7 Transportation Criteria

7.1 Introduction

A goal of this project is to improve mobility in the corridor. To that end, all the major Project alternatives identified at this point in the study include significant transit components:

- Bus rapid transit (BRT) in Alternative 3 and Options 3A, 3B and 4D
- Light rail transit (LRT) in the Westchester component of Alternative 4B (but not on the bridge)
- Commuter rail transit (CRT) in Alternatives 4A, 4B and 4C and Option 4D

The alternatives that do not include transit are Alternative 1, the no build (by definition), and Alternative 2, which is represented in this report by Rehabilitation Option 1. Recognizing that Alternative 2 as developed in the AA report did not meet Project Purpose and Need, other Rehabilitation Options were developed as part of this report and are designed to include BRT or CRT service. With respect to transit, these new Rehabilitation Options are functionally equivalent to the Replacement Options being studied.

The BRT or CRT services would not be fundamentally different if provided on a rehabilitated or a replacement bridge. Therefore, the appropriate comparison in the evaluation of transportation criteria is to compare Rehabilitation Option 1 – that has no provision for transit service – to the other Rehabilitation and Replacement Options that do. Thus, this chapter is organized somewhat differently from the other criteria evaluations in this report.

The transportation evaluation criteria considered to be used in the evaluation of the bridge options modes were:

- Transit Ridership
- Roadway Congestion
- Transit Capacity
- Travel Time

7.2 Transit Ridership

As Rehabilitation Option 1 would include no transit component, it would obviously have no new transit ridership, while all the other options do. Whether a given transit mode is part of a replacement or rehabilitated option, it would operate at the same speeds, have the same level of comfort and the same travel times. Consequently, Rehabilitation Options 2 and 3 would have the same BRT ridership as Replacement Option 1, and those riders would enjoy the same travel time benefits. Rehabilitation Option 4 and Replacement Options 2 and 3 offer the same characteristics and benefits to CRT riders.

Table 7-1 provides the ridership characteristics of the options. Rehabilitation 1 offers no transit capacity increase, while the other Rehabilitation and Replacement Options provide significant transit ridership benefits.

7.3 Roadway Congestion

Two measures of roadway congestion were analyzed:

- **Vehicles Diverted** - 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 volumes obtained from BPM for each option are compared to determine the net number of auto users diverted to transit for a given option.
- **Vehicle Miles Traveled (VMT**) - BPM assignments for the AM peak period were used to calculate VMT for selected counties (Rockland, Westchester, Orange, Bergen, Bronx).

Under Rehabilitation Option 1 there would be 139,600 eastbound vehicles crossing the Hudson River in the AM peak period. The VMT in the AM peak period would be 17,561,000. Finally, no vehicles would be diverted from any Hudson River crossings. The other options would offer the potential for diverting vehicles from the Hudson River crossings and reductions in VMT of several hundred thousand in the AM peak period. Table 7-2 (page 67) provides number of vehicles and vehicle miles of the options.

OPTION DESCRIPTION	Rehab 1 No New Transit	Rehab 2,3 and Replace 1 Full Corridor BRT Enhanced	Rehab 4 and Replace 2,3 Full Corridor CRT with Hudson Line (HL) Connection
Total Daily Transit Trips for Selected Major Markets (Weekday)			
Cross-Corridor	66,500	81,000	75,200
To/From NYC	94,900	103,800	108,000
Total	161,400	184,800	183,200
System Wide New Transit Trips	NA	23,400	21,800
Daily Transit Ridership on New Service (Weekday)			
Intra-Rockland/ Orange-Rockland	NA	12,800	3,200
Cross-Hudson Circumferential	NA	10,700	11,600
Intra-Westchester/ Westchester-CT	NA	29,700	17,500
Cross-Hudson to/from GCT	NA	800	25,800
Tappan Zee Station to/from GCT	NA	NA	3,800
Total	NA	54,000	61,900
Eastbound Transit Accessibility West of Hudson (passengers)	820	3,260	11,830

Table 7-1
Transportation Criteria - Ridership (2035)

OPTION DESCRIPTION	Rehab 1 No New Transit	Rehab 2,3 and Replace 1 Full Corridor BRT Enhanced	Rehab 4 and Replace 2,3 Full Corridor CRT with Hudson Line (HL) Connection
Roadway Congestion			
Eastbound Vehicles Crossing Hudson River (AM Peak Period)	139,600	135,300	134,700
Eastbound Vehicles Diverted from Hudson River Crossings (AM Peak Period)	NA	4,300	4,900
Vehicle Miles Traveled (AM Peak Period)	17,561,000	17,366,000	17,335,000

Table 7-2

Transportation Criteria - Roadway Congestion (2035)

Rehabilitation Option 1 would not include any of the improvements to the Tappan Zee Bridge that the other rehabilitation options would include. As a result, it would provide no transit service, garner no transit riders, put the most vehicles on the Tappan Zee Bridge and would result in the most vehicle miles of travel of the options. The other options would have the higher transit ridership, result in fewer vehicles on the Tappan Zee Bridge and fewer overall vehicle miles of travel.

7.4 Transit Capacity

Two types of capacity calculations were performed: capacity based on the alternative service plans, and a theoretical maximum capacity of the system. Capacity based on the service plan was calculated separately for the cross corridor and Manhattan bound routes (see Transit Mode Selection Report, Appendix A). 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 a highly flexible parameter as the percent utilization for any mode can readily be increased or decreased by changing the number of passenger cars in each train , by changing type of bus, etc.

This criterion is not pertinent to Rehabilitation Option 1 as there is no transit capacity on the Bridge. As shown in Table 7-3, all the other options make possible a transit system in the corridor with sufficient capacity for the ridership projected for 2035 as well as reserve system capacity for future generations of transit riders. Rehabilitation Option 1 would provide no transit capacity and would therefore provide no potential for increased transit service. The other Rehabilitation Options would provide the same substantial increase in transit capacity as their equivalent Replacement Options.

7.5 Travel Time

To facilitate the analyses of travel time, numerous trip pairs were selected to analyze changes in areas where new facilities and services are provided to represent the variety of markets served by the corridor. The results for selected trip pairs are presented in Tables 7-4 and 7-5 (page 68). These tables show the time for the fastest transit path for each pair, regardless of transit mode, whether by commuter rail, light rail, bus, or some combination of those. The travel times are door-to-door values, which include waiting time, walking time, and driving time (if driving to a transit stop is part of the fastest path).

- **Travel Time for New Service for Selected Trip Pairs** (Table 7-4) - Travel times in minutes were calculated based on the BPM runs. The outputs used were the AM period shortest path tables (in terms of time), which include all components of a journey, such as access time, in-vehicle time and egress time. The BPM calculates the shortest paths based on four access categories - drive or walk to commuter rail or other transit. The minimum of these four shortest paths was used to compute door-to-door travel times. Due to the inherent difference in drive and walk access markets, they were analyzed separately.
- **Travel Time Savings for New Service for Selected Trip Pairs** (Table 7-5) - Travel time savings were calculated by comparing the results of each option to Rehabilitation Option 1 (no build from a transit perspective).

Under Rehabilitation Option 1 travel times would increase significantly from those experienced in 2005 (Table 7-4, page 68). Because the other options make provision for transit modes, they offer significant travel time savings (Table 7-5, page 68) depending on the transit mode.

OPTION DESCRIPTION	Rehab 1 No New Transit	Rehab 2,3 and Replace 1 Full Corridor BRT Enhanced	Rehab 4 and Replace 2,3 Full Corridor CRT with Hudson Line (HL) Connection
Capacity at Peak Load Point for New Service			
Weekday AM Peak Hour, Peak Direction Transit Ridership on New Service			
Total	NA	1,330	4,760
Manhattan-Bound	NA	80	3,500
Cross Corridor	NA	1,250	1,260
Weekday Peak Hour, Peak Direction Transit Ridership Capacity (seated capacity based on service plan)			
Total	NA	2,000	7,450
Manhattan-Bound	NA	500	4,800
Cross Corridor	NA	1,500	2,650
Service Utilization (%)			
Total	NA	67%	64%
Manhattan-Bound	NA	16%	73%
Cross Corridor	NA	83%	48%
Potential to Meet Future Growth Projections			
Seated Capacity	NA	9,000	39,000

Table 7-3

Transportation Criteria - Capacity (2035)

OPTION		Rehab 1	Rehab 2,3 and Replace 1	Rehab 4 and Replace 2,3
FROM	TO	No New Transit	Full Corridor BRT Enhanced	Full Corridor CRT with Hudson Line (HL) Connection
Intra-Rockland				
Suffern	Palisades Mall	60	25	30
Rockland – Westchester				
Spring Valley	White Plains (Martine and Lexington)	78	37	45
Spring Valley	Mt. Pleasant (9A and 100C)	94	56	63
Nyack	Platinum Mile	80	41	46
Suffern	White Plains (Martine and Lexington)	96	44	51
Suffern	Yonkers	114	72	97
Manhattan Bound				
Harriman	45th & Madison	114	114	97
Nyack	45th & Madison	96	77	63
Suffern	45th & Madison	85	85	68
Newburgh	40th & 3rd Ave	141	141	123
Spring Valley	40th & 3rd Ave	105	107	71
Middletown	Macy's, 34th and 7th	142	142	142
Nyack	Macy's, 354h and 7th	113	91	77
Middletown	World Trade Center	154	151	154
Spring Valley	World Trade Center	102	100	84
Harriman	36th and 11th	115	115	116
Nyack	36th and 11th	118	104	86
Westchester-CT				
Elmsford	Stamford (Main St./Washington Blvd)	67	57	53
CT-Westchester				
Darien	Platinum Mile	80	75	62
Westchester-Westchester				
Port Chester	White Plains (Martine and Lexington)	41	28	34
Other Trip Pairs				
Bronx (Gr.Concourse, 180th St.	Palisades Mall	130	93	89
Spring Valley	Bronx (Montefiore Hospital)	115	74	101

Table 7-4

Transportation Criteria – Travel Time (Minutes) (2035)

AM Peak Travel Times (Door to Door) for Selected Pairs

OPTION		Rehab 1	Rehab 2,3 and Replace 1	Rehab 4 and Replace 2,3
FROM	TO	No New Transit	Full Corridor BRT Enhanced	Full Corridor CRT with Hudson Line (HL) Connection
Intra-Rockland				
Suffern	Palisades Mall	0	35	30
Rockland – Westchester				
Spring Valley	White Plains (Martine and Lexington)	0	41	33
Spring Valley	Mt. Pleasant (9A and 100C)	0	39	31
Nyack	Platinum Mile	0	40	35
Suffern	White Plains (Martine and Lexington)	0	52	44
Suffern	Yonkers	0	42	17
Manhattan Bound				
Harriman	45th & Madison	0	0	17
Nyack	45th & Madison	0	19	33
Suffern	45th & Madison	0	0	16
Newburgh	40th & 3rd Ave	0	0	18
Spring Valley	40th & 3rd Ave	0	-2	34
Middletown	Macy's, 35th and 7th	0	0	0
Nyack	Macy's, 35th and 7th	0	21	35
Middletown	World Trade Center	0	3	0
Spring Valley	World Trade Center	0	2	18
Harriman	34th and 11th	0	0	0
Nyack	34th and 11th	0	14	33
Westchester-CT				
Elmsford	Stamford (Main St./Washington Blvd)	0	11	15
CT-Westchester				
Darien	Platinum Mile	0	5	18
Westchester-Westchester				
Port Chester	White Plains (Martine and Lexington)	0	13	7
Other Trip Pairs				
Bronx (Gr.Concourse, 180th St.	Palisades Mall	0	36	41
Spring Valley	Bronx (Montefiore Hospital)	0	42	14

Table 7-5

Transportation Criteria – Travel Time (Minutes) (2035)

AM Peak Travel Time Savings (Door to Door) for Selected Pairs

7.6 Traffic Safety

7.6.1 Rehabilitation Option 1

The horizontal and vertical geometric cross-section elements of Rehabilitation Option 1 have been evaluated and a number of features that compromise traffic safety have been identified. These include the retention of the main span roadway, which is not in accordance with current highway design standards as recommended by "A Policy on Geometric Design of Highways and Streets" (AASHTO, 2004). The rehabilitated main span roadway would retain non-standard lane widths, no outside shoulders and a movable median barrier also without shoulders. The rehabilitation would introduce a horizontal transition curve at the connection from the causeway to the main span that lacks lane continuity at certain times of each day. Motorists react to these non-standard and undesirable roadway features by driving more defensively and adjusting their speed and their travel paths, resulting in a greater potential for rear-end and side-swipe collisions. The specific roadway cross-section elements identified are described below:

- **Lack of Shoulders**: The main-span and deck trusses would retain the existing cross-section, which has no left or right shoulders. The proposed full shoulders on the new causeways to the west would terminate west of the connection to the existing main-span. Dropping both shoulders will result in motorists shying away from the outer edges of the left and right most lanes toward the middle lanes The lack of shoulders over the eastern half of the Bridge would continue to prevent safe and timely recovery from breakdowns and accidents and deny motorists a path to avoid collisions and a safe refuge when they have mechanical failures.
- **Reverse Peak Direction Lane Drop**: The rehabilitated main-span and deck trusses would retain the existing seven-lane configuration utilizing a moveable barrier to provide 4 lanes in the peak direction. The proposed reconstructed causeways would carry four lanes in each direction. During the PM peak period, eastbound motorists would experience a left-lane-drop as the new causeway ends and connects to the deck truss. Dropping the fourth and high-speed left lane, before the main-span, would require motorists in the left lane to merge into the adjacent lane to the right. This would increase the probability of sideswipe and rear end collisions as motorists in this area adjust their speed and travel paths to merge or to accommodate the merging vehicles.
- **Moveable Median Barrier**: The main-span and deck trusses would retain the operation of the moveable median barrier, from the west end of the main-span to the Westchester shoreline, to provide four lanes in the peak direction and three in the off-peak direction. The daily transfer operations of the moveable barrier system occur directly adjacent to the high-speed left lane of both travel directions. Motorists would likely adjust their speed and travel paths,when passing the transfer vehicle. This results in a ripple-effect along the route of the operation where motorists become more defensive by adjusting their speed and their travel paths to accommodate the change in roadside conditions.
- **Lane Width**: The main-span would retain the non-standard lane widths that vary from 11'-5" to 11'-9". While the proposed causeways will be constructed to provide standard 12'-0" wide lanes, the transition from standard lane widths on the eastbound causeway to the non-standard lane widths, on the main-span, would create driver discomfort and require them to adjust their travel paths to the more confining narrower lanes. This results in motorists becoming more defensive in this area, by reducing their speed to accommodate the travel path adjustments.
- **Horizontal Alignment**: The introduction of the proposed horizontal transition curve, on each causeway at the west end of the main-span, (which previously had a straight alignment), would oblige motorists to become more defensive in this area. They will react by adjusting their speed and their travel paths to avoid collisions as they navigate the curves. These changes in speed often produce shock waves which create stop-and-go conditions during periods of high volume traffic potentially leading to higher rear-end collision rates and greater lane changing leading to increased numbers of side-swipe accidents.
- **Vertical Alignment – Grades and Glare:** The eastbound approach to the main-span is on a 3 percent uphill grade and faces due east. The transition to the uphill grade, after the flat causeway, results in significant turbulence in the vehicle stream, as motorists recognize at different times the need to apply power to maintain consistent speed. This situation is exasperated when there is bright sun glare during the AM peak period. The result is large gaps in the traffic stream which could lead to driver frustration and excessive lane changing which in turn leads to higher potential for collisions.

7.6.2 Rehabilitation Option 2

Rehabilitation Option 2 would improve the geometry provided in Rehabilitation Option 1 by including continuous 12-foot lanes without transition curves, outside and median shoulders and lane continuity (8 continuous general purpose (GP) lanes in both directions).

However a potentially unsafe condition would be introduced at both east and west approaches to the widened and rehabilitated main span. Both eastbound and westbound lane groups would be split to avoid the existing main span trusses (see Figure, 3-4, Figure 3-5 Section 2 – Main Span and Figure 3-3 bottom, pages 16, 19 & 15). One GP lane would be paired with the BRT/HOV lane, while the remaining three GP lanes would be carried on the added outside truss section. Although clear advanced signage would be provided, some inattentive motorists or those unfamiliar with the Bridge will become confused on the approach to the split. As a result they would slow down to give themselves more time to react or engage in erratic lane changing maneuvers, possibly at high speed as they move to the other lane group, leading to potentially serious collisions.

Another traffic safety issue related to the lane split occurs in the eastbound direction as the split lanes are rejoined at the end of the main span. After the split, motorists would have to determine if they are correctly positioned as they approach the Toll Plaza to proceed through the highway speed E-Z Pass lanes, the cash paying toll booths, or exit at the far right for Interchange 9. To reposition themselves, a driver would have to weave across one or more of the four GP lanes on the Bridge while traversing the long curve that terminates into the plaza. Considering that cars would be weaving in both directions (some cars moving left to the E-Z Pass lanes while others would be moving right to the cash booths or to exit), this would create turbulence in the traffic flow and the unsafe condition of cars unexpectedly weaving in both directions. Compounding the issue is the fact that the available weaving distance from the split to the start of the plaza is less than the recommended length to weave across a four highway lanes. Ideally the distance provided would be 1,000 ft per lane or 3,000 ft to move from the far left lane to the outer right lane. This is less than the approximately 2,500 ft available.

In summary, although Rehabilitation Option 2 removes a number of the non-standard features that are included in Rehabilitation Option 1, it introduces a lane split, which is an undesirable highway feature that compromises traffic safety and creates operational difficulties.

7.6.3 Replacement Options and Rehabilitation Options 3 & 4

The Replacement Bridge Options and Rehab Options 3 and 4 all provide lane continuity across the Bridge, continuous full width median and outside shoulders, continuous 12-foot wide travel lanes and no horizontal transition curves or obstructing structure to maneuver around. The roadway cross-sections of each of these options would be designed to all applicable standards and would therefore have no related traffic safety issues.

7.6.4 Comparison of Options

Rehabilitation Option 1 has a number of significant traffic safety issues that are directly related to the retention of the existing the main span cross-section with its non-standard elements. These issues may be expected to perpetuate the already high and severe accident rate on the main span. The safety issues related to the nonstandard features on the main span are compounded by the addition of a transition curve from the new causeway and the need for a lane drop in the eastbound direction during the PM peak period. The inability to rapidly respond to accidents and clear collisions or breakdowns, due to the lack of shoulders in the rehabilitated section, would also perpetuate the sense of unreliability of the Bridge that would increase over time as traffic levels rise.

Rehabilitation Option 2 introduces traffic safety and operational concerns connected with the separation of travel lanes to cross the main span trusses. As a long term solution, this lane separation would create a permanent safety deficiency that could result in unnecessary collisions at rates equal to or possibly exceeding the already poor safety conditions on the main span.

The Replacement Bridge Options and Rehabilitation Options 3 and 4 would be designed to eliminate the existing non-standard features and provide roadway cross-section elements that meet or exceed all recommended highway design guidelines. They would maximize vehicular safety.

7.7 Other Evaluation Criteria

A number of other evaluation criteria are briefly noted:

- **Transportation System Integration** – Without a transit capability, Rehabilitation Option 1 offers no opportunities for transit system integration. The other options include a transit component, with those including CRT offering the opportunity for integration with the existing Metro-North commuter rail system.
- **Alternative Mode(s) Not in Mixed Traffic** – Rehabilitation Option 1 would not address the Project Purpose and Need to improve mobility, particularly by expediting transit based riders as it offers no alternative mode that is not in mixed traffic. All other options offer BRT or CRT in dedicated rights-of-way.
- **Rail Freight** - Only the bridge options with CRT facilities can accommodate rail freight. Rehabilitation Options 1, 2 and 3 along with Replacement Option 1 offer no capability for rail freight in the future.