

CLINTON/HELLS KITCHEN NEIGHBORHOOD TRAFFIC STUDY

FINAL REPORT
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City of New York
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A Member of the New York
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EXECUTIVE SUMMARY

The Clinton/Hell's Kitchen Neighborhood Traffic Study has been undertaken by the New York City Department of Transportation (NYCDOT) with the goals of improving safety, mobility, and the quality of life for all street users (pedestrians, cyclists, transit users and motorists). This report presents recommended improvement measures based on analysis of existing and projected future conditions, as well as community input and feedback.

The Clinton/Hell's Kitchen neighborhood study area extends from West 29th Street to West 55th Street, and from 8th Avenue to the Hudson River. It lies entirely within the boundaries of Manhattan Community Board 4 and includes the entire Hell's Kitchen neighborhood, the Special Clinton District and the western part of the Garment District.

The initiation of this study coincided with a number of major ongoing public and private projects in the study area, including public works projects, rezoning actions, and large-scale private developments. As a result, there is ongoing and growing competition between the various functions of the street, curb, terminal/parking facilities and sidewalk space, by competing street users including pedestrians, bicyclists, transit users, tour buses, delivery trucks, taxis and private autos.

As a result of these competing demands for the use of the street network and in response to congestion-related concerns expressed by the Community Board and local elected officials, NYCDOT is performing this study to address these issues. Problems were identified based on data collection and analyses, field observations and consultation with stakeholders such as residents, local businesses, transportation providers, Community Board members, elected officials, local government agencies and various interest groups. The following is a summary of the major problems that were identified:

- High levels of congestion in the study area network, mainly due to spillback from the Lincoln Tunnel.
- Problematic access and egress points to the Lincoln Tunnel because of bottleneck conditions, especially on 9th Avenue.
- Discontinuous sidewalk on west side of 9th Avenue between West 36th and West 37th Streets.
- Crosswalk safety is compromised when pedestrians crossing concurrently with conflicting turning vehicles.
- Conditions of sidewalks, including sidewalk overcrowding, auto repair and other unauthorized parking on sidewalks, and poor condition of roadbed and pavement markings.
- Lack of bicycle facilities.
- Problems caused by transit, charter and tour buses, including unsafe bus turning movements, bus layover and pick-up/drop-off areas and conflicts with pedestrians.

In order to address these identified issues, improvement measures were designed and analyzed. Improvements that have already been implemented are:

- Crosswalks with set-back stop bars.
- Improved signage.
- Bike Lanes on 8th and 9th Avenues.
- 34th Street Select Bus Service Phase I.
- Relocated bus layover areas and expanded bus stops.
- Signal timing changes, including leading pedestrian intervals (LPIs), increased time to cross wide avenues, offset changes to improve progression, feathering of 9th Avenue, split phase for bikes and increased green time for 9th Avenue.
- Curb extension at West 41st Street and 9th Avenue.
- “Canoe” project to provide expanded, attractive landscaped pedestrian island and provide continuous sidewalk on west side of 9th Avenue between West 36th and West 37th Streets.
- Turn prohibitions at selected locations to reduce congestion and improve pedestrian and vehicular safety on 9th Avenue.

Other improvements planned for later implementation include:

- 34th Street Select Bus Service Phase II.
- Split phase for conflict-free crossing of 9th Avenue at West 43rd Street.
- Split-phase for conflict free crossing of West 41st Street at 9th Avenue.
- Split-phases or LPIs for conflict free crossing of 8th and 9th Avenues at other problem locations.
- Improved signage for 9th Avenue.
- Conversion of 11th Avenue to two-way south of West 37th Street.
- Alternative configurations for 11th Avenue north of West 44th Street.
- PM peak period contra-flow bus lane on Dyer Avenue to relieve congestion and improve pedestrian safety on 9th Avenue.
- Expansion of Port Authority Bus Terminal.

These improvements have been evaluated and their benefits and costs have been quantified using Synchro/SimTraffic software, where applicable.

CHAPTER 1 INTRODUCTION

The Clinton/Hell’s Kitchen Neighborhood Traffic Study has been undertaken by the New York City Department of Transportation (NYCDOT) with the goals of improving mobility, safety and the quality of life for all street users. The study is consistent with the City’s goal of building “Complete Streets” that accommodate all street users including pedestrians, cyclists, transit users and motorists.

As shown in Figure 1.1.1, the study area boundaries are West 29th Street on the south, West 55th Street on the north, 8th Avenue on the east and the Hudson River on the west. It lies entirely within the boundaries of Manhattan Community Board #4 and includes the entire Hell’s Kitchen neighborhood, the Special Clinton District and the western part of the Garment District. The study area consists of 131 signalized intersections, three signalized mid-block crosswalks, four signalized driveways and four unsignalized intersections.

Existing regional transportation facilities within the study area include the Lincoln Tunnel, NYS Route 9A, and the Port Authority Bus Terminal (PABT). In addition, there are major trip generators within the study area, including the Javits Convention



Figure 1.1.1: Study Area

Center, the Manhattan Cruise Terminal, the USS Intrepid Museum, Theater Row, Restaurant Row, the Hudson River Greenway Bike Path, the Caemmerer Rail Yards, the Quill Bus Depot, the US Postal Service complex, and major distribution centers of three package delivery companies. The study area is also home to about 37,000 residents and 96,000 jobs. Directly adjacent to the study area are the theater district, Times Square, the garment district, Penn Station and Madison Square Garden on the east, the Chelsea neighborhood on the south, and the Upper West Side on the north.

The study area is poised to experience significant growth in residential and commercial development as a result of the Hudson Yards Rezoning & Development Program and the Number 7 Subway Extension actions. This allows and provides for development at increased densities in the area. As a result, there is ongoing and growing competition among the various functions of the street, curb, terminal/parking facilities and sidewalk space, by several types of users including pedestrians, cyclists, transit users, delivery vehicles, tour buses, taxis and private autos.

The public outreach effort to obtain community input was a critical component throughout the study process. This has involved the participation of elected officials, Community Board 4, transportation/transit providers, merchants/shoppers, and other community groups/civic organizations. Inter-agency coordination was also critical, as various city, state and federal agencies have specific requirements, issues and jurisdictions within the study area. Input from these activities have facilitated the identification of community issues which were incorporated into the development of the various improvement options and the selection of the recommended improvements. A detailed record of the public and agency involvement process and the resulting input on problems to address was regularly documented.

CHAPTER 2 EXISTING CONDITIONS

As a result of existing transportation facilities that provide regional transportation through the study area – such as the Lincoln Tunnel and the PABT– as well as trip generators within and adjacent to the study area, there is ongoing competition between the various functions of the street, curb, terminal/parking facilities and sidewalk space. Geometric constraints make this study area challenging to provide safe and efficient operations for all street users, including pedestrians, cyclists, transit users, delivery vehicles, taxis and private autos. This chapter summarizes the findings of existing and future without improvements conditions.

2.1 Traffic

The main traffic problem to be addressed is the chronic congestion caused by vehicular access to and from the Lincoln Tunnel. This is especially apparent during the weekday PM peak hour, when vehicular demand for the New Jersey-bound (outbound) Lincoln Tunnel exceeds capacity, causing congestion on corridors leading to the tunnel. For this reason, the focus of traffic analysis is on corridors leading to and affected by the Lincoln Tunnel during the weekday PM peak hour. This is not meant to underestimate the traffic problems during other times, but rather to focus the attention on the time that has the worst congestion.

The Lincoln Tunnel contains three tubes which provide two lanes each for a total of six lanes. The south tube is always inbound (New York bound), and the north tube is always outbound (New Jersey bound). The reversible center tube typically provides two inbound lanes during the weekday AM peak period, two outbound lanes during the weekday PM peak period, and one lane in each direction during all other times. There are exceptions to this rule, for example, to accommodate events at Met Life Stadium. During a typical weekday PM peak hour, there are a total of four outbound lanes.

Synchro and SimTraffic software was used to analyze network performance during base year conditions, future without improvements conditions, and to test the effectiveness of improvement packages. The performance measures analyzed include average speeds for roadway segments, and delays and queues for individual movements, where applicable.

The model was customized to account for the effects of Lincoln Tunnel backups on individual intersection throughput and overall street network performance. The results of analysis are presented for all or part of the following eight corridors within the study area:

- 8th Avenue from West 29th to West 43rd Streets
- 9th Avenue
 - from West 48th to West 41st Streets
 - from West 41st to West 36th Streets
 - from West 36th to West 29th Streets
- 10th Avenue from West 29th to West 42nd Streets
- 11th Avenue southbound
 - from West 46th to West 40th Streets
 - from West 40th to West 29th Streets

- 11th Avenue northbound from West 34th to West 40th Streets
- West 34th Street both directions between 8th Avenue and Route 9A
- West 41st Street from 8th to 11th Avenues
- West 42nd Street both directions between 8th Avenue and Route 9A

Ninth Avenue is broken up as described above because access to the Lincoln Tunnel at West 41st and West 36th Streets causes this corridor to behave like three distinct segments. Likewise, southbound 11th Avenue is divided into two segments at West 40th Street.

The analysis of existing conditions was performed for the base year 2008 for the weekday PM peak hour for two scenarios which differ in the enforcement of a turn prohibition. Signs prohibit the right-turn from 9th Avenue to West 41st Street for all traffic except buses from 4PM to 7PM weekdays. There is often non-compliance when this is not enforced with a traffic enforcement agent. The first scenario uses the volumes as shown in Figure 2.1.1 when the ban was not enforced, which includes 280 cars and 20 trucks making this turn illegally, in addition to 100 buses that make this turn legally. Figure 2.1.2 presents a schematic diagram of the ramps leading to the Lincoln Tunnel, and the processed volumes under this scenario.

The second scenario represents the condition when the right-turn ban is enforced. The 280 cars are reassigned to the ramp just north of West 36th Street that leads to the Lincoln Tunnel (Ramp C), and the 20 trucks are reassigned to the north tube via West 39th Street and 11th Avenue. This dual-scenario approach was chosen because the presence or absence of cars and trucks making right-turns from 9th Avenue onto West 41st Street makes a significant difference in overall traffic operations on 9th Avenue, especially the segment between West 41st and West 36th Streets, and for bus flow on West 41st Street.

The results of the SimTraffic simulation for the two existing conditions scenarios are displayed in Figure 2.1.3. The model was calibrated so that the speeds reported by the simulation are in the same ranges as actual speeds from field collected travel time and delay runs as well as from taxi GPS data.

As shown in Figure 2.1.3, the biggest difference in operations between the two scenarios is the average travel speed on West 41st Street. Under the Ban Not Enforced scenario, in which 280 cars and 20 trucks illegally turn onto West 41st Street, the average travel speed is 4.0 mph on the West 41st Street segment. Under the Ban Enforced scenario, the average travel speed is 10.9 mph, a noticeable improvement. The reason for the ban is that West 41st Street is the principal on-street connection for buses between the Port Authority Bus Terminal and the Lincoln Tunnel. The congestion caused by cars and trucks turning illegally onto West 41st Street delays thousands of bus passengers.

On the segment of 9th Avenue from West 48th to West 41st Streets, the average travel speed is 7.5 mph under the Ban Not Enforced scenario. Under the Ban Enforced scenario, the travel speed is slightly lower at 7.4 mph. On the segment of 9th Avenue from West 41st to West 36th Streets, where the entrance to Ramp C is, the differences between the two scenarios are more pronounced. Under the Ban Not Enforced scenario, the average travel speed on this segment is a relatively brisk 13.6 mph, but under the Ban Enforced

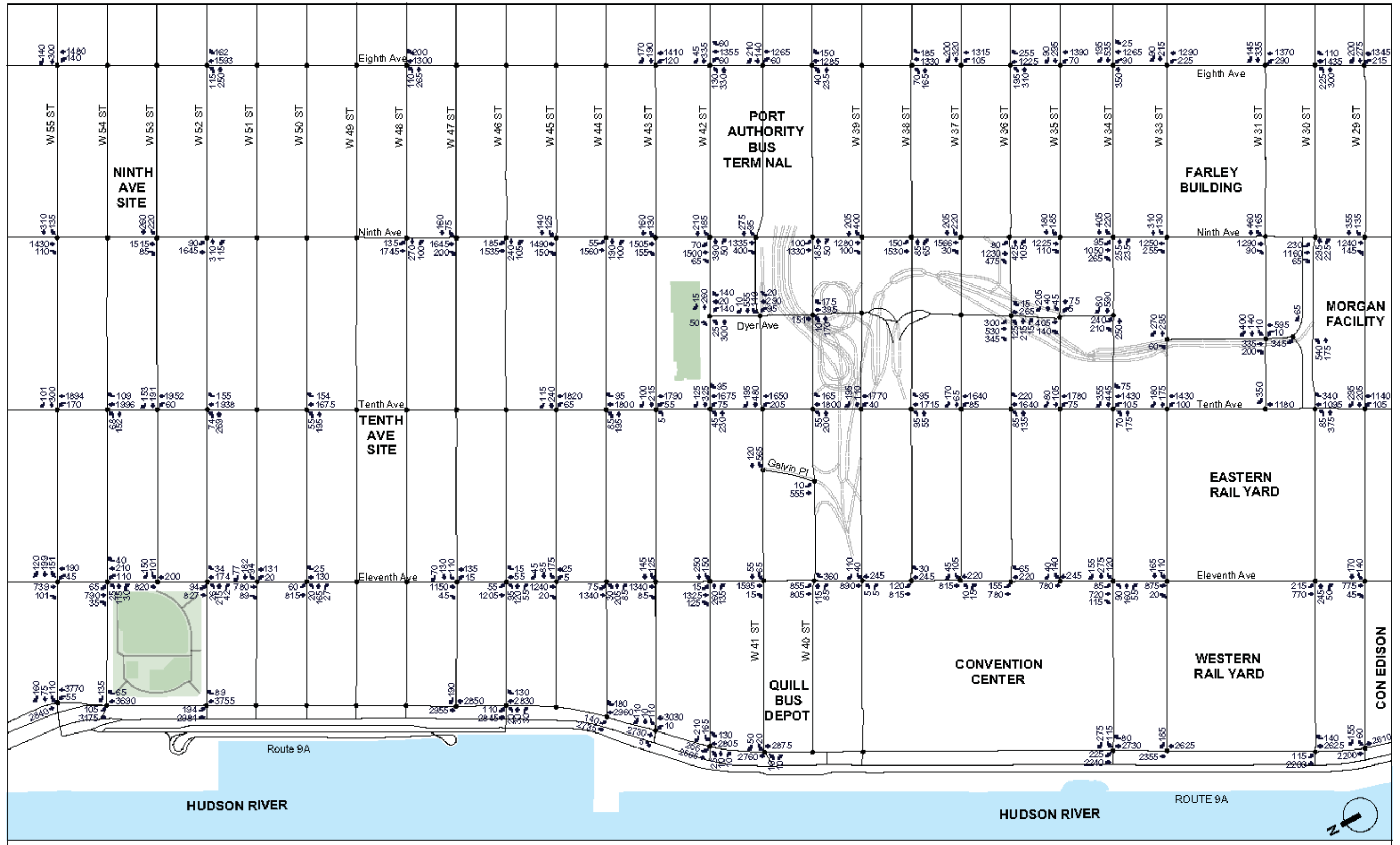


Figure 2.1.1:
 Traffic Volumes – 2008 Base Condition – Weekday PM Peak Hour

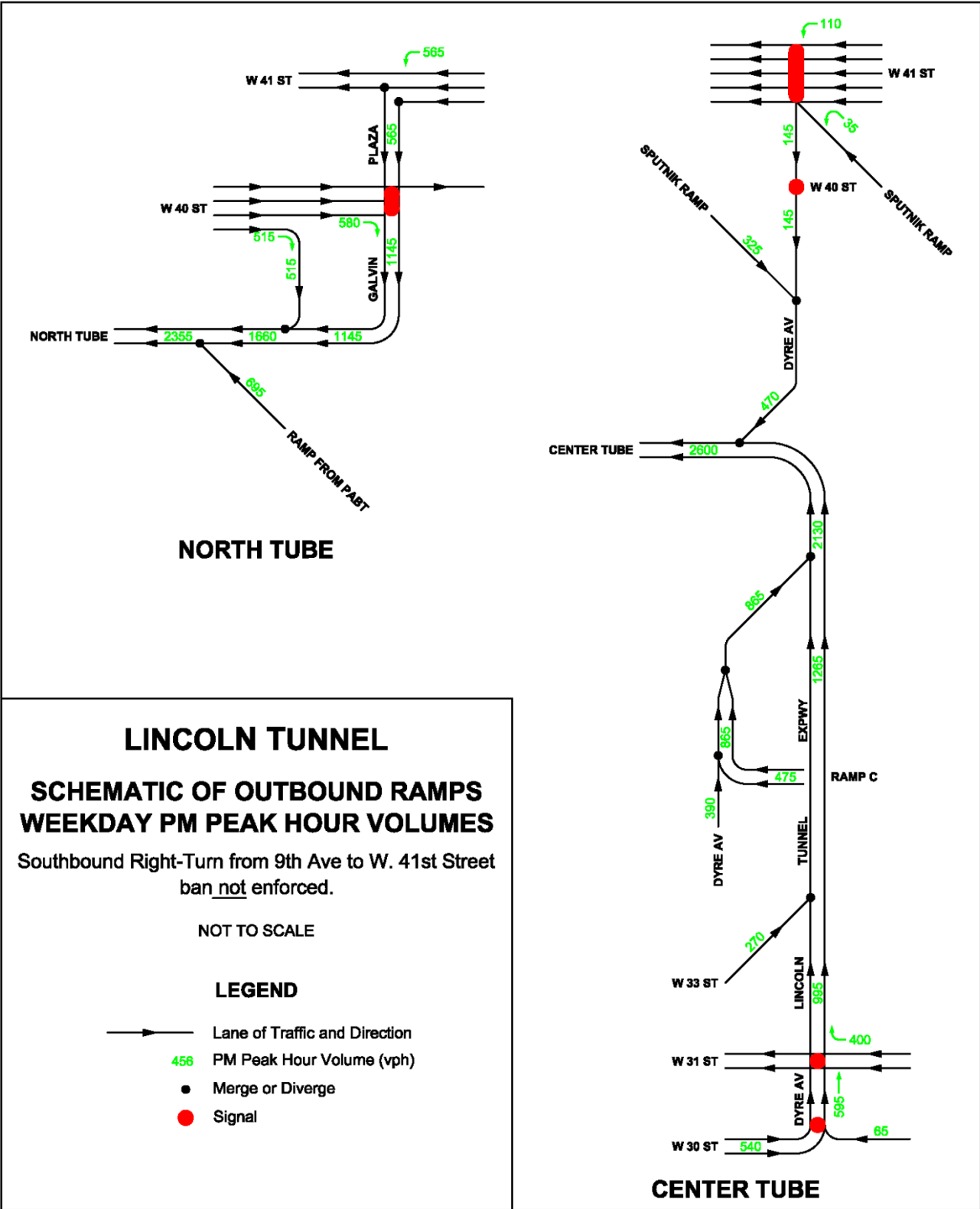
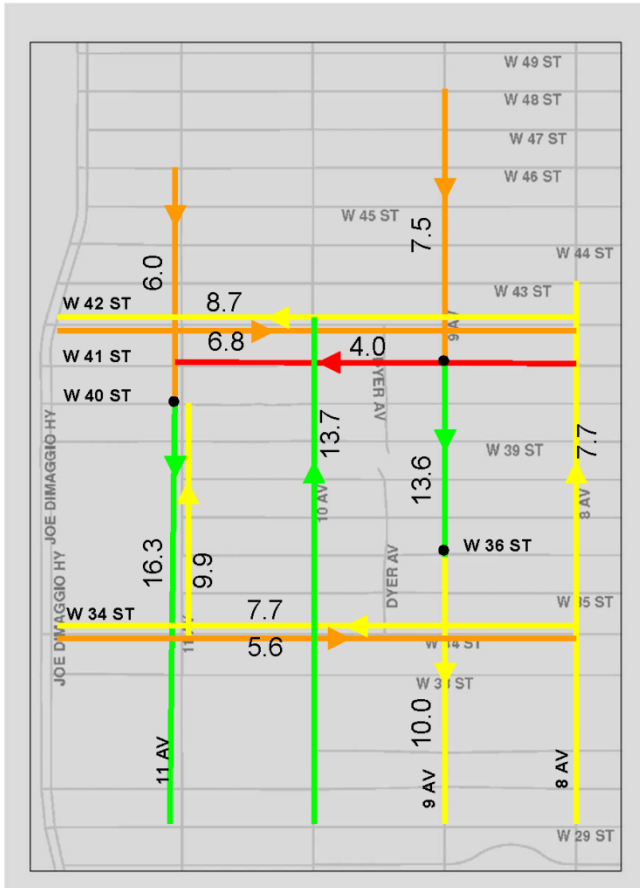
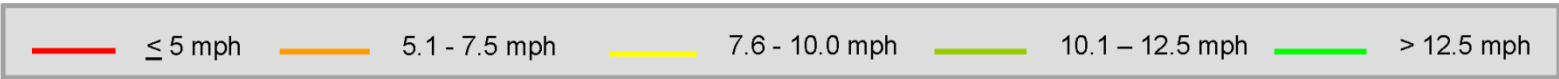


Figure 2.1.2: Schematic of Outbound Ramps to Lincoln Tunnel with PM Peak Hour Volumes



SB RIGHT-TURN FROM 9 AV TO W 41 ST
BAN NOT ENFORCED



SB RIGHT-TURN FROM 9 AV TO W 41 ST
BAN ENFORCED

Figure 2.1.3: Average Travel Speeds – 2008 Base Year – Weekday PM Peak Hour

scenario, it is a plodding 5.5 mph. The increased congestion on this segment of 9th Avenue caused by enforcing the turning ban on West 41st Street is offset by the reduced person-delay on West 41st Street for the higher number of bus passengers.

The segment of southbound 11th Avenue from West 46th to West 40th Streets is better under the Ban Enforced scenario compared to the Ban Not Enforced scenario, 7.2 mph vs. 6.0 mph, respectively, because fewer cars use the north tube under the Ban Enforced scenario. Likewise, 11th Avenue northbound from West 34th to West 40th Streets is slightly better under the Ban Enforced scenario compared to the Ban Not Enforced scenario, 10.6 mph vs. 9.9 mph, respectively. And for the same reason, 10th Avenue operates better under the Ban Enforced scenario compared to the Ban Not Enforced scenario, 16.6 mph vs. 13.7 mph, respectively. The difference is the extra delays that result from vehicles wishing to turn left from 10th Avenue onto West 41st Street under the Ban Not Enforced scenario.

For most other corridor segments, speeds are not affected significantly by whether or not the turn ban is enforced. Ninth Avenue from West 36th to West 29th Streets operates fairly well at about 10 mph, and 11th Avenue southbound from West 40th to West 29th Streets operates very well at about 16 mph. West 34th Street westbound, West 42nd Street in both directions, and 8th Avenue average travel speeds are in the 8 to 10 mph range. West 34th Street eastbound is slower at about 5.6 mph due to lane reduction and congestion east of the study area.

Because change is occurring rapidly in the study area, a seven-year planning horizon was employed for estimating future transportation conditions and needs; hence, the future year for planning purposes is set at 2015. The analysis of future conditions without improvements represents expected traffic conditions if volumes grow as projected, in the absence of any improvements to the transportation system other than those that have already occurred or are planned for implementation by 2015 independent of this study. This analysis is performed for two reasons: to provide a hypothetical estimate of the consequences of doing nothing, and to provide a basis for comparing the potential benefits of various transportation system improvements.

A 4.0% traffic growth rate was assumed from 2008 to 2015, and was assigned uniformly throughout the network. In addition, the future analysis includes the following network changes that took place or will take place by 2015:

- “Green Light for Midtown” – Broadway closed to traffic or reduced to one lane between Columbus Circle and Herald Square. The main consequence of this project to the Clinton/Hell’s Kitchen study area is increased traffic volume to 9th and 11th Avenues, and reduced volume to 8th Avenue.
- West 41st Street fully re-opened to traffic between 8th and 9th Avenues.
- MTA/NYCTA bus route M27 canceled; M10 curtailed to Columbus Circle; M104 cross-town extension eliminated (not analyzed in this study).
- Sidewalk extensions on West 33rd Street at 8th Avenue (SW corner), 9th Avenue (SW and SE corners), 10th Avenue (all corners) and 11th Avenue (all corners), and on West 31st Street at 9th Avenue (all corners).

- Widening of selected crosswalks crossing the avenues at West 31st and West 33rd Streets and Route 9A at West 34th Street.

PM peak hour traffic operations for 2015 future without improvements conditions were analyzed using Synchro and SimTraffic software for the same two scenarios as analyzed in the existing conditions. The first scenario is for the condition that the right-turn ban from 9th Avenue to West 41st Street is not enforced. The second scenario is the condition for which the ban is enforced. The results are shown in Figure 2.1.4. Table 2.1.1 compares these two 2015 future without improvement scenarios to the 2008 base year conditions.

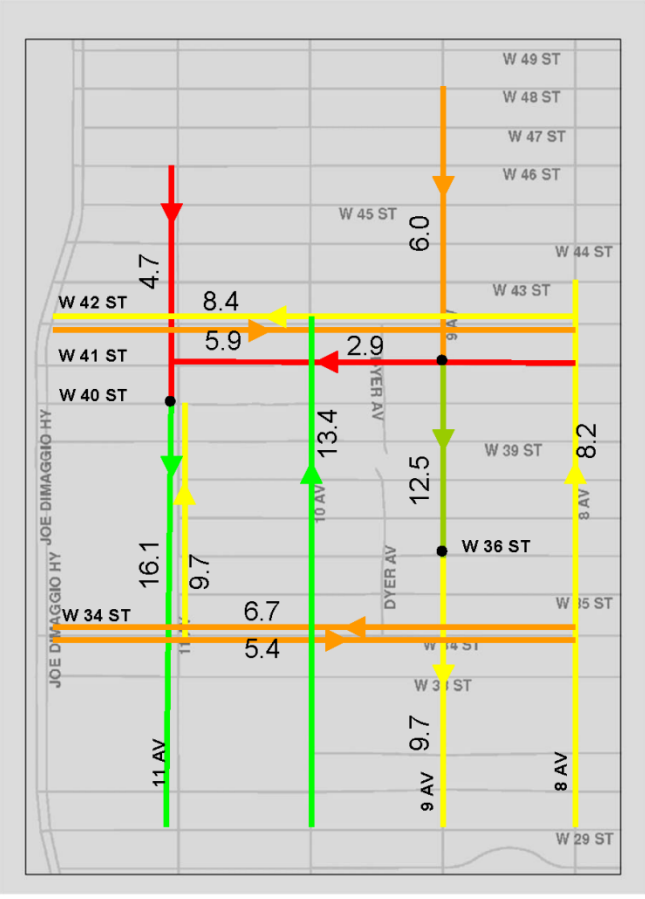
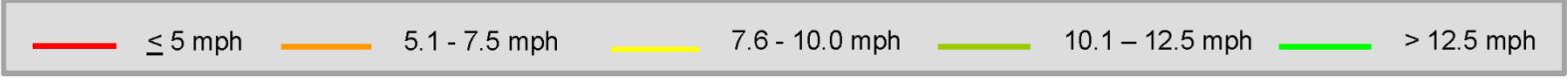
Because of the projected increase in traffic volume from the base year to future year 2015, average speeds are expected to decrease along all corridors, though the degree of impact varies by corridor. Ninth Avenue degradation is more pronounced because of the additional traffic due to the Broadway closure in Times Square. Under the Ban Not Enforced scenario, average travel speed on 9th Avenue from West 48th Street to West 41st Streets is projected to decrease from 7.5 mph in 2008 to 6.0 mph in 2015. Under the Ban Enforced scenario, average travel speed on this segment is expected to decrease from 7.4 mph in 2008 to 5.9 mph in 2015. This is roughly equivalent to traveling about three blocks during each signal cycle.

The average travel speed on the segment of 9th Avenue leading to Ramp C (West 41st Street to West 36th Street) is projected to remain relatively high at 12.5 mph under the Ban Not Enforced scenario for year 2015, down from 13.6 mph in 2008. Under the Ban Enforced scenario, the average travel speed on this segment is expected to decrease from 5.5 mph in 2008 to 4.0 mph in 2015. This is roughly equivalent to traveling about two blocks during each signal cycle.

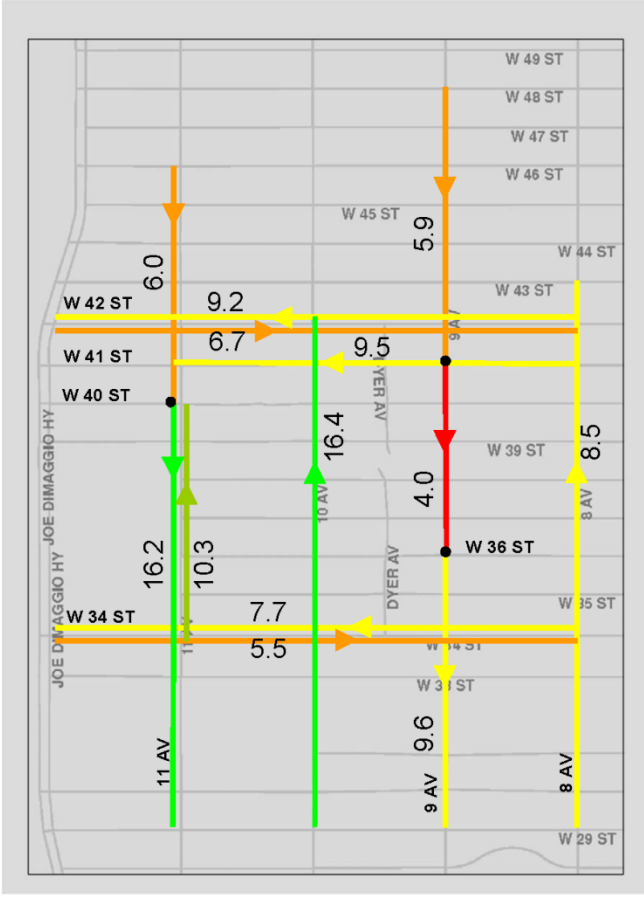
Average travel speed on West 41st Street under the Ban Not Enforced is expected to decrease from 4.0 mph in 2008 to 2.9 mph in 2015. Under the Ban Enforced scenario, average travel speed on this segment is expected to decrease from 10.9 mph in 2008 to 9.5 mph in 2015.

The average travel speed on 8th Avenue is expected to increase slightly from 2008 to 2015, partially because traffic is diverted to 6th Avenue as a result of the improvements from the Broadway closure in Herald Square. Under the Ban Not Enforced scenario, the improvement is from 7.7 mph in 2008 to 8.2 mph in 2015. Under the Ban Enforced scenario, the improvement is from 7.9 mph to 8.5 mph.

Because of the importance of preserving the operation of West 41st Street for buses that travel from the PABT to the Lincoln Tunnel, NYCDOT supports the enforcement of the turning ban from 9th Avenue to West 41st Street from 4PM to 7 PM weekdays. All future improvement packages have been tested assuming the ban is enforced.



SB RIGHT-TURN FROM 9 AV TO W 41 ST
BAN NOT ENFORCED



SB RIGHT-TURN FROM 9 AV TO W 41 ST
BAN ENFORCED

Figure 2.1.4: Average Travel Speeds – 2015 Future w/o Improvements – Weekday PM Peak Hour

Table 2.1.1 – Travel Speeds for 2008 Base Year and 2015 Future w/o Improvements (mph)

SEGMENT	2008 BASE YEAR		2015 FUTURE WITHOUT IMPROVEMENTS	
	SB-R Turn from 9 Av to W 41 St BAN <u>NOT</u> ENFORCED	SB-R Turn from 9 Av to W 41 St BAN <u>ENFORCED</u>	SB-R Turn from 9 Av to W 41 St BAN <u>NOT</u> ENFORCED	SB-R Turn from 9 Av to W 41 St BAN <u>ENFORCED</u>
9 Av W 48 St to W 41 St	7.5	7.4	6.0	5.9
9 Av W 41 St to W 36 St	13.6	5.5	12.5	4.0
9 Av W 36 St to W 29 St	10.0	9.8	9.7	9.6
W 41 St 8 Av to 11 Av	4.0	10.9	2.9	9.5
Southbound 11 Av W 46 St to W 40 St	6.0	7.2	4.7	6.0
Southbound 11 W 40 St to W 29 St	16.3	16.3	16.1	16.2
Northbound 11 Av W 34 St to W 40 St	9.9	10.6	9.7	10.3
Northbound 8 Av 29 St to 43 St	7.7	7.9	8.2	8.5
Northbound 10 Av 29 St to 42 St	13.7	16.6	13.4	16.4
Eastbound W 34 St 12 Av to 8 Av	5.6	5.6	5.4	5.5
Westbound W 34 St 8 Av to 12 Av	7.7	7.8	6.7	7.7
Eastbound W 42 St 12 Av to 8 Av	6.8	7.5	5.9	6.7
Westbound W 42 St 8 Av to 12 Av	8.7	9.7	8.4	9.2

2.2 Safety

After reviewing the entire study area, consisting of 131 intersections, for three-year crash history from 2007-2009, 13 High Pedestrian Crash Locations were identified. A High Pedestrian Crash Location is an intersection where 5 or more pedestrian crashes are recorded in one year. Figure 2.2.1 shows them on a study area map.

There were a total of 181 pedestrian injuries at the 13 High Pedestrian Crash Locations during the three year period. The worst intersection was West 42nd Street and 8th Avenue with 50 pedestrian injuries. The next worst were West 42nd Street and 9th Avenue, and West 34th Street and 8th Avenue with 24 and 23 pedestrian injuries, respectively. About 44% of all 181 injuries occurred when the pedestrian had the right of way, as opposed to crossing against the signal.

Fatal crash locations were also identified. There were 9 fatal crashes in the study area resulting in 10 deaths. Figure 2.2.2 shows the locations on a study area map. Most of the fatal crashes were recorded on the 9th Avenue corridor. Two motorcyclists were killed in a single fatal crash in 2008 at the intersection of West 30th Street and 12th Avenue. All other fatal crashes involved pedestrians. Most of the pedestrian fatalities involved pedestrians crossing an avenue. None involved vehicles turning from an avenue onto a side street.

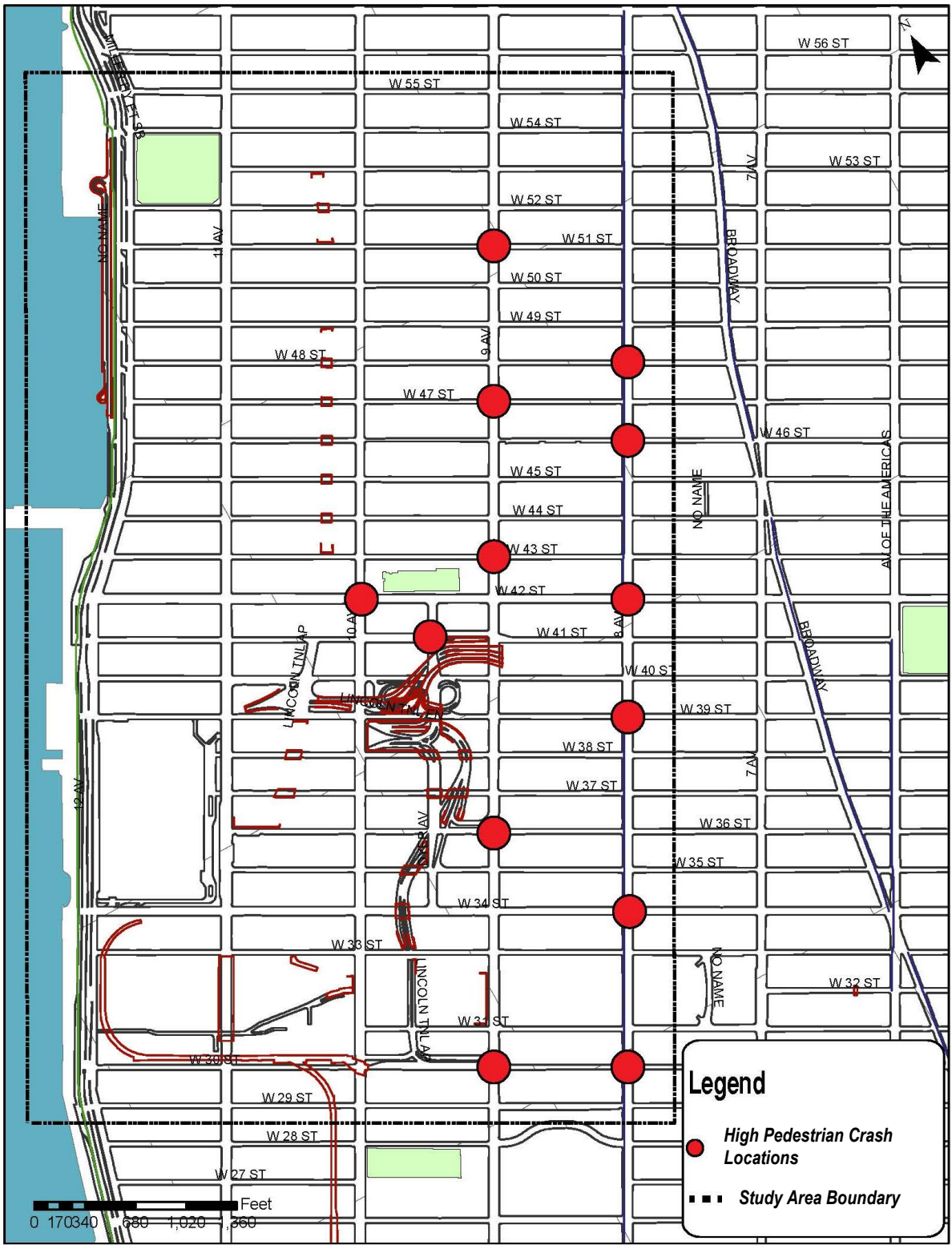


Figure 2.2.1: High Pedestrian Crash Locations (2007-2009)



Figure 2.2.2: Fatal Crash Locations (2007-2009)

2.3 Pedestrians

Under base year conditions, the most deficient pedestrian location in the study area has been along the west side of 9th Avenue between West 37th and West 36th Streets where the sidewalk was discontinuous. As shown in the aerial view of Figure 2.3.1, the sidewalk on the west side of 9th Avenue south of West 37th Street abruptly ended just north of Ramp C. There was no crosswalk across Ramp C.



Figure 2.3.1: Aerial View of 9th Ave between West 37th and West 36th Streets

Figure 2.3.2 shows 9th Avenue traffic at West 37th Street separated by cones. Vehicles on the far side of the cones - the two western-most lanes of the roadway - are channeled to Ramp C. A fence along the west curb of 9th Avenue physically prevents pedestrians from using the west sidewalk to cross Ramp C.



Figure 2.3.2: West 37th Street, Looking West towards 9th Avenue

Figure 2.3.3 shows a view looking south on the west sidewalk towards Ramp C where the sidewalk ends. Pedestrians have been observed to walk down here, only to realize they must turn around, walk back up towards West 37th Street, and cross 9th Avenue to continue walking south. Pedestrians coming from the south have been observed to use the west crosswalk to cross West 36th Street walking northbound, then jaywalk across Ramp C. Since the fence prevents them from getting to the sidewalk on the other side, they have been observed to walk in the travel lanes, a very dangerous condition. This is shown in Figures 2.3.4 and 2.3.5.



Figure 2.3.3: West Sidewalk of 9th Avenue, Looking South towards Ramp C



Figure 2.3.4: Pedestrian Jaywalking Across Ramp C, Facing North



Figure 2.3.5: Fence Forces Jaywalking Pedestrian into Traffic Lanes

The next most deficient pedestrian facility is the west crosswalk of West 41st Street and 9th Avenue, shown in Figure 2.3.6. The west leg is 39 feet wide, wider than the normal 30-32 feet for a minor cross street. There is heavy traffic volume, especially buses, making the southbound right turn from 9th Avenue onto West 41st Street towards the Lincoln Tunnel and Quill Bus Depot. During the weekday PM peak hour, about 100 buses make this turn. As mentioned in Section 2.1, this turn is prohibited except for buses from 4PM to 7PM weekdays, but when it is not enforced with a traffic enforcement agent, about 280 cars and 20 trucks illegally turn here, for a total volume of 400 vehicles per hour. Turning volumes during other times during the week when it is legal for all vehicles reach as much as 350 vehicles per hour. This turning traffic conflicts with pedestrians in the west crosswalk. Pedestrian crossing volumes are moderate, about 150 pedestrians per hour during peak periods, but this is expected to increase with completion of nearby development projects. A seven second leading pedestrian interval (LPI) is provided to give pedestrians a head start into the crosswalk so as to deter aggressive “jump starts” by turning motorists, but the conflict still exists during the simultaneous 9th Avenue green time and the west crosswalk WALK time. This crosswalk has often been pointed out by the community as being perilous. In February 2013, a pedestrian in the west crosswalk was killed by a southbound right-turning vehicle.



Figure 2.3.6: Pedestrians Crossing West Crosswalk at West. 41st Street and 9th Avenue, Facing North.

Of all the crosswalks analyzed in the study area, 15 operate with unacceptable LOS during the AM period, 17 during midday and 29 during the PM. These locations are

mainly concentrated along 8th Avenue in the vicinity of the Port Authority Bus Terminal and Penn Station, where pedestrian volumes and conflicting vehicle volumes are highest.

2.4 Trucks

Figure 2.4.1 shows the official truck route network in the study area. While the network includes the Lincoln Tunnel Expressway and ramps between West 30th Street and the south and center tubes, that route is presently closed to outbound trucks. Signs direct trucks to use 10th and 11th Avenues to get to the north tube at West 40th Street.

Truck volumes are higher during the weekday AM and midday peak hours than during the weekday PM peak hour. Saturday midday peak hour truck volumes are lower than any of the three weekday peak hours, but not far below the weekday PM peak hour.

Concern has been expressed about trucks using neighborhood streets that are not designated as truck routes. West 55th Street and West 43rd have been specifically mentioned in this regard. The lack of east-west truck routes north of West 42nd Street and south of West 57th Street may be causing some trucks to use in-between streets. For further analysis regarding curbside usage, please see the Section 2.7 Parking.

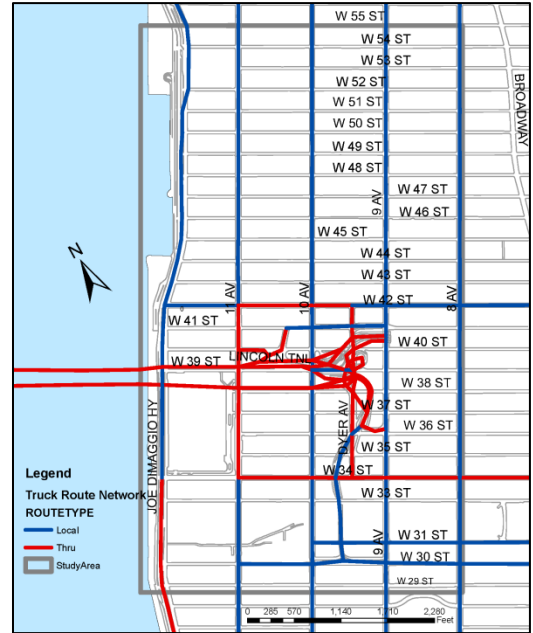


Figure 2.4.1: Truck Routes

2.5 Transit

The eastern edge of the study area is presently served by the A, C and E lines of the 8th Avenue Subway, with stations at 34th Street/Penn Station, 42nd Street/PABT and 50th Street. An underground walkway provides transfers to the Nos. 1, 2, 3, 7, N, Q and R lines at the Times Square Station. Construction has begun on a City-funded extension of the Number 7 subway line west under West 41st Street and south under 11th Avenue. The terminal station for the extension will be at West 34th Street and 11th Avenue.

Figure 2.5.1 presents local bus service provided by MTA/NYCT to and within the study area. North-south service is provided by the M11 along 9th and 10th Avenues, and the M20 and M104 along 7th and 8th Avenues. Cross-town service is



Figure 2.5.1: Bus Routes

provided by the M34 and M34A on West 34th Street, the M42 on West 42nd Street and the M50 on West 49th and West 50th Streets. The M34 and M42 provide direct access to and from the Javits Center. The westbound M34A loops around 8th Avenue to West 43rd Street, then down 9th Avenue back to eastbound West 34th Street. In addition, several MTA/NYCT bus routes connect the areas near PABT and Penn Station with other parts of Manhattan and the outer boroughs. A new bus route for 11th Avenue is also planned.

The M104, which travels along 7th and 8th Avenues has the highest ridership in the study area, with the M11 having the second highest. Overcrowding on these buses sometimes results in buses bypassing waiting passengers. In addition, many of these riders transfer to or from the subway, adding to the heavily used sidewalks, crosswalks and corners.

The MTA/NYCT Quill Bus Depot, located at West 40th Street and 11th Avenue, serves a crucial function for transit operations, though it is not directly used by riders. A half-block long layover area is designated for NYCT buses on West 43rd Street between 8th and 9th Avenues, and a layover zone for MTA Bus Company express buses is designated on West 54th Street between 10th and 11th Avenues.

The PABT, the world's busiest bus station, serves a vast network of suburban and inter-city bus routes. The massive bus terminal, which occupies two city blocks between 8th and 9th Avenues and West 40th and West 42nd Streets, is the New York City terminus for NJ Transit commuters, who, along with tourists and others, ride buses in and out of the depot 65 million times a year. The terminal handles about 8,000 bus trips a day, and is used by more than 120,000 riders. It is over capacity during peak hours, and lacks adequate daytime parking for buses that take commuters into New York from New Jersey in the morning and then back at night. The situation leads to an inefficient, environmentally unfriendly system in which buses, emptied of passengers following the morning commute, drive back to New Jersey during the day, then head back into New York, still empty, for the evening commute. A key operational issue is the long queue of empty buses waiting to enter the Port Authority Bus Terminal from 10th Avenue before the evening peak period.

A number of bus operations spill over in the streets, aggravating congestion and idling in the neighborhood, with many of these buses using residential streets for detours. Because the study area is close to major tourist attractions, tour buses of many kinds are also a major presence on the streets of the study area. As they pick up and drop off customers at many points within the study area, they also must lay over. Figure 2.5.2 presents the block faces around the study area are designated for on-street layover for buses. During peak times, the demand exceeds the number of designated on-street layover zones, resulting in a significant level of illegal bus parking, most egregiously on residential streets, in school zones and in NYCT bus stops.

Penn Station, though not within the study area boundaries, is directly adjacent to it. Both Penn Station and PABT are hubs not only for the trains and buses, respectively, that use those two facilities, but also for numerous other private bus and jitney services that pick up and drop off passengers on the streets immediately surrounding those facilities.

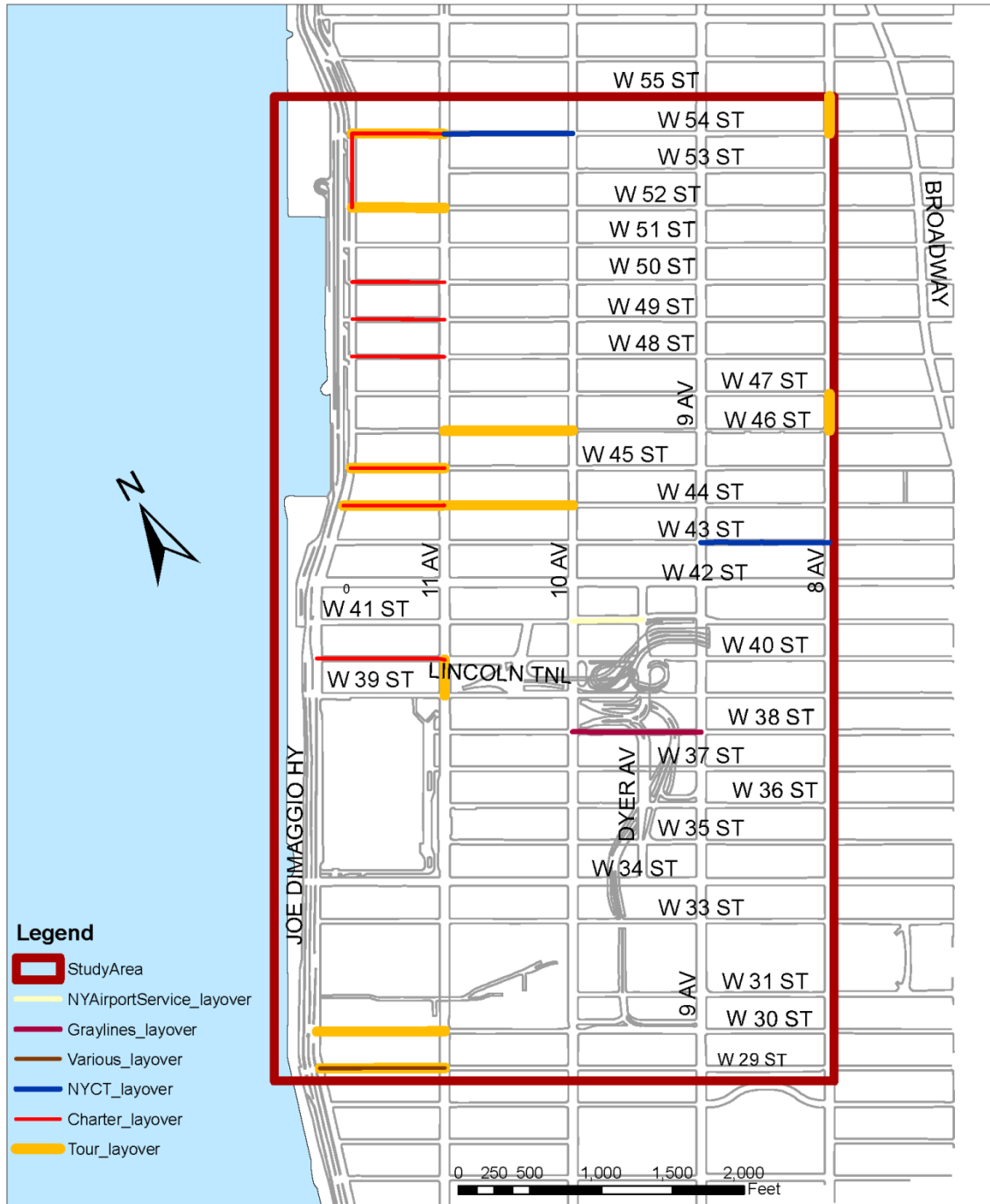


Figure 2.5.2: Bus Layover Areas

Another bus-layover issue is the effect of the many private bus/van services that stop on the north side of West 42nd Street between 8th and 9th Avenues, which is designated as a PM peak period bus-only lane. The long dwell times of these vehicles (observed to consistently be longer than the three minutes allowed) does not allow for the lane to function as a moving lane for buses.

Ferry transportation is also a presence in the study area. Commuter ferry service is provided to and from seven New Jersey locations via a ferry terminal at West 39th Street on the Hudson River. An extensive shuttle bus system provides access to the ferry terminal via West 34th, 42nd, 44th, 49th and 50th Streets, also traveling on Route 9A and portions of 8th and 10th Avenues within the study area.

2.6 Bicycles

During the base year of this project, there were no bike lanes in the study area. However, the Hudson River Greenway, located just west of route 9A, provides a protected bicycle path. Bicycle volumes were analyzed for twenty intersections for the weekday AM, midday, PM and Saturday midday peak traffic hours, with the midday and PM hours resulting in the highest bicycle volumes. During the PM peak hour, bicycle volumes were noticeably higher on 8th and 9th Avenues, compared to 10th and 11th Avenues, presumably because of the existing bike lane south of West 34th Street. The Hudson River Greenway bike path carries more bikes than any of the avenues. Bicycle volumes on the avenues crossing the West 50th Street screenline are shown in Table 2.6.1:

Table 2.6.1 – 2008 Base Year Bicycle Volumes on Selected Avenues at West 50th Street

ROADWAY	8-9 AM	12-1 PM	5-6 PM
8 th Ave	25	71	75
9 th Ave	51	132	136
10 th Ave	30	64	27
11 th Ave	38	98	67
Hudson River Greenway	179	181	278

CHAPTER 3 IMPROVEMENT MEASURES – IMPLEMENTED

In order to address the concerns of the community as well as the issues found in the analysis of the existing and future without improvement conditions, improvement measures were identified. NYCDOT implemented several early action measures identified during the course of the study. This section describes improvements that have already been implemented. They are presented roughly in chronology of implementation.

3.1 Crosswalks with Set-Back Stop Bars

The conflict between vehicles and pedestrians crossing at every intersection is a major concern. Installing these pavement markings alert drivers to stop at a far enough distance for pedestrian to cross freely and makes the pedestrian aware of the space they should be using. These have been installed at the following locations:

- 8th Avenue, at West 30th, 31st and 34th Streets
- 9th Avenue, at West 31st, 34th, 38th and 40th Streets
- 10th Avenue and West 42nd Street
- Dyer Avenue and West 34th Street



3.2 Signage

“Don’t Block the Box” signs have been installed at several locations. When drivers enter but do not get through the entire intersection, the cross-street vehicles are blocked, and their green time is wasted, causing major delays. These signs enforce and remind drivers that there is a penalty to for this infraction. They have been implemented at intersections that often have queues leading up to the Lincoln Tunnel, specifically at:

- 9th Avenue, at West 42nd, 43rd and 44th Streets



3.3 Left-Turn Only Lane at 42nd & 9th

On westbound West 42nd Street approaching 9th Avenue, an unmarked shared through-left lane, which behaved as a de-facto left-turn lane, was converted to an exclusive left-turn lane. This measure will facilitate the conversion of the westbound left-turn phase from permitted/protected to protected only in order to protect pedestrians in the south crosswalk. Further improvements related to this intersection’s signal timing plan are described in Section 3.10.



3.4 Bike Lanes on 8th & 9th Avenue – Phase I

As a result of a previous phase of the 8th and 9th Avenue bike lane project, parking protected bike lanes have been installed on 8th Avenue up to West 34th Street, and on 9th Avenue up to West 31st Street, affecting the lower part of the Hell’s Kitchen study area. General purpose travel widths have been narrowed, and left-turn bays have been created for 9th Avenue at West 30th Street, and 8th Avenue at West 29th, 31st, 33rd and 34th Streets. All but one of these locations were implemented with “mixing zones,” where left-turning vehicles share the same green time as the bikes, and must therefore yield to the bikes on their left, as well as the pedestrians in the crosswalk they are turning into. Mixing zones are described in more detail in Section 3.8.

3.5 34th Street Select Bus Service – Phase I

The 34th Street Select Bus Service (SBS) project addresses three major issues facing the corridor: slow bus service, crowded sidewalks, and projected population and employment growth. The project also provides the opportunity to expand curb access and loading for residents, businesses, and institutions on 34th Street. NYCDOT has developed a design that meets these goals, and has incorporated changes based on community feedback.

The first phase of the 34th Street Select Bus Service was implemented on November 13, 2011 and included off-board fare collection, and renaming the M34 and M16 buses to the M34 SBS and M34A SBS, respectively. These changes have been made to improve passenger communication. The service frequency and routes remain the same. In addition, video camera enforcement has been expanded for the existing bus lanes.

The second phase of the project will be implemented in 2013. This is described in Section 4.5.

3.6 Other Bus Operations

Both public and private bus operations have a significant presence in the Hell’s Kitchen study area. While they are an efficient method of transportation because of their large capacity, they can also pose other problems like blocking traffic, wide turning movements and noise. The following improvements address these issues:

- The Grayline bus layover has been relocated from its former location on a residential street near a school to West 38th Street between 9th Avenue and 10th Avenue.
- More tour bus layover locations have been created in 2009 west of 11th Avenue.
- The far side bus stop of eastbound West 42nd Street at 9th Avenue has been extended eastward, creating more room for multiple buses to maneuver in and out.



- NYPD Operation 8/42 has been instrumental in removing illegal jitneys from West 42nd Street near the Port Authority Bus Terminal, thereby decreasing bus blockages.
- A new law requires that all long distance buses obtain a permit to operate a stop on city streets.

3.7 Initial Signal Timing Changes

Signal timing changes implemented through 2012 are summarized in Table 3.7.1. Most of the signal timing changes fall into one of the following categories:

- Leading pedestrian intervals (LPIs) have been provided to give pedestrians a head start into the crosswalk so as to deter aggressive turning movements by motorists.
- Green time was reallocated from the avenues to the cross streets at several locations on 9th and 11th Avenues to give more time for pedestrians to cross the avenues.
- Offsets have been changed to improve progression.
- The green time on 9th Avenue north of West 42nd Street has been “feathered” to discourage blocking the box. Less green time has been available for 9th Avenue traffic at West 42nd Street than at upstream minor cross streets for two reasons:
 - An LPI where no traffic moves has been provided for pedestrians to cross West 42nd Street, which is 30 feet wider than the minor cross streets.
 - Since West 42nd Street is two-way and it would be difficult to find a gap in opposing traffic flow to safely make left-turns, a westbound protected left-turn phase has been provided.

Previously, there was a sharp drop in 9th Avenue green time from 55 seconds at West 45th Street to 40 seconds at West 42nd Street. During January 2012, feathering was implemented to provide a more gradual drop in green time approaching the West 42nd Street bottleneck as follows:

- 40 seconds for West 42nd, West 43rd and West 44th Streets.
- 45 seconds for West 45th, West 46th and West 47th Streets.
- 50 seconds for West 48th, West 49th and West 50th Streets.

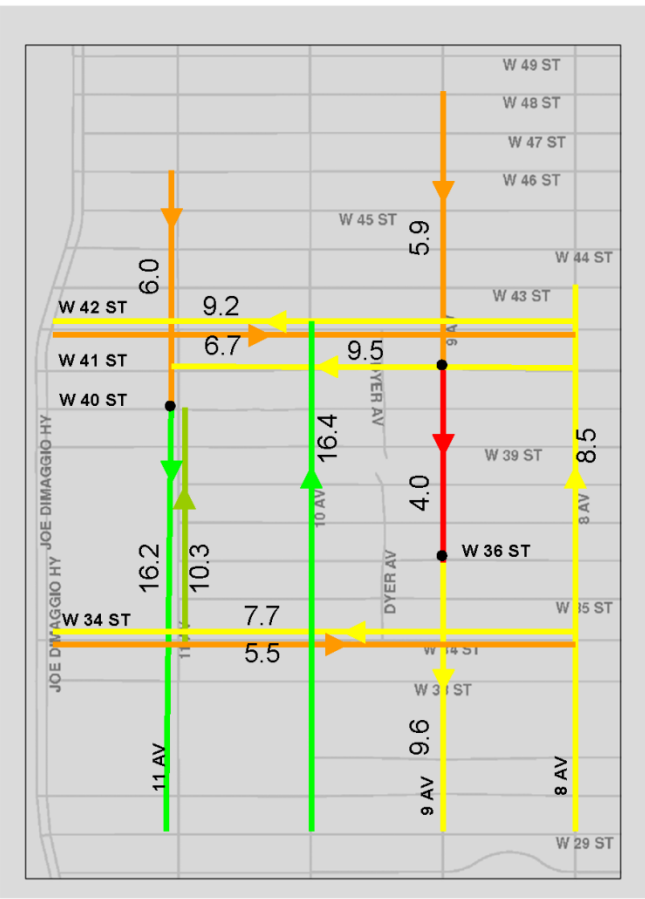
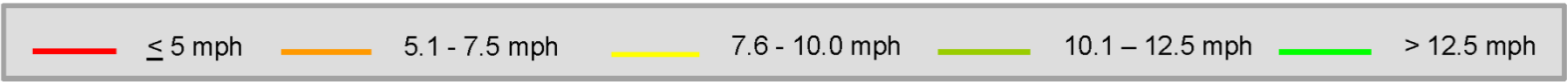
The effect of these signal timing changes, in combination with all other improvements previously mentioned, is presented in Figure 3.7.2. It is compared to the 2015 Future without Improvements condition for the Ban Enforced scenario. While most of these improvements are geared towards the safety of all street users, they are expected to have a small impact on traffic as compared to the 2015 Without Improvements condition.

The feathering action on 9th Avenue described in the 4th bullet of the previous section has the effect holding back traffic and thus decreasing average travel speed on the segment between West 48th and West 41st Streets, from 5.9 mph to 5.3 mph. However, this is partially offset by an increase in speed between West 41st and West 36th Streets from 4.0 to 4.5 mph. The travel times for both segments combined is changed very little because

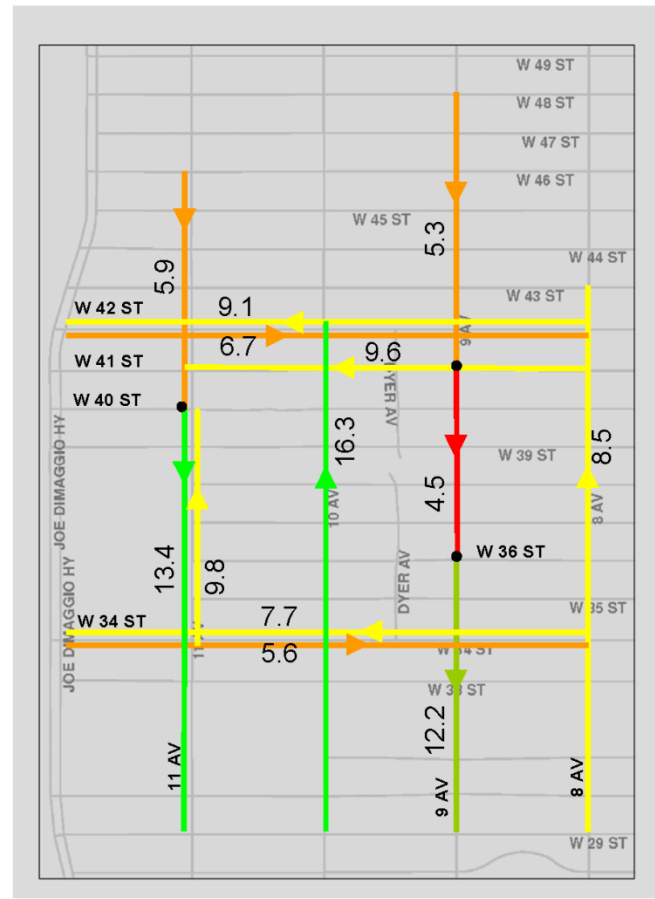
Table 3.7.1
SIGNAL PHASING, TIMING AND OFFSET
INITIAL IMPROVEMENTS IMPLEMENTED THROUGH 2012
OFFSET REFERENCED TO START OF GREEN ON MAJOR STREET (LISTED FIRST)

LOCATION	PHASING CHANGE	TIMING CHANGE	OFFSET CHANGE
8 Av & W 42 St	--	Previous: NB 40, EB-L 20, E-W 30 Revised: NB 38, EB-L 18, E-W 34	--
8 Av & W 47 St	Add SB pre-empt for FDNY	Previous: NB 55, WB 35 Revised: NB 55, WB 35, SB-Pre-empt 50	--
9 Av & W 30 St	Add LPI	SB-T 50 (SB-LPI 8, SB-L 42), EB-LPI 7, EB 33	--
9 Av & W 33 St	--	--	Previous: 43 Revised: 3
9 Av & W 38 St	Add LPI	Previous: SB 55, EB 35 Revised: SB 52, EB 31, LPI 7	--
9 Av & W 39 St	--	Previous: SB 55, WB 35 Revised: SB 50, WB 40	--
9 Av & W 40 St	--	Previous: SB 55, EB 35 Revised: SB 50, EB 40	--
9 Av & W 41 St	Add LPI	Previous: SB 50, WB 40 Revised: SB 50, WB 33, LPI 7	--
9 Av & W 42 St *	See Section 3.10	See Section 3.10	--
9 Av & W 43 St *	--	Previous: SB 45, WB 45 Revised: SB 40, WB 50	--
9 Av & W 44 St *	--	Previous: SB 45, EB 45 Revised: SB 40, EB 50	--
9 Av & W 45 St	--	Previous: SB 55, WB 35 Revised: SB 45, WB 45	--
9 Av & W 46 St	--	Previous: SB 55, EB 35 Revised: SB 45, EB 45	--
9 Av & W 47 St	Add LPI	Previous: SB 55, WB 35 Revised: SB 45, WB 38, LPI 7	--
9 Av & W 48 St	--	Previous: SB 55, EB 35 Revised: SB 50, EB 40	--
10 Av & W 33 St	Add LPI	Previous: NB 53, WB 37 Revised: NB 50, WB 33, LPI 7	--
11 Av & W 33 St	--	Previous: N-S 60, WB 30 Revised: N-S 59, WB 31	--
11 Av & W 36 St	--	Previous: N-S 63, Ped 27 Revised: N-S 59, Ped 31	--
11 Av & W 37 St	--	Previous: N-S 63, E-W 27 Revised: N-S 58, E-W 32	--
11 Av & W 40 St	--	Previous: N-S 63, EB 27 Revised: N-S 61, EB 29	--
11 Av & W 43 St	--	Previous: N-S 63, WB 27 Revised: N-S 59, WB 31	--
11 Av & W 44 St	--	Previous: N-S 63, EB 27 Revised: N-S 59, EB 31	--
11 Av & W 45 St	--	Previous: SB 63, WB 27 Revised: SB 59, WB 31	--
11 Av & W 46 St	--	Previous: SB 63, EB 27 Revised: SB 59, EB 31	--
11 Av & W 47 St	--	Previous: SB 63, WB 27 Revised: SB 59, WB 31	--
11 Av & W 48 St	--	Previous: SB 63, EB 27 Revised: SB 59, EB 31	--
12 Av & W 29 St	--	Previous: N-S 119, EB 31 Revised: N-S 118, EB 32	--
12 Av & W 42 St	Add bike signals	N-S 91, N-S+SB-L+WB-R12, SB-L+WB-R 8, E-W 39	--
Dyer Ave & W 30 St	--	--	Previous: 32 Revised: 6
Dyer Ave & W 31 St	--	--	Previous: 68 Revised: 11
Dyer Ave & W 35 St	--	Previous: N-S 30, WB 34, NB 26 Revised: N-S 30, WB 32, NB 28	--
Dyer Ave & W 41 St	--	Previous: NB 36, Ramp 12, WB 27, LPI 15 Revised: NB 36, Ramp 12, WB 35, LPI 7	--
43 St betw 8 & 9 Avs	New Signal	WB: 60, Crosswalk & Parking Exit: 30	30

* Subsequent changes were made in 2013 - see Section 3.10



2015 FUTURE W/O IMPROVEMENTS



2015 FUTURE WITH IMPROVEMENTS:
 • Signal Timing Improvements as of 2012

Figure 3.7.2: Average Travel Speeds – 2015 Future w/ Initial Signal Timing Improvements – Weekday PM Peak Hour

of the bottleneck at West 42nd Street as described above, and the ultimate bottleneck at Ramp C.

The effect of the reduction in green time for 11th Avenue is to decrease average travel speed northbound from West 34th to West 40th Streets (towards the Lincoln Tunnel) from 10.3 mph to 9.8 mph. The decrease in speed southbound from West 40th to West 29th Streets (away from the tunnel) is more pronounced – from 16.2 mph to 13.4 mph. Considering the number of pedestrians that the Javits Center generates, the reduced travel speeds for vehicles is justified by providing safer crossing for pedestrians.

The most noticeable difference is the improved speed of 9th Avenue between West 36th Street and West 29th Street – from 9.6 mph to 12.2 mph – mainly due to an offset adjustment at West 33rd Street.

Signal timing at 9th Avenue and West 42nd, West 43rd and West 44th Streets has been revised again during 2013. This is described in Section 3.10.

3.8 Bike Lanes on 8th and 9th Avenues – Phase II

As mentioned in Section 3.4, the first phase of the 8th and 9th Avenue bike lanes extended as far north as West 34th Street on 8th Avenue and West 31st Street on 9th Avenue. During the 2nd half of 2012, they have been expanded north to Columbus Circle on 8th Avenue and to West 59th Street on 9th Avenue. A typical section at minor cross streets is shown in Figure 3.8.1. They are continuations of the parking protected design, with the bike lane adjacent to the left curb, protected by floating parking lanes. The design retains four general travel lanes, but they are narrower by one or two feet from 12 feet to 10 or 11 feet. Left turn bays are provided where left turns are permitted. Concrete pedestrian islands are provided as shown, effectively reducing the crossing distance across 8th and 9th Avenues. Parking is retained on the right side, but the left-turn bays and concrete islands necessitate the removal of about 76 parking spaces each on 8th and 9th Avenues. An outreach effort to merchants assures that loading zones will be provided where needed.



Figure 3.8.1: Typical Plan for 8th and 9th Avenue Bike Lanes with Mixing Zones at Minor Cross Streets.

As shown in Figure 3.8.1, “mixing zones” are provided at minor cross streets where left turns are permitted. Under this design, the left-turning vehicles share the same green time as bikes, and must therefore yield to the bikes and pedestrians on their left, as well as the pedestrians in the crosswalk they are turning into. At the approach to cross streets where left turns are permitted, the green bike lane is interrupted with shared markings to emphasize that this is a shared space where vehicles “mix” with bicycles. There is no need for signal timing changes with mixing zone layout.

At major cross streets along 9th Avenue – West 34th, West 42nd, and West 57th Streets – split phases will be used. Under this design, the 9th Avenue green time will be split into two parts. In the first part, the bike lane has a green indication, and the conflicting crosswalk has the WALK display, while the left-turning vehicles are held with a red left-arrow to provide conflict-free crossing. In the second part of the split phase, the bike lane has a red indication, and the conflicting crosswalk displays the steady hand, while the left-turn bay has a green arrow for conflict-free turning. During both parts of the split phase, the avenue has a ball green display for through traffic, and the non-conflicting

crosswalk has the WALK display. Figure 3.8.2 shows the split phase layout, where the bike lane and turning bay retain separate space up to the crosswalk, as opposed to the mixing zone design.

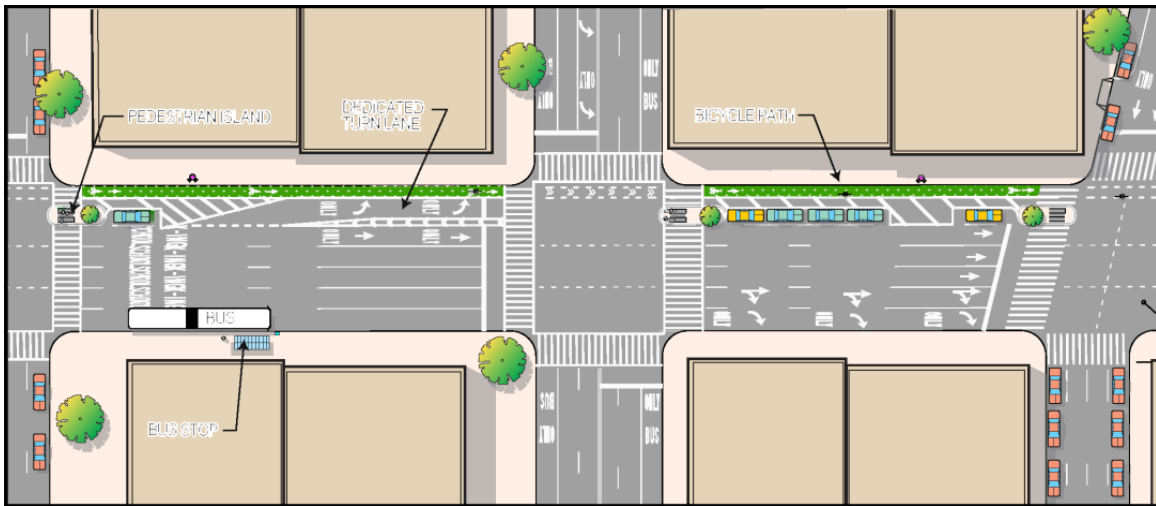


Figure 3.8.2: Typical Plan for 9th Avenue Bike Lanes with Split Phase at Major Cross Streets.

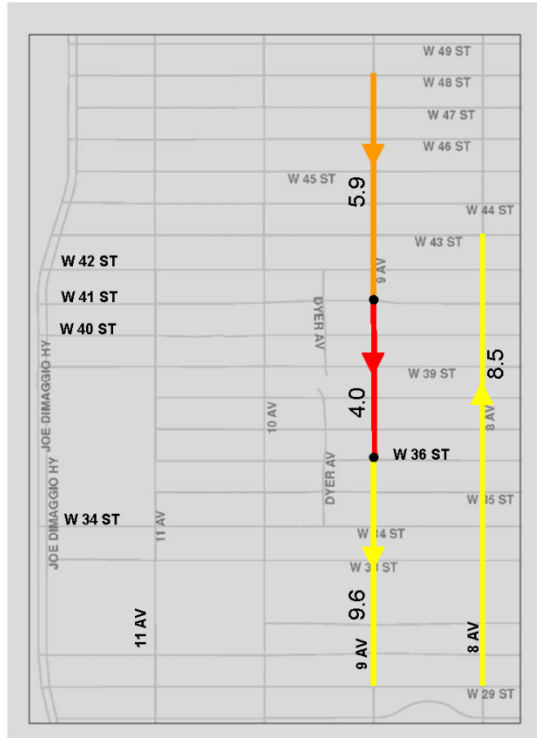
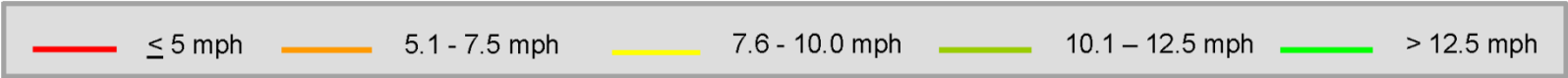
Because of the taxi stand on 8th Avenue in front of the Port Authority Bus Terminal, the bike lane is not parking protected on 8th Avenue between West 39th and West 42nd Streets. The design for this section is shown in Figure 3.8.3.



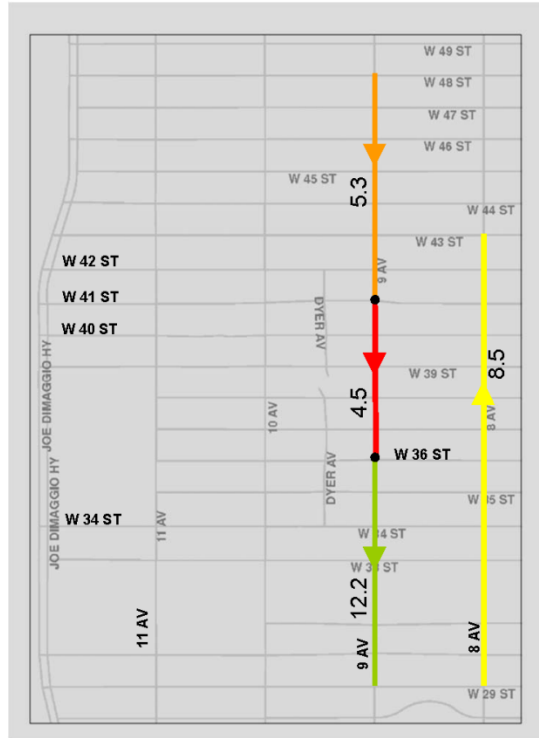
Figure 3.8.3: Bike Lane on 8th Avenue in front of PABT.

The 8th and 9th Avenue bike lanes have been implemented in 2012, except for the new split phase signals. This is discussed in Section 3.10.

Figure 3.8.4 presents future projected average travel speeds on 8th and 9th Avenues with the bike lanes, compared to the future condition with no improvements, and the future condition with improvements previously mentioned. The effects of the bike lanes are to slightly reduce average travel speeds by about 2 to 4 percent. The reduction in lane widths that make the bike lanes possible is roughly offset by the benefit of the left-turn bays.

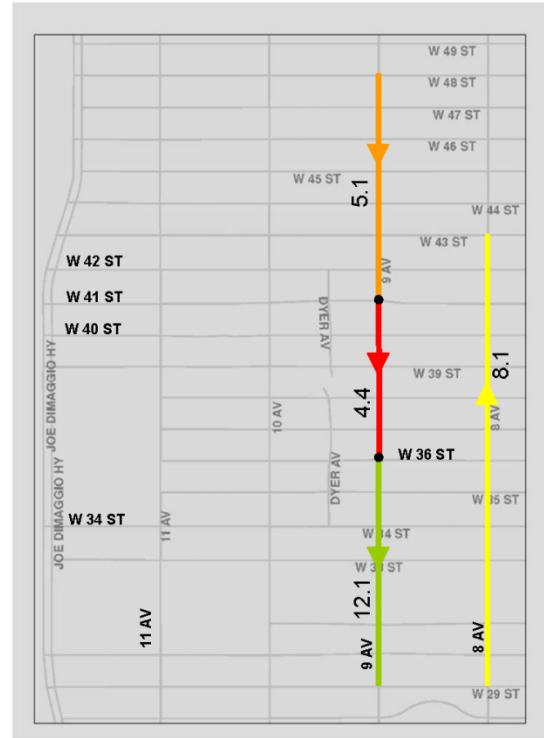


2015 FUTURE W/O IMPROVEMENTS



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes

Figure 3.8.4: Average Travel Speeds – 2015 Future with and without 8th and 9th Avenue Bike Lanes – Weekday PM Peak Hour

3.9 Curb Extension at West 41st Street and 9th Avenue

Because of “Sputnik” ramps from the PABT, West 41st Street between 9th Avenue and Dyer Avenue is shifted north from its natural position on the Manhattan street grid. This causes a misalignment as West 41st Street crosses 9th Avenue. This is shown in the aerial view of Figure 3.9.1.

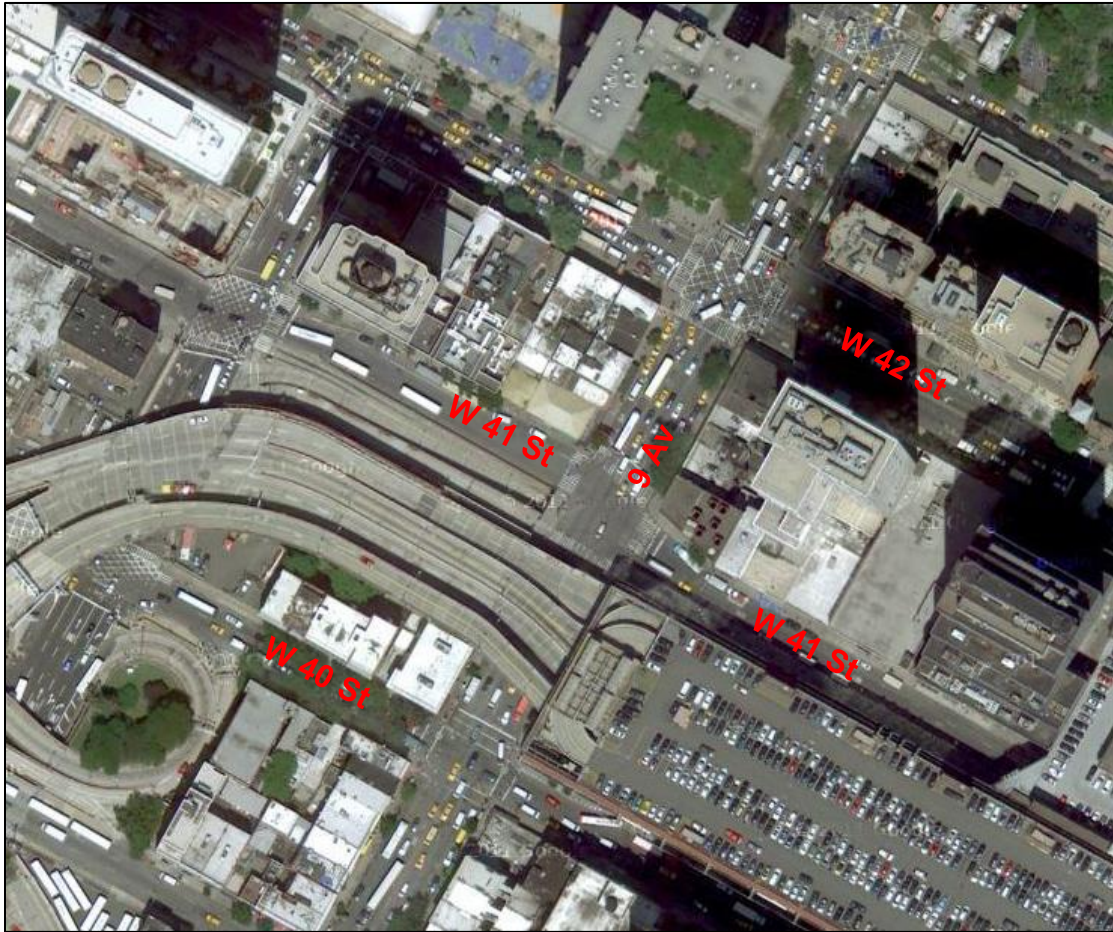


Figure 3.9.1: Misalignment of West 41st Street Across 9th Avenue.

In order to correct this misalignment, and also to create extra pedestrian space, the east leg was realigned in 2012. A curb extension was added at the southeast corner. Figure 3.9.2 presents the new design. A photo of the improved southeast corner is shown in Figure 3.9.3.

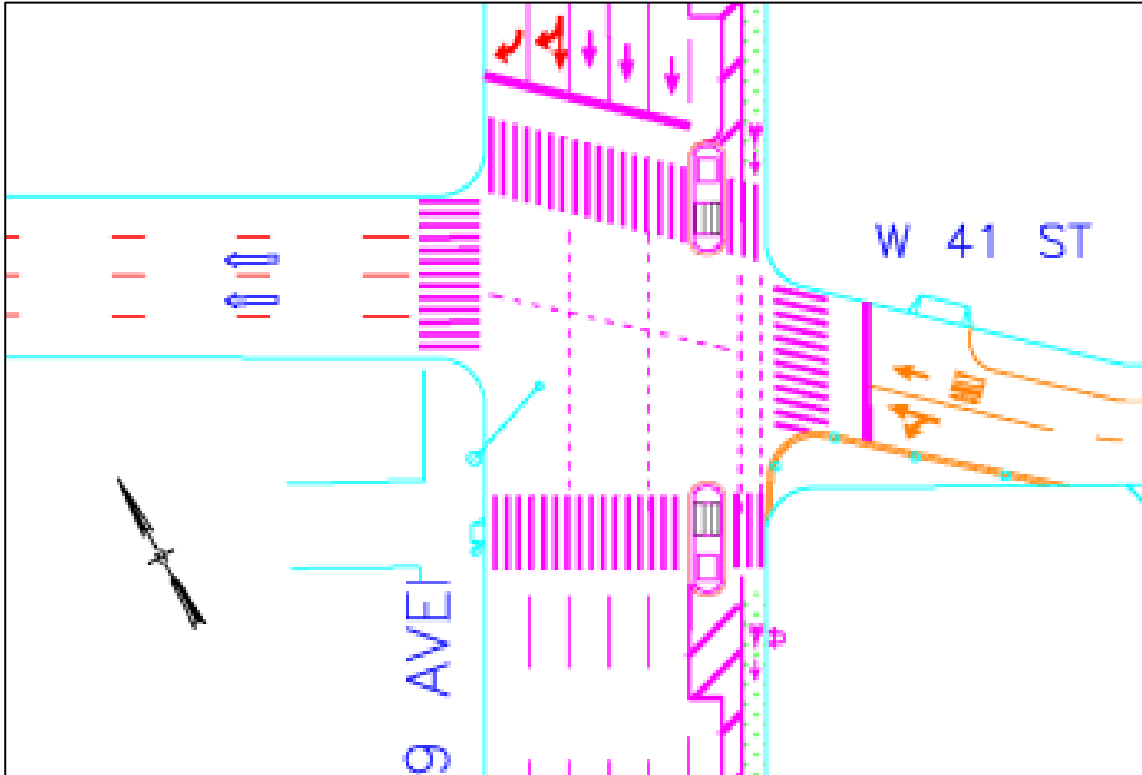


Figure 3.9.2: Realignment of East Leg of West 41st Street and 9th Avenue



Figure 3.9.3: Curb Extension at Southeast Corner of West 41st Street and 9th Avenue

3.10 Additional Signal Timing Changes

Analysis indicates that a major cause of traffic congestion on 9th Avenue, in addition to the spillback from traffic funneling into the Lincoln Tunnel at West 41st Street and at Ramp C, was the bottleneck at West 42nd Street. The previous timing plan for this intersection is presented on the left side of Figure 3.10.1. The signal operated as four phases: in addition to ball green phase for 9th Avenue (Phase 1) and for West 42nd Street (Phase 3), there was an overlapping LPI along 9th Avenue for crossing West 42nd Street where all traffic was stopped (Phase 4), and a leading westbound protected left-turn phase (Phase 2). The green time for Phase 1 for 9th Avenue traffic including yellow and all red was 40 seconds out of a 90 second cycle (35 seconds actual green, 3 seconds yellow, and 2 seconds all red). The green time for 9th Avenue at West 43rd and West 44th Streets (simple two-phase operations) was also 40 seconds (as a result of the “feathering” previously described in Section 3.7). At all other intersections along 9th Avenue north of West 37th Street in the study area, the green time for 9th Avenue is at least 45 seconds, most of them 50 to 55 seconds. In addition to causing congestion, this discrepancy encouraged blocking the box, which made it difficult and dangerous for pedestrians to cross 9th Avenue.

To remedy this bottleneck situation, and to facilitate the split phase for bikes described in Section 3.8, ball green time for 9th Avenue traffic was increased from 40 seconds to 46 seconds at West 42nd Street, and from 40 to 45 seconds at West 43rd and West 44th Streets. The right side of Figure 3.10.1 presents the details of the improved signal timing for West 42nd Street and 9th Avenue. The green time for 9th Avenue traffic is split into two phases – 29 seconds for Phase 1, and 17 seconds for Phase 2. During Phase 1, the bike lane has a green indication, and the east crosswalk has the WALK display, while the southbound left-turning vehicles are held with a red left-arrow to provide conflict-free crossing. During Phase 2, the bike lane has a red indication, the east crosswalk displays the steady hand, while the southbound left-turn bay has a green arrow for conflict-free turning. During both parts of the split phase (Phases 1 and 2 combined), 9th Avenue has a ball green display for through and right-turning traffic, and the west crosswalk has the WALK display.

This required the removal of the existing LPI for the east and west crosswalks. Because of the split phase for bikes, the east crosswalk will receive protected crossing free of conflict from turning vehicles, and therefore does not need an LPI. This crosswalk receives less crossing time than it previously did, but all of it is free of conflicting vehicles – a favorable tradeoff that is common to all split phase operations. The west crosswalk receives about the same amount of crossing time as previous, but does not get the seven second LPI that it previously did – all of its time is concurrent with right-turning vehicles. This is the downside to the revised timing plan. However, the number of conflicting vehicles that make the southbound right-turn into the west crosswalk is less than 100 vehicles per hour for any time period. This is far less than the informal standard of 200 vph to trigger the need for an LPI.

The north crosswalk continues to receive more than adequate time to cross the street, all of it free from conflicting vehicles. The south crosswalk receives five seconds less

crossing time than previous, but the crossing distance is reduced by a comparable amount because of the pedestrian island.

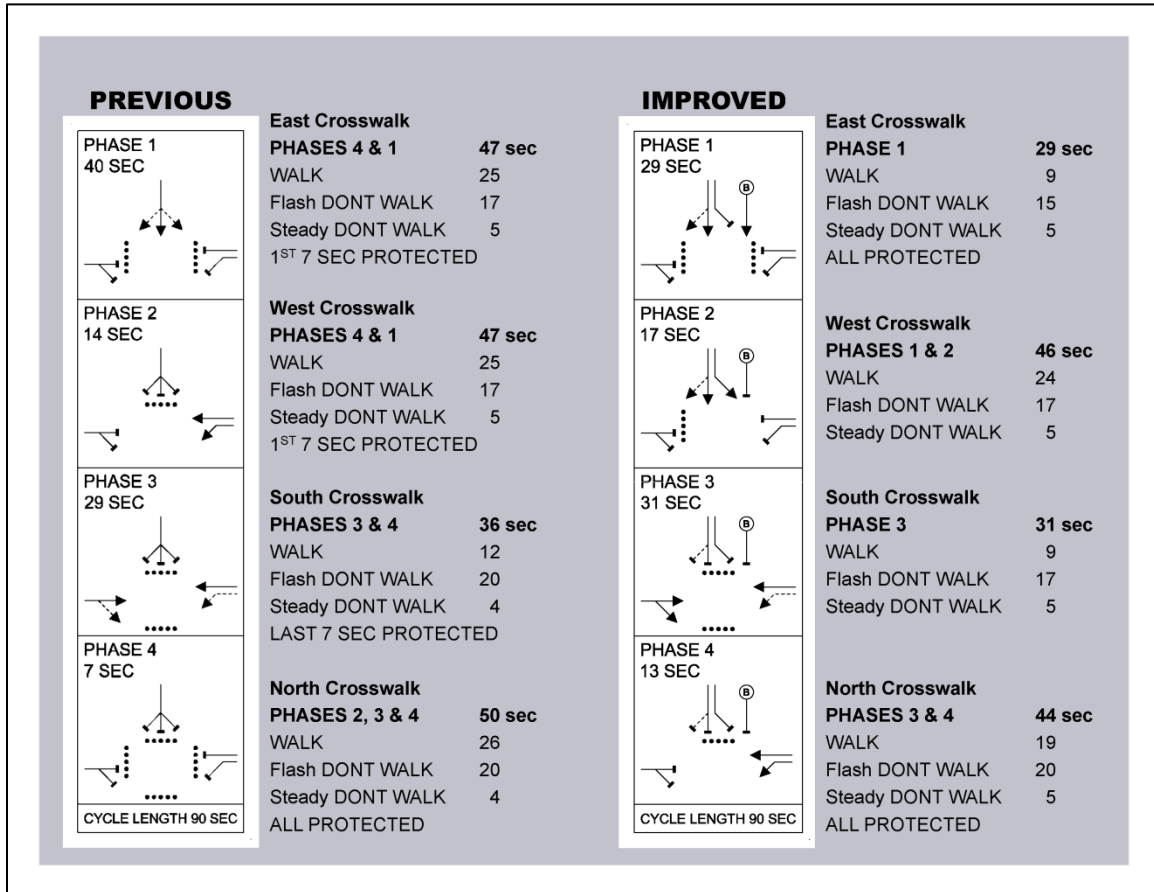


Figure 3.10.1: Signal Timing for West 42nd Street and 9th Avenue with Split Phase for Bikes

As mentioned earlier, to accompany the increased green time for 9th Avenue at West 42nd Street, the green time for 9th Avenue at West 43rd and West 44th Streets was increased from 40 to 45 seconds. These intersections operate as simple two-phase, and the five seconds were merely reallocated from the cross streets to 9th Avenue. These timing changes were implemented in July 2013.

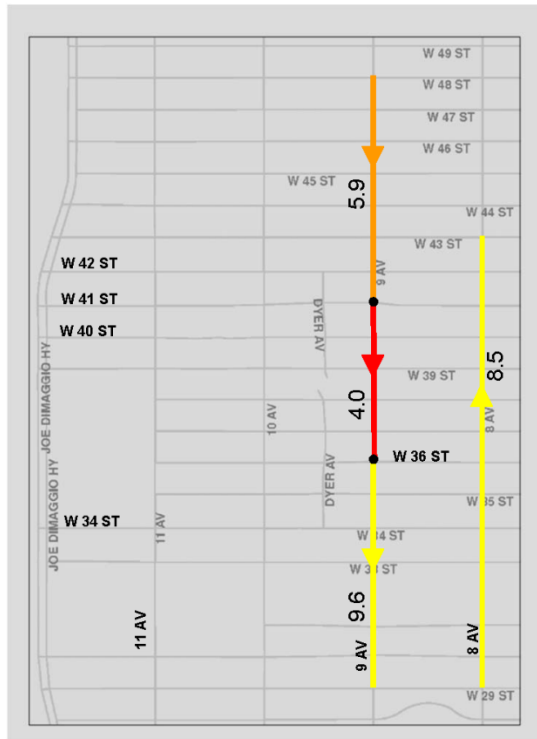
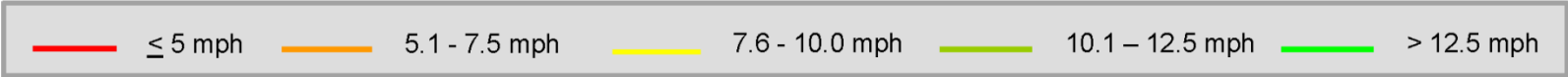
An additional adjustment in the sequence of the phasing at 9th Avenue and West 42nd Street was made in September 2013. Previously, the protected westbound left-turn phase was leading as shown in the left diagram of Figure 3.10.1. Phase 2 was the leading protected left-turn phase which displayed the westbound ball green and green left-arrow while eastbound traffic and pedestrians in the south crosswalk were held, and Phase 3 displayed ball green without turning arrow for both eastbound and westbound approaches. The problem was that, after observing the signal for 9th Avenue traffic turning red at the end of Phase 1, pedestrians would prematurely cross in the south crosswalk to cross 9th Avenue during Phase 2, despite the steady hand indication. This caused a dangerous conflict with westbound left-turners trying to complete their protected turn during Phase 2. For this reason, the sequence of the protected westbound

left-turn was changed from leading to lagging, as shown in the right diagram of Figure 3.10.1. Phase 3 displays the ball without turning arrow for both eastbound and westbound approaches, and Phase 4 is the lagging protected left-turn phase which displays the westbound ball green and green left-arrow while eastbound traffic and pedestrians in the south crosswalk are held. Now when pedestrians cross into the south crosswalk after observing the signal for 9th Avenue traffic turning red at the end of Phase 2, they will do so under the WALK indication. The downside of this sequence is that, after observing the signal for eastbound traffic turning red at the end of Phase 3, pedestrians may jump into the west crosswalk to cross West 42nd Street during Phase 4, despite the steady hand indication. This could cause a dangerous conflict with westbound through traffic, which continues to receive the green signal. Preliminary monitoring has revealed that conflicts in the south crosswalk have been greatly reduced, with no discernible increase in problems with the west crosswalk. Monitoring will continue during 2014.

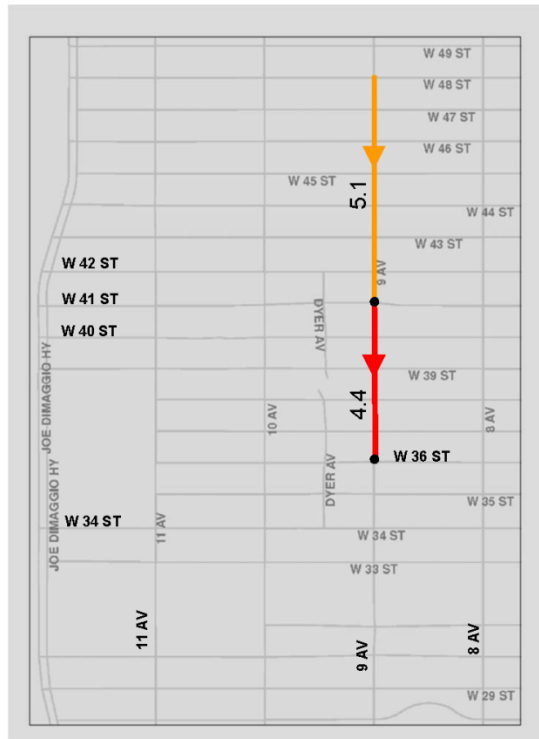
Figure 3.10.2 presents the effect on traffic with and without the split phase for bikes and increased green time for 9th Avenue described in this section, in combination with all improvements in the previous sections. The increased green time for 9th Avenue at West 42nd through West 44th Streets is projected to result in increased average travel speed on the upper section of 9th Avenue from 5.1 to 5.7 mph, about a 12% improvement.

Another timing change has been considered, but not implemented, is to provide protected-only westbound left-turn phasing at 9th Avenue and West 42nd Street. Currently, the westbound left-turns are permitted-protected. During Phase 3, left-turns are permitted, where the ball green signal indicates they must yield to opposing eastbound traffic and to conflicting pedestrians in the south crosswalk. During Phase 4, the green left-arrow indicates left-turns are protected, where they may turn without conflicts with eastbound traffic or the south crosswalk. Under protected-only phasing, during Phase 3 a red left-arrow would accompany the ball green, which would indicate left turns are not permitted, and they could only be made during the protected Phase 4. This would provide additional protection to pedestrians in the south crosswalk. A westbound left-turn-only lane, a necessary condition to accommodate this type of phasing, has already been marked, as described in Section 3.3.

Preliminary analysis reveals that this action may have the potential to cause substantial queues extending back to Times Square. A final decision on whether to implement the protected-only phasing will be reached after a monitoring period during 2014.

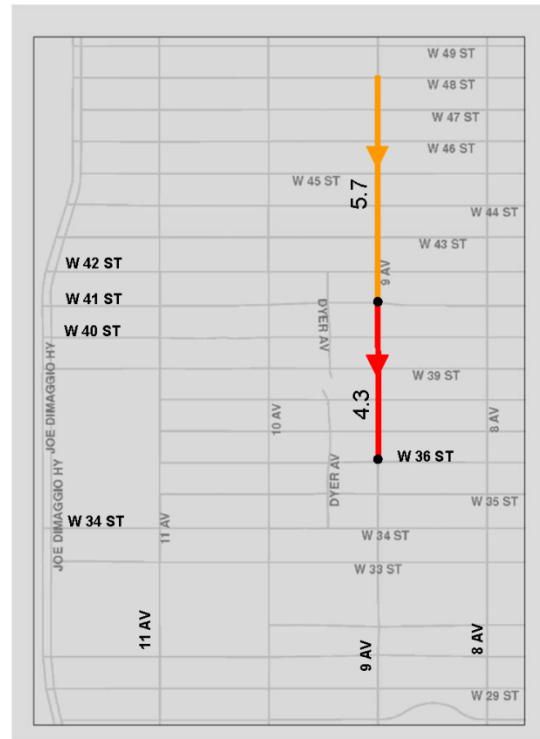


2015 FUTURE W/O IMPROVEMENTS



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes
- Split Phase for Bikes and Increased Green Time for 9th Avenue

Figure 3.10.2: Average Travel Speeds – 2015 Future with and without Split Phase for Bikes – Weekday PM Peak Hour

3.11 Canoe Project

As mentioned in Section 2.3, the biggest pedestrian deficiency in the study area was the discontinuity in the sidewalk on the west side of 9th Avenue between West 36th and West 37th Streets. This was caused by the free right-turn of the two right-most lanes from 9th Avenue onto Ramp C. The “Canoe” project, implemented during November 2013, addresses this deficiency.

The traffic island bounded by 9th Avenue on the east, Dyer Avenue on the west, Ramp C on the north, and West 36th Street on the south previously was occupied by vehicles that parked illegally, causing an eyesore. Under the Canoe project, southern edge of the raised island was expanded by 13 feet, taking up what was previously the north parking lane on West 36th Street. The eastern edge was also expanded. In Figure 3.11.1, the dark grey is the previous raised island, and the light grey shows the expanded raised sections. A canoe shaped landscaped area was created, with plantings on the south and west edges, a bike rack, granite blocks, and benches to be added in 2014. A section of the existing pedestrian fence along the west curb of 9th Avenue was removed to provide access to a new signalized crosswalk across Ramp C. “Qwik Curb” delineators that separate the two right lanes, which are channeled to Ramp C, from the 9th Avenue through traffic were installed in 2012 as part of the bike lane project described in Section 3.8.

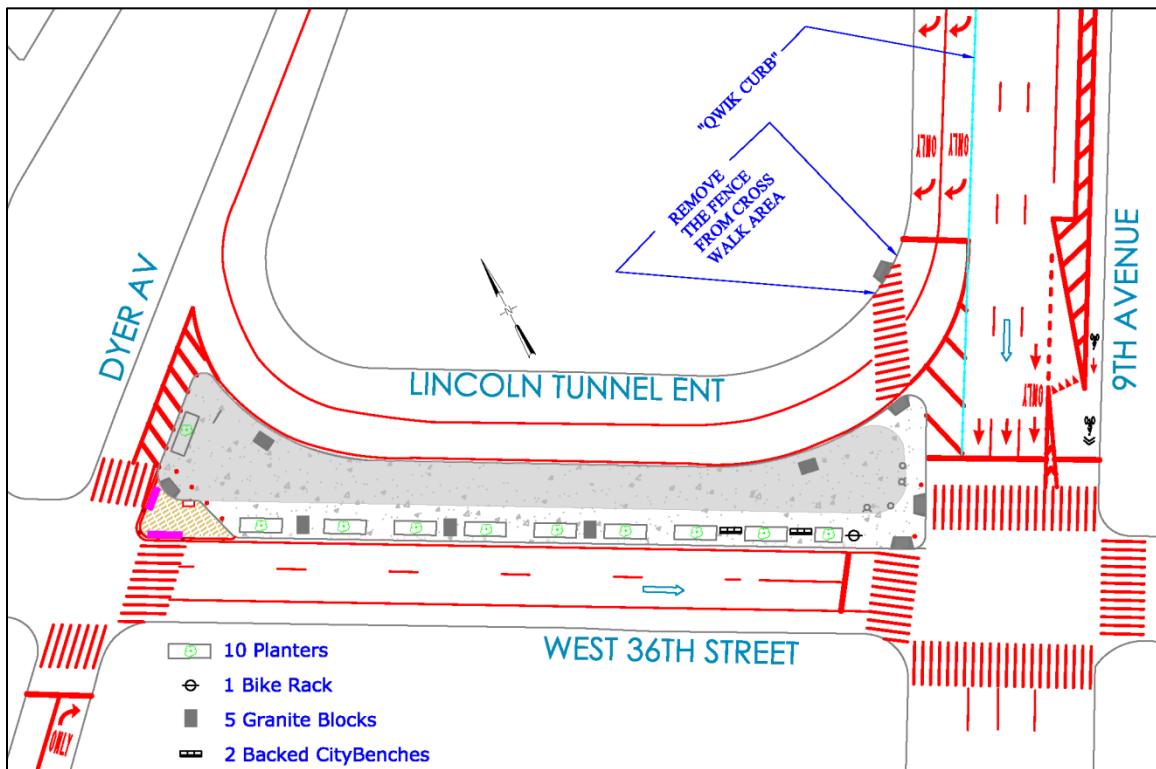


Figure 3.11.1: “Canoe” Design with New Signalized Crosswalk

Figure 3.11.2 presents the previous and improved signal timing. Under the previous two-phase operation shown on the left side of Figure 3.11.2, there was 55 seconds green time (including yellow and all-red) for southbound 9th Avenue approaching West 36th Street (Phase 1), and 35 seconds for West 36th Street (Phase 2). The right turn onto Ramp C was free, meaning it effectively had 100% green time during both phases. There was previously no crosswalk for crossing Ramp C.

Under this improved arrangement shown on the right side of Figure 3.11.2, green time for 9th Avenue approaching West 36th Street (Phase 1) is the same as previous – 55 seconds. Green time for West 36th Street (Phases 2 and 3) is also the same as previous – 35 seconds. The crossing time for all four crosswalks at West 36th Street and 9th Avenue also remains unchanged. The difference is that vehicles in the two right lanes that are channeled to Ramp C now encounter a separate signal, in which they receive 65 seconds of green time out of a 90 second cycle to turn right (Phases 3 and 1). The remaining 25 seconds are for pedestrians to cross Ramp C at the new crosswalk (Phase 2).

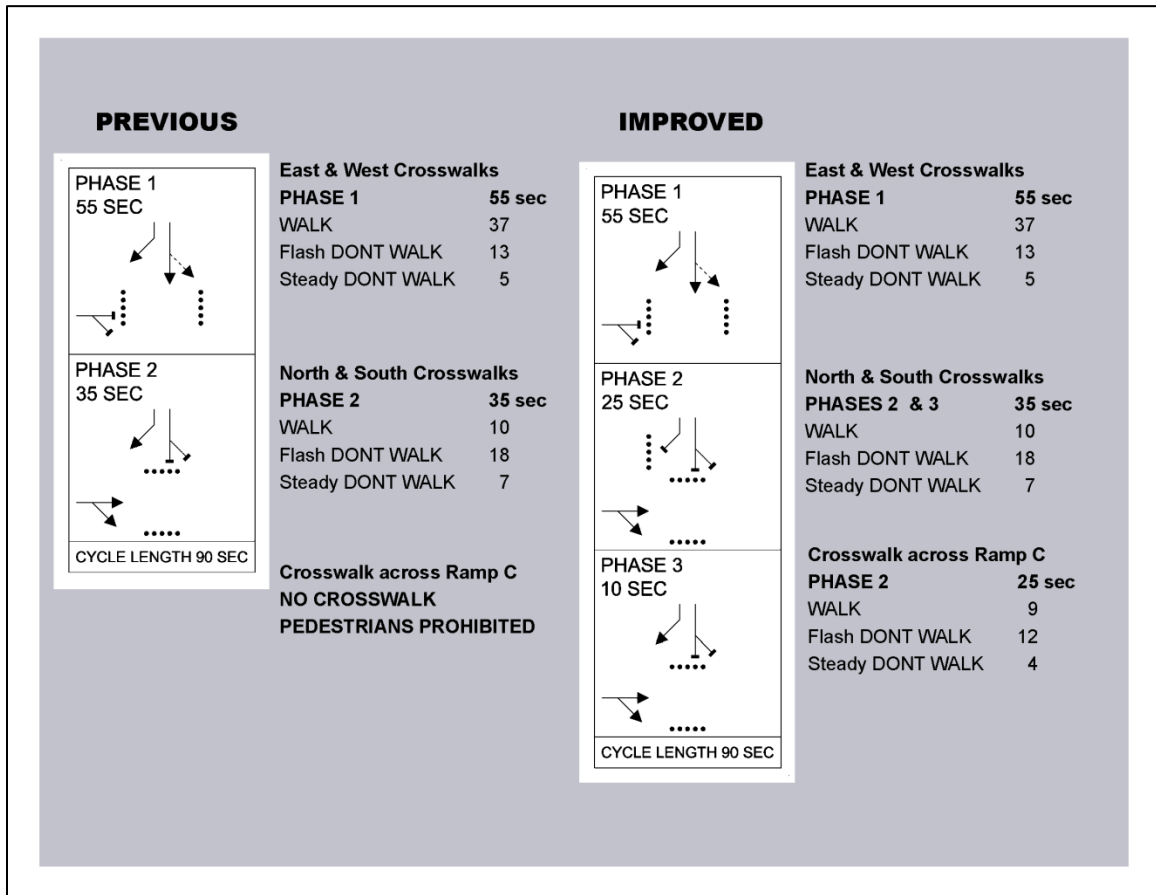
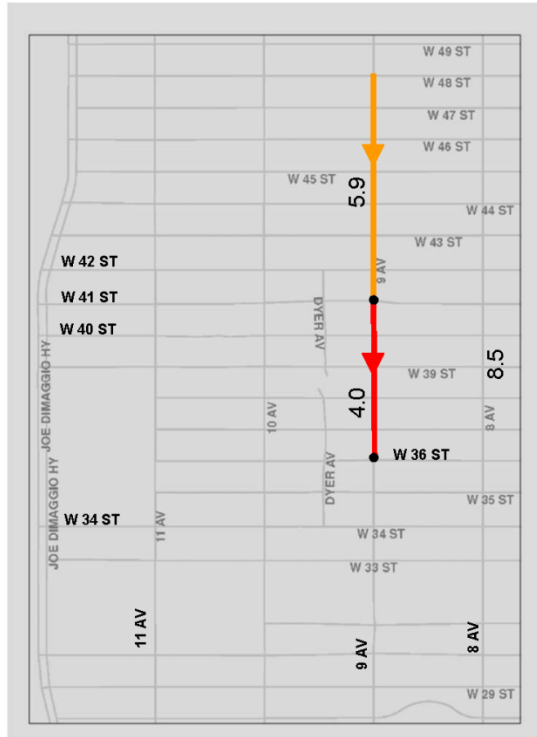
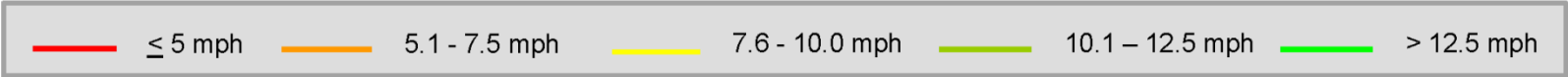


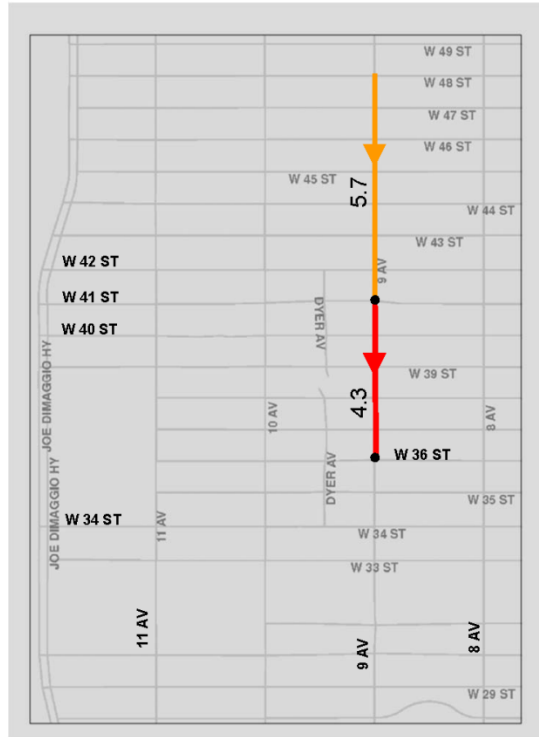
Figure 3.11.2: Previous and Improved Signal Timing for 9th Ave, W. 36th St and Ramp C

The resulting delays for 9th Avenue are not expected to increase much during peak periods, because drivers using Ramp C encounter delays anyway as this traffic merges with Dyer Avenue and the Lincoln Tunnel Expressway further downstream. Figure 3.11.3 presents the effect on traffic for the affected corridors with and without the Canoe project in combination with all improvements in the previous sections. The pedestrian operational and safety benefits of these improvements will be enormous.

Most of the Canoe project was implemented during November 2013. It will be finished during spring 2014.

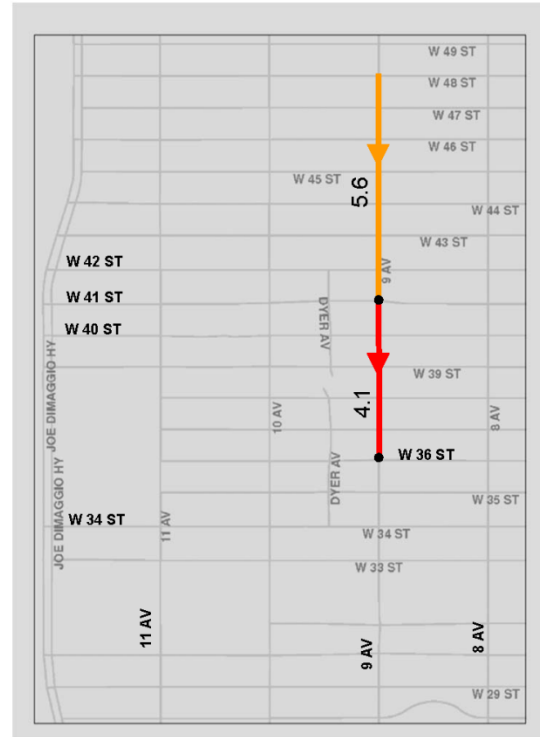


2015 FUTURE W/O IMPROVEMENTS



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes
- Split Phase for Bikes and Increased Green Time for 9th Avenue



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes
- Split Phase for Bikes and Increased Green Time for 9th Avenue
- Canoe Project with New Signalized Crosswalk

Figure 3.11.3: Average Travel Speeds – 2015 Future with and without Canoe Project – Weekday PM Peak Hour

3.12 Turn Ban from West 37th Street to Ramp C

During 2012, permanent “Qwik Curb” delineators were installed on 9th Avenue between West 38th Street and West 36th Street to separate the two right lanes, which are channeled to Ramp C, from 9th Avenue through traffic, as opposed to the cones that the police previously set up every afternoon. In November 2013, a turn ban was implemented to prohibit vehicles from West 37th Street approaching 9th Avenue from turning left into Ramp C (right side of delineators), but continued to allow the left-turn onto southbound 9th Avenue (left side of delineators). The sign that drivers encounter on West 37th approaching 9th Avenue is shown in Figure 3.12.1. Additional trailblazing signage was posted at West 37th Street approaching 9th, 10th and 11th Avenues to inform drivers that the route to the Lincoln Tunnel is to continue through on West 37th Street to 11th Avenue, then turn right.



Figure 3.12.1: Sign on W.37th St approaching 9th Avenue

The expected diversions as a result of this left-turn ban are shown in Figure 3.12.2. During the weekday PM peak hour, about 125 vehicles turned from West 37th Street into Ramp C previous to the ban. Assuming 100% compliance, it is projected that 50% will continue through on West 37th Street. Of those, about half (25% of the total) will turn right onto 10th Avenue, and the other half (25% of the total) will turn right onto 11th Avenue. Another 25% of the total will turn left from West 37th Street onto 9th Avenue (left side of the delineators), and access the Lincoln Tunnel by turning right onto West 35th Street. The remaining 25% would be diverted to westbound West 35th Street further east.

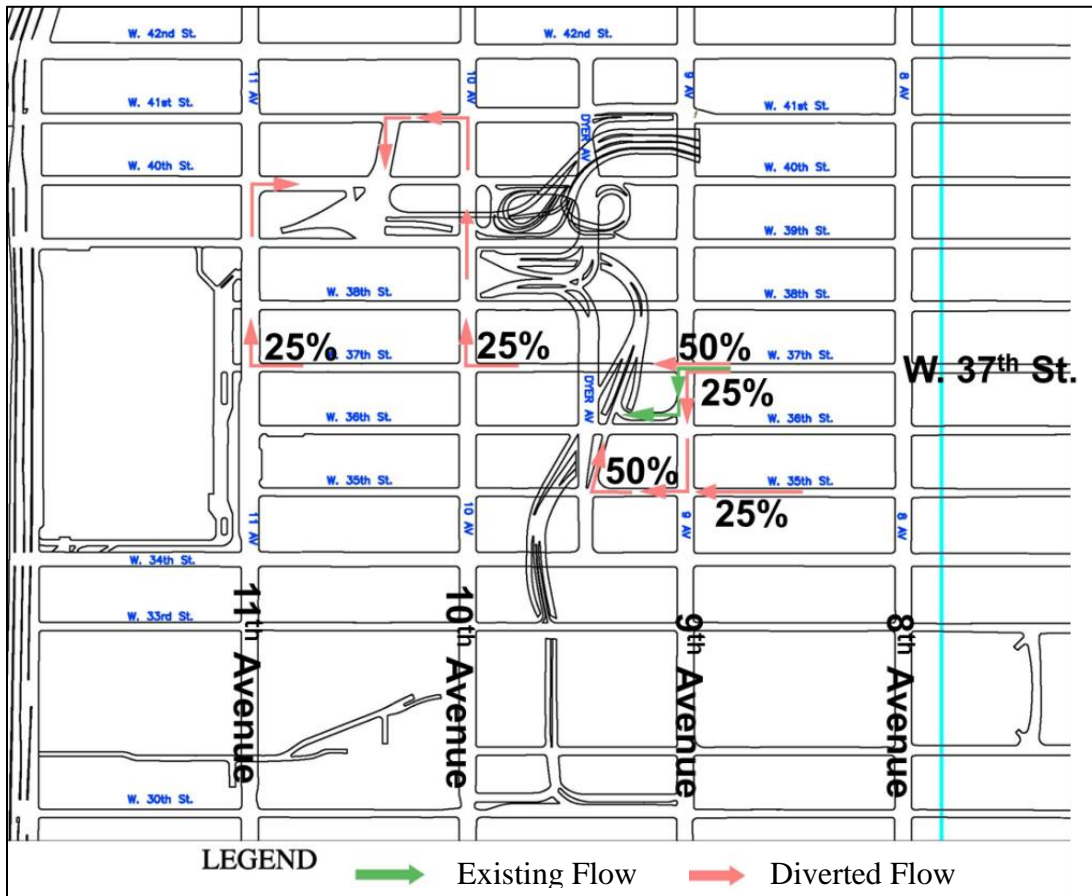
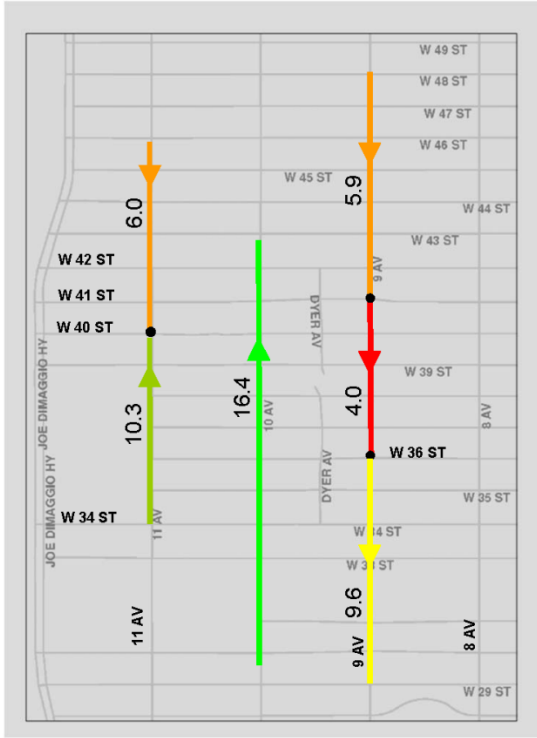
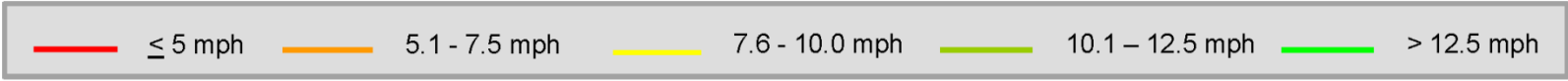


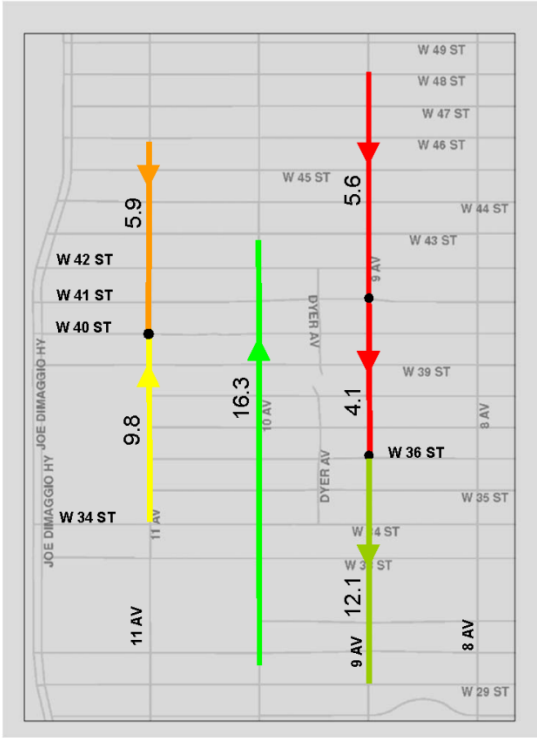
Figure 3.12.2: Projected Diversion from Turn Ban from West 37th Street to Ramp C

The benefits of this turning ban to 9th Avenue operations are projected to be significant. The results are shown in Figure 3.12.3. It is projected that during the weekday PM peak hour, the average travel speed on 9th Avenue between West 48th and West 41st Street will improve from 5.6 mph to about 7.4 mph. The segment between West 41st Street and West 36th Street is expected to improve from 4.1 mph to 6.1 mph. These results are cumulative in that they also figure in all improvements in the previous sections.

The downside is that 10th Avenue is projected to experience a small decrease in average travel speed from 16.3 mph to 15.9 mph, while the projected reduction in average travel

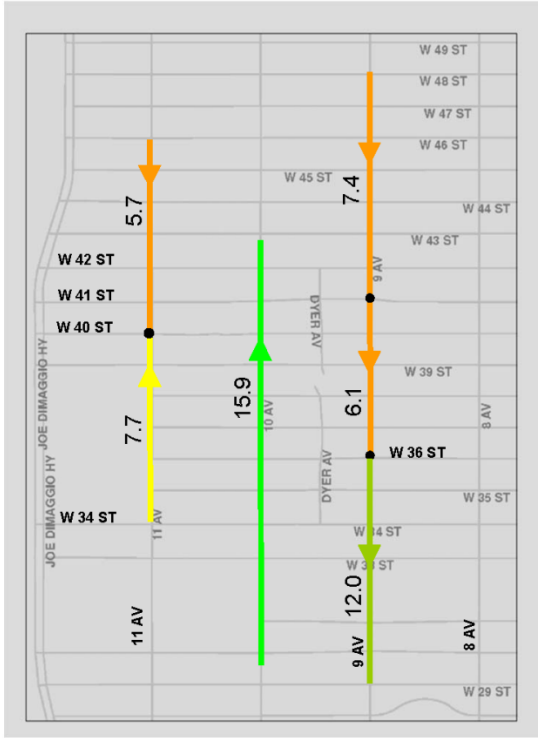


2015 FUTURE W/O IMPROVEMENTS



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes
- Split Phase for Bikes and Increased Green Time for 9th Avenue
- Canoe Project with new Signalized Crosswalk



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes
- Split Phase for Bikes and Increased Green Time for 9th Avenue
- Canoe Project with New Signalized Crosswalk
- Turn Ban from W. 37th St to Ramp C

Figure 3.12.3: Average Travel Speeds – 2015 Future with and without Turn Ban from W. 37th St to Ramp C – Weekday PM Peak Hour

speed on northbound 11th Avenue is noticeable from 9.8 mph to 7.7 mph. This is a result of vehicles being diverted to northbound 10th and 11th Avenues. Southbound 11th Avenue from West 46th to West 40th Streets would be indirectly affected, because more vehicles will use the north tube. Average travel time on this segment is projected to decrease from 5.9 mph to 5.7 mph. Also, the delay at westbound West 35th Street approaching 9th Avenue is projected to increase from about 48 seconds to about 67 seconds.

The turn ban from West 37th Street to Ramp C was implemented in November 2013. A priority for 2014 will be to review placement of the OK-NO signs and the trailblazers to the Lincoln Tunnel, and to work with NYPD and PAPD to heighten enforcement and enhance compliance.

3.13 Turn Ban from West 36th Street to Dyer Avenue

Another turn ban that was implemented in November 2013 in order to improve operations is the left-turn from eastbound West 36th Street onto Dyer Avenue. Previously, about 125 vehicles made this turn during the weekday PM peak hour, competing with vehicles from northbound Dyer Avenue, and ultimately with vehicles from Ramp C. These left-turning vehicles often blocked the intersection by trying to force their way through when there was no room to complete the turn.

Figure 3.13.1 presents the assumed diversion as a result of this turn ban. Signage has been changed to direct vehicles originating from northbound 10th Avenue to turn left onto West 37th Street and use 11th Avenue to access the Lincoln Tunnel, instead of turning right onto West 36th Street to Dyer Avenue as directed by previous signage. It is assumed that about 40% will be diverted to this preferred route. As with all such turn bans, diligent enforcement is necessary to be effective.

It is assumed that another 40% of the diverted motorists will continue northbound on 10th Avenue to West 40th Street. Finally, it is conservatively assumed that the remaining 20% will turn right from 10th Avenue onto West 36th Street despite the signage, only to discover that the left turn onto Dyer Avenue is banned, and will have to travel around the block to West 35th Street as shown in Figure 3.13.1 to get to Dyer Avenue.

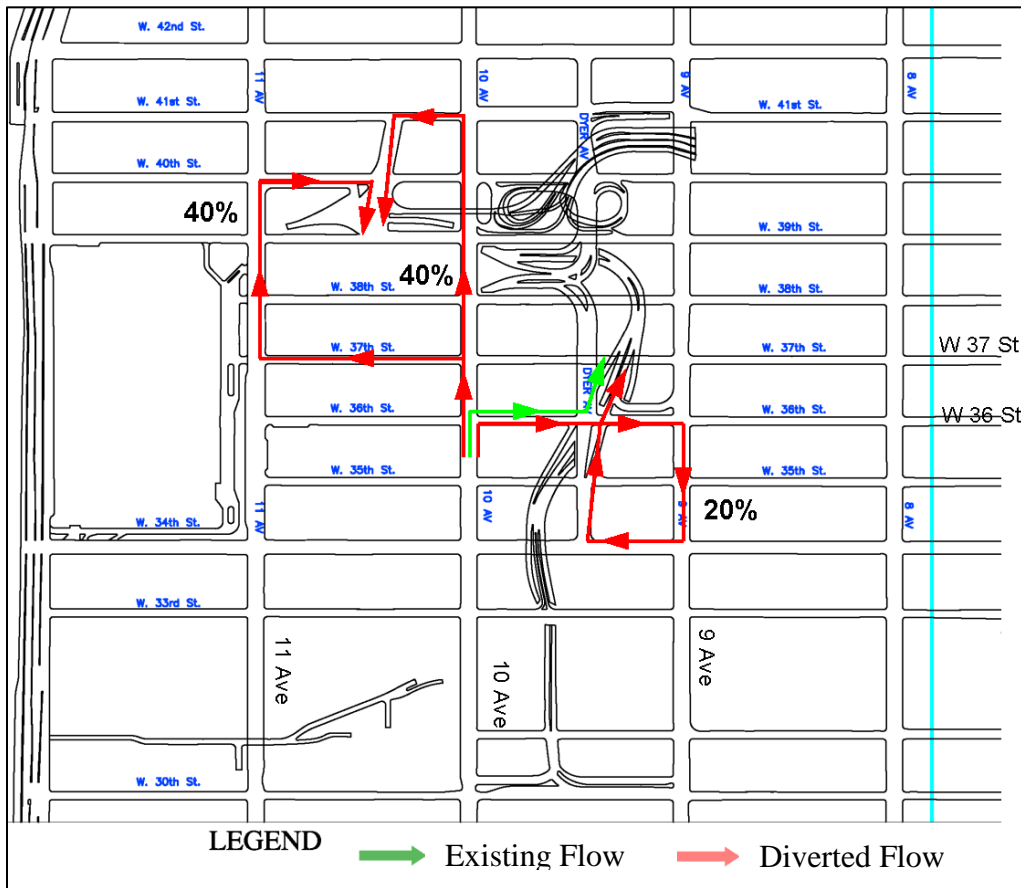
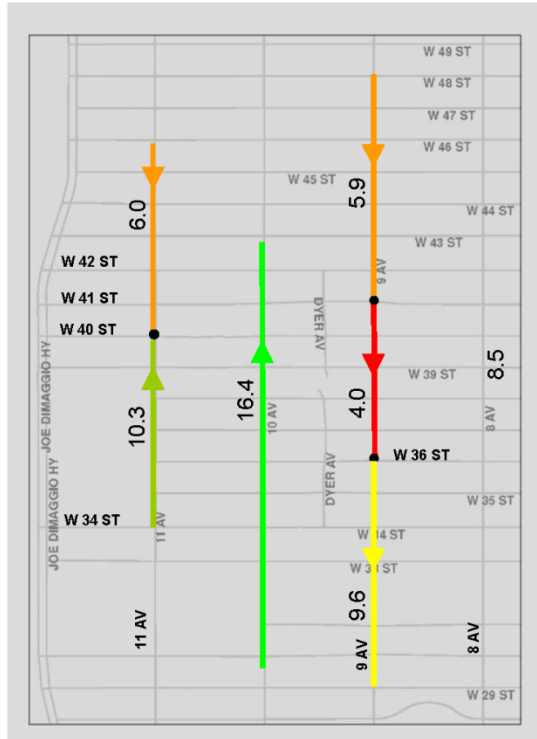
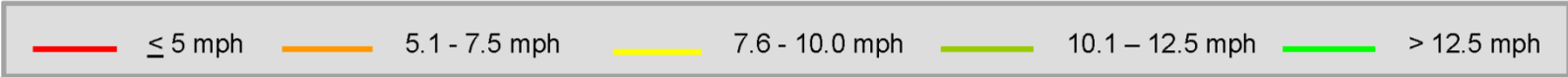


Figure 3.13.1: Projected Diversion from Turn Ban from West 36th Street to Dyer Avenue

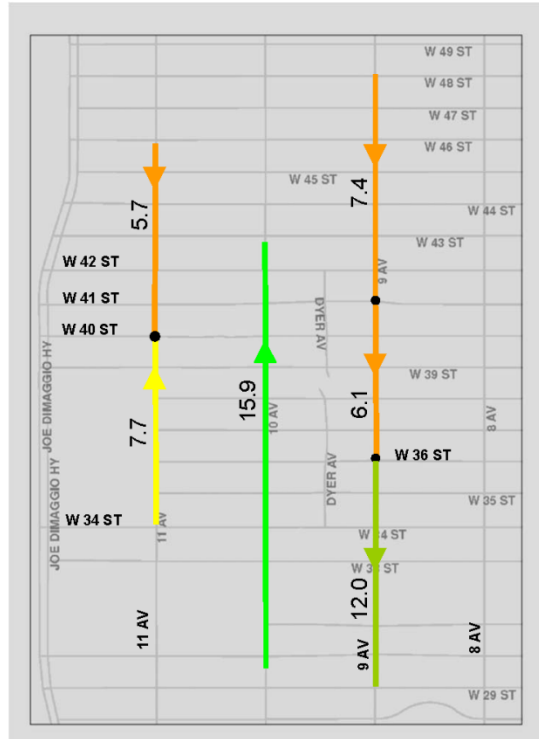
The benefits of this turning ban to 9th Avenue operations are projected to be significant. The results are shown in Figure 3.13.2. It is projected that during the weekday PM peak hour, the average travel speed on 9th Avenue between West 48th and West 41st Street will improve from 7.4 mph to about 8.9 mph. The segment between West 41st Street and West 36th Street is expected to improve from 6.1 mph to 8.6 mph. These results are cumulative in that they also figure in all improvements in the previous sections.

Similar to the turn ban described in the previous section, the downside is that 10th Avenue is projected to experience a small decrease in average travel speed from 15.9 mph to 15.5 mph, while the projected reduction in average travel speed on northbound 11th Avenue is from 7.7 mph to 6.8 mph. This is a result of vehicles being diverted to northbound 10th and 11th Avenues. Southbound 11th Avenue from West 46th to West 40th Streets would be indirectly affected, because more vehicles would use the north tube. Average travel time on this segment is projected to decrease from 5.7 mph to 5.5 mph.

The turn ban from West 36th Street to Dyer Avenue was implemented in November 2013. As with the turn ban described in the previous section, a priority for 2014 will be to review placement of signs, and to work with NYPD and PAPD to heighten enforcement and enhance compliance.

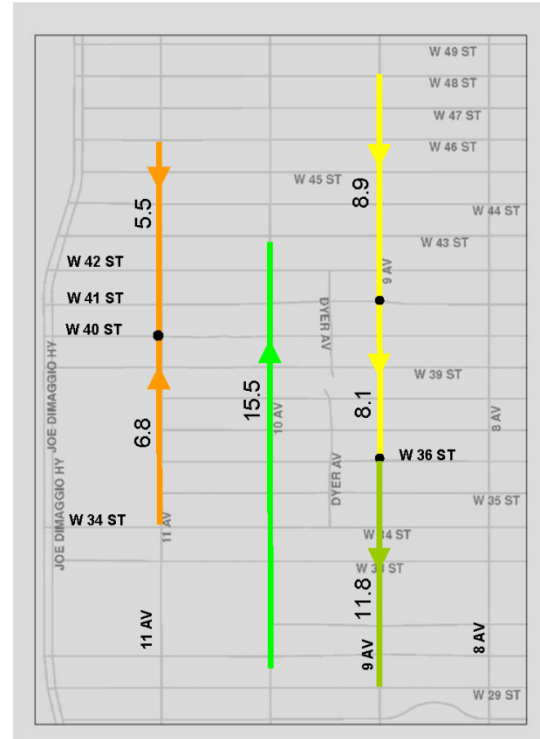


2015 FUTURE W/O IMPROVEMENTS



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes
- Split Phase for Bikes and Increased Green Time for 9th Avenue
- Canoe Project with new Signalized Crosswalk
- Turn Ban from W. 37th St to Ramp C



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes
- Split Phase for Bikes and Increased Green Time for 9th Avenue
- Canoe Project with New Signalized Crosswalk
- Turn Ban from W. 37th St to Ramp C
- Turn Ban from W. 36th St to Dyer Ave

Figure 3.13.2: Average Travel Speeds – 2015 Future with and without Turn Ban from W. 36th St to Dyer Ave – Weekday PM Peak Hour

CHAPTER 4 POTENTIAL/PLANNED FUTURE IMPROVEMENT MEASURES

This chapter describes the improvement measures that are not yet implemented. Some are planned for implementation in 2014. Others are more long term.

4.1 34th Street Select Bus Service – Phase II

The 34th Street Select Bus Service project seeks to improve bus speeds, pedestrian safety and curb access on a corridor that extends for two miles from 12th Avenue to the FDR Drive. As mentioned in Section 3.5, the first phase of the project has already been implemented. Fare prepayment began on November 13, 2011. The M34 was renamed the M34 SBS, and the M16 was renamed the M34A SBS. In addition, video camera enforcement has been expanded for the existing bus lanes.

The two routes together carry over 17,000 passengers daily, but their average speed before implementation of Phase I was only about 4.5 miles per hour. The street is also used by commuter buses that carry over 16,000 passengers daily. During weekday peak hours, over 100 transit buses an hour traverse 34th Street, and hundreds of tour buses use the street over the course of a typical day.

During the second phase, NYCDOT will create improved offset bus lanes along 34th Street, as well as bus bulbs at many station stops, and sidewalk expansion to address pedestrian safety. The improved bus lanes will also benefit the express and tour buses that use the corridor. At the same time, NYCDOT will implement transit signal priority and other signal improvements to improve bus speeds and general traffic flow. Curbside loading zones will be expanded.

The following is a description of the typical treatments for the study area section of West 34th Street between 12th and 8th Avenues.

The section between 12th Avenue and 11th Avenue will remain the same as today, with two travel lanes and parking in each direction. There will be no bus lanes in this section.

In the section between 11th Avenue and 9th Avenue, where the curb to curb roadway width is 60 feet, there are currently two travel lanes and a curbside bus lane in each direction, with no parking. The proposed plan features one travel lane, an offset bus lane, and a parking lane in each direction. Figure 4.1.1 illustrates the proposed typical treatment. Offset bus lanes are located next to the parking lane, instead of next to the curb, reducing the conflict with stopped vehicles. The parking lanes on both sides will provide

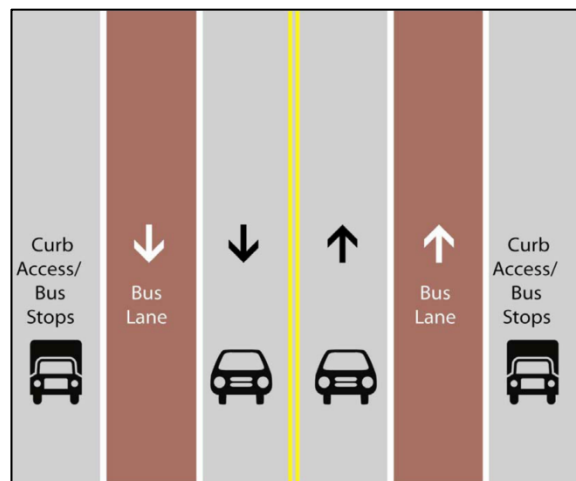


Figure 4.1.1: Proposed Treatment, West 34th Street between 11th & 9th Avenues

sidewalk will be expanded for the length of the bus stop into the parking lane, so that buses will not need to pull over at bus stops, and pedestrians have more space to walk and wait. The curb lanes will be used for right-turn bays at approaches where right-turns are permitted, as shown in Figure 4.1.2. This treatment will also be used for the section east of 3rd Avenue, outside the study area.

In the section between 9th Avenue and 8th Avenue, where the curb to curb roadway width is 52 feet, there are currently two westbound travel lanes, one eastbound travel lane, and a curbside bus lane in each direction, with no parking. The proposed plan features one travel lane in each direction, a westbound curbside bus lane, an eastbound offset bus lane, and an eastbound parking lane. Figure 4.1.3 illustrates the proposed typical treatment. The eastbound parking lane will provide 24 hour loading zones, which do not currently exist. At bus stops, bus bulbs will provide wider sidewalks. This treatment will also be used for the section between 8th Avenue and 3rd Avenue, outside the study area.

The proposal will improve bus reliability and increase bus speeds for over 33,000 daily riders. Corridor wide, it will add 18,000 square feet of new pedestrian space, reducing sidewalk crowding and improving pedestrian safety. It will also increase daytime loading from 32 to 258 spaces, with a loading zone on one side of every block between 8th and 3rd Avenues, and on both sides of every block west of 9th Avenue and east of 3rd Avenue.

Figure 4.1.4 presents the proposed layout of West 34th Street between 12th and 8th Avenue, showing the travel lanes, bus lanes, parking lanes, bus stops and bulbouts. Existing and proposed views are shown in Figures 4.1.5 and 4.1.6, respectively.

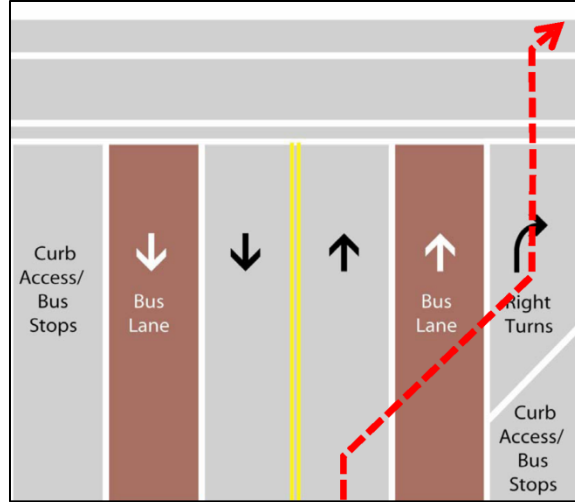


Figure 4.1.2: Proposed Right-Turn Bays

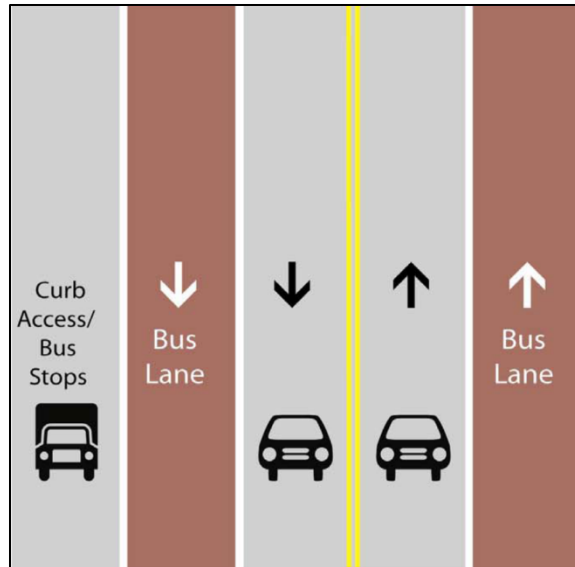


Figure 4.1.3: Proposed Treatment, West 34th Street between 9th and 8th Avenues

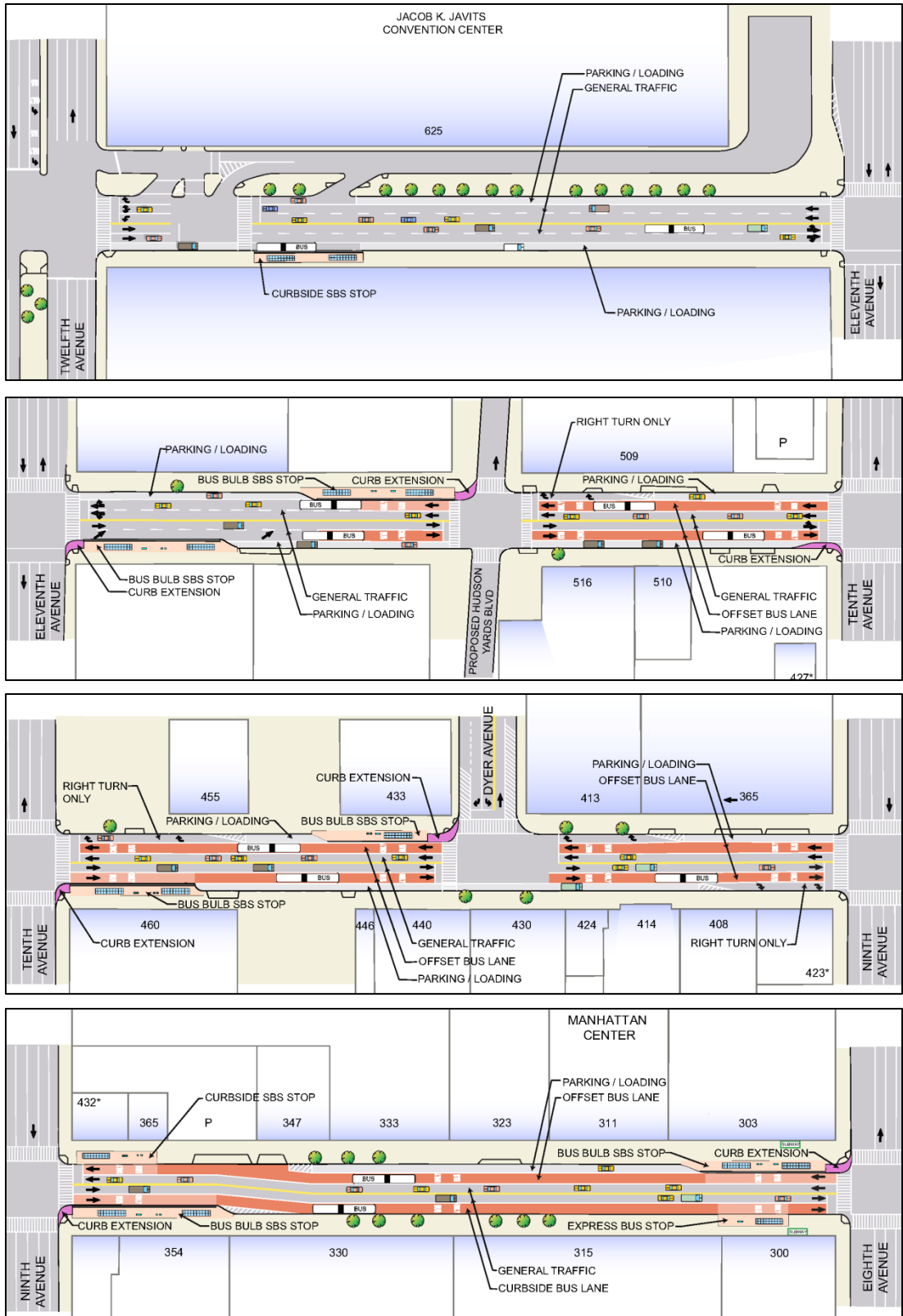


Figure 4.1.4: Proposed Bus Lane Layout on W. 34th St between 12th and 8th Avenues



Figure 4.1.5: Existing View, West 34th Street Looking East from Dyer Avenue

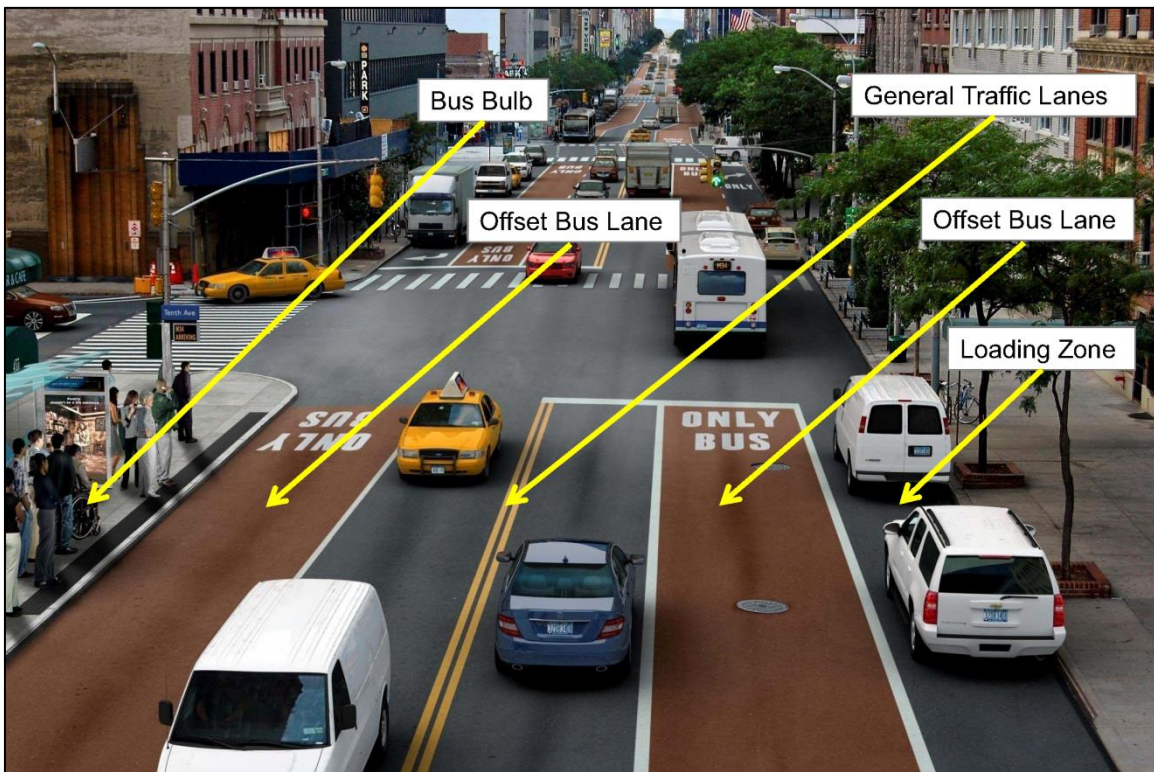


Figure 4.1.6: View of West 34th Street Looking East from Dyer Avenue with Proposed Treatments

The following measures are proposed to address the effects of lane reduction on traffic operations:

- Ban the westbound left turn from West 34th Street onto 9th Avenue.
- Ban the westbound right turn from West 34th Street onto 8th Avenue.
- Signal timing changes to provide more green time to West 34th Street. They are summarized in Table 4.1.1.

**Table 4.1.1
SIGNAL TIMING CHANGES FOR 34 ST SBS**

LOCATION	CHANGE
11 Av & W 34 St	Change protected E-W dual LT to protected WB+L (14 sec)
10 Av & W 34 St	Reallocate 5 sec from NB to EB-WB
9 Av & W 34 St	Remove protected WB-L (because it will be banned), add to EB (15 sec)
8 Av & W 34 St	Remove LPI (because turns from W 34 St will be banned), give extra 7 sec to E-W.
10 Av & W 35 St	Reallocate 2 sec from NB to WB

Overall, it is projected that traffic delays will remain roughly the same as existing. The right turn bays, turning bans, and increased green time for West 34th Street will offset the lane reduction. The offset bus lanes, which will be blocked less often than curbside bus lanes, will be able to carry more buses. Figures 4.1.7 and 4.1.8 presents projected level of service for 34th Street from 12th Avenue to the FDR Drive for future with and without the bus lanes, respectively for the weekday AM peak hour.

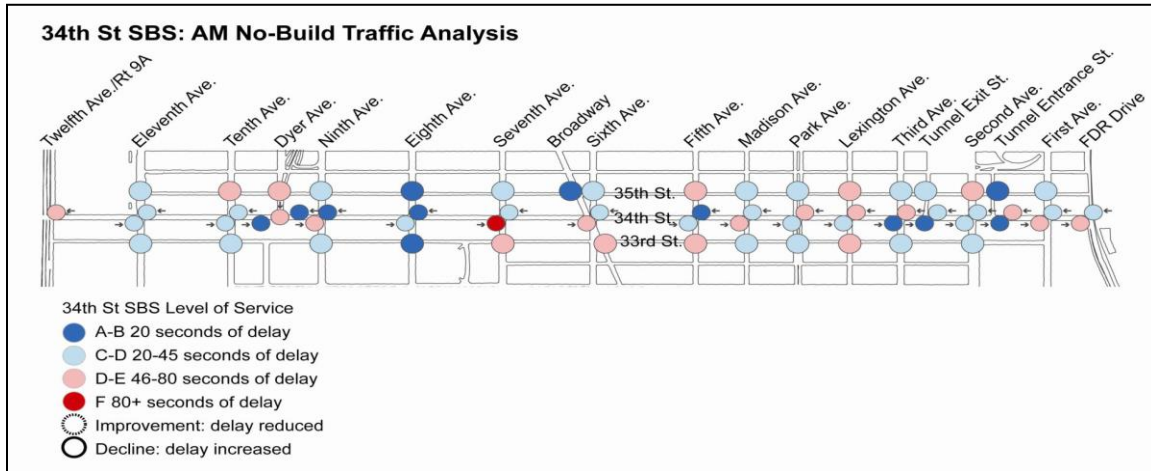


Figure 4.1.7: 2015 Future Level of Service on West 34th Street w/o Bus Lane Improvements – Weekday AM Peak Hour

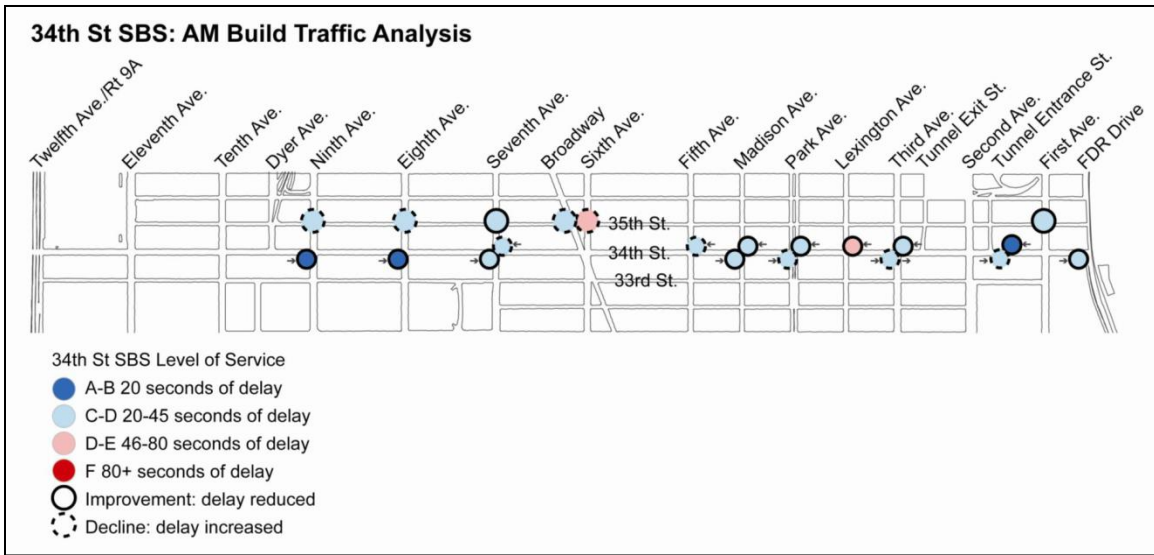


Figure 4.1.8: 2015 Future Level of Service on West 34th Street with Bus Lane Improvements – Weekday AM Peak Hour

The western section of 34th Street Select Bus Service project, between 11th Avenue and 10th Avenue, is largely completed. Two bus bulbs have been built, although at this time they are used for staging for construction of the No. 7 train extension. The section between 10th Avenue and Lexington Avenue is scheduled to be completed in 2014. The section from Lexington Avenue to the FDR Drive, coordinated with the Water Tunnel No. 3 project, is scheduled to be completed in 2016.

4.2 Safe Crossing of 8th and 9th Avenues

As mentioned earlier, the conflict between pedestrians crossing 9th Avenue at south crosswalks, and 8th Avenue at north crosswalks, while vehicles concurrently turn from the cross streets onto these avenues, is a problem that has been brought up by the community. These conflicts also exist at east and west crosswalks at intersections with major cross streets, such as West 34th, 42nd and 57th Streets.

Figure 4.2.1 illustrates three types of treatments for protecting pedestrians crossing a wide one-way avenue like 8th Avenue or 9th Avenue. An LPI (leading pedestrian interval) gives pedestrians a head start – typically about seven seconds – to “take” the crosswalk before the adjacent cross street traffic is released. This improves motorists’ visibility of pedestrians as they establish themselves in the crosswalk. It also discourages aggressive “jackrabbit” starts by motorists trying to turn before pedestrians get in their way. However, this type of treatment does not completely eliminate the conflict. The adverse effect on traffic is that cross street green time must be reduced for both turning vehicles and through vehicles.

Another treatment is the split phase, in which green time for the cross street would be split into two parts. In the first part, the south crosswalk at 9th Avenue intersections (north crosswalk for 8th Avenue intersections) would have the WALK display, while the turning vehicles are held with a red arrow to provide conflict-free crossing. In the second part of the split phase, the south crosswalk for 9th Avenue intersections (north crosswalk for 8th Avenue intersections) would display the steady hand, while the turning vehicles have a green arrow for conflict-free turning. During both parts of the split phase, the cross street would display through-arrow green for through traffic, and the opposite crosswalk would display the WALK indication. A disadvantage of split phase treatment is that the WALK time for the conflicting crosswalk and green time for the conflicting turning movement are both drastically reduced in order to completely eliminate the conflict. The green time for the through movement, however, is not penalized as with LPI treatment. A prerequisite to split phase treatment is that a turning lane must be provided.

A third type of treatment is the split LPI. Like the standard LPI, pedestrians are given a head start into the intersection while adjacent turning traffic is held. Unlike the standard LPI, the adjacent through traffic is not penalized. Turning traffic is held with a red turning-arrow while through traffic is released by simultaneously displaying a green through-arrow. As with split phase, a turning lane must be provided to accomplish this. At the end of the LPI, the red arrow changes to a flashing yellow arrow to release the turning vehicles and to emphasize they must yield to pedestrians in the crosswalk. As with standard LPI treatment, split LPI does not completely eliminate the conflict. However, the duration of the LPI can often be longer than with standard LPI, because only the green time of the turning movement must be reduced, not the through movement.

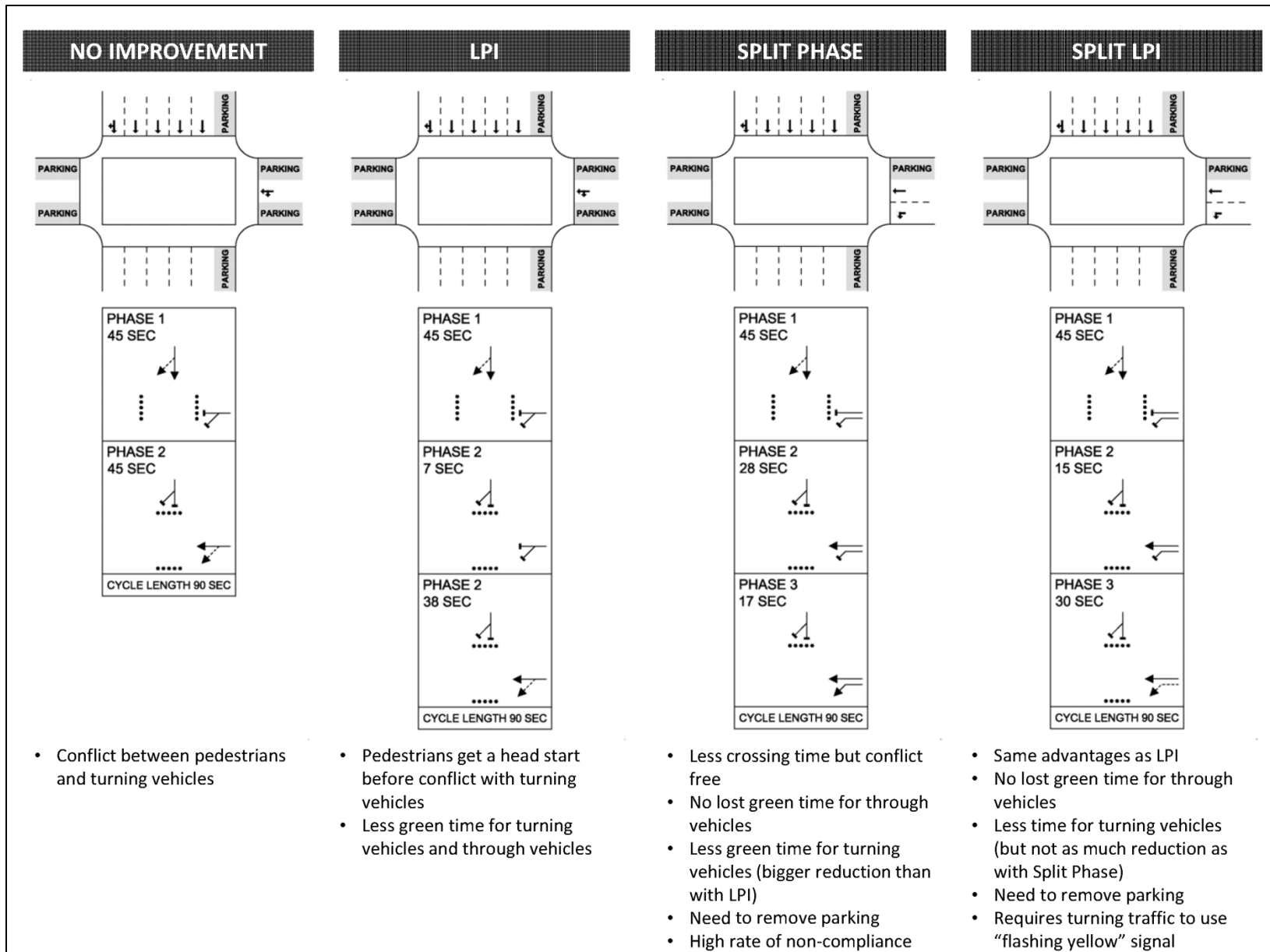


Figure 4.2.1: Comparison of LPI, Split Phase and Split LPI for Providing Safe Crossing

A necessary condition for a split phase and split LPI for a 9th Avenue intersection is that the south curb of the cross street (north curb for an 8th Avenue intersection) be available for a turn bay of sufficient length to store turning vehicles. NYCDOT is agreeable to converting metered curbside parking spaces to No Standing Anytime regulations in order to provide the turning lane, but would be hesitant to remove any loading/unloading spaces for merchants.

Table 4.2.1 summarizes all intersections on 8th and 9th Avenues from West 43rd Street to West 50th Street of the suitability for split phases or split LPIs. Unfortunately, only seven of the 16 locations are suitable. The most requested location, West 43rd Street and 9th Avenue, appears to not be suitable. In addition to the loading zone on the south curb at the West 43rd Street approach to 9th Avenue, there is a bus stop for the M34A bus on the north curb, which turns left onto 9th Avenue. It would be impossible for the bus to turn from the south curb lane if it stops on the north curb at the corner. However, priority has been given to overcome these obstacles and convert this intersection to a split phase in 2014. This is described in detail in the next section.

Intersections with high pedestrian crashes and fatalities – especially West 42nd Street and 8th Avenue – will be investigated in more detail during 2014 to determine feasibility for LPI, split phase or split LPI.

**Table 4.2.1
Availability of Turning Lane for Split Phase or Split LPI**

Avenue	Cross Street	Curb Available for Turning Lane?	If No, Why Not?
8th Ave	West 43rd St	Yes	
8th Ave	West 44th St	No	Authorized Vehicle Parking
8th Ave	West 45th St	No	Loading Zone
8th Ave	West 46th St	Yes	
8th Ave	West 47th St	Yes	
8th Ave	West 48th St	No	Fire Dept. Parking
8th Ave	West 49th St	Yes	
8th Ave	West 50th St	No	Authorized Vehicle Parking
9th Ave	West 43rd St	No	Loading Zone, Bus Stop
9th Ave	West 44th St	Yes	
9th Ave	West 45th St	No	Loading Zone
9th Ave	West 46th St	No	Curb Extension
9th Ave	West 47th St	Yes	
9th Ave	West 48th St	Yes	
9th Ave	West 49th St	No	Loading Zone
9th Ave	West 50th St	No	Bus Stop

4.3 Split Phase for West 43rd Street and 9th Avenue

West 43rd Street and 9th Avenue lies within the Midtown West Senior Safety Area. CB 4 has frequently requested protecting pedestrians in the south crosswalk from turning vehicles. This conflict is shown in Figure 4.3.1. A pedestrian was hit by a turning bus in July 2013.

There is a heavy westbound left-turn volume – up to about 200 vehicles per hour – due primarily to vehicles heading to the Lincoln Tunnel. South crosswalk pedestrian volume is moderate for this section of town – about 60 pedestrians per hour – but is expected to increase with nearby development.



Figure 4.3.1: South Crosswalk at West 43rd St & 9th Avenue, Looking West

Figure 4.3.2 presents the existing and proposed signal timing. As shown on the left side, the existing signal operates as a simple two-phase, with 45 seconds green time (including yellow and all-red) for 9th Avenue traffic during Phase 1, and 45 seconds for West 43rd Street traffic during Phase 2. The north and south crosswalks display the WALK indication during Phase 2, with the south crosswalk in conflict with the left-turning vehicles.

The proposed timing is shown on the right side of Figure 4.3.2. It is a split LPI as described in the previous section. The green time for West 43rd Street through traffic is split into Phases 2 and 3. During Phase 2, the south crosswalk would have the WALK display, while the turning vehicles are held with a red-left arrow to provide 15 seconds conflict-free crossing. In the second part of the split phase, the westbound turning vehicles are released with a flashing left-arrow to emphasize they must yield to pedestrians in the crosswalk. During both parts of the split phase, through-arrow green would be displayed for westbound through traffic, and the north crosswalk would display the WALK indication. All four crosswalks would receive the same crossing time as existing, but, unlike existing, the first 15 seconds of the south crosswalk time would be free of conflict from turning vehicles. All traffic movements would receive the same amount of green time as existing, except the westbound left would be reduced from 45 seconds to 30 seconds.

This improvement is not expected to have any effect on 9th Avenue traffic, since the southbound approach would receive the same green time as existing. Westbound through traffic is projected to improve slightly, because they would have their own lane with left-turning vehicles removed. Left-turning traffic is expected to experience roughly the same level of service; it would have less green time than existing, but would have its own turning lane.

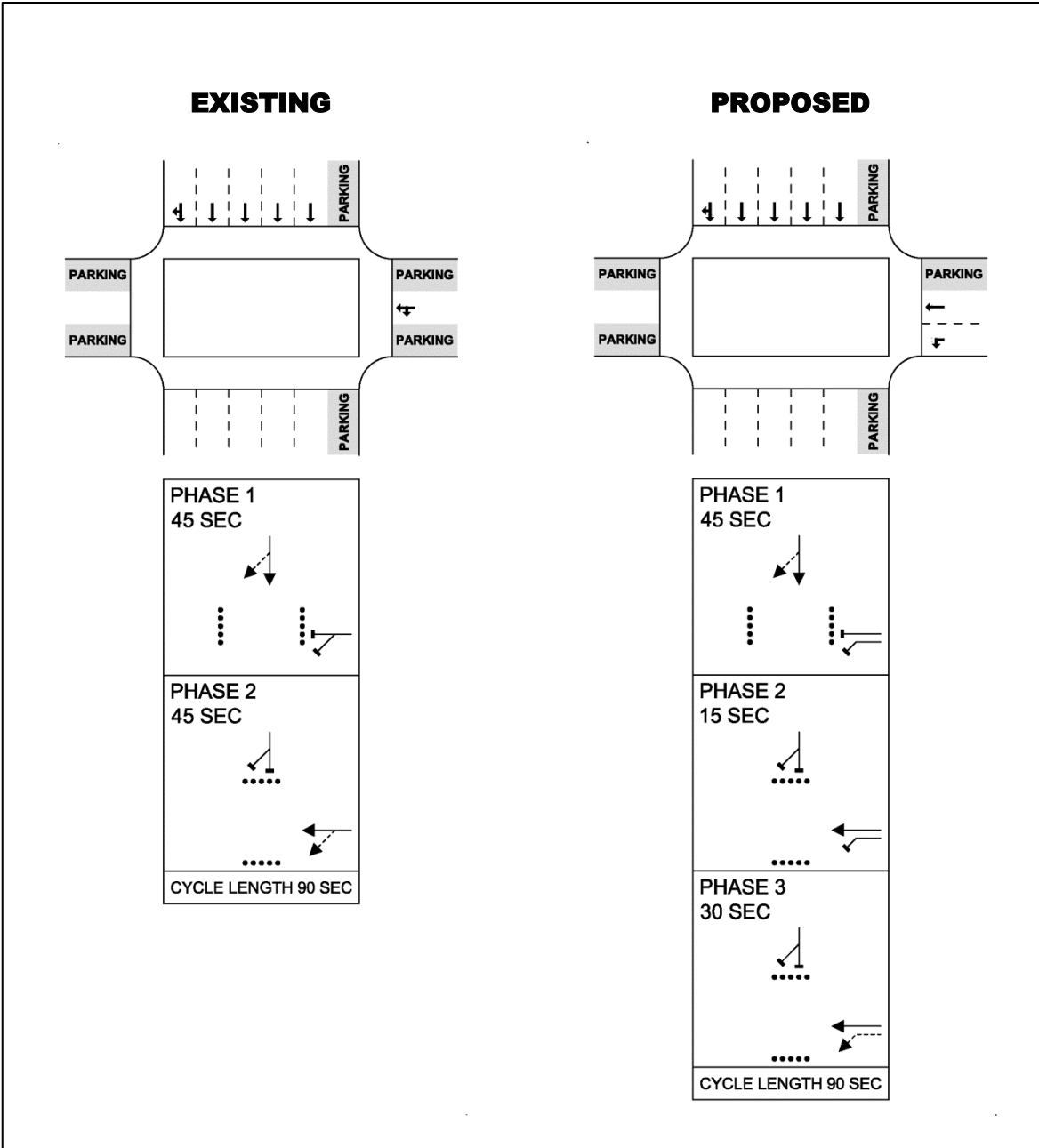


Figure 4.3.2: Existing and Proposed Signal Timing for Split LPI at West 43rd St and 9th Ave

Figure 4.3.3 presents the existing layout and markings. Figure 4.3.4 presents the proposed markings with the left-turn bay and relocated loading zone and bus stop. The bus stop for the M34A bus on the north curb just east of 9th Avenue, which turns left from West 43rd Street onto 9th Avenue, would be relocated towards the middle of the block to give room to maneuver into the turning lane. The length of the bus stop would be 135 feet to accommodate two 62 foot articulated buses. The loading zone on the south side of West 43rd Street would be relocated across the street to the space made available by the relocated bus stop to provide for the left-turn bay.

The split LPI for West 43rd Street and 9th Avenue is planned for implementation in Spring 2014.

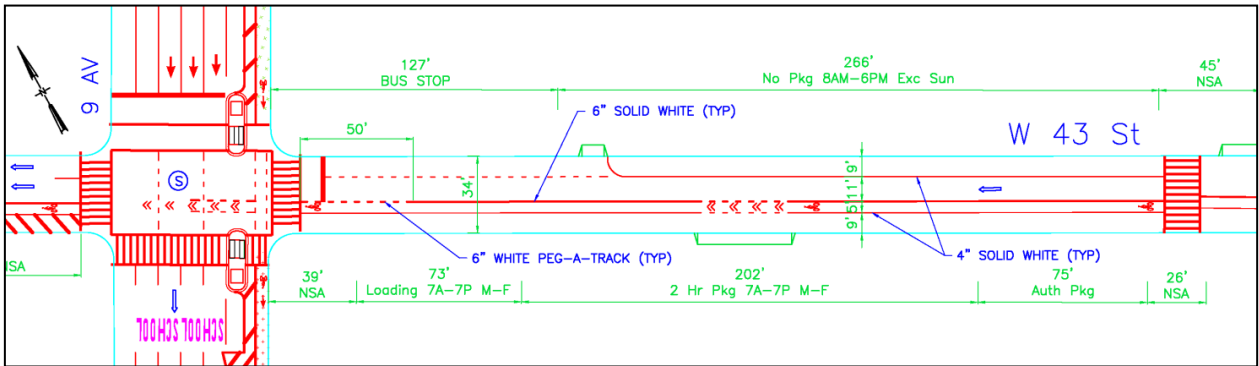


Figure 4.3.3: Existing Layout and Markings at West 43rd Street and 9th Avenue

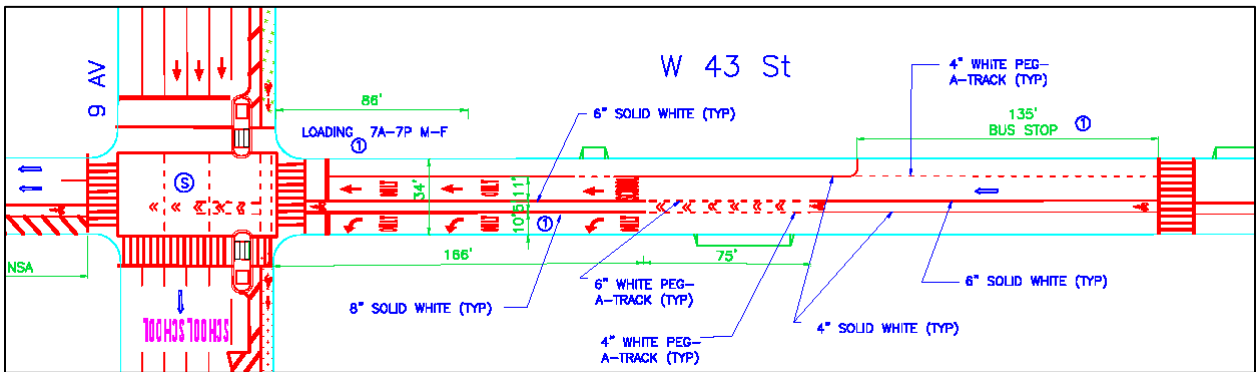


Figure 4.3.4: Proposed Layout and Markings at West 43rd Street and 9th Avenue

4.4 Split Phase for West 41st Street and 9th Avenue

Another crosswalk in need of protection from turning traffic is the west crosswalk at West 41st Street and 9th Avenue. The west leg is 39 feet wide, wider than the normal 30-32 feet for a minor cross street. There is heavy traffic volume, especially buses, turning right from 9th Avenue into this crosswalk bound for the Lincoln Tunnel and Quill Bus Depot. An LPI is already provided for this crossing. This crosswalk has often been pointed out by the community as being perilous, and is expected to get worse with nearby future development. A fatal crash occurred in February 2013 when a southbound right-turning vehicle struck a pedestrian in the west crosswalk.

Figure 4.4.1 presents the existing and proposed split phase signal timing. As shown on the left side, there is currently 50 seconds green time (including yellow and all-red) for southbound 9th Avenue traffic (Phase 1), 33 seconds for westbound West 41st street (Phase 2), and a 7 second LPI for crossing 9th Avenue (Phase 3). The west crosswalk receives a total of 57 seconds crossing time (Phases 3 and 1) – 37 WALK, 15 FDW and 5 DW. The first seven seconds of WALK time is the LPI during Phase 3 where there is no conflict with turning vehicles. The remaining 50 seconds is during Phase 1 where conflict exists during the simultaneous 9th Avenue ball green time.

Under the proposed arrangement shown on the right side of Figure 4.4.1, green time for 9th Avenue traffic would be split into two phases – 23 seconds for Phase 1, and 34 seconds for Phase 2. During Phase 1, the west crosswalk has the WALK display, while the southbound right-turning vehicles are held with a red right-arrow to provide conflict-free crossing. During Phase 2, the west crosswalk displays the steady hand, while the right-turning vehicles have a green arrow for conflict-free turning. During both parts of the split phase (Phases 1 and 2 combined), 9th Avenue has a through-arrow green display, and the east crosswalk has the WALK display.

The west crosswalk would receive a total of 23 seconds for conflict free crossing – 9 WALK, 10 FDW and 4 DW. This compares with 57 seconds time under existing conditions – 37 WALK, 15 FDW, and 4 DW. As with all split phase operations, pedestrians would have less time to cross, but all of it is protected from turning vehicles, as opposed to just the first seven seconds in the current operation.

Southbound through traffic vehicles would receive 57 seconds of green time (including yellow and all-red), seven seconds more than the existing 50 seconds. The southbound right-turning vehicles would receive 34 seconds of conflict-free turning time (including yellow and all red), as compared to 50 seconds under existing conditions where they must yield to pedestrians. The 34 seconds would be adequate to handle the turning volume, even during the weekday PM peak hour when the turn ban for cars and trucks is not enforced, though it would be close to capacity under this extreme condition. Westbound 41st Street traffic would get the same green time as existing.

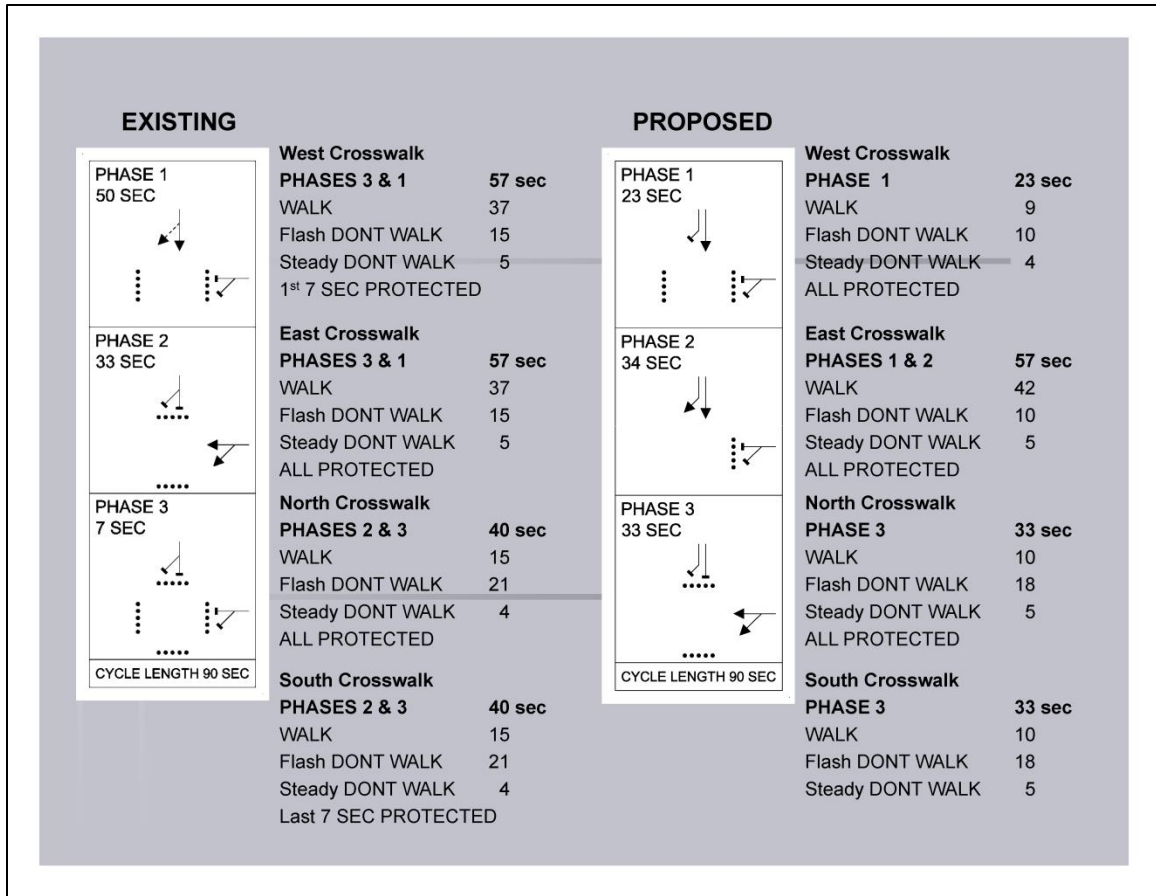


Figure 4.4.1: Existing and Proposed Signal Timing for West 41st Street and 9th Avenue

Currently, the lane arrangement for the southbound approach is one right-only lane, one shared through-right lane, and three through lanes, as shown in the existing layout on the left side of Figure 4.4.2. A necessary condition for implementation of the split phase is that the shared through-right lane must be converted to right-only, so that the lane arrangement would be two right-turn-only lanes, and three through lanes, as shown in the proposed layout on the right side of Figure 4.4.2. Also shown in the proposed layout is a curb extension that would reduce the crossing distance for the south crosswalk.

This project presents signage difficulties due to the double right-turn-only lanes onto West 41st Street, and the turn ban that applies to cars and trucks but not buses, and that is in effect only during 4-7 PM Monday through Friday. Thus, Lincoln Tunnel bound cars and trucks on 9th Avenue in the low 40s should not keep right during the weekday PM peak period when the turn is banned for them, but it is okay to do so during other times. To keep cars and trucks out of the right lane during this time, it is proposed to designate the right lane as a bus lane from West 46th Street to West 41st Street during the time of the turn ban Monday through Friday 4-7 PM. Further discussion of long-term signage is given in Section 4.5.

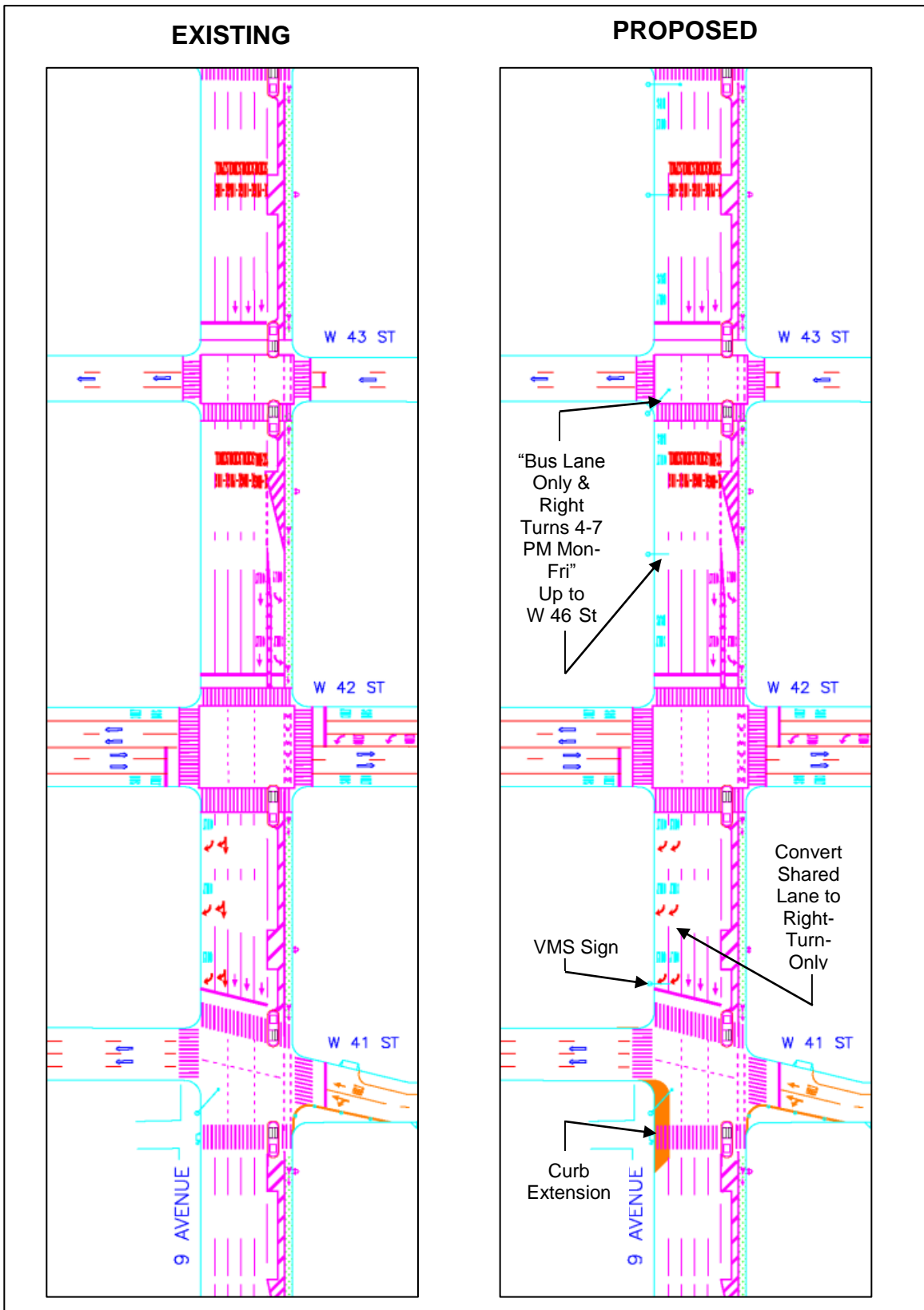
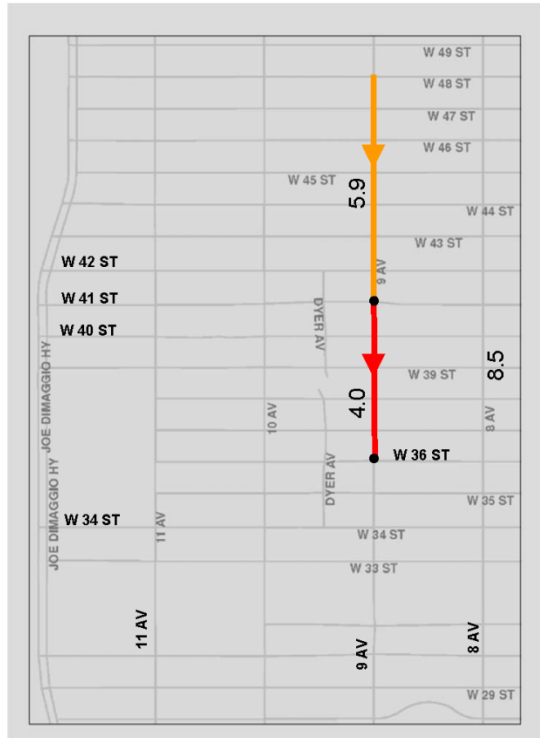
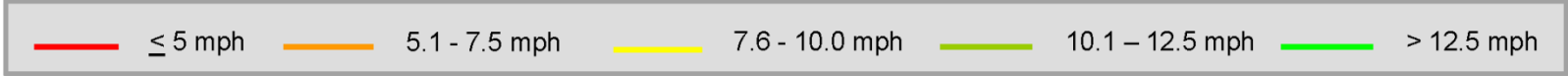


Figure 4.4.2: Existing and Proposed Markings, Signs and Curb Extension for 9th Avenue between West 46th and West 41st Streets

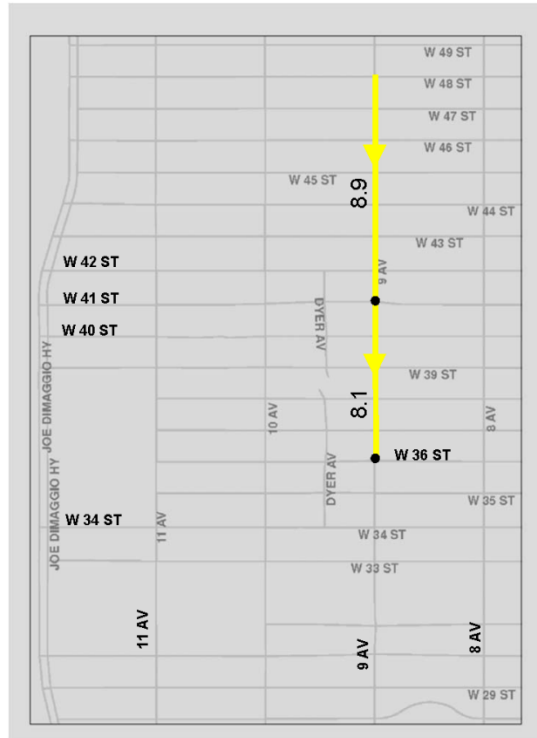
At this time, consideration is being given to extending the hours of the turn ban to start at 3PM instead of 4PM, and also to include the weekday morning peak 7-10 AM Monday through Friday, and possibly certain weekend hours. If this should come to fruition, then the bus lane hours would also be extended, which would justify painting them red.

The effect on 9th Avenue traffic of the signal timing, lane arrangement, marking and sign changes during the weekday PM peak hour is shown in Figure 4.4.3. The number of lanes would be reduced from four to three approaching West 41st Street, but this would partially be offset by the increase in green time from 50 to 57 seconds. The net effect is that the overall projected average travel speed on the upper segment of 9th Avenue is projected to be reduced from 8.9 mph to 7.6 mph, wiping out some of the improvement from the turn bans from West 37th Street to Ramp C (Section 3.12), and from West 36th Street to Dyer Avenue (Section 3.3). However, there would still be significant improvement over the Future without Improvements condition, in which the average travel speed is projected to be 5.9 mph.

The split phase for West 41st Street and 9th Avenue is planned for implementation in Spring 2014.

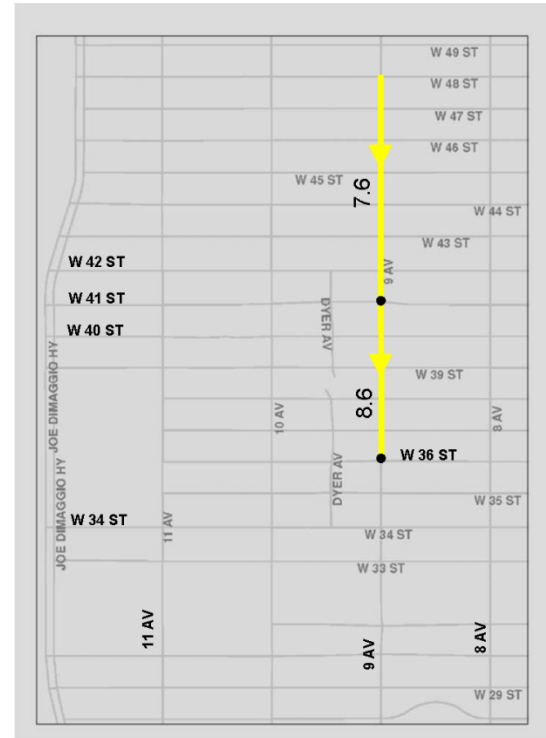


2015 FUTURE W/O IMPROVEMENTS



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes
- Split Phase for Bikes and Increased Green Time for 9th Avenue
- Canoe Project with new Signalized Crosswalk
- Turn Ban from W. 37th St to Ramp C
- Turn Ban from W. 36th St to Dyer Ave



2015 FUTURE WITH IMPROVEMENTS:

- Signal Timing Improvements as of 2012
- 8th and 9th Avenue Bike Lanes
- Split Phase and Increased Green Time for 9th Avenue
- Canoe Project with New Signalized Crosswalk
- Turn Ban from W. 37th St to Ramp C
- Turn Ban from W. 36th St to Dyer Ave
- Split Phase for W. 41st St and 9th Ave

Figure 4.4.3: Average Travel Speeds – 2015 Future with and without Split Phase at West 41st Street and 9th Avenue – Weekday PM Peak Hour

4.5 Signage for 9th Avenue

As shown in Figure 3.11.2, “Qwik Curb” delineators on 9th Avenue approaching West 36th Street separate the two right lanes, which are channeled to Ramp C, from southbound 9th Avenue through traffic on the left. These delineators start about 50 feet south of West 38th Street. Therefore, at West 38th Street, drivers need to know to stay to the left of the delineators for through traffic, and to the right for the Lincoln Tunnel via Ramp C. Currently there is little signage to provide such guidance.

Figure 4.5.1 presents a proposed fixed cantilevered gantry sign at 9th Avenue near West 38th Street, just before the start of the delineators. This sign emphasizes that the two right lanes are only for the Lincoln Tunnel and West 37th Street. With modest dimensions of 3 feet high by 10 feet wide – same as bus lane signs on cantilevered gantry mounts – it is designed to get the message across without being an imposing highway type sign.

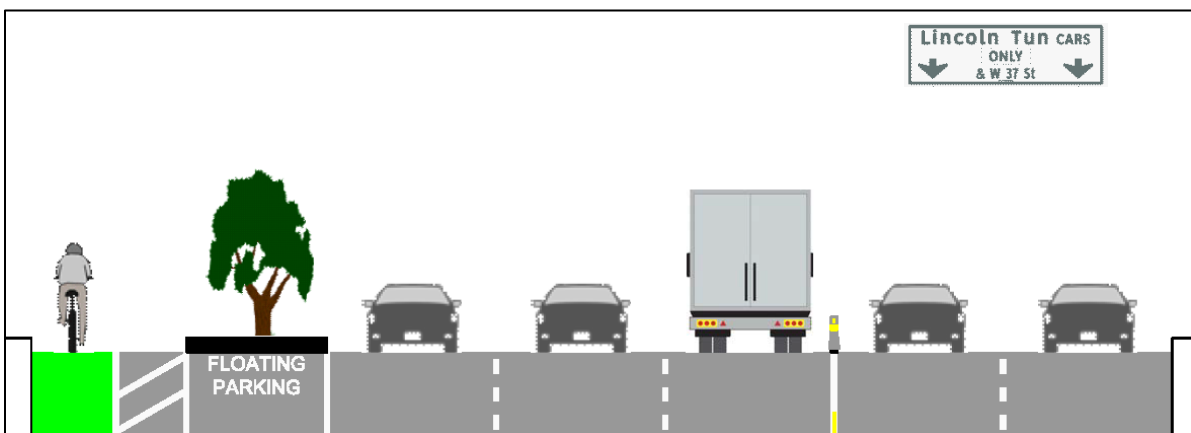


Figure 4.5.1: Proposed Cantilever Gantry-Mounted Sign on 9th Avenue Approaching West 38th Street

Preliminary investigation reveals that a foundation for such a sign just north of West 38th Street appears feasible. However, there is an existing Port Authority of New York and New Jersey (PANY&NJ) owned electronic variable-message sign just one block upstream, on 9th Avenue approaching West 39th Street, shown in Figure 4.5.2. It is not good practice to have two gantry type signs in such close proximity to each other. Because of its size and position, it would be impossible to program the existing variable-message sign to contain the message of the proposed fixed sign. A long term solution would be to relocate the variable-message sign, a task that could take years. During the interim, the PANY&NJ has agreed to program the variable-message sign with a word message that the two right lanes are for cars to the Lincoln Tunnel.

Another PANY&NJ owned variable-message sign is located on 9th Avenue approaching West 41st Street, shown in Figure 4.5.3. The message in this photo is displayed weekdays from 4PM to 7PM when the turn ban for cars and trucks is in effect. During other times, this sign is blank.



Figure 4.5.2: Variable-Message Sign on 9th Avenue Looking South towards West 39th Street.



Figure 4.5.3: Variable-Message Sign on 9th Avenue Looking South towards West 41st Street.

As mentioned in Section 4.4, the two right lanes approaching West 41st Street will be converted to right-turn-only, which are for buses only weekdays 4-7 PM. The variable-message sign conveys the message that buses only are permitted to turn here. However, it does not convey the message that the two right lanes must turn right, and that cars and trucks for the Lincoln Tunnel should be in the third lane from the right. Standard fixed lane usage signs will be needed to supplement the variable-message sign.

It is desirable that Lincoln Tunnel bound cars and trucks know further upstream that they should not be in the right lane. The currently underused variable-message sign on 9th Avenue approaching West 39th Street could be put to better use if it was relocated to 9th Avenue near West 44th Street to inform cars, trucks and buses which street to use to access the Lincoln Tunnel by time of day. Figure 4.5.4 presents the display of such a sign weekdays 4-7 PM and all other times.

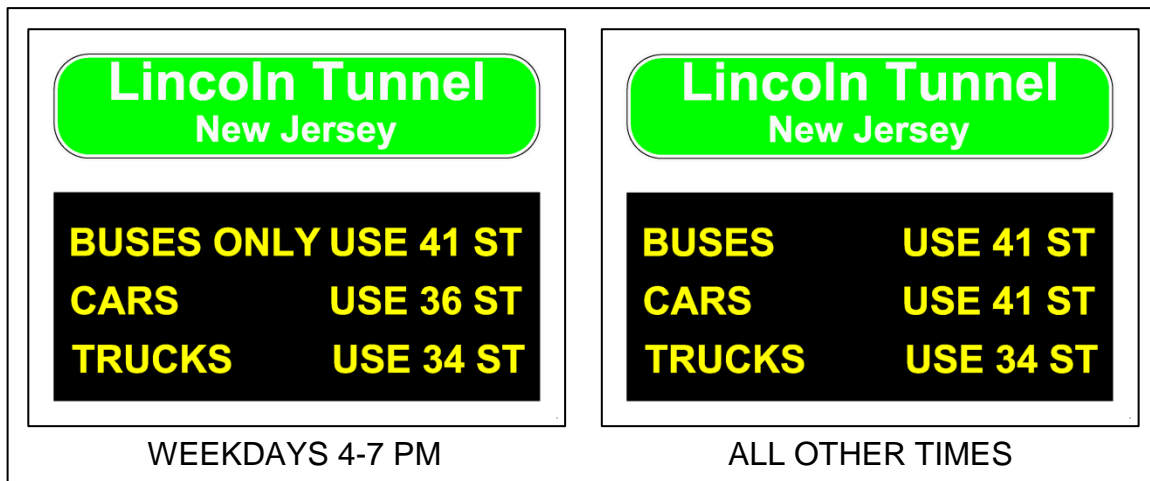


Figure 4.5.4: Proposed Variable-Message Signs on 9th Avenue Near West 44th Street.

Funds for relocation and reprogramming the variable-message sign as described above are currently not available, and the feasibility of such an action remains to be determined.

4.6 Conversion of 11th Avenue to Two-Way South of West 37th Street

New development along 11th Avenue in the West 30s, associated with the Hudson Yards Rezoning, the extension of the Number 7 subway line, and the Eastern and Western Railyards projects, will change this former manufacturing district into a more residential and retail neighborhood. The potential for two-way operation between West 24th and West 37th Streets has been examined which would better allow 11th Avenue to accommodate needed vehicular access to these planned uses.

The portion of 11th Avenue between West 30th and West 33rd Streets is currently being redeveloped into the Eastern and Western Railyards, which will be part of mixed use developments situated on top of the Long Island rail Road's West Side Yard. In addition, the Javits Center is located just north of this area on the west side of 11th Avenue between West 34th and West 38th Streets. Between West 30th and West 24th Streets, new developments have also been undertaken, replacing auto repair shops and other similar uses.

From a traffic viewpoint, 11th Avenue is underutilized in its current one-way southbound configuration between West 24th and West 37th Streets. Current volumes are similar to 11th and West End Avenues between West 55th and West 66th Streets, which already operates with two-way flow. This Upper West Side section of 11th and West End Avenues serves the similar land uses to 11th Avenue between West 24th and West 37th Streets. Converting the segment from West 24th to West 37th Streets to two-way traffic will make its operation consistent with the rest of the avenue and allow for better circulation with the new developments at Hudson Yards. It will also allow the installation of pedestrian refuge islands on certain blocks in order to make pedestrian crossings safer and provide esthetic improvements with tree planters which would also supplement the development at Hudson Yards. A feasibility study that has recently been completed concludes that signal timing modifications to the intersections within this segment of 11th Avenue would greatly improve the level of service and therefore it is recommended that this portion of 11th Avenue be converted to two-way operation.

Figure 4.6.1 presents a proposed design for the two-way layout. Outreach will be conducted during 2014. If consensus is reached, implementation may take place in 2015.

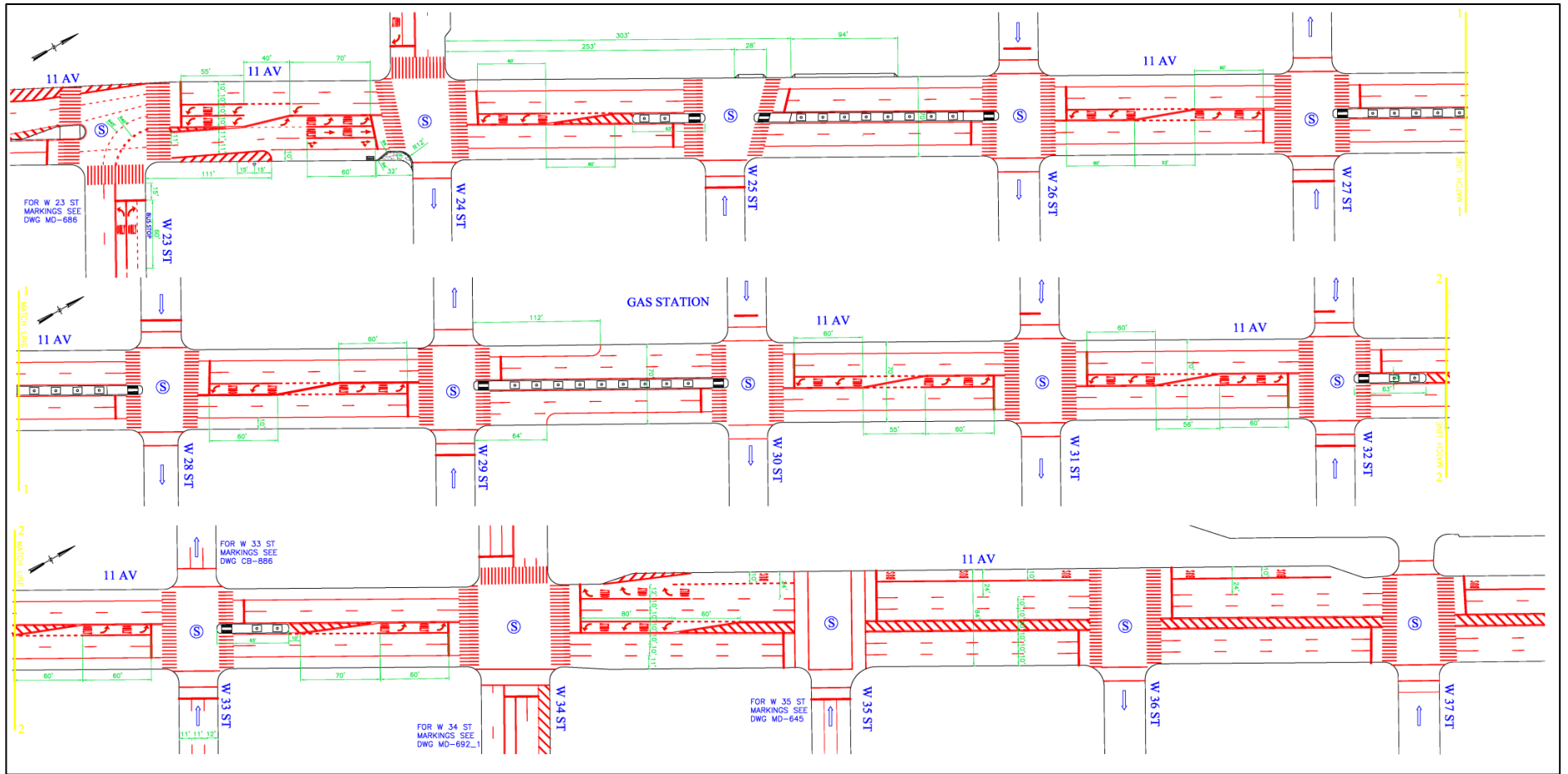


Figure 4.6.1: Proposed Design for Two-Way layout of 11th Avenue South of West 37th Street.

4.7 Alternative Configurations for 11th Avenue North of West 44th Street

Currently 11th Avenue is two-way north of West 44th Street, with two travel lanes and parking on both sides, and left-turn bays in the median. South of West 44th Street, it becomes one-way southbound, with a sudden increase in the number of southbound lanes from three to seven, including parking. See Figure 4.7.1. The northbound lanes are underused, while the southbound lanes experience heavy congestion with Lincoln Tunnel bound traffic. If the median were shifted to the east for four or more blocks, an extra southbound lane would be created to provide more storage for the heavy southbound traffic and a more gradual transition. Figure 4.7.2 illustrates the proposal.

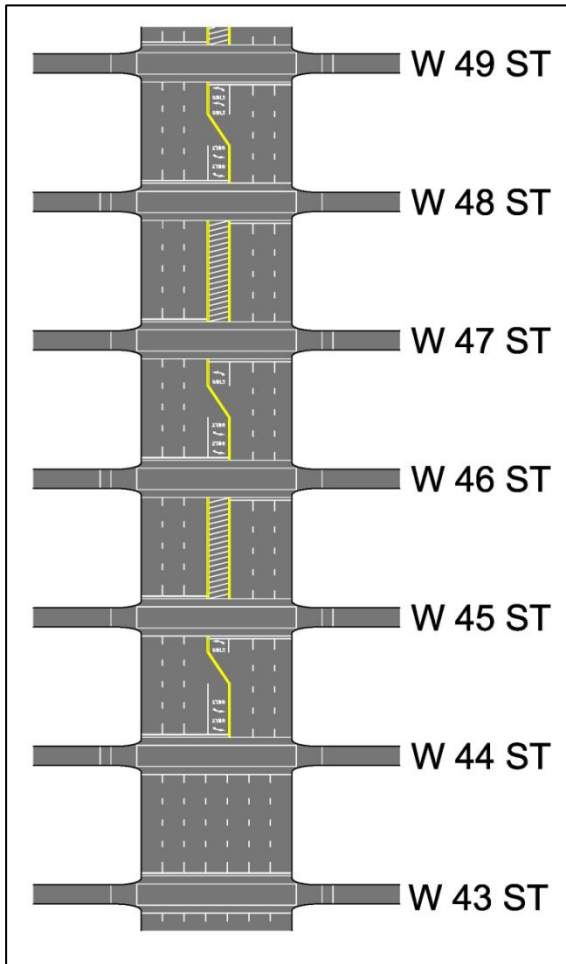


Figure 4.7.1: Existing Layout of 11th Avenue from West 43rd to West 49th Street

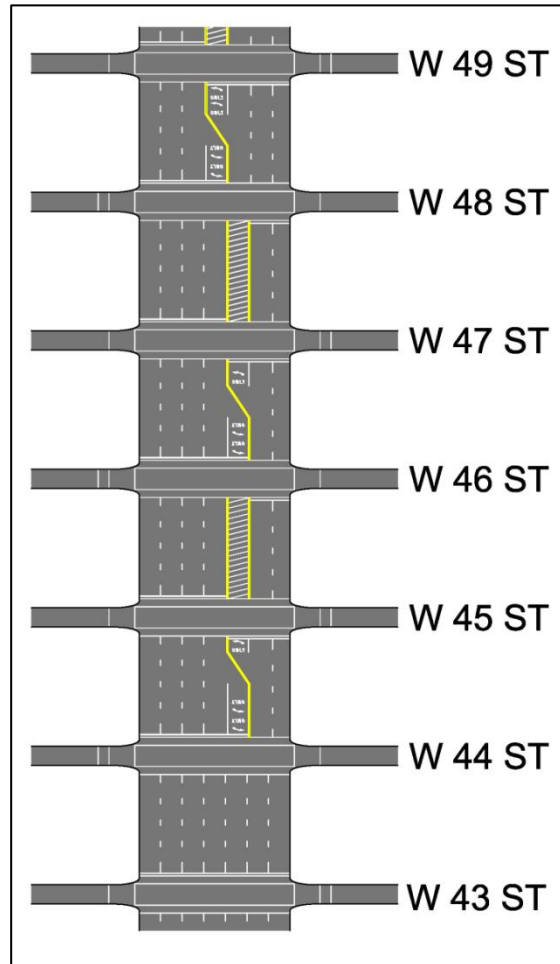
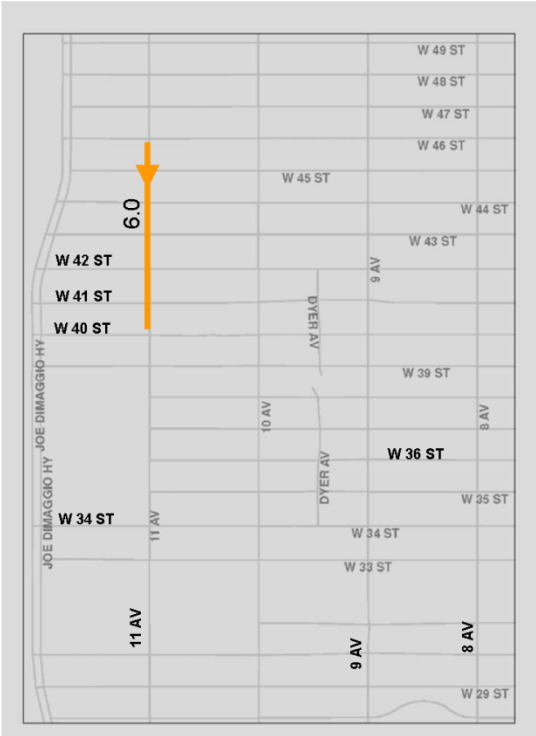
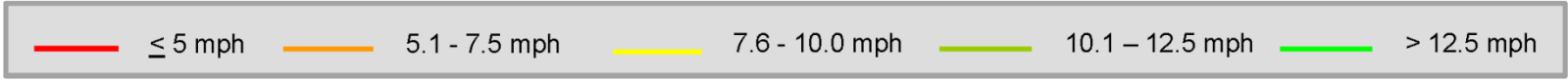
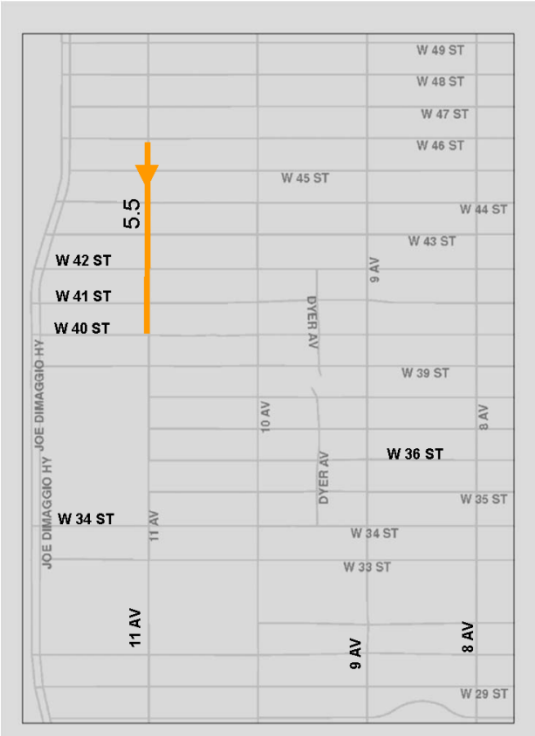


Figure 4.7.2: Layout of 11th Avenue from West 43rd to West 49th Street with Shifted Median

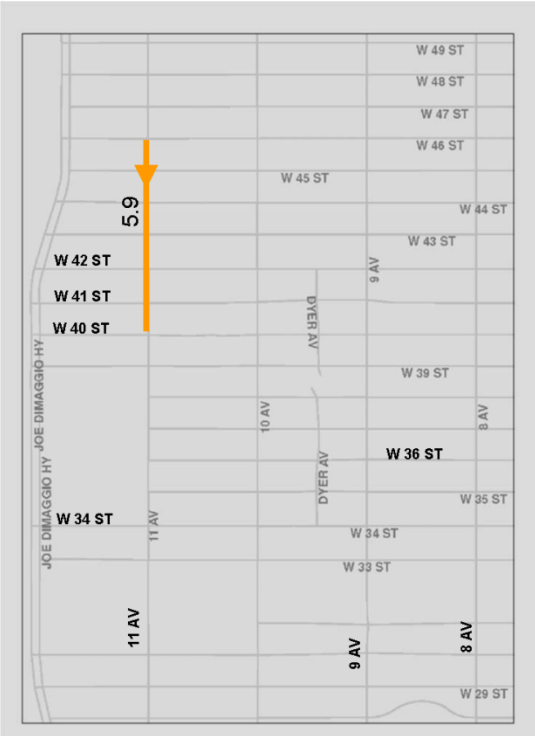
As shown in Figure 4.7.3, analysis indicates that southbound travel speeds on 11th Avenue would show a modest improvement from 5.5 mph to 5.9 mph. Non-Lincoln Tunnel traffic would have room to separate from Lincoln Tunnel traffic by keeping right. Queues would not extend as far north because of the extra storage, which could entice traffic from overused 9th Avenue.



2015 FUTURE W/O IMPROVEMENTS



- 2015 FUTURE WITH IMPROVEMENTS:**
- Signal Timing Improvements as of 2012
 - 8th and 9th Avenue Bike Lanes
 - Split Phase and Increased Green Time for 9th Avenue
 - Canoe Project with new Signalized Crosswalk
 - Turn Ban from W. 37th St to Ramp C
 - Turn ban from W. 36th St to Dyer Ave



- 2015 FUTURE WITH IMPROVEMENTS:**
- Signal Timing Improvements as of 2012
 - 8th and 9th Avenue Bike Lanes
 - Split Phase and Increased Green Time for 9th Avenue
 - Canoe Project with New Signalized Crosswalk
 - Turn Ban from W. 37th St to Ramp C
 - Turn Ban from W. 36th St to Dyer Ave
 - Median Shift of 11th Avenue between W.44th and W. 48th Sts.

Figure 4.7.3: Average Travel Speeds – 2015 Future with and without Median Shift on 11th Ave – Weekday PM Peak Hour

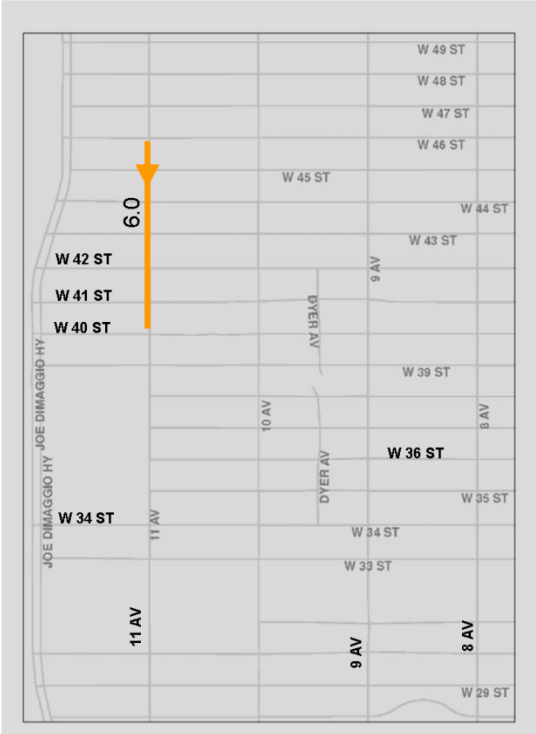
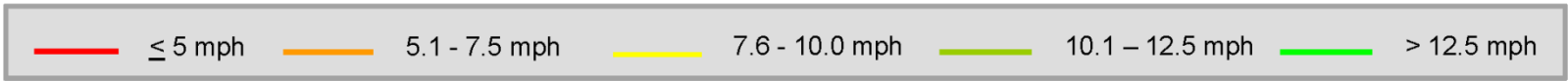
The downside of this proposal is that the few vehicles that wish to turn left from northbound 11th Avenue onto West 45th or 47th Street (about 10 and 20, respectively, during the weekday PM peak hour) would have as many as four lanes to turn against.

A more radical, modified plan to provide more storage for Lincoln Tunnel bound traffic on 11th Avenue would be to convert 11th Avenue from two-way to one way as far north as West 57th Street, with no transition. As shown in Figure 4.7.4, analysis indicates that southbound travel speeds on 11th Avenue would show a modest improvement over the median shift proposal depicted in Figure 4.7.3, from 5.5 mph to 6.2 mph instead of 5.9 mph – an extra gain of 0.3 mph.

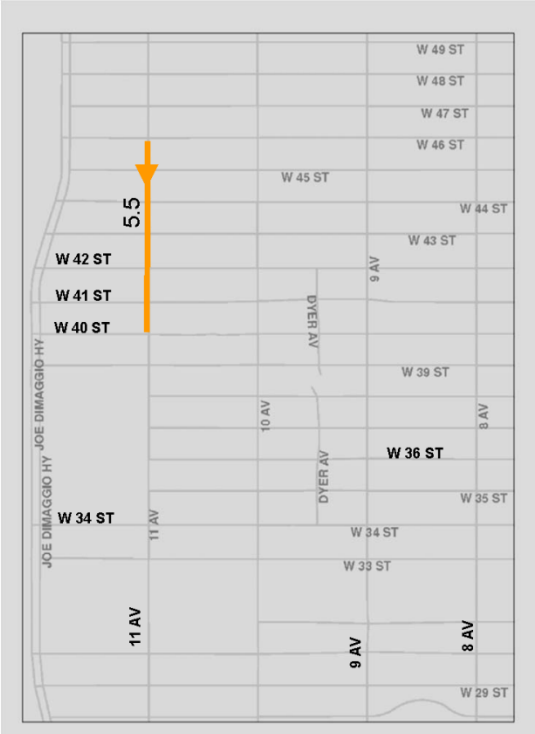
Maintaining 11th Avenue as two-way with median shift north of West 44th Street offers significant circulation benefits that may outweigh the additional 0.3 mph gained from the one-way conversion. 11th Avenue is an edge road and significantly impacts circulation patterns on the west side of Manhattan. Eliminating the northbound option on 11th Avenue will force more traffic onto 10th and 12th Avenues and require more circuitous travel on the network to access locations on 11th Avenue previously reached using 11th Avenue's northbound lanes. Other major edge roads in Manhattan operate as two-way, including West End Avenue, East End Avenue, York Avenue and Avenue C.

Additionally, the 11th Avenue thoroughfare begins at West 106th Street as West End Avenue and runs bi-directional for 62 blocks. As mentioned in the previous section, NYCDOT is planning to convert 11th Avenue from one-way southbound to two-way from West 37th Street to West 24th Street, in part to create continuity with the operation of the northern majority of the corridor.

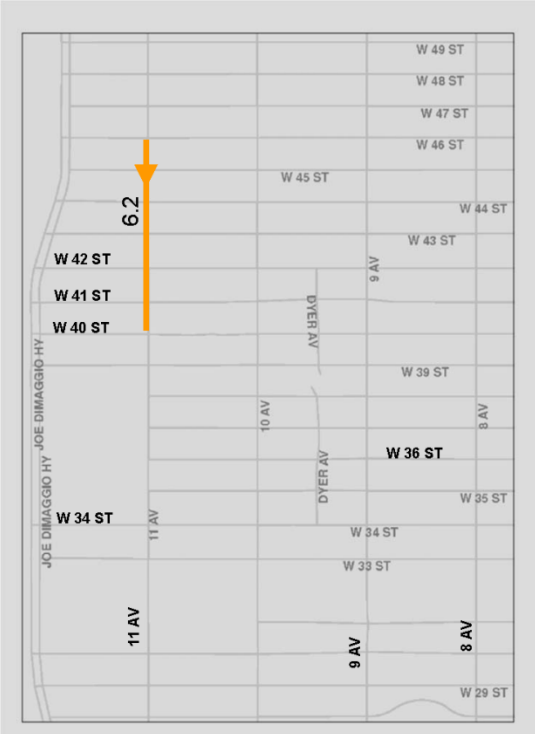
For the section north of West 44th Street, NYCDOT is considering the shifted median alternative and the one-way conversion alternative. A decision will be made later in 2014, after investigating deliveries and other access issues. If either plan is proven to be feasible, implementation would be tentatively planned for 2015.



2015 FUTURE W/O IMPROVEMENTS



- 2015 FUTURE WITH IMPROVEMENTS:**
- Signal Timing Improvements as of 2012
 - 8th and 9th Avenue Bike Lanes
 - Split Phase and Increased Green Time for 9th Avenue
 - Canoe Project with new Signalized Crosswalk
 - Turn Ban from W. 37th St to Ramp C
 - Turn ban from W. 36th St to Dyer Ave



- 2015 FUTURE WITH IMPROVEMENTS:**
- Signal Timing Improvements as of 2012
 - 8th and 9th Avenue Bike Lanes
 - Split Phase and Increased Green Time for 9th Avenue
 - Canoe Project with New Signalized Crosswalk
 - Turn Ban from W. 37th St to Ramp C
 - Turn Ban from W. 36th St to Dyer Ave
 - Conversion of 11th Ave to One-Way Southbound between W. 44th & W. 57th Sts

Figure 4.7.4: Average Travel Speeds – 2015 Future with and without One-Way Conversion on 11th Ave – Weekday PM Peak Hour

4.8 PM Peak Period Contra-flow Bus Lane on Dyer Avenue from West 41st to West 42nd Streets

As mentioned earlier, the intersection of West 42nd Street and 9th Avenue is critical for both pedestrians and traffic. It has often been suggested that the westbound left-turn be banned at this location. Currently a 13 second lagging protected left-turn phase eats up valuable green time. Prohibiting this turn would allow reallocation to provide extra time for pedestrian and traffic movements, and would remove a dangerous pedestrian/traffic conflict. However, at this time, banning the left turn would push the problem elsewhere. Origin-destination surveys indicate that as many as 60 buses per hour make this left-turn, then turn right one block downstream onto westbound West 41st Street. To ban this turn without causing bigger problems, accommodations need to be made for these buses.

Currently, Dyer Avenue is one way northbound between the south Lincoln Tunnel tube and West 42nd Street during most times. During the weekday PM period (approximately 4-7 PM), the two western lanes are reversed for southbound buses. These contra-flow lanes accommodate buses departing the PABT from three locations: the Sputnik ramp at West 41st Street, the West 41st Street ramp just east of 9th Avenue, and the ramp to Dyer Avenue just south of West 41st Street.

If the PM contra-flow lane were extended one block north to West 42nd Street, it would eliminate the need for 60 buses to turn left from West 42nd Street onto 9th Avenue. This could facilitate banning this left turn, or at least converting from a protected-permitted left-turn to protected only operation. The diversion of the proposed ban is shown in Figure 4.8.1.

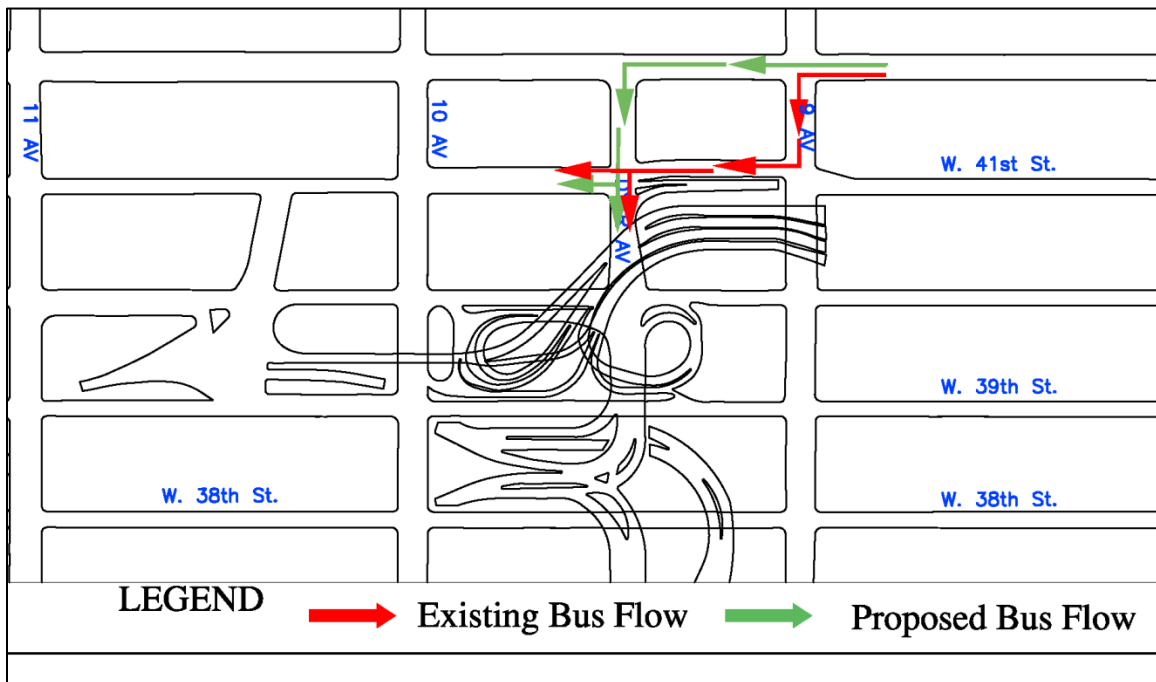


Figure 4.8.1: Bus Diversion with Extended PM Peak Period Dyer Ave Contra-Flow Lane

To implement this improvement measure, the following needs to be considered:

- It would have to be made clear that the westbound left-turn from West 42nd Street to Dyer Avenue is permitted only from 4-7 PM, and then only for buses.
- Preliminary analysis indicates that buses can make this turn without a protected arrow, but if this proves to be necessary, it would only apply to buses during only three hours a weekday.
- The contra-flow lane would have to be set up during the specified times.
- The intersection of West 41st Street and Dyer is currently three phase, with separate phases for Dyer Avenue, West 41st Street, and the Sputnik ramp from the PABT. Southbound traffic would need its own phase to eliminate the conflict with northbound left traffic. Preliminary analysis indicates that this is possible without degrading to unacceptable levels of service.
- There are possible turning radius problems for buses that turn right from Dyer Avenue onto West 41st Street.

NYCDOT and PANYNJ have started and will continue to address these problems, with a final determination to be made in 2014.

4.9 Expansion of PABT

An 18-month study of the PABT will examine expanding or replacing the facility to accommodate increasing demand at the world's busiest bus station. The PANY&NJ commissioned Kohn Pederson Fox and Parsons Brinkerhoff to develop a comprehensive study to explore ways to accommodate future growth in bus commuting to and from midtown Manhattan. The study, begun in July 2013, is intended to ensure the terminal remains a vital part of the interstate transportation network as the region continues to grow over the next 50 years. It is expected to be complete in 2015.

CHAPTER 5 CONCLUSION

In the development of improvements, every attempt was made to include as many multimodal elements as is practically possible because of the conflicting needs of street users. Following the Complete Street concept, emphasis is placed on safety and operation of all street users, including pedestrians, cyclists, transit users, and motorists.

Improvement measures have been developed, evaluated and proposed for implementation within the confines of existing constraints. Community feedback was instrumental in identifying problems and refining solutions. It is anticipated that the improvements will benefit all users in the Clinton/Hell's Kitchen neighborhood.

For the recommended improvements to yield optimal benefits, stepped-up enforcement of traffic laws and regulations will be necessary. While traffic enforcement is not under the jurisdiction of NYCDOT, agency coordination and cooperation involving NYCDOT, NYPD, MTA, PANY&NJ and other key agencies will be critical to ensure that maximum benefits are achieved from implementation.

Each improvement measure will be monitored after implementation.