5 Transportation Evaluation

Transportation performance measures were developed to evaluate the various alternatives/options under study. Ridership was measured both on the proposed service itself and in the study area as a whole. Door-to-door time savings for a representative sample of transit trips, as well as an overall aggregate time savings measure, were developed. The alternatives/options were also evaluated in terms of their capacity, both with their planned service plans and the maximum capacity supported by the proposed infrastructure. Large-scale impacts on roadway traffic were measured in terms of volumes across the Hudson and total vehicle miles traveled (VMT).

The transportation analysis was based mainly on outputs of the Best Practice Model (BPM) developed by the New York Metropolitan Transportation Council (NYMTC). The analysis was based on a model year of 2035. In the EIS, a sub-area Paramics traffic microsimulation model will also be used to obtain more comprehensive and detailed traffic impacts.

5.1 Transportation Demand Modeling

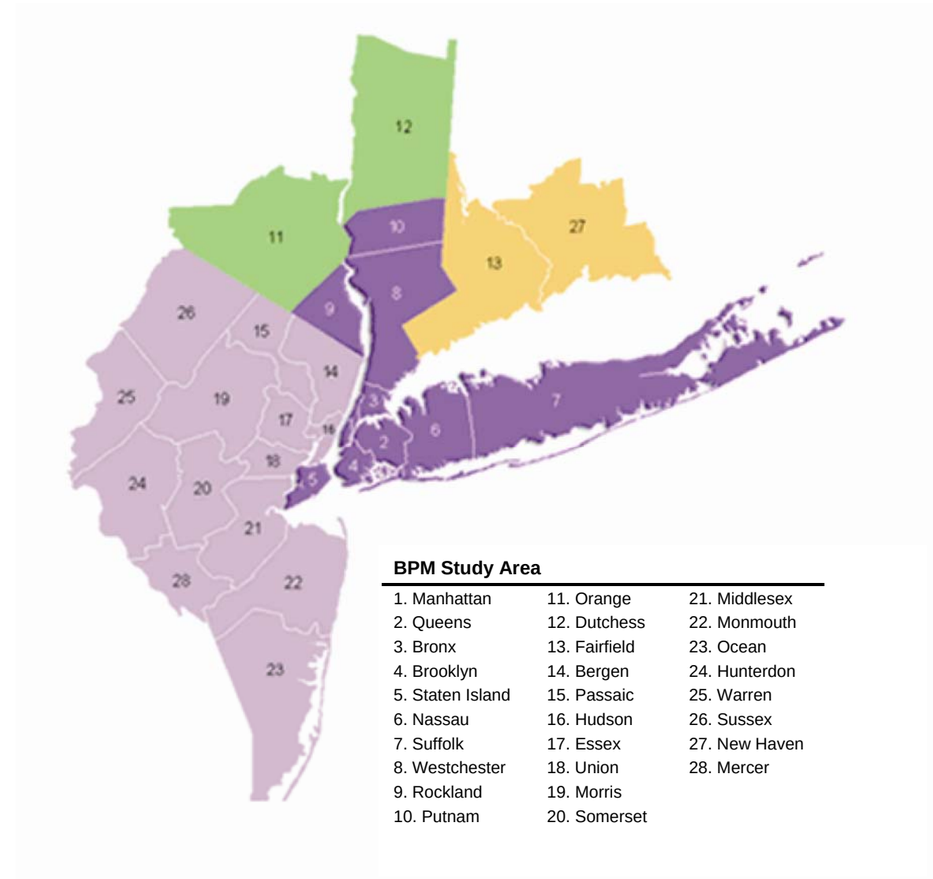
5.1.1 BPM Structure

BPM represents a state-of-the-art process for forecasting future urban travel based on assumptions regarding land use and transportation facilities and services. The model region consists of 28 counties in the New York Metropolitan Area, including 14 counties in northern New Jersey and two counties in southwestern Connecticut (Figure 5-1). The regional roadway network is represented in BPM with about 40,000 links. A separate transit network includes about 3,300 transit routes.

The counties are divided into 3,586 internal zones and 111 external stations (i.e., points where vehicles from outside the model area enter the model network). In Manhattan and other dense areas, the zones are typically equivalent to census tracts, and in some places are subdivisions of tracts. In the study area in Rockland County and Westchester County, several zones are composed of multiple tracts, and the tracts themselves are quite large. Figure 5-2 shows the BPM zone structure in the corridor.

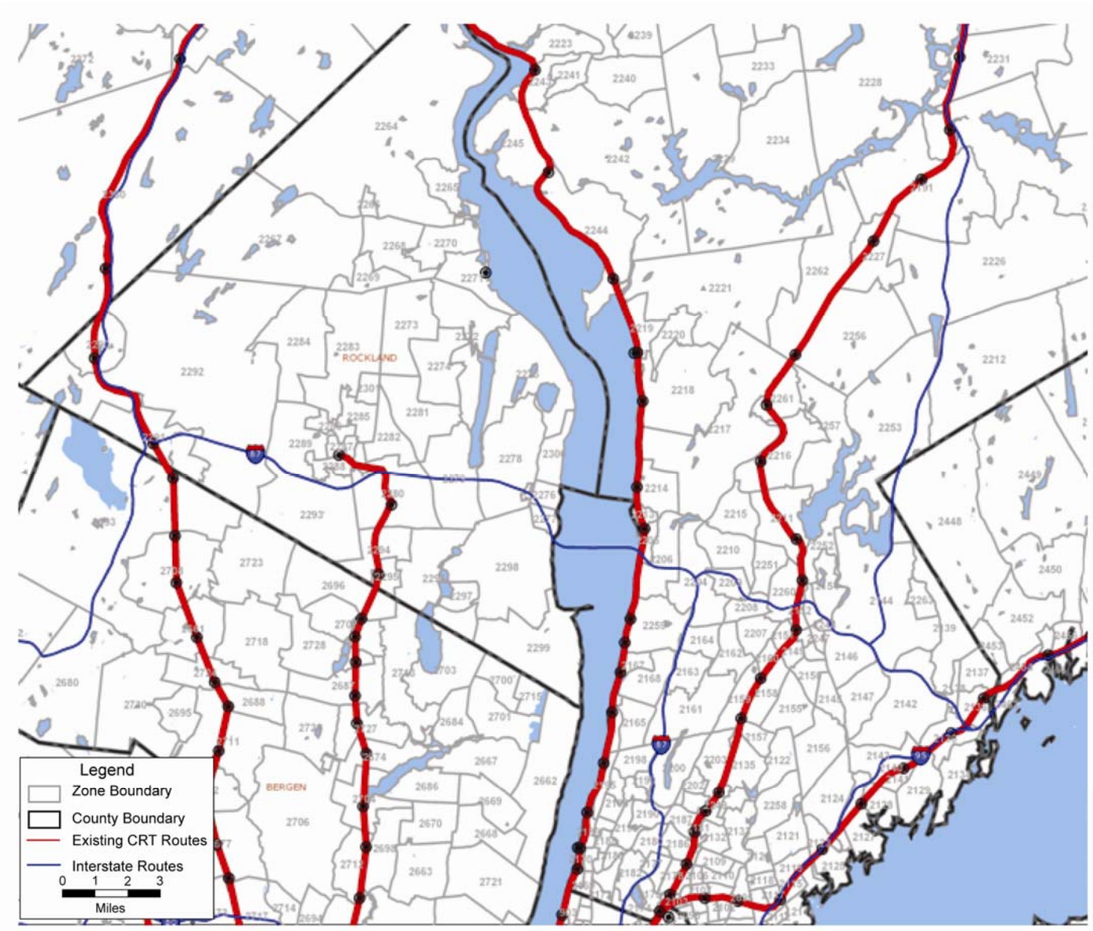
Demographic variables are prepared by NYMTC for each zone and are available for 1996, 2000, 2002, and five-year increments through 2030 (2035 forecasts are described below in Subchapter 5.1.2). These variables are:

- Household Population.
- Population in Group Quarters (Total).
- Population in Group Quarters (in institutions, i.e., college dormitories, prisons, etc.).
- Population in Group Quarters (street population).
- Population in Group Quarters (other).
- Number of Households.
- Average Household Size.
- Employed Labor Force (by place of residence).
- Median Household Income.



Source: NYMTC, January 30, 2005.

Figure 5-1 BPM Study Area



Source: New York Best Practice Model, 2007.

Figure 5-2 Zone Structure in the Corridor

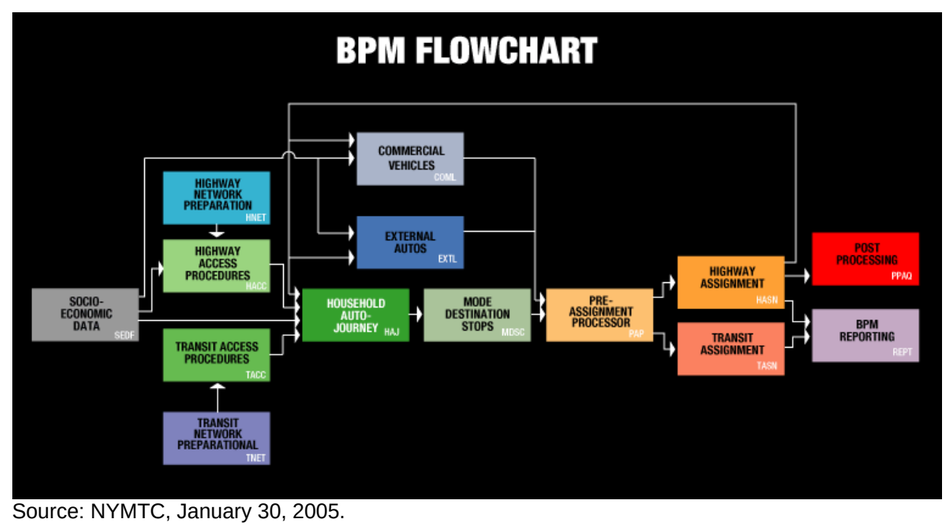
- Total Employment (by place of work).
- Retail Employment.
- Office Employment.
- Median Earnings of Employees.
- University Enrollment (by location of university).
- K-12 Enrollment (by location of school).

The model is structured as a series of modules (Figure 5-3). The outputs of each module are used as inputs to successive modules. Starting with the socioeconomic data for a given year, the Household Auto-Journey (HAJ) module generates a list of households and trip-makers with various characteristics for each zone. It then generates a list of typical weekday journeys by six different purposes:

- Work.
- School (K-12).
- University.
- Household maintenance.
- Discretionary activity.
- At-work journeys (i.e., office-to-office, lunch time trips).

The generation rates of each type of trip from each type of household are based on an extensive 1997 household survey conducted by NYMTC.

The destinations and modes of journeys are modeled in the BPM's "Mode Destination Stops Choice" (MDSC) module. The key variable in determining mode choice is the comparison of best paths by various modes – by commuter rail, by transit (i.e., subway and bus only) and by highway. These paths are expressed as matrices that describe the travel time and costs between any two zones by a given mode.



Source: NYMTC, January 30, 2005.

Figure 5-3 BPM Flow Chart

After those two modules are run, a "Pre-Assignment Processor" (PAP) creates a set of trip tables for highway and transit assignment by several modes for four time periods: AM Peak (6am-10am), Midday (10am-3pm), PM Peak (3pm-7pm) and Night (7pm-6am). Besides the outputs of the MDSC, additional inputs are used from modules that forecast commercial vehicles and external auto trips (i.e., auto trips with either origins or destinations outside the model area).

A separate trip table is prepared for each mode. The six highway modes are as follows:

- Drive Alone.
- Shared Ride-2/Taxi (a driver plus one passenger, or taxis).
- Shared Ride-3+ (a driver plus two or more passengers).
- External (autos with one or both trip ends outside of the BPM region).
- Truck.
- Other Commercial Vehicles.

In the mode-choice procedures, bus, subway and light rail are grouped as one mode[1], while any trip using commuter rail is in a separate commuter rail mode. (If a trip includes both bus and commuter rail, or both LRT and commuter rail, it is placed in the commuter rail category.) For both of these modes, there is a sub-division between those who drive to the first transit mode, and those who walk. Thus, the transit trip tables are divided into four modes:

- Commuter Rail (with transit feeder lines) with walk access.
- Commuter Rail with drive access.
- Other Transit (including bus, subway, light rail and ferry) with walk access.
- Other Transit with drive access.

Once the trip tables are in place, highway and transit assignments in BPM are similar to those in traditional models. The assignment process is capacity-restrained – trips are first assigned to the minimum time path, volumes are compared to capacities, speeds are adjusted, then traffic is reassigned in an iterative process. Weekend travel forecasts are not available for either transit or highway assignments. Transit assignments are only available for AM peak periods.

The BPM was delivered by NYMTC calibrated to 2002 baseline conditions. As part of the Tappan Zee Bridge/I-287 Environmental Review study, the project team updated the baseline to match 2005 conditions and then recalibrated the model to better match markets served by the corridor (NYSDOT et. al., June 10, 2008).

5.1.2 No Build

At the time of the transit mode analysis, NYMTC had not prepared official 2035 forecasts. Instead, a set of 2035 forecasts were developed for this project by extrapolating from 2025 to 2030 growth. Since then, NYMTC has released updated 2035 forecasts, which will be the basis of the EIS. Population and employment forecasts developed for the project are summarized in Table 5-1.

Table 5-1

Demographic Forecasts by County, 2005 and 2035

County	Population			Employment		
	2005	2035	Growth	2005	2035	Growth
Rockland	298,907	383,966	28%	106,336	139,428	31%
Orange	375,620	567,913	51%	136,723	197,317	44%
Westchester	968,070	1,021,621	6%	405,667	510,770	26%
Putnam	101,914	143,177	40%	26,242	36,277	38%
Dutchess	300,052	486,328	62%	117,633	173,207	47%
Fairfield	916,115	1,105,758	21%	432,178	513,404	19%
New Haven	850,374	1,008,446	19%	358,188	432,561	21%
Manhattan	1,583,303	1,726,196	9%	2,081,871	2,693,638	29%
Queens	2,272,677	2,835,038	25%	610,676	748,765	23%
Bronx	1,367,473	1,567,226	15%	280,920	355,641	27%
Kings	2,515,300	2,831,161	13%	641,590	877,712	37%
Richmond	470,890	677,983	44%	128,253	222,613	74%
Bergen	905,374	1,017,043	12%	434,363	518,847	19%
Passaic	498,753	569,188	14%	167,958	183,798	9%
Rest of North NJ	5,522,541	6,967,784	26%	2,338,810	3,287,990	41%
Nassau	1,353,012	1,445,423	7%	550,769	629,068	14%
Suffolk	1,480,046	1,832,743	24%	587,691	830,825	41%
Total	21,782,426	26,189,029	20%	9,407,873	12,353,896	31%

Compared to the rest of the region, these forecasts show somewhat higher than average growth in Rockland County, but very high growth in Orange County. Westchester County population is expected to grow at a much slower than average pace, although its job growth is projected to be closer to average.

For 2035, a No-Build alternative (Alternative 1) was initially developed as a baseline, with other alternatives/options subsequently built upon Alternative 1 networks. The 2035 forecasts described above, combined with 2035 transit and highway networks, were the key inputs to 2035 runs. Alternative 1 included network improvements from NYMTC's Transportation Improvement Program (TIP). Among the notable highway improvements included were the programmed improvements to I-287 in Westchester County. Transit improvements included Access to the Region's Core (ARC), East Side Access, Second Avenue Subway, and the extension of NYC Transit's 7 train. Amongst the transit projects mentioned, ARC is the most notable in terms of potential impact on the Tappan Zee Bridge/I-287 Corridor project. It would provide a one-seat ride from Orange and Rockland Counties (in addition to counties in New Jersey) to mid-town Manhattan and almost double the capacity. The principal difference between the two projects is improved access to the west side of Manhattan via ARC and to the east side via the Tappan Zee service. Although the majority of the markets served by the two projects are different, there is some overlap, especially the Orange, Rockland, and Northern Bergen County to Manhattan market. For this project, ARC service plans were adjusted to match updated service plans assessed in the March 2008 ARC Supplemental DEIS.

[1] The BPM has been structured with LRT grouped with bus and subway for mode-choice purposes. Since no LRT currently exists in the project corridor, a stated preference survey was conducted in 2003 to validate the reasonableness of that structure. It was found that when variables such as fare, run time and wait time were held constant, survey respondents do not show a statistically significant preference for LRT.

5.1.3 Coding of Alternatives/Options

For each build alternative/option, new transit services were coded into the TransCAD[2] route structure (Figures 5-4, 5-5, and 5-6), and the entire model process was re-run. Service plans are coded in as TransCAD "routes". Each route corresponds to a column in the service plans described in Appendix A (i.e., every service with a unique set of stops is considered a route, so there can be multiple routes over the same physical space). Only AM and Midday periods are modeled, and assignments by route are only produced for the AM period.

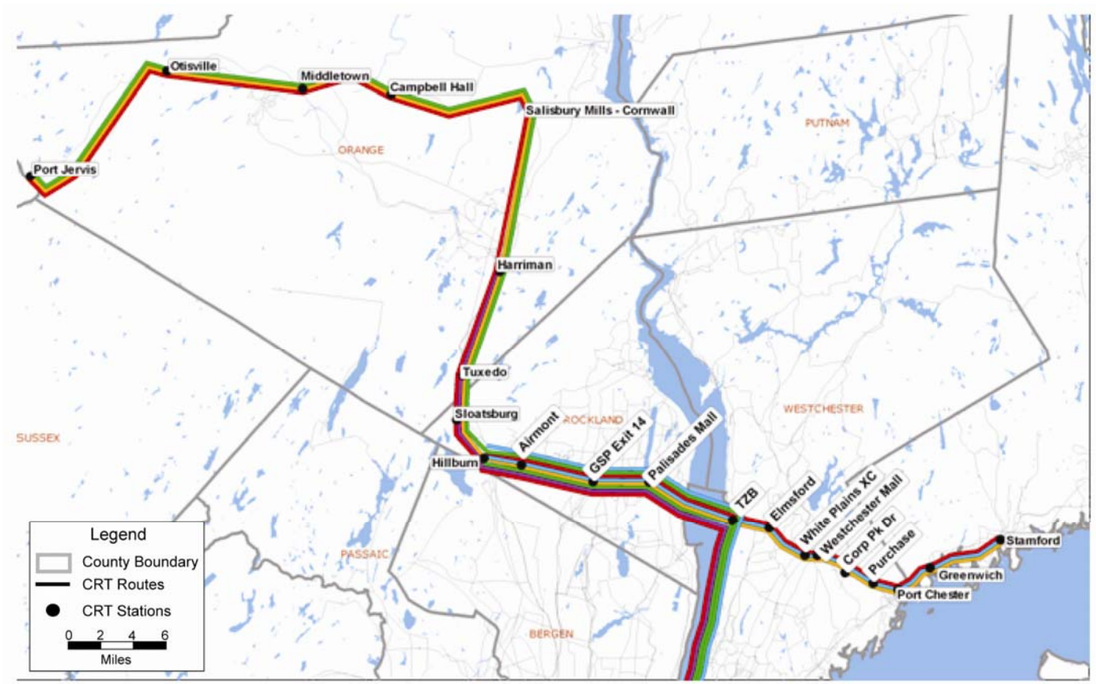


Figure 5-4 CRT Route Coding

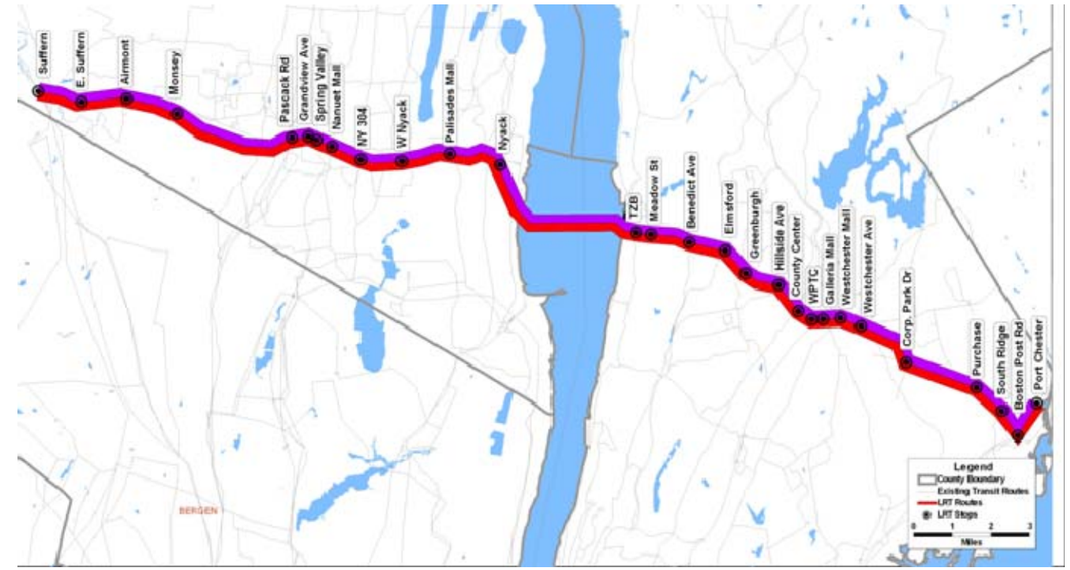


Figure 5-5 Light Rail Route Coding

[2] TransCAD is a transportation planning software package developed by Caliper Corporation.

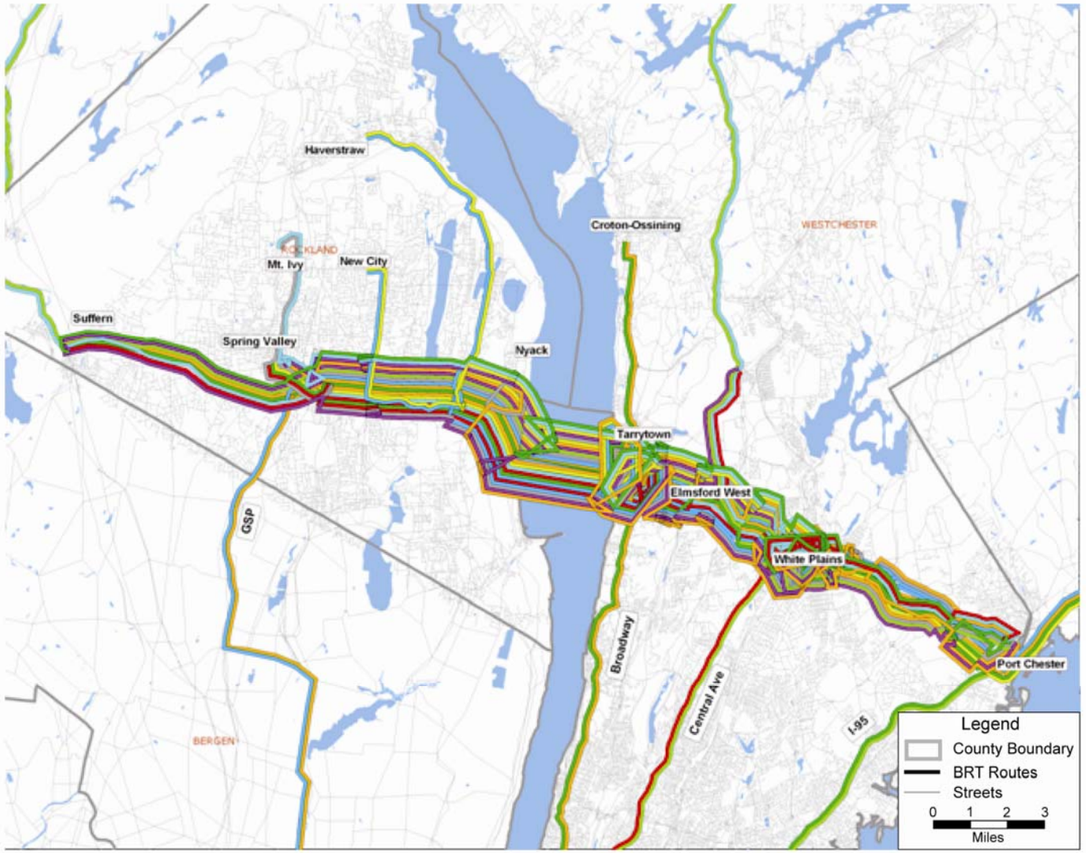


Figure 5-6 BRT Route Coding

Within the "other transit" mode, there are sub-mode definitions that are used in determining best paths (but which are not used in the mode-choice procedures described above in Section 5.1.1). Among these are LRT, express bus and local bus. BRT routes were coded as express bus routes. In the course of the project, it was determined that using the express bus designation led to conservative ridership results, due to the way BPM handles the interaction of express bus routes with CRT[3].

[3] In determining best paths, the express bus portion of a path which includes commuter rail is assigned a relatively high weight to discourage transfers between the two modes. Transfers between the two modes are discouraged since traditionally, express buses are not feeders to commuter rail and vice-versa. By comparison, in paths which include both local bus and commuter rail, the local bus portion of the path is assigned a relatively lower weight. Since the BRT was conceived in part to specifically serve such transfers, the project team also tested sensitivity runs with BRT coded as "local bus", but with identical service characteristics (stopping patterns, headways and run times). These runs showed substantially higher ridership, particularly for longer-distance trips, such as the GCT-bound riders connecting at Tarrytown, and trips between Connecticut and the corridor connecting at Port Chester.

Commuter rail fares were set at one fortieth (1/40) of the monthly commuter fares, to represent the discounted one-way fare to which BPM modeling is calibrated. (See Appendix A for station-to-station fares). LRT routes were given a flat fare of $1.50 (1996 dollars); BRT routes were given flat fares, ranging from $1.25 to $2.85. (Distance-based fares cannot be simulated on bus routes.) Note that while BPM transit procedures are able to simulate free or discounted transfers between bus routes or between bus and LRT routes, they cannot simulate any discount on transfers between LRT and CRT, or between BRT and CRT.

All new fixed rail stations were modeled with effectively unlimited parking, to determine the unconstrained demand. Parking costs at new stations and park-and-rides were made comparable to costs at the nearest existing CRT stations.

All build alternatives/options also included the identical highway improvements – an eight-lane bridge, HOT lanes in Rockland County, as well as climbing lanes. A range of tolls on the HOT lanes was iteratively tested until traffic assignments reached target HOT-lane volumes (about 1,300 per hour).

5.2 Transit Ridership

Transit ridership indicates how many people will directly benefit by using the proposed service. Ridership is measured here both in terms of total transit users by market (i.e., using any transit route), and in terms of ridership on the new proposed service itself. "Transit Accessibility West of Hudson" explicitly measures peak cross-Hudson flows, both on the Tappan Zee Bridge, and on all cross-Hudson crossings. Passenger miles is a metric that indicates the average length of trips on new service, which has substantial variations across alternatives/options.

5.2.1 Criterion

Several measures of transit ridership were developed and analyzed, as described below.

5.2.1.1 Total Daily Transit Trips for Selected Major Markets (Weekday)

This measure looks at total transit riders on all routes in markets served by the corridor. These reflect origins and final destinations of travelers (i.e., "trip table" data), regardless of which transit mode or transit route they use – in other words, on both no-build and proposed service. The BPM calculates trips for the 28-county region, but for this measure, markets that potentially could be served by the corridor were isolated. A wide range of markets are served by the corridor, but for this purpose they have been grouped into two categories: cross-corridor markets and New York City-bound markets.

Cross-corridor markets include:

- Rockland and Orange trips to and from Westchester and Connecticut.
- Trips between Orange and Rockland.
- Intra-Rockland trips with at least one end in the corridor.
- Intra-Westchester trips with at least one end in the corridor.
- Connecticut trips to and from central and western Westchester.
- New Jersey trips to and from central and northern Westchester.
- New Jersey trips to and from central Rockland.

NYC-bound markets here include:

- All of Rockland to and from NYC.
- All of Orange to and from NYC.
- Central Westchester along the corridor to and from NYC.

5.2.1.2 New Transit Trips

New transit riders were directly estimated by looking at the increase in total daily transit trips for each alternative/option as compared to the No-Build alternative.

5.2.1.3 Daily Transit Ridership on the New Service (Weekday)

This measure shows the number of passengers specifically on the new BRT, LRT or CRT services. While measuring total transit trips in major markets indicates how many new transit riders are attracted to the overall transit system, it does not show the extent to which people shift from existing transit lines to the new routes. Ridership on new service is based on BPM AM assignments, with a factor of 2.86 to arrive at a total number of daily trips. Alternative 1, which, as the No-Build alternative, has no proposed new service, by definition attracts no passengers to new service.

Ridership has been grouped into segments defined by station boardings and alightings. Thus, an intra-Rockland trip is a single passenger boarding and exiting a new service in Rockland County. However, because the final destinations of passengers exiting at a given station are not reported by the BPM, many of these passengers may actually transfer to southbound buses to New Jersey or even NYC. Similarly, individuals identified as "intra-Westchester" trips could also transfer to bus or rail to the Bronx, Manhattan, Connecticut, or elsewhere.

The exception to this type of grouping is Cross-Hudson Manhattan-bound passengers. While these passengers are directly served by new service in Alternatives 4A, 4B and 4C and in Option 4D, they require transfers at Tarrytown in Options 3A and 3B, at the Tappan Zee Station in LRT, and at White Plains in Option 4A-X. (The model suggests that traveling to White Plains would be quicker than using a shuttle bus from Tappan Zee Station to Tarrytown.) For the sake of consistency, these trips are, therefore, placed in the "Cross-Hudson to Manhattan" category in all alternatives/options. (Although the origin and destination of passengers cannot be directly determined when examining station boardings, in the case of BRT and LRT to Tarrytown/TZB Stations, it has been assumed that most passengers making that transfer would continue on to Manhattan).

In presenting ridership on new transit routes, the modeling team excluded trips that only use existing portions of the transit network. For example, in Alternative 4A passengers may use the new commuter rail routes to travel within Orange County, or between Port Chester and Stamford, but these trips are already served by existing commuter rail routes, so they have not been included in this measure. (Such riders are, however, accounted for in the total transit market measures.) Similarly, ridership in the BRT scenarios was limited to passengers who would ride over some portion of the BRT, and excluded passengers who would board and exit a new route prior to its entry onto the BRT.

5.2.1.4 Transit Accessibility West of the Hudson

Transit accessibility west of the Hudson is defined here as two measures: (1) the number of weekday AM peak-period transit passengers crossing the Tappan Zee Bridge from west to east, and (2) the number of weekday AM peak-period transit passengers crossing the Hudson River in either direction. The second category includes:

- All cross-Hudson ferries.
- Bus (and potential rail) routes across the Tappan Zee Bridge.
- Bus routes across the George Washington Bridge.
- Bus routes through the Lincoln Tunnel.
- NJ Transit trains into Penn Station and the new 34th St. Station planned for ARC.
- PATH trains through both tubes.
- Bus routes through the Holland Tunnel.

5.2.1.5 Passenger Miles

Passenger-mile measures indicate whether certain modes tend to serve longer- or shorter-distance trips. Passenger-miles are assessed in two categories – along proposed infrastructure, and along existing infrastructure. Passenger miles on existing infrastructure were determined by measuring passenger loads along the main transit corridor from Suffern to Port Chester. Passenger miles were divided by riders on proposed new service to determine an average trip length.

Passenger miles on existing infrastructure were estimated by including the following components:

- In Alternatives 4A, 4B, and 4C, and in Option 4D, the portion of trips along the Hudson Line to GCT as well as along the Port Jervis Line to and from Orange County. Intra-Orange passengers were excluded.
- In Alternative 4A, the portion of trips along the New Haven Line, to and from Stamford. For mileage purposes, it was assumed that all such Connecticut riders start or stop in Stamford.
- BRT and LRT transfers to and from the Tarrytown Metro-North Station. They are assumed to travel the full length to GCT.
- BRT and LRT transfers at Suffern to and from commuter rail. They are assumed to travel the same average number of miles as Orange County CRT riders (30.6 miles).
- BRT and LRT transfers to and from commuter rail at Port Chester. They are assumed to travel to Stamford.
- Passenger miles on the portion of other BRT routes not actually in BRT are not included (e.g., the distance between New City and the corridor traveled by riders of Route H, or the distance between Yonkers and the corridor traveled by riders of Route F). (See service plans in Appendix A.)
- In Alternative 4A without a Hudson Line connection (Option 4A-X), Manhattan-bound transfers at White Plains from west of the Hudson were estimated, and their mileage to GCT was included.

5.2.2 Comparison of Transit Modes

In general, ridership results show that BRT performs best in cross-corridor markets, particularly among shorter-distance intra-Rockland and intra-Westchester trips compared to other modes. CRT alternatives/options (with the exception of Option 4A-X) generate the greatest number of NYC-bound trips. The numbers for Alternative 1 (Figure 5-2) represent No-Build transit riders for those markets. These are daily numbers, so a person traveling to work in the morning and returning home in the evening would generate two trips. If that person makes a stop on the way for some other purposes, three trips would be measured.

In examining total transit trips, Option 4D attracts the greatest number of trips in both cross-corridor and NYC-bound markets. In cross-corridor markets, Option 4D has BRT service comparable to Options 3A and 3B, but in addition, the CRT component helps to serve Orange-Rockland and intra-Rockland trips. Alternatives/options with Manhattan-bound rail generate the greatest number of NYC-bound trips. Option 4D generates slightly more than the others, indicating that the time saved by eliminating Airmont and Tappan Zee Stations more than makes up for the associated reduction in access.

Alternatives/options without the Manhattan-bound rail connection still lead to an increase in transit trips in that market compared to the No Build alternative, indicating that substantial numbers of passengers would use new cross-corridor service to access existing NYC-bound routes (i.e., one of the five branches of Metro-North, express bus service into the Port Authority Bus Terminal, or Bee-Line bus service from Westchester County). The results are shown in Table 5-2.

Table 5-2

Daily Transit Trips for Selected Major Markets (Weekday)

Criterion	Alternative/Option								
	1 No Build	**3A** Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Cross-Corridor	66,500	81,000	81,100	75,200	74,200	73,900	74,000	83,400	75,500
To/From NYC	94,900	103,800	104,100	108,000	101,000	108,500	108,800	109,200	102,800
Total	161,400	184,800	185,200	183,200	175,200	182,400	182,800	192,600	178,300
New Transit Trips*	NA	23,400	23,800	21,800	13,800	21,000	21,400	31,200	16,900

* New transit trips are estimated by taking the difference between the total transit trips in the build alternative/option versus the no build. It includes any new transit trip on any mode in the selected major markets considered. The new transit trips are not necessarily on the new transit infrastructure.

Ridership on the proposed new service (Figure 5-7, Table 5-3) is mostly consistent with the measures for total transit market numbers, with Option 4D services attracting the most total transit riders, and Option 4A-X and LRT attracting the fewest. In specific route segments, ridership trends are as follows:

- **Intra-Rockland.** BRT shows the most intra-Rockland ridership, with LRT outperforming CRT. This is because the multiple routes made possible by BRT allow for greater access and egress than both LRT and CRT, while LRT makes more frequent stops than CRT. Option 4D performs best because it includes full BRT in Rockland County as well as CRT service, which can serve some additional intra-Rockland and Orange-to-Rockland trips.

- **Intra-Westchester/Westchester-Connecticut.** Similar patterns are seen in this segment, with BRT attracting the most riders. One difference is that cross-corridor CRT (Alternative 4A and Option 4A-X) is competitive with LRT (Alternative 4B and Full-Corridor LRT) because CRT serves the Connecticut to Westchester market without a transfer, while LRT requires a transfer at Port Chester. Note that Alternative 4C generates significantly less ridership than Options 3A and 3B, indicating that the robust service plans in Options 3A and 3B (i.e., 5-minute headways in both directions on the trunk line) and additional stations are key to their ridership potential.

- **Cross-Hudson Circumferential.** For this segment (i.e., Rockland-to-Westchester trips), CRT slightly outperforms BRT, with LRT lagging behind both. Since these tend to be longer-distance trips than the intra-Rockland and intra-Westchester segments, it appears that the faster in-vehicle times and added comfort of CRT outweigh the access and egress benefits of BRT. Alternative 4B, which requires a transfer, attracts the fewest riders in this segment. Alternative 4C, in which some – but not all – cross-Hudson circumferential trips require a transfer, also performs poorly. Option 4D attracts fewer cross-corridor trips than Option 3A, even with an identical bus service plan. This appears to be due to the relative attractiveness of Manhattan-bound CRT, which shifts origin-destination patterns so that more people travel between Rockland County and Manhattan and fewer travel between Rockland County and other places (including Westchester County).

- **Manhattan-bound CRT.** Predictably, Manhattan-bound CRT alternatives/options dominate in the GCT-bound segment, with ridership ranging from 25,800 in Alternative 4A to 29,200 in Option 4D (Figure 5-7, Table 5-3). Again, Option 4D attracts the most riders, indicating that the time saved by eliminating Airmont and Tappan Zee Stations attracts more riders at other stops in Rockland County and Orange County than are lost from the Airmont Station. With ARC present in both the No-Build and all build alternatives/options, the two-seat ride to GCT required with BRT and LRT is not attractive for trips from Orange County, western Rockland, or central Rockland, which could use the Port Jervis Line and the Pascack Valley Line for direct service into Manhattan; only passengers from eastern Rockland (e.g., Nyack, Haverstraw) would benefit.

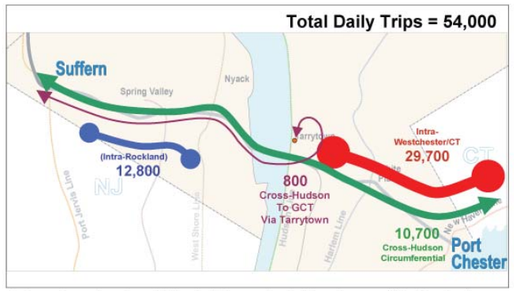
- **Manhattan-bound BRT and LRT.** Less predictably, BRT and LRT perform differently relative to each other in the GCT-bound segment than when looking at the market-based measures in Table 5-2. Options 3A and 3B show low numbers of riders making the transfer at Tarrytown between BRT and the Hudson Line (with 800 and 1,400 daily riders respectively), while LRT and Option 4A-X show about 4,000 to 4,500 daily making similar moves. The LRT service plan allows for a transfer at the Tappan Zee Station, which reduces the in-vehicle time required to reach the Hudson Line. In Option 4A-X, a dedicated shuttle bus between The Tappan Zee Station and Tarrytown was coded into the transit network. However, that bus attracted no riders. Instead, it appears that GCT-bound passengers would find it more convenient to continue on cross-corridor rail to White Plains and transfer to the Harlem Line there. (That number was estimated from the increase in AM Eastbound cross-corridor rail alightings in White Plains in Option 4A-X with Alternative 4A.) This pattern is the opposite of that found in Table 5-2, where BRT outperformed LRT and Option 4A-X in the NYC-bound markets. This shows that, as described above, significant numbers of NYC-bound passengers from Rockland and Orange Counties would still use BRT service to gain access to the Port Jervis Line, Pascack Valley Line, or express bus service at Interchange 14 or Palisades Mall. Similarly, NYC-bound Westchester County riders could use the BRT to gain access to the Harlem Line at White Plains or the New Haven Line at Port Chester. However, since such trips are mixed in with other local moves from which they cannot be distinguished, they would be included in the intra-Rockland or intra-Westchester segments in Table 5-3. Also note that, as described in Subchapter 5.1, BRT-to-CRT transfers may have been conservatively estimated in general.

- **Tappan Zee Station.** Alternatives 4A, 4B, 4C and Full-Corridor LRT include a Tappan Zee Station, which attracts some Westchester County riders destined for GCT, a market segment not directly served in other alternatives/options. These riders would mostly be diverted from the Tarrytown or White Plains Stations.

The first measure in Table 5-4 (Transit Accessibility, West of Hudson) predictably shows Alternatives 4A, 4B, and 4C and Option 4D carrying more transit passengers across the Tappan Zee Bridge, as they include Manhattan-bound rail. For the broader measure of all cross-Hudson transit trips (including New Jersey to Manhattan), Option 3A performs best. Alternative 4A and Option 4D are the next-highest performing alternatives/options.

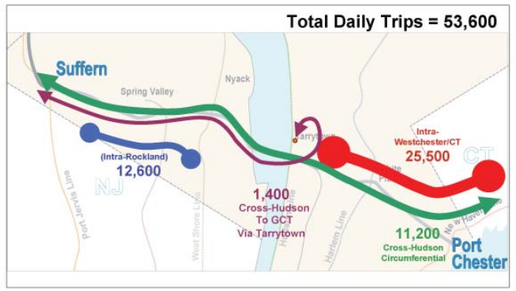
Figure 5-7 Daily Transit Ridership on New Service (Weekday)

Option 3A
Daily Trips (2035)



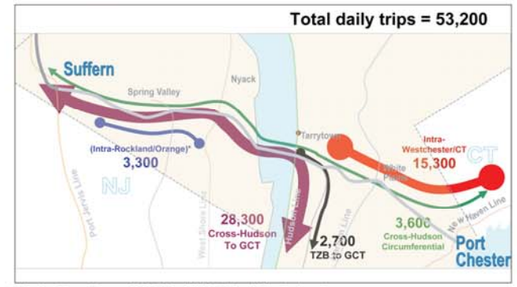
Enhanced service plan additional stations, extended bus lanes on Westchester Ave., and connection to Port Chester Station

Option 3B
Daily Trips (2035)



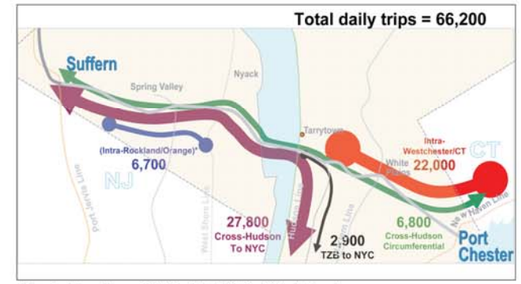
High occupancy toll (HOT) lanes in Rockland and a dedicated busway in Westchester

Alternative 4B
Daily Trips (2035)



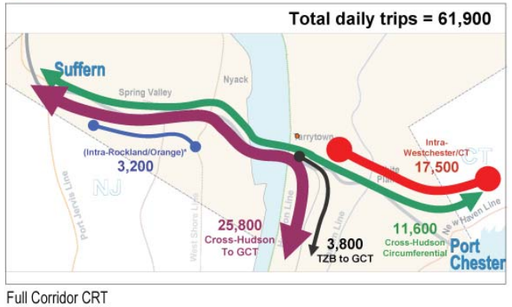
Manhattan Bound CRT with LRT in Westchester

Alternative 4C
Daily Trips (2035)



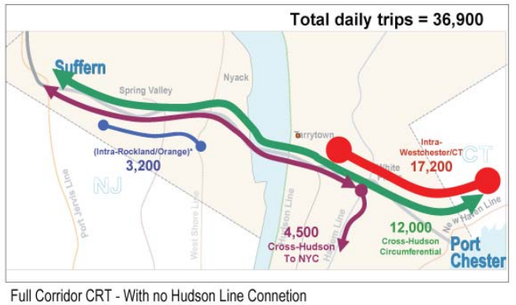
Manhattan Bound CRT with BRT in Westchester

Alternative 4A
Daily Trips (2035)



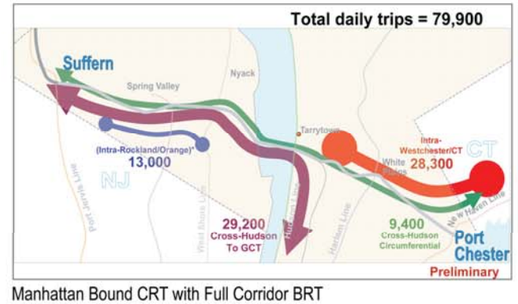
Full Corridor CRT

Option 4A-X
(No Hudson Line Connection)
Daily Trips (2035)



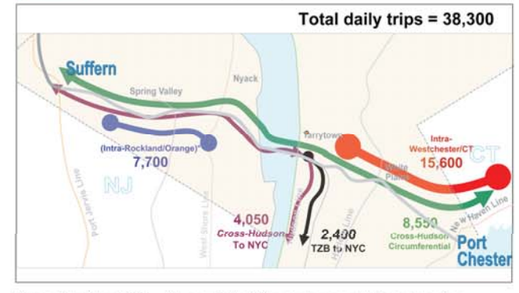
Full Corridor CRT - With no Hudson Line Connetion

Option 4D
Daily Trips (2035)



Manhattan Bound CRT with Full Corridor BRT
(as in Alt 3A) but with no Airmont or Tappan Zee CRT Stations)

Cross Corridor LRT
Daily Trips (2035)



Cross Corridor LRT - with new TZ station and cross platform transfer
to Manhattan Bound CRT

Figure 5-7 Daily Transit Ridership on New Service (Weekday)

Table 5-3

Daily Transit Ridership on New Service (Weekday)

Segment	Alternative/Option								
	No Build	**3A** Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland HL Connection LRT in Westchester	**4C** CRT in Rockland HL Connection BRT in Westchester	**4D** CRT in Rockland HL Connection Full-Corridor BRT (3A)	Full-Corridor LRT
Intra-Rockland/ Orange-Rockland	NA	12,800	12,600	3,200	3,200	3,300	6,700	13,000	7,700
Cross-Hudson Circumferential	NA	10,700	11,200	11,600	12,000	3,600	6,800	9,400	8,550
Intra-Westchester/ Westchester-CT	NA	29,700	28,400	17,500	17,200	15,300	22,000	28,300	15,600
Cross-Hudson to/from GCT	NA	800	1,400	25,800	4,500*	28,300	27,800	29,200	4,050
Tappan Zee Station to/from GCT	NA	NA	NA	3,800	NA	2,700	2,900	NA	2,400
Total	NA	54,000	53,600	61,900	36,900	53,200	66,200	79,900	38,300

Notes:
NA = Not applicable
*Option 4A-X totals to Manhattan are inferred from changes in passengers alighting at White Plains Station, and then deducted from the Intra-Westchester figure.

Table 5-4

Transit Accessibility, West of Hudson

Criterion	Alternative/Option								
	1 No Build	**3A** Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Transit Accessibility West of Hudson (AM peak period, peak direction passengers) on TZB	820	3,260	3,560	11,830	4,660	10,400	11,400	12,380	3,540
Transit Accessibility West of Hudson (AM peak period total passengers, both directions) on Hudson River Crossings *	454,900	492,600	473,600	480,900	474,100	476,900	477,700	478,700	473,300

Note: * Hudson River Crossings include all crossings from the Holland Tunnel to the Newburg-Beacon Bridge.

Table 5-5 shows total passenger miles carried by the proposed new services. Rail alternatives/options tend to perform best, as they carry longer-distance trips. Alternative 4A carries the most passenger miles, slightly ahead of Option 4D, even though Option 4D carries more riders. This indicates that cross-corridor rail carries more long-distance trips (such as those between Orange and Westchester Counties, or between White Plains and Connecticut), while Option 4D would carry more intra-Rockland and intra-Westchester trips. Options 3A and 3B carry the fewest passenger-miles, indicating that BRT specializes in local trips. Note that Option 3B carries slightly more passenger miles than does Option 3A, as the benefits of the full busway tend to favor trips over the full length of the corridor, while slightly reducing access, making it less attractive for local trips. However, because this measure does not fully account for passengers on all feeder routes (such as those serving Nyack, Haverstraw, and Spring Valley) before they enter the BRT system, it may underestimate BRT passenger-miles.

Table 5-5

AM Peak Passenger Miles (Thousands of Miles)

Criterion	Alternative/Option							
	3A Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland HL Connection LRT in Westchester	**4C** CRT in Rockland HL Connection BRT in Westchester	**4D** CRT in Rockland HL Connection Full-Corridor BRT (3A)	Full-Corridor LRT
In Corridor	97	113	226	95	193	212	249	106
On Existing Facilities Beyond Corridor	54	68	428	147	404	415	399	118
Total	151	181	654	242	596	627	648	224
Miles per Rider	7.8	9.5	29.6	18.4	31.4	26.5	22.7	16.4

5.3 Transit Travel Time

Several measures of transit travel time were developed and analyzed, as described below.

5.3.1 Description of Criterion

In order to facilitate the analyses of travel time, numerous trip pairs were selected to illustrate changes in areas where new facilities and services are provided, so as to represent the variety of markets served by the corridor. The results are presented in Tables 5-6, 5-7, and 5-8. It is important to note that the travel times in the tables are door-to-door values.

5.3.1.1 Transit Travel Time for Selected Trip Pairs

AM peak-period transit times in minutes were calculated from BPM runs (Table 5-6). As described in Subchapter 5.1.1, BPM uses four different "modes" – drive to commuter rail, walk to commuter rail, drive to other transit, and walk to other transit. For any alternative/option, a best path is determined for each of these four modes. The transit times shown here represent the fastest of those four times, with all components of time (i.e., in-vehicle time, wait time, walk time, etc.) weighted equally. In some cases, the best path remains a path using No Build service.

Table 5-6

AM Peak Travel Times, Selected Trip Pairs (Minutes)

Market Group	from	to	1	3A	3B	4A	4A-X	4B	4C	4D	Cross-Corridor LRT
Intra-Rockland	Suffern	Palisades Mall	60	25	25	30	34	34	34	29	32
Rockland-Westchester	Spring Valley	White Plains	78	37	32	45	45	58	51	37	60
	Spring Valley	Mt. Pleasant	94	56	54	63	61	72	58	56	70
	Nyack	Platinum Mile	80	41	35	46	46	62	45	40	48
	Suffern	White Plains	96	44	40	51	51	65	59	44	57
	Suffern	Yonkers	114	72	72	97	102	94	99	72	104
Manhattan Bound	Harriman	45th & Madison	114	114	114	97	114	97	97	97	114
	Nyack	45th & Madison	96	77	78	63	81	63	63	61	64
	Suffern	45th & Madison	85	85	85	68	89	68	68	65	86
	Newburgh	40th & 3rd Ave	141	141	141	123	146	123	123	123	141
	Spring Valley	40th & 3rd Ave	105	107	107	71	89	71	71	69	98
	Middletown	34th & 7th	142	142	142	142	142	142	142	142	142
	Nyack	34th & 7th	113	91	92	77	95	77	77	75	78
	Middletown	World Trade Center	154	151	151	154	154	154	155	155	154
	Spring Valley	World Trade Center	102	100	100	84	102	84	84	82	103
	Harriman	Javits Center, 36th & 11th	115	115	115	116	116	116	116	116	116
	Nyack	Javits Center, 36th & 11th	118	104	105	86	104	86	86	84	86
Westchester-CT	Elmsford	Stamford	67	57	50	53	53	81	53	54	81
Ct-Westchester	Darien	Platinum Mile	80	75	74	62	62	72	75	75	72
Westchester-Westchester	Port Chester	White Plains	41	28	27	34	34	38	41	28	38
To and from Bronx	Bronx (Grand Concourse, 180th St.)	Palisades Mall	130	93	92	89	89	90	84	85	110
	Spring Valley	Bronx (Montefiore Hospital)	115	74	81	101	101	96	84	74	98

These reflect "door-to-door" times as calculated by the BPM, not station-to-station times.
Note that BPM calculates "best path" travel times for four "modes" (Walk to Bus/Light Rail, Walk to Commuter Rail, Drive to Bus/Light Rail, Drive to Commuter Rail)
This table shows the minimum total time (with no extra weight given to walking or waiting time) among those four "modes"
In some cases, the travel time may be slower than the No Build time because the model accepts longer in-vehicle time in order to avoid a transfer or have somewhat shorter waits or walking times.
With the presence of ARC, travel times to PSNY will be 7 minutes faster in Alternative 1 than with current conditions.

5.3.1.2 Transit Travel -Time Savings for Selected Trip Pairs

Travel-time savings were calculated by comparing the results of each alternative/option to the No Build alternative (Table 5-7). Note that due to what is considered the "best path", the unweighted time in the build alternatives/options is in some cases slightly slower than in the No Build. For example, Spring Valley to 40th St. and 3rd Avenue would take two minutes longer in Options 3A and 3B than in the No Build alternative. This indicates that a trip on BRT with a single transfer at Tarrytown to GCT would take two minutes longer in pure time, but would still be slightly

preferable to using the No Build path, which appears to use the Pascack Valley Line with two transfers in Manhattan (i.e., the NYCT 1 train and the 42nd St. Shuttle) to get to the East Side.

Table 5-7

AM Peak Travel Time Savings, Selected Trip Pairs (Minutes)

Market Group	from	to	1	3A	3B	4A	4A-X	4B	4C	4D	Cross-Corridor LRT
Intra-Rockland	Suffern	Palisades Mall		35	35	30	26	26	26	31	28
Rockland-Westchester	Spring Valley	White Plains		41	46	33	33	20	27	41	18
	Spring Valley	Mt. Pleasant		39	41	31	33	22	36	39	24
	Nyack	Platinum Mile		40	45	35	35	18	36	40	33
	Suffern	White Plains		52	56	44	44	31	36	52	38
	Suffern	Yonkers		42	42	17	12	21	15	42	10
Manhattan Bound	Harriman	45th & Madison		0	0	17	0	17	17	17	0
	Nyack	45th & Madison		19	18	33	15	33	33	35	32
	Suffern	45th & Madison		0	0	16	-4	16	16	19	-1
	Newburgh	40th & 3rd Ave		0	0	18	-5	18	18	18	0
	Spring Valley	40th & 3rd Ave		-2	-2	34	16	34	34	36	7
	Middletown	34th & 7th		0	0	0	0	0	0	0	0
	Nyack	34th & 7th		21	20	35	18	35	35	37	35
	Middletown	World Trade Center		3	3	0	0	0	-1	-1	0
	Spring Valley	World Trade Center		2	2	18	0	18	18	20	-1
	Harriman	Javits Center, 36th & 11th		0	0	0	0	0	0	0	0
	Nyack	Javits Center, 36th & 11th		14	13	33	15	33	33	35	32
Westchester-CT	Elmsford	Stamford		11	18	15	15	-14	15	14	-14
Ct-Westchester	Darien	Platinum Mile		5	6	18	18	8	5	5	8
Westchester-Westchester	Port Chester	White Plains		13	14	7	7	3	0	13	3
To and from Bronx	Bronx (Grand Concourse, 180th St.)	Palisades Mall		36	37	41	41	40	45	45	20
	Spring Valley	Bronx (Montefiore Hospital)		42	34	14	14	19	32	42	17

5.3.1.3 Number of Transfers

The number of transfers was also determined (Table 5-8). The same BPM output files showing travel times for the best transit path also show the number of transfers between routes. Note that in some markets where the traveler has a choice among different reasonable paths, the BPM will calculate an average. In some cases this results in a fractional number of transfers. However, in Table 5-8, all values are rounded to whole numbers. Auto-to-transit movements are not counted as transfers.

5.3.1.4 Aggregate Transit Travel-Time Savings

Aggregate travel-time savings represent a single composite time-savings measure for each alternative/option by combining travel-time savings for each origin-destination pair and weighting them by the number of travelers actually making that trip. Time benefits have also been disaggregated by cross-corridor and NYC-bound markets.

The measure was calculated using these time savings for all zone pairs in markets affected by new service – basically the same markets analyzed for "Total Weekday Daily Transit Trips". For each pair, time saved in the AM peak period was multiplied by the number of No-Build transit trips for that pair. To account for time benefits accrued by new transit riders, half of that time saved was multiplied by the new transit trips for that zone pair, and added to the total. Half of that time is used because, on one extreme, these new transit riders could be shifted over to transit with a time savings of just one second, and on the other extreme, the full savings experienced by existing transit users is necessary to shift them. Thus, on average, their time savings benefit would be comparable to half of that full time savings. Time savings were divided by total riders on the proposed new service to determine average time saved per rider. Aggregate time savings in hours for the AM peak period would be:

- 3A – 4,400 4A – 7,400 4B – 6,200 4D – 8,100
- 3B – 4,500 4A-X – 3,900 4C – 6,000 LRT – 3,800

Table 5-8

AM Peak Transfers, Selected Trip Pairs

Market Group	from	to	1	3A	3B	4A	4A-X	4B	4C	4D	Cross-Corridor LRT
Intra-Rockland	Suffern	Palisades Mall	0	0	0	0	0	0	0	0	1
Rockland-Westchester	Spring Valley	White Plains	0	0	0	0	0	1	2	0	1
	Spring Valley	Mt. Pleasant	1	0	0	1	1	2	0	0	2
	Nyack	Platinum Mile	1	0	0	0	0	1	1	0	0
	Suffern	White Plains	0	0	0	0	0	1	1	0	0
	Suffern	Yonkers	1	1	1	1	2	2	2	1	2
Manhattan Bound	Harriman	45th & Madison	1	1	1	0	1	0	0	0	1
	Nyack	45th & Madison	1	1	1	0	1	0	0	0	1
	Suffern	45th & Madison	2	2	2	0	1	0	0	0	2
	Newburgh	40th & 3rd Ave	2	2	2	0	1	0	0	0	2
	Spring Valley	40th & 3rd Ave	2	1	1	0	1	0	0	0	2
	Middletown	34th & 7th	0	0	0	0	0	0	0	0	0
	Nyack	34th & 7th	1	2	2	1	2	1	1	1	2
	Middletown	World Trade Center	1	1	1	1	1	1	1	1	1
	Spring Valley	World Trade Center	1	1	1	1	1	1	1	1	1
	Harriman	Javits Center, 36th & 11th	1	1	1	1	1	1	1	1	1
	Nyack	Javits Center, 36th & 11th	2	3	3	1	2	1	1	1	2
Westchester-CT	Elmsford	Stamford	2	1	1	0	0	1	0	1	1
Ct-Westchester	Darien	Platinum Mile	2	2	1	1	1	2	1	2	2
Westchester-Westchester	Port Chester	White Plains	0	0	0	0	0	0	0	0	0
To and from Bronx	Bronx (Grand Concourse, 180th St.)	Palisades Mall	2	2	2	1	1	1	1	1	2
	Spring Valley	Bronx (Montefiore Hospital)	2	1	1	1	1	1	2	1	2

5.3.2 Comparison of Transit Modes

In cross-corridor markets, substantial time savings are available in all alternatives/options. In part this is due to improvements in running time, because existing transit services in the No Build alternative would slow down with increases in traffic, especially across the bridge. However, large savings are also attributable to improvements in access to possible station locations, and, in the case of Options 3A and 3B, to much shorter wait times. Alternative 4B tends to have the smallest time savings cross-corridor, since it requires a transfer at Tappan Zee Station. BRT offers time savings to a wider variety of trips cross-corridor. Even trips to major centers like White Plains and Stamford can be faster with BRT because in many cases the bus can get closer to the final destination than can rail.

In Manhattan-bound markets, the largest savings are found from trips originating in Nyack, as that part of Rockland County is not well-served by ARC, and all alternatives/options show improvements. BRT and LRT offer little savings to Manhattan for areas west of Nyack. Substantial savings to East Midtown from all origins in Rockland County are

obtained with Manhattan-bound rail, with smaller savings to the west side and lower Manhattan, depending on the origin. In general, savings from Orange County origins are smaller, as there are no stations proposed in Orange County, so station access is the same across all alternatives/options, including the No Build. Direct service to GCT would offer time savings for trips from Orange County to East Midtown. However, trips from Orange County to West Midtown or lower Manhattan would not necessarily be improved over the No Build service.

Another way of assessing travel times is to graphically illustrate best paths. Travel times into Manhattan are particularly complicated because there are multiple routes between the study area and Manhattan, with commuter rail stations at GCT, Penn Station (and the proposed 34th St. Terminal used by ARC), and Hoboken, from which passengers can use PATH trains to reach Manhattan. Figure 5-8 illustrates just one case of how different parts of Manhattan are best served by the various commuter rail services from a sample zone in Orange County (in this case, a zone in Harriman) in Alternatives 4A, 4B and 4C. As expected, according to BPM outputs, the new GCT-bound service serves the East Side, the new 34th Street Station built for ARC would serve the West Side, and Hoboken trains would continue to be the most convenient station for many lower Manhattan destinations as well as Greenwich Village. A few zones would be equally well-served by two or even all three of these branches. Table 5-9 shows employment in these zones (a proxy for trip destinations), grouped according to the most convenient commuter rail station. Zones best served by GCT or 125th Street contain just over 50 percent of Manhattan's office employment.

It is important to note that both this map and this allocation of employment would be different for other areas of Orange County, and would vary by zone in Rockland County. Figure 5-9 shows a similar map for a zone in Spring Valley, showing that the new GCT service would be most convenient for a much larger portion of Manhattan than it would be for Orange County residents.

Table 5-9

Distribution of Manhattan Jobs by Best Commuter Rail Station from Orange County, Alternatives 4A, 4B, 4C (2035)

Best Station	All Jobs	Retail Jobs	Office Jobs	% Office Jobs
GCT	1,279,664	145,712	835,535	49%
125th	179,455	19,557	54,882	3%
34th	606,089	73,476	391,663	23%
Hoboken	372,755	23,884	264,654	15%
GCT or 34th	68,071	7,278	51,806	3%
34th or Hoboken	132,756	19,000	87,825	5%
GCT or Penn or Hoboken	34,700	4,861	22,527	1%
Other Stations	19,756	3,838	7,511	0%
TOTAL	2,693,246	297,606	1,716,403	100%

Figures 5-10 through 5-12 show the converse side of these patterns – illustrating which rail branches would be most convenient for Orange and Rockland County zones for a particular Manhattan zone.

- Figure 5-10 shows that the zone including Rockefeller Center (east of 6th Avenue) would be best reached via GCT for almost all of Orange and Rockland.
- Figure 5-11 shows that for the zone on the other side of 6th Avenue, Penn Station is more convenient from the southern part of Orange and from additional areas in Rockland.
- Figure 5-12 shows that the zone containing the Empire State Building is best reached from Penn Station for almost all of Orange and the majority of Rockland.

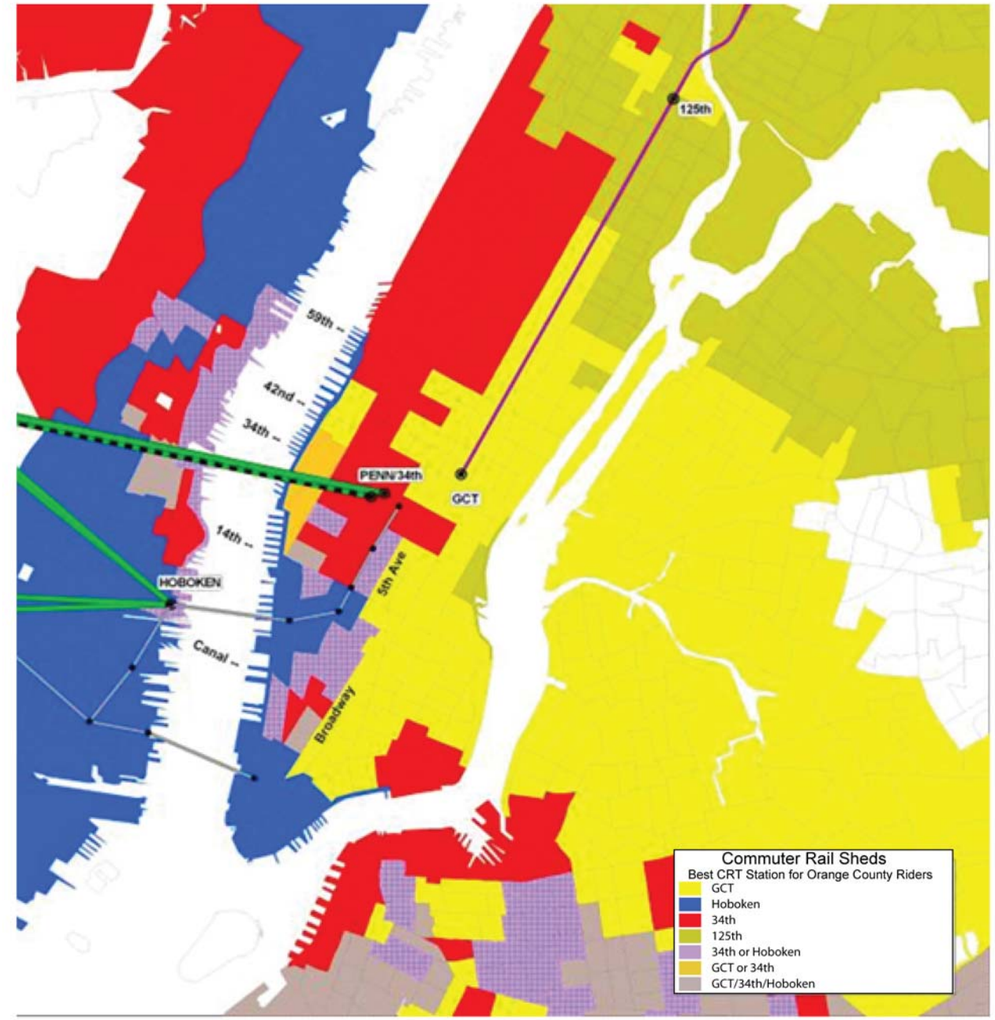


Figure 5-8 Commuter Rail Sheds from Orange County (Alternatives 4A, 4B, 4C)

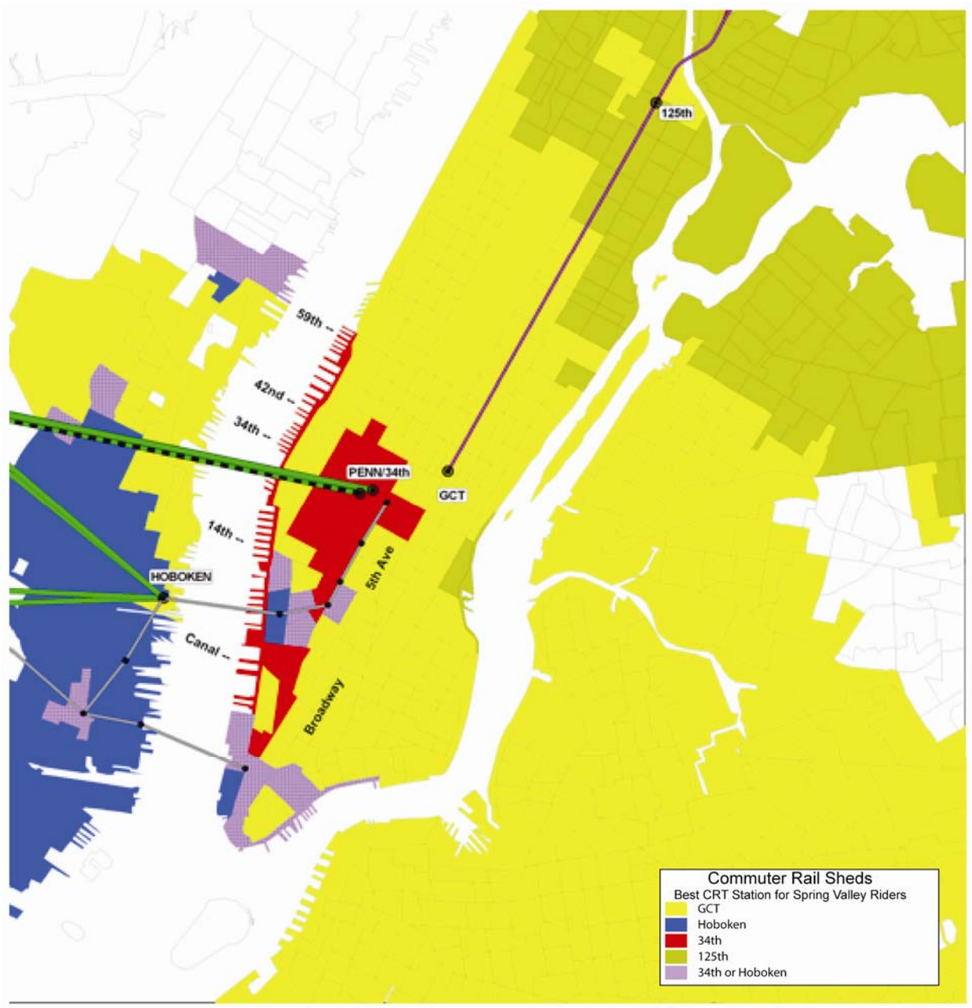


Figure 5-9 Commuter Rail Sheds from Spring Valley (Alternatives 4A, 4B, 4C)

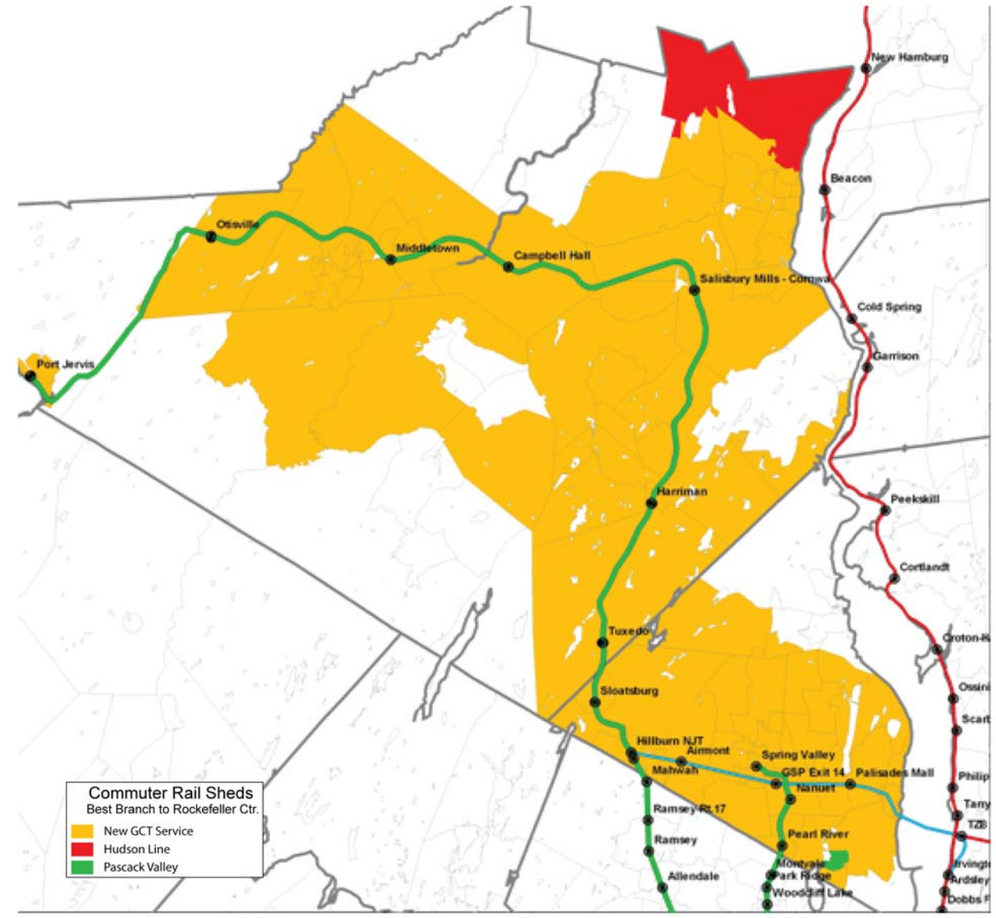


Figure 5-10 Commuter Rail Sheds to Rockefeller Center (East Side)

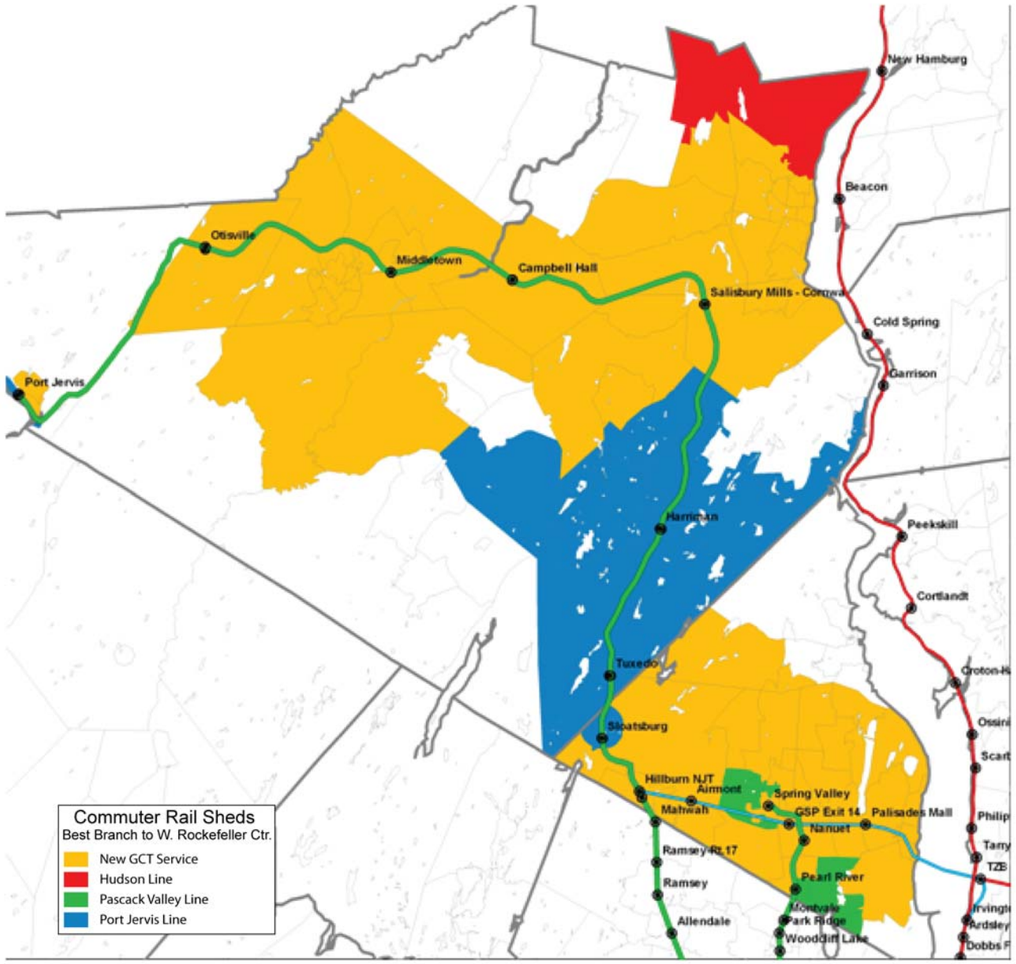


Figure 5-11 Commuter Rail Sheds to Rockefeller Center (West Side)

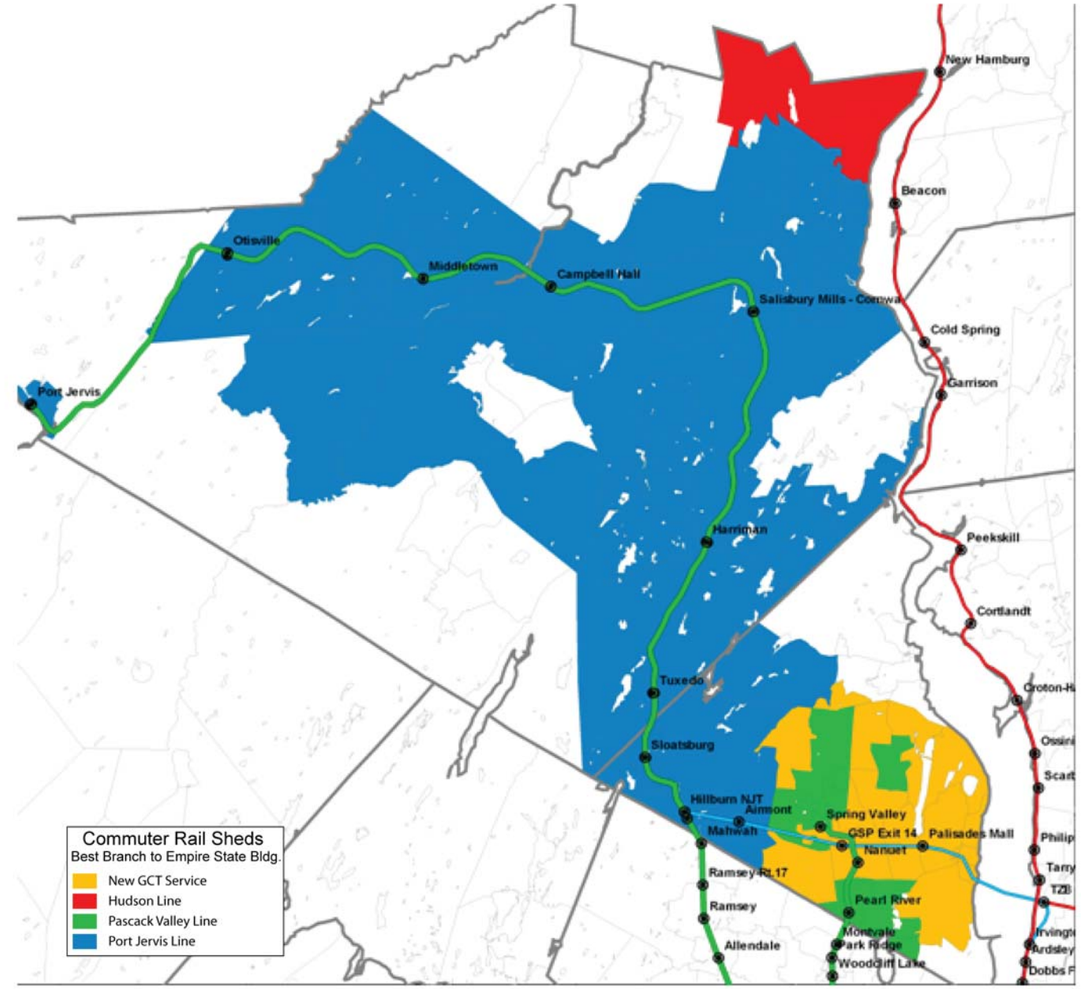


Figure 5-12 Commuter Rail Sheds to the Empire State Building

In terms of aggregate time savings, Option 4D leads the alternatives/options, with 8,100 hours (Table 5-10). Alternative 4A outperforms Alternative 4C, even though it carries fewer riders, especially in the cross-corridor market. This indicates that CRT across the corridor saves more time per trip on average than BRT does. Similarly, Options 3A and 3B only moderately exceed both Option 4A-X and Full-Corridor LRT, even though they generate far more riders, again indicating that BRT serves proportionally more trips with fewer time benefits. This is consistent with measures showing that BRT serves more short-distance trip and more intra-Westchester trips (where BRT savings over Bee-Line bus service are smaller).

Table 5-10

Aggregate Travel-Time Savings (Hours in the Peak Period [6-10 AM])

Criterion	Alternative/Option							
	3A Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Total Time Savings	4,400	4,500	7,400	3,900	6,200	6,000	8,100	3,800
Cross-Corridor Markets	3,900	4,100	3,600	3,600	2,400	2,500	4,200	2,900
NYC-Bound Markets	400	400	3,800	300	3,800	3,500	3,900	900
Minutes Saved Per Rider	14.0	14.4	20.5	18.1	20.0	15.6	17.4	17.0

5.4 Capacity

5.4.1 Description of Criteria

Two types of capacity measures were calculated: capacity based on the alternative/option service plans, and a theoretical maximum capacity of the proposed infrastructure. Capacity based on the service plan was calculated separately for the cross-corridor and Manhattan-bound routes. In both analyses, the peak-load point is the Tappan Zee Bridge. It should be noted that the capacity based on the service plan calculations is highly flexible, as the percentage utilization for any mode can readily be increased or decreased by changing train consists, type of bus, etc.

5.4.1.1 Capacity at Peak-Load Point for New Service

Weekday peak-hour transit ridership was derived from the BPM outputs by multiplying AM peak-period (6-10 AM) ridership by a factor of 0.40; this factor was arrived at on the basis of a combination of available Metro-North and Bee-Line data. The service plans developed were then used to derive a "capacity" for the new service at the bridge, and the percentage of service utilization was calculated. Capacity was calculated assuming maximum seated loads as follows:

- **Bus** – 50 passengers per vehicle.
- **Light Rail** – 320 passengers per train (four cars at 80 passengers per car).
- **Commuter Rail** – 100 passengers per car (with train lengths varying from four to eight cars, depending on the service pattern).

Service plans called for the following frequency of vehicles. (Note that the service plans for non-BRT alternatives/options – Alternatives 4A and 4B, Option 4A-X, and Cross-Corridor LRT – maintained the No-Build frequency of five cross-Hudson buses per hour. In the alternatives/options with BRT, those five buses have been converted into BRT service and are among the numbers listed.)

Hourly Frequencies

- **Option 3A:** 30 cross-corridor buses and 12 Tarrytown-bound (serving Manhattan market).
- **Option 3B:** 32 cross-corridor buses and 12 Tarrytown-bound (serving Manhattan market).
- **Alternative 4A:** cross-corridor - 5 buses and 4 commuter trains (24 cars); Manhattan-bound commuter trains – 10 (48 cars).
- **Option 4A-X:** cross-corridor - 5 buses and 4 commuter trains (24 cars).
- **Alternative 4B**: 5 cross-corridor buses and 10 Manhattan-bound commuter trains (52 cars).
- **Alternative 4C:** 18 cross-corridor buses and 10 Manhattan-bound commuter trains (48 cars).
- **Option 4D:** cross-corridor- 40 buses and 10 Manhattan-bound commuter trains (48 cars).
- **Cross-Corridor LRT**: cross-corridor - 6 light-rail trains and 5 buses.

Note that while Alternative 4B includes an LRT element, it begins on the Westchester County side, and thus does not factor into capacity on the bridge. Similarly, the commuter rail spur at the Tappan Zee Station is not factored into the capacity calculation in the full-corridor LRT. Allocation of capacity to "Manhattan-Bound" and "Cross-Corridor" segments is relatively straightforward in alternatives/options with Manhattan-bound commuter rail. In Options 3A and 3B, the capacity of buses serving Tarrytown Station was placed in the Manhattan-bound category. In Full-Corridor LRT and Option 4A-X, capacity was simply apportioned according to estimated ridership patterns.

5.4.1.2 Potential to Meet Future Growth Projections

The potential to meet future growth projections is defined as the theoretical maximum seated capacity at a peak-load point (the Tappan Zee Bridge). Vehicle assumptions in this case differ from the capacity based on the service plan. It was assumed that the number of cars per train is higher – 10 cars per train for trains originating at Harriman or south of it, and 8 otherwise. The number of passengers per train was assumed to be 1,000. Additionally, a minimum headway of two minutes was assumed for both LRT and CRT, and 20 seconds for bus in a HOT lane or BRT lane.

Alternatives 4A, 4B, and 4C, Option 4D, and Option 4A-X (commuter rail without the Hudson Line connection) all have the same theoretical maximum capacity, as they all include HOT/BRT lanes on the bridge and commuter rail. The theoretical capacity calculation assumes the maximum number of buses in the HOT/BRT lanes and the maximum number of trains on the CRT tracks. Thus, the theoretical capacity is the same for all.

5.4.2 Comparison of Transit Modes

Results show adequate capacity in all alternatives/options, with total utilization rates ranging from 64 percent to 82 percent (Table 5-11). As can be seen in the table, these service utilization rate totals mask considerable differentials between the rates for the two component markets. In particular, although Options 3A and 3B show the highest and second-highest utilization rates, respectively, in the cross-corridor market, they have the lowest and second-lowest utilization rates, respectively, in the Manhattan-bound market. That is, there is relatively low ridership on the bus routes that make the Tarrytown connection, as discussed above in Subchapter 5.2.2. This indicates that there is room to further adjust service plans to more precisely match demand.

The maximum capacity is clearly highest with rail alternatives/options, as CRT with minimum headways could theoretically carry 39,000 passengers per hour across the bridge. Maximum LRT capacity exceeds BRT capacity.

Table 5-11

Transportation Criteria – Capacity (2035)

Criterion	Alternative/Option								
	1 No Build	**3A** Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Capacity at Peak-Load Point for New Service									
Weekday AM Peak Hour, Peak Direction Transit Ridership on New Service									
Total	NA	1,330	1,430	4,760	1,860	4,160	4,560	4,950	1,420
Manhattan-Bound	NA	80	130	3,500	600	3,750	3,870	3,840	560
Cross-Corridor	NA	1,250	1,300	1,260	1,260	420	690	1,110	850
Weekday Peak Hour, Peak Direction Transit Ridership Capacity(seated capacity based on service plan)									
Total	NA	2,000	2,100	7,450	2,650	5,050	5,700	6,800	2,170
Manhattan-Bound	NA	500	500	4,800	855	4,400	4,800	5,300	860
Cross-Corridor	NA	1,500	1,600	2,650	1,795	650	900	1,500	1,310
Service Utilization (Percent)									
Total	NA	67	68	64	70	82	80	73	65
Manhattan-Bound	NA	16	26	73	70	85	81	72	65
Cross-Corridor	NA	83	81	48	70	65	77	74	65
Potential to Meet Future Growth Projections									
Seated Capacity	NA	9,000	9,000	39,000	39,000	39,000	39,000	39,000	18,600

Notes:
NA = Not applicable.
Potential to Meet Future Growth Projections = theoretical maximum peak direction seated capacity at a peak-load point (Tappan Zee Bridge).

5.5 Roadway Congestion

Transit alternatives/options can have varying impacts on the roadway network, as people switch from auto to transit. Note that all the build alternatives/options include an eight-lane bridge, HOT lanes and climbing lanes. It is important to remember that not all new transit trips are trips diverted from autos – many will be new trips to those markets. Moreover, in a congested region, the benefits of reductions in vehicle demand tend to get diluted over a wide area, as vehicles on congested roads seek out newly freed-up capacity.

A much more thorough analysis of roadway impacts will be conducted for the DEIS, with a microsimulation model assessing traffic conditions all along the corridor.

5.5.1 Description of Criteria

5.5.1.1 Eastbound Vehicles Crossing Hudson River

The BPM AM peak-period (6-10 AM) highway assignment was used to estimate eastbound vehicles crossing the Hudson River, from the Holland Tunnel to the Newburgh-Beacon Bridge. The difference in volumes obtained from BPM for each alternative/option was then compared, to determine the net number of autos diverted to transit for a given alternative/option.

5.5.1.2 Vehicle Miles Traveled (VMT)

BPM assignments for the AM peak period were used to calculate VMT for counties where notable changes were observed across alternatives/options. These were Rockland, Westchester, Orange, Bergen, and Bronx Counties.

5.5.2 Comparison of Transit Modes

Table 5-12 shows the results for roadway congestion for the five measures in the AM peak – eastbound vehicles crossing the Hudson, eastbound autos diverted from Hudson crossings, eastbound diversions from the Hudson crossings based solely on transit impacts, eastbound Rockland and Orange County vehicles crossing the Hudson, and Regional VMT. Option 4D removes the greatest number of autos from Hudson River crossings, which is consistent with transit ridership results. The 6,000 vehicles removed over four hours are nearly equivalent to the capacity of one vehicle lane. Options 3A and 3B reduce peak-period cross-Hudson traffic the least, at 4,300 and 4,000 vehicles, respectively. This is consistent with their attracting the fewest total cross-Hudson passengers.

All build alternatives/options include highway improvements (HOT lanes, climbing lanes, and a rehabilitated or replacement bridge) which have substantial impact on traffic measures. To isolate impacts of transit only, another model run with highway improvements but no transit improvements was conducted. That run showed 142,100 vehicles crossing the Hudson. The peak-period cross-Hudson diversions when compared to this alternative are even higher when comparisons are made to the No Build alternative, since it has a higher number of vehicles crossing the Hudson. Table 5-12 also illustrates the eastbound Rockland and Orange County vehicle crossings which were derived from trip tables and not highway assignments in order to isolate vehicles from the two counties.

In regional VMT, Alternative 4A and Option 4D show the lowest overall VMT levels, with 17.335 million miles; Alternative 4B is essentially the same, at 17.336 million miles. However, on a percentage basis, the differences among

alternatives/options are not significant, as the total for the worst performer among the build alternatives/options – Option 3B – is 17.38 million miles, a figure which is just over one-quarter of one percent larger than the best performer.

Table 5-12

Transportation Criteria – Roadway Congestion (2035)

Criterion	Alternative/Option								
	1 No Build	**3A** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**3B** Full- Corridor BRT Enhanced	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full- Corridor BRT (3A)	Full- Corridor LRT
Eastbound Vehicles Crossing Hudson River (AM Peak Period)	139,600	135,300	135,600	134,700	134,800	134,400	134,100	133,600	134,800
Eastbound Autos Diverted from Hudson River Crossings (AM Peak Period)	NA	4,300	4,000	4,900	4,800	5,200	5,500	6,000	4,800
Eastbound auto Diversions solely based on transit impacts (AM Peak Period)*	NA	6,700	6,400	7,300	7,200	7,600	7,900	8,400	7,200
Eastbound Rockland and Orange vehicles crossing the Hudson River (AM Peak Period)	41,500	40,400	40,400	39,900	40,600	40,000	40,000	39,400	40,300
Regional Vehicle Miles Traveled (AM Peak Period)***	17,561,000	17,366,000	17,376,000	17,335,000	17,370,000	17,336,000	17,345,000	17,335,000	17,360,000
Reduction in Regional Vehicle Miles Traveled (AM Peak Period)***	NA	195,000	185,000	226,000	191,000	225,000	216,000	226,000	201,000

* These numbers reflect a comparison with a different base which includes the No Build transit network and HOT lanes in the highway network.

** Includes journeys across all Hudson River crossings - from the Verrazano to the Newburgh-Beacon Bridges.

***VMT in five counties: Rockland, Orange, Westchester, Bergen and the Bronx.
NA = Not applicable.

5.6 Summary

The various measures discussed in this chapter tell similar stories – Option 4D attracts the most transit riders, though Alternative 4A includes proportionally more longer-distance trips with greater time savings, so on some measures, Alternative 4A ranks highest. BRT serves the most shorter-distance trips, whether they are intra-Rockland or intra-Westchester County trips. CRT serves the Manhattan-bound market best. Longer-distance circumferential trips show mixed results; all modes that do not require a transfer perform well, with CRT slightly outperforming BRT, which in turn outperforms LRT. Since LRT requires a transfer for Orange County users (at Suffern) and for Connecticut users (at Port Chester), it lags behind both CRT and BRT. While CRT offers greater in-vehicle time savings than BRT, the ability of BRT to support a geographically extensive service plan enables it to compensate for slower run times by reducing both access and egress times.

BRT

LRT

CRT