	Not a differentiator.
Aquifers and Floodplains	Not a differentiator.	Not a differentiator.
Parklands	Not a differentiator.	Not a differentiator.
Historic and Archaeological Resources	Not a differentiator.	Not a differentiator.
Hudson River Ecosystems	Not applicable.	Not applicable.
Noise	Not a differentiator	Not a differentiator.
Visual	Notable visual impacts to residences adjacent to the viaduct crossing Airmont Road.	Moderate visual impacts from tunnel vent buildings to adjacent properties in the vicinity of Airmont Road and Monsey Hill.

2.3 Monsey to West Nyack

In the Monsey-to-West Nyack area, the CRT alignment options relate to the placement of CRT in either the median or on the south side of the Thruway (Median and South Options). The study area for these options follows the Thruway ROW for a distance of approximately 8 miles from the top of the Monsey Hill to Interchange 11 in West Nyack. The Thruway profile in this area is comprised of two hills and a large valley (Figure 2-12):

- The western and taller hill is the Monsey Hill at the Route 59 overbridge (elevation 618 feet). From this location the Thruway descends 6.4 miles at grades up to 3-percent to the Hackensack River Valley (elevation 65 feet).
- From the valley, the Thruway proceeds on a 3-percent upgrade to the top of the second and smaller hill in Nyack at Interchange 11 (elevation 250 feet). The distance between the Hackensack River and Interchange 11 is approximately 2.5 miles; the elevation difference is 185 feet.

Since the CRT equipment cannot achieve the steeper Thruway grades, the CRT profile would be in a deep cut or in a tunnel at the two hill areas and on a viaduct across the Hackensack River Valley. This would be the same for both CRT options.

Area features that warranted consideration in the development and evaluation of the Median and South Options are:

- The Strawtown Road Historic District.
- Parks and nature reserves, including Monsey Glen County Park and Mountainview Nature Reserve.
- The Spring Valley Toll Plaza located between Hungry Hollow Road and Chestnut Ridge Road.
- Bridges carrying local roadways over the Thruway, including Hungry Hollow Road, Scotland Hill Road, Route 59, Pascack Valley Line, North Middletown Road, CSX West Shore Line, and Palisades Center Drive, among others.
- Interchange ramps and associated infrastructure at Interchanges 14A, 14, 13, and 12.
- Existing transit facilities adjacent to the Thruway, such as the park-and-ride lots at Interchange 14 and Parking Lot J (Interchange 12/Palisades Mall).

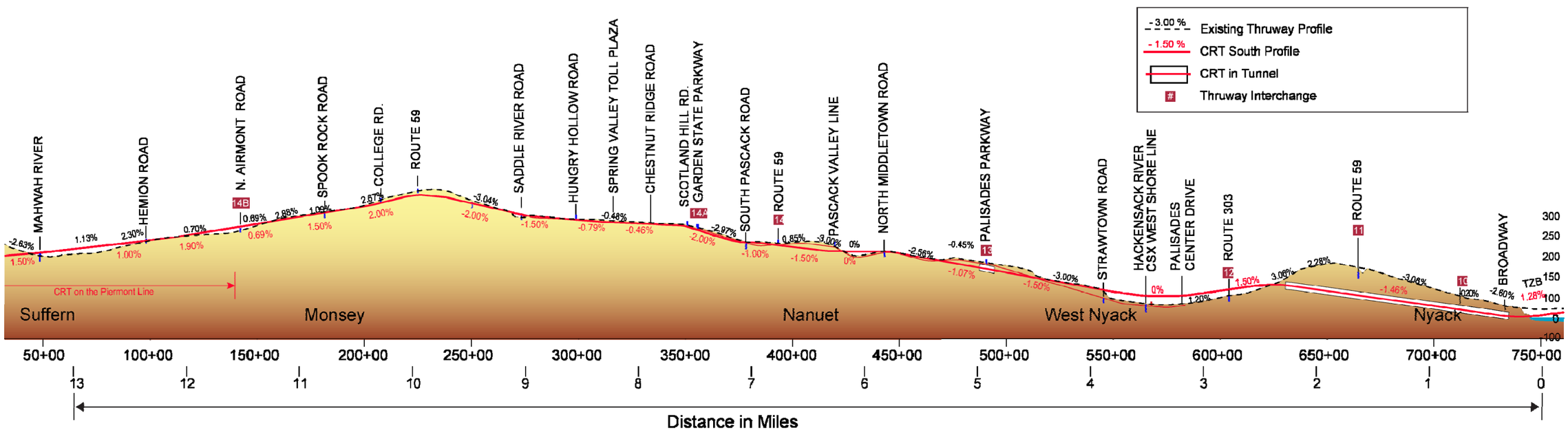


Figure 2-12 CRT Profile in Rockland County

2.3.1 Proposed Transit Operations

2.3.1.1 Commuter Rail Transit Operations

Both CRT options include two proposed stations (Interchange 14 and Palisades Mall), which are important transit facilities because they function as intermodal stations with direct BRT connectivity. The proposed stations would provide access to the CRT system from the central and eastern sections of Rockland County along the I-287 corridor. These intermodal stations are:

- **Interchange 14 Station** – Located in the heavily developed commercial area of Nanuet, this station would be accessible from Interchanges 14A and 14, and Route 59, and would be adjacent to the existing park-and-ride facilities on Forman Drive. The transit interconnectivity would be provided by the CRT and BRT trunk line station plus five BRT feeder routes that would access the BRT trunk line at this station (Figure 2-13). In addition, the local TOR bus routes 59 and 93, operating along Route 59, and other local bus routes would provide local transfer capability adding to the transit connectivity of this important transportation hub at the center of the county. Based on this station location and its configuration, the eastbound Thruway access ramp from Old Nyack Turnpike, (between Interchanges 14A and 14), would be closed with both options.

- **Palisades Mall Station** – Located in West Nyack in the vicinity of Interchange 12, Routes 303 and 59 at the existing Parking Lot J park-and-ride facility at the west end of the Palisades Mall, this station, in addition to being an important destination would become the transportation hub for the eastern portion of the county. The CRT station would be connected to the BRT trunk line plus two additional BRT feeder routes would access the BRT system at this station (Figure 2-14). In addition, local bus services (i.e., TOR Routes 59, 91, 92 and 97, and Clarkstown Mini-Trans Routes A and D) approach the station area from various directions.

2.3.1.2 CRT Alignment Options and Bus Rapid Transit

BRT would operate either in HOV/HOT lanes in the Thruway median or in a busway either in the median or on the north side or south side of the Thruway (as described in Chapters 3 and 4). The major difference between the CRT alignment options and the BRT alternatives is how the BRT station access and configuration would integrate with CRT at the Interchange 14 and Palisades Mall intermodal stations.

- **Busway alternatives** - stations would be located along the busway alignment ("on-line").
- **BRT in HOV/HOT lane alternatives** - stations would be located alongside the Thruway ("off-line").

With the CRT South Option and HOV/HOT lane alternatives, exclusive BRT ramps (referred to as "Texas-Ts") would be built to provide access to and from the off-line stations for both BRT buses in the HOV/HOT lanes and for feeder buses to access the HOV/HOT lanes directly from the stations (Photo 2-2). With the CRT Median Option, the HOV/HOT lanes would be split to allow the CRT to occupy the center of the Thruway. As a result, the Texas-Ts would be reconfigured to span over the CRT alignment to access the BRT stations. This ramp configuration is referred to as a "Texas-H" (Photo 2-3).

With the in-line station configuration of the busway alternatives, the CRT Median and South Options would have no impact on the BRT accessibility to and from the busway.

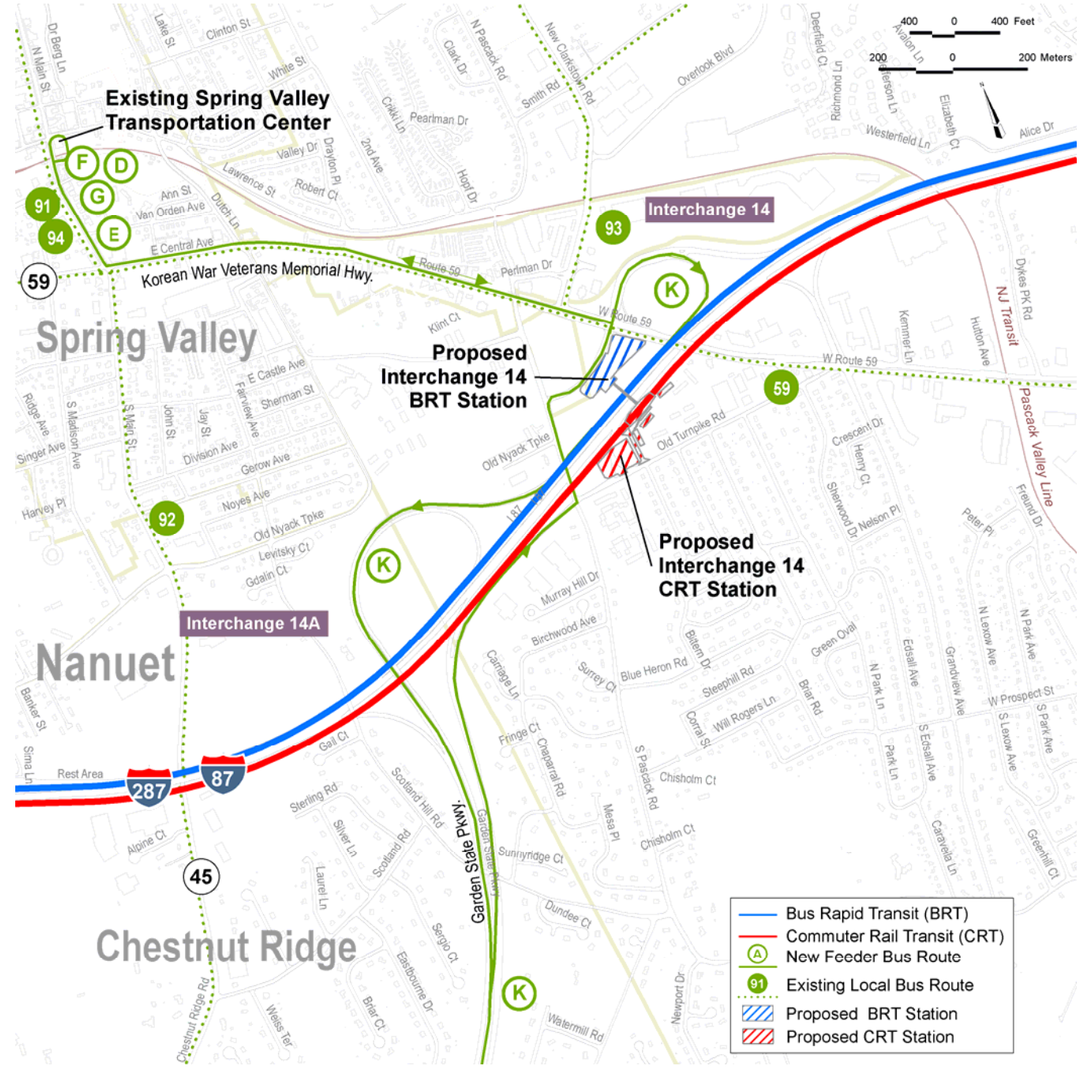


Figure 2-13 Interchange 14 Station Connectivity Diagram

Figure 2-14 Palisades Mall Station Connectivity Diagram

Photo 2-2 HOV Texas-T Configuration

Photo 2-3 HOV Texas-H Configuration

2.3.2 Description of Alignment Options

Both the South and Median Options, with either the HOV/HOT lane or busway alternatives, would generally fit within the Thruway ROW. The Median Option being in the center of the roadway would have a profile that is closer to the Thruway's profile thus reducing the extent of retaining walls in comparison to the South Option. The Median Option would also avoid interaction with entry and exit ramps at Interchanges 14A, 14 and 13, which reduces the length of track at steeper grades compared to the South Option. The Median Option CRT stations would be located in the center of the Thruway requiring pedestrian bridges over the highway for access to the platforms whereas the CRT South Option stations would be along the side of the highway with simpler pedestrian accessibility.

2.3.2.1 South Option

The South Option alignment features are shown on Figure 2-15. The South Option would require long lengths of 2-percent grade to approximate the Thruway grade from the Monsey Hill down to the Hackensack River and then up to the tunnel portal west of Interchange 11. It would also require a 7,640-foot long viaduct over the Hackensack River Valley to avoid very deep cuts and long tunnels. This viaduct would be 25 feet above the Thruway at Strawtown Road and 50 feet above the Thruway at the Palisades Mall.

The ramps of Interchanges 14A, 14, and 13 would be relocated and/or modified to accommodate the South Option. There would also be the need to provide additional length to every bridge over the Thruway to accommodate the CRT alignment beyond what would be required for BRT alignments (whether in HOV/HOT lanes or a busway).

2.3.2.2 Median Option

The Median Option alignment features are shown on Figure 2-15. This option would place CRT in the Thruway median from the top of the Monsey Hill to the tunnel portal between Interchanges 12 and 11. From the west, the CRT alignment would enter a tunnel at the Monsey Hill and would transition from the Thruway's south side to the median and daylight just west of the abandoned Piermont Line crossing.

The Median Option would also include a viaduct over the Hackensack River Valley that is slightly longer (7,750 feet) than the South Option. The height of the median viaduct would be 30 feet above the Thruway at Strawtown Road and 50 feet above the Thruway at the Palisades Mall. As with the South Option there would be the need to provide additional length to every bridge over the Thruway along the alignment beyond what would be required for the BRT alignments (whether in HOV/HOT lanes or a busway).

2.3.3 Evaluation Results

This subchapter presents the evaluation results for the CRT Median and South Options.

2.3.3.1 Engineering

The engineering evaluation of the options is presented below.

Engineering Design (CRT Horizontal Alignment)

The horizontal alignments of both options do not differ substantially as they are each aligned with and constrained by the horizontal alignment of the existing Thruway. As a consequence, both options have similar operating speeds and resulting travel times across the Rockland County and remain "tight" to the alignment of the Thruway. The Median Option is marginally wider (4 feet) than the South Option as the tracks of the former separate to pass each side of the central piers at overbridges. This increased width, together with the additional width at the Texas-H access ramps at the BRT stations in the HOV/HOT alternatives, result in larger footprints for the Median Option.

Engineering Design (CRT Vertical Alignment)

There are no substantive differences between the vertical profiles of both options. Generally, it would be expected that the Median Option would have a smoother and lower grade CRT profile through interchanges as it avoids conflict with the Thruway access ramps. However, the overall topography governs the profile for both options. Thus, the Median Option would be in a deep cut at Interchanges 14A, 14 and 13, and high above Interchange 12 with no conflict with the existing interchange ramps.

The South Option at Interchange 14A would conflict with the two existing ramps, which would need to be reconfigured – one as a short tunnel under the CRT and the other as a viaduct over the CRT. At Interchanges 14 and 13 the South Option profile would require new ramp structures to allow the ramps to span over the CRT alignment below. At Interchange 12 the profile would be similar to the Median Option with no conflicts with the interchange ramps.

In summary, the CRT profile grades of both options were dominated by the general topography of the study area rather than the anticipated conflicts at interchange ramps. Although both options have extensive lengths of high grade (at or above 1.5 percent), this is not considered a differentiator between the options. The total length of CRT at high grades for the Median and South Options, excluding the tunnel sections where high grades are permissible, is 4.5 miles for both options.

Operations and Maintenance

The introduction of CRT within the Thruway ROW presents a number of operational and maintenance issues relative to the interactivity of the highway and commuter rail. Table 2-4 provides a summary comparison of the primary operating and maintenance activities for both options. Of the 21 activities and incidents considered, preference for the Median and South Options was identified in two and seven activities, respectively, with no preference identified in the remainder.

Specific advantages of the South Option are:

- Access to CRT from the Thruway's outside shoulder can be provided without the need for additional widening of the Thruway for Hi-Rail access or passenger emergency egress.
- CRT would potentially only be affected by major incidents on the southbound Thruway and vice versa.
- Thruway traffic can be diverted to the northbound lanes during periods of major repair or rehabilitation at any point along the Thruway.
- Bridges over the Thruway can be reconstructed without interfering directly with CRT operations. Nighttime closure would be sufficient to perform the work.

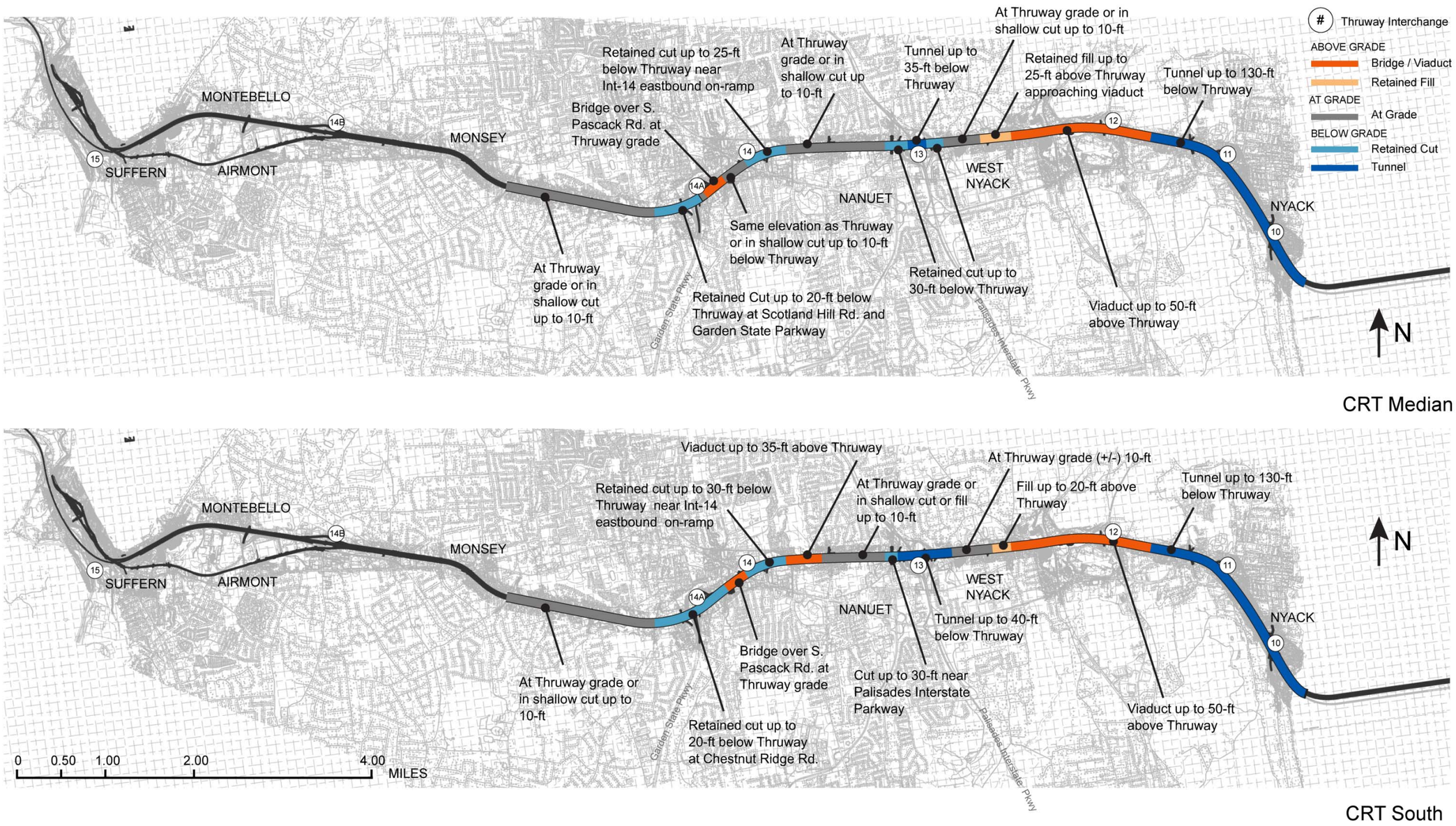


Figure 2-15 CRT in Median or on South Side of Thruway – Engineering Features

Table 2-4

Comparison of Primary Operation and Maintenance Activities/Incidents

Activity or Incident (Only primary activities are included)		Special Provisions or Response Requirements	Option Preference and Basis
Accidental Events			
1.	Minor incident on Thruway	Access for highway patrol required using interchanges for circulation.	None.
2.	Major incident on Thruway	Likely closure of Thruway with potential closure of CRT depending on location of incident. Emergency response from both directions on the Thruway.	South Option preference, as only incidents on the southbound Thruway are likely to affect CRT.
3.	Thruway flooding	Flooding anticipated only in the region of Hackensack River.	None, as CRT for both options is elevated through the area of concern.
4.	Disabled CRT consist	Requires passengers to transfer to consist on adjacent track.	None, as activities are confined to CRT tracks.
5.	Minor incident on CRT	Evacuation of passengers to track required to nearest side road. Stair access from side roads required.	South Option preference, as access stairs can be accommodated locally without realignment of the Thruway.
6.	Major incident on CRT	Same as minor incidents but emergency services required. Emergency response from both directions on the Thruway. Requires ability to direct traffic onto opposite pavement.	South Option preference, as incidents on CRT tracks would affect only southbound Thruway operations. Crossovers are possible at five locations in the Median Option
7.	Regional Emergency	Potential need for all traffic on both pavements to be directed northbound or southbound.	None.
8.	Low adhesion CRT tracks	This condition occurs when leaf residue and oil deposits fall on the tracks, which can cause operational and emergency access issues.	Median Option preference, as the track is at some distance from the adjacent foliage on either side of the Thruway.
Inspections and Minor Repairs			
9.	Pavement	No special provisions required,	None.
10.	Bridge	Agreements between operating authorities required for safe access.	None.
11.	Drainage	Agreements between operating authorities required for safe access.	None.
12.	Electrical	No special provisions required.	None.
13.	Pump stations, substations, and vent facilities	These facilities are all located on the south side of the Thruway.	South Option preference, to keep facilities adjacent to CRT, thus minimizing maintenance and Thruway disruption.
14.	Trackwork	Access to CRT for Hi-Rail vehicles required specifically at interlockings.	South Option preference, as maintenance vehicles can stop on the hard shoulder. In the Median Option overwidening would be required to provide space to stop vehicles.

Table 2-4 (cont)

Comparison of Primary Operation and Maintenance Activities/Incidents

Activity or Incident (Only primary activities are included)		Special Provisions or Response Requirements	Option Preference and Basis
General Maintenance Activities			
15.	Snow removal	Snow plowed to both shoulders of the Thruway. CRT consists plow snow during normal operations with special plow when necessary.	Over-widening of CRT to allow for storage of snow may be required in both options.
16.	Vegetation control	Access for equipment and personnel required.	Median Option preference due to simplified access from the highway shoulder. South Option would require coordination with MNR to access the vegetation.
Enforcement and Security			
17.	Highway patrol access	No special provisions required.	None.
18.	Security monitoring	No special provisions required.	None.
19.	Traffic operations monitoring	No special provisions required.	None.
Major Repair or Refurbishment (representative examples)			
20.	Thruway pavement replacement	Diversion of traffic required around construction.	South Option preference, as traffic can be diverted onto part of opposite pavement if necessary.
21.	Bridge replacement	Agreements between operating authorities required for safe access.	South Option preference, as construction of central pier does not disrupt CRT operations as it would in the Median Option.

Low adhesion conditions could result from leaf residue, icing, oil deposits, and steep grades. While the potential for leaf residue on the tracks is less with the Median Option (track location being further away from vegetation), there is no difference between the two options as it relates to the other factors causing low adhesion conditions. Improvement to service in low adhesion conditions can be achieved by a combination of measures (e.g., track maintenance, cleaning, water jetting, sanders, vegetation offsets and end-end running). Additionally, low adhesion conditions could be offset by equipment upgrades or enhancements (e.g., addition of a third locomotive, reduction in the number of cars in a consist, introduction of Diesel Multiple Units and future new engine technology).

Constructability

Constructability evaluates how these options would be constructed and includes consideration of complexity, duration, temporary access and construction site requirements, and locations for support facilities. The key differentiators are:

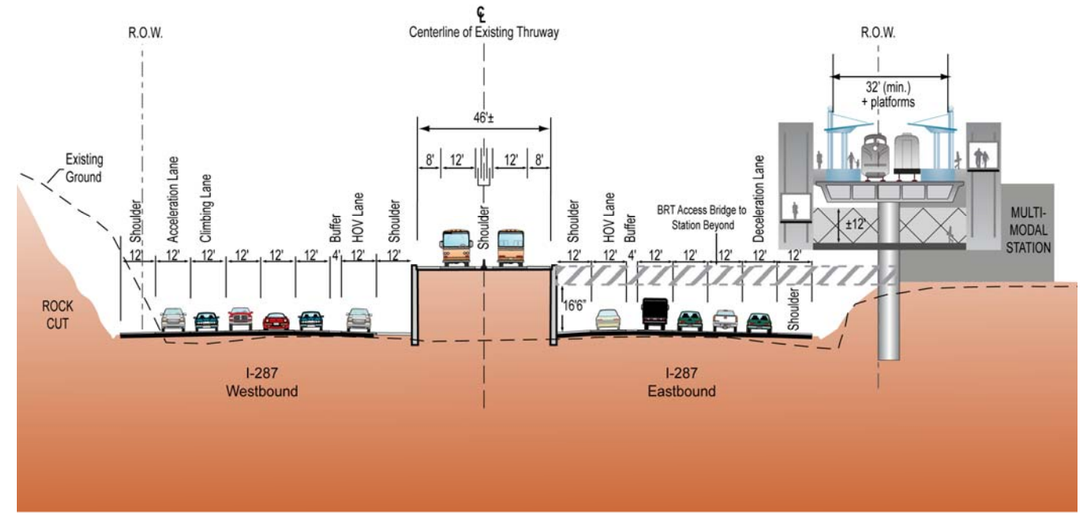
- **Thruway Relocation -** The need to relocate the westbound lanes of the Thruway in the Median Option is a major differentiator compared to the South Option. In the South Option not only is the Thruway undisturbed, except for some interchange ramps, but CRT would also fit within the space between the edge of the Thruway and the ROW boundary.

- **Station Structures -** The proposed CRT station in the Median Option at the Palisades Mall (Figure 2-16) would be elevated (50 feet above the Thruway), with substantial structure above an active Thruway including station platforms, stairs, and elevator shafts. This station is complex to construct because of the extensive structure to be supported, the future integration of CRT and highway operations required for inspection and maintenance, and the potential integration of BRT ramps underneath the station in the BRT in HOV/HOT lanes alternatives. These issues can be simplified or eliminated in the South Option.

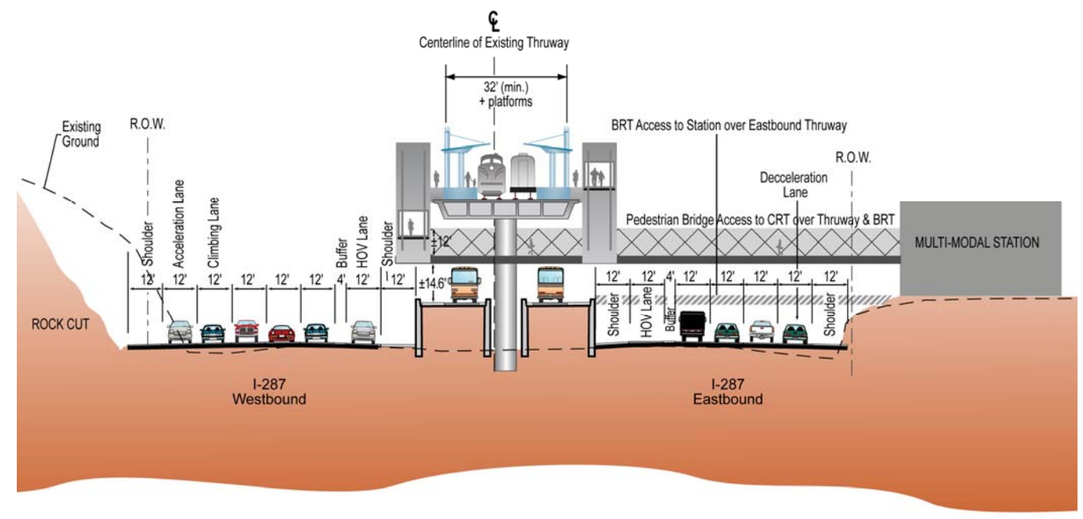
- **Space and Access for Construction -** There are many locations from which CRT can be staged and constructed in the South Option. For example, there are extensive open areas that would facilitate a construction site with direct access to the CRT alignment in the Interchange 13 area where CRT is in deep cut. In comparison, in the Median Option access would be highly restricted with construction occurring on a limited width work site between the westbound and eastbound lanes of the Thruway. Construction would need to be carefully staged with only limited activities occurring simultaneously because of constricted access and safety requirements adjacent to high-speed traffic lanes. As a result, the rate of construction for the Median Option would be substantially lower than that of the South Option.

  In the Median Option heavy equipment to construct tunnels and retaining walls would be located directly adjacent to existing high speed traffic lanes. This would result in extensive traffic relocations in both directions with closure of the inside shoulders anticipated for long durations. In the South Option closure of only one outside shoulder would be required with substantially less impacts to traffic operations anticipated during construction.

- **Support Facilities -** Ventilation facilities would need to be placed over each of the three CRT tunnels in both options to provide the necessary air intakes and extracts in emergency conditions. In the Median Option this would result in facilities between the eastbound and westbound Thruway lanes with limited access. Ventilation buildings in the South Option could be accessed easily from the Thruway shoulder or from side roads with little or no disruption to Thruway traffic.



South Option



Median Option

Figure 2-16 CRT with BRT in HOV/HOT Lanes
Typical Cross-Section at Proposed Palisades Mall Station

- **Extent of Retaining Walls -** Substantially more retaining walls are required in the Median Option than the South Option. For example, one retaining wall would be required in the South Option located at the interface of the CRT and highway lanes where the existing Thruway is in cut with CRT at a lower elevation. In comparison, three retaining walls would be required in the Median Option – two that support each side of the CRT excavation and one to support the relocated edge of the Thruway. These added retaining walls result in more complex construction activities that lead to longer construction duration and greater cost for the Median Option.

- **Construction Duration –** For the South Option, construction duration would be substantially shorter than the Median Option. Construction of the primary components (tunnels, facilities, cuts and fills) in the South Option could occur simultaneously in many locations with many construction crews spread along the alignment. Construction duration of 3 to 4 years would be expected.

  In the Median Option the existing westbound Thruway would have to be relocated before any construction of the CRT could occur – an activity that would take 3 to 4 years or longer. CRT construction would only commence when relocation of the Thruway is completed, and duration of 4 to 5 years is anticipated just for the CRT. This duration is substantially longer than that of the South Option because of the difficulties of access, restrictions on equipment beside interstate highway traffic and associated safety considerations. In particular, the linear construction of foundations for the long viaducts would take a substantially longer time and would require longer nighttime lane closures and overnight construction.

2.3.3.2 Cost

The total capital cost estimates for the Median and South Options have been developed with consideration of BRT in HOV/HOT lanes and BRT in busway (Table 2-5). The limits of the estimate include the 7.6 mile segment from 200 feet east of Route 59 in Monsey to 800 feet west of Mountainview Road. These costs include all infrastructure, systems, and trackwork to provide for the CRT. Costs of BRT in either HOV/HOT lanes or in a busway with associated stations and access ramps have been included. Additionally, the proposed highway improvements, (i.e., climbing lanes), and modifications to overbridges and access ramps are included, as are any local roadway improvements to accommodate transit. Costs associated with transit rolling stock and equipment are not included in the estimate

Table 2-5

Cost Estimates for CRT in Median and South Options with BRT

Option	Cost Estimate (2012 Billions $)
CRT South with BRT in HOV/HOT Lanes	5.23
CRT South with BRT Busway North	4.95
CRT South with BRT Busway South	5.30
CRT Median with BRT in HOV/HOT Lanes	7.36
CRT Median with BRT Busway North	6.52
CRT Median with BRT Busway South	6.76

The greater costs for CRT in the Median Options are a result of:

- Major rock cuts in the Nyack area between Interchanges12 and 11.
- CRT crossover tunnel at the top of the Monsey Hill.
- Duplication of retaining walls where the CRT is in retained cut below the highway.
- Construction complexity at overbridges, tunnels and facilities.
- Slower construction rate due to restricted access.

2.3.3.3 Transportation

There is no difference in either travel time or traffic network changes between the two options. However, there are some differences related to the proposed CRT stations with respect to access from parking areas, station operation and maintenance, and transit connectivity with local services:

- **Transit Connectivity at the Interchange 14 Station –** The Median Option CRT station would be closer to the BRT station than the South Option with a proposed BRT station located on the north side of the Thruway adjacent to the existing park-and-ride facilities, thus reducing intermodal and local bus transfer times.

- **Transit Connectivity at the Proposed Palisades Mall Station -** The South Option would reduce intermodal transfer and local bus transfer times compared to the Median Option because the BRT station would be located in the vicinity of Parking Lot J as would the CRT station, rather than in the middle of the Thruway.

- **Station Operations and Maintenance –** In general with the Median Option maintenance and emergency access to the CRT system could be more difficult compared to the South Option due to its location in the center of the highway, which could be compounded with the surrounding bus access ramps in the HOV/HOT lane alternative.

- **Parking Access –** Parking for the proposed Interchange 14 Station would be on the north side of the Thruway, where the existing park-and-ride lots are located. The Median Option would allow for a shorter distance to walk between the parking area and the CRT station platforms. Parking for the Palisades Mall Station would be located in the area of the existing Parking Lot J at the Palisades Center Mall. The South Option allows for a shorter walk between these parking areas and the Palisades Mall Station.

In summary, both the Median and South Options would have minor advantages in transfer time for one of the two intermodal stations. Transit system integration is not considered a differentiator.

2.3.3.4 Environment

An environmental evaluation was performed for potential impacts related to the CRT Median and South Options. The analysis is focused on the area of the Monsey Hill to Interchange 11. For context, the analysis is presented with consideration of BRT in HOV/HOT lanes and in a busway. The results of the environmental evaluation are:

- **Land Use/Potential for TOD.** With both options largely within the Thruway ROW, neither option would directly affect existing land uses, although some acquisitions and displacements would occur in proximity to proposed stations, these effects would be generally common to both options. Land use is not considered a differentiator. Potential for TOD exists with both options and the areas available for redevelopment within ¼ to ½ mile of the stations would be common to both options. TOD potential is not considered a differentiator.

- **Displacement and Acquisitions**. The Median and South Options would result in 37 and 39 total displacements, respectively, when considered with BRT in HOV/HOT lanes. The Median and South Options would result in 53 and 56 total displacements, respectively, when considered with BRT in a busway. Since the

difference in total displacements is only two and three respectively, displacements and acquisitions are not considered differentiators.

- **Wetlands**. The Median and South Options would each result in approximately 25 acres of direct impacts to wetlands, regardless of whether BRT is in HOV/HOT lanes or a busway. Both options would cross the Hackensack River (a Class A water body) and impact the NYSDEC-mapped wetlands adjacent to the river. Wetlands are not considered a differentiator.

- **Aquifers and Floodplains**. The presence of the Ridgewood sole-source aquifer would require USEPA approval for both options and may require special runoff controls if a potential to contaminate the aquifer is identified. Any impacts to floodplains would be common to both options; therefore they are not considered a differentiator.

- **Parklands.** Both options would affect parks located near the Thruway. There would be sliver takings of Lillian G. & Frank J. Schwartz Memorial Park, Mountainview Nature Preserve, and Monsey Glen Park totaling less than 1 acre whether BRT is in HOV/HOT lanes or in a busway. Parkland impacts are not considered a differentiator.

- **Historic Resources.** Both options would result in the same impacts to historic architectural resources when considered with BRT in HOV/HOT lanes. While more resources would be affected when the CRT options are considered with a busway, there is no difference between the properties affected in each CRT option. In all cases, the impacts would not significantly compromise the historic feeling and setting of the resources. Historic resources are not considered a differentiator.

- **Archaeological Resources.** Both options have the same potential for archaeological sensitivity regardless of whether BRT is in HOV/HOT lanes or a busway. Archaeological resources are not considered a differentiator.

- **Hudson River Ecosystems**. Neither option affects the Hudson River. Hudson River ecosystems are not considered a differentiator.

- **Noise.** For both options the CRT noise would be largely masked by the highway traffic noise and it is not anticipated that the CRT noise increase would be perceptible on an average hourly basis. Where the highway is in deep cut there would potentially result in a perceptible noise increase; however this would apply to both options. Therefore noise is not considered a differentiator.

- **Visual.** Visual impacts from the Median Option would be less than those of the South Option. The South Option would be closer to residences on the south side with those segments of CRT on structure. For example, at Louise Drive, near Strawtown Road, trains and the top of structure would be visible to residences, with notable visual impacts. The Median Option would be approximately 30feet farther from these residences with those segments of CRT on structure; although vehicles would be closer, their impacts could be screened by noise barriers.

  For both options, the nearest homes would likely retain some screening from vegetation and, typically, it would be the second tier of homes across Deer Meadow Drive or Louise Drive that may be most visually exposed to the CRT viaduct. At greater distances, the viaduct feature would be less visually prominent. Visual impacts are not considered a differentiator.

2.3.4 Transit Alignment Recommendation

The evaluation of the Median and South Options in the 9 mile area between Monsey and West Nyack is summarized in Table 2-6. The South Option is recommended for advancement into the EIS as an element of Alternatives B, C, D, and E based on the following criteria differentiators:

- **Engineering** – The South Option has more advantages than the Median Option. The South Option reduces potential interference between CRT and Thruway operations and maintenance activities during both normal and emergency conditions; minimizes construction duration and complexity; facilitates construction from available land with adjacent access; and simplifies construction of the proposed elevated CRT station at the Palisades Mall.

- **Cost** – The cost differential between the CRT Median and the South Option with BRT in HOV/HOT lanes is $2.13 billion. The cost differential between the CRT Median and the South Option with Busway North is $1.57 billion, and is $1.46 billion with Busway South.

Table 2-6

CRT Median vs. South Options

Criteria	CRT in Median	CRT on South Side
Engineering		
Engineering Design	Not a differentiator.	Not a differentiator.
Operations and Maintenance	O & M preference for reduced leaf residue on tracks that cause low adhesion conditions and easier vegetation control on the side of the Thruway.	O & M preference for facility inspections; less potential impact to Thruway and CRT operations in the event of a major incident; major bridge repair or pavement rehabilitation on the Thruway.
Constructability	Construction complexity due to the need to relocate the Thruway prior to CRT construction; station construction in the center of the Thruway; limited and constrained work areas; an additional four to five year construction duration.	Construction is less complex due to easier site access; multiple work sites; simpler station construction on the side of the Thruway; shorter construction duration.
Cost		
Capital Costs (2012 $)	$7.36 billion (HOV/HOT lanes) $6.76 billion Busway South; $6.52 Busway North	$5.23 billion (HOV/HOT lanes); $5.30 billion Busway South; $4.95billion Busway North
Transportation		
Travel Time	Not a differentiator.	Not a differentiator.
Traffic Network Changes	Not a differentiator.	Not a differentiator.
Transportation System Integration	Not a differentiator.	Not a differentiator.
Environment		
Land Use / Potential for TOD	Not a differentiator.	Not a differentiator.
Displacements and Acquisitions	Not a differentiator.	Not a differentiator.
Wetlands	Not a differentiator.	Not a differentiator.
Aquifers and Floodplains	Not a differentiator.	Not a differentiator.
Parklands	Not a differentiator.	Not a differentiator.
Historic Resources	Not a differentiator.	Not a differentiator.
Archaeological Resources	Not a differentiator.	Not a differentiator.
Hudson River Ecosystems	Not a differentiator.	Not a differentiator.
Noise	Not a differentiator.	Not a differentiator.
Visual	Not a differentiator.	Not a differentiator.

2.4 Clarkstown and Orangetown

The CRT alignment that crosses the Hackensack River Valley is proposed to be on a long viaduct that spans over the West Shore Line (WSL). This alignment is referred to as the Over-WSL Option. Another alignment option was developed that would avoid the long viaduct and travel beneath the WSL (Under-WSL Option). The WSL, (also known as the River Line) is located directly east of the Hackensack River and is less than ½-mile west of Interchange 12. The WSL is owned and operated by CSX and carries 24 freight trains daily; thus, operations must be maintained at all times. Factors that warranted consideration in the development and evaluation of the options are:

- Five major and four minor watercourses, including the Hackensack River, which requires approximately 60-foot clearance under, or a 10-foot clearance over, to meet the 100-year flood standards.
- The Strawtown Road Historic District.
- Residential properties along Deer Meadow Drive and Louise Drive.
- WSL Line bridge over the Thruway and the continuation of existing freight service.
- Proposed intermodal Palisades Mall Station at Parking Lot J.
- Interchange 12 ramps.
- Palisades Center Drive Bridge over the Thruway.

The analysis of Under-WSL and Over-WSL Options is complicated by the fact that there are also CRT Median and South Options in the Clarkstown and Orangetown area. However, the vertical alignments of Median and South Options in this area are similar, and therefore this subchapter focuses on evaluation of the Under- and Over WSL Options without specific reference to the CRT Median or South options.

2.4.1 Description of Alignment Options

In the Over-WSL Option there would be a long viaduct, approximately 7,700-feet long from Strawtown Road to east of Interchange 12 because of the Thruway grades described in Subchapter 2.3 (Figure 2-17). The Under-WSL Option would be at Thruway grade where it crosses over the Hackensack River and under the WSL. In addition to the Thruway and CRT profile grade differences there are other area features to consider when setting the CRT profile. These include:

- Interchanges 14A, 14, 13, and 12.

- Three watershed areas with numerous watercourses:
  - Upper Saddle River watershed basin (Saddle River tributary and one minor watercourse).
  - Pascack Brook watershed basin (Pascack Brook).
  - Headwaters of the Hackensack River (Nauraushaun Brook, Hackensack River, two minor watercourses, and three major watercourses).

- Twelve crossroads.

2.4.2 Evaluation Results

2.4.2.1 Engineering

The engineering evaluation of the options is presented below.

Engineering Design

Both options have the same horizontal alignment with no substantive differentiation between options. Vertical alignments, however, differ substantially. As shown on Figure 2-17, the two options differ from South Pascack Road near Interchange 14A to the replacement Tappan Zee Bridge. In particular, the options differ with respect to the extent of tunnels (4.3 and 2.1 miles, respectively) for the Under- and Over-WSL Options.

For the Under-WSL Option the critical grade section is from beneath the WSL to over the South Pascack Road Bridge just east of Interchange 14A. The elevation difference through this area is 315 feet over a length of 19,000 feet with a corresponding average grade of 1.7 percent. The CRT would primarily be in tunnel (1.96-miles) and would pass under the North Middletown Road; however, it would conflict with Strawtown Road, which also passes under the Thruway. To avoid this conflict, Strawtown Road would need to be lowered by 10 to 15 feet below its current elevation – a requirement that would impact the access roads to the properties along the side roads. An alternative would be to lower the CRT below Strawtown Road, but this would extend the tunnel for an undesirable 6 miles to the top of the Monsey Hill.

The feasibility of the proposed Interchange 14 Station in the Under-WSL Option is also an issue as the grades through the proposed station location are 2 percent. This would exceed the 1-percent maximum grade allowable at stations in accordance with the project design criteria. The proposed station would be relocated to the west in the vicinity of Chestnut Ridge Road where access to the station would be limited.

By contrast the highest grade in the Over-WSL Option occurs between North Middletown Road and the WSL – a distance of about 2 miles with an average grade of 1.87 percent. It would then flatten to 1.5 percent to reach South Pascack Road. No modifications to side roads would be necessary for the Over-WSL Option. The proposed location of the Interchange 14 Station in Over-WSL option would be feasible and functional.

Differences between the two options are also evident in the modifications to existing watercourses. The Under-WSL Option would conflict with a number of existing watercourses and would require major diversions and new culverts to maintain flow. No conflicts would exist with the Over-WSL Option.

Operations and Maintenance

The primary differentiator is the operation of the tunnel in the Under-WSL Option in the area from South Pascack Road to Interchange 12. This long tunnel (approximately 10,000 feet), would require ventilation buildings located near quarter points or tunnel portals. Space to site and access these facilities would be required within secure areas. These ventilation buildings would be sized for both emergency and normal venting requirements as the CRT service includes the possibility for running both electric and diesel units. Potential locations for the ventilation buildings would include NYSTA and other state property within Interchanges 13 and 14A.

The Over-WSL Option has a 700-foot long tunnel in the area of Interchange 13. This tunnel would not require ventilation facilities because it less than the minimum 800 feet required by the National Fire Protection Association for rail tunnels.

Drainage and flood control would be a major operating concern for the Under-WSL Option through the area extending from the Hackensack River through Interchange 12 (particularly where the CRT would pass below the Interchange 12 ramps and Route 303). The CRT would be below the water table through much of this area and specific measures to control drainage, including pump stations, would be required. Further, based on local records this is an area that is prone to flooding and there is the potential for CRT service disruptions during flood events. The introduction of flood ramps would not be possible in this area because of the proximity and low elevations of the Interchange 12 ramps above the tunnel. The potential for the tunnel to flood is a major operating vulnerability and is considered a differentiator.

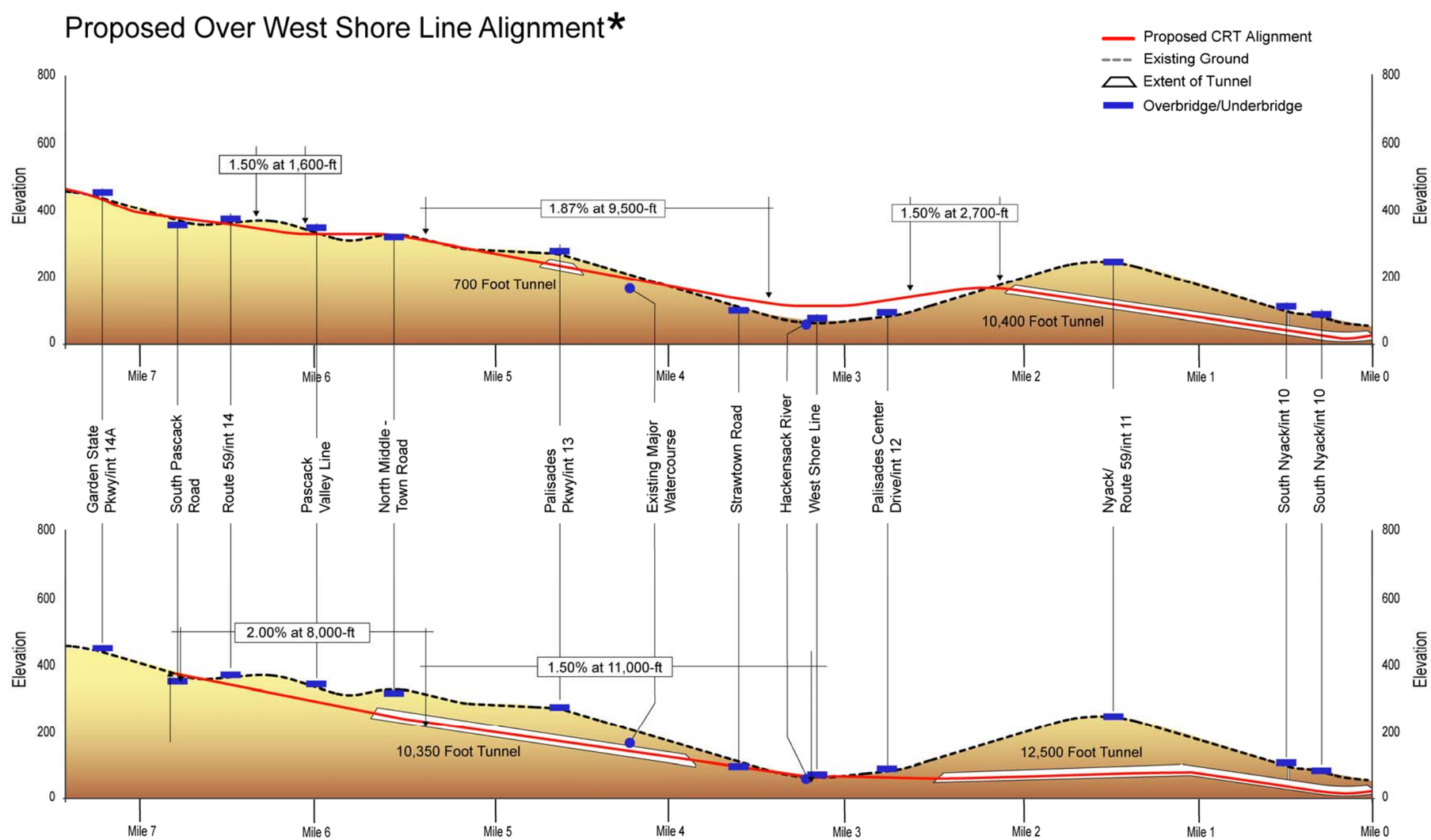


Figure 2-17 Over- and Under-WSL Profile

Drainage and flood control is not a concern for the Over-WSL Option as the vertical alignment is elevated through the Interchange 12 area.

Constructability

Constructability evaluates how each option would be constructed and includes complexity, duration, temporary access and construction site requirements as well as locations for support facilities.

The Over-WSL Option for the most part remains relatively close to the elevation of the existing Thruway between Interchanges 14A and 12. However, there are two segments of cut, one of which includes a short tunnel, and two lengths of viaducts. With CRT on the south side of the Thruway, it would be possible to have multiple construction crews on site simultaneously. Access to the cut and viaduct sections would be directly from the adjacent Thruway or from temporary construction sites located in the enclosed areas at the various interchanges. This simple access and multiple work areas would result in construction duration of 2 to 2.5 years through this area, dictated largely by the long viaduct through Interchange 12.

Construction of the Under-WSL Option would be dominated by two long discreet tunnels with a short section between that matches the existing elevation of the Thruway. Construction would be limited to three work faces for tunnel excavation with access shafts located near Interchange 13 and 12 because most of the construction would be underground. All construction activities would be focused at each of these access shafts and would include access for personnel and equipment and also the removal of spoil. Overall, the construction duration for this option including ventilation buildings would be 3 to 3.5 years because of the limited work faces.

2.4.2.2 Cost

The capital cost estimates for the Over- and Under-WSL Options are $2.0 and $2.69 billion (2012$), respectively. The extents of these cost estimates are from approximately South Pascack Road (just east of Interchange 14A) to the replacement Tappan Zee Bridge (a total of about 6.8 miles). The greater cost estimate for the Under-WSL Option is primarily a consequence of the greater extent of tunnels. The costs include all the infrastructure, systems, and track work for CRT. They also include modifications to overbridges or underbridges and local roadways to accommodate CRT. Costs associated with BRT Busway or HOV/HOT lanes and transit rolling stock and equipment are not included in the estimate.

2.4.2.3 Transportation

There is no difference in travel times and no effect on the local traffic network for the options. Travel time and traffic network changes are not considered differentiators.

The Over-WSL Option allows for an Interchange 14 Station that satisfies the engineering criteria for grade and is situated in a desirable location with respect to connectivity and access between South Pascack Road and Route 59. The Under-WSL Option has a 2-percent profile grade in a retained cut section at this location that is too steep for a CRT station platform. As a result the station would be relocated to the west in the vicinity of Chestnut Ridge Road, which is not considered a suitable location because access and connectivity would be difficult and limited, respectively.

2.4.2.4 Environment

The results of the environmental evaluation are summarized below:

- **Land Use/Potential for TOD.** The Under-WSL Option would cause the Interchange 14 Station to be moved because of engineering constraints to a location that would have lower potential for TOD than for the Over-WSL Option. Potential for TOD is considered a differentiator.

- **Displacements and Acquisitions.** The Over- WSL Options would displace four structures (one commercial facility and three residential ancillaries). The Under-WSL Option would displace five structures (one residential, two residential ancillary, one institutional (currently vacant) and one commercial property (possibly vacant). Since there is very little difference in the total number of displacements, this criteria is not considered a differentiator.

- **Wetlands. The wetland impact**s for over or under the WSL would be 4.1 acres and 3.1 acres, respectively. All impacted wetlands would be freshwater wetlands and no impacts to tidal wetlands associated with the Hudson River would occur. The impacts would occur to wetlands that border and/or occur within the Thruway ROW. For placement of the CRT alignment over or under the WSL, the impacted wetlands vary in ecological quality from disturbed roadside ditches to NYSDEC-regulated Class I wetlands associated with the Hackensack River. Given the similar level of wetland impacts between both options, impacts to freshwater wetlands are not a differentiator for this option.

- **Aquifers and Floodplains.** The lower elevation of the Under-WSL Option has the potential for significant impacts to watercourses and floodplains. Vertical alignments indicate that the proposed tunnel, or deep cut leading to the tunnel, would interfere with the current course of the Nauraushaun and Pascack Brooks, requiring substantial realignment. Aquifers and floodplains are considered a differentiator.

- **Parklands**. Neither option would affect parklands. Parklands are not considered a differentiator.

- **Historic Resources**. The Over-WSL Option would directly impact two historic resources:

  - NRL Palisades Interstate Parkway (reconstruction of parkway bridge over the Thruway; CRT tunnel construction beneath parkway; acquisition of permanent easement).

  - Recommended NRE 64 North Greenbush Road (partial acquisition).

  The Under-WSL Option would also directly impact two historic resources:

  - NRL Palisades Interstate Parkway (CRT tunnel construction beneath parkway; acquisition of permanent easement).

  - Recommended NRE Strawtown Road Historic District (lowering of Strawtown Road, a contributing resource to the district; partial acquisitions from contributing resources along the eastern and western edges of the road to accommodate the lowered roadway; driveway reconstruction; and retaining wall construction).

  Historic Resources are considered a differentiator because the Under-WSL Option would result in significant direct impacts to the Recommended NRE Strawtown Road Historic District. These direct impacts would alter the historic setting and character of the district.

- **Archaeological Resources**. Both options have the potential to directly impact a 300-foot-long area of prehistoric sensitivity located in the south ROW, west of Route 304. Archaeological resources are not considered a differentiator.

- **Hudson River Ecosystems**. Neither option would affect Hudson River ecosystems. Hudson River ecosystems are not considered a differentiator.

- **Noise.** In general, CRT noise from the Over-WSL Option would be largely masked by highway traffic noise and it is not anticipated that the noise increase would be perceptible on an average hourly basis. In the Under-WSL Option there would be less noise to nearby communities expected as the CRT alignment would be located in deep cuts and tunnels. Therefore noise is not considered a differentiator between the options.

- **Visual.** The Over-WSL Option would result in the loss of vegetative buffer and would have visual impacts from the long viaduct to land uses located along the south side of the Thruway (e.g., Deer Meadow Drive and Louise Drive). The trains and the transportation infrastructure in this area would be visible to residences. The Under-WSL Option would result in a loss of vegetative buffer in cut and cover sections only but visual impacts are not anticipated where the CRT travels in a tunnel. Visual impacts are considered a differentiator.

2.4.3 Transit Alignment Recommendation

2.4.3.1 Over/Under West Shore Line

The evaluation of the Over-WSL and Under-WSL Options in the Clarkstown/Orangetown area is summarized in Table 2-7. The Over-WSL Option is recommended for advancement into the EIS as an element of Alternatives B, C, D, and E based on the following criteria differentiators:

- **Engineering -** The primary engineering differentiator is the extent of deep retained cuts and long tunnels between Interchange 14A and Interchange 12 required for the Under-WSL Option, versus the use of a 7,600-foot long viaduct over the Hackensack River Valley for the Over-WSL Option. The Under-WSL Option would require 2.2 miles of additional tunnel length than the Over-WSL Option. The infrastructure difference is a direct result of the WSL being located at the base of the long climb from the Hackensack River to the Monsey Hill. While both options are feasible in terms of engineering, there are a number of important infrastructure implications for the Under-WSL Option, which do not occur for the Over-WSL Option. The vertical alignment of the Under WSL would have the following impacts::

  - Lowering Strawtown Road by 10 to15 feet would impact access to properties adjacent to the Thruway that are in the Strawtown Historic District.

  - Implementing drainage and flood control would be a major operating concern particularly in the area around the Hackensack River.

  - Diverting a number of existing watercourses that cross beneath the Thruway.

- **Cost –** The capital cost estimates for the Over- and Under-WSL Options are $2.0 and $2.69 billion (2012$), respectively, a difference of $690 million.

- **Transportation –** The Under-WSL Option would require relocating the proposed Interchange 14 Station approximately 1,000 feet to the west of the proposed location near South Pascack Road. This would create connectivity and access problems at the new location because it would be removed from the routes of existing local buses and the proposed feeder buses. Access to this location would be difficult because it is surrounded by narrow local residential streets. The proposed location at Interchange 14 in the Over-WSL Option provides superior connectivity and access.

- **Environment -** Three of the four evaluation criteria that were considered differentiators favored the Over-WSL Option (visual impact favored the Under-WSL Option):

  - **Land Use/Potential for TOD**. The Under-WSL Option would provide a poor Interchange 14 CRT station location with respect to potential TOD.

  - **Aquifers and Floodplains**. The Under-WSL Option would have the potential for significant impacts to watercourses and floodplains.

  - **Historic Resources**. The Under-WSL Option would result in direct impacts to the recommended NRE Strawtown Road Historic District. These direct impacts would alter the historic setting and character of the district.

  - **Visual**. The Over-WSL Option would have visual impacts from the 7,600-foot long CRT viaduct to land uses located along the south side of the Thruway.

Table 2-7

CRT Over/Under West Shore Line

Criteria	CRT Over West Shore Line	CRT Under West Shore Line
Engineering		
Engineering Design	• 2.1 total miles of tunnel between Interchange 14A and the replacement bridge. • 1.7-mile viaduct over the Hackensack River Valley. • No need to divert watercourses. • Alignment above water table.	• 4.3 total miles of tunnel between Interchange 14A and the replacement bridge. • Lower Strawtown Road by 10 to15 feet. • Diversion of multiple major and minor watercourses. • Alignment below water table in an area that is prone to flooding.
Operations and Maintenance	• No flooding impacts to operations	• High likelihood of flooding and resulting impacts to operations. • Requires ventilation and fire-handling systems
Constructability	• Access to construction site from south side of Thruway or from temporary construction sites at various Interchanges. • Construction duration estimate: 2 to 2.5 years.	• Construction (and removal of spoil) would be limited to three work faces with access shafts located near Interchange 13 and 12. • Construction duration estimate: 3 to 3.5 years.
Cost		
Capital Cost (2012)	$2.0 billion	$2.69 billion
Transportation		
Travel Time	Not a differentiator.	Not a differentiator.
Traffic Network Changes	Not a differentiator.	Not a differentiator.
Transportation System Integration	Allows for development of an at-grade station at Interchange 14 which is central location for Spring Valley and West Nyack transit interconnections.	Would require the CRT station to be located west of Interchange 14, near Chestnut Ridge Road to meet the 1-percent grade requirement for a CRT station. Chestnut Ridge Road does not offer useful transit system integration and connectivity.
Environment		
Land Use / Potential for TOD	Good TOD potential.	Diminished TOD potential because of the relocated Interchange 14 Station location.
Displacements and Acquisitions	Not a differentiator.	Not a differentiator.
Wetlands	Not a differentiator.	Not a differentiator.
Aquifers and Floodplains	No significant impacts.	• Significant impacts due to realignment of Nauraushaun and Pascack Brooks. • Nauraushaun and Pascack Brook stream realignment may cause significant complications due to USACE aquatic life passage requirements and NYSDEC requirements for zero increase in base flood elevation. • Impacts to Hackensack River floodplain.
Parklands	Not a differentiator.	Not a differentiator.
Historic and Archaeological Resources	No significant impacts.	Significant direct impacts to the Recommended NRE Strawtown Road Historic District.
Hudson River Ecosystems	Not a differentiator.	Not a differentiator.
Noise	Not a differentiator.	Not a differentiator.
Visual	• Loss of vegetative buffer. • Visual impacts from 7,500-foot long CRT viaduct for land uses located along the south side (e.g., Strawtown Road, Deer Meadow Drive and Louise Drive).	• Loss of vegetative buffer in cut and cover sections. • Visual impacts are not anticipated where the CRT travels in a tunnel.

2.5 Tarrytown Area

The CRT connection from the replacement Tappan Zee Bridge to Metro-North's Hudson Line occurs in Westchester County in the Village of Tarrytown. The study area in Tarrytown revolves around the landing of the Tappan Zee Bridge including the eastbound toll plaza, and the Hudson Line rail tracks that are approximately 110 feet below the bridge deck. South of the landing area is a residential community along Van Wart and Paulding Avenues. Factors that warranted consideration in the development and evaluation of the options are:

- Steep topography, which would require steep grades, deep cuts, and/or trestle structures.
- Complex infrastructure including the Hudson Line, proposed BRT alignments and local roads.
- Historic resources including Lyndhurst, Sunnyside, New County Park and others.
- Existing residential and commercial properties.
- Tappan Zee Bridge Toll Plaza and Thruway toll operations facilities.
- The proposed BRT Broadway Station location.
- Maintaining the existing Hudson Line CRT service.

There are two alignment options under consideration for the Hudson Line Connection (Figure 2-18). Typical cross-sections for both options are shown on Figure 2-19.

2.5.1 Proposed Transit Operations

The connection between the CRT on the replacement Tappan Zee Bridge to the Hudson Line would allow for a direct track connection and service between Rockland and Orange Counties and GCT on the east side of Manhattan.

There are no proposed CRT stations associated with the new alignment in Tarrytown; however there is a proposed BRT station in this area:

- **Broadway BRT Station –** would be located immediately adjacent to the Westchester landing on the north side of the replacement Tappan Zee Bridge in NYSTA property. It would be accessible from South Broadway and Route 119. It would also have a direct connection for BRT buses from the bridge into the station. (For more information on BRT operations in the area see Chapters 5 and 6.)

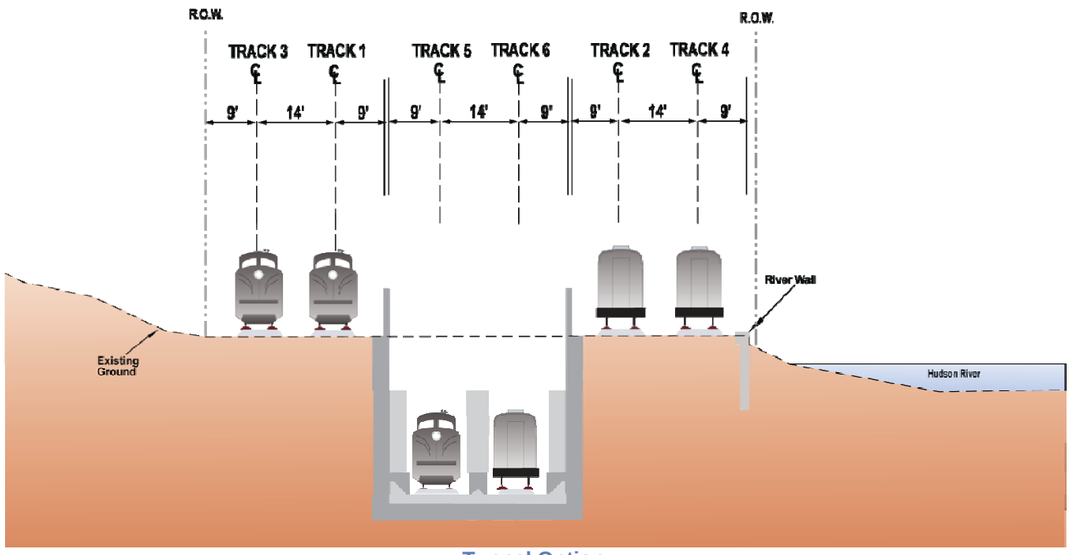
2.5.2 Description of Alignment Options

Two concepts were studied to make the CRT connection from the replacement Tappan Zee Bridge down to the Hudson Line: a waterside concept (Trestle Option) and a landside concept (Tunnel Option). The critical factors in evaluating these options are the significant changes in elevation from the Rockland County to the Westchester County side of the river, navigational clearances for the Tappan Zee Bridge, and certain characteristics of the Metro-North Hudson Line:

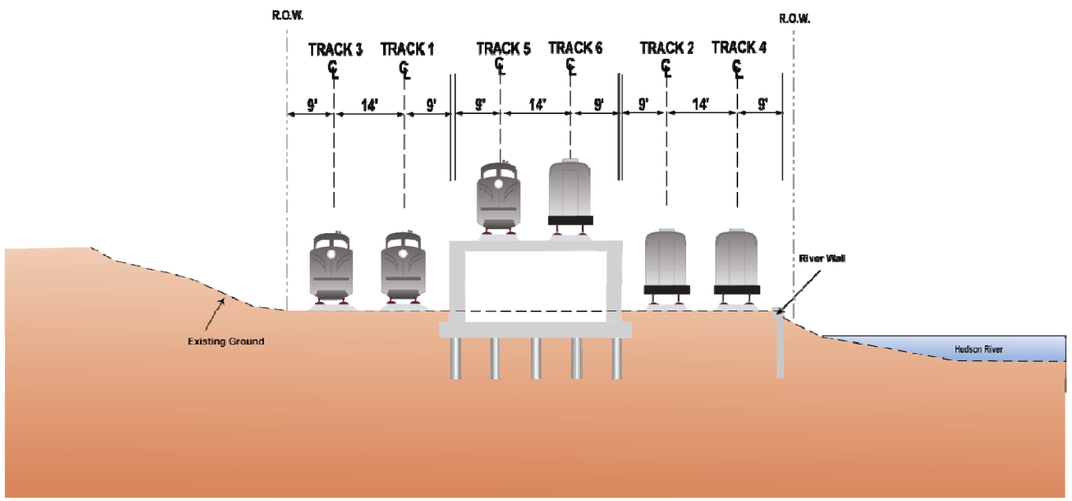
- The Westchester County escarpment drops abruptly to the river. As a result, the existing Tappan Zee Bridge is well above the river (approximately 115 feet) when it reaches its abutment. The Rockland County approach climbs steadily until reaching the main span whereupon it curves over the shipping channel to begin its descent towards the Westchester shore.

- The clearance of the replacement bridge over the 600-foot wide shipping channel would be increased from its existing 142 feet to 155 feet in order to conform to bridge clearances elsewhere on the Hudson River. The challenge of crossing the Hudson River and connecting to the Hudson Line is making an approximately 165-foot transition in elevation starting approximately 0.67 miles from shore. This is dictated by the clearance and location of the shipping channel and the elevation of the Hudson Line.

Figure 2-18 Hudson Line Connection Options



Tunnel Option



Trestle Option

Figure 2-19 Hudson Line Connection
Typical Cross-Sections at Lyndhurst Property

- Finally, the existing Hudson Line runs adjacent to the Hudson River and has limited ROW.

A number of variations were considered for both the Tunnel and Trestle Options. However, many of these were eliminated from further consideration prior to assessing them against the full range of evaluation criteria. Additional information regarding the options that were considered and ultimately eliminated can be found in *Technical Paper 10: Comparative Analysis of Shoulder Tunnel and Trestle Options for the Hudson Line Connection*.

2.5.2.1 Tunnel Option

The Tunnel Option that was selected for further evaluation was a 40-mph alignment with a six-track junction (Figure 2-20). The Tunnel Option would descend from the bridge and enter into the tunnel at 1.96 percent, reduced to 1.9 percent as it turns north slightly to pass under the intersection of Routes 9 and 119 (adjacent to which future construction access could occur). It would then turn south into a sweeping 45-mph curve that would pass just west of Broadway along the eastern edge of the Kraft property. The alignment would then turn west, then south through the Requa House property into a reverse 40-mph curve to enter under the Hudson Line tracks outside of Lyndhurst.

Once under the northbound Hudson Line tracks, the two tracks of the tunnel would rise out of the ground at a 1.5 percent grade in a portal between the separated northbound tracks (Tracks 1 and 3) and southbound tracks (Tracks 2 and 4). The tracks would pass over an 8-foot flood ramp and descend at a 1.5 percent grade until merged with their respective express tracks in a six-track junction. The existing track would be shifted to accommodate the six-track junction and 8-foot flood ramps.

2.5.2.2 Trestle Option

The Trestle Option that was selected for further evaluation was a 45-mph south alignment with a six-track junction (Figure 2-21). It would proceed from the south side of the single- or dual-level replacement bridge, descending from the main span at a 2-percent grade. It would then proceed into the first horizontal curvature of D=1.99° (radius = 2,876 feet) with an allowable speed of 75 mph that parallels the highway spans with a 1.96 percent grade. The horizontal curvature would tighten to D=4.98° (radius = 1,150 feet) and a reduced speed of 45 mph with a 1.80 percent grade as it approaches the Westchester County shoreline.

Once over the Hudson Line, the track would straighten and descend at 1.5 percent grade and would make a six-track (overall) junction by descending in between and then merging with Tracks 1 and 2 of the Hudson Line. The trestle would reach existing track grade in front of New County Park, approximately 600-feet south of Lyndhurst. The existing track would be shifted to accommodate the six-track junction.

2.5.3 Evaluation Results

The engineering evaluation of the options is presented below. A more detailed evaluation can be found in *Technical Paper TP-10*.

2.5.3.1 Engineering

Two engineering aspects of the Hudson Line Connector are considered differentiators between the Tunnel and Trestle Options:

- The inability of the Trestle Option to provide for a potential cross county continuation of the CRT due to the preclusion of an interlocking (switches and crossovers) on the bridge structure.

- Constructability.

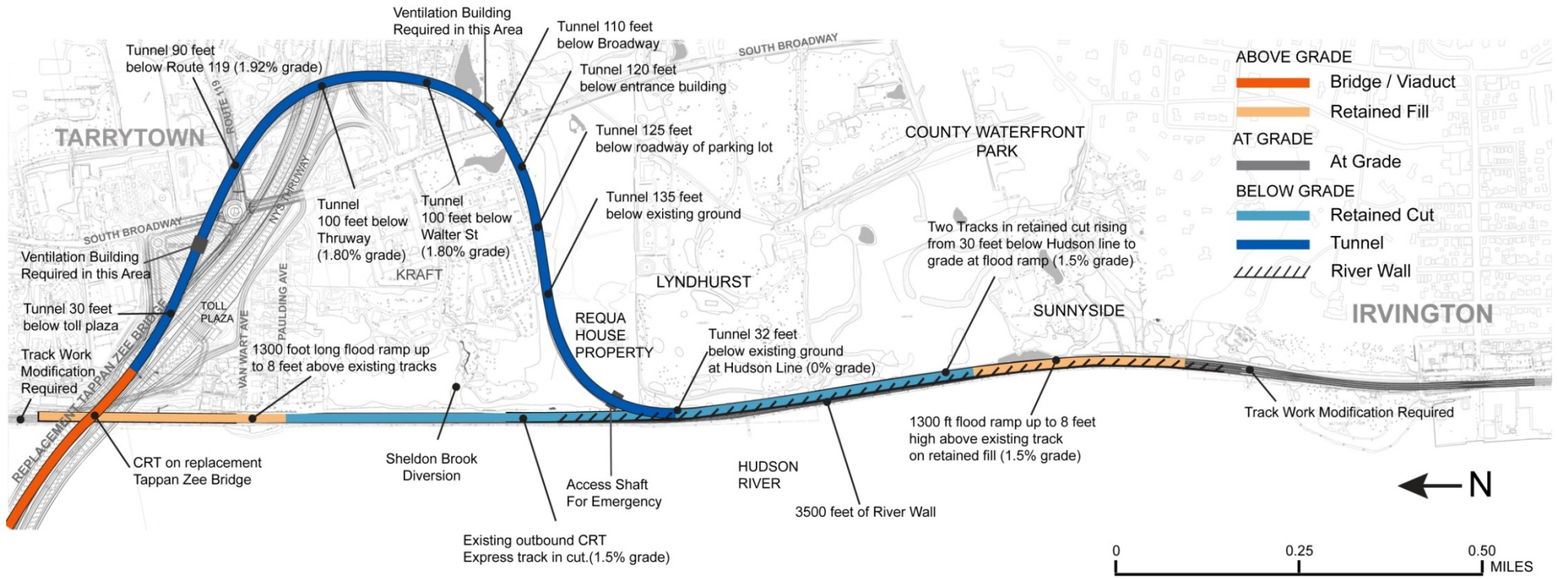


Figure 2-20 CRT Hudson Line Connection via Tunnel – Engineering Features

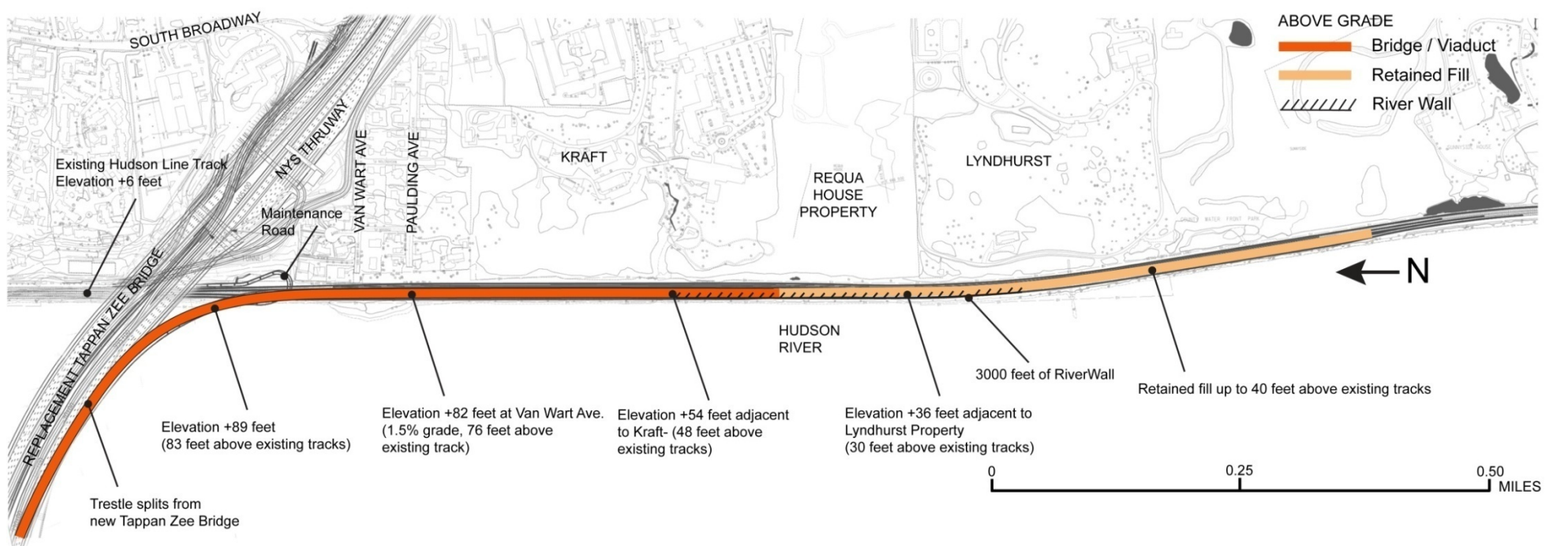


Figure 2-21 CRT Hudson Line Connection via Trestle – Engineering Features

Both options generally meet the engineering design criteria, except for the desirable 90-mph design speed. Other aspects of the engineering evaluation criteria would be similar for both options or otherwise would not be differentiators.

Engineering Design

- **Structural Integrity** – The structure of the trestle or tunnel connection would fully comply with the current American Railway Engineering and Maintenance-of-Way Association (AREMA), American Association of State Highway and Transportation Officials (AASHTO), and NYSDOT Design Specifications requirements.
- **Vulnerability** – This is not a differentiator as this will be addressed as part of the EIS for the selected option.
- **Seismic** – The tunnel and trestle structures would be designed with inherent ductility to provide a measure of protection for even the largest events. Seismic assessment indicates that the Trestle Option foundations could meet current performance requirements with feasible foundation sizes and pile depths.
- **Redundancy** – Features inherent to the design of the overall Tappan Zee Bridge crossing that support redundancy aspects would be included in the particular designs for the tunnel and trestle components.

Operations and Maintenance

The Trestle Option would preclude both a future cross-Westchester CRT alignment and a future Tappan Zee Station because the required interlocking would be on the replacement Tappan Zee Bridge. The difficulty in maintaining and operating an interlocking on a bridge structure would prevent its use.

The tracks for both options would be located to enable a "rescue" train to pull alongside and transfer passengers. Across the bridge, and along a portion of the trestle span, a maintenance access way would provide a drivable 12-foot wide roadway that could support the mobilization of first responders including fire, police, and other equipment onto the bridge. For the Tunnel Option, fire suppression, ventilation facilities and access ways would be designed in accordance with, and provided at locations as recommended by National Fire Protection Association (NFPA) codes. Navigation would not be an issue for either option as the CRT alignment would be designed to provide the requisite 155-foot clearance at Mean High Water.

Constructability

The construction of a Hudson Line Connector would result in a number of impacts as discussed below.

Tunnel Construction Impacts:

- Temporary easement to support in-board construction staging area at foot of Requa House property.
- Permanent subsurface easements for length of tunnel alignment.
- Staging of trackwork and disruption of Metro-North service.
- Cut and cover work in soft soils through the foot of the Requa House property.
- Drilling, blasting, and construction noise and vibration.
- Permanent easements for ventilation and access shafts.
- Construction of ventilation/access shafts.
- Spoil removal.
- In-river construction of a river wall 2 feet into the Hudson River across the frontage of Sunnyside.
- Constructability duration 2 to 4 years

Trestle Construction Impacts:

- Staging of trackwork and disruption of Hudson Line service.
- Additional near-shore dredging or the construction of a platform for two in-river foundations.
- Constructability duration 1.5 to 2years

2.5.3.2 Cost

The capital cost estimates for the options would be $1.34 billion for the -Tunnel Option and $263 million for the Trestle Option (2012$). The extent of the estimate for the Tunnel Option begins at the abutment of the replacement Tappan Zee Bridge through to Irvington on the Hudson Line and includes all the associated track work, infrastructure and systems for CRT. The estimate for the Trestle Option begins at the point where the alignment diverges from the replacement Tappan Zee Bridge and extends to Irvington on the Hudson Line and includes all associated track work, infrastructure and systems for CRT. The higher cost estimate for the Tunnel Option reflects the longer alignment, which would be approximately 1 mile longer than the trestle, and the more expensive construction costs associated with tunneling in hard rock.

2.5.3.3 Transportation

There is a negligible difference in terms of travel time between the two options. Traffic network changes are not applicable, as both options are completely segregated from road traffic.

There are differentiators between the two options in terms of transportation system integration. Both options allow for a train to serve the local stop at Irvington along the Hudson Line. However, only the Tunnel Option allows for the future construction of a cross-Westchester CRT alignment and a possible future Tappan Zee Station in Tarrytown. The Trestle Option would preclude both a future cross-Westchester CRT alignment and a future Tappan Zee Station because the required interlocking would be on the replacement Tappan Zee Bridge.

2.5.3.4 Environment

Results of the environmental evaluation for the Hudson Line Connector Options are summarized below:

- **Land Use/Potential for TOD.** The Tunnel Option would be well beneath the surface and would not affect land use or neighborhood character in Tarrytown. However, two associated vent shafts would be notable surface features. The Tunnel Option does not preclude a future CRT station at Tarrytown near South Broadway or the associated potential for TOD.

  The Trestle Option would change the character of the Van Wart/Paulding Avenue neighborhood of Tarrytown by substantially obstructing the views to the Hudson River from these streets and residences. The Trestle Option presents no potential for future CRT-related TOD in Tarrytown near South Broadway as the alignment bypasses this segment entirely. Thus, land use and potential for TOD is considered to be a differentiator between the options.

- **Displacements and Acquisitions.** The Tunnel Option would require displacement or acquisition of:
  - 0.2 acres for the placement of an access shaft and a traction substation on Requa property.
  - 0.3 acres for the placement of a vent structure at Gracemere Road, which would also result in one single-family residential displacement. (This shaft could alternatively be located to the west side of Route 9 on the Kraft or Requa House property without displacing the residence.)

- 0.03 acres at the western terminus of Van Wart Avenue for a maintenance access road alongside the Hudson Line tracks.

While the Trestle Option would require no displacements or acquisitions, the small number of displacement and acquisitions with the Tunnel Option is not considered a differentiator.

- **Wetlands.** The Tunnel Option has the potential to impact several perennial and ephemeral streams that discharge to the Hudson River as a result of re-construction of culverts under the Hudson Line tracks and would also disturb 0.01 acres of freshwater wetlands (those wetlands found east of the Hudson Line tracks). Track widening associated with the Trestle Option would result in disturbance to 0.28 acres of freshwater wetlands. The Trestle Option results in somewhat greater impacts to freshwater habitats than the Tunnel Option. However, given the small difference in acreage, wetlands is not considered a differentiator.

- **Aquifers and Floodplains.** Both options impact the 100-year and 500-year floodplain of the Hudson River. These differences are not considered a differentiator due to the scale and tidal nature of the Hudson River. There are no sole-source aquifers in this study area. Aquifers and floodplains are not considered a differentiator.

- **Parklands.** Neither option would have direct impacts to parklands. Parklands are not considered a differentiator between the options.

- **Historic Resources.** The Tunnel Option would directly affect eight historic architectural resources:

  - Recommended NRE NYSTA Police Barracks and Office building (displacement results from bridge construction staging requirements and the proposed BRT Broadway Station at this location).
  - NHLs Lyndhurst, Sunnyside, and Old Croton Aqueduct (underground easement).
  - 100 White Plains Road, Glenwolde Park, South End Historic District (underground easement).
  - Hudson Line ROW (construction of rail facilities).

  The Trestle Option would directly affect five historic architectural resources:

  - Recommended NRE NYSTA Police Barracks and Office building (displacement results from bridge construction staging requirements and the proposed BRT Broadway Station at this location).
  - NHLs Lyndhurst and Sunnyside (underground easement).
  - South End Historic District (underground easement).
  - Hudson Line ROW (construction of rail facilities).

  Architectural resources are not considered a differentiator given the comparability of impacts between both options.

- **Archaeological Resources.** For the Tunnel Option, the archaeological area of potential effect for a mined tunnel is the footprint of the tunnel alignment at the surface where this option passes under the archaeologically sensitive NHL Old Croton Aqueduct, the Requa Property, and the southern portion of the Kraft complex. Additionally, the Tunnel Option would have subsurface impacts to the Requa Property for the construction of an access shaft and a traction substation, and surface impacts from the proposed maintenance access road. The potential impacts of the Trestle Option include the construction of retaining wall sections inboard of the Hudson Line tracks from the Requa Property south to New County Park.

  The Tunnel Option has greater direct impacts to intact historic and prehistoric archaeological resources than the Trestle Option. Therefore, archaeological resources are a differentiator between these options.

- **Hudson River Ecosystems.** The Tunnel Option would impact the Hudson River shoreline and intertidal habitat as a result of a new river wall along the Hudson River for a length of approximately 4,600 feet and other shoreline stabilization activities, (this 3.12-acre area would be regulated by NYSDEC as tidal wetlands), and would also result in minor disturbances to the Hudson River shoreline wherever stabilization activities are required along the Hudson Line tracks.

  Requirements for a 4,000–foot river wall for the Trestle Option would impact the Hudson River shoreline and intertidal habitat (the impacted area of 1.9 acres would be regulated by NYSDEC as tidal wetland). The Trestle Option also introduces two additional in-river supporting piers (for a single-level bridge) which would encumber 0.02 acres of the river bottom.

  The Tunnel Option would impact a larger area of intertidal and shoreline habitat than the Trestle Option; therefore, impacts to Hudson River ecosystems are considered a differentiator.

- **Noise.** The Tunnel Option is expected to result in a minimal operational noise increase due to train operations in the tunnel. During operation of the Trestle Option, trains connecting to the Hudson Line would be operating in direct line of sight to the adjacent Van Wart/Paulding community, thus, likely producing a noticeable increase in noise levels. The Trestle Option would have the greatest potential for noise impacts between the two options; therefore, noise is considered to be a differentiator.

- **Visual.** The Tunnel Option would have visual impacts related to potential vent and access shafts, a traction substation and an elevated track bed (approximately 7 feet above existing tracks) for flood control in the vicinity of Sunnyside. The vent shafts are likely to be tall structures (60 to 100 feet) on a 100 by 100 foot base, and are presently shown located in two areas: on Thruway property west of Route 9 near the bridge landing, and on Gracemere Road at South Broadway displacing a residential property. Both locations are sensitive or likely to generate viewer reaction. The height of the flood ramp may preclude near shore views of the Hudson River from historic Sunnyside.

  The Trestle Option would have major visual impacts to the Van Wart/Paulding Avenue neighborhood, Riverwalk trail, and Lyndhurst. The Trestle would be elevated over 75 feet in front of the Van Wart/Paulding neighborhood, where homes are at an elevation of 30 or more feet above the river. The elevated tracks would be highly visible to the new Riverwalk trail as it proceeds south from the Tappan Zee Bridge. At Lyndhurst, the elevated tracks would be visible to the caretaker's cottage, the bowling alley, and the main house (about 800 feet from the tracks).

  Visual impacts are considered to be a differentiator between the options because of the Trestle Option's extensive visual impacts to Lyndhurst and the Van Wart/Paulding Avenue neighborhood.

2.5.4 Transit Alignment Recommendation

The evaluation of the Tunnel and Trestle Options in the Tarrytown area is summarized in Table 2-8. The Tunnel Option is recommended for advancement into the EIS as an element of Alternatives B, C, D, and E based on the criteria differentiators listed below. It is also recommended that further study be conducted in the DEIS to develop potentially lower cost versions of the Tunnel Option.

- **Engineering –** In general, there are no significant differentiators between the Tunnel and Trestle Options as both would fully comply with requirements for structural integrity, vulnerability, seismic events, and redundancy. However, to enable a possible future extension of the CRT into Westchester would require an interlocking on the replacement Tappan Zee Bridge. This condition would be undesirable because of the difficulty in maintaining and operating an interlocking on a bridge structure.

- **Cost –** The capital cost estimates for the options are $1.34 billion for the tunnel and $263 million for the trestle (2012$), a difference of over $1 billion. Given the magnitude of this cost differential, further study is recommended to determine if there are lower cost versions of the Tunnel Option that could be developed.

- **Transportation –** The Tunnel Option allows for the future construction of a cross-Westchester CRT system and a possible future Tappan Zee Station. The Trestle Option would preclude both a future cross-Westchester CRT alignment and a future Tappan Zee Station because the required interlocking would have to be on the bridge.

- **Environment –** There were a number of differentiators with respect to the environmental criteria, some favoring the Tunnel Option and some favoring the Trestle Option:

  - **Land Use/Potential for TOD**. The Tunnel Option does not preclude a future CRT station at South Broadway with its associated TOD potential. The Trestle Option would present no potential future for TOD in Tarrytown, as the alignment bypasses this area entirely.

  - **Archaeological Resources**. Given the basic nature of the Tunnel Option (underground construction), the potential for impact to archaeological resources is greater than for the Trestle Option.

  - **Hudson River Ecosystems**. The Tunnel Option would impact the Hudson River shoreline and intertidal habitat as a result of a new river wall along the Hudson River and other shoreline stabilization activities (3.12-acres of tidal wetlands). The Trestle Option would impact the Hudson River shoreline and intertidal habitat (1.9 acres of tidal wetland) due to construction of a new river wall. The Trestle Option would also affect 0.02 acres of the river bottom for the piers for a single-level bridge.

  - **Noise**. The Tunnel Option is expected to result in a minimal operational noise increase due to train operations in the tunnel. However, during operation of the Trestle Option, trains connecting to the Hudson Line would be operating at the elevation of the adjacent Van Wart/Paulding community, thus, likely producing a noticeable increase in noise levels.

  - **Visual**. The Tunnel Option would result in few visual changes, basically related to ancillary facilities (such as vent and access shafts) and a short section of elevated trackbed. The Trestle Option would add a major new visual element to the scenic Hudson River viewshed, resulting in major visual impacts to Lyndhurst, the Riverwalk trail, and waterfront property in the Van Wart/Paulding Avenue neighborhood in Tarrytown.

Table 2-8

Tarrytown: Hudson Line Connection Options

Criteria	Tunnel	Trestle
Engineering		
Engineering Design	Not a differentiator.	Not a differentiator.
Operations & Maintenance	• Maintenance roadway is not needed within tunnel. Maintenance access accommodated through access shafts. • Requires ventilation and fire-handling systems	• Maintenance roadway on trestle. • Difficult y in maintain interlocking on bridge
Constructability	Construction duration 2 to 4 years.	Construction duration 1.5 to 2 years.
Cost		
Capital Costs (2012 $)	$1.34 billion	$263 million
Transportation		
Travel Time	Not a differentiator.	Not a differentiator.
Traffic Network Changes	Not a differentiator.	Not a differentiator.
Transportation System Integration	• Future Cross-Westchester CRT not precluded. • Future Tappan Zee Bridge CRT Station not precluded.	• Future Cross-Westchester CRT is precluded. • Future Tappan Zee Bridge CRT Station precluded.
Environmental		
Land Use / Potential for TOD	Does not preclude future station at Tarrytown/Broadway and associated potential TOD.	No potential for future TOD at Tarrytown/Broadway. Impacts to land use at Van Wart/Paulding community
Displacements and Acquisitions	Not a differentiator.	Not a differentiator.
Wetlands (acres)	Not a differentiator.	Not a differentiator.
Aquifers and Floodplains	Not a differentiator.	Not a differentiator.
Parklands (acres)	Not a differentiator.	Not a differentiator.
Historic Resources	Not a differentiator.	Not a differentiator.
Archaeological Resources	▪ Impacts to resources at Old Croton Aqueduct, Kraft Property, and Requa site.	▪ Impacts to potential resources along Hudson Line.
Hudson River Ecosystems	• Impacts to 3.12 acres of tidal wetlands.	• Impacts to approximately 2 acres of regulated tidal wetlands.
Noise	▪ No significant operational noise impact.	▪ Increased ambient noise levels from operation of trains opposite Van Wart/Paulding community.
Visual	• Visual impacts from vent and access shafts and substation. • Additional visual impacts from elevated tracks at Sunnyside for flood control measures.	▪ Major visual impacts to Van Wart/Paulding Community. Also visual impacts to Lyndhurst and Riverwalk trail.

3 Rockland County – BRT in HOV/HOT Lanes with CRT Alignment (Alternatives D and E)

This chapter describes the alignment for BRT in HOV/HOT lanes in conjunction with CRT in Rockland County (Figure 3-1). There are no alignment options for BRT operating in HOV/HOT lanes, as the lanes by definition are in the median of the Thruway. The discussion is presented geographically from west to east.

Alternatives D and E include HOV/HOT lanes as the guideway for BRT in Rockland County. HOV/HOT lanes are "high-occupancy vehicle" or "high- occupancy toll" lanes that are reserved for vehicles carrying a high number of occupants (typically buses and automobiles with three or more occupants) or vehicles willing to pay a toll to use the lane. These lanes are operated to be less congested than general-purpose lanes, thus making them more attractive. The HOV/HOT lane's vehicle occupancy requirements and toll rates would be adjusted to maintain uncongested flow to ensure that BRT travel times would always be consistent with the current service plan.

3.1 Suffern Area

The study area begins in the Village of Hillburn just north of the intersection of the 4th Street Bridge and Orange Avenue (Route 59). It continues along the Thruway and through the Villages of Suffern and Airmont, across Interchange 14B (Airmont Road), to about ½ mile east of where Route 59 crosses the Thruway in Monsey, for a total distance of approximately 4.6 miles.

3.1.1 Proposed Transit Operations

In the Suffern area the proposed BRT station locations are:

- **Hillburn BRT Station**, which would be the western terminus of the cross-corridor BRT service. The station would be co-located with CRT and function as an intermodal station. Three BRT bus routes (B, C and T [trunk line]) would use Hillburn as their western terminal.

- **Airmont Station**, which is similar to the remaining BRT Stations in Rockland County in that it is defined as an "off-line" station. Access between the HOV/HOT lanes and the station is accomplished by providing bus-only ramps – known as "Texas-Ts" – that allow BRT to exit or enter the HOV/HOT lane and cross over the Thruway for direct access to the station. Feeder buses would also use the Texas-Ts for direct access to and from the stations.

The Hillburn and Airmont Stations would also serve as transfer points between the BRT bus routes on the trunk line and the existing local bus services (e.g., Transit of Rockland and Monsey Loop), thereby creating a transit network in western Rockland County. Finally, both the Hillburn and Airmont Stations would have park-and-ride facilities.

3.1.2 Description of Alignment

Due to the constraints created by Interchange 15 and Harriman State Park, the eastbound and westbound HOV/HOT lanes would begin and end east of Interchange 15, respectively. Westbound BRT vehicles heading to the proposed Hillburn Station would exit the HOV/HOT lane and merge into general-purpose lanes in the vicinity of the Thruway viaduct over Wayne Avenue and the Mahwah River. Buses would continue in mixed traffic on the Thruway to Interchange 15A, where they would exit and travel south on Orange Avenue to reach the station. Eastbound BRT vehicles from the Hillburn Station would enter the Thruway at Interchange 15A, travel in mixed traffic on the Thruway, and enter the HOV/HOT lane where it begins between the Mahwah River and Hemion Road.

As part of the alignment, the westbound HOV/HOT lane would be extended as a general purpose lane. The end of the westbound HOT/HOV lane would be approximately 2,600 feet west of Hemion Road, approximately 3,100 feet west of the Wayne Avenue overpass, and just under a mile east of Interchange 15. The westbound HOV/HOT lane merge into the three general use lanes involves tapering both the 12-foot HOV/HOT lane and its 4-foot buffer strip into the three Thruway lanes over a length of approximately 1,100 feet. This three-lane segment would extend for approximately two-thirds of a mile, where the existing Thruway expands from three to four lanes just west of the Wayne Avenue viaduct and then widens to five lanes within Interchange 15 (two lanes heading toward southbound I-287 and three continuing north on the Thruway). Figure 3-2 shows the relationship of these various elements of the highway and the proposed HOV/HOT lanes.

This configuration would result in the westbound highway going from four lanes (three general purpose lanes and one HOV/HOT lane) to three general purpose lanes and then quickly back to four general purpose lanes leading up to Interchange 15. Dropping a lane in this manner so close to the next interchange is generally not recommended because: (1) it increases the amount of weaving and merging, and (2) dropping the left (median side) lane generally is not recommended due to the higher average speeds in the left-side lanes and drivers' lack of familiarity with left-side merges.

In addition to the lane-drop causing a likely bottleneck as HOV/HOT drivers merge into the general purpose lanes, vehicles in the three Thruway lanes are also beginning to change lanes to be in the correct position for the I-87/I-287 split in less than one mile. The addition of these movements in this section would potentially cause further driver confusion and erratic movements that would create unsafe and inefficient traffic conditions. These problems would be particularly difficult in the weekday PM peak when volumes in this segment are at their highest. In order to avoid these problems, the fourth westbound lane created at the end of the HOV/HOT would be extended up to the existing four-lane segment west of the Wayne Avenue viaduct.

3.2 Monsey to West Nyack

This study area follows the Thruway ROW for a distance of approximately 9.1 miles. The Thruway profile in this area is comprised of two hills and a large valley (Figure 2-12). The first and higher hill is at the Route 59 crossing in Monsey (the highest elevation in the corridor at 610 feet). From this location the Thruway descends 6.4 miles on 2.5- to 3-percent grade to the Hackensack River Valley (elevation 65 feet). From the valley, where the Hackensack River is the corridor low point (elevation 65 feet) the Thruway proceeds on a 3-percent upgrade for 2.5 miles to the top of the second and smaller hill in Nyack at Interchange 11 (elevation 250 feet).

3.2.1 Proposed Transit Operations

There are three proposed BRT stations in the study area:

- **Monsey Station** would be located in the vicinity of the Route 59 crossing at the corridor highpoint.

- **Interchange 14 Station** would include a CRT station and be an intermodal facility located in the area between the Garden State Parkway and the Route 59 crossing in Nanuet.

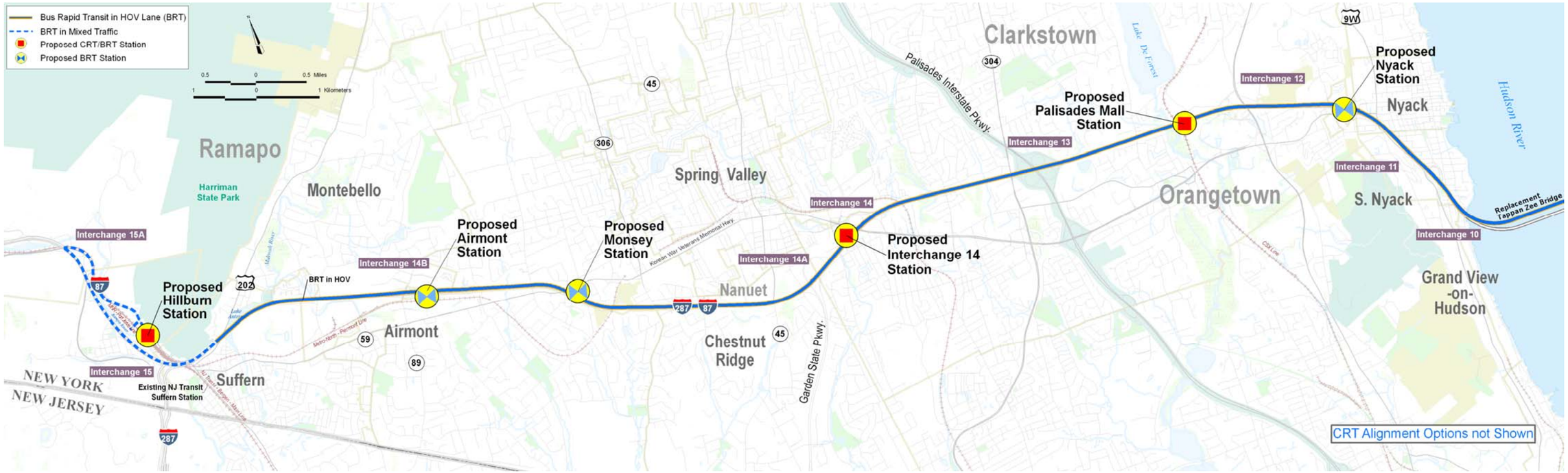


Figure 3-1 BRT in HOV/HOT Lanes in Rockland County

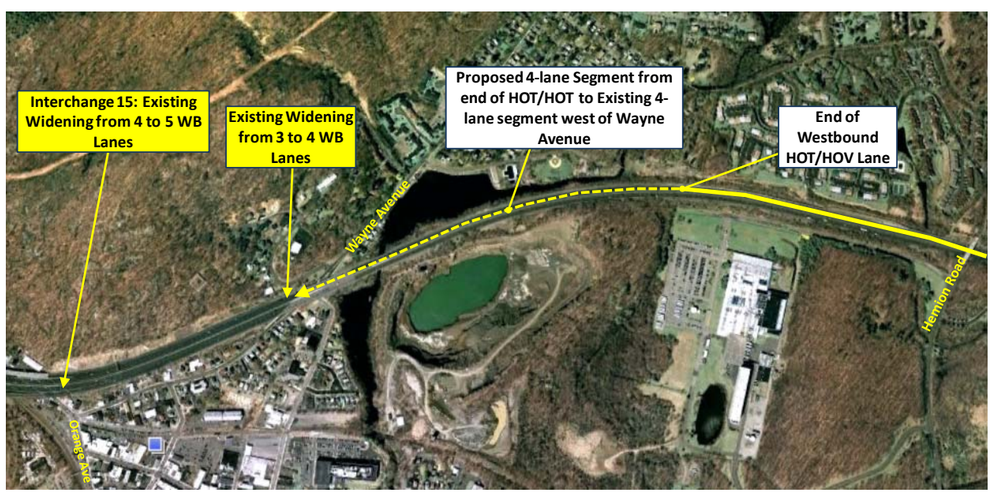


Figure 3-2 Transition Concept for Western End of HOT/HOV Lanes

N 1,000 ft. Approx. Scale

- **Palisades Mall Station** in West Nyack would also be an intermodal facility that would be located at an adjoining park-and-ride facility to the mall referred to as Parking Lot J.

The four BRT routes from the west (A, B, C, and T) would be joined by seven additional feeder routes, for a total of 11 BRT routes in this segment of the county. These seven additional feeder routes would initially make stops on local arterials before entering a BRT station and then the HOV/HOT lanes. Feeder routes would access the trunk line from the BRT stations. Figures 2-13 and 2-14 show the connectivity between the CRT, BRT, and local buses at the Interchange 14 and Palisades Mall Stations. These stations would be important intermodal facilities serving the central and eastern sections of the county. The feeder routes that would join the trunk line at these stations are as follows:

- **Interchange 14 Station** – five additional BRT routes would enter or exit the BRT trunk line: Routes E, F and G, which share a western terminal at the NJ Transit Spring Valley Station of the Pascack Valley Line; Route D with a western terminal at Mt. Ivy; and Route K with a western terminal in Bergen County in northern New Jersey.

- **Palisades Mall Station** – two BRT feeder routes would access the BRT trunk line: Route H (western terminal in New City) and Route I (western terminal in Haverstraw).

Each of the three BRT stations in this study area would provide transfers between the various BRT routes and the existing local bus services, and would include park-and-ride facilities.

3.2.2 Description of Alignment

The BRT in HOV/HOT lanes alternatives would be located in the Thruway median with a lane in each direction. These lanes would be separated from the Thruway general-traffic lanes by a 4-foot wide painted buffer strip, with slip ramps strategically located along the Thruway that would allow HOV/HOT vehicles to enter and exit. The alignment would be built as a widening of the existing Thruway pavement and, therefore, the profile and alignment would be that of the existing Thruway.

The HOV/HOT lane alignment would generally fit within the existing Thruway ROW. However, the BRT profile would diverge from the Thruway for access to and from BRT station locations, and, as a result, the width of the Thruway would expand at the station areas. Exclusive BRT ramps (Texas-Ts, see Photo 2-2) would be built to provide access to off-line stations and would allow feeder buses to access the HOV/HOT lanes directly from the stations.

Figure 3-3 shows the typical six-lane existing Thruway cross-section between Interchanges 15 and 11. Figure 3-4 shows typical cross-sections with BRT in HOV/HOT lanes and CRT in a cut section below the Thruway grade. Figure 3-5 shows typical cross-sections in the Hackensack River Valley where CRT would be on a viaduct above the Thruway. These cross-sections demonstrate that BRT in the HOV/HOT lanes with a CRT alignment would generally fit within the existing Thruway ROW. However, where Texas-T ramps are added for BRT station access, the Thruway would be expanded to accommodate the ramps and the appropriate lane shifts and transitions before and after the ramps. Standard lane and shoulder widths for the Texas-T layout were established based on the Tappan Zee Bridge/I-287 Corridor Project Design Criteria (April, 2009) (included in Appendix A).

The typical length and width of a Texas-T ramp structure is shown on Figure 3-6. As a result of the Thruway grades, geometry, and acceleration/deceleration requirements, the length of each BRT Texas-T ramp would vary. Table 3-1 shows the proposed length of the Texas-T ramps and overall length of the Thruway modifications that would be needed to accommodate the ramps. Each BRT station would use an elevated Texas-T ramp arrangement, except for the proposed Nyack Station at Interchange 11, which has the BRT ramps descending from the Thruway to reach the station at Route 59.

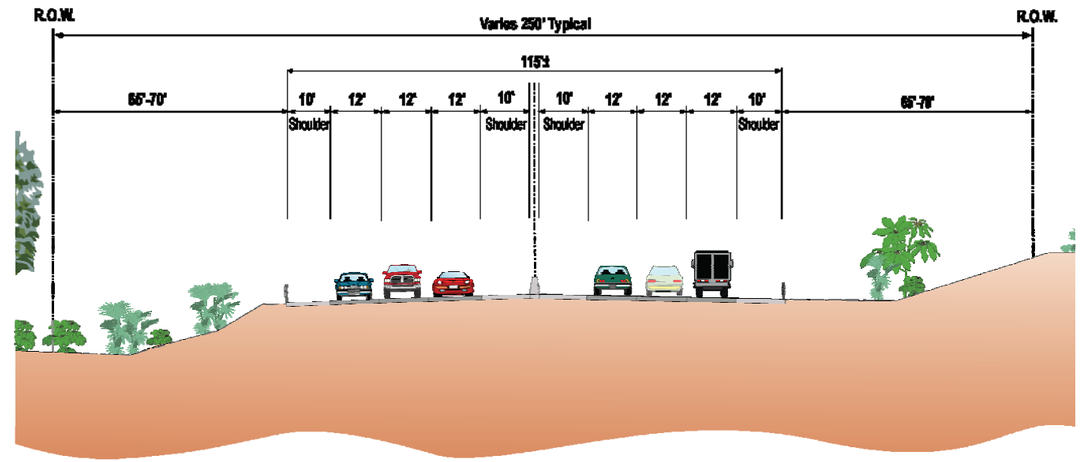


Figure 3-3 Existing Thruway
Typical Cross-Section between Interchanges 15 and 11

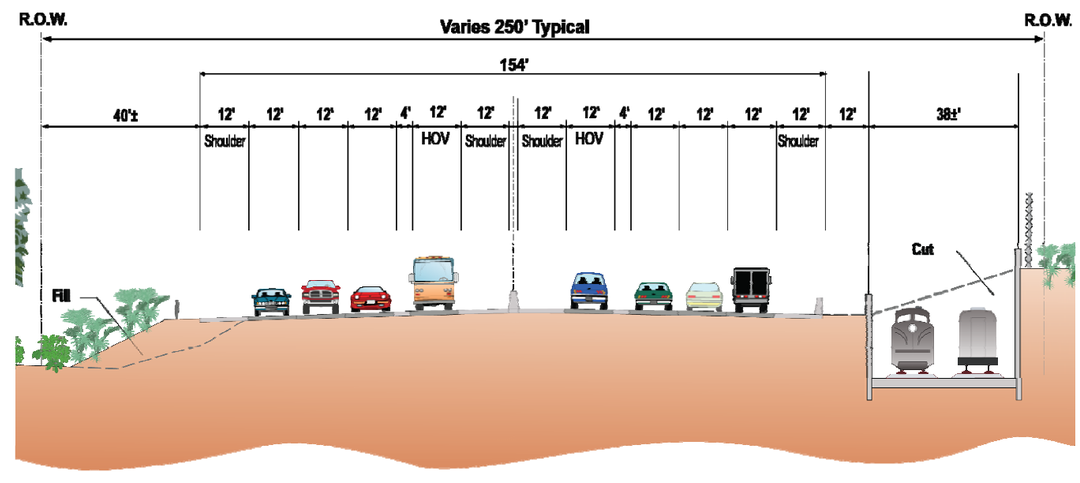


Figure 3-4 BRT in HOV/HOT Lanes
Typical Cross-Section between Interchanges 14B and 13 (CRT in Retained Cut)

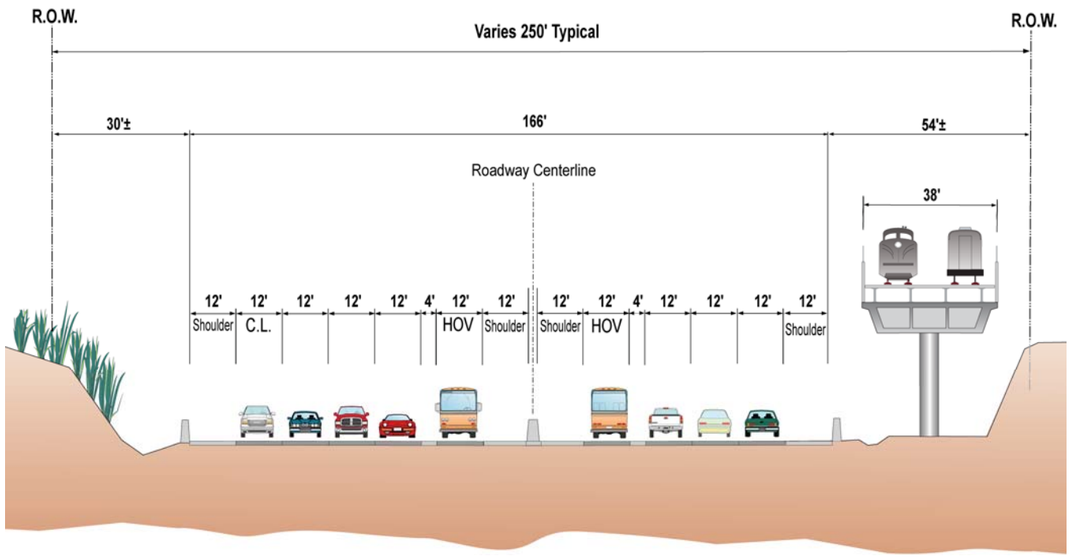


Figure 3-5 BRT in HOV/HOT Lanes
Typical Cross-Section between Interchanges 13 and 12 (CRT on Viaduct)

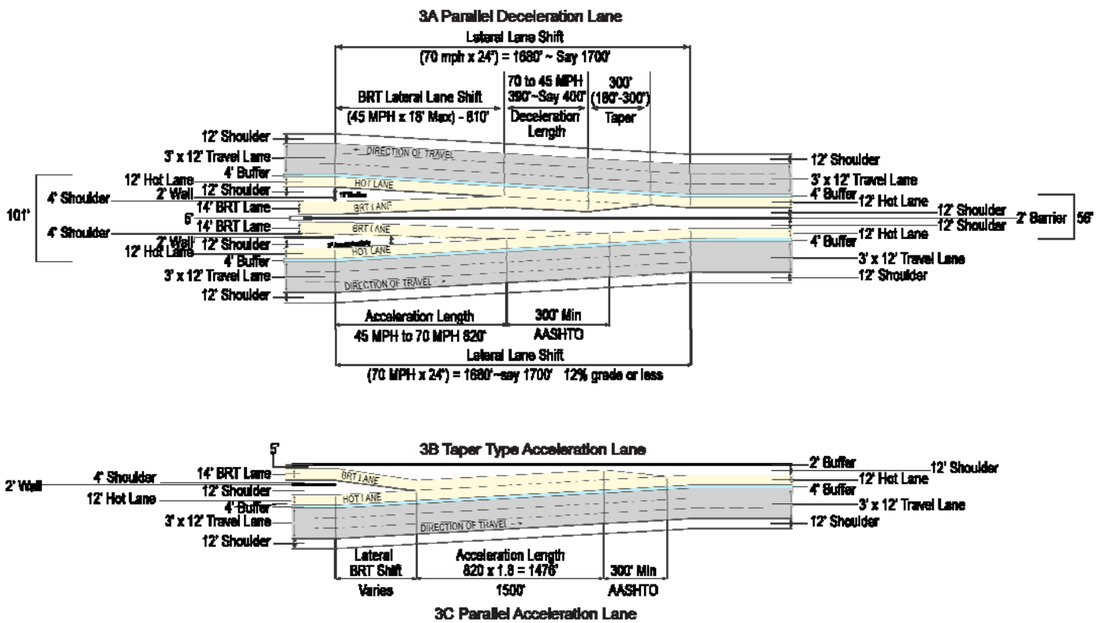


Figure 3-6 Typical Layout of a BRT Texas-T Ramp

Table 3-1

Lengths of BRT Texas-T Ramps and Thruway Modifications by Proposed Station
BRT in HOV/HOT Lanes with CRT on the South Side of Thruway

Station	Length of BRT Texas-T Ramps (in feet)	Length of Thruway Modifications (in feet)	Notes
Airmont	1,800	5,100	
Monsey	2,150	5,550	
Interchange 14	2,800	8,600	Thruway widening would occur through the curves east and west of the station.
Palisades Mall	2,150	6,000	The BRT bridge would cross over the Thruway and under the CRT viaduct.
Nyack	2,000	5,800	Access ramps would be in retained cut and descend to connect to the station.

3.3 East of Interchange 11

This area of the study begins at Interchange 11 and continues to the Hudson River, where the BRT alignment connects to the replacement Tappan Zee Bridge. The Thruway proceeds on a downgrade of 3.0 percent in this area.

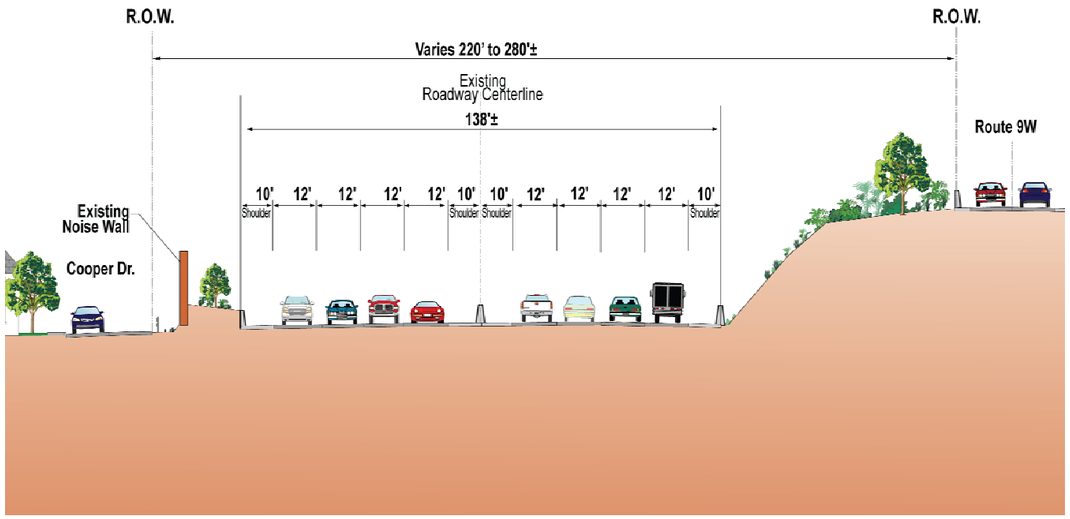
3.3.1 Proposed Transit Operations

The proposed Nyack BRT station would be located at Interchange 11. The station is challenging to locate due to the combination of the highway geometry, the angle at which Route 59 passes under the Thruway, the Mountainview and Highland Avenue overpasses, and the interchange ramps. The proposed location for the station would be adjacent to the south side of the Thruway just west of where it crosses over Route 59. The Thruway would be widened approximately 60 feet to provide drop ramps from both directions to connect to the at-grade station. An advantage of this layout is the ability of feeder buses to access the station and easily connect to the HOV/HOT lanes from Route 59 via the drop ramps.

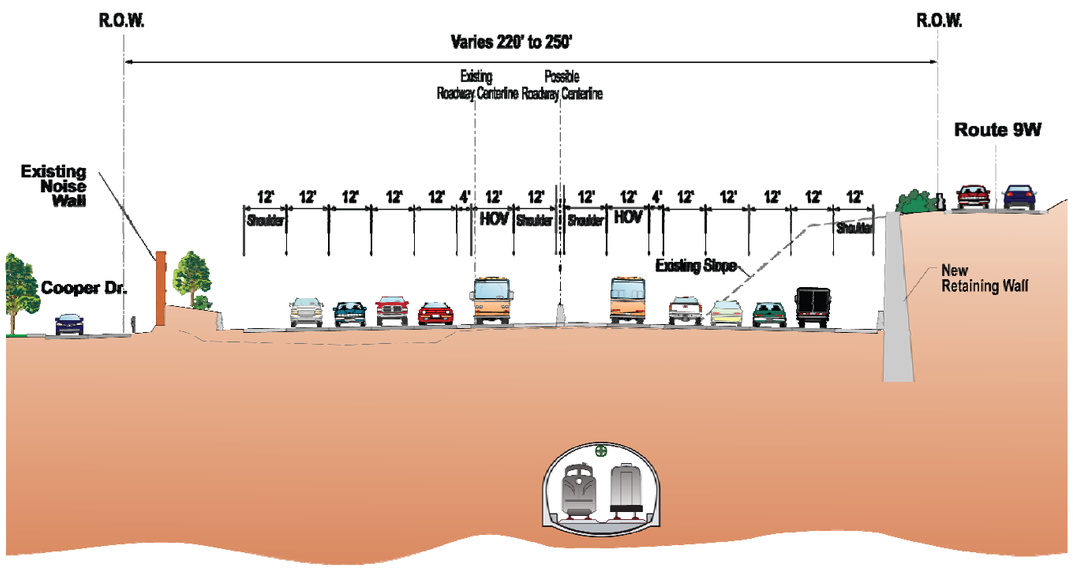
The proposed Nyack BRT Station would be served by the 11 BRT routes from the west and one additional feeder route (J) with a western terminal in Nyack would enter the trunk line from this station. As a result there are 12 BRT routes that would cross the replacement Tappan Zee Bridge into Westchester.

3.3.2 Description of Alignment

Between Interchange 11 and the Tappan Zee Bridge, the BRT alignment would remain in the HOV/HOT lanes. However, because of the narrow available ROW on the north side and the proximity of dense residential housing to the Thruway, the highway mainline would shift south to accommodate widening for the HOV/HOT lanes. Typical existing and proposed cross-sections are shown on Figure 3-7.



Existing



Proposed

Figure 3-7 BRT in HOV/HOT Lanes
Typical Cross-Sections East of Interchange 11


environment

4 Rockland County – BRT in Busway with CRT Alignment (Alternatives B and C)

This chapter describes the development process for the busway alignment in Rockland County. There are three options for the busway alignment: north, median, or south side of the Thruway. The area that would include the busway extends from the proposed Hillburn Station to the Tappan Zee Bridge, primarily adjacent to the Thruway (Figure 4-1). Key alignment considerations for a busway in this Rockland County corridor are shown in Figure 4-2. For most of the alignment, the existing Thruway ROW would be sufficient to incorporate a bi-directional busway along with a CRT alignment, although much of the existing buffer areas on each side of the highway would be eliminated.

4.1 Proposed Transit Operations

All busway options would have stations at Hillburn, Airmont, Monsey, Interchange 14, Palisades Mall, and Nyack. The stations at Hillburn, Interchange 14 and Palisades Mall would be intermodal as they would also be CRT stations. The BRT stations would also serve as transfer points between the proposed BRT feeder routes and the existing local bus services (e.g., TOR, Monsey Loop, Clarkstown Mini-Trans, etc.). All of the proposed BRT stations would have park-and-ride facilities.

Unlike the HOV/HOT lane alternatives that have off-line stations, the busway options place the BRT stations "in-line" directly along the busway; thus, there is no need for Texas-Ts or Texas-Hs to access the BRT stations. These in-line stations would include a bypass lane for a bus route that would skip the station. Busway alignments on either side of the Thruway would preferably have their stations located at arterials to facilitate feeder-bus access to the BRT trunk line, local bus transfers, and easier access for passengers from adjacent park-and-ride facilities or those walking or bicycling to the station.

The proposed BRT service plan is the same for all busway options and includes the following stations:

- **Hillburn Intermodal Station**, the western terminus of the new BRT and CRT services in Rockland County. Three bus routes (B, C and T) would originate, access the busway, and continue eastward through the corridor.
- **Airmont Station,** located in the vicinity of Interchange 14B, would also be served by Route A en route to and from Middletown in Orange County. At the Airmont Station four bus routes (A, B, C and T) would operate east of the station along the busway.
- **Monsey Station,** located where Route 59 crosses the Thruway would not have BRT feeder routes entering the trunk line. However local TOR and Monsey Loop buses would allow transfers to the BRT system.
- **Interchange 14 Intermodal Station**, located between the GSP and Route 59, would have five additional routes enter and exit the busway (Routes E, F, and G) and which all share a western terminal at the Spring Valley Station of the NJ Transit Pascack Valley Line (located to the north of the Thruway); Route D with a western terminal at Mt. Ivy; and Route K with a western terminal in Bergen County in northern New Jersey.
- **Palisades Mall Intermodal Station,** located at Parking Lot J in West Nyack would have two additional routes enter and exit the busway: Route H (western terminal in New City) and Route I (western terminal in Haverstraw).
- **Nyack Station,** located at Interchange 11 where Route 59 passes beneath the Thruway, would have one additional bus route (J) with a western terminal in downtown Nyack and would access the busway at the Nyack BRT Station.

In summary, the BRT service plan would provide 12 BRT routes that would cross the replacement Tappan Zee Bridge and operate between Rockland and Westchester Counties along any of the busway alignment options.

4.2 Preliminary Evaluation of Alignment Options

The three busway options (north, median, and south) were subjected to a preliminary analysis to determine if any of them did not meet fundamental criteria inherent to the successful performance of a BRT system. This enabled the focus of project resources on the options that could provide a more robust and effective BRT system.

4.2.1 Station Configurations and Feeder-Bus Access

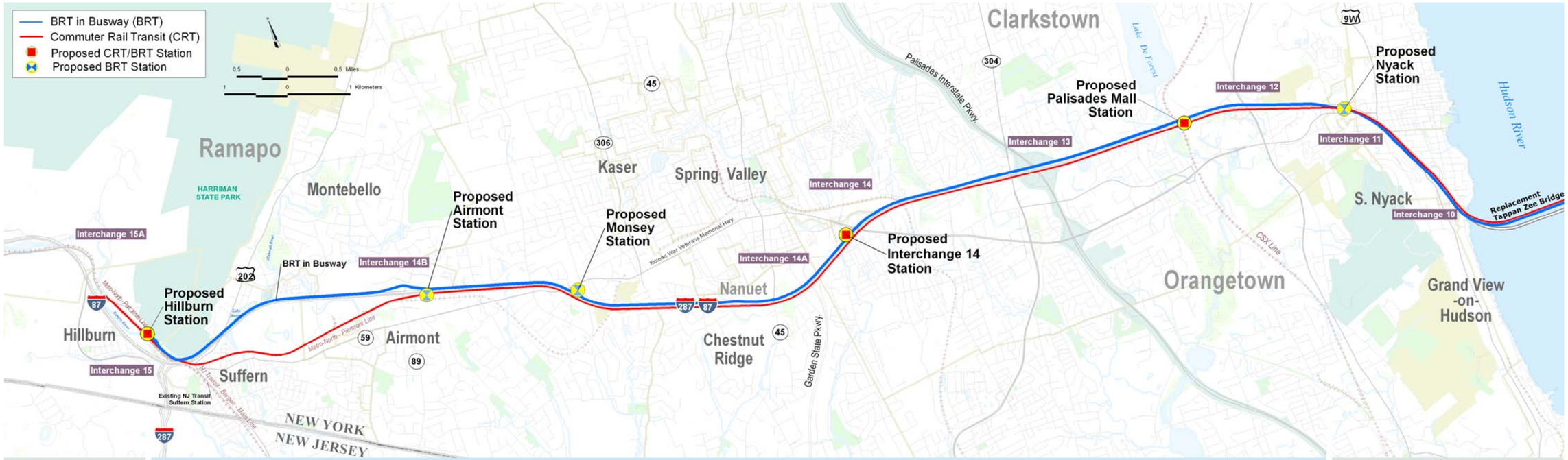
The primary differences between the busway options are how the BRT stations would be configured and how BRT feeder buses would access the stations and the busway. The distinctions are mainly between the busway being located along either the north/south side of the Thruway or within the Thruway's median:

- **Busway on North or South Side of Thruway** – From the sides of the Thruway, the BRT stations would literally be located along the busway (i.e., "in-line" stations). Feeder buses access would be straightforward, with access generally provided from the adjacent roadways directly into the BRT station. Pedestrian and local buses would access the station in a similar fashion via adjacent streets.
- **Busway in Thruway Median –** The BRT median stations would also be "in-line" along the busway. In this manner, bus travel times would not be significantly increased by requiring that buses on the trunk route leave the busway to access off-line stations on the side of the Thruway. Pedestrian and local transit access to median stations would be more difficult with the station location in the highway median. More importantly, the ability of feeder buses to directly access the busway is more complex with a median busway. Instead direct access to the station from adjacent roadways, the BRT feeder buses would be required to enter the Thruway at interchanges, and then use exclusive BRT slip ramps (exclusive openings to access the busway) that would allow access to the median busway.

Overall, in terms of pedestrian access, local transit access, and feeder-bus access, the busway options that utilize either the north or south side of the Thruway would provide simpler and less complex interfaces with the adjacent street network and local transit systems when compared to the median busways.

4.2.2 Preliminary Evaluation Criteria and Analysis

Six preliminary evaluation criteria were developed to determine if any of the three busway options should be removed from further consideration at this stage of the analysis. These six criteria were used to evaluate the fundamental effectiveness of the various busway options relative to each other and should not be confused with the overall evaluation criteria (Chapter 1) being utilized to compare the transit alignment options.



No BRT Options	Options: Busway on north side of Thruway Busway in median of Thruway Busway on south side of Thruway	No BRT Options

Figure 4-1 Busway Options in Rockland County

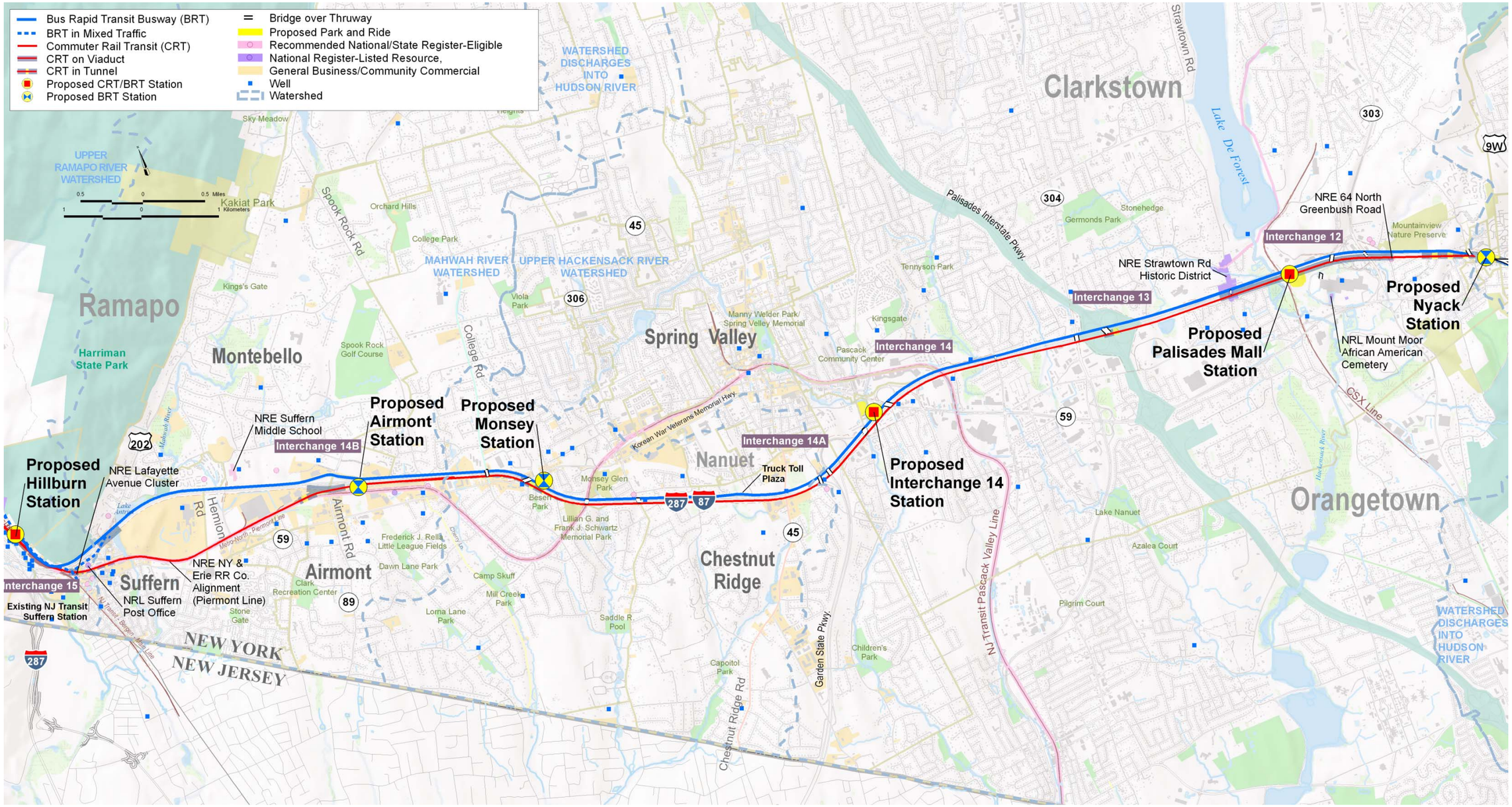


Figure 4-2 Busway - Key Alignment Considerations

The six evaluation criteria fall into three categories: BRT performance measures, land use impact, and engineering and cost impact. They were measured in straightforward terms of presenting a "favorable" or "unfavorable" result. While it is recognized that much of this analysis is qualitative, it nonetheless allowed the study team to screen out busway alignment options in Rockland County that were so unfavorable and unreasonable as to not warrant further consideration in the study process. The criteria and the analysis for each busway alignment option in Rockland County are presented below.

4.2.2.1 BRT Performance Measures

The BRT performance measures are:

- **Direct CRT Connectivity** – This criterion examines how well the busway service at the proposed Hillburn, Interchange 14, and Palisades Mall stations interface with the proposed CRT service. Only the Busway South Option rates favorably in this regard, because both the busway stations and the CRT stations would essentially be co-located. The busway alignment and the CRT alignment are separated in the other options; therefore, the connection between modes would be more complex.

- **Ease of Passenger Access to BRT Stations** – This criterion examines the ease with which passengers can access the BRT stations – both in terms of pedestrian and bicycle accessibility from adjacent communities, as well as through connections from other local transit services. Only the Busway Median Option rates unfavorably in this regard. Pedestrian and local transit access becomes more complicated with this option because of the station location in the highway median.

- **Ease of Feeder-Bus Access to Busway and Stations** – This criterion examines how easily the BRT feeder buses can access both the busway and the stations. Only the Busway Median Option rates unfavorably in this regard. Feeder-bus access becomes more complex with this option because the feeder buses would need to use the interchanges to access the Thruway, and then access bus-only slip ramps to access the median busway. The feeder buses would be subject to congestion along the Thruway, thus reducing their service reliability.

- **Future Flexibility** – This criterion examines the potential for future expansion of service along the busway. Such expansions might include adding new stations or feeder-bus access points. Only the Busway Median Option rates unfavorably in this regard: by being located in the median of the Thruway, additional stations or expansion opportunities are significantly limited by the adjacent Thruway travel lanes.

4.2.2.2 Land Use Impact

This criterion examines the ability of the busway to spur TOD at the various BRT station locations. In the wider context of stimulating TOD, the area within ¼ to ½-mile is relevant, whether the station is on the side or median of the Thruway does not materially affect this issue, assuming the adjacent road network provides sufficient connectivity to the station. However, at a micro level of analysis, the Busway Median Option rates unfavorably to stations on the sides because median stations could not be as closely integrated with adjacent properties to provide additional TOD activities, and they would require pedestrians to cross over/under the Thruway to reach the stations.

4.2.2.3 Engineering and Cost Impact

This criterion examines each busway option's impact on the Thruway's roadway in combination with the CRT alignment options. The engineering and cost criterion are related to the extent to which the available Thruway ROW could be utilized for both modes, and whether there would be a need to relocate all or part of the Thruway to accommodate the improvements.

The Busway South and Median Options rate unfavorably in this regard because accommodating both the busway and CRT alignment in these options would require the Thruway to be reconstructed and/or shifted within its ROW either north or south. The Busway North Option rates favorably because the CRT and busway alignments are on either side of the existing Thruway roadway, thus requiring only basic transit accommodations and interchange modifications for the Thruway. This option could therefore be considered a "low cost" option in terms of overall impacts on the Thruway.

The analyses of the various criteria are summarized in Table 4-1. A check mark indicates that the criterion was rated as "favorable" and an "X" indicates that it was rated as "unfavorable".

Table 4-1

Preliminary Evaluation of Rockland County Busway Options

Busway Option	BRT Performance Measures				Land Use	Engineering & Cost
	Direct CRT Connectivity	Ease of Passenger Access to BRT Stations	Ease of Feeder Bus Access to Busway & Stations	Future Flexibility	TOD Potential	Impact on Thruway Roadway
North	X	✓	✓	✓	✓	Minor
South	✓	✓	✓	✓	✓	Major
Median	X	X	X	X	X	Major

4.2.2.4 Conclusions

This preliminary evaluation of the fundamental effectiveness of the three busway options indicates that the Busway Median Option should not be advanced for further consideration. This busway alignment option rated the most unfavorable in terms of the BRT performance measures evaluated in comparison to a busway on the side of the highway as shown in Table 4-1. In general, busways located in the median of a roadway are typically utilized to provide a line-haul trunk service (one with minimal stops or access points) to one major destination or activity center (e.g., a central business district) and do not require multiple stops to serve several stations en route. Since the proposed BRT system would serve multiple stops along the two-county corridor, it reinforces the recommendation to eliminate the median busway, and continue the analyses of alignments along the north or south side of the Thruway.

While a median busway may not be desirable, it is important to note that it is significantly different from BRT in HOV/HOT lanes in the median. Thus, the alternative of BRT in HOV/HOT lanes along the Thruway median as described in Chapter 3 will be brought forward for further analysis in the EIS and compared to the busway alternative recommended as part of this study.

4.3 Description of Alignment Options

The two options described below have been advanced for further development and analysis based on the evaluation of the preliminary busway options (as summarized in Table 4-1). They are being evaluated using the criteria described in Chapter 1.

4.3.1 Busway North

The Busway North Option would generally parallel the Thruway alignment both horizontally and vertically, except at the interchanges where the BRT profile would cross under or over the interchange ramps. Beginning at the proposed Hillburn Intermodal Station the busway would elevate above the CRT tracks on a viaduct, turn east to cross over Route 59, and climb to join the north side of the Thruway (Figure 4-3). It would continue at grade to Interchange 14B where it would follow the interchange ramps, cross under a new bridge that would carry Airmont Road over the busway, and then access the proposed Airmont BRT Station adjacent to a commercial property near the Thruway westbound off-ramp. Typical cross-sections are shown on Figure 4-4.

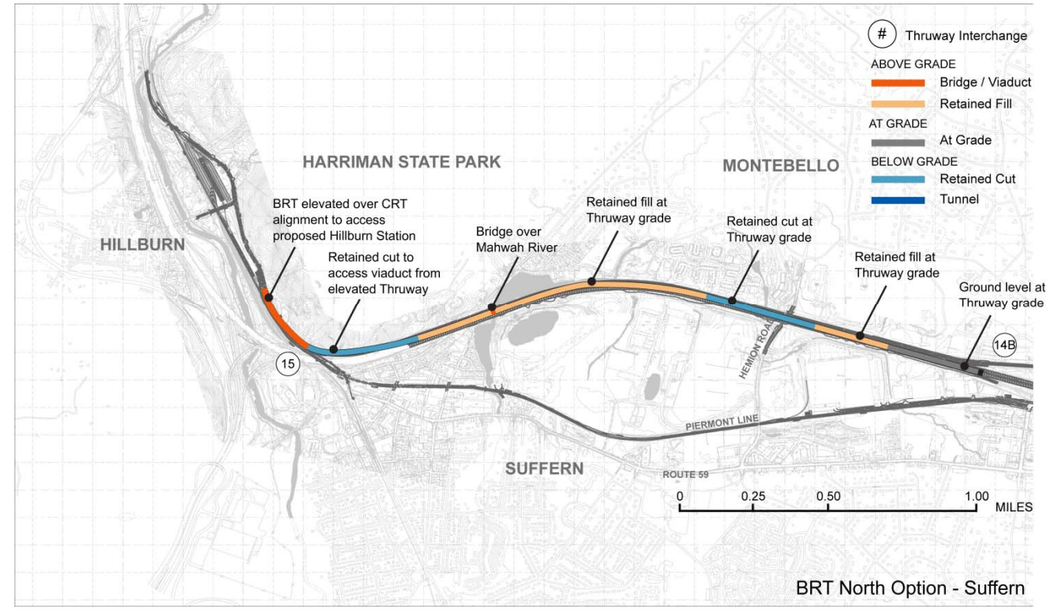
The busway east of Interchange 14B would continue adjacent to the Thruway for 3.6 miles, crossing under College Road and Route 59 to access the proposed Monsey BRT Station sited at the existing self-storage facility. It would proceed under Hungry Hollow Road and around a reconfigured/reduced Spring Valley truck toll facility, over Chestnut Ridge Road and under Scotland Hill Road. From there the alignment would descend under the Garden State Parkway and Interchange 14A ramps. It would then flatten to approximately match Thruway grade over South Pascack Road and access the proposed Interchange 14 Intermodal Station before descending again to pass under the Interchange 14 ramps.

The BRT would operate at Thruway grade east of Interchange 14 and would cross under the Pascack Valley Line and over North Middletown Road. It would then descend to cross under South Main Street and under the Palisades Interstate Parkway/Interchange 13 ramps. The busway east of Interchange 13 would follow the Thruway grade over Strawtown Road and under the West Shore Line. The busway would then climb a Texas-T to cross the Thruway and connect directly to the proposed Palisades Mall Intermodal station located on the south side at Parking Lot J.

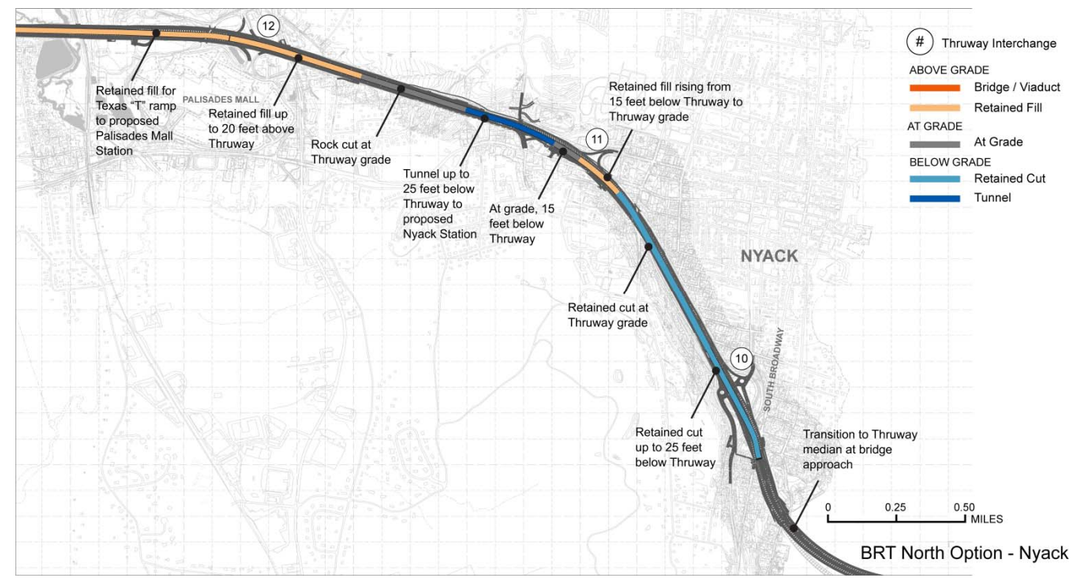
The busway east of the Texas-T on the north side of the Thruway would then descend to cross under Palisades Center Drive, but would quickly rise on a 7-percent grade segment to cross over the Interchange 12 ramps and Route 303 before descending to rejoin the Thruway grade.

The busway east of Route 303 would follow the Thruway grade for about ½ mile before descending to cross under the Thruway in a 1,700-foot-long cut-and-cover tunnel to a portal east of where the Thruway crosses over Route 59. This would permit access to the proposed Nyack BRT Station located on the Thruway's south side at Route 59.

The busway east of the portal would climb over Route 59 and run adjacent to the south side of the Thruway before diverging on a 1,600-foot downgrade for a 1,000-foot long cut-and-cover tunnel to shift to the median of the Thruway for the busway approach onto a replacement Tappan Zee Bridge. Placing the busway east of Interchange 11 along the south side is preferable to placing it on the north side because there is available ROW on the south side, whereas the north side through this area is directly adjacent to local streets and residences. A cross-section in the area of the Nyack BRT Station is shown on Figure 4-5.

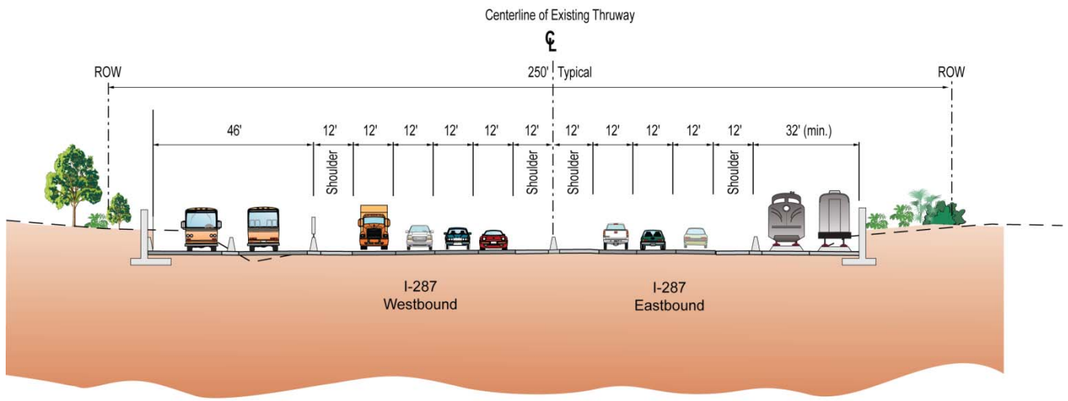


Suffern Area

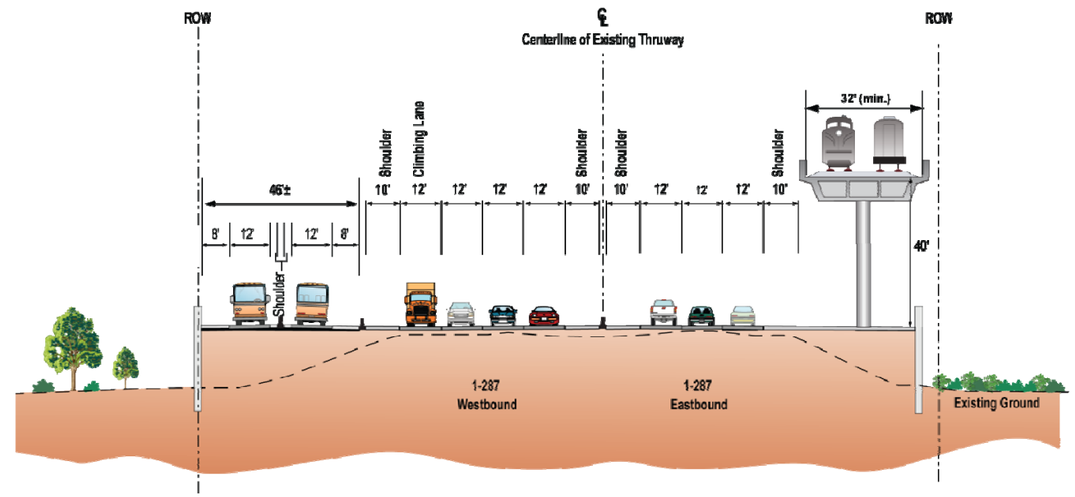


Interchange 12 to Tappan Zee Bridge

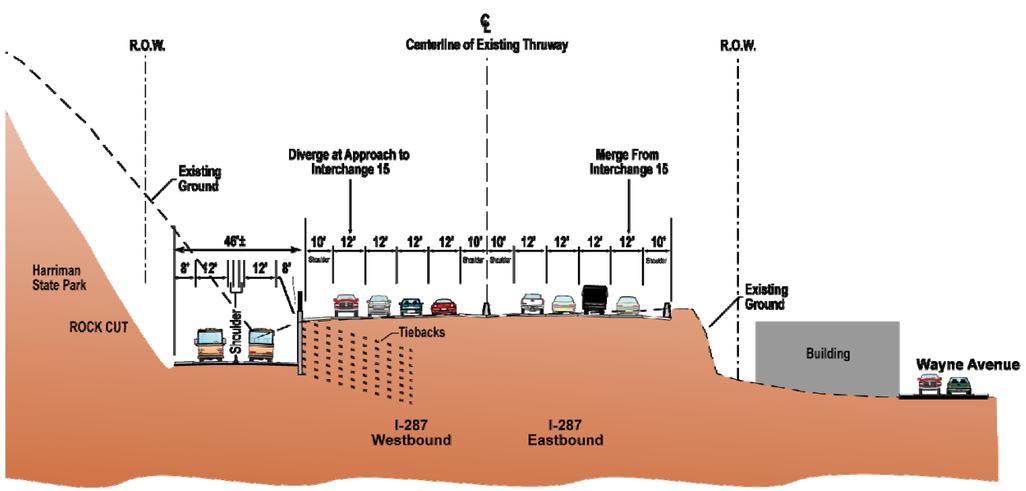
Figure 4-3 Busway North – Engineering Features



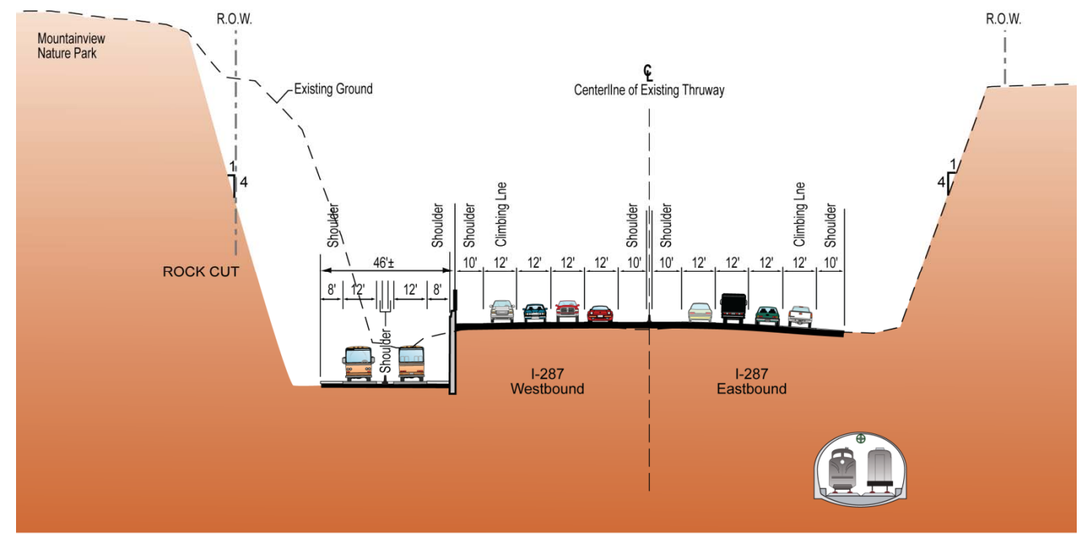
East of Interchange 14



West of Interchange 12



Harriman State Park



East of Interchange 12

Figure 4-4 Busway North - Typical Cross-Sections

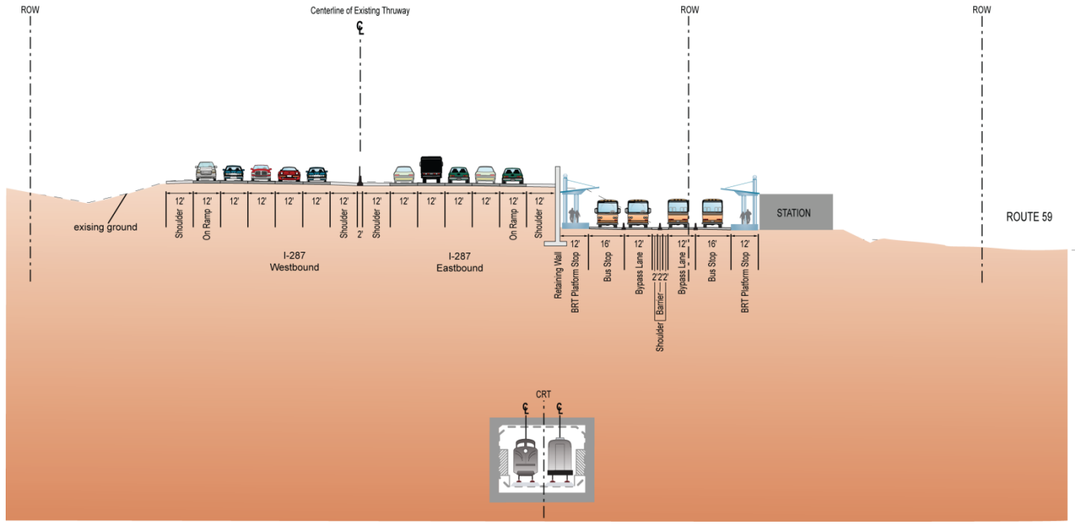


Figure 4-5 Proposed Nyack Bus Station Cross-Section

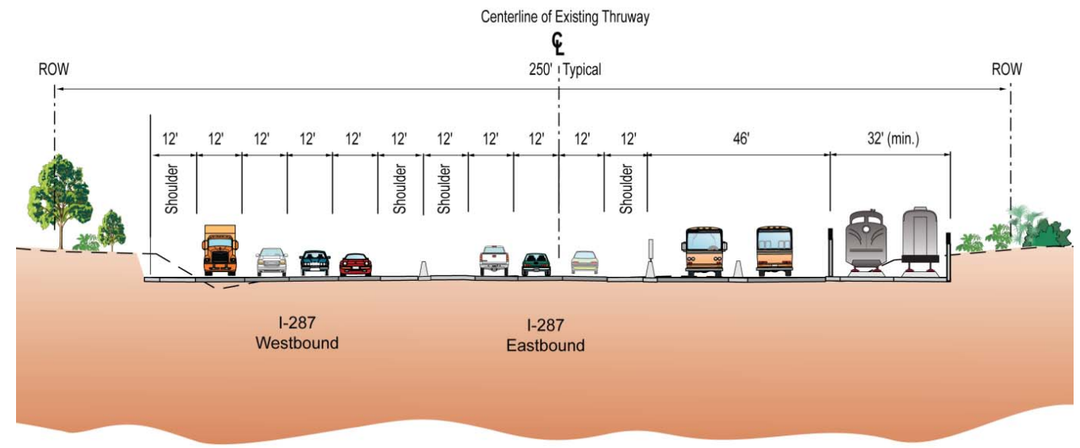
4.3.2 Busway South

The Busway South Option would parallel the Thruway alignment both horizontally and vertically in a similar manner as the Busway North Option. Typical cross-sections are shown on Figure 4-6. The CRT alignment would be built adjacent to the busway thus creating a transit corridor along the south side of the Thruway. The busway would be located adjacent to the Thruway because it could be built as an extension of the existing pavement, thus simplifying construction.

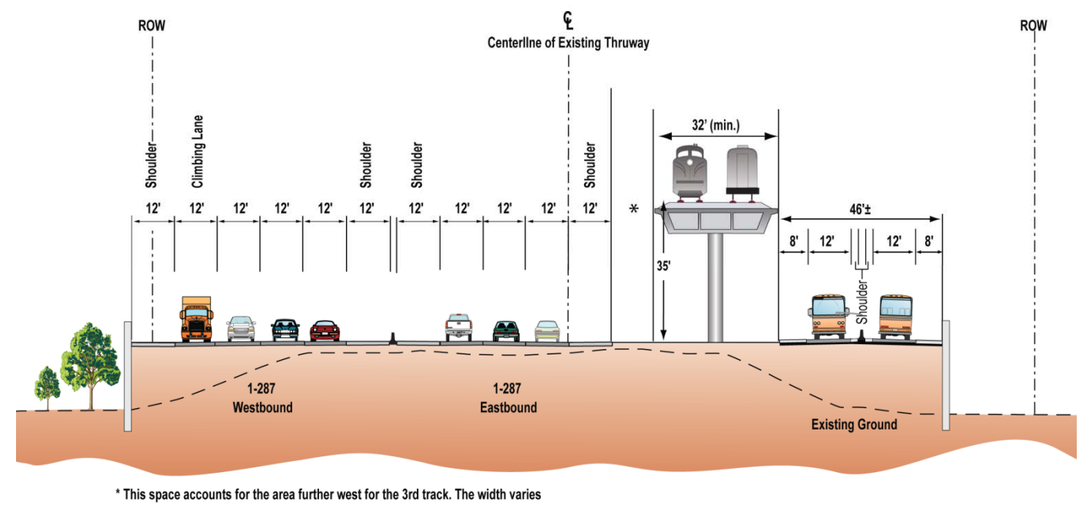
The Busway South Option would differ from the Busway North Option with respect to its western segment in Suffern (Figure 4-7). A direct Busway South connection from the proposed Hillburn Intermodal Station to the Thruway ROW would be difficult due to the existing Interchange 15 infrastructure and the proposed CRT alignment. Therefore the Busway South alignment would operate in mixed traffic from the Hillburn Station along Route 59 and then north on Wayne Avenue to the Thruway.

From Wayne Avenue, the busway would climb to a bridge over the Mahwah River and travel along the south side of the Thruway for more than 1.5 miles. At Interchange 14B, the busway would follow the south side of the eastbound off-ramp in a retained cut, cross under Airmont Road, and travel along the eastbound on-ramp to the proposed Airmont Road BRT Station at the site of the existing recycling facility.

The CRT alignment would join the Thruway east of Interchange 14B and would parallel the busway along the south side for close to 2 miles before the CRT alignment would enter the tunnel under the Monsey Hill. By being in tunnel, the CRT alignment would not interfere with the proposed Monsey BRT Station.

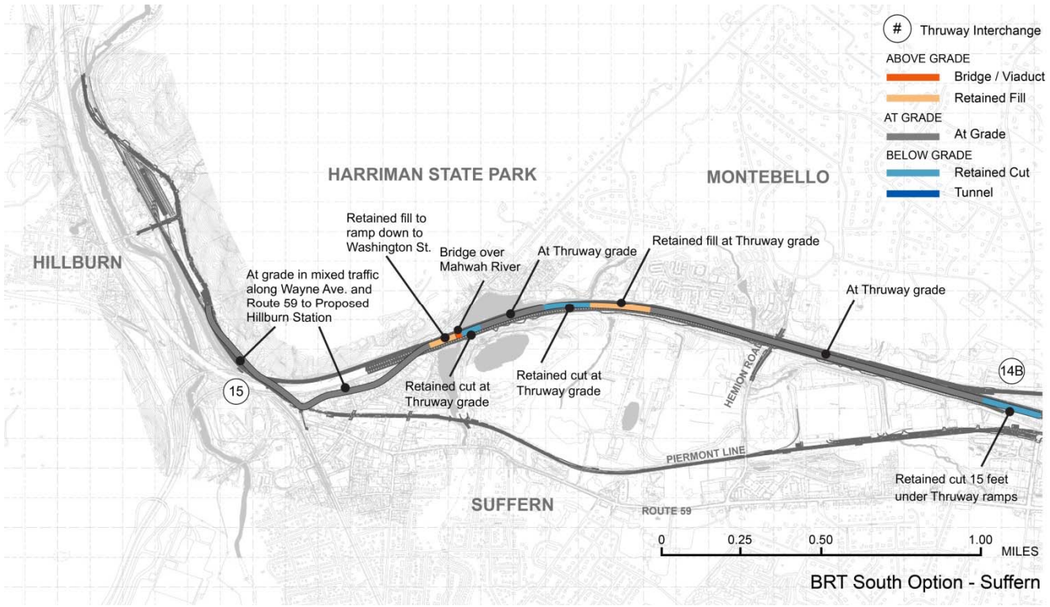


East of Interchange 14

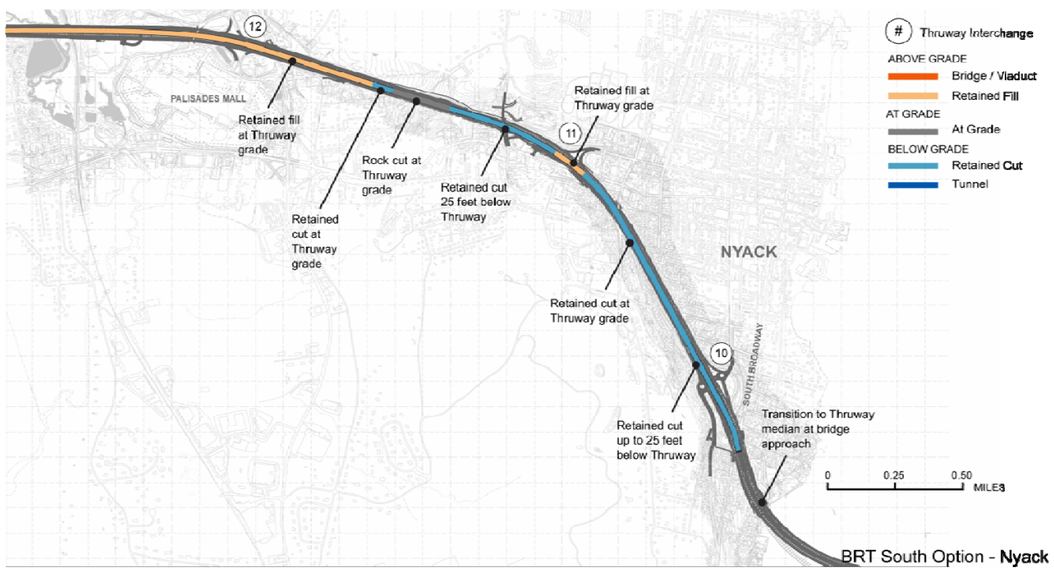


West of Interchange 12

Figure 4-6 Busway South – Typical Cross-Sections



Suffern Area



Interchange 12 to Tappan Zee Bridge

Figure 4-7 Busway South - Engineering Features

The busway would cross under College Road and Route 59 to reach the proposed BRT Monsey Station at the southwest quadrant of Route 59 and the Thruway. The busway would then cross over East Saddle River Road and under Hungry Hollow Road. At Chestnut Ridge Road the busway ascends onto a viaduct to cross over the CRT alignment to the south edge of the Thruway ROW. The busway then would descend under the Garden State Parkway and Interchange 14A ramps and then flatten to be at Thruway grade over South Pascack Road and through the proposed Interchange 14 Intermodal Station. The busway transition to the outside allows the busway to be readily accessible for feeder buses at the Interchange 14 Station without the need to cross over the CRT tracks.

East of Interchange 14 the busway alignment would remain along the south edge of the Thruway ROW and CRT would run adjacent to the Thruway pavement. This configuration would continue through the proposed Palisades Mall Station where the CRT would be on a tall viaduct above the busway. The busway heading east from the station would cross back under the CRT viaduct to be adjacent to the Thruway while the CRT would enter the tunnel under the Palisades rock cut. The busway alignment would continue on the south side under the Interchange 11 ramps to access the proposed Nyack BRT Station. From the station to the bridge the alignment would be the same as the Busway North Option.

4.4 Evaluation Results

This subchapter presents the evaluation results for the busway options.

4.4.1 Engineering

The engineering evaluation primarily considers the busway alignment and the interaction of the busway with the CRT alignment options. The descriptions and evaluations of CRT alignment options associated with the busway options are those presented in Subchapter 2.3; thus, assessment of the grades and operations for CRT are not repeated in this subchapter.

4.4.1.1 Engineering Design

Modifications to the Thruway

Figure 4-8 shows typical cross-sections for both options compared to the existing Thruway. The cross-sections show the extent of widening and the shift in the Thruway centerline; the dimensions shown include the possible westbound climbing lane, but do not account for additional widths for stormwater management facilities and edge slope requirements, as these are common to all options. A proposed 1,000-foot long third CRT track is provided for west of Interchange 12 to accommodate space needed in the event of a disabled train. The space for the third track is shown in Figure 4-6. The specific location will be further investigated during detailed design. Significant results from the typical cross-section comparison are presented in Table 4-2.

There is minimal difference between the options with respect to their final footprint within the existing Thruway ROW. However, the options differ in the extent of Thruway pavement reconstruction. The Busway North Option is notable, as no major change to the existing Thruway pavement is required. The Busway South Option requires the Thruway to be shifted to the north and to be reconstructed.

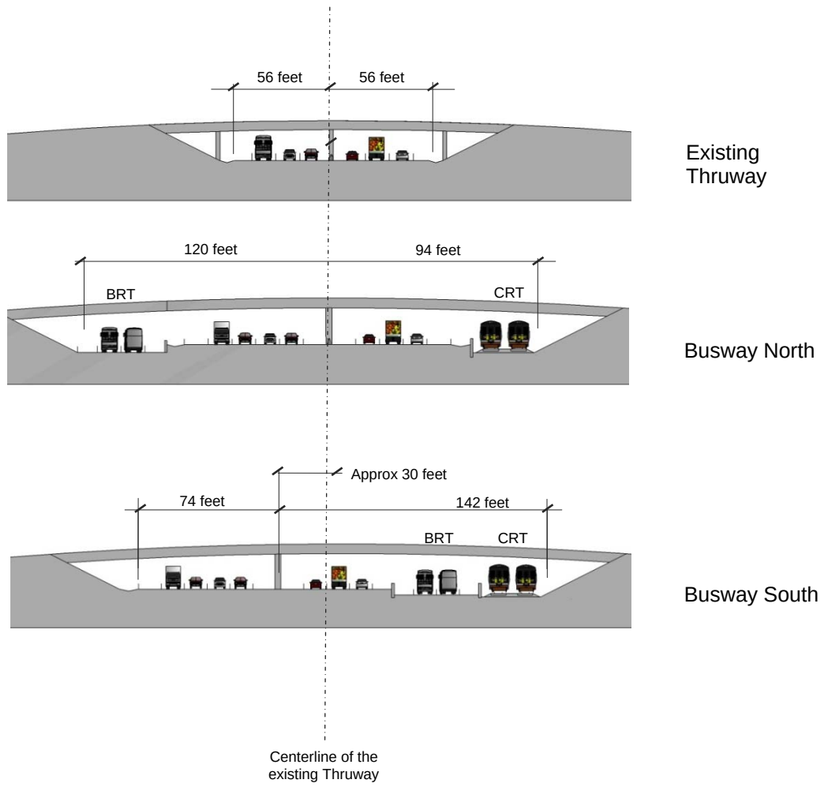


Figure 4-8 Comparison of Bridge Lengthening among Busway Options at a Typical Overbridge

Table 4-2

Thruway Modifications Required for the Busway Options

Busway North	Busway South
1. The overall footprint of the combined modes is 214 feet. 2. The overall footprint of the combined modes is 120 feet and 94 feet along the north and south sides of the Thruway, respectively. The overall footprint is approximately 13 feet offset from the centerline of the existing Thruway ROW. 3. The centerline of the Thruway remains unchanged. 4. The existing Thruway pavement would not need to be replaced as a result of the introduction of BRT and CRT.	1. The footprint of the combined modes is 216 feet. The difference in overall width compared to the north option is a result of the introduction of a barrier between the adjoining BRT and CRT. 2. Both the eastbound and westbound Thruway would be shifted to the north to make space for BRT and CRT along the south side. 3. The centerline of the Thruway is relocated approximately 30 feet north of its current location. 4. Full rebuild of the Thruway pavement would be required because of the change in positioning, superelevation and drainage of the Thruway. 5. Relative to the new Thruway centerline, the footprint of the combined modes is 74 feet and 142 feet along the north and south sides of the Thruway, respectively. 6. Relative to the existing Thruway centerline, the footprint of the combined modes is 104 ft and 112 ft respectively and is therefore approximately only 4 feet offset from the centerline of the existing Thruway ROW.

Busway Alignment

For both options, the busway is generally at the same elevation of the Thruway, but with some notable similarities and differences as presented in Table 4-3. In summary, the primary differentiators between the Busway North and South Options are:

- To accommodate the Busway South from Airmont Road to just east of the Monsey Hill, the eastbound and westbound Thruway would need to be reconstructed and shifted to the north over a length of approximately 1.8 miles. Thruway reconstruction would not be required in this segment for the Busway North Option.

- The Busway North Option in the area of the rock cut west of Interchange 11 passes below the Thruway in a 1,700-foot tunnel that requires ventilation and full fire control to reach the proposed Nyack BRT station on the south side. Two ventilation buildings, as well as their support facilities and access, would be required. (Ventilation is needed for fire safety for any tunnel over 800 feet long). A BRT tunnel is not required for the Busway South Option.

Table 4-3

Busway Alignment

Location	Common Factors for Busway North and South	Busway North	Busway South
Interchange 15 Area		Busway on a viaduct east of Interchange 15 providing a direct connection to Hillburn Station using a new dedicated route adjacent to Harriman Park.	A direct connection to the Hillburn Station is not provided. Instead BRT travels on Routes 202 and 59.
Interchange 15 to 14B	Bridge over Mahwah River.	Is on shallow cut or fill, but would require substantial construction adjacent to Lake Antrim of a 20-to-25-foot retaining wall.	Is on similar shallow cut or fill with no construction required adjacent to Lake Antrim. A long viaduct over the Mahwah River would be required.
Interchange 14B	Both alignments pass under Airmont Road with minor modifications to existing ramps. Both options would retain the existing Airmont Road Bridge over the Thruway.	Busway would follow the north side of the interchange ramps and cross under Airmont Road.	The busway would follow the south side of the interchange ramps and cross under Airmont Road.
Interchange 14B to East Saddle River Road	Both options would require replacement of the three bridges over the Thruway in this area. Both options may require retaining walls up to 35 feet high to be built into existing deep-fill areas over existing watercourses, with potential extensive construction access route requirements.	Occupies all of the available Thruway ROW from Interchange 14B to College Road. From College Road to East Saddle River Road, the ROW increases in width through an area of rock cut. No modification to the existing Thruway, beyond edge details and water management requirements, would be anticipated to accommodate BRT.	Is adjacent to CRT in all of the options with BRT on the south. The Busway is located in the same space currently occupied by the eastbound Thruway. To accommodate BRT, the eastbound and westbound Thruway would need to be reconstructed and shifted to the north over a length of approximately 1.8 miles.
Route 59 to Scotland Hill Road		Occupies all of the available Thruway ROW through most of this area. BRT passes to the north of the existing truck toll plaza.	Occupies all of the available Thruway ROW through most of this area. BRT does not conflict with the existing truck toll plaza. However, the BRT route would reduce the area available for the truck inspection plaza, located within the footprint of the removed eastbound toll plaza, if this is determined to be required later in the EIS.
Interchange 14A-14, Garden State Parkway Area	BRT in both options diverts slightly from the typical position adjacent to the Thruway in the area of the Garden State Parkway (GSP). Both options pass under the GSP and Interchange 14 ramps in 25-to-30-feet-deep cuts.	Extends outside of the Thruway ROW by 5-10-ft through much of this area, with further space required for the construction of retaining walls. BRT diverts to the north from the Thruway to pass under all four interchange ramps of the Garden State Parkway (GSP).	Footprint is within the Thruway ROW. Busway would cross under four interchange ramps.
Interchange 14 to North Middletown Road	With the exception of the area around North Middletown Road, BRT is within the Thruway ROW for both options. At North Middletown Road, both options occupy the entire available ROW. In this area, the North Option is combined with the climbing lane and has a wider footprint. Thruway access ramps from the Old Nyack Turnpike near Pascack Road would be closed.		
Interchange 13 Area To Strawtown Road	Both options place BRT in deep cuts (25 to 30 feet deep) to pass under the interchange ramps for a distance of approximately 3,000 feet.	Busway would cross under the interchange ramps.	Busway would cross under the interchange ramps.
Palisades Mall Station		Busway profile would elevate to a Texas-T to access a station in the vicinity of Parking Lot J and return to the north side to continue east.	The busway profile would rise to the elevation of Parking Lot J.
Strawtown Rd to Interchange 12	Both options are generally within the Thruway ROW.		
Interchange 12 Area	In both options, BRT is grade-separated above the Interchange 12 ramps.	Busway would cross over the interchange ramps.	Busway would cross over the interchange ramps.
Interchange 12 to Highland Avenue	Both options have substantial lengths outside of the Thruway ROW, particularly in the deep rock cut west of Interchange 11. Both options require extensive modifications to the existing rock cut with the existing rock cut face shifted by up to 50 feet.	In the area of the rock cut, passes below the Thruway in a 1, 700-foot long tunnel that requires ventilation and full fire control. Two ventilation buildings would be required as well as their support facilities and access.	A BRT tunnel is not required in the south option.
Interchange 11, Nyack Station		Busway would cross under the Thruway to the south side to access the Nyack Station, and continue along the south side to Interchange 10.	The busway would cross under the interchange ramps to the Nyack Station.
Highland Avenue to Interchange 10	Both options are identical in this area with BRT on the south side.	Busway would cross from the south side of the Thruway to the median in a shallow cut and cover tunnel to align itself with the center lanes on the replacement Tappan Zee Bridge	The busway would cross from the south side of the Thruway to the median in a shallow cut-and-cover tunnel to align itself with the center lanes to cross the replacement Tappan Zee Bridge.

The requirement of the Busway South Option for the Thruway to be relocated to the north is not needed for the Busway North Option; therefore engineering design is considered an important differentiator.

4.4.1.2 Operations and Maintenance

The evaluation of operations and maintenance activities for a busway on either the north or south side with respect to Thruway operations results in no significant differences. Thus, operations and maintenance are not considered a differentiator.

4.4.1.3 Constructability

Constructability factors are presented in Table 4-4. The Busway North Option does not require Thruway reconstruction allowing construction of the BRT and CRT to start without limitations on commencing location. The potential for BRT and CRT to be constructed independently and possibly simultaneously, and most importantly without the need to relocate the Thruway, results in the shortest overall construction period of 4 to 5 years.

Table 4-4

Busway Options Constructability

Option	Thruway Reconstruction	Construction Duration
Busway North	None Required	4-5 years
Busway South	Complete Thruway	6-7 years[1]

Notes:
1. Depending on the number of stages implemented for the highway reconstruction, the overall construction duration could extend beyond 10 years.

The Busway South Option would have longer construction duration as both the eastbound and westbound lanes would need to be reconstructed before both of the transit modes could be implemented. This option has less flexibility as spatial requirements dictate that the highway be reconstructed first. The overall construction duration would be at least 6 to 7 years with the first 3 to 4 years largely required for relocation of the Thruway. These durations assume that the full length of the Thruway between Interchanges 11 and 15 would be reconstructed in one phase. However, because of the scale of this project, it is likely that smaller contracts and staging of the highway construction across Rockland County would be used. This would potentially further lengthen the overall construction duration to more than 10 years before completion of the transit modes.

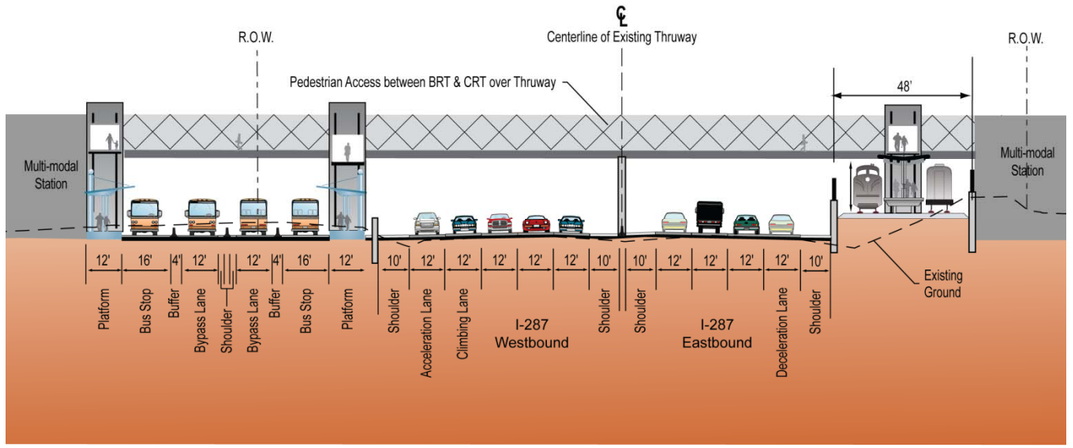
4.4.2 Cost

Total capital cost estimates for the Busway North and South Options with CRT are $7.08 and $7.54 billion, respectively. These estimates include all busway infrastructure, stations, and access ramps; all CRT infrastructure, systems, track work and stations; proposed highway improvements, modifications to overbridges, interchange ramps, and any local roadway modifications to accommodate transit. These estimates are for the 14.7 mile corridor from the proposed CRT maintenance yard in Hillburn to the CRT portal at the replacement Tappan Zee Bridge in Rockland.. Costs were estimated assuming CRT would be on the Piermont Line crossing over Airmont Road with a maximum allowable 2.0-percent grade. The Busway North Option cost is less due to its minimal impact to the existing Thruway.

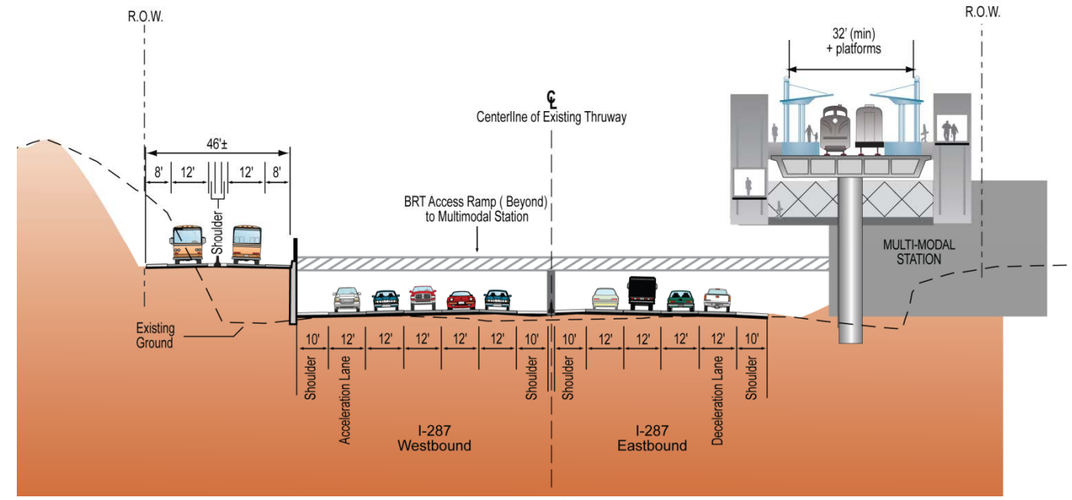
4.4.3 Transportation

The results of the transportation evaluation are summarized below:

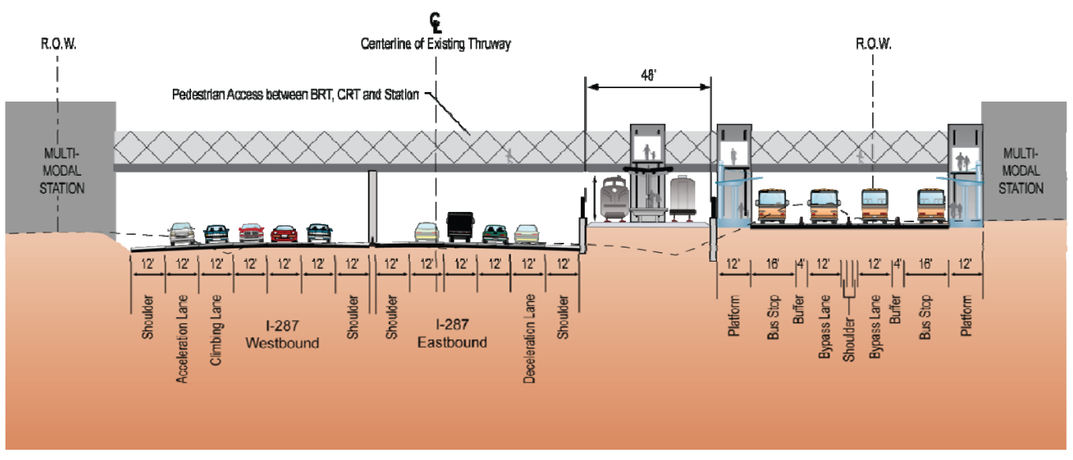
- **Travel Time.** There is no discernable difference in travel time between the two options. Travel time is not considered a differentiator.
- **Traffic Network Changes.** The differences between the two options are relatively minor in terms of traffic network changes (e.g., the eastbound on-ramp from the Old Nyack Turnpike onto the Thruway is closed in both options). The BRT South Option would have a minor impact to traffic on a portion of Wayne Avenue in Suffern and Route 59 in Hillburn to access the proposed Hillburn Intermodal Station. Traffic network changes are not considered a differentiator.
- **Transportation System Integration.** There are differences among the two options related to BRT station locations:
  - The Airmont Road Station would be on the north side of the Thruway for the Busway North Option; however the location is not close to existing commercial and retail areas that are south of the Thruway. Locating the station on the south side of the Thruway under the Busway South Option could be complicated by the CRT alignment operating through the same area. Both station locations would be accessible from Airmont Road.
  - At the Monsey Station, the North Busway Option has good access from Route 59 and there exists a suitable commercial site for station development. The South Busway Option location would be difficult because of the constrained and limited station area.
  - At the Interchange 14 Intermodal Station (Figure 4-9), there are several factors to consider:
    - Feeder buses connecting to this station are generally traveling to and from the north. Therefore, the North Busway Option simplifies feeder bus access to the station and busway.
    - Transfers between the two modes would be relatively easy in the Busway South Option as the stations would be adjacent to each other. In the Busway North Option, passengers transferring between the BRT and CRT modes would have to cross over the Thruway.
    - Transfers between local bus services and the BRT services are more easily facilitated with the North Busway Option because of the proximity of the station to Route 59.
    - The South Busway Option does not allow for direct integration between the existing park-and-ride facilities located on the north side of the Thruway and the BRT station.
  - At the proposed Palisades Mall Intermodal Station (Figure 4-10) there are also several factors to consider:
    - In both options the BRT station would be located on the south side at Parking Lot J, requiring feeder buses and connecting local transit services to use the mall's ring road to access the station.
    - The Busway South Option provides the most direct transfers between the modes and the most direct feeder bus access to the busway. The Busway North Option requires a Texas-T to connect the BRT trunk route, and provide feeder bus access to this important station.



Busway North

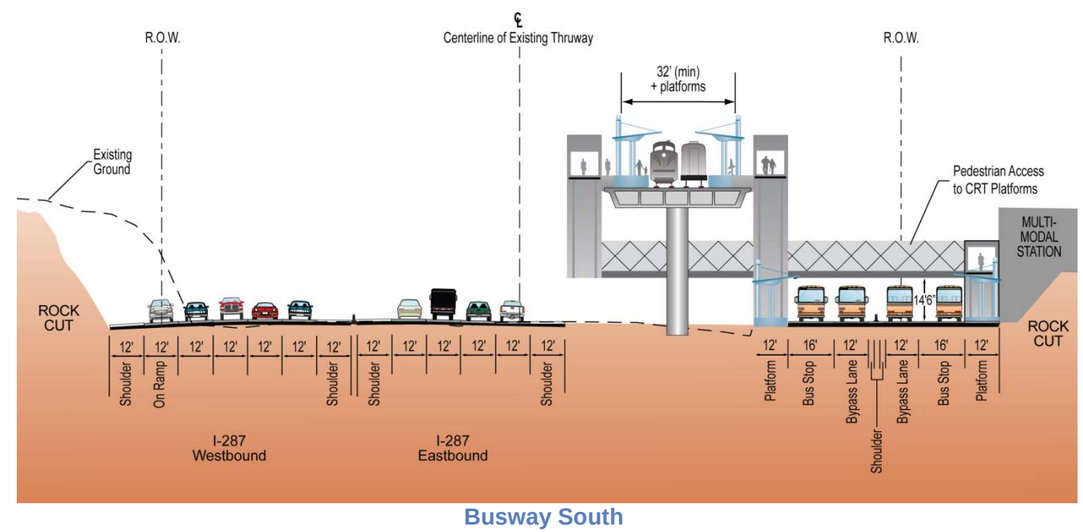


Busway North



Busway South

Figure 4-9 Busway
Typical Cross-Sections at the Proposed Interchange 14 Intermodal Station



Busway South

Figure 4-10 Busway
Typical Cross-Sections at the Proposed Palisades Mall Intermodal Station

The Busway North Option BRT stations at Airmont, Monsey and Interchange 14 have preferable locations compared to the Busway South Option. South side station locations for Airmont, Monsey and Interchange 14 have conflicts or are constrained. The proposed Palisades Mall and Nyack stations would be on the south side for both options. The Busway North Option is able to connect to all the best locations whereas the south side locations for three of the five station locations are not preferred. Therefore, transportation system integration is considered a differentiator.

4.4.4 Environment

The results of the environmental evaluation are summarized below:

- **Land Use/Potential for TOD.** Each proposed station would only be marginally better suited for one side of the Thruway and no option would preclude the potential for TOD at proposed station areas. Therefore, land use and TOD are not considered differentiators.

- **Displacement and Acquisitions**. There would be displacements under both options (Table 4-5). The total number of structures (including station areas) displaced or acquired ranges between 56 for the Busway North Option and 45 for the Busway South Option. However, when considering the numbers of businesses and residential units (not including ancillary structures), the number of these dwelling units displaced for the Busway North Option would be 15, while for the Busway South Option there would be 33 displaced dwelling units. In addition, the Busway North Option would displace 28 businesses (not including ancillary structures) whereas the Busway South Option would displace 34 businesses. The greater number of residences and businesses displaced by the Busway South Option is considered a differentiator between the options.

- **Wetlands**. There would be direct wetland impacts of 26 and 25 acres, respectively for the Busway North and South Options. Both options would cross the Hackensack River (a Class A water body) and impact the NYSDEC-mapped wetlands adjacent to the river. Wetlands are not considered a differentiator.

- **Aquifers and Floodplains**. There is a potential differential impact to the Ramapo Valley sole-source aquifer under the Busway North Option because this option would result in 3.7 acres of additional impervious surface due to its direct connection to the Hillburn Station. The Busway South Option runs on existing local streets to the Hillburn Station and does not add impervious surface acreage. Floodplains may also be a differentiator. The Busway North Option would encroach on 3,600 linear feet of floodplain, while the Busway South Option would encroach on 1,400 linear feet of floodplain. The majority of the floodplain encroachment on the Busway North Option would occur along Lake Antrim.

- **Parklands**. The parks affected by the busway options are Harriman State Park, Monsey Glen Park, and the Mountainview Nature Preserve (Table 4-6). Total acreage affected by each option is less than 1 acre. Thus, potential impacts to these parks are not considered differentiators.

- **Historic Resources**. Up to 10 historic architectural resources would be impacted by the two options (Table 4-7). Impacts range from reconstruction of resources (the Piermont Line) to strip takes, easements, and construction adjacent to resources. However, the two options would have similar impacts to historic architectural resources, and the impacts would not significantly compromise the historic feeling or setting of the resources. Historic resources are not considered a differentiator.

- **Archaeological Resources**. Both options have the same potential for archaeological sensitivity in several locations (Table 4-8). Archaeological resources are not considered a differentiator.

- **Hudson River Ecosystems**. None of the options affect the Hudson River. Hudson River ecosystems are not considered a differentiator.

- **Noise**. The potential changes in noise levels are considered for both the BRT and CRT components of the busway options. A perceptible change in hourly traffic noise along a highway would require a doubling of traffic volumes. Therefore, given the limited increase in bus traffic relative to total traffic on the Thruway, there would not be a perceptible change in traffic noise levels for either of the busway options. With respect to the CRT component, CRT noise would be largely masked by highway traffic noise and the CRT noise increase would not be perceptible on an average hourly basis. Noise is not considered a differentiator among the busway options.

- **Visual**. Both options would result in the loss of most of the vegetative buffer on each side of the Thruway. Both options would also result in visual impacts related to the CRT viaduct in the vicinity of Strawtown Road. Visual impacts are not considered a differentiator between these BRT options.

4.5 Transit Alignment Recommendation

The evaluation of the busway options in Rockland County is summarized in Table 4-9. The Busway North Option is recommended for advancement into the EIS as an element of Alternatives B and C based on the following criteria differentiators:

- **Engineering -**. The main differentiator between the Busway North and South Options is the extent of Thruway modifications required to implement the alignment. For the North Option, no major change to the existing Thruway pavement would be required, whereas the Busway South Option would require the Thruway to be shifted north and reconstructed prior to construction of the busway. Additionally, for the Busway North Option construction staging would be more straightforward and have a shorter duration as it could be accomplished independently of the CRT implementation. The North Option would include a 1,700-foot long tunnel beneath the Thruway at Interchange 11 to access the proposed BRT Nyack Station, which would not be required of the South Option.

- **Cost -** The capital cost estimates of the Busway North and Busway South Options are $7.08 billion and $7.54 billion, respectively, a cost difference of $500 million due to the minimal impact of the Busway North Option to the existing Thruway.

- **Transportation -** The Busway North Option connects to the most suitable locations for the proposed BRT stations in Rockland County. The Airmont, Monsey, and Interchange 14 BRT Stations have preferable locations on the north side, while the Palisades Mall and Nyack Stations would be on the south side for both options.

- **Environment –** There are minimal differences between the options regarding their footprint within the Thruway ROW. As a result, there are only two environmental differentiators. With the Busway North Option there would be 18 less displaced residential units and six less displaced businesses compared to the Busway South Option. With respect to aquifers and floodplains, the Busway North Option would result in 3.7 acres of additional impervious surface because of its direct connection to the Hillburn Station, as compared to the South Option using existing roads in Suffern.

Table 4-5
Displacements and Acquisitions

Structures	Busway North	Busway South
Commercial	30 (28 businesses and 13 ancillary)	20 (34 businesses and 3 ancillary)
Residential	23 (15 dwelling units and 16 ancillary)	21 (33 dwelling units and 12 ancillary)
Institutional	1	2
Transportation or Utility	2	2
Total	56	45
Total Businesses and Dwelling Units	43	67

Table 4-6
Parklands

Park	Busway North	Busway South
Harriman State Park (acres)	0.046 (strip-taking adjacent to Thruway and Route 59)	0.004 (sliver impact at Route 59)
Monsey Glen Park (acres)	0.002 (strip-taking)	0.030 (strip-taking)
Mountainview Nature Park (acres)	0.358 (strip-taking due to slope cutback)	0.477 (strip-taking due to slope cutback)

Table 4-7
Archaeological Resources

Location	Busway North	Busway South
West of Route 304 on South ROW	400 feet of prehistoric Native American finds	400 feet of prehistoric Native American finds
West of Chestnut Ridge Road on south ROW	1,100 feet of prehistoric Native American finds 200 feet of historic former Elbert Talman estate features	1,100 feet of prehistoric Native American finds 200 feet of historic former Elbert Talman estate features
West of Saddle River Road/East of Route 59 over the Thruway	200 feet of prehistoric Native American finds	200 feet of prehistoric Native American finds

Table 4-8
Historic Resources

Property	Busway North	Busway South
Recommended NRE E. Hillburn Historic District	Roadway realignment	Roadway realignment
Reconstruction of NRE NY & Erie RR Co. Alignment	Piermont Line	Piermont Line
Recommended NRE Lafayette Avenue Cluster	Possible strip take associated with cut-and-cover tunnel)	Possible strip take associated with cut-and-cover tunnel)
NRL Suffern Post Office	Subsurface easement	Subsurface easement
NRE Suffern Middle School	Subsurface easement	NA
NRL Palisades Interstate Parkway	Reconstruction of the Thruway bridge over parkway and parkway/Interchange 13 ramps)	Reconstruction of the Thruway bridge over parkway and parkway/Interchange 13 ramps)
Recommended NRE Strawtown Road Historic District	Strip take from contributing resources on north side of the Thruway - fee without acquisition	Strip take from contributing resources on north side of the Thruway - fee without acquisition; possible strip take from contributing resource on south side
Recommended NRE 64 North Greenbush Road	Strip take	Strip take
Recommended NRE 44 South Highland Avenue	Potential strip take	Potential strip take
NRL Mount Moor African- American Cemetery	Palisades Mall Station; road improvements on west side of cemetery	Palisades Mall Station; road improvements on west side of cemetery

Table 4-9

Suffern Area to Interchange 10: Busway with CRT Options

Criteria	Busway North	Busway South
Engineering		
Engineering Design	• Thruway mainline not relocated or reconstructed. • 1,700-foot BRT tunnel at Interchange 11.	• Entire Thruway would be relocated and reconstructed. • Thruway centerline shifted approx 30 feet to the north.
Operations & Maintenance	Not a differentiator.	Not a differentiator.
Constructability	• Simplest construction staging, as Thruway centerline unchanged. • Shorter construction duration.	• More construction stages required to shift and reconstruct the Thruway • Longer construction duration.
Cost		
Capital Construction Costs (2012 $)	$7.08 billion	$7.54 billion
Transportation		
Travel Time	Not a differentiator.	Not a differentiator.
Traffic Network Changes	Not a differentiator.	Not a differentiator.
Transportation System Integration	Airmont, Monsey and Interchange 14 BRT Stations have preferable locations on the north side. Busway alignment would require additional infrastructure to connect to the preferable Palisades Mall and Nyack south side stations.	South side station locations for Airmont, Monsey and Interchange 14 have conflicts or are constrained. Busway alignment would connect directly to the Palisades Mall and Nyack south side stations.
Environment		
Land Use / Potential for TOD	Not a differentiator.	Not a differentiator.
Displacements and Acquisitions	56 structures. 43 businesses and dwelling units.	45 structures. 67 businesses and dwelling units.
Wetlands	Not a differentiator.	Not a differentiator.
Aquifers and Floodplains	The Busway North Option has 3.7 acres of additional impervious surface, which may impact the Ramapo Valley SSA, and has 2,200 linear feet more floodplain encroachment than the Busway South Option.	The Busway South Option has less aquifer and floodplain impacts compared to the Busway North Option.
Parklands	Not a differentiator.	Not a differentiator.
Archaeological Resources	Not a differentiator.	Not a differentiator.
Historic Resources	Not a differentiator.	Not a differentiator.
Hudson River Ecosystems	Not applicable.	Not applicable.
Noise	Not a differentiator.	Not a differentiator.
Visual	Not a differentiator.	Not a differentiator.


environment

5 Westchester County – BRT in Bus Lanes Alignment (Alternatives C and E)

This chapter describes the development process for the BRT in bus lanes alignment in Westchester County. It should be noted that several segments of the "bus lanes" alternatives actually include busway sections. The bus lane alignment options under consideration in Westchester County are the connection of BRT service to the existing Metro-North Tarrytown Station, and the BRT route through downtown White Plains. The discussion treats the individual segments within Westchester County in a geographic progression from west to east. While some geographic segments have only one alignment option, they are described so as to present a complete discussion of the recommended alignment in the county (Figure 5-1).

5.1 Tarrytown – BRT Connector Options

This area of study encompasses much of the same areas as the Hudson Line Connector in Chapter 2 as it focuses on the vicinity of the Westchester County landing of the Tappan Zee Bridge. The bridge touches down on a general northwest-southeast alignment approximately 118 feet above the Hudson River. The eastbound toll barrier is approximately 1,000 feet inland; the South Broadway Bridge is approximately 1,000 feet east of the toll barrier. North of the toll plaza is the intersection of South Broadway with Route 119 and a westbound entrance to the Thruway. South of the landing area is a residential community along Van Wart and Paulding Avenues. North of the landing is a large office building at 303 South Broadway and the tennis courts, pool, and recreational facilities related to residential development. Factors that warranted consideration in the development and evaluation of options are:

- Steep topography, which would require steep grades, deep cuts, and/or trestle structures.
- Complex infrastructure including the Thruway, Hudson Line, proposed Hudson Line Connection, proposed BRT in a busway or in HOV/HOT lanes and existing local roads.
- Existing residential and commercial properties.
- Thruway Maintenance Facilities.
- New York State Police Troop T Headquarters.
- Tappan Zee Bridge Toll Plaza and Thruway toll operations facilities.
- Limited ROW on the north side.
- The proposed BRT Broadway Station location.
- Maintaining the existing Hudson Line CRT service.

There are two alignment options under consideration for the Tarrytown Connector (Figure 5-2).

5.1.1 Proposed Transit Operations

There are two proposed BRT stations in this area:

- **Broadway BRT Station –** would be located immediately adjacent to the Westchester landing on the north side of the replacement Tappan Zee Bridge in NYSTA property. It would accommodate local Bee-Line bus transfers from South Broadway and Route 119, allow for BRT Route L to access the BRT trunk line, and would have a connection to the Tarrytown Connector.

- **Tarrytown BRT Station -** would be located at the northern terminus of the Tarrytown Connector, adjacent to south end of the existing Metro-North Tarrytown Station. It would provide direct connections between the proposed BRT trunk line and the Hudson Line commuter rail service. The northern terminus of the Tarrytown Connector would be designed to allow for the BRT Route L to access the connector at this station.

After crossing the replacement Tappan Zee Bridge, the BRT routes would either go directly to the existing Metro-North Tarrytown Station via the Tarrytown Connector or enter the Broadway BRT Station, depending on its specific service route. Most of the BRT routes would go directly to the Broadway BRT Station since the Tarrytown Station is not on the BRT trunk line (see the BRT Service Plan in Appendix A). As part of the TMSR, coordination was performed with the bus operators in both Rockland and Westchester counties to establish the seventeen proposed bus routes included.

Twelve BRT routes (A, B, C, D, E, F, G, H, I, J, K and T) would cross the replacement Tappan Zee Bridge from Rockland County. Three routes (E, J, I) of the 12 would use the connector and serve the Tarrytown Station. The remaining nine routes would go directly to the Broadway BRT Station, bypassing the Tarrytown Station. Route L from Croton-Ossining would stop at the Tarrytown Station and use the Connector to access the Broadway BRT Station and continue east on the trunk line. Route F would stop at the Broadway BRT Station and continue along Route 9 to Yonkers and the Bronx. The remaining BRT routes, except Route E, which returns to Rockland, would continue east along the BRT trunk line.

The intermodal connection opportunities that would be available at the proposed Broadway BRT Station and the existing Tarrytown Station are illustrated in Figure 5-3.

5.1.2 Description of Alignment Options

Four options were initially identified for the Tarrytown BRT Connector to the existing Metro-North Tarrytown Station. The four options were derived based on a possible north or south approach to the proposed Broadway BRT Station. Two of the options were dropped after initial study:

- **South Broadway Option** - From the proposed Broadway BRT Station, the connector would use South Broadway via a roundabout at the intersection of South Broadway and Route 119. It would then turn west onto Van Wart, through the toll plaza administration parking lot, to an access road that would follow the existing terrain of the escarpment down until it reaches grade with the Hudson line (west of North Tappan Landing Road). It would then proceed at the grade of the Hudson Line to the Tarrytown Station. This option was not further developed as it would not provide exclusive BRT ROW for the Tarrytown Connector.

- **South Bridge Option** – This option would come up from the Hudson Line to the east of the Toll Administration building and rise to an elevation high enough to cross over the toll plaza and westbound approach on a bridge structure. The north end of the bridge would be west of the intersection of South Broadway and Route 119 and would provide access to both that intersection and to the proposed Broadway BRT Station. This would require a much greater transition in elevation – from +8 feet to +140 feet – as well as a 250-foot long skewed bridge to cross over the east end of the toll plaza and the westbound general-travel lanes. The option was not further developed due to the excessive infrastructure that would be required.

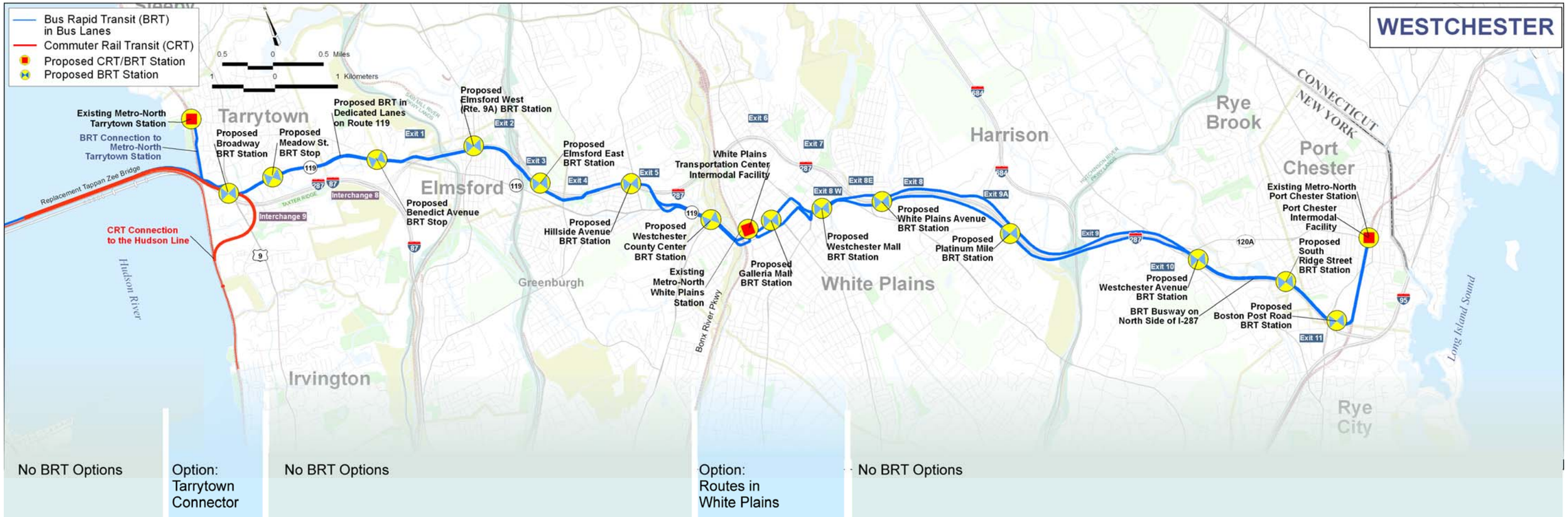


Figure 5-1 Bus Lane Options in Westchester County

Figure 5-2 Tarrytown BRT Connector Options

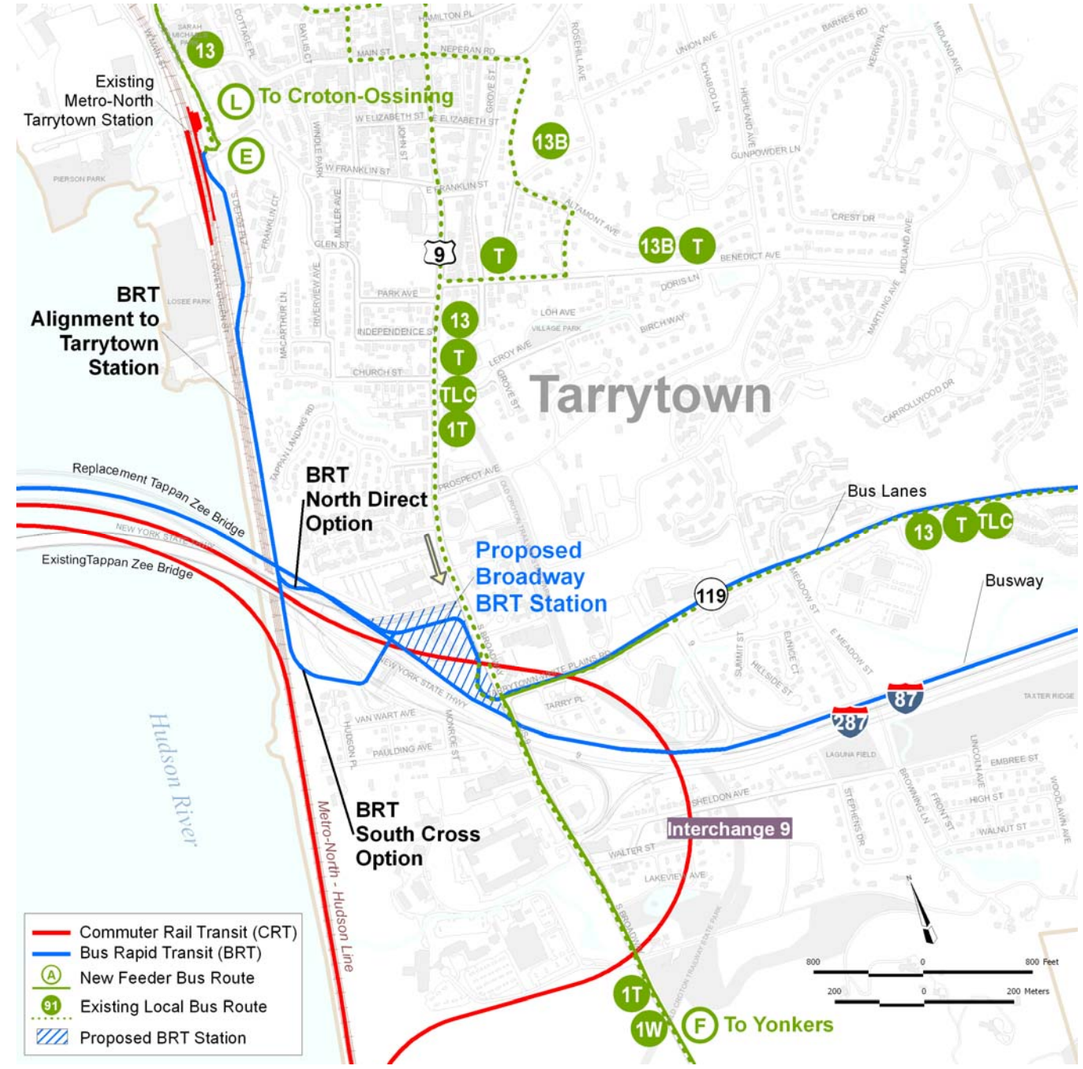


Figure 5-3 Broadway BRT Station Connectivity Diagram

The remaining two options for analysis are:

- **North Direct Option.** This option would have 1,000 feet of 7-percent grade from the BRT station and would pass under the relocated Interchange 9 on-ramp from South Broadway in a 25-foot-deep cut (Figure 5-4). It would be at elevation 48 feet when it passes the tennis courts of the Quay Condominiums, at approximately the same level as the tennis courts. It would include 3,500 feet of pavement and 500 feet of structure.

- **South Cross Option**. The alignment would be in a tunnel under the toll plaza from the proposed Broadway BRT Station. It would then be on a structure, descending at a 1,000 foot long 7-percent grade (from the 103-foot elevation on the south side of the Thruway) under the Tappan Zee Bridge approach until it reaches grade with the Hudson line (west of North Tappan Landing Road). It would then proceed at the grade of the Hudson Line to the Tarrytown Station (Figure 5-4). The option would be at 24 feet elevation when it passes the Quay Condominium tennis courts, or about 16 feet below the tennis courts. It would include 3,500 feet of pavement, 1,100 feet of structure, and 400 feet of tunnel.

5.1.3 Evaluation Results

This subchapter presents the evaluation results for the BRT Tarrytown Connector options.

5.1.3.1 Engineering

Engineering Design

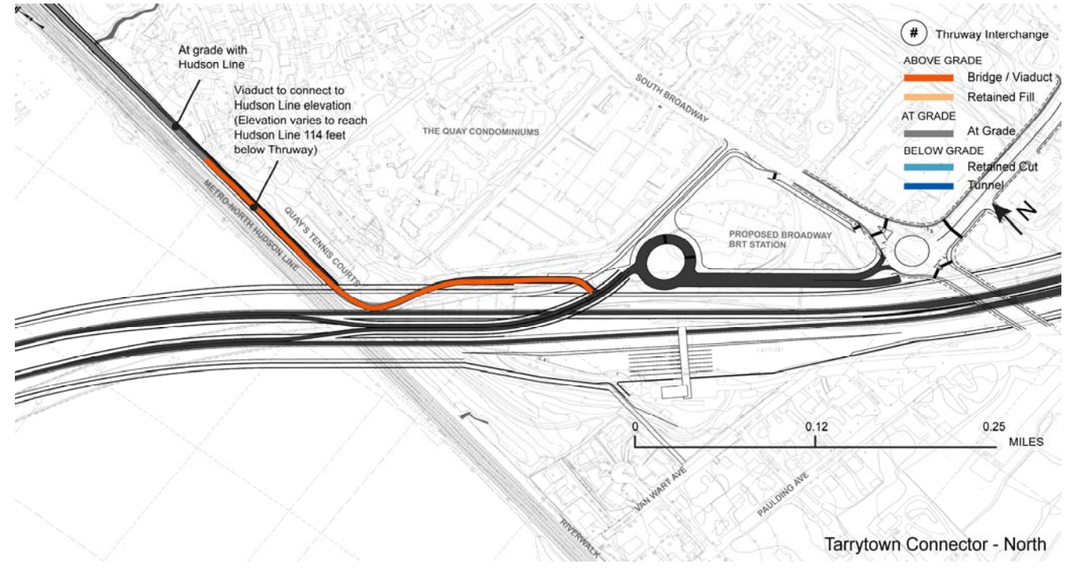
Both options would be very similar in terms of grades and overall profile. The only difference between the options would be their location north or south of the Thruway. Both options could be constructed within NYSTA property in the area adjacent to the toll plaza. Both the North Direct and the South Cross Options would work with any of the single or dual-level bridge options still under consideration.

Both Tarrytown Connector options would make use of the maximum permissible grade of 7 percent as they negotiate the escarpment. The elevation of the North Direct Option would be at approximately the same level as the Quay Condominium courts. The South Cross Option would be at about 16 feet below the tennis courts.

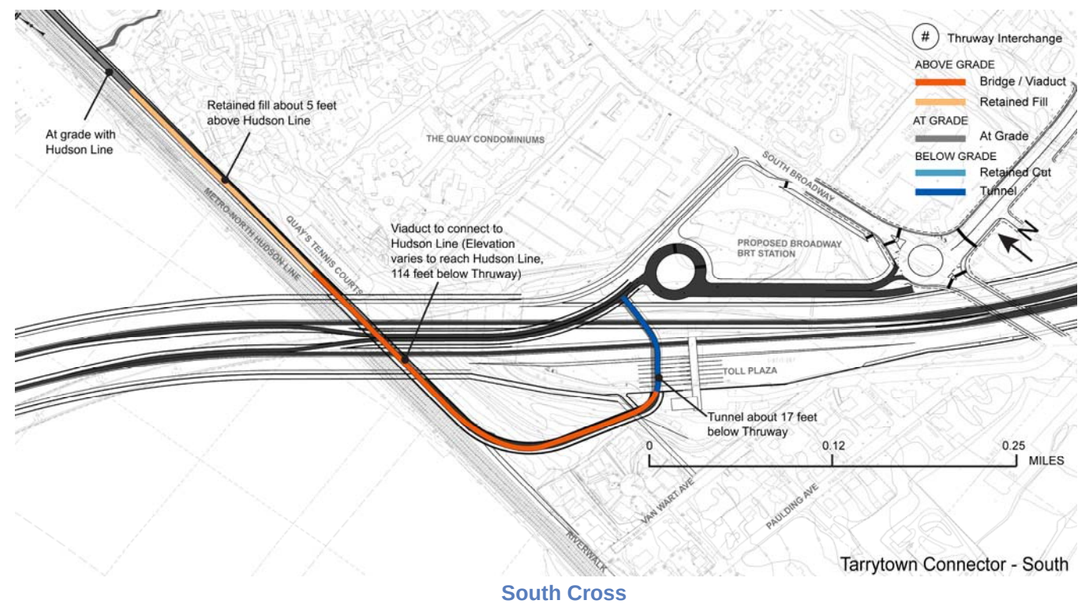
Engineering design is not considered a differentiator.

Operations and Maintenance

Operations and maintenance for the North Direct and the South Cross Options would be similar. The main differentiator is that the South Cross Option would utilize the traverse tunnel, which would be shared with other uses (e.g., NYSTA maintenance, NYSTA access to the toll plaza). However, the operations and maintenance impacts would be minor, as the length of the shared use facility is short and the frequency of use would vary temporally. Therefore, operations and maintenance is not considered a differentiator.



North Direct



South Cross

Figure 5-4 Tarrytown Connector Options – Engineering Features

Constructability

While both options would be constructible, the South Cross Option would provide distinct advantages over the North Direct Option, as follows:

- The South Cross Option would follow the anticipated alignment of a temporary haul road that could connect some staging areas on the landside south of the existing Tarrytown Station to the replacement Tappan Zee Bridge construction site. Both options would be located within the landing footprint of the replacement Tappan Zee Bridge, with connector construction integrated into the overall construction of the landing.

  A temporary haul road from south of the existing Tarrytown Station to the construction site would largely follow the alignment of the South Cross Option. This access road would be unlikely to follow the alignment of the North Direct Option, as this option would be directly under the alignment of the replacement bridge and the space would not be available until the bridge is completed. Utilizing the same route for the temporary haul road and permanent-access connector would reduce the overall construction impacts of the bridge and would provide for design and construction efficiency.

- The South Cross Option would provide for much greater flexibility in the pier locations for the replacement Tappan Zee Bridge. The North Direct Option would be required to weave around and through the piers of the replacement bridge in order to avoid impacts to the adjacent properties to the north of the existing bridge. As a result, the radii for the roadway would be at the minimum allowed in the design standards, which would consequently reduce speeds and increase the potential for conflicts with foundations.

  The South Cross Option would avoid these complexities, as it would pass under the replacement bridge near the Hudson Line tracks as a straight alignment with no interference with the piers. This alignment simplicity would result in safer highway operations and would minimize interaction between the Tarrytown Connector and the replacement bridge during maintenance and operations.

- The South Cross Option would avoid construction complexities in a limited space. The North Direct Option would be in a location where there are extensive program requirements, including:

  - The existing Tappan Zee Bridge.
  - Existing NYSTA storage facility.
  - The existing NYSTA access road.
  - The existing westbound on-ramp.
  - Existing NYSTA maintenance access to Thruway.
  - A proposed replacement Tappan Zee Bridge north span.
  - A proposed replacement westbound on-ramp.
  - Proposed NYSTA maintenance access to Thruway.
  - A proposed new BRT station and access.
  - Proposed new CRT access.
  - Proposed new BRT station access ramps.
  - Proposed new NYSTA circulation access.
  - Proposed new pedestrian access and circulation.
  - A proposed shared-use path.

Together, all of these program requirements more than fill the available space. Given that the space to the north of the existing Tappan Zee Bridge would also be used as a construction staging area, there would be an even greater demand and complexity involved in the construction activities required.

Introducing another program element into the area north of the existing Tappan Zee Bridge would not be preferred as a route alignment for the Tarrytown Connector given the space requirements identified above. The South Cross Option would eliminate conflicts that are considered in this limited space.

- The South Cross Option would allow for the possibility of integrating the following access requirements:

  - NYSTA vehicular access from north to south of toll plaza.
  - NYSTA personnel access to toll booths.
  - Metro-North maintenance access to CRT tracks.
  - BRT access to and from the proposed Tappan Zee Station.

All of these options could utilize the underpass under the toll plaza as a single combined access route that would pass over CRT in the tunnels below. This combination of access requirements would not be possible in the North Direct Option as the location of the underpass would interfere with the CRT in the tunnels.

5.1.3.2 Cost

The capital cost estimate for the North Direct and South Cross Options would be $69 and $85 million (2012$), respectively. The extent of the estimate is from 200 feet north of the Quay Condominiums to the proposed BRT Broadway Station. The estimate includes the costs for the BRT infrastructure and ramps only. Costs for the both options are dominated by the substantial rock cuts and extent of the elevated structure required. The costs for the South Cross Option would be greater, reflecting the longer alignment and the cost for the tunnel underneath the Thruway at the toll plaza.

5.1.3.3 Transportation

The results of the transportation evaluation are summarized below:

- **Travel Time.** There is no difference in travel time between the two options. Travel time is not considered a differentiator.

- **Traffic Network Changes.** There are no traffic network changes in this area. Traffic network changes are not considered a differentiator.

- **Transportation System Integration.** Both options connect the Broadway BRT Station with the existing Tarrytown Station and allow for feeder bus access (i.e., BRT Route L at Tarrytown and BRT Route F at South Broadway). Transportation system integration is not considered a differentiator.

5.1.3.4 Environment

The results of the environmental evaluation are summarized below:

- **Land Use/Potential for TOD.** There is no difference between impacts to land use for either Tarrytown Connector Option, and neither option precludes TOD. Land use/potential for TOD is not considered a differentiator.

- **Displacements and Acquisitions.** Both options would impact one commercial property occupied by distribution and warehousing uses. Displacements and acquisitions are not considered differentiators.

- **Wetlands.** The North Direct Option would result in direct impacts to 0.14 acres of wetlands and the South Cross Option would result in direct impacts to 0.21 acres of wetlands. Given the small acreage of wetlands

affected and the roughly similar affected acreage under both scenarios, wetlands are not considered a differentiator.

- **Aquifers and Floodplains**. There are no aquifers or floodplains affected by the South Cross or North Direct Options. Aquifers and floodplains are not considered differentiators.
- **Parklands**. No parklands are affected in this segment. Parklands are not considered a differentiator.
- **Historic Resources.** Both options would impact the same four historic architectural resources. The most significant impacts would occur at the Recommended NRE NYSTA Police Barracks & Office Building and within the Recommended NRE Hudson River Railroad ROW. While the barracks and office building would be removed, the railroad would continue to be used for its historic purpose, a railroad ROW, and therefore, its character and setting would be preserved. Both options would also have minor effects on the Recommended NRE Tappan Landing Historic District (possible strip take from rear yards of contributing resources) and the Recommended NRE Irving Historic District (pedestrian path entry onto north side of Van Wart Avenue). Historic resources are not considered a differentiator.
- **Archaeological Resources**. The area encompassed by the South Cross and the North Direct Options possesses low to moderate archaeological sensitivity based on the Phase IA assessments. Phase IB intensive walkover surveys are in progress. Archaeological resources are not considered a differentiator.
- **Hudson River Ecosystems**. Hudson River ecosystems are not affected by either option. Hudson River ecosystems are not considered a differentiator.
- **Noise**. Potential noise increase to adjacent sensitive receptors would be similar under both options. Noise is not considered a differentiator.
- **Visual**. The South Cross Option introduces a new visual element and reduces vegetative screening for residences located off of Hudson Place and Van Wart Avenue. Both options would visually impact residences at the Tappan Landing, Quay of Tarrytown and the associated tennis courts. However, the North Direct Option would have a more notable impact to residences at Tappan Landing, where the BRT is on structure downgrade from two residences. The South Cross Option also features a BRT on structure in this segment, but travels at an elevation 16 feet lower, causing fewer impacts. Both options would also be visible to the public housing near the existing Tarrytown Station. Visual impacts are considered a differentiator.

5.1.4 Transit Alignment Recommendation

The evaluation of the North Direct and South Cross Options in Tarrytown is summarized in Table 5-1. The South Cross Option is recommended for advancement into the EIS as an element of Alternatives B, C, D, and E based on the following criteria differentiators:

- **Engineering -** Both options would be similar in terms of grades and overall profile and each would work with the proposed bridge configuration options. However, the South Cross Option has a number of advantages in constructability over the North Direct Option, including avoiding the area north of the bridge that already has extensive program requirements, providing greater flexibility in the pier locations for the replacement Tappan Zee Bridge, and utilizing a temporary haul road that would be needed to construct the replacement bridge.
- **Environment -** Both options would have visual impacts. However, the North Direct Option would have a more notable impact to residences at Tappan Landing, where the BRT is on structure. The South Cross Option also features a BRT on structure in this segment, but at a lower elevation that would have a lesser visual impact.

5.2 Tarrytown – Bus Lanes on Route 119 (White Plains Road)

This area of study begins at South Broadway in Tarrytown and continues along Route 119 at grade to I-287 Exit 1, a distance of about 1.8 miles. Typical cross-sections are shown on Figure 5-5. Factors that warranted consideration in the development of the alignment included:

- Route 119 (White Plains Road): General traffic movements, local bus movements, driveways, available ROW, and adjacent commercial and residential properties.
- Complex infrastructure at I-287 Exit 1.

Whether the bus lanes are ultimately developed as dedicated curbside bus lanes or as bus lanes along the median of Route 119 in this segment would be determined as part of the Tier 2 Transit analysis. Median lanes are assumed for purposes of the EIS.

5.2.1 Proposed Transit Operations

There would be two BRT stations in this area: Meadow Street and Benedict Avenue. Both stations would be on-street BRT stations, staggered at their respective intersections to minimize the total station width and to allow vehicles to make left turns. In the case of these two BRT stations, their location in the Route 119 median would require passengers to utilize crosswalks to access the bus-boarding areas, or to connect with local buses at the curbside bus stops.

East of the proposed Broadway BRT Station, the BRT service in the bus lanes alternative would travel on Route 119 and stop at the two BRT stations. The bus lanes would have a median-lane configuration to prevent interference with the numerous curbside Bee-Line bus stops. The bus lanes would not be grade-separated at intersections; therefore traffic-signal priority would be introduced to maintain bus speeds assumed in the current service plan. The BRT service at the two stations would be provided by 11 BRT routes (A, B, C, D, G, H, I, J, K, L and T).

5.2.2 Description of Alignment

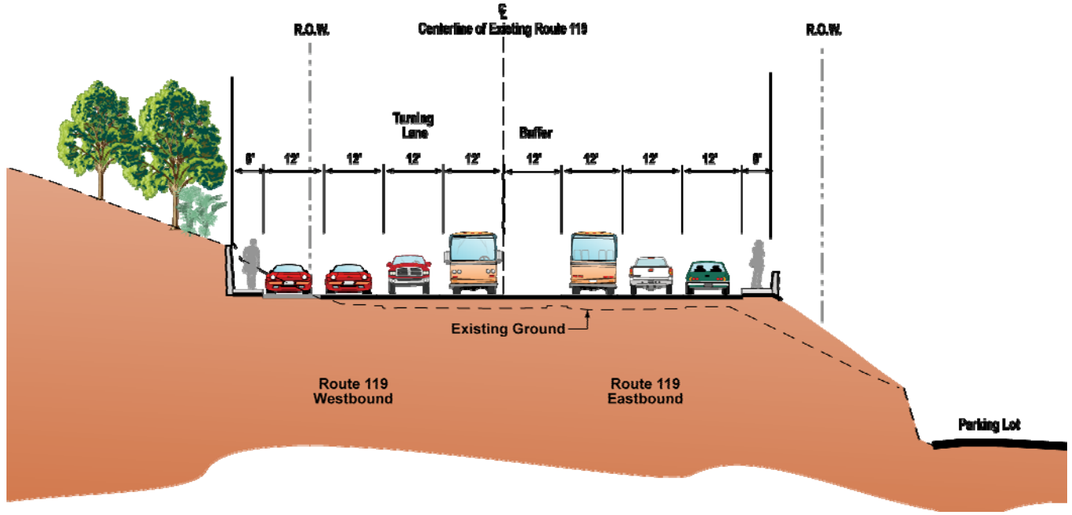
The BRT would travel through the proposed roundabout at the South Broadway/Route 119 intersection from the proposed Broadway Station. Once on Route 119, they would travel in bi-directional bus lanes, (one lane in each direction) in the roadway median to I-287 Exit 1. Key details of this alignment include:

- 9,000 feet of median bus lanes along Route 119.
- Two to three lanes of general traffic, along with left-turn lanes at key intersections, would be proposed to be maintained along Route 119 between South Broadway and the I-287 ramps at Exit 1.
- Proposed stations on Route 119 at Meadow Street and Benedict Avenue.

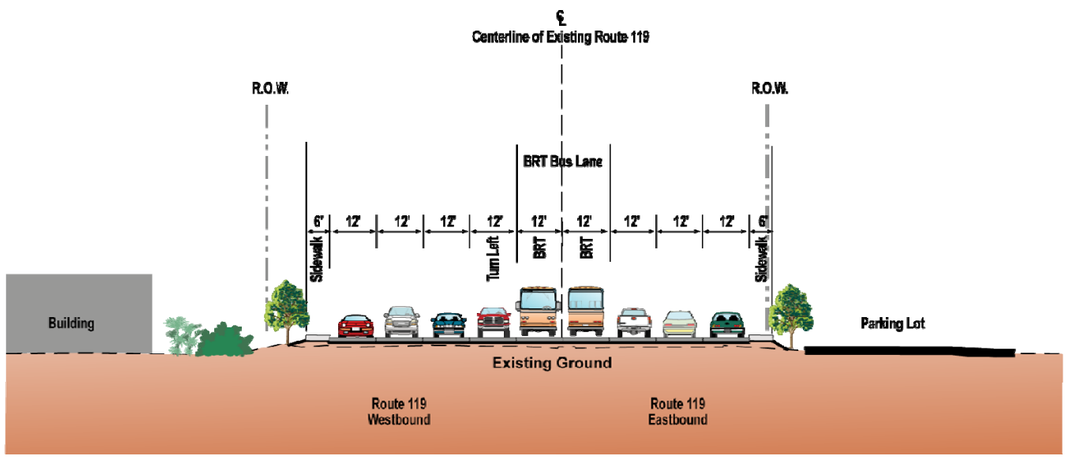
Table 5-1

Tarrytown: BRT Connector Options

Criteria	South Cross Alignment	North Direct Alignment
Engineering		
Engineering Design	Not a differentiator.	Not a differentiator.
Operations & Maintenance	Not a differentiator.	Not a differentiator.
Constructability	• Follows the anticipated alignment of a temporary landside haul road. • Allows for integration of NYSTA, MNR, and BRT access requirements. • Avoids construction complexities in a limited space. • Provides for much greater flexibility in the pier locations for the replacement Tappan Zee Bridge.	• Conflicts with program requirements in area of tight ROW. • Minimum radii used on steep grades.
Cost		
Capital Costs (2012 $)	Not a differentiator.	Not a differentiator.
Transportation		
Travel Time	Not a differentiator.	Not a differentiator.
Traffic Network Changes	Not a differentiator.	Not a differentiator.
Transportation System Integration	Not a differentiator	Not a differentiator.
Environmental		
Land Use / Potential for TOD	Not a differentiator.	Not a differentiator.
Displacements and Acquisitions	Not a differentiator.	Not a differentiator.
Wetlands	Not a differentiator.	Not a differentiator.
Aquifers and Floodplains	Not a differentiator.	Not a differentiator.
Parklands	Not a differentiator.	Not a differentiator.
Historic Resources	Not a differentiator.	Not a differentiator.
Archaeological Resources	Not a differentiator.	Not a differentiator.
Hudson River Ecosystems	Not a differentiator.	Not a differentiator.
Noise	Not a differentiator.	Not a differentiator.
Visual	The South Cross Option introduces a new visual element and reduces the area of vegetative screening for residences located off of Hudson Place and Van Wart Avenue. There would be a visual impact for residences at the Tappan Landing, Quay of Tarrytown and associated tennis courts, and public housing at Tarrytown Station. The South Cross Option would have a less notable visual impact than the North Direct Option, due to the South Cross Direct Option's lower elevation of structure.	The North Direct option would not impact residences off of Hudson Place and Van Wart Avenue. There would be visual impacts for residences at the Tappan Landing, Quay of Tarrytown and associated tennis courts, and public housing at Tarrytown Station. The North Direct Option would have a more notable visual impact than the South Cross Option, due to the North Direct Option's higher elevation of structure.



Near Broadway



Near Benedict Avenue

Figure 5-5 Bus Lanes on Route 119 – Typical Cross-Sections

5.3 Elmsford/Greenburgh

This area of study begins on the east side of Exit 1 in the Town of Elmsford and continues through Greenburgh to Exit 5 (Figure 5-6), a distance of about 2.6 miles. There would be major crossings over the Saw Mill River Parkway and Route 9A (Saw Mill River Road) and crossings under the Sprain Brook Parkway, Hartsdale Avenue, and Hillside Avenue. Typical cross-sections are presented on Figures 5-7 and 5-8. Factors that warranted consideration in the development of the alignment included:

- Complex infrastructure at Exit 1 and the Saw Mill River Parkway.
- The narrow I-287 ROW in Elmsford around Route 9A and parts of Greenburgh.
- Power station and power lines east of the Sprain Brook Parkway.
- Commercial and residential properties on both sides of I-287.
- Parklands, water courses, and wetlands along the Saw Mill River Parkway and the Sprain Brook Parkway.
- Parkland adjacent to I-287 ROW in Greenburgh.

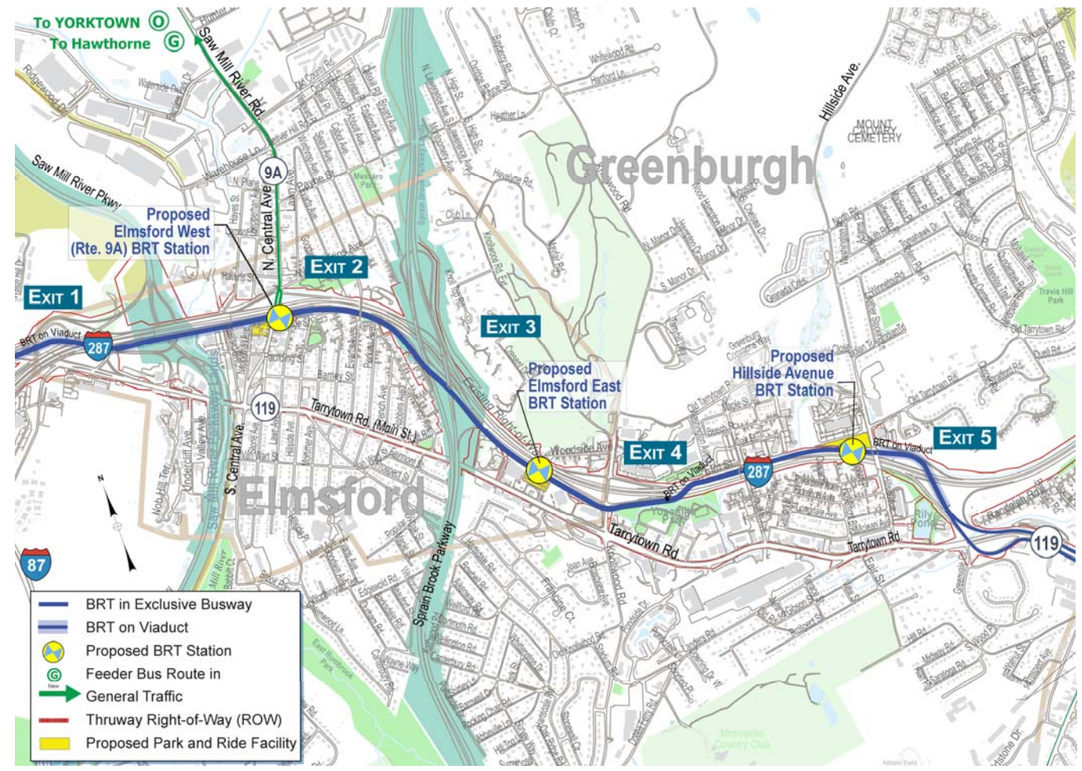


Figure 5-6 Busway Alignment in the Elmsford/Greenburgh Area

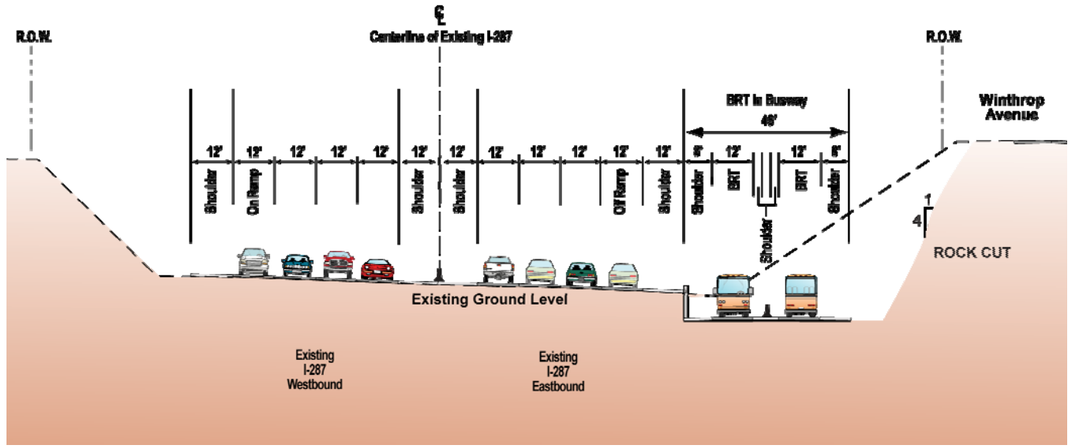


Figure 5-7 Bus Lanes Alignment in Elmsford
Cross-Section at Winthrop Avenue

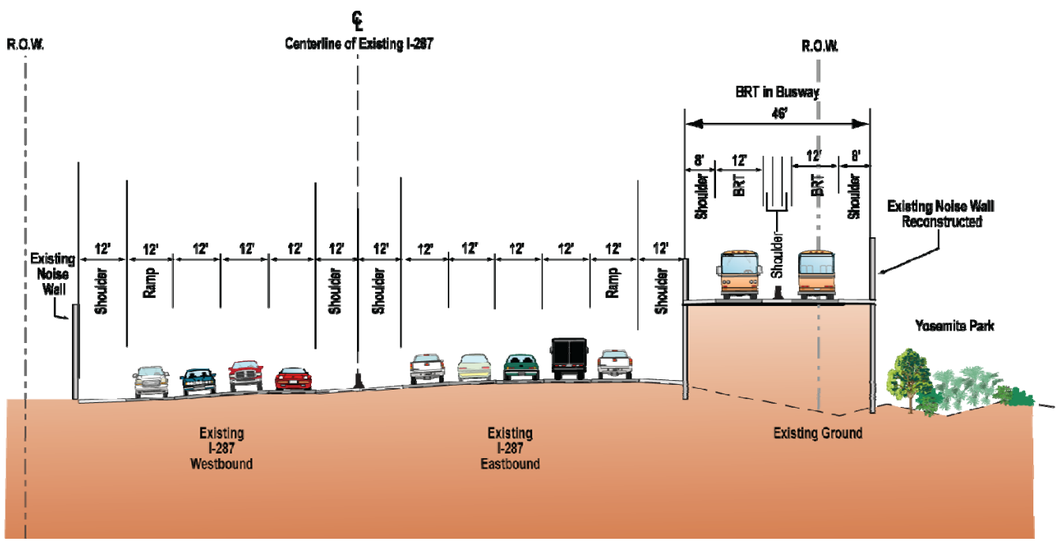


Figure 5-8 Bus Lanes Alignment in Greenburgh
Cross-Section at Yosemite Park

5.3.1 Proposed Transit Operations

Three BRT stations would be located along the busway: Elmsford West, Elmsford East, and Hillside Avenue. All three would be "on-line" stations that would allow for transfers with the existing local bus system, provide pedestrian and bicyclist accessibility, and include park-and-ride facilities.

BRT would operate in a busway located primarily along the south side of the I-287 ROW. Eleven BRT routes (A, B, C, D, G, H, I, J, K, L and T) would access this segment of the study corridor en route to and from western locations. At the Elmsford West BRT Station, Routes G and O would access the busway en route to and from Hawthorne and Yorktown via Route 9A, respectively.

Eleven BRT routes (A, B, C, D, H, I, J, K, L, O and T) continue in the BRT alignment east of the Elmsford West BRT Station. These 11 BRT routes all serve the Elmsford East Station and the Hillside Avenue BRT Station. East of this station Route B would exit the trunk line and access the eastbound I-287 general-traffic lanes and bypass the White Plains central business district. Therefore, east of the Hillside Avenue BRT Station, 10 BRT routes (A, C, D, H, I, J, K, L, O and T) would utilize the trunk line.

5.3.2 Description of Alignment

The bus lanes would not continue on Route 119 due to the narrow ROW and existing congestion on Route 119 Tarrytown Road), in Elmsford and Greenburgh. Instead, they would operate in a dedicated busway adjacent to I-287. From Route 119, they would cross over Exit 1 and I-287 on a viaduct to reach the south side of I-287. They would continue along the south side of I-287 until a viaduct crosses over I-287 to reach the proposed Hillside Avenue BRT Station. Key details of the alignment include:

- A 4,100-foot long viaduct to cross over Exit 1 ramps, I-287, and the Saw Mill River Parkway.
- An at-grade segment with crossings that would include transit signal priority, at Route 9A and Knollwood Avenue and a cut and cover segment under the Sprain Brook Parkway.
- A 2,200-foot long viaduct to cross from the south side of I-287 to the north side.
- A 1,200-foot long at-grade segment.
- A 1,100-foot long retained cut to cross under Hillside Avenue and the Exit 4 ramps.
- A 1,600-foot long fill and bridge to cross over I-287 at Exit 5 to access Route 119.
- An on- and off-ramp would be provided from the bus lanes to I-287 to enable buses that do not need to access downtown White Plains to merge with mixed traffic on I-287 between Exits 5 and 8.

5.4 Exit 5 to White Plains - Bus Lanes on Route 119

White Plains is a major employment generator and retail destination and therefore the bus lanes would transition from the existing I-287 alignment to connect to the White Plains Transportation Center (WPTC) and other key commercial and retail destinations in downtown White Plains. Whether the bus lanes are ultimately developed as dedicated curbside bus lanes or as bus lanes along the median of Route 119 in this segment would be determined as part of the Tier 2 Transit analysis. Curbside lanes are assumed for purposes of the EIS. The route would use the existing Hamilton Avenue and Main Street underpasses of the Harlem Line to reach downtown White Plains (a distance of

about 1.0 mile from Exit 5). The bus lanes would not be grade-separated at intersections, but traffic-signal priority would be used to allow the BRT buses to maintain the speeds necessary to meet their route schedule. Factors that warranted consideration in the development and evaluation of options included:

- Local traffic and bus movements, driveways, available ROW, and adjacent commercial and residential properties on Route 119 and the Hamilton Avenue and Main Street entries to downtown White Plains.
- Operations on the Harlem Line.
- The Bronx River Parkway and adjacent parklands, water courses, and wetlands.
- Providing connection to a future Central Avenue BRT route.

5.4.1 Proposed Transit Operations

A proposed BRT station would be located adjacent to the Westchester County Center, which would include transfer capability with the proposed Central Avenue BRT service and with local Bee-Line routes.

Ten BRT routes (A, C, D, H, I, J, K, L, O and T) would operate in this segment of the corridor. From downtown White Plains, Route N would stop at the Westchester County Center BRT Station, and turn south onto Central Avenue as a feeder route to and from Yonkers and the Bronx. Therefore, east of the Westchester County Center BRT Station, 11 BRT routes (A, C, D, H, I, J, K, L, N, O and T) would continue on the trunk line into White Plains.

5.4.2 Description of Alignment

The BRT bus lane alignment would travel from Exit 5 in the curb lanes of Route 119 to reach downtown White Plains. A typical cross-section is shown on Figure 5-9. The bus lanes would reach the White Plains Transportation Center (WPTC) using the existing underpasses of the Harlem Line on Hamilton Avenue and Main Street. Key details of this alignment include:

- 5,000 feet of on-street bus lanes, likely in the curb lanes, along Route 119.
- Proposed station at the Westchester County Center at the intersection of Route 119 and Central Avenue.

5.5 White Plains – BRT Bus Routes

The bus lanes would travel on local streets within downtown White Plains to provide access to local commercial, retail, and residential destinations. The bus lanes in downtown White Plains would operate in dedicated lanes along the local street network. They would not be grade-separated at intersections, thus necessitating the use of traffic-signal priority as a preferential BRT treatment. The bus lanes would re-connect with I-287 at Exit 8 on the eastern side of the central business district (a distance of approximately 1.3 miles). Factors that warranted consideration in the development and evaluation of options included:

- Local traffic and bus movements, driveways, available ROW, and adjacent commercial and residential properties on local streets, including Hamilton Avenue, Main Street, Martine Avenue, Broadway, and Westchester Avenue.
- Complex infrastructure at Exit 8.

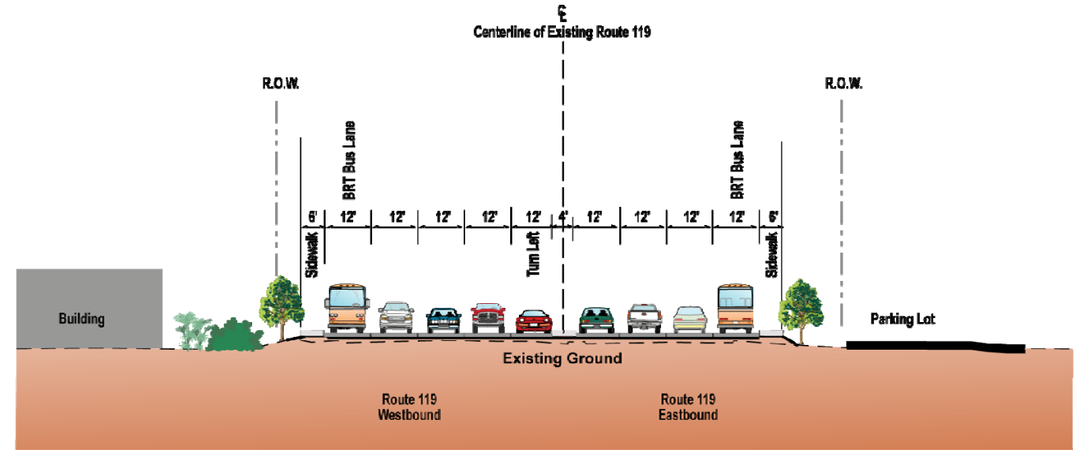


Figure 5-9 Bus Lanes on Route 119
Cross-Section near Central Avenue (View Looking South)

5.5.1 Proposed Transit Operations

There would be three proposed BRT stations in White Plains: WPTC, Galleria Mall, and Westchester Mall. The WPTC BRT Station would be part of the existing WPTC complex, a major intermodal hub. This station would also be served by the Harlem Line and several local bus routes (Figure 5-10); in addition, there is existing automobile parking as well as pedestrian and bicyclist accessibility available at this facility.

Unlike the WPTC BRT Station, both the Galleria Mall and Westchester Mall BRT Stations would be on-street BRT stations with such features as boarding curbs level with the proposed low-floor buses, passenger waiting shelters, real-time information systems, fare-payment accommodations and other amenities. Connections would be possible with the local Westchester County Bee-Line buses at these BRT stations.

The proposed service plan has 11 BRT routes (A, C, D, H, I, J, K, L, N, O and T) on the trunk line into White Plains from the west:

- Six routes (A, C, H, I, L and O) would terminate in White Plains.
- Five routes (D, J, K, N and T) would continue through White Plains and provide service to the east.

Seven BRT routes would enter the White Plains along the BRT trunk line from the east:

- The five BRT routes mentioned above from Port Chester that run through White Plains (D, J, K, N and T).
- Routes M and P, which enter White Plains from the east, but terminate at the WPTC.

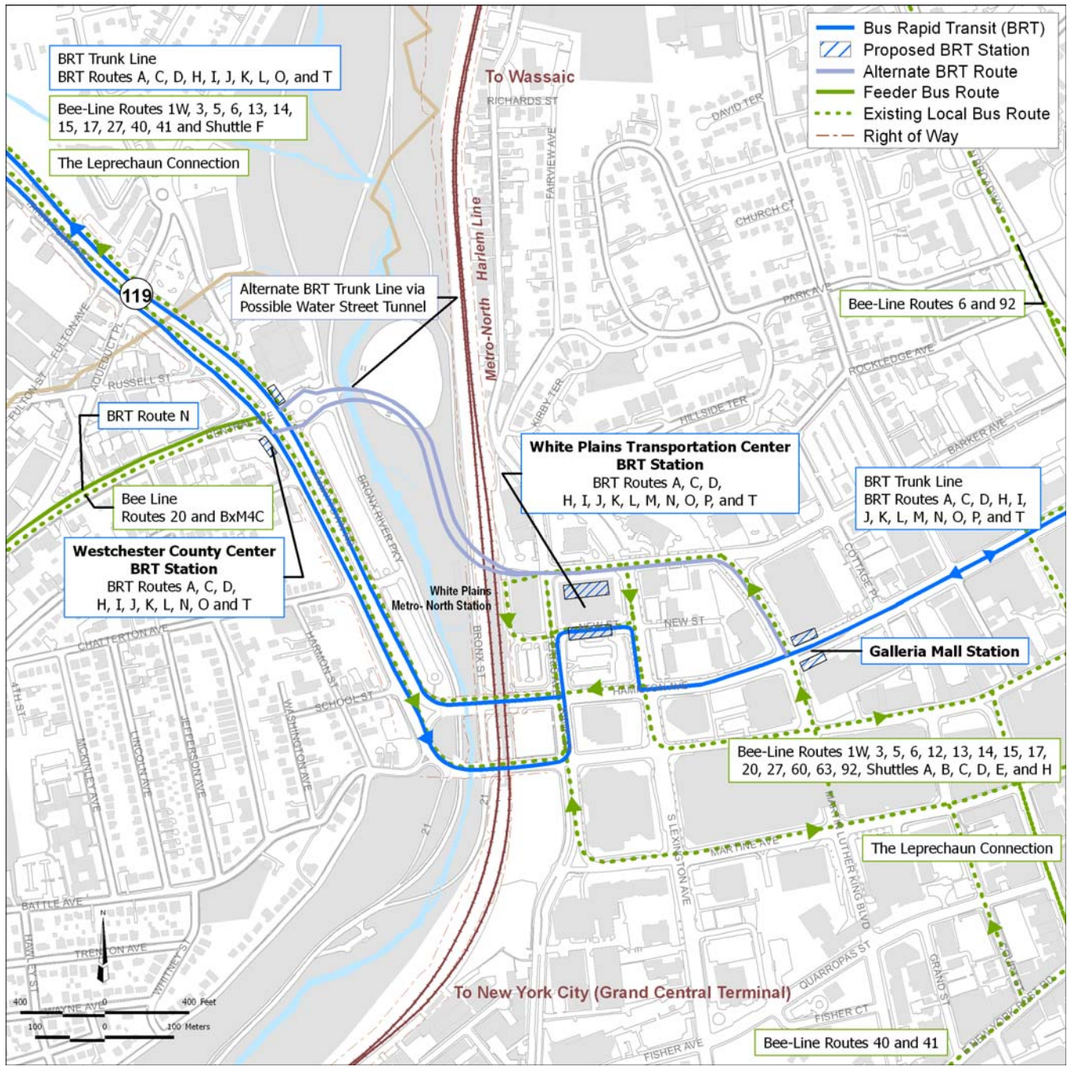


Figure 5-10 WPTC Intermodal Station Connectivity Diagram

5.5.2 Description of Alignment

5.5.2.1 Preliminary Analysis

A separate study (*White Plains LRT and BRT Alignment Analysis*, August 2008) was conducted to compare alignment options for BRT routes in White Plains. Special consideration was given to the routing of the BRT service through White Plains as the city is the central hub of the corridor and has the most congested urban traffic in the corridor. In addition, White Plains is a major activity center and would generate a significant level of ridership for the BRT system; therefore, the ability of the BRT service to effectively and reliably serve White Plains is important to the overall functionality of the cross-corridor BRT system.

Crossing White Plains from west to east, connecting to the WPTC and Metro-North Harlem Station, and serving the other activity centers is not easily accomplished. Key destinations (Figure 5-11) include the Galleria Mall, White Plains Mall, City Center, and Westchester Mall, the complex of county buildings along Martine Avenue, and the City Hall.

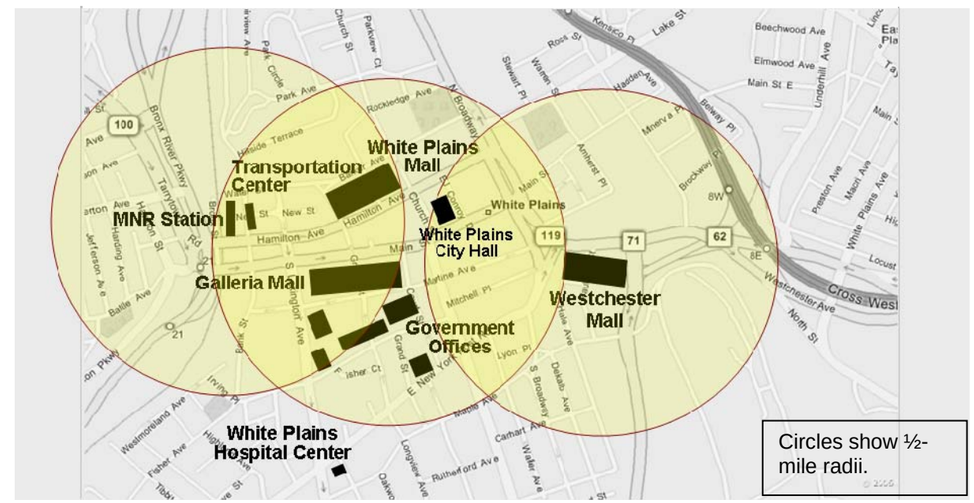


Figure 5-11 Key Destinations and Walk Distances in White Plains

The alignment options considered use of dedicated lanes on existing streets for the BRT operation, crossing streets at grade, and priority traffic signals. They were evaluated and compared using the criteria shown in Table 5-2. Options 1 and 3 both use Hamilton Avenue and Main Street and were proposed for further analysis. The options that were eliminated from consideration had significant operational, access, or service issues.

Table 5-2

BRT Alignment Options in White Plains – Performance Summary

Alignment Option	Route	Minutes Run Time	Split Service Over 1 Block Apart	180° Turns	Length in Miles	Walk Distances to Key Destinations
BRT 1	Hamilton and Main					
BRT 2	Main and Martine			●		
BRT 3	Hamilton and Main					
BRT 4	Main, Martine, and Grove.		●	●		
BRT 5	Lexington, Maple, Church, and Barker.	●	●		●	●
Note: ● Does not meet criterion.						

5.5.2.2 Further Development of Alignment

After these bus route options were first developed – which occurred prior to the introduction of the concept of tiering the EIS – a number of meetings were held with Westchester County agencies such as the Departments of Planning and Transportation. A variety of issues were identified with these options and other potential routes were suggested (e.g., use of Martine Avenue or a bi-directional route on Hamilton Avenue). Based on that input, a sixth option (bi-directional operations on Hamilton Avenue) was selected for analysis in this study for comparison to the Hamilton Avenue and Main Street Option. These two options (Figure 5-12) were subjected to a more detailed evaluation in terms of their traffic impacts (see details in Appendix B).

The lane arrangement utilized for the analysis of Option 6 included two lanes along the center of Hamilton Avenue (i.e., one in each direction). However, as part of the Tier 2 transit analysis, other lane arrangements along Hamilton Avenue (e.g., both BRT travel lanes on the north side of the street, etc.) may also be examined. The results of this evaluation are summarized as follows:

- In the analysis of the Hamilton Avenue and Main Street service split (Options 1 and 3), the intersection of Main Street and Lexington Avenue demonstrates operating failure with average delays of 156 seconds per vehicle in the morning and 114 seconds per vehicle in the evening peak hour. There is little opportunity for mitigation, as there are insufficient lanes to accommodate both the BRT service and the high traffic volume (assuming that the BRT would occupy a dedicated lane). Traffic-signal timing adjustments would not achieve the needed improvement.

  Two-way service along Hamilton Avenue (Option 6), by contrast, does not impact this intersection because it does not follow Main Street; this troublesome location is thus avoided. Option 6 also shows benefits at other intersections; for example, Main Street intersections west of Broadway are not impacted at all by providing two-way BRT service along Hamilton Avenue, which clearly would benefit local traffic circulation.

- Hamilton Avenue is a wider street than Main Street, and as a consequence has more capacity and flexibility to absorb the loss of a lane in each direction for mixed traffic, and to accommodate the additional bus and pedestrian activity associated with BRT. In addition, other bus routes (i.e., Bee-Line services) do not stop along Hamilton Avenue and so there is less potential conflict between BRT buses and conventional transit buses. This has the beneficial impact of improving the BRT system's reliability while still allowing BRT passengers to access the various activities located in central White Plains.

- Providing BRT service in both directions along Hamilton Avenue does cause a degree of degradation to the traffic flow (i.e., the "level of service" – or LOS – which is measured from A to F, with A being best) on Hamilton Avenue. In the AM and PM peak hours the effects of providing two-way BRT service along Hamilton Avenue are more pronounced than providing split BRT service along Hamilton Avenue and Main Street, with levels of service degrading into LOS F. Other issues along Hamilton Avenue are:

  - Any increased delay at Broadway and Hamilton Avenue may be mitigated fairly easily since there apparently is space available to construct additional street space.

  - The intersection of Hamilton Avenue and Martin Luther King, Jr. Boulevard is problematic, with little opportunity for widening or other traffic engineering improvements.

  - Utilizing Hamilton Avenue in both directions for the new BRT service provides a time advantage over the combination of Hamilton Avenue and Main Street since the route travels through fewer intersections and travels a shorter distance.

5.5.2.3 Transit Alignment Recommendation

Implementation of bus lanes on Hamilton Avenue is recommended for advancement into the EIS as an element of Alternatives B, C, D, and E. In the aggregate, providing two-way BRT service along Hamilton Avenue would have less impact on downtown White Plains street and intersection operations than any of the other routes investigated. The BRT bus routing through downtown White Plains and station locations will be subject to further study in the Tier 2 transit analysis for this project.

5.5.2.4 Western Access to White Plains

There are two possible access routes to downtown White Plains from the west (Figure 5-13). The first option has the dedicated BRT lanes along Route 119 and uses the Main Street and Hamilton Avenue bridges that cross over the Bronx River, pass under the Metro-North tracks and enter downtown. This is the direct access point for all vehicular traffic to and from the central business district from the west. This western access is assumed for the bus lanes alternatives in Westchester County.

In the second option, the dedicated lanes would turn east at the Westchester County Center and then south through the area that includes the Bronx River Parkway crossing and the Bronx River Parkway Reservation where they would reach the Harlem Line embankment. A new underpass beneath the Harlem Line tracks would bring the BRT to Water Street, which is on the north side of the WPTC. The reasoning for creating this second option is based on the anticipated severe traffic impacts that would result if BRT dedicated lanes were to be brought through the Main Street/Hamilton Avenue connection to downtown. The new underpass option is also a more direct route to the WPTC from Route 119, and could also be utilized by buses on the Central Avenue BRT route for access to the WPTC.

This route would have significant impacts to the sensitive environmental features that need to be crossed, as well as the expense of the underpass construction beneath the railroad tracks. These impacts, along with the impacts to White Plains traffic, will be analyzed in the EIS. For the EIS, it is assumed that the busway alternatives in Westchester County would use the new underpass to Water Street for direct access from the west into White Plains.

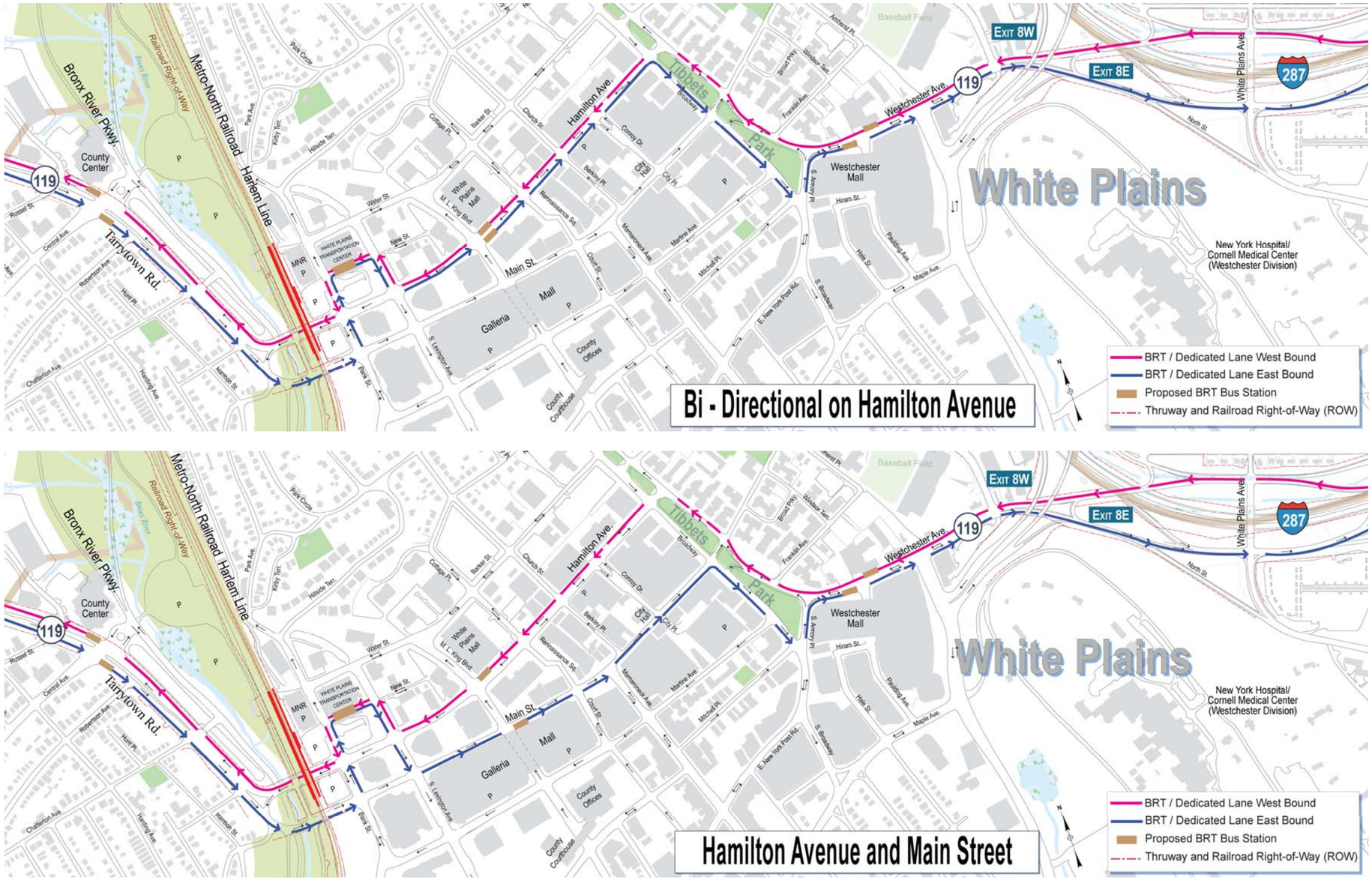
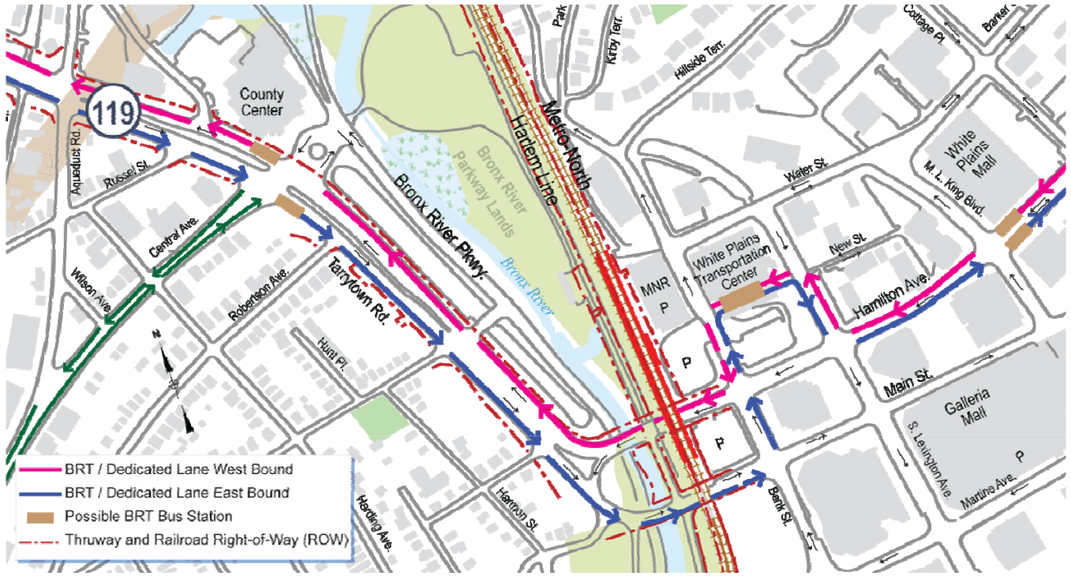
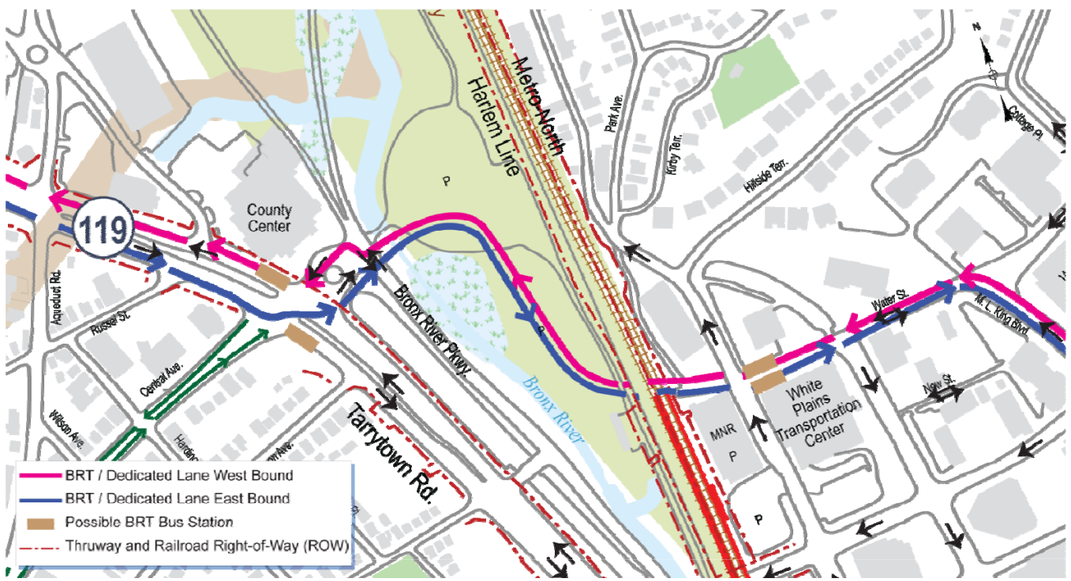


Figure 5-12 Bus Lane Options in White Plains



Bus Lanes



Busway

Figure 5-13 BRT Options into Downtown White Plains

5.6 East of White Plains

This area begins at Exit 8 in White Plains, where the bus lanes would be split on Westchester Avenue to operate on the shoulders in the direction of general traffic to Exit 10 (Figure 5-14). A typical cross-section is shown on Figure 5-15. Intersections in this segment would operate at grade with transit signal priority. Westchester Avenue turns north at Exit 10, becomes Route 120A, and continues in a northwest direction into downtown Port Chester. This route had been considered for the BRT connection to the Port Chester terminus, but Westchester Avenue narrows to a lane in each direction in Port Chester, which is not suitable for dedicated bus lanes.

Alternatively the bus lanes on Westchester Avenue could be combined on the north side of I-287 and continue in a busway to the Boston Post Road Station just north of the I-95 interchange. East of this station, the alignment would turn north along the west side of the New Haven Line ROW to access the trunk line terminus at the existing Port Chester Station. This would be a distance of about 6.3 miles. Factors that warranted consideration in the development of the alignment included:

- Complex infrastructure at Exit 8, Exit 9A, and Exit 9.
- Interchange ramps and associated merges between I-287 and the service road on Westchester Avenue.
- The narrow I-287 ROW in Rye Brook and Port Chester.
- Connectivity to commercial properties in the Platinum Mile.
- Local traffic and bus movements, driveways, available ROW, and adjacent commercial and residential properties on Westchester Avenue.
- The Hutchinson River Parkway and adjacent parklands, water courses, and wetlands.
- Commercial and residential properties and St. Mary's Cemetery in Rye Brook.
- Existing rail facilities, service, and maintenance access on the New Haven Line.

5.6.1 Proposed Transit Operations

There are six proposed BRT stations east of downtown White Plains: White Plains Avenue, Platinum Mile, Westchester Avenue, South Ridge Street, Boston Post Road, and Port Chester. The proposed White Plains Avenue, Platinum Mile, and Westchester Avenue BRT Stations would be on-street BRT stations, with transfer capability to the local Westchester County Bee-Line buses. The White Plains Avenue and Boston Post Road stations would also have park-and-ride facilities.

The Port Chester BRT Station would be the eastern terminus of the cross corridor BRT trunk line and five BRT service routes (D, J, K, N and T). This BRT station would be integrated with the existing Metro-North Port Chester Station and serves as an intermodal station by serving the New Haven Line and several local bus routes, including Bee-Line Routes 13, 61, and the existing CT Transit Routes 11A and 11B (Figure 5-16).

At the proposed Westchester Avenue BRT Station three BRT routes would exit the trunk lines, join the I-287 general purpose lanes at Exit 10, and continue in mixed traffic to I-95. Routes B and P would travel to Stamford and Route M would travel to the Bronx.

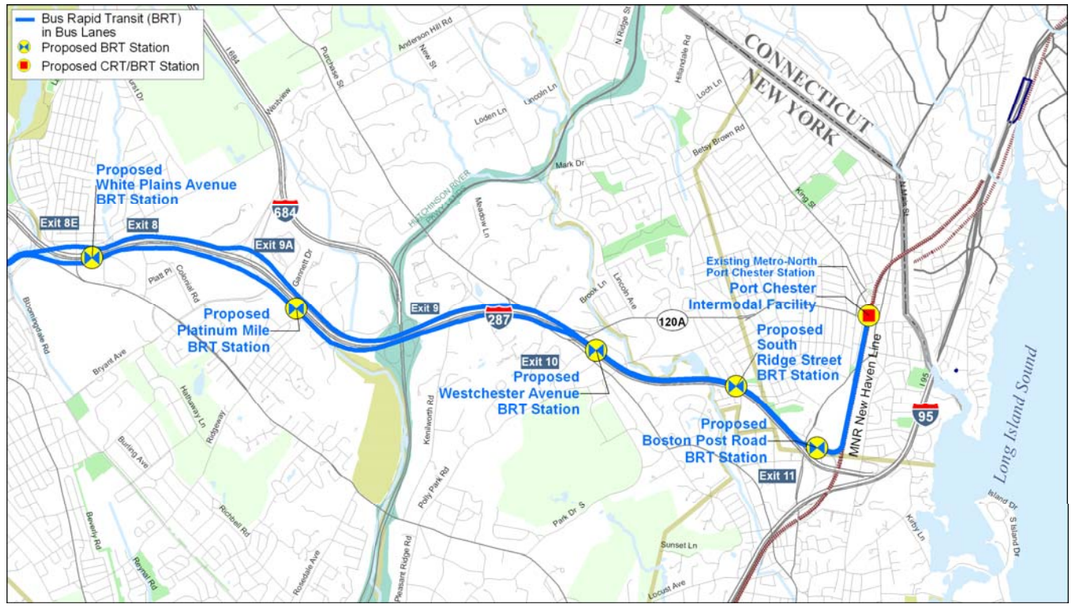


Figure 5-14 Bus Lane Alignment East of Downtown White Plains

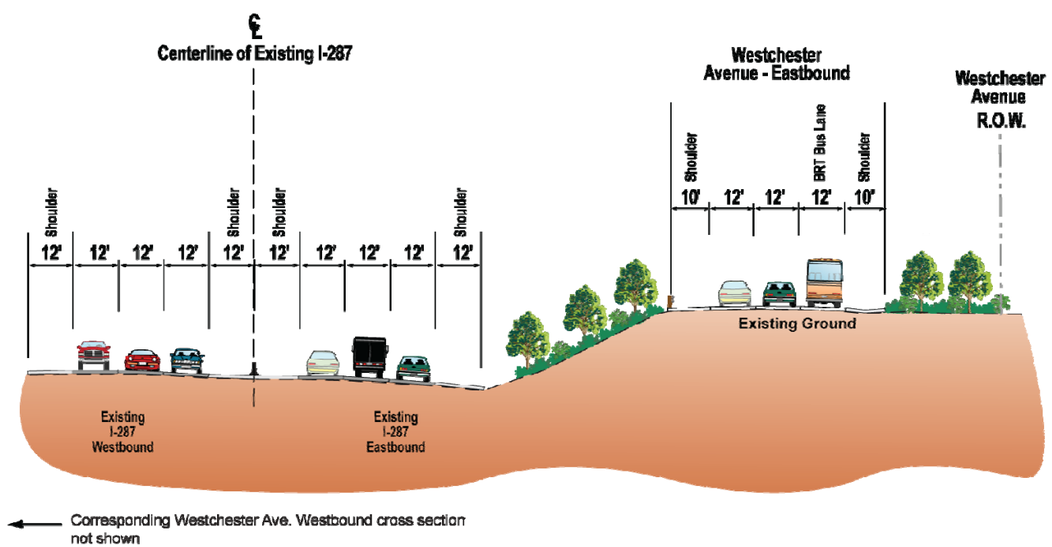


Figure 5-15 Bus Lanes at Westchester Avenue
Cross-Section at Butcher Avenue

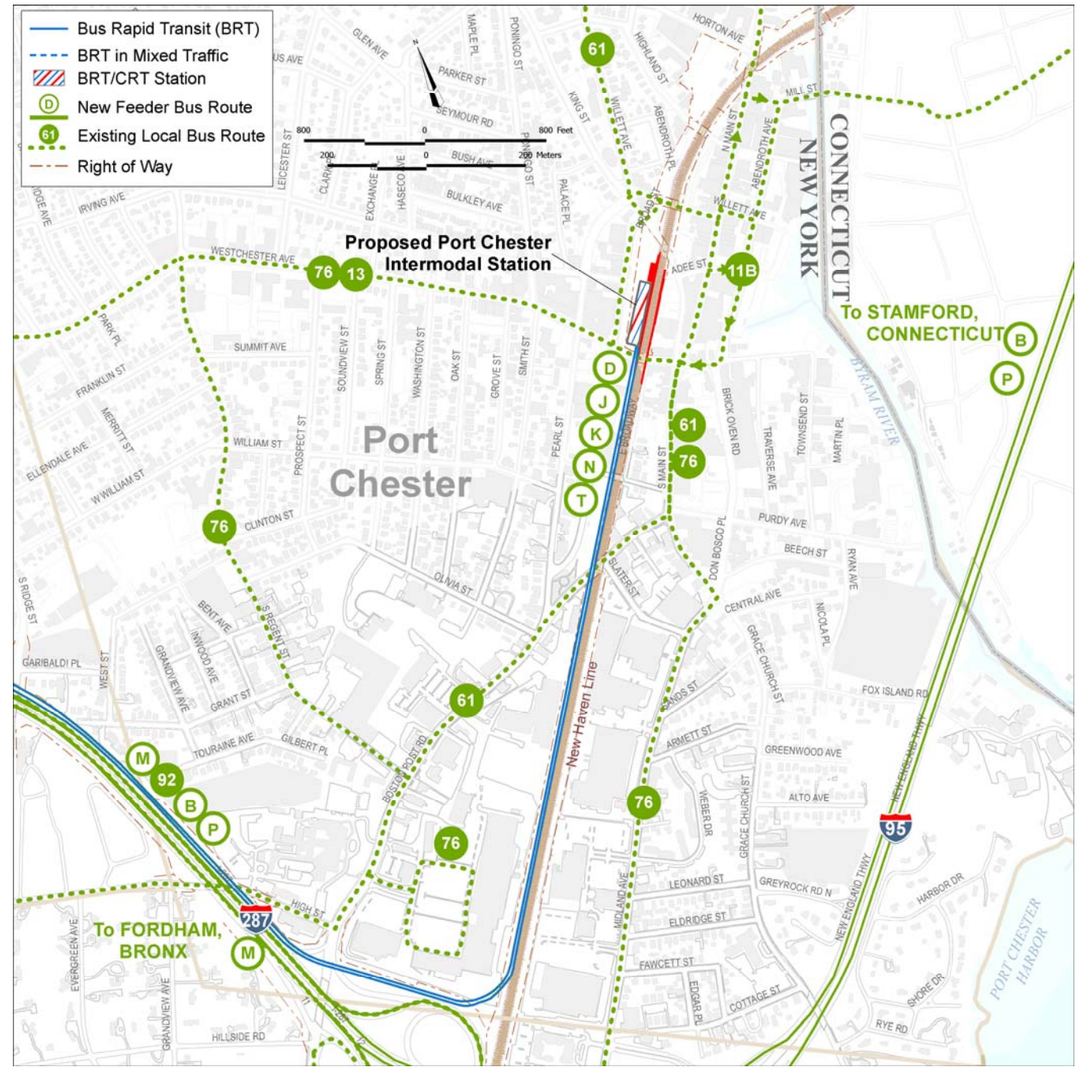


Figure 5-16 Port Chester Station Connectivity Diagram

5.6.2 Description of Alignment

Using the eastbound and westbound shoulders of Westchester Avenue, the bus lanes would continue through White Plains and Harrison. Intersections with local streets would be at-grade with transit signal priority. Before Exit 10, the eastbound bus lane would proceed on a viaduct over I-287 to join the westbound lane. East of Exit 10 the lanes would transition to a busway that would descend into a retained cut under Ridge Street, High Street, and Boston Post Road. Typical cross-sections are shown on Figures 5-17 and 5-18

The busway would pass through the existing retail center near I-287 Exit 11 and turn northward to join the ROW of the New Haven Line. The busway would travel parallel to the New Haven Line (Figure 5-19) to reach its terminus at the Port Chester Station. Key details in this area would include:

- 18,600 feet of on-street bus lanes in each direction on the shoulder of Westchester Avenue. The eastbound bus lane would use the shoulder of eastbound Westchester Avenue, while the westbound bus lane would use the shoulder of westbound Westchester Avenue.
- A 1,000-foot-long viaduct to join the eastbound and westbound bus lanes 2,000 feet west of Exit 10.
- A 1,400-foot-long at-grade segment.
- A 4,500-foot-long retained cut under Ridge Street, High Street, and Boston Post Road.
- An at-grade busway, parallel to the New Haven Line.

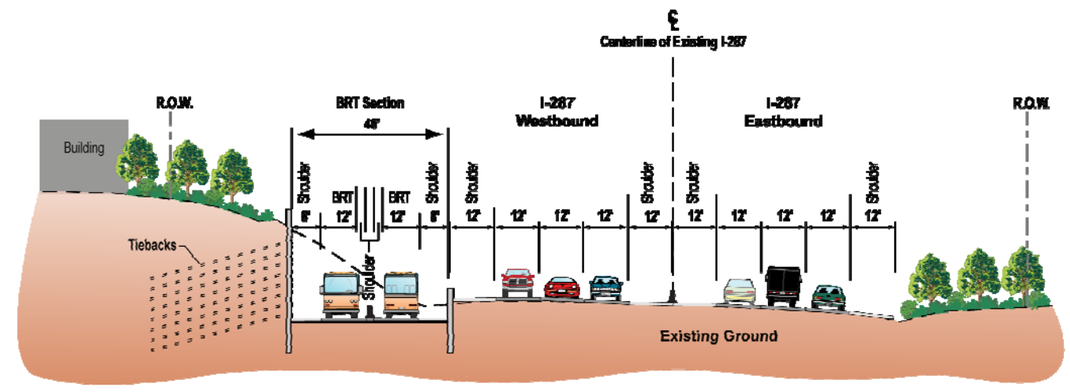


Figure 5-18 Bus Lanes (as a Busway) along North Side I-287
Cross-Section at South Ridge Street

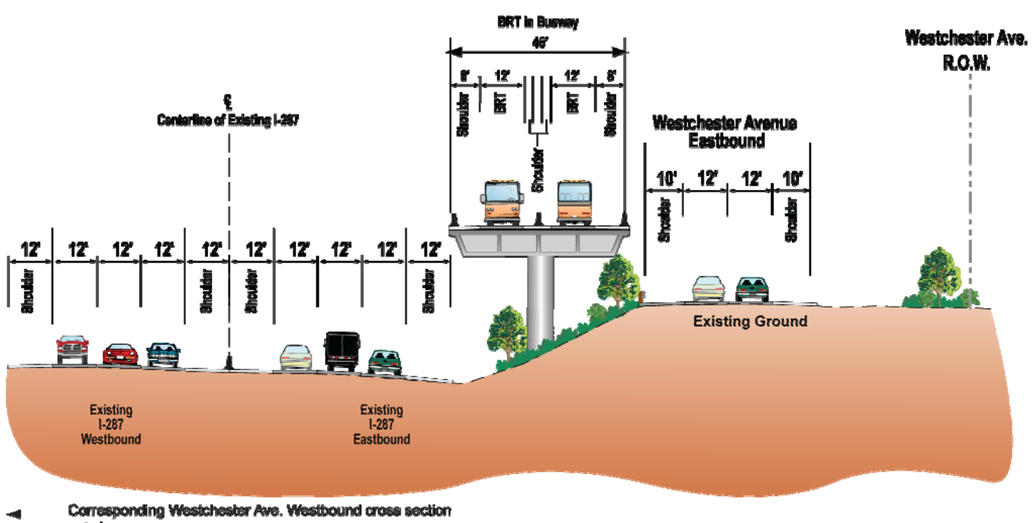


Figure 5-17 BRT Busway East of White Plains
Cross-Section at Butcher Avenue

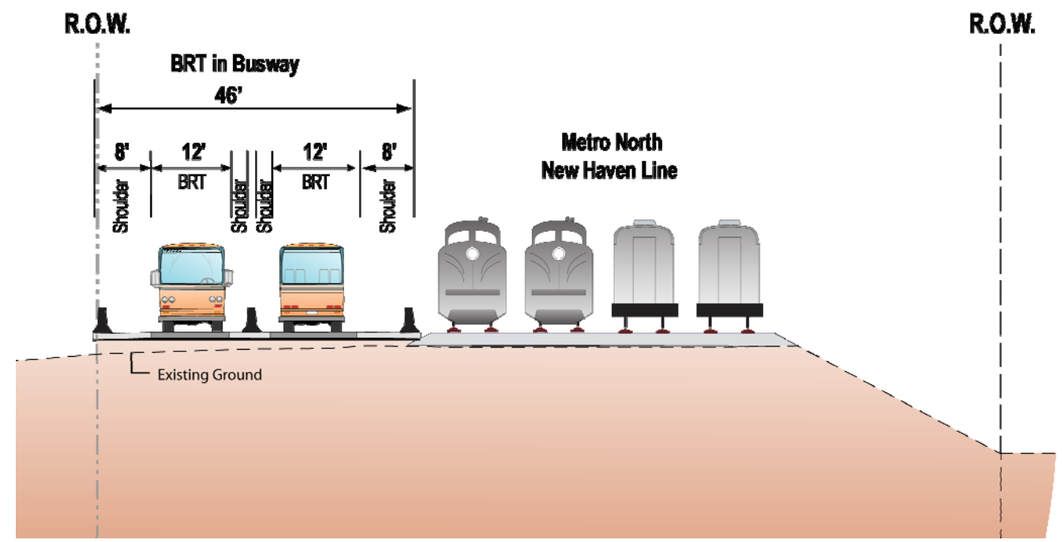


Figure 5-19 Bus Lane Alignment in Port Chester
Cross-Section at Metro-North New Haven Line (View Looking North)

6 Westchester County – BRT in Busway Alignment (Alternatives B and D)

This chapter describes the development process for the alignment of the BRT busway in Westchester County, with the individual segments discussed in geographic order progressing from west to east. The busway alignment options in Westchester County are:

- BRT Connector to Tarrytown Station (same as the bus lane alternatives in Chapter 5).
- Busway alignment at Interchange 8.
- BRT route through downtown White Plains.

None of the other geographic segments have options. However, they are described in this chapter so as to present a complete presentation of the busway alignment and proposed stations in Westchester County (Figure 6-1).

6.1 Tarrytown

This area of study begins at the Tappan Zee Bridge landing in Westchester County and continues to Interchange 8 (Figure 6-2). The busway could travel over or under the Thruway's westbound general-purpose lanes, depending on the type of bridge selected, to reach the proposed Tarrytown Connector or the Broadway BRT Station on the north side of the toll plaza in the same alignments as the HOV/HOT lanes described in Chapter 5, Section 5.1.2. Factors that warranted consideration in the development and evaluation of options included:

- The tight circulation space between the bridge landing and South Broadway to accommodate the Hudson Line Connector, the Tarrytown Connector, a busway, a Broadway BRT Station, and feeder and local bus routes.
- Commercial and residential properties on both sides of the Thruway, between the bridge landing and Interchange 9.
- Maintaining operations at the Tappan Zee Bridge toll plaza.

6.1.1 Proposed Transit Operations

The proposed BRT stations in this area are:

- **Broadway BRT Station,** which would be located immediately north of the toll plaza of the replacement Tappan Zee Bridge in NYSTA property. It would be a trunk line busway station and would accommodate feeder routes L and F and local Bee-Line bus transfers.
- **Tarrytown BRT Station,** which would be located at the terminus of the Tarrytown Connector, adjacent to the existing Metro-North Tarrytown Station along the Hudson Line. It would provide direct connections between the proposed BRT system and the Metro-North Hudson Line trains.
- **Benedict Avenue BRT Station,** which would be an in-line station located along the busway west of Interchange 8 and would be served by all BRT routes continuing along this portion of the busway. Depending upon the alignment option selected, it would also have pedestrian and bicyclist accessibility and would accommodate local (i.e., Bee-Line) bus transfers.

Twelve BRT routes (A, B, C, D, E, F, G, H, I, J, K and T) would cross the replacement Tappan Zee Bridge from Rockland County (see service plan in Appendix A). All of these routes, except for Route E, would serve the Broadway BRT Station (described in Subchapter 5.1). Route E would go directly from the bridge to the existing Tarrytown Station on the Tarrytown Connector and return to Rockland County in the same alignment. Route L, from Ossining, would stop at the Broadway BRT Station and continue east on the busway alignment.

6.1.2 Description of Alignment

Under Alternatives B and D, the busway would be in the center lanes of the replacement Tappan Zee Bridge and, depending on the type of bridge designed, could ramp over or under the westbound travel lanes of the Thruway to access the proposed Broadway BRT Station. From the proposed Broadway BRT Station, it would remain in a cut, adjacent to the Thruway travel lanes, passing under the South Broadway Bridge, over Meadow Street and east along the north side of I-287 at the edge of the Talleyrand Swamp to Interchange 8.

The busway alignment has two options approaching Interchange 8 (Figures 6-3 and 6-4):

- **Benedict Avenue Option** – Before reaching Interchange 8 this option would turn north out of the I-287 ROW, transition to grade and continue into the office park area for about 1,000 feet and meet Route 119. Along this segment the proposed Benedict Avenue BRT Station would be located within walking distance to the local Bee-Line services on Route 119. This alignment and station location would require property acquisition and/or easements between I-287 and Route 119.
- **I-287 ROW Option** – This option would maintain the alignment along the north side of Interchange 8 at grade, with the proposed station located on the alignment at the rear of the commercial properties abutting the interchange.

6.1.3 Evaluation of Options and Alignment Recommendation

There are two major differentiators between the alignment options through Interchange 8. With respect to transportation system integration, the Route 119 Option would provide a Benedict Avenue station that would be located within the office park area and close to Route 119. This would provide better overall accessibility to the office parks as well as better visibility for the station. It would also provide better access for transfers to Bee-Line buses running along Route 119. The I-287 Option would place the station at the rear of the office parks and a long distance from Route 119.

The second differentiator pertains to property acquisitions. Both options would require takings and/or easements for the alignment and station. However, with the Route 119 Option there are choices as to how the alignment would travel north towards Route 119 for a best fit within the office parks and the optimal station location. This would require discussions and coordination with the various property owners. With the I-287 Option there is only one alignment route, and that would be directly adjacent to the north side of Interchange 8. There would be insufficient clearance between the interchange retaining wall and the rear service road of the Westchester Marriot Hotel because of the narrow available I-287 ROW in this area. As a result there would be property acquisition and possible reconfiguration of the hotel's service entrances.

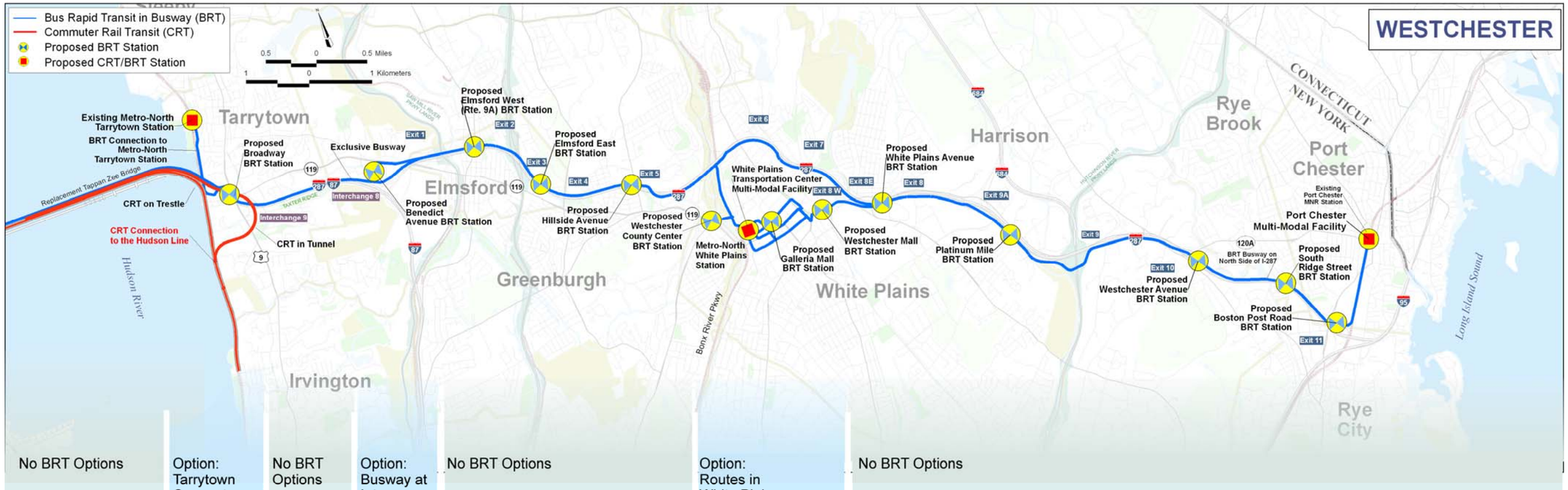


Figure 6-1 BRT Busway Options in Westchester County

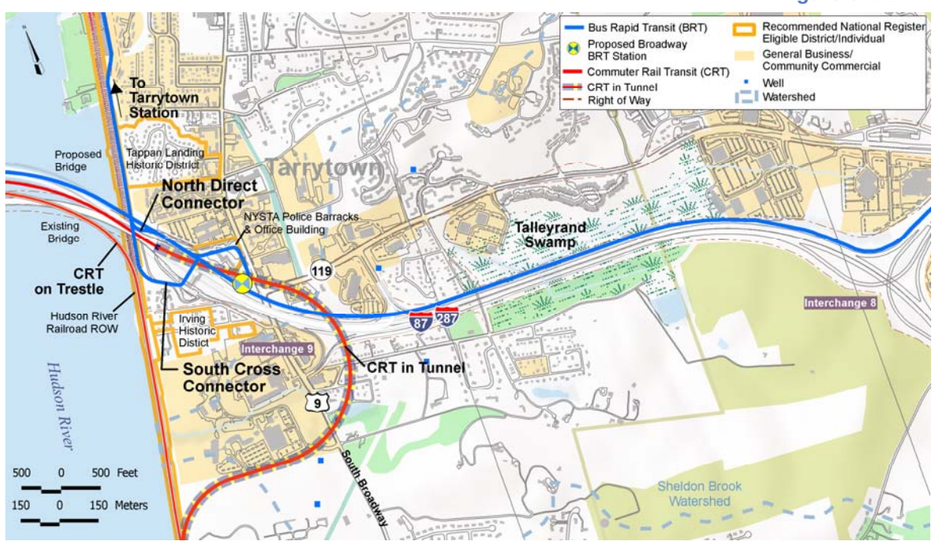


Figure 6-2 BRT Busway Alignment in Tarrytown Area

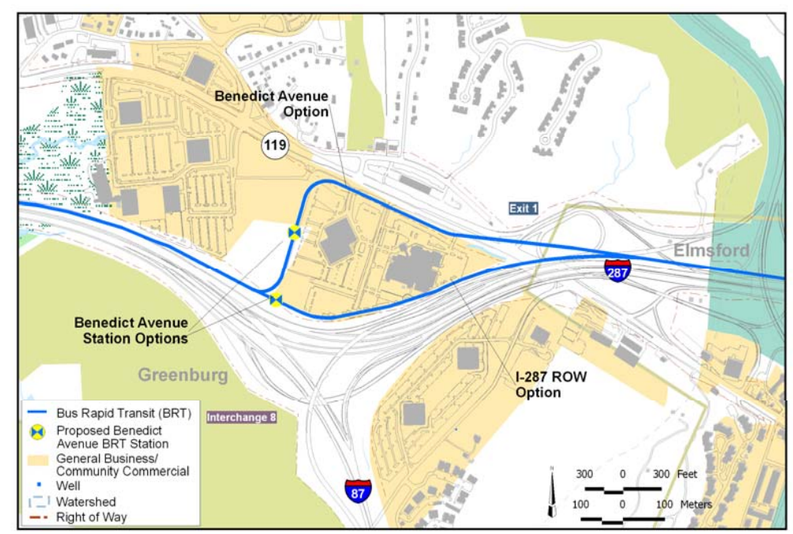
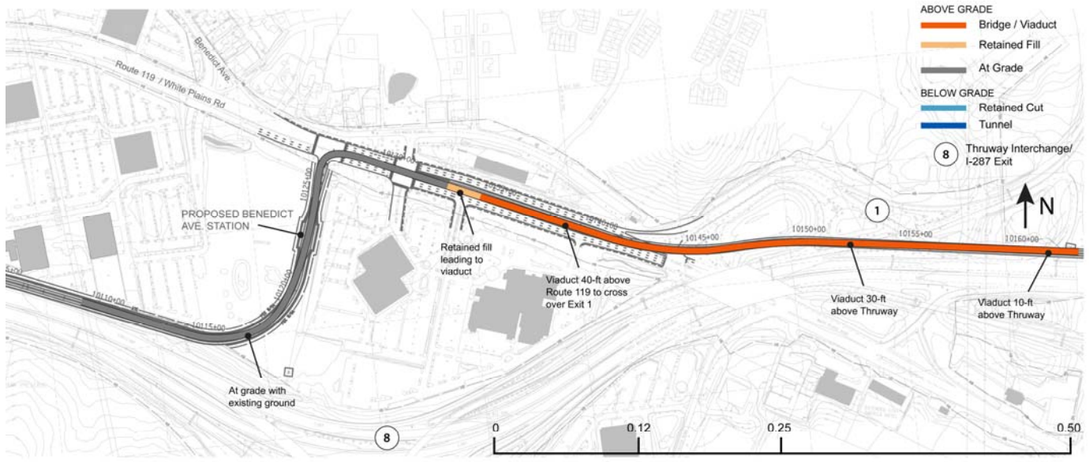
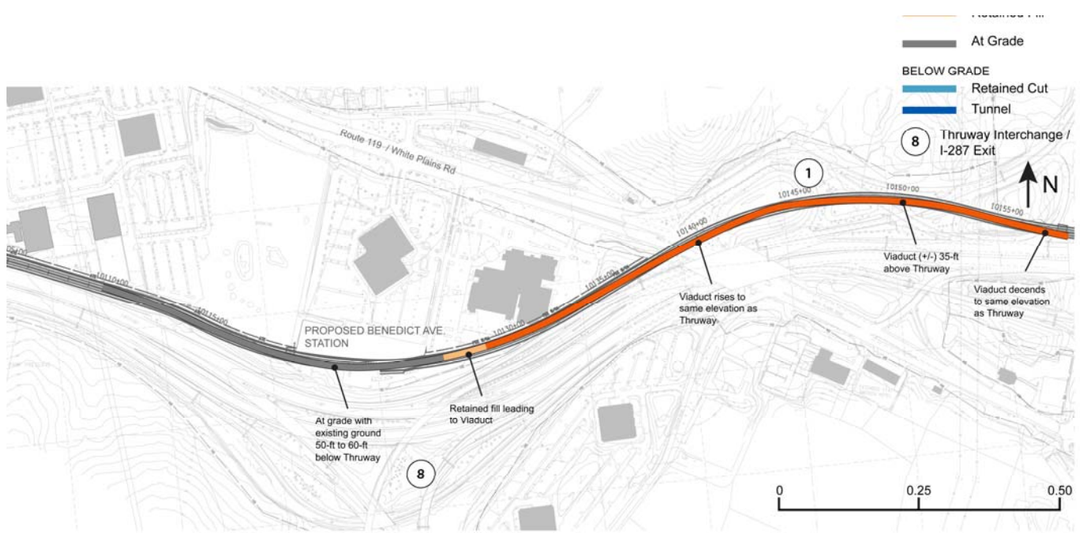


Figure 6-3 BRT Busway Options at Interchange 8



Benedict Avenue Option



I-287 Option

Figure 6-4 BRT Busway at Interchange 8 – Engineering Features

6.1.4 Transit Alignment Recommendation

The Benedict Avenue Option is recommended for advancement into the EIS as an element of Alternatives B and D based on the following criteria differentiators:

- **Transportation –** The I-287 Option would place the proposed Benedict Station along the alignment at the rear of the office parks and a long distance from Route 119. The Benedict Avenue Option would provide a station that would be located within the office park area and close to Route 119. This would provide better overall accessibility to the office parks as well as better visibility for the station compared to the I-287 Option. It would also provide better access for transfers to local Bee-Line buses running along Route 119.

- **Environment -** Both options would require takings and/or easements for the alignment and station. However, the Benedict Avenue Option has flexibility as to how the alignment would travel north to Route 119 for a best fit within the office parks and the optimal station location. This would require discussions and coordination with the various property owners. With the I-287 Option the alignment route would be directly adjacent to the north side of Interchange 8, where there would be insufficient clearance. As a result there would be property acquisition and possible reconfiguration of the existing hotel's service entrances.

6.2 Elmsford/Greenburgh

This area of the study begins on the east side of Exit 1 in the Town of Elmsford and continues through Greenburgh to Exit 5, a distance of approximately 2.6 miles (Figure 6-5). The area includes major crossings over the Saw Mill River Parkway and Route 9A (Saw Mill River Road), and crossings under the Sprain Brook Parkway, Hartsdale Avenue, and Hillsdale Avenue. Factors that warranted consideration in the development and evaluation of options included:

- Complex infrastructure at Exit 1 and the Saw Mill River Parkway.
- Narrow I-287 ROW in Elmsford around Route 9A and parts of Greenburgh.
- Power station and power lines east of the Sprain Brook Parkway.
- Commercial and residential properties on both sides of I-287 in Elmsford and Greenburgh.
- Parklands, water courses, and wetlands along the Saw Mill River Parkway and the Sprain Brook Parkway.
- Parkland adjacent to I-287 ROW in Greenburgh.

6.2.1 Proposed Transit Operations

The three proposed on-line BRT stations on the busway in this area – Elmsford West, Elmsford East, and Hillside Avenue – would provide for transfers with the existing local bus system, provide for pedestrian and bicyclist accessibility and include park-and-ride facilities.

The BRT service would operate along a busway located along the north side of the I-287 ROW, adjacent to the westbound travel lanes, as far east as Interchange 5. Eleven BRT routes access this segment of the study corridor en route to and from western locations (A, B, C, D, G, H, I, J, K, L, and T). All of these routes would serve this area (as described in Subchapter 5.3.1) as there is no difference in the transit service plan between the bus lanes and busway alternatives at this location.

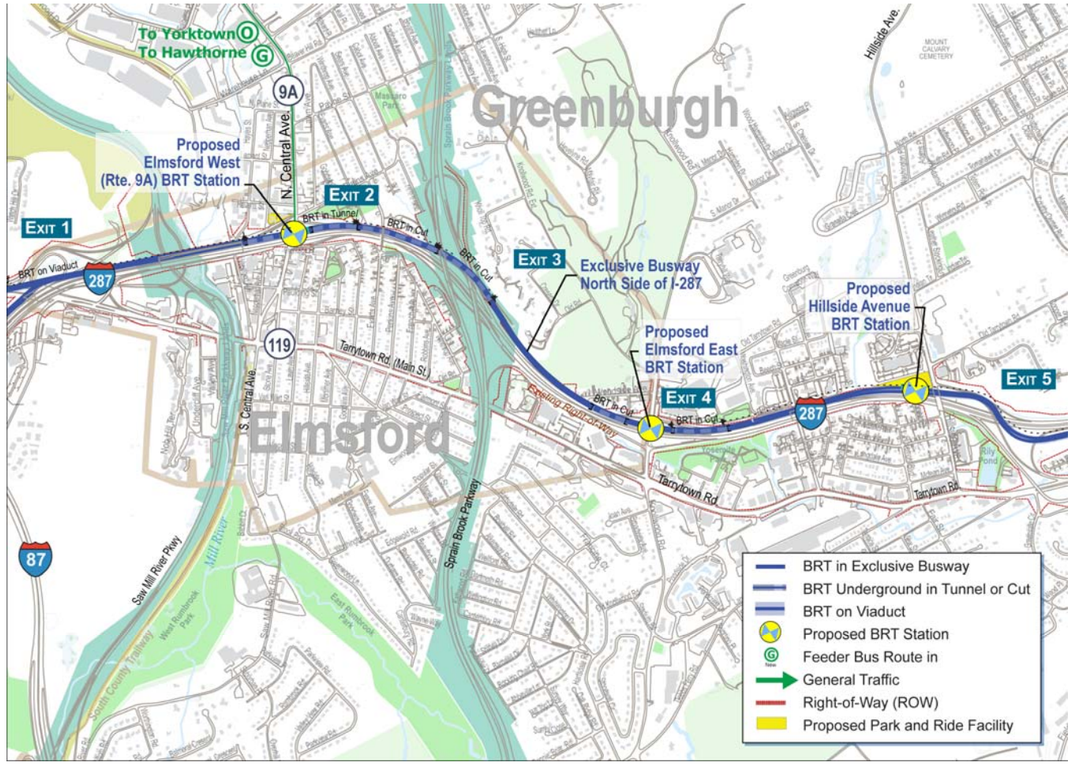


Figure 6-5 BRT Busway Alignment in Elmsford/Greenburgh

6.2.2 Description of Alignment

The BRT busway would cross over Exit 1 and the Saw Mill River Parkway on a viaduct to continue on the north side of I-287. The busway would transition to grade to service the proposed Elmsford West Station and permit connection with feeder buses along Route 9A. The busway would then continue in a retained cut (Figure 6-6) along the north side of I-287, daylighting after passing under the Sprain Brook Parkway. The busway would continue on the north side of I-287 until Exit 5, where it would then cross over I-287 to reach Route 119.

Key details of this alignment include:

- A 4,500-foot long viaduct over Exit 1 and the Saw Mill River Parkway with a maximum height of 40 feet.
- A 3,000-foot long retained cut under the Sprain Brook Parkway.
- A 1,100-foot long at-grade segment at Woodside Avenue.
- A 3,900-foot long retained cut to cross under Knollwood Road.
- A 700-foot long fill and bridge over Manhattan Avenue.
- A 1,100-foot long retained cut to cross under Hillside Avenue.
- A 1,600-foot long fill and bridge to cross over I-287 at Exit 5 to access Route 119.
- Access ramps from the busway to I-287 for buses to bypass downtown White Plains.

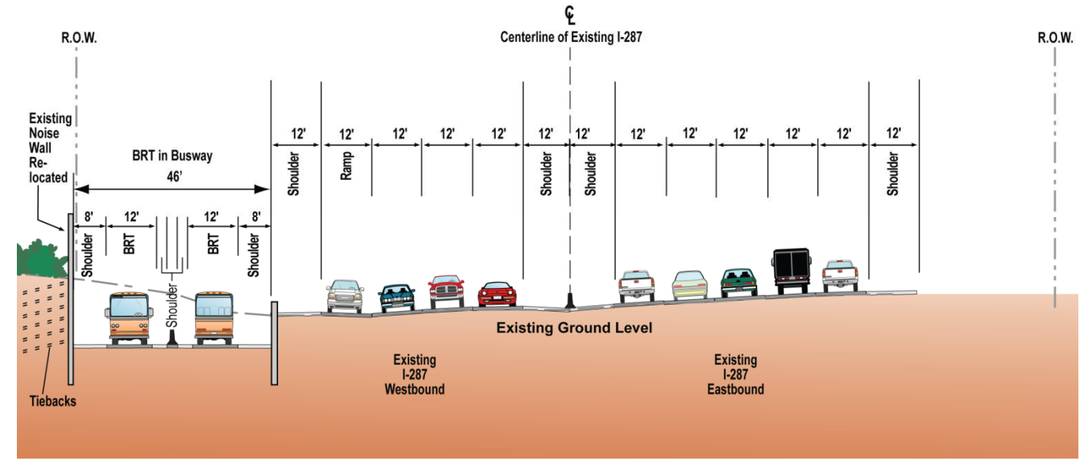


Figure 6-6 BRT Busway in Elmsford/Greenburgh Area
Typical Cross-Section at Knollwood Road

6.3 Route 119 from Exit 5 to White Plains

To provide service to the downtown White Plains the busway alignment would transition from the I-287 corridor to connect to the WPTC and the city's key commercial and retail destinations. This area extends from Exit 5 on Route 119 to the Metro-North Harlem Line, a distance of about 0.9 miles. Factors that warranted consideration in the development of the alignment included:

- Local traffic and bus movements, driveways, available ROW, and adjacent properties on Route 119.
- Maintaining operations on the Harlem Line.
- The Bronx River Parkway and adjacent parklands, water courses, and wetlands.
- Providing a connection to a future Central Avenue BRT route.

6.3.1 Proposed Transit Operations

Transit operations for the busway alternative would be the same as for the bus-lanes alternatives described in Subchapter 5.4.1.

6.3.2 Description of Alignment

The BRT busway alignment would be in dedicated lanes in the median of Route 119, which is the same alignment as the bus-lanes alternatives described in Chapter 5. The busway would connect to the WPTC via a new underpass under the Harlem Line tracks at Water Street. This would enable the busway to bypass Route 119 to enter White Plains. Key factors affecting development of this alignment include:

- 3,200 feet of on-street median bus lanes along Route 119.
- 1,600 feet of dedicated bus lanes around the Westchester County Center's parking area.

- A new underpass under the Harlem Line.
- A station at the intersection of Route 119 and Central Avenue near the Westchester County Center.

6.4 White Plains

The busway alternatives would travel in dedicated lanes on local streets to provide access to the local commercial, retail, and residential destinations. It would re-connect with I-287 at Exit 8 on the eastern side of downtown White Plains. This is a distance of approximately 1.3 miles. Factors that warranted consideration in the development of the alignment included:

- Local traffic and bus movements, driveways, available ROW, and adjacent commercial and residential properties on local streets, including Hamilton Avenue, Main Street, Broadway, and Westchester Avenue.
- Complex infrastructure at Exit 8.

6.4.1 Proposed Transit Operations

Transit operations for the busway alternatives would be the same as for the bus-lanes alternatives described in Subchapter 5.5.1 with respect to stations and the alignment through the central business district.

6.4.2 Description of Alignment

6.4.2.1 BRT Bus Lanes in White Plains

It was determined based on the traffic analyses presented in Appendix B that the BRT alignment through the White Plains central business district to be evaluated in the EIS will be a two-way arrangement along Hamilton Avenue, utilizing traffic signal priority and with BRT stations at the WPTC, Westchester Mall, and Martin Luther King, Jr. Boulevard (Galleria Mall Station). On the east side of downtown White Plains, the BRT would traverse Broadway – possibly in mixed traffic for short segments– and travel along Westchester Avenue to reach I-287 Exit 8. Key details in this area include:

- 5,800 feet of on-street median bus lanes along Hamilton Avenue.
- 3,700 feet of dedicated bus lanes on the shoulder or curb lane along Broadway and Westchester Avenue.
- Stations at the WPTC, central downtown (possibly the Galleria Mall), and the Westchester Mall.

6.4.2.2 Use of Harlem Line ROW

Previous concepts for the busway alternatives called for continuing the busway viaduct along the I-287 ROW east of Interchange 5 and utilizing the ROW of the Harlem Line to approach the White Plains central business district from the west and north (Figure 6-7). This concept was removed from further consideration because it would constrain any future modifications to the Harlem Line, have permanent impacts on the surrounding parklands, and require diverting the alignment through the new parking facility for the development of a BRT station at the Westchester County Center to connect to the proposed Westchester County DOT Central Avenue BRT.

6.4.2.3 White Plains Bypass

Previous concepts for the busway alternatives also considered a dedicated busway on I-287 that would bypass downtown White Plain; however, this concept was eliminated because of the significant ROW impacts of the busway infrastructure to the properties adjacent to I-287 and the low projected use of this alignment by the proposed BRT services (Figure 6-7). Instead, new entry and exit ramps from the busway to I-287 would be provided to allow buses to bypass White Plains in mixed traffic.

6.5 East of White Plains

This area begins at Exit 8 in White Plains and continues to Port Chester, a distance of approximately 6.3 miles (Figure 6-8). Factors that warranted consideration in the development of the alignment are:

- Reconfiguration of the Exit 8 and Westchester Avenue
- Complex infrastructure at Exit 9A, and Exit 9.
- Entry and exit ramps and associated merging between I-287 and its service road on Westchester Avenue.
- Narrow I-287 ROW in Rye Brook and Port Chester.
- Connectivity to commercial properties in the Platinum Mile.
- Traffic, driveways, available ROW, and commercial and residential properties on Westchester Avenue.
- The Hutchinson River Parkway and adjacent parklands, water courses, and wetlands.
- Commercial and residential properties and St. Mary's Cemetery in Rye Brook.
- Existing rail facilities and service on the New Haven Line.

6.5.1 Proposed Transit Operations

Transit operations for the busway alternatives would be the same as for the bus-lanes alternatives described in Subchapter 5.6.1.

6.5.2 Description of Alignment

Upon leaving downtown White Plains the busway alignment would enter the I-287 ROW between the eastbound I-287 lanes and Westchester Avenue in separate guideway that would primarily be on a viaduct to clear the many bridges over I-287. A typical cross-section is shown on Figure 6-9. About 2,000 feet before Exit 10 (Westchester Avenue), the busway would cross over I-287 on a viaduct to reach the north side of I-287. The busway would descend into a retained cut under Ridge Street, High Street, and Boston Post Road.

The busway would pass through the existing retail center near I-287 Exit 11 and turn northward to join the ROW of the New Haven Line. The busway would travel parallel to the New Haven Line to reach its terminus at the Port Chester Station. Buses continuing north or south on I-95 would access the busway at the proposed Westchester Avenue Station and utilize general-purpose lanes on I-287 east of Interchange 10. Key factors that affected development of the alignment in this area include:

- A 21,700-foot long viaduct from Exit 8 past North Westchester Avenue and Bowman Avenue.
- A 1,400-foot long at-grade segment.
- A 4,500-foot long retained cut under Ridge Street, High Street, and Boston Post Road.
- An at-grade busway, parallel to the New Haven Line.
- Proposed elevated stations at White Plains Avenue, Platinum Mile, and Westchester Avenue. Proposed Ridge Street Station in a cut and proposed Boston Post Road and the Port Chester Metro-North Stations at grade.

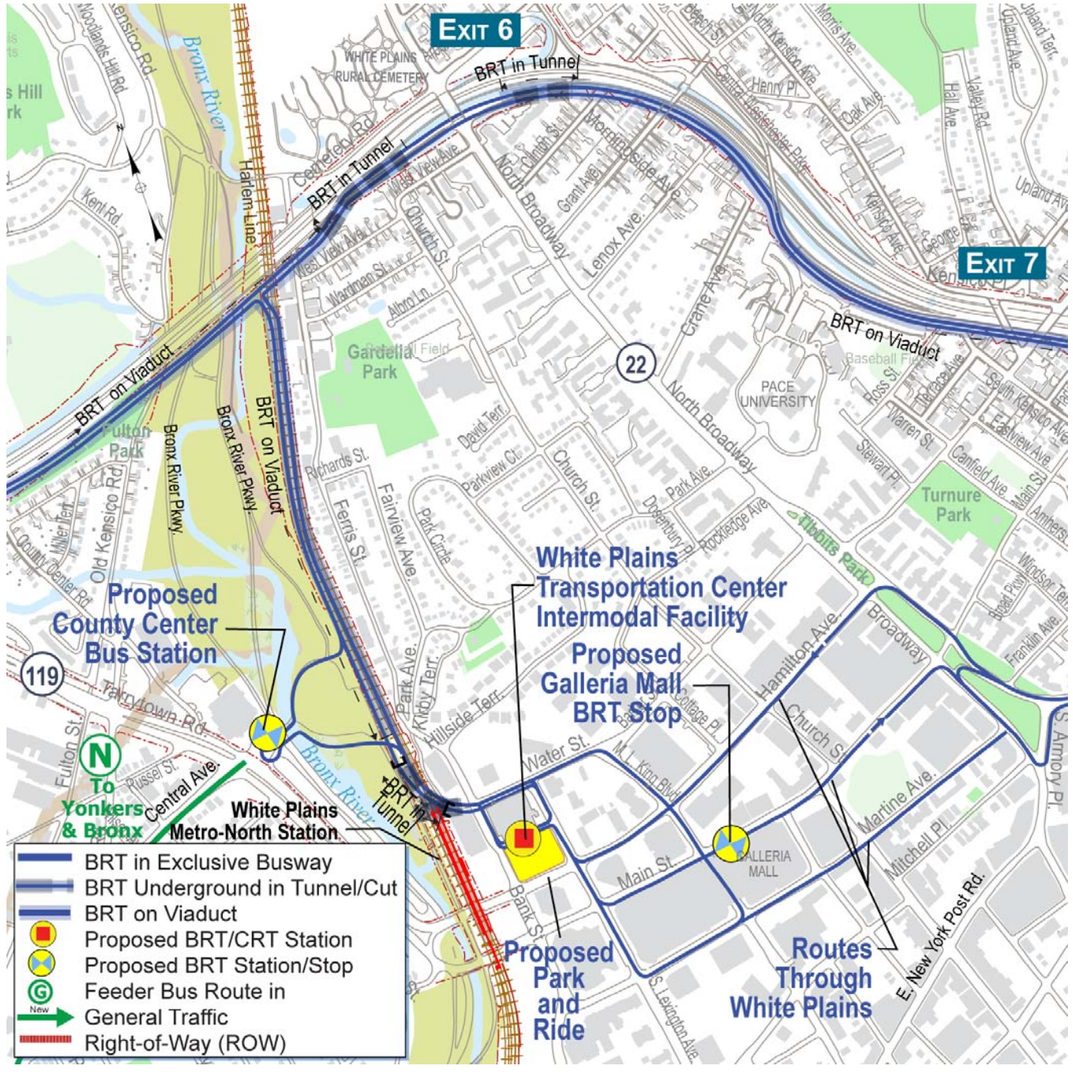


Figure 6-7 White Plains Bypass and Busway Alignment Connector

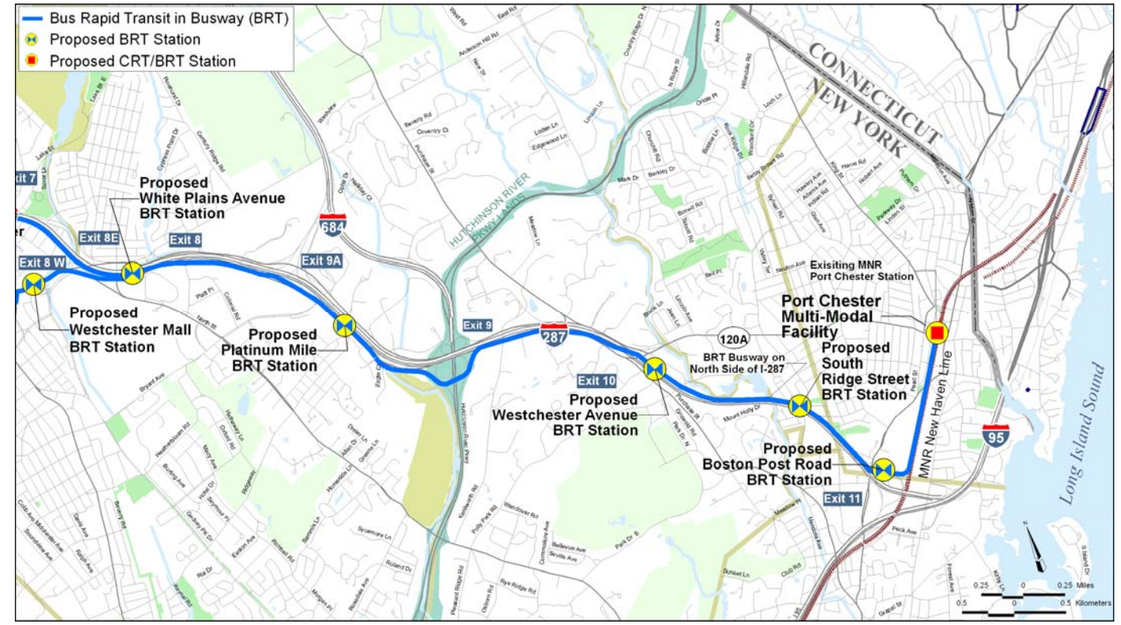


Figure 6-8 BRT Busway Alignment East of Downtown White Plains

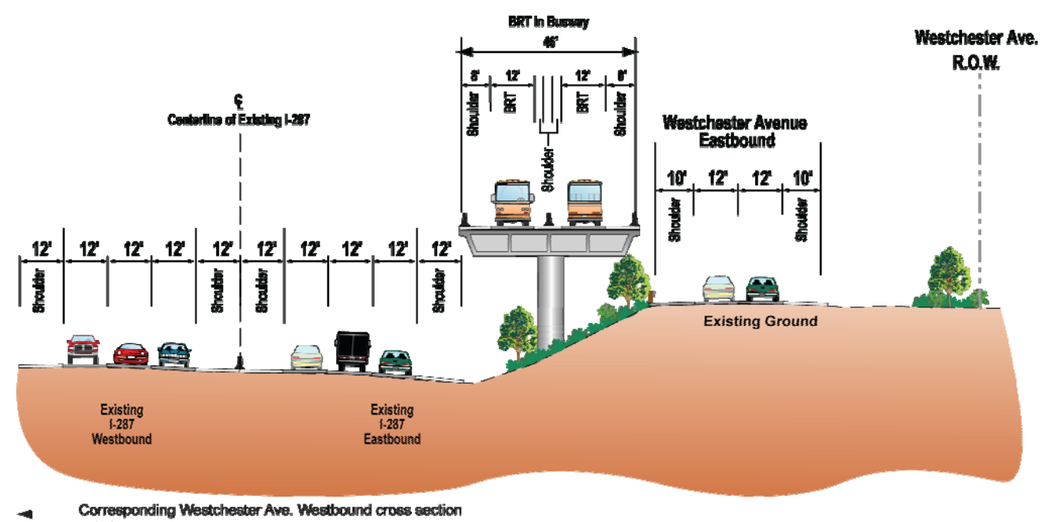


Figure 6-9 BRT Busway East of White Plains
Cross-Section at Butcher Avenue

7 Description of EIS Alternatives

The EIS Alternatives will consist of the No-Build and the four Build Alternatives. Each of the build alternatives contains common elements, which include a replacement Tappan Zee Bridge, highway improvements, and CRT in Rockland County. Based on the evaluations and recommendations included in this report the transit alignments for each of the build alternatives are now fully defined. The five EIS Alternatives are as follows (Table 7-1):

- **Alternative A – No Build –** The key components of the No Build Alternative are continuous maintenance of the bridge structure and I-87/I-287 in both counties and the proposed projects listed in the latest TIP.
- **Alternative B – Full-Corridor Busway and Rockland CRT** – BRT service between Suffern and Port Chester in an exclusive busway alignment that would also include exclusive bus lanes through downtown White Plains. CRT service is provided for Orange and Rockland Counties to GCT.
- **Alternative C – Busway in Rockland, Bus Lanes in Westchester, and Rockland CRT** – Alternative C would provide BRT service between Suffern and Port Chester in an exclusive busway in Rockland County and exclusive bus lanes in Westchester County, including downtown White Plains. CRT service is provided for Orange and Rockland Counties to GCT.
- **Alternative D – HOV/HOT Lanes in Rockland, Busway in Westchester, and Rockland CRT** – Alternative D would provide BRT service between Suffern and Port Chester. In Rockland County BRT would be in shared-use HOV/HOT lanes, and in an exclusive busway in Westchester County that would include exclusive bus lanes through downtown White Plains. CRT service is provided for Orange and Rockland Counties to GCT.
- **Alternative E – HOV/HOT Lanes in Rockland, Bus Lanes in Westchester, and Rockland CRT** – Alternative E would provide BRT service between Suffern and Port Chester. In Rockland County BRT would be in shared-use HOV/HOT lanes, and in exclusive bus lanes in Westchester County including downtown White Plains. CRT service is provided for Orange and Rockland Counties to GCT.

Table 7-1

Key Elements of the Build Alternatives

Alternative	BRT in Rockland County		BRT in Westchester County		CRT in Rockland County*	Replacement Bridge	Highway Improvements in Rockland County
	Busway	HOV/ HOT Lanes	Busway	Bus Lanes			
B	✓		✓		✓	✓	✓
C	✓			✓	✓	✓	✓
D		✓	✓		✓	✓	✓
E		✓		✓	✓	✓	✓

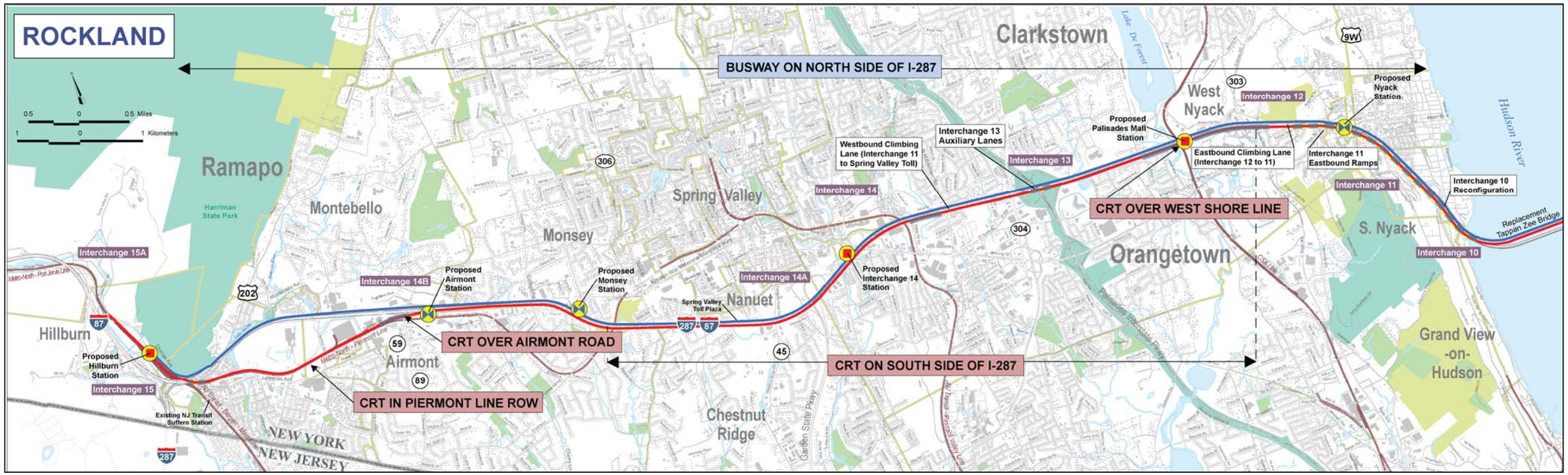
Note*: CRT also includes a short section in Westchester County connecting to the Metro-North Hudson Line.

Table 7-2 summarizes the recommended transit alignment options for CRT and BRT for the build alternatives. Figures 7-1 through 7-4 show the CRT and BRT alignments in Rockland and Westchester Counties along with the recommended transit alignment options for each of the respective build alternatives

Table 7-2

Transit Alignment Options Recommended for the Build Alternatives

Recommended Option	Alternative			
	B	C	D	E
Commuter Rail Transit				
CRT in the Piermont Line ROW	✓	✓	✓	✓
CRT over Airmont Road	✓	✓	✓	✓
CRT on the south side of the Thruway	✓	✓	✓	✓
CRT over the West Shore Line	✓	✓	✓	✓
CRT Hudson Line connection in a tunnel	✓	✓	✓	✓
Bus Rapid Transit				
Busway on north side of the Thruway	✓	✓		
South Cross BRT connection to Tarrytown Station	✓	✓	✓	✓
Bi-directional bus lanes on Hamilton Avenue	✓	✓	✓	✓
Benedict Avenue busway alignment at Interchange 8	✓		✓	



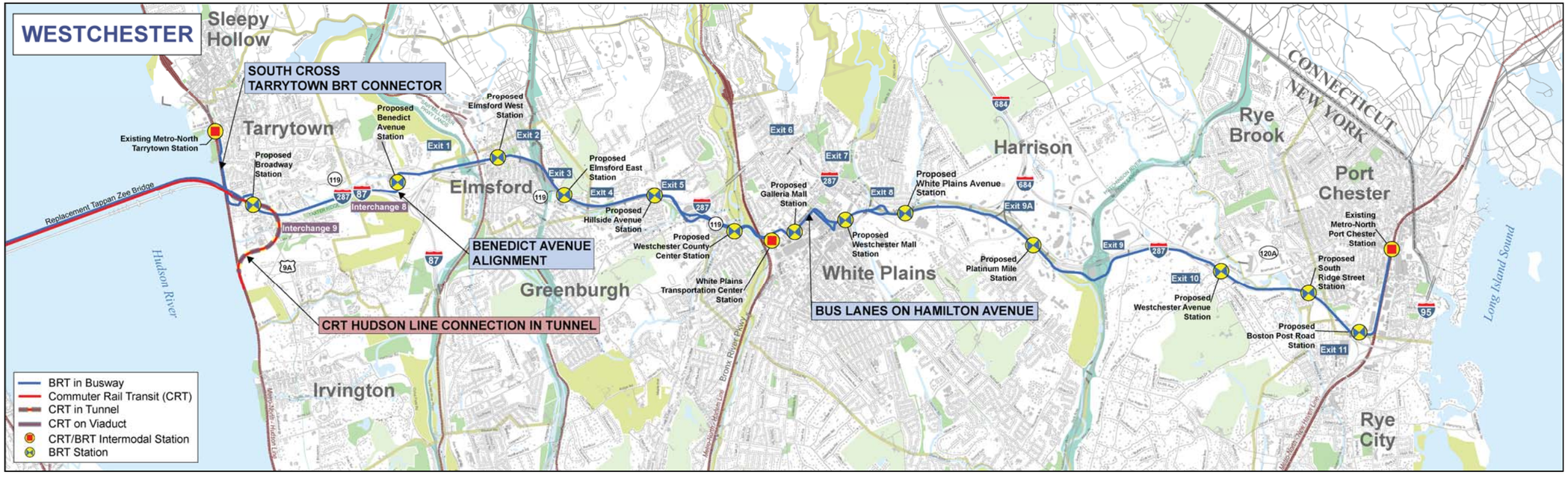


Figure 7-1 Alternative B – Cross Corridor Busway with CRT in Rockland

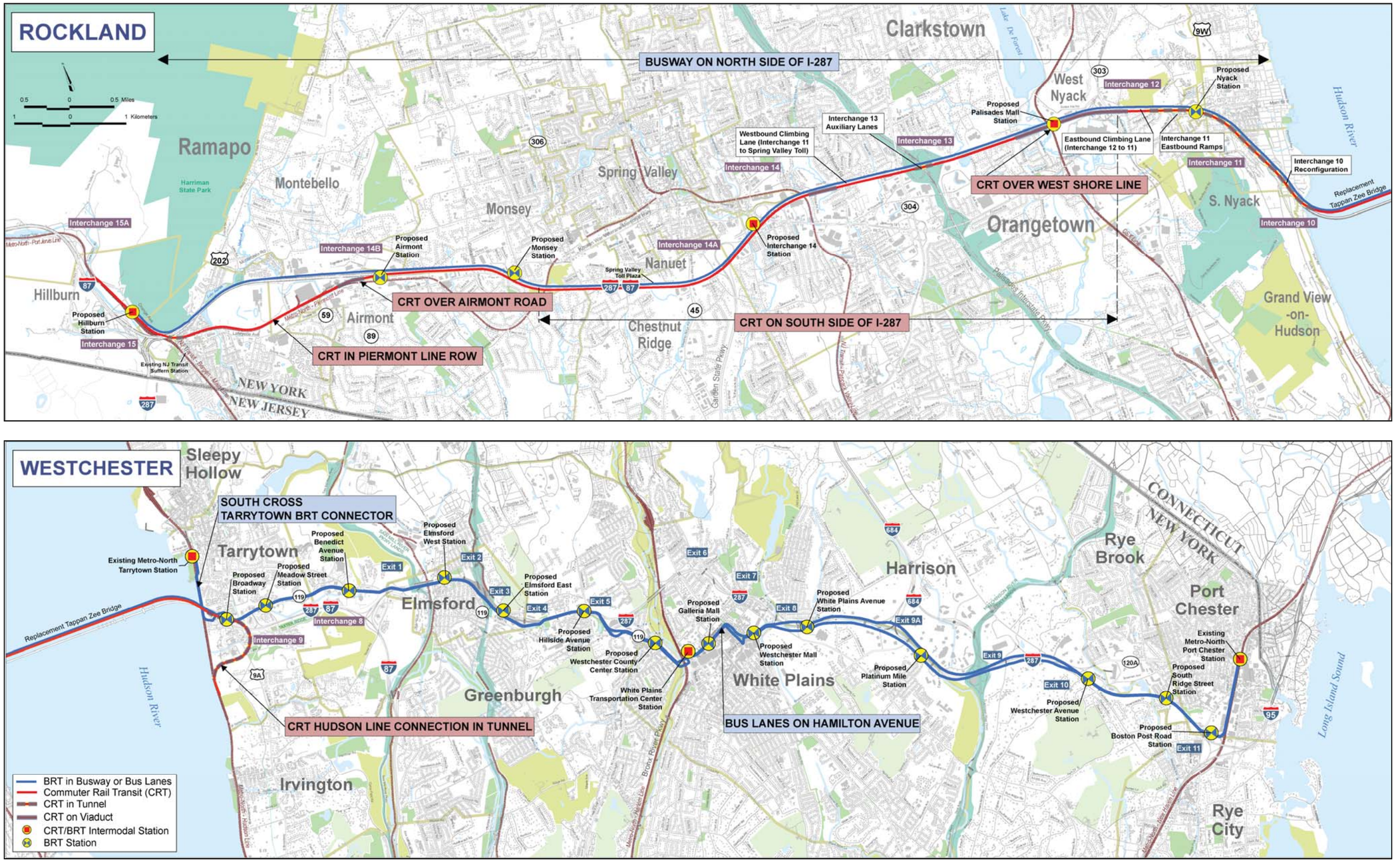


Figure 7-2 Alternative C – Busway in Rockland, Bus Lanes in Westchester, CRT in Rockland

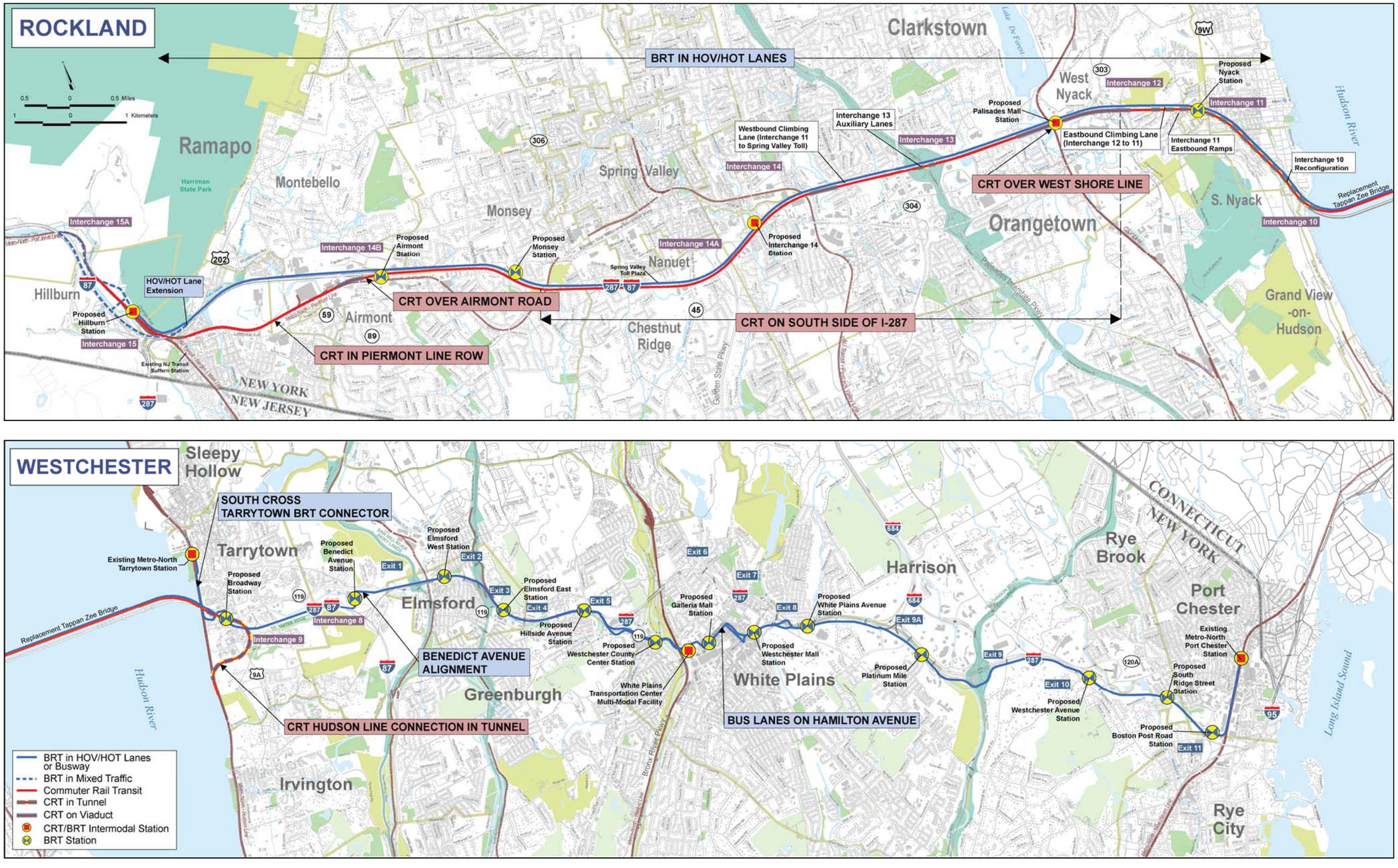


Figure 7-3 Alternative D – BRT/HOV/HOT in Rockland, Busway in Westchester, CRT in Rockland

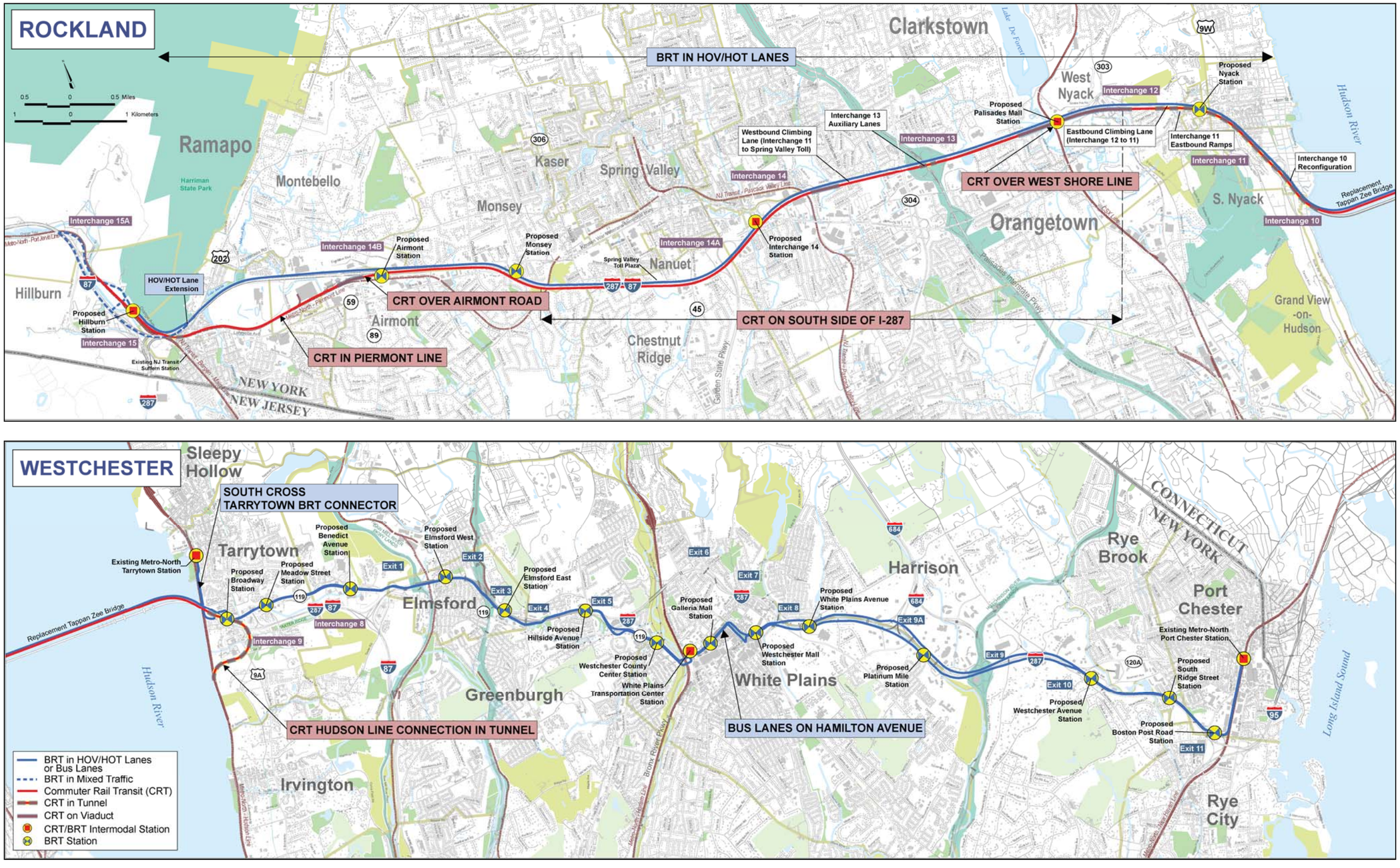


Figure 7-4 Alternative E – BRT/HOV/HOT in Rockland, Bus Lanes in Westchester, CRT in Rockland


environment

8 List of Preparers

This document was prepared by the Project Sponsors under the direction of and with the active involvement from the FHWA and FTA. Key individuals and firms involved in the preparation of the report are indicated below.

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environment

Appendix A

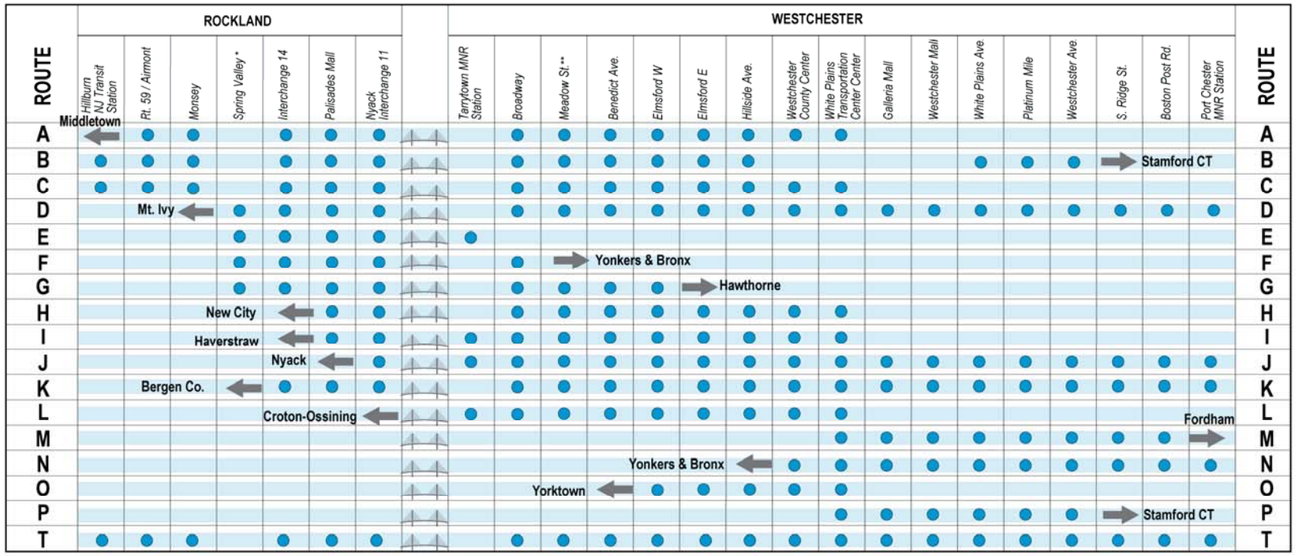
Service Plans and Design Criteria


environment

A Service Plans and Design Criteria

Table A-1

BRT and CRT Service Plans



BRT Service

NOTES:
*Not a Station.
**Bus Lane only.

BRT Station Functions				
Station	CRT Connection	Feeder Bus Entrance	Local Bus Transfer	Transit Hub
Hillburn	●	●	●	●
Airmont			●	
Monsey			●	
Interchange 14	●	●	●	●
Palisades Mall	●	●	●	●
Nyack		●	●	

Stops	Peak Uni-Directional Service							By Terminal	Off-Peak - Bi-Directional Reverse Peak - Uni-Directional			
	A	B***	C	D***	E	F	G		A	B***	E	G
No Trains in peak hour	1	1	1	1	2	4	4	14				
Peak Hour Headways	60	60	60	60	30	15	15					
Shoulder-Peak Headways	X	X	60	60	30	30	30					
Off-Peak Headways									120	120	60	60
Port Jervis	●	●	●	●	●				●	●	●	
Otisville	●	●	●	●	●				●	●	●	
Middletown	●	●	●	●	●				●	●	●	
Campbell Hall	●	●	●	●	●				●	●	●	
Salisbury Mills	●	●	●	●	●				●	●	●	
Harriman	●	●	●	●	●	●			●	●	●	
Tuxedo			●	●		●			●	●	●	
Sloatsburg			●	●		●			●	●	●	
Hillburn						●	●		●	●	●	●
Interchange 14							●				●	●
Palisades Mall							●				●	●
Harlem-125th Street					●	●	●				●	●
Grand Central					●	●	●	10			●	●
Suffern			●	●					●	●		
Ramsey-Route 17			●	●					●	●		
Secaucus	●	●	●	●					●	●		
Hoboken	●		●					2	●			
New York Penn		●		●				2		●		

Commuter Rail Service

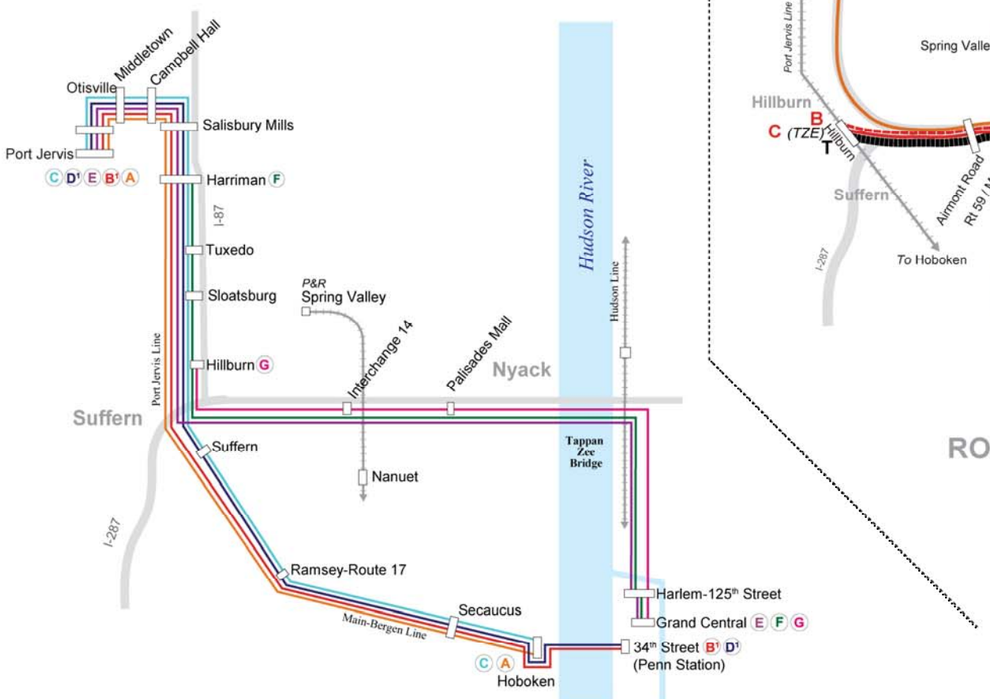
Service Branch

- Hoboken/New York Penn
- Grand Central Terminal

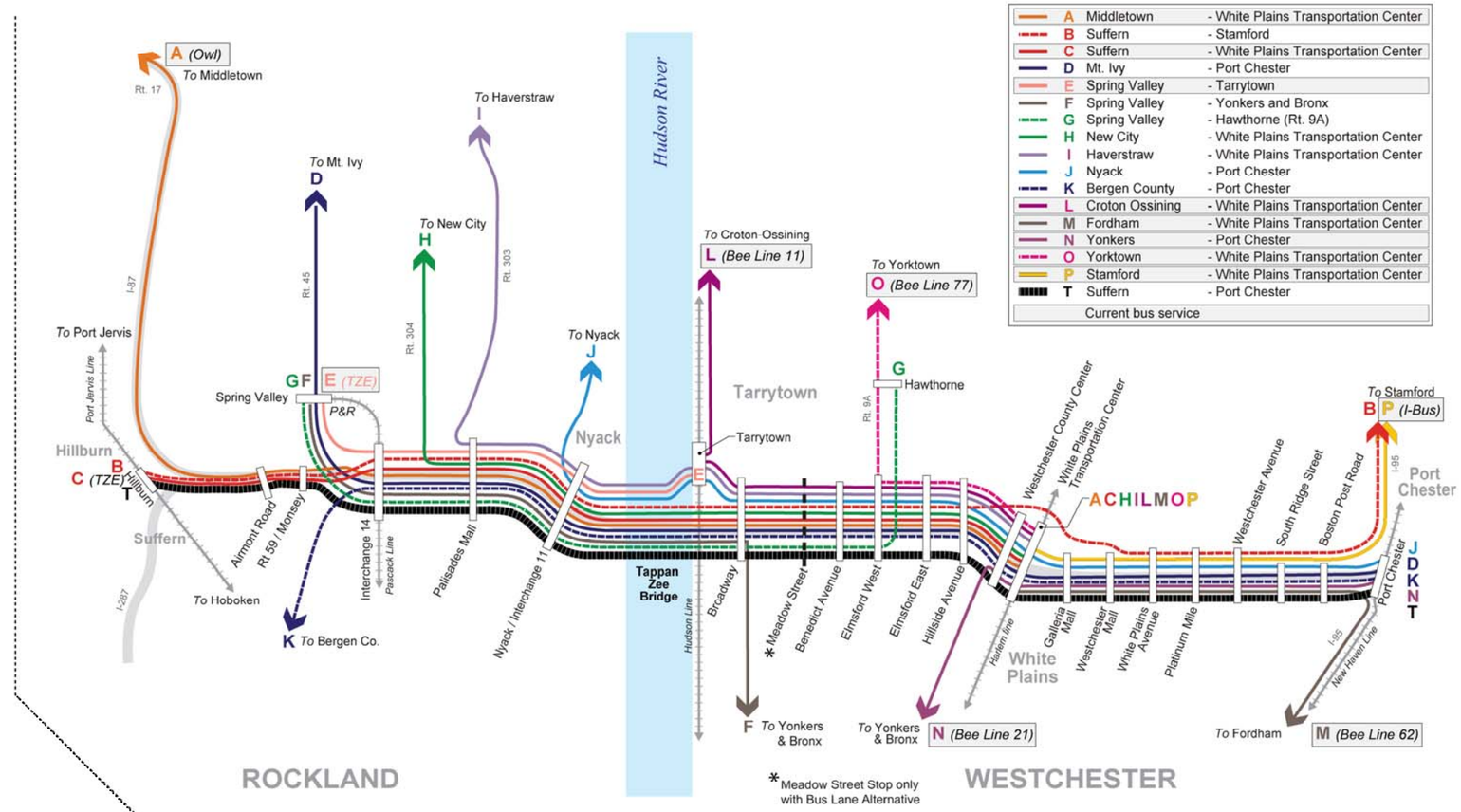
NOTES:
In addition to the direct service to each terminal, customers will have additional service to each terminal via transfers at Harriman or the new Hillburn Stations.
Reverse peak and off peak Bergen Line and Main Line trains will terminate at Hillburn instead of Suffern.
***Additional trains in 2017 & 2047 using the Trans Hudson Express tunnel.

No. of Trains	Headways (minutes)			
1	60	A	Port Jervis	- Hoboken
1	60	B[1]	Port Jervis	- New York Penn Station
1	60	C	Port Jervis	- Hoboken
1	60	D[1]	Port Jervis	- New York Penn Station
2	30	E	Port Jervis	- Grand Central Terminal
4	15	F	Harriman	- Grand Central Terminal
4	15	G	Hillburn	- Grand Central Terminal

[1] Additional trains in 2017 & 2047 using the Trans Hudson Express Tunnel



Commuter Rail Transit Service Plan



A	Middletown	- White Plains Transportation Center
B	Suffern	- Stamford
C	Suffern	- White Plains Transportation Center
D	Mt. Ivy	- Port Chester
E	Spring Valley	- Tarrytown
F	Spring Valley	- Yonkers and Bronx
G	Spring Valley	- Hawthorne (Rt. 9A)
H	New City	- White Plains Transportation Center
I	Haverstraw	- White Plains Transportation Center
J	Nyack	- Port Chester
K	Bergen County	- Port Chester
L	Croton Ossining	- White Plains Transportation Center
M	Fordham	- White Plains Transportation Center
N	Yonkers	- Port Chester
O	Yorktown	- White Plains Transportation Center
P	Stamford	- White Plains Transportation Center
T	Suffern	- Port Chester
	Current bus service	

Bus Rapid Transit Service Plan

Figure A-1 Bus Rapid Transit and Commuter Rail Service Plans

Table A-2

Concurrent Mainline BRT (HOV) Lane Geometric Standards

	Element	Standard Criteria^	Source
1	Design Speed (mph)	70	HDM §24.2.3.2
2	Minimum Lane Width (feet)	12, 11 With documentation	HDM §24.2.3.4 A, §24.2.7.2; AASHTO HOV Facilities Guide
3	Minimum Left Shoulder Width (feet) BRT HOV Lanes Dedicated Enforcement Area (Left)	 10 2 14	HDM §24.2.3.4B, C, §24.2.7.2; AASHTO HOV Facilities Guide; FHWA HOT Lane Guide
	Right Buffer Area Width (feet) Minimum Maximum	1, 4 Desirable^^ 14, 10 Allowable^^	
4	Minimum Bridge Roadway Width (feet)	Match approach highway	BM §2.3.1, Table 2-1
5	Maximum Grade [Rolling]	3%	NYSTA
6	Horizontal Curvature, Min. Radius @e=8% (feet) @e=6%	 1810 2040	HDM §2.7.1.1F Exhibit 2-2
7	Maximum Superelevation Rate	8%, 6% may be used in urban and suburban areas	HDM §2.7.1.1G
8	Minimum Stopping Sight Distance (feet)	730	HDM §2.7.1.1H, Exhibit 2-2
9	Minimum Horizontal Clearance (feet)	Shoulder width (not less than 4)	HDM §2.7.1.1I; AASHTO HOV Facilities Guide
10	Mini. Vertical Clearance (feet) Vehicular Bridges Rehabilitation* Replacement** Pedestrian Bridges OH Sign Structures & Signs	 14, 14.5 Desirable 14¤, 16.5 Desirable¤ 15, 17.5 Desirable¤¤ 15, 17.5 Desirable¤¤	HDM §2.7.1.1J; BM §2.4.1, Table 2-2
11	Pavement Cross Slope	1.5% min; 2% max	HDM §2.7.1.1K
12	Maximum Rollover Between Lanes At edge of Traveled Way	 4% 8%	HDM §2.7.1.1L
13	Structural Capacity Rehabilitation* Replacement**	 HS20, H25 Desirable HL93, NYSDOT Design Permit Vehicle	HDM §2.7.1.1M; BM §2.6; TSDM §2.1
14	Minimum Level of Service	Higher than General-Use lanes, not less than C	HDM §24.2.3.3
15	Control of Access	Designated Ingress/Egress Locations	HDM §24.2.7.3
16	Pedestrian Accommodation	Prohibited	NYS Highway Law, Article 1, §3.2
17	Minimum Median Width (feet)	22	HDM §24.2.7.2, Figure 24-13b

^ Concurrent BRT lane standards are governed by those of the adjoining Thruway mainline.
^^ Buffer widths between 4 feet and 10 feet are not deemed appropriate.
* Structure Rehabilitation excludes deck replacement.
** Structure Replacement includes new, reconstruction, and superstructure replacement
¤ Allow 6" additional for future resurfacing. 16.5' Desirable per TSDM §1.8.1.
¤¤ The 17.5' desirable vertical clearance for Ped Bridges & OH Structures & Signs is based on TSDM Sec 1.8.2

Table A-3

Busway Geometric Standards

	Element	Standard Criteria			Source
		Single Lane One-Way	Barrier Separated Two-Way	Undivided Two-Way	
1	Design Speed (mph)	70	70	45	HDM §24.2.3.2, §24.2.6
2	Minimum Lane Width (feet)	12 , 11 with documentation	12 , 11 with documentation	12 , 11 with documentation	HDM §24.2.6.2 Figs. 24-11, a, b
3	Minimum Shoulder Width (feet) Left Right Enforcement Area	2, 4 Des. 8, 10 Des. 14	2, 4 Des. 8, 10 Des. 14	- 8, 10 Des. 14	HDM §24.2.6.2 Figs. 24-11, a, b
4	Minimum Bridge Roadway Width (feet)	Match Busway width	Match Busway width	Match Busway width	BM §2.3.1, Table 2-1 TSDM
5	Maximum Grade [Rolling]	4%	4%	7%	HDM §2.7.1.1E, Exhibit 2-2; HDM §2.7.2.2E, Exhibit 2-4
6	Horizontal Curvature, Min. Radius (feet) @e=8% @e=6% Undivided @e=4%	1810 2040	1810 2040	 711	HDM §2.7.1.1F, Exhibit 2-2; HDM §2.7.2.2F, Exhibit 2-4
7	Maximum Superelevation Rate	8%, 6% allowed in urban/suburb areas	8%, 6% allowed in urban/suburb areas	4%	HDM §2.7.1.1G, §2.7.2.2G
8	Minimum Stopping Sight Distance (feet)	730	730	360	HDM §2.7.1.1H, Exhibit 2-2; HDM §2.7.2.2H, Exhibit 2-4
9	Minimum Horizontal Clearance (feet) Without Barrier/Rail With Barrier/Rail	 15 Shoulder width (not less than 4)	 15 Shoulder width (not less than 4)	 15 Shoulder width (not less than 4)	HDM §2.7.1.1I
10	Minimum Vertical Clearance (feet)	14, 14.5 Desirable	14, 14.5 Desirable	14, 14.5 Desirable	HDM §2.7.1.1J, §2.7.2.2J; BM §2.4.1, Table2-2
11	Pavement Cross Slope	1.5% min; 2% max	1.5% min; 2% max	1.5% min; 2% max	HDM §2.7.1.1K, §2.7.2.2K
12	Maximum Rollover Between Lanes At edge of Traveled Way	 4% 8%	 4% 8%	 4% 8%	HDM §2.7.1.1L, §2.7.2.2L
13	Structural Capacity	HL-93, NYSDOT Design Permit Vehicle	HL-93, NYSDOT Design Permit Vehicle	HL-93, NYSDOT Design Permit Vehicle	HDM §2.7.1.1M, §2.7.2.2M; BM §2.6, TSDM §2.6.1, 2.6.2
14	Minimum Level of Service	Higher than General Use lanes, not less than C	Higher than General Use lanes, not less than C	Higher than General Use lanes, not less than C	HDM §24.2.3.3
15	Control of Access	Full	Full	Full	HDM §2.7.1.1O
16	Pedestrian Accommodation	At Stations	At Stations	At Stations	ADAAG
17	Minimum Median Width (feet)	NA	10	NA	HDM §24.2.6.2 Figure 24-11a, b

Prototypical Buses – Standard - 8.5 feet wide by 10 feet high by, 30, 35, 40 feet long
Articulated - 60 feet long
Double articulated – 80 feet long

Table A-4

Concurrent On-Street Bus Lane Geometric Standards

	Element	Indicative Criteria Urban Arterials	Indicative Criteria Local Streets	Source
1	Design Speed (mph)	60	30	HDM §24.4.1.1; HDM §2.7.2.2A (Urban Arterials); HDM §2.7.4.2 A(Local Streets)
2	Minimum Lane Width (feet)	11, 12 Desirable	11, 12 Desirable	HDM §24.4.2.3; AASHTO HOV Guide
3	Minimum Shoulder Width (feet)	5	5	HDM §2.7.2.2C, Exhibit 2-4 ; HDM §2.7.4.2C, Exhibit 2-8; AASHTO HOV Guide
4	Minimum Bridge Roadway Width (feet)	Match approach highway	Match approach highway	BM §2.3.1 Table 2-1; TSDM
5	Maximum Grade [Rolling]	6%	8%	HDM §2.7.2.2E, §2.7.4.2E
6	Horizontal Curvature, Minimum Radius @e=4% (feet)	1500	250	HDM §2.7.2.2F, Exhibit 2-4 ; HDM §2.7.4.2F, Exhibit 2-8
7	Maximum Superelevation Rate	4%	4%	HDM §2.7.4.2G
8	Minimum Stopping Sight Distance (feet)	570	200	HDM §2.7.2.2H, Exhibit 2-4 ; HDM §2.7.4.2H, Exhibit 2-8
9	Minimum Horizontal Clearance (feet) Without Barrier/Rail With Barrier/Rail	1.5, 3 at intersections 0	1.5, 3 at intersections 0	HDM §2.7.2.2I, §2.7.4.2I
10	Minimum Vertical Clearance (feet)	14, 14.5 Desirable	14, 14.5 Desirable	HDM §2.7.2.2J, §2.7.4.2J; BM §2.4.1, Table 2-2
11	Pavement Cross Slope	1.5% min, 2% max	1.5% min, 2% max;	HDM §2.7.4.2K
12	Maximum Rollover Between Lanes At edge of Traveled Way	 4% 8%	 4% 8%	HDM §2.7.4.2L
13	Structural Capacity Rehabilitation* Replacement**	HS20, HS25 Des. HL-93, NYSDOT Design Permit Vehicle	HS20, H25 Des. HL-93, NYSDOT Design Permit Vehicle	HDM §2.7.2.2M, §2.7.4.2M; BM §2.6
16	Pedestrian Accommodation	At Stations/Stops	At Stations/Stops	HDM §2.7.2.2N; HDM Ch 18; ADAAG

* Structure Rehabilitation excludes deck replacement.
** Structure Replacement includes new, reconstruction, and superstructure replacement

Prototypical Buses – Standard - 8.5 feet wide by 10 feet high by, 30, 35, 40 feet long
Articulated - 60 feet long
Double articulated – 80 feet long.

Table A-5

Key Railroad Geometric Requirements

	Element	Standard Criteria	Source
1	Design Speed (mph)	90	MNR MW4 57.1(C) i
2	Gage (inches)	56.5	AREMA 2.1.1.4a; MNR MW4 53.0(C)
3	Maximum Grade Compensated Gradient Adjustment	1.5%, 2% for short distances 0.04% per Degree of Curve	MNR MW4 62.0(C); AREMA 5.3.7.1
4	Maximum Superelevation (inches)	5	MNR MW4 57.0(C)
5	Maximum Superelevation Unbalance (inches)	3	MNR MW4 57.0(C)
6	Minimum Horizontal Curvature	1°30'	AREMA 5.3.3.1g Table 5.3.2
7	Length of Spiral (feet)	As determined by using the greatest length obtained from the formulas in subsection (j)	MNR MW4 57.4(C)
8	Minimum Vertical Curve Length (feet)	L = (D x V² x 2.15)/0.6 [D= % grade change, V=speed (mph)]	AREMA 5.3.6, Passenger Lines; MNR MW4 62.4(C)
9	Minimum Horizontal Clearance (feet)	9 from track center, AREMA 8.5 from track center, NYS Law 25 without crash wall	AREMA figure 28.1.1 NYS Railroad Law §51-a.2; BM 2.5.3, Figure 2.6
10	Minimum Vertical Clearance (feet) (see attached Fig. 28-1-1)	23 above rail, AREMA 22 above rail, NYS Law	AREMA Figure 28-1-1; NYS Railroad Law §51-a.1; BM 2.5.3, Figure 2.5
11	Minimum Track Centers Separation (feet)	14, tangent 13.5 NYS Law	MNR MW4 62.1(C); NYS Railroad Law §51-a.4 ;
12	Structure Live Load	Cooper E80	AREMA 8.2.2.3c, 15.1.3.3a
13	Electrification	Bottom Contact 3rd Rail	MNR drawing SP-101
14	Safety Walkways (feet) 1. Walking Surface 2. 56" Above Walking Surface (Headroom) 80"Above Walking Surface (Headroom)	 24 30 24	NFPA130, 6.2.1.11 Egress for Passengers NFPA 130,6.3 Construction Material
15	Tunnels Min. Horizontal Clearance (feet) Min. Vertical Clearance (feet) Max. emergency egress spacing (feet) Single bore To fire-walled refuge	 9 from track center, AREMA 8 from track center, NYS Law 23 above rail, AREMA 2500 800	 AREMA Figures Single Track 28-1-3, Double Track 28-1-4; NYS Railroad Law §51-a.2 AREMA Figures 28-1-3, 28-1-4 NFPA 130 6.2.2.2 NFPA 130 6.2.2.3.2
16	Tunnel Ventilation Design fire load (Megawatt) Exhaust Purge Rate	As determined by the greatest criteria developed from the model	NFPA 130 NFPA 502 ASHRAE (2007) for Tunnel Ventilation

Exhibit 2-9 Traveled Way Widths for Ramps and Turning Roadway

Radius on Inner Edge of Traveled Way, R (ft.)	Traveled Way Width (ft.)												
	Case I One-lane, One- way Operation – No Provision for Passing a Stalled Vehicle				Case II One-lane, One-way Operation- With Provision for Passing a Stalled Vehicle				Case III Two-Lane Operation - Either One-Way or Two-Way				
	Design Traffic Condition [1]												
	A	B	C	D	A	B	C	D	A	B	C	D1	D2
50	18	18	23	29	23	25	29	49	31	35	42	60	99
75	16	17	19	26	21	23	27	45	29	33	37	36	54
100	15	16	18	26	20	22	25	42	28	31	35	35	49
150	14	16	17	24	19	21	24	37	27	30	33	33	38
200	13	16	16	21	19	21	23	35	27	29	31	31	32
300	13	15	16	19	18	20	22	31	26	28	30	30	30
400	13	15	16	18	18	20	22	29	26	28	29	29	29
500	12	15	15	18	18	20	22	27	26	28	29	29	29
Tangent (≥ 1000 ft.)	12	15	15	15	17	19	21	21	25	27	27	27	27
Width Modification Regarding Edge of Traveled Way Treatment:													
No Stabilized Shoulder	None				None				None				
Sloped Curb	None				None				None				
Vertical-Faced Curb (adj. to traveled way) One Side	Add 1 ft.				None				Add 1 ft.				
Two Sides	Add 2 ft.				Add 1 ft.				Add 2 ft.				
Stabilized Shoulder, One or Both sides	Lane width for conditions B & C on tangent may be reduced to 12 ft. where combined shoulder is 4 ft. or wider				Deduct combined right and left shoulder width; use minimum travel lane width as under Case I				Deduct 2 ft. where either shoulder is 4 ft. or wider				

Note:

1. The design traffic conditions are defined:

A Predominantly P vehicles, but some consideration for SU trucks. Accommodates occasional WB 40 trucks.

B Sufficient SU vehicles to govern design, but some consideration for semitrailer vehicles. Generally SU plus semitrailer vehicles = 5 to 10% of the total traffic volume. Accommodates occasional WB 40 trucks.

C Sufficient bus and combination-types of vehicles to govern design (over 10% of total traffic volume). Accommodates occasional WB 50 trucks.

D Use on ramps and turning roadways with a WB 65 design vehicle (e.g., ramps connecting to Qualifying Highways on the national network of Designated Truck Access Highways 1982 STAA highways)). Values are from Exhibit 3-50 of AASHTO's *A Policy on Geometric Design of Highways and Streets*, 2004. Design Traffic Condition D values are reduced by as much as 2 ft. for Case I and as much as 4 ft. for Cases II & III to account for reduced lateral clearance allowed for turning roadways with a combination of large vehicles and sharp radii. Case I, Design Traffic Condition D assumes WB 65 vehicle with no provision for passing a stalled passenger vehicle. Case II, Design Traffic Condition D assumes WB 65 passing P vehicle.

D1/ D2 For Case III, use Condition D1 for one-way, two-lane ramps and Condition D2 for two-way, two-lane ramps. Case III, Design Traffic Condition D1 assumes passenger car overtaking a WB 67 vehicle. Case III, Design Traffic Condition D2 assumes opposing WB 67 vehicles.

Exhibit M2-9 Traveled Way Widths for Ramps and Turning Roadways

Radius on Inner Edge of Traveled Way, R (m)	Traveled Way Width (m)												
	Case I One-lane, One- way Operation - No Provision for Passing a Stalled Vehicle				Case II One-lane, One-way Operation- With Provision for Passing a Stalled Vehicle				Case III Two-Lane Operation - Either One-Way or Two-Way				
	Design Traffic Condition [1]												
	A	B	C	D	A	B	C	D	A	B	C	D1	D2
15	5.4	5.5	7.0	15.1	6.0	7.8	9.2	16.6	9.4	11.0	13.6	18.4	30.1
25	4.8	5.0	5.8	8.4	5.6	6.9	7.9	9.6	8.6	9.7	11.1	11.4	16.6
30	4.5	4.9	5.5	7.5	5.5	6.7	7.6	8.7	8.4	9.4	10.6	10.6	14.8
50	4.2	4.6	5.0	5.9	5.3	6.3	7.0	7.0	7.9	8.8	9.5	9.5	11.5
75	3.9	4.5	4.8	5.3	5.2	6.1	6.7	6.7	7.7	8.5	8.9	8.9	9.9
100	3.9	4.5	4.8	5.3	5.2	5.9	6.5	6.5	7.6	8.3	8.7	8.7	9.2
125	3.9	4.5	4.8	5.3	5.1	5.9	6.4	6.4	7.6	8.2	8.5	8.5	8.7
150	3.6	4.5	4.5	5.3	5.1	5.8	6.4	6.4	7.5	8.2	8.4	8.4	8.4
Tangent (>300 m)	3.6	4.2	4.2	4.2	5.0	5.5	6.1	6.1	7.3	7.9	7.9	7.9	7.9
Width Modification Regarding Edge of Traveled Way Treatment:													
No Stabilized Shoulder	None				None				None				
Sloped Curb	None				None				None				
Vertical-Faced Curb (adj. to traveled way) One Side	Add 0.3 m				None				Add 0.3 m				
Two Sides	Add 0.6 m				Add 0.3 m				Add 0.6 m				
Stabilized Shoulder, One or Both sides	Lane width for conditions B & C on tangent may be reduced to 3.6 m where combined shoulder is 1.2 m or wider				Deduct combined right and left shoulder width; use minimum travel lane width as under Case I				Deduct 0.6 m where either shoulder is 1.2 m or wider				

Note:

1.The design traffic conditions are defined:

A. Predominantly P vehicles, but some consideration for SU trucks. Accommodates occasional WB 12 trucks.

B Sufficient SU vehicles to govern design, but some consideration for semitrailer vehicles. Generally SU plus semitrailer vehicles = 5 to 10% of the total traffic volume. Accommodates occasional WB 12 trucks.

C Sufficient bus and combination-types of vehicles to govern design (over 10% of total traffic volume). Accommodates occasional WB 15 trucks.

D Use on ramps and turning roadways with a WB 20 design vehicle (e.g., ramps connecting to Qualifying Highways on the national network of Designated Truck Access Highways (1982 STAA highways)). Values are from Exhibit 3-54 of AASHTO's *A Policy on Geometric Design of Highways and Streets*, 2004. Design Traffic Condition D values are reduced by as much as 0.6 m for Case I and as much as 1.2 m for Cases II & III to account for reduced lateral clearance allowed for turning roadways with a combination of large vehicles and sharp radii. Case I, Design Traffic Condition D assumes WB 20 vehicle with no provision for passing a stalled passenger vehicle. Case II, Design Traffic Condition D assumes WB 20 passing P vehicle.

D1/ D2 For Case III, use Condition D1 for one-way, two-lane ramps and Condition D2 for two-way, two-lane ramps. Case III, Design Traffic Condition D1 assumes passenger car overtaking a WB 20 vehicle. Case III, Design Traffic Condition D2 assumes opposing WB 20 vehicles.


environment

Appendix B

BRT Alignment Options in White Plains


environment

B BRT Alignment Options in White Plains

Several options exist for BRT routes through downtown White Plains (Figure B-1). The alignment options use dedicated lanes on existing streets for the BRT operation, crossing streets at grade, and using priority traffic signals. The options consider various combinations of portions of Hamilton Avenue, Main Street, and Martine Avenue, plus appropriate connector streets. At Broadway both alignments would circle Tibbits Park and rejoin on Westchester Avenue. In addition to the BRT station at the White Plains Transportation Center, two additional BRT stations are proposed in downtown White Plains, with possible locations at the Galleria Mall and the Westchester Mall.

B.1 Traffic Analysis Methodology

A study of traffic issues was performed to determine the expected performance of BRT operations on key routes in downtown White Plains. The analyses included the following:

- The physical and operational characteristics of streets and intersections in the study area were determined through field inventories, supplemented by aerial and ground photography. Condition diagrams of each intersection, and of each street segment, showing number of lanes by lane usage, parking conditions, width restrictions, unusual curb activity, and related items were prepared.
- Examination of operational conditions in the study area revealed several issues that might affect BRT operation on the street system.
- Local bus activity on each street segment was determined using information from Westchester County web sites. Local bus routings through downtown streets were annotated on the GIS route map, and bus schedules were used to summarize AM and PM peak hour bus frequencies on each street segment for each route. The total frequencies per hour were divided by 60 to determine frequencies per minute, and then that number was doubled to account for bunching (scheduled or operational). The highest quantity seen was 1.3 (buses per minute) on a segment of Main Street.
- In addition, the proposed BRT total frequency was determined (29 per hour in the AM and 26 per hour in the PM). Therefore, if the BRT would use Main and Martine Avenues (and not replace currently operating buses), the highest total (local bus plus BRT) per minute bus frequency on a street segment would be 1.8 buses per minute.
- An analysis of traffic flow conditions was conducted for the No Build condition (no BRT buses added) for 2005 and for 2035.
- AM and PM peak hour traffic volumes for each intersection were determined from available counts. Volumes were tabulated for each intersection approach, including turning movements. These volumes were projected to the design year (2035) using a single study area growth factor as utilized by Westchester County (25 percent growth). Current signal timing for each intersection was used for current and future analyses.
- Traffic conditions were analyzed for the weekday 8-9 AM and 5-6 PM peak hours. These hours represent the highest levels of vehicular demand on the White Plains downtown street system.
- Measures of flow quality, including level of service, volume/capacity (v/c) ratios, and delay, were calculated for each intersection approach.

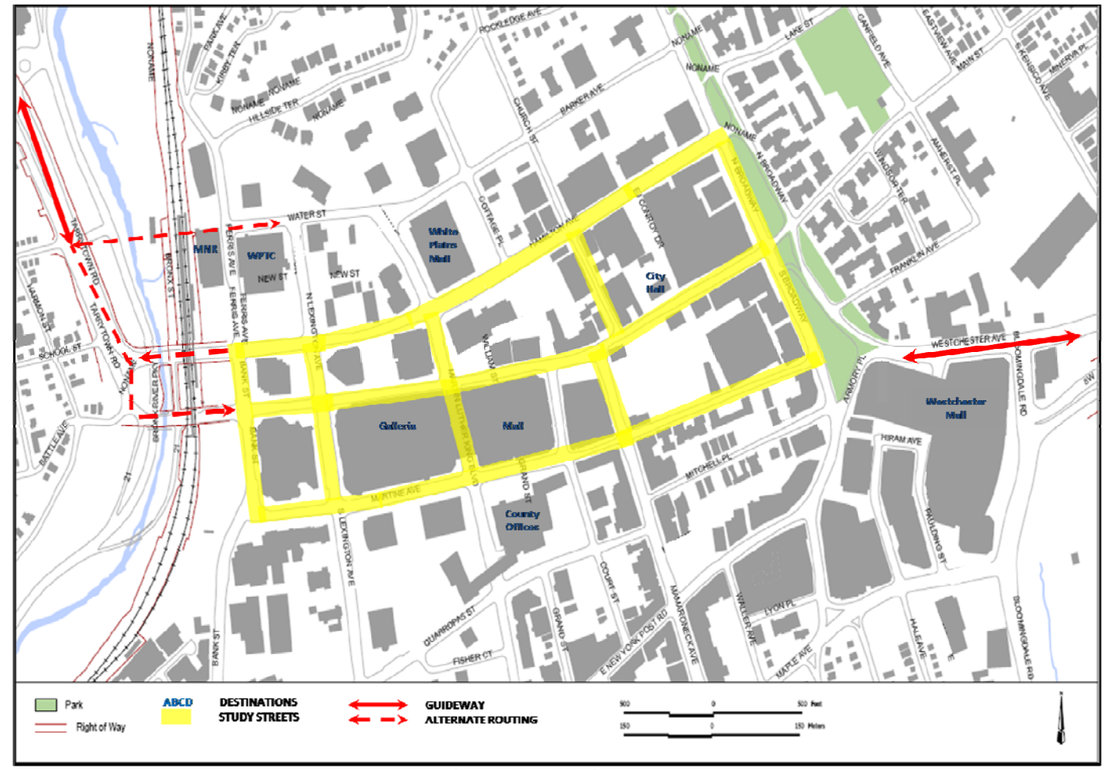


Figure B-1 Study Area

B.1 Summary of Existing Traffic Conditions

Existing traffic conditions were established for 2005 based on manual turning movement count and automatic traffic recording data. Using the regional travel demand model, it was estimated that traffic volumes in downtown White Plains will increase by about 25 percent over the 30-year period from 2005 to 2035. Therefore the 2005 traffic volumes were increased by 25 percent to bring them up to 2035 conditions.

The key intersections selected for analysis are along two streets: Main Street and Hamilton Avenue. These are the east-west streets in downtown White Plains on which BRT routes will most likely operate. Eleven intersections were analyzed for the AM and PM peaks:

- Main St / Bank St
- Main St. / Lexington Ave
- Main St. / Martin Luther King/Grove St.

- Main St. / Court St.
- Main St. / Church/Mamaroneck Ave.
- Main St. / Broadway SB
- Hamilton Ave. / Broadway SB
- Hamilton Ave. / Church St.
- Hamilton Ave. / Martin Luther King/Grove St.
- Hamilton Ave. / Lexington
- Hamilton Ave. / Bank St. / Ferris Ave.

Main Street is the principal eastbound roadway providing access through the White Plains business district connecting Tarrytown Road on the west to Broadway and Westchester Avenue to the east. West of Lexington Avenue, Main Street has four through travel lanes. It narrows to three travel lanes from Lexington Avenue to Broadway. Curbside parking is prohibited on both sides of Main Street west of Church Street and is permitted on both sides from Church Street to Broadway. Parking pull-outs are provided for short term parking and for passenger drop-off at the Galleria Mall between Lexington Avenue and Court Street. Traffic volumes on Main Street range from 1,050 to 4,070 vehicles per hour (veh/hr) in the AM peak hour and from 1,300 to 2,550 veh/hr in the PM peak hour.

Hamilton Avenue is an east-west street with two-directional traffic on the east from Martin Luther King Boulevard to Broadway and one-way (westbound) traffic to the west of Martin Luther King Boulevard. As with Main Street, Hamilton Avenue connects Tarrytown Road on the west with Broadway and Westchester Avenue on the east and serves as the westbound corridor through downtown White Plains. Through travel lanes vary between four and five. Curbside parking is prohibited on both sides west of Church Avenue and permitted on both sides from Church Avenue to Broadway. Traffic volumes on Hamilton Avenue range from 1,230 to 2,200 veh/hr in the AM peak hour and from 2,000 to 2,770 in the PM peak hour.

Traffic conditions at study area intersections were analyzed using Highway Capacity Manual procedures. Quality of flow is expressed in terms of level of service (LOS), which is based on the estimated average amount of delay that a driver experiences at an intersection. The LOS ranges from A, with minimal delay, to F, which represents long delays and congestion. Table B-1 shows the estimated delays and LOS for the signalized intersections for the 2005 Existing and 2035 No-build conditions. The conclusions are:

- All intersections operate at good LOS (C or better) in the 2005 AM peak hour. In the 2005 PM peak hour 10 intersections operate with good LOS and one (Hamilton Ave/Bank St.) has LOS of D.

- In the 2035 No-Build condition, two intersections on Hamilton Avenue are expected to operate with LOS D during the AM peak hour, and two intersections on Main Street are expected to operate with LOS D or E. The intersection of Main Street and Lexington Avenue is expected to operate at LOS F in AM peak hour in the 2035 No-build condition.

- All intersections on Main Street are expected to operate with good LOS in the PM peak hour in the 2035 No-build condition with the exception of Main Street and Broadway where the proposed LOS drops to D. On Hamilton Avenue, three intersections are expected to operate at a good LOS. Two intersections – Hamilton/Broadway and Hamilton/Bank – are expected to operate with LOS D and F, respectively.

Table B-1

Peak Hour Traffic Flow Condition 2005 Existing and 2035 No-Build

Intersection		2005 AM Existing		2035 AM No-Build		2005 PM Existing		2035 PM No-Build	
		Delay*	LOS	Delay*	LOS	Delay*	LOS	Delay*	LOS
1	Main St / Bank St	19.4	B	60.7	E	20.3	C	26.2	C
2	Main St. / Lexington Ave	29.3	C	80.1	F	18.9	B	31.4	C
3	Martin Luther King/Grove St. Main St.	22.0	C	45.1	D	20.6	C	29.6	C
4	Court St. Main St.	9.9	A	10.8	B	10.5	B	18.5	B
5	Church/Mamaroneck Ave. Main St.	12.2	B	16.3	B	16.1	B	28.8	C
6	Broadway SB Main St.	20.4	C	29.1	C	26.0	C	43.5	D
7	Hamilton Ave. / Broadway SB	25.6	C	36.2	D	28.0	C	49.9	D
8	Hamilton Ave. / Church St.	12.3	B	18.2	B	12.6	B	20.9	C
9	Hamilton Ave. / Martin Luther King/Grove St.	19.6	B	35.5	D	20.1	C	27.0	C
10	Hamilton Ave. / Lexington	15.8	B	18.6	B	20.2	C	28.4	C
11	Hamilton Ave. / Bank St. / Ferris Ave.	18.8	B	20.4	C	43.2	D	116.7	F

* Average peak hour Intersection delay in sec/veh.

B.2 Proposed BRT Options

Two proposed BRT alignments – called Option 1 and 6 in this analysis – were subjected to further analysis (Figures B-2 and B-3).

Option 1 would utilize the combination of Main Street and Hamilton Street. The eastbound BRT service starts at the Transit Center, proceeds south on Lexington to Main, and then eastbound on Main to Broadway. It follows Broadway south to Westchester Avenue, and thence eastward out of White Plains. Westbound service enters downtown on Broadway, proceeds northbound to Hamilton, and continues westbound on Hamilton to Martin Luther King Boulevard. It turns onto Water Street to the Transit Center.

It is assumed that this option takes a dedicated lane in each direction throughout, and that mixed traffic will be constrained to one less through lane than is presently available. It is anticipated that some level of transit signal prioritization will be implemented, but the frequency of transit service on these city streets is such that the effect of prioritization on street traffic will be minimal.

Option 6 is similar, but utilizes Hamilton Avenue for both directions of service, in place of using Main Street. The eastbound BRT service starts at the Transit Center, proceeds south on Lexington to Hamilton, and then eastbound on Hamilton to Broadway. It follows Broadway south to Westchester Avenue, and thence eastward out of White Plains. Westbound service enters downtown on Broadway, proceeds northbound to Hamilton, and continues westbound on Hamilton to Martin Luther King Boulevard. It turns onto Water Street to the Transit Center. BRT operates in the two center lanes of Hamilton Avenue from Martin Luther King Boulevard to Broadway. Eastbound service runs in one center lane between Lexington and Martin Luther King Boulevard.

As with Option 1, it is assumed that this option takes a dedicated lane in each direction throughout, and that mixed traffic will be constrained to one less through lane than is presently available. It is anticipated that some level of transit signal prioritization will be implemented, but the frequency of transit service on these city streets is such that the effect of prioritization on street traffic will be minimal. An additional traffic signal phase is allocated to BRT bus movement at intersections of Hamilton/Lexington and Hamilton/Martin Luther King Boulevard to accommodate BRT turning movements to and from Hamilton Avenue.

In Option 6, a BRT midblock stop is proposed on Hamilton Avenue either between Martin Luther King Boulevard and Renaissance Square, or one block east between Renaissance Square and Church Street. The proposed bus stop will be located near the entrance to the White Plains Mall and service shoppers as well at business activities. To reduce the effect of pedestrian crossing time on adjacent intersections and promote safety, a mid-block signal should be considered. The signal would be coordinated with signals at adjacent intersections.

For safe passenger boarding/alighting, a 12-foot refuge island is required for BRT operation in the center of Hamilton Avenue. To accommodate center BRT lanes, the width of the mixed traffic travel lanes on Hamilton Avenue are expected to be reduced from the current 12 foot width to 11 feet at intersections and to 10 feet adjacent to the mid-block bus stop.

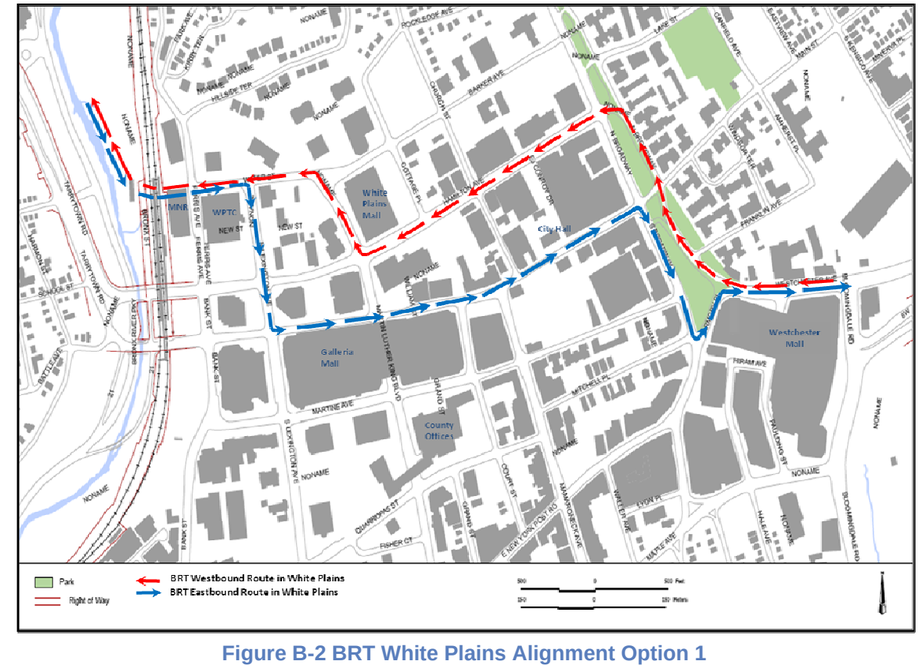


Figure B-2 BRT White Plains Alignment Option 1

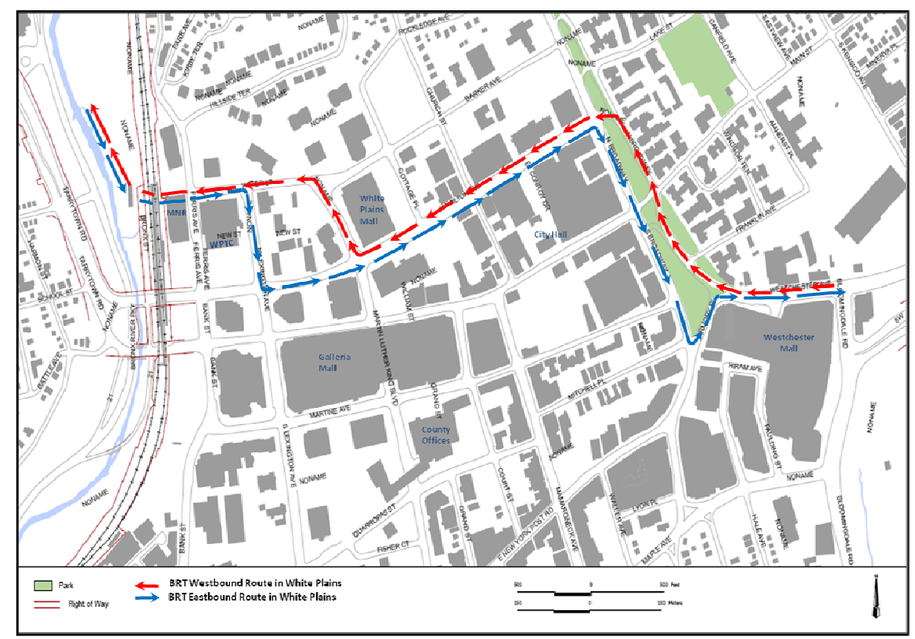


Figure B-3 BRT White Plains Alignment Option 6

B.3 Summary of Option 1 and 6 Traffic Conditions

The proposed BRT options will affect Main Street and Hamilton Avenue by removing one travel lane in the eastbound and westbound direction respectively. Table B-2 shows results of the traffic analysis for both options.

Table B-2

Traffic Flow Condition 2035 BRT Option 1 and BRT Option 6

	Intersection	2035 AM BRT1		2035 AM BRT6		2035 PM BRT1		2035 PM BRT6	
		Delay*	LOS	Delay*	LOS	Delay*	LOS	Delay*	LOS
1	Main St / Bank St	60.8	E	60.8	E	26.1	C	26.1	C
2	Main St. / Lexington Ave	156.9	F	80.2	F	114.0	F	31.4	C
3	Martin Luther King/Grove St. Main St.	61.1	E	45.3	D	54.1	D	29.5	C
4	Court St. Main St.	14.2	B	10.7	B	44.0	D	18.2	B
5	Church/Mamaroneck Ave. Main St.	17.5	B	16.4	B	30.8	C	28.9	C
6	Broadway SB Main St.	31.3	C	42.3	D	51.7	D	75.9	E
7	Hamilton Ave. / Broadway SB	37.0	D	70.2	E	60.5	E	95.2	F
8	Hamilton Ave. / Church St.	24.3	C	26.8	C	33.0	C	41.4	D
9	Hamilton Ave. / Martin Luther King/Grove St.	38.9	D	97.0	F	38.5	D	137.0	F
10	Hamilton Ave. / Lexington	21.0	C	23.7	C	37.7	D	68.7	E
11	Hamilton Ave. / Bank St. / Ferris Ave.	20.2	C	20.2	C	115.1	F	115.1	F

Note: * Average Peak Hour Intersection delay in sec/veh.

Option 1 implementation will cause two intersections on Main Street to operate with at LOS E in AM peak hour (Figure B-4). The intersection of Main Street and Lexington Avenue will have severe delays at LOS F. During the PM peak hour three intersections on Main Street will operate with LOS D (Figure B-5). The LOS at the intersection of Main Street and Lexington Avenue will decrease from C to F with extensive delays to traffic.

In the AM peak hour on Hamilton Avenue, two intersections will operate at LOS D as in the No-build condition. The LOS will significantly decrease during the PM with the westbound travel peaking on Hamilton Avenue. Reduction of one travel lane will make the intersections with Martin Luther King Blvd and Lexington Street operate at LOS D, the intersection with Broadway SB operate at LOS E, and create severe congestion at Bank Street with LOS F.

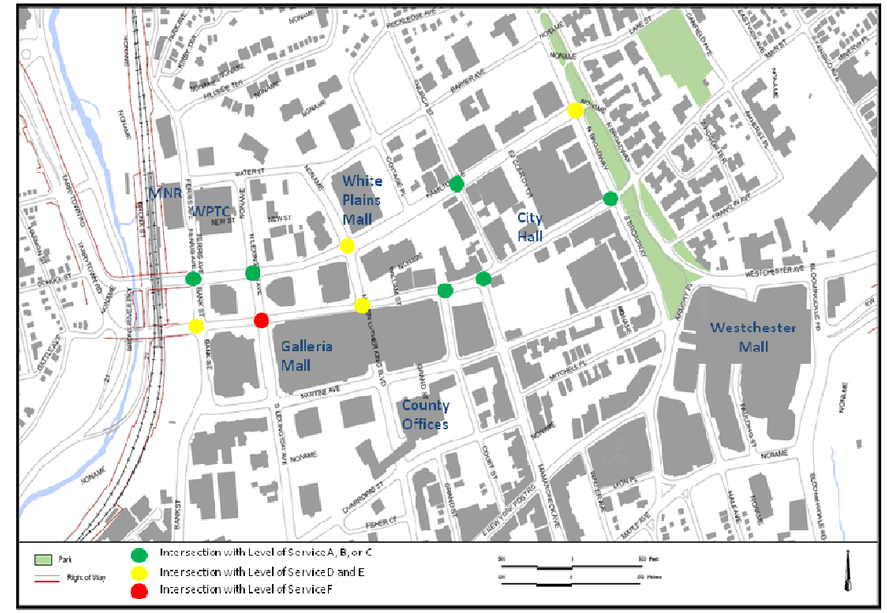


Figure B-4 BRT Option 1 Bus AM Operation Analysis

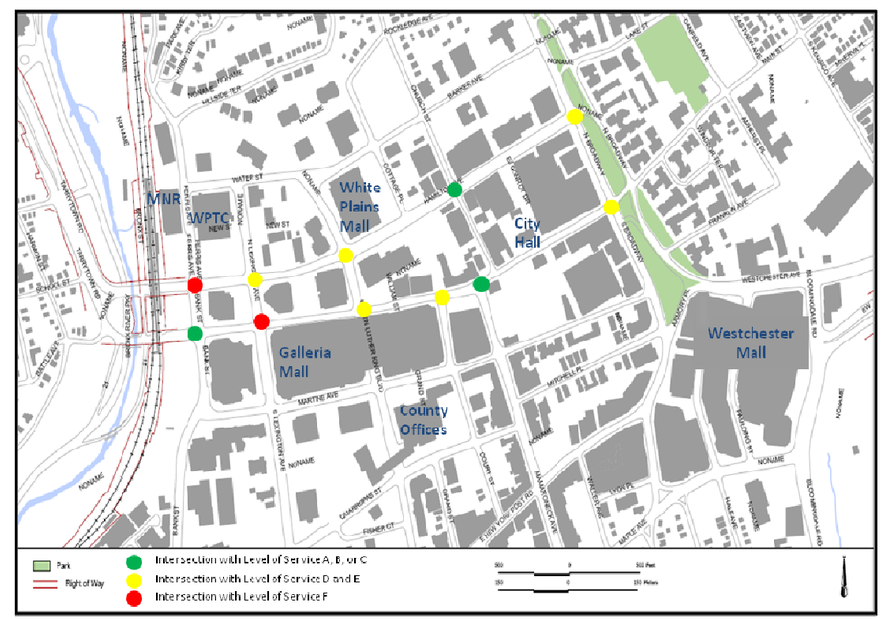


Figure B-5 BRT Option 1 Bus PM Operation Analysis

Option 6 will not affect traffic operation on Main Street west of Broadway since the BRT will be traveling east-west on Hamilton Avenue. During the AM peak hour one intersection on Hamilton Avenue will operate at LOS E and one at LOS F (Figure B-6). In the PM three intersections on Hamilton Avenue will operate with LOS F while capacity is reduced by two travel lanes taken for BRT running way (Figure B-7). One intersection will operate at LOS D and one at LOS E.

The intersection of Main Street and Broadway will be affected in Option 6 with the BRT running north-south bound on Broadway. The LOS at this intersection will be reduced to D and E in the AM and PM, respectively.

The intersections expected to be most affected are Hamilton/Lexington and Hamilton/Martin Luther King with significant degradation of LOS from No-Build condition.

Local buses utilize Martine Avenue to travel westbound and depart downtown White Plains. However, Martine Avenue has certain physical constraints that affect flow for buses as well as general traffic. Just west of Broadway, travel lanes are narrow, and parking is allowed on both sides of the street. Along Martine Avenue, turning movement accommodations frequently reduce the number of through lanes. Since this route is longer than Hamilton Avenue, a greater number of traffic signals are encountered, thereby also adding to total travel time. An exclusive lane treatment would not be feasible along Martine Avenue. For these and other reasons, earlier analyses directed further work away from use of Martine for BRT operation and towards use of Main Street and Hamilton Avenue.

B.4 Summary of Findings

Based on the above analyses a number of observations can be made:

1. The intersection of Main and Lexington demonstrates crucial failure under Option 1, with average delays of 156 seconds per vehicle in the morning and 114 seconds per vehicle in the evening peak hour. There is little opportunity for mitigation: there are insufficient lanes to accommodate both the BRT and the high volume of traffic (again, it is assumed that the BRT will occupy a dedicated lane). Traffic signal timing adjustments would not achieve the needed improvement. Option 6, by contrast, does not impact this intersection because it does not follow Main Street. This troublesome location is thus avoided.

2. Hamilton Avenue is a wider street than Main Street, and as a consequence has more capacity and flexibility to absorb the loss of a lane in each direction for mixed traffic, and to accommodate the additional bus and pedestrian activity associated with the BRT project. Option 6 makes more use of Hamilton by putting both directions of service onto it. In addition, other bus routes do not use Hamilton and so there is less potential conflict between BRT and conventional transit buses.

3. Option 6 also shows benefits over Option 1 at other intersections. Main Street intersections west of Broadway are not impacted at all by Option 6, which clearly would benefit local traffic circulation.

4. Option 6 does cause some degree of degradation to LOS on Hamilton Avenue. In AM and PM peak hours the effects of Option 6 are more pronounced than Option 1, with levels of service degrading into LOS F.

5. The increased delay at Broadway may be mitigated fairly easily since there apparently is space available to construct additional street space.

6. The intersection of Hamilton and Martin Luther King Boulevard is problematic, with little opportunity for widening or other traffic engineering improvements.

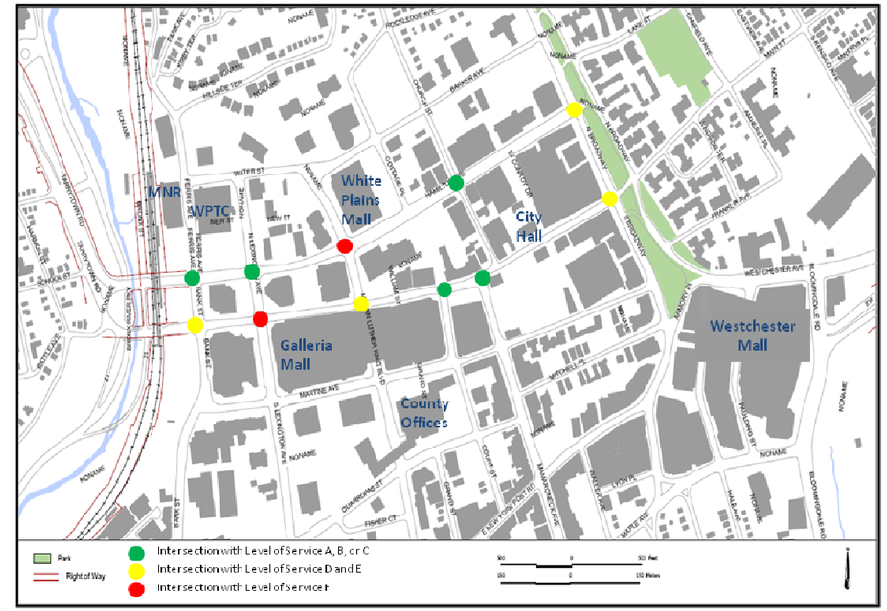


Figure B-6 BRT Option 6 Bus AM Operation Analysis

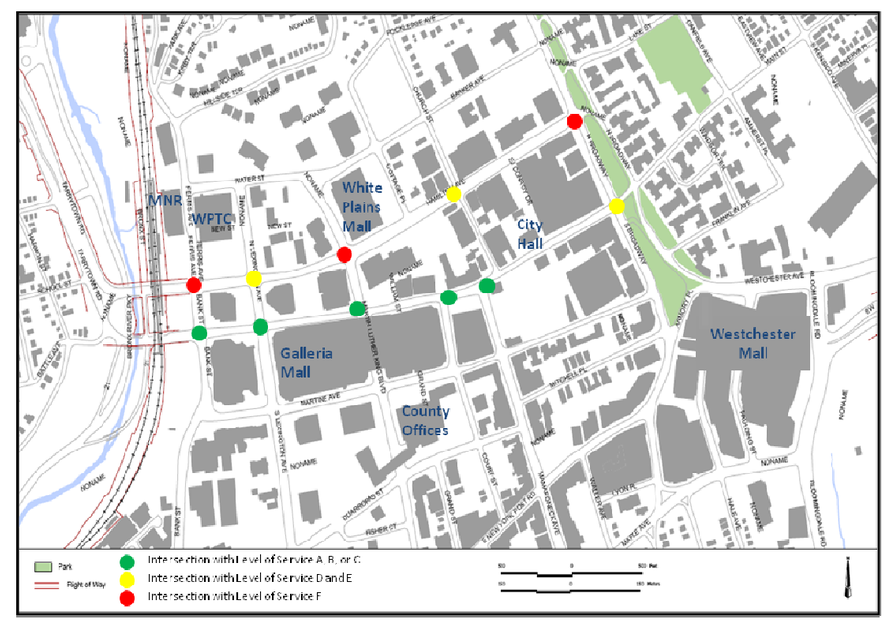


Figure B-7 BRT Option 6 Bus PM Operation Analysis

7. End to end, Option 6 provides a time advantage over Option 1 since it travels through fewer intersections and travels a shorter distance.

On balance, it appears that Option 6 has less impact on downtown White Plains street operations than does Option 1. In addition, the intersection impacts that result from the BRT implementation are generally manageable and acceptable in a downtown environment.