Metropolitan Transportation Authority

FINAL REPORT

MTA NYCT SUBWAY SPEED AND CAPACITY REVIEW

STV 100 Years

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EXECUTIVE SUMMARY

In July 2019, New York Governor Andrew Cuomo assembled an expert task force to examine the potential to safely increase speeds and capacity while decreasing running times on the New York City Transit System. The task force is chaired by former U.S. Federal Aviation Administrator Jane Garvey and its members include:

- Andy Byford, President, New York City Transit
- Veronique Hakim, former Managing Director, MTA
- Robert Lauby, former Chief Safety Officer, Federal Railroad Administration
- Thomas Quigley, General Counsel, MTA
- Dominick M. Servedio, Executive Chairman, STV
- Tony Utano, President, TWU Local 100
- Pat Warren, Chief Safety Officer, MTA

As evidenced by the findings and recommendations of the ensuing final report, the answer is *yes*, the goals set forth in the Governor's challenge can be achieved.

Before implementation and before the benefits can be realized, confirmation of these findings and recommendations must be completed through simulation and testing on a line-by-line basis to determine the interaction with the fixed block system. As with all investments in the system, these changes are also subject to a cost-benefit analysis. The object of this effort, which the task force hired STV to undertake, has been to conduct a comprehensive independent review of existing NYCT built infrastructure and engineering standards for track, signals and subway cars. This includes the review of NYCT operating practices and procedures and the scheduling of revenue service trains. This report determines those elements that generally conform to current industry standards and practices. It identifies areas for change that could result in safely improving overall train speeds.

The committee will issue a final report, with findings and recommendations, to the head of the MTA on December 31, 2019.

The following findings and recommendations are highlighted in the report.

1. Curve Speeds

Any study of increasing speeds on a rapid transit system must consider curve speeds. To increase the comfort speed and vehicle stability through some curves, railroads raise the rail on the outside of a curve so that the train leans into a curve, thereby reducing the amount of uncompensated lateral acceleration experienced by the car and its occupants. The tilt is termed superelevation. If a train is going around a curve faster than the speed correlated with its superelevation and curve radius, the resulting unbalanced speed is called the V-speed. A V0 speed is where the superelevation and the train speed cancel out the uncompensated lateral acceleration. A V4 speed is the speed at which the existing superelevation would need to be increased by 4 inches for the lateral acceleration to be kept at a small acceptable value. All railroads allow operation at speeds above V0, as this improves service while not being uncomfortable for passengers.

NYCT's comfort speed for curves is currently set at V4. This was based on tests by NYCT's Speed Policy Committee over 25 years ago; these tests were conducted at different speeds over well-maintained track and sharp curves. The consensus at that time was that speeds over V4 were perceived as being somewhat uncomfortable for standing passengers. STV's report recommends that NYCT reconsider increasing the allowable speed in certain curves from V4 to V6.

STV performed a speed curve analysis on both the 7th Avenue and Flushing lines. This incremental approach calculated the curves at V4.66 (one-third of the difference between V4 and V6), V5 and V6 speeds. STV found that speeds on certain curves on these two lines could be increased between 1 mph and 8 mph, depending on the radius of those curves and their respective superelevations.

An additional analysis was performed on curves with radii between 750 ft. and 2,500 ft. that had no superelevation. Curves with radii less than 750 ft. typically have guard rails and are without spirals; they are not ideal candidates for future investigation and were therefore excluded from the study.

The findings of this preliminary analysis have important implications for curves with common characteristics across the NYCT system:

1. Curves with radii between 750 ft. and 1,600 ft. are candidates for speed increases based on V6 up to the Maximum Attainable Speed of 50 mph.
2. Curves with radii between 1,600 ft. and 2,000 ft. are candidates for speed increases based on V5 up to the Maximum Attainable Speed of 50 mph.

Curves with radii of 2,500 ft. were not included in the analysis because speeds up to 50 mph at V4 can already be achieved. Also excluded were curves with radii greater than 2,000 ft. where the Maximum Attainable Speed of 50 mph would be exceeded at V6.

The results imply that there is the potential to increase speeds on curves with common characteristics systemwide. This would require a case-by-case engineering review and additional operational testing to confirm safety and passenger comfort at these potential speeds.

2. Operator Confidence

The TWU has formally stated that train operators operate trains at speeds lower than those posted, particularly in territory where the signal system enforces speed using timers, for several reasons. One is that some of the system's timed signals are improperly calibrated and will cause trains to be tripped, even when operating slower than posted speeds. Another is that existing signage at some locations can be difficult to read, making it more challenging to accommodate changes in posted speeds. The last relates to concerns regarding disciplinary action.

One of the most effective means for increasing speeds across the NYCT system will be to ensure that trains operate near or at posted speeds. The potential for appreciable time savings over the total run time, terminal-to-terminal, would be significant. The key is that train operators need to understand the corrections and improvements made to the signal system, including those relating to calibration and improved signage at certain locations. Much of this is already underway with NYCT's ongoing Save Safe Seconds program and Fast Forward initiatives and NYCT has already adopted a revised approach to discipline.

Three areas of potential improvement have been identified and supported by the findings and recommendations of this task force study are recommended for immediate action:

- Speed limit signage positioning and readability in certain areas.
- Associated timer design methodology, circuit components, calibration equipment, and test procedures.
- More frequent verification of onboard speedometers with train operators.

This will supplement the Save Safe Seconds program in two ways. First, it would further address operator reports of slow-clearing timed signals that are used to control train speed around curves (Grade Time) and entering stations (Station Time) by improving speed control precision. Second, it would ensure that speed restrictions are clearly visible to operators.

These improvements would result in trains being able to operate at speeds that are much closer to the currently posted speeds approaching these specific signal locations. Since the first draft report was issued on September 20, 2019, and an alternative method for determining timer settings was suggested, NYCT has made multiple improvements to their prototype measurement equipment to facilitate more accurate values and improve set up and use. Further testing of this equipment verified the consistency of results between this method and recently tested alternatives.

The findings of the study suggest that improved operator confidence should result in behavioral speed performance increases that extend well beyond just the few affected signals, as the fear of tripping due to this type of issue is proven to be diminished. When taking into consideration increases in train speeds due to improved Train Operator confidence in the signal system, there is the potential for speed increases of up to 50% at some locations on the NYCT system. Therefore, the emphasis in the near term should be to continue to prioritize slow clearing signals for calibration using the latest methods and measurement technology.

3. Bottlenecks

Bottlenecks are locations where the design of the track infrastructure and signal system have fundamental restrictions that impact route capacity and throughput. STV studied three bottleneck locations on the NYCT system identified by the agency as areas of primary concern: Nostrand Junction Interlocking, Brooklyn; 142nd Street Interlocking, Manhattan; and 149th Street - Grand Concourse, Bronx.

This analysis considered operating schedules, track and signal layouts, and previous studies of relieving bottlenecks via infrastructure improvements. The study team observed that while the operating schedules, as developed and refined by NYCT over many years, contain closely scheduled train movements that are susceptible to interference and delay, these schedules are fundamentally constrained by the infrastructure in place today. While major infrastructure renewal could eliminate conflicting train movements and relieve these bottlenecks in the long run, in the shorter term, STV recommends that NYCT focus on potential signal solutions to these issues.

From the signaling perspective, 149th Street - Grand Concourse was identified as a good candidate for the implementation of modern axle counter technologies to safely and significantly reduce the time that it takes to release switches between route changes by verifying that an approaching train is stopped at the station. Action on this recommendation has been taken since issuance by the task force of the initial draft report dated September 20, 2019. NYCT, STV and Frauscher (an axle counter vendor) have collaborated, developed and continue to work on a detailed design using axle counters at 149th Street – Grand Concourse.

4. Subway Cars and Signals

STV performed an initial analysis of the NYCT Subway car fleet to see if opportunities exist to safely increase vehicle performance. This analysis concluded that the NYCT's equipment is in line with industry standards. NYCT's normal acceleration, braking, and speeds in curves are comparable to those at other steel-wheel agencies. These rates are largely set to minimize the risk of injury to standing passengers that results from quick changes in velocity.

Data provided by NYCT shows that the acceleration performance of the DC propulsion-equipped vehicles was reduced circa 1996 in the aftermath of an accident investigation. This reduction was to make the vehicles compliant with the performance of the signal system. Subsequent vehicle procurements, and overhaul of existing vehicles, were performed in compliance with this reduced acceleration performance.

The safety of the system is predicated on the NYCT vehicle and signal design standards being compatible. NYCT's car fleets were confirmed by STV via testing to accelerate and brake in accordance with these NYCT design standards. STV has also determined that NYCT's signal system design standards utilized the vehicle rates in accordance with industry standards, including NYCT's nominal braking safety factor that is in accordance with the IEEE standard.

Subway cars cannot be allowed to accelerate faster than the current standards permit unless extensive changes are also made to the fixed block signal system. If the acceleration rate of a vehicle-type is increased, the train will be operating at a higher speed when the brakes are applied by the signal system; this would require that the block be lengthened. A multi-year effort and significant resources would be required to lengthen signal blocks and their respective insulated joints, even on a single line. Some vehicles, such as the R46 that date from the 1970s, are not capable of running faster and would not benefit from this redesign. Until the acceleration of the new vehicles was increased, and the older vehicles retired, this signal system redesign would likely reduce the amount of service on the line.

NYCT plans to continue upgrading the fixed block signal system to a modern moving block signaling system. Such systems do not require the cars to meet the fixed block signal system acceleration standards, as the system can safely handle trains with better performance characteristics. This allows new cars, such as the R160, to accelerate faster when in Communications-Based Train Control (CBTC) territory while continuing to safely obey the limits when operating on the fixed block signal system. Furthermore, the previously noted Grade Time/Station Time issues, which are vestiges of the fixed block system, would be eliminated by a moving block signaling system.

5. Dwell Time

While it was not part of this study, dwell time cannot be underestimated as a major percentage of running time. Continued evaluation and reduction of dwell time by NYCT as part of its Save Safe Seconds Program is recommended.

Recommended Next Steps

An initial simulation is needed to identify the specific opportunities for speed increases and improving bottlenecks and dwell time issues for comprehensive analysis.

1. Safely increase speeds on curves:
    a. Employ the curve analysis methodology used in the subject study to review curve speeds on NYCT lines not yet studied.

b. Identify and prioritize candidate curves for further investigation to determine where speeds could be safely increased. The 7th Avenue and Flushing lines should be considered priorities for this effort.

c. More rigorously analyze candidate curves following the NYCT Civil Speed Restriction Check-in meeting format:

   i. *Evaluate curves by direction in order of their track position along each track and line.*

   ii. *Obtain existing signal arrangement drawings showing the location of curves with respect to current infrastructure.*

   iii. *Evaluate each curve for the following characteristics:*

      1. *Proximity to a station*
      2. *Location within GT signal territory:*
         a. *Other nearby signals*
         b. *Other signal or timing issues*
      3. *Signal control line issues:*
         a. *Maximum Authorized Speed lower than existing V4 comfort speed*
         b. *Adequate braking distance and safety margin*
      4. *Location near turnout or crossover, or within an interlocking*
      5. *Proximity to adjacent curves or reverse curves or are part of a compound curve*
      6. *Other physical, maintenance, or operational constraints*

   iv. *Curves not constrained by the criteria listed above would be recommended for further review by the Speed Team.*

   v. *NYCT conduct further testing on the Flushing Line to gauge comfort levels up to V6 speeds in Automatic Train Protection Mode (ATPM and Automatic Train Operation (ATO)).*

d. Analyze passenger comfort levels at potential speeds identified in the study:

   i. *Operate test trains at higher curve speeds calculated by NYCT and elicit opinions of test train occupants.*

   ii. *Operate a geometry car to generate data concerning track condition and geometry data in areas of interest.*

   iii. *Provide track condition and geometry data to a third party (such as ENSCO) to simulate acceleration and jerk on the carbody at higher curve speeds and evaluate them against jerk rates acceptable to NYCT or longitudinal jerk limits already in the vehicle specifications.*

2. Get trains running at posted speeds and continue to recalibrate and replace mechanical timer relays:
    a. Validate operating speeds with specific attention to those portions of the system where restricted speeds are posted. This could be accomplished by NYCT Rapid Transit Operations (RTO) and Car Equipment staff. The resulting empirical data will be a valuable tool for forward planning.
    b. Continue to improve, adjust and replace signage, prioritizing any reported areas of poor visibility.
    c. Continue to recalibrate and replace mechanical timer relays, prioritizing reported slow-clearing Grade Time and Station Time circuits. These relays are a long-lead item and may be labor intensive depending on the location. Testing and calibration using the latest methods will also require on-track time under flagging protection and engineering oversight. It is recommended that NYCT begin replacing the timer relays with the 200 applicable electronic relays on hand. Replacements should be made as additional relays are able to be procured and resources permit associated site surveys, installation and testing. Resolution at the 600 to 900 priority Grade Time locations estimated by NYCT should be accelerated via the use of outside resources if necessary.
    d. Continue to report late-clearing signals.
    e. Continue to expand NYCT design methodology to determine more accurate, site-specific timer values and modernize associated equipment (relays and delay measurement tools) used to set these timer values.
    f. Continue to communicate to train operators, via operating bulletins as well as training and recertification curricula, the steps being taken to increase their level of confidence that they can operate at or near posted speeds. Consistent with this, NYCT has instituted a new operating policy relating to new crew standards of conduct regarding operations of trains at posted speeds.

3. Address bottlenecks:
    A Further evaluation of bottlenecks would require the deployment of resources external to NYCT, as follows:
        i. *Perform a comprehensive, systemwide network simulation analysis to identify all bottleneck locations and their interrelationships. This should include a more detailed analysis of the three initial locations identified in the study, including the interrelationships between these locations and other constrained points on the system.*
        ii. *Continue to progress the axle counter solution being developed for 149th Street - Grand Concourse. This will involve installing a test setup, monitoring performance, and verifying the benefit, reliability and safety of the solution before moving to a full tie-in to the existing NYCT circuitry.*
        iii. *Continue to examine the potential use of axle counter technology in bottleneck areas like 149th Street - Grand Concourse, and where other uses of the technology might be prudent (for instance, to eliminate the need to modify*

existing track circuits where modification of the block design would be beneficial). This is a full detailed design option that must be tied into the existing signaling system; it only makes sense as a short-term improvement ahead of full modernization of the signal system. It is a logical next step because, while it is still part of a longer-term solution that requires significant engineering and construction costs/efforts, it may be quicker to implement, is less costly and more flexible than modifications to existing traditional track circuits. Utilization of axle counters also aligns with NYCT's intent to implement counters as part of its CBTC design moving forward, which will allow equipment to be repurposed without duplicating some costs later.

iv. *Perform detailed analysis of Automatic Train Supervision (ATS) trigger points for automatic routing on the 7th Avenue line and provide recommendations for optimization based on current operating schedules. These ATS triggers are pre-programmed conditions and schedules used by the operational rail control system to automatically set up routes for trains in a manner that maximizes throughput.*

4. Determine, via cost-benefit analysis, any viable fixed block signaling system modifications required to accommodate increased speeds and simulate impacts on the system on a line-by-line basis, prioritized on capacity needs, and coordinated with upcoming signal related capital projects:
   a. Fixed block lines should be modeled in parallel with corresponding curve analysis efforts, using an industry standard signaling system software block design package. This will create design baselines that can be dynamically updated with any recommended parameter changes. STV recommends this work start with the 7th Avenue Line, with prioritization of subsequent choices determined by congestion levels and planned modernization efforts.
   b. Update the existing design speeds as determined by the recommendations above.
   c. Re-calculate the safe braking margins and determine which control lines would need to be extended and which signals would need to be relocated.
   d. Iteratively repeat step c until safe braking margins meet all required design standards.
   e. Model and simulate the associated runtime and capacity impacts and only implement speed changes if line capacity is not reduced.
   f. This process and baseline may be also used to demonstrate the effect of any vehicle performance improvements, dwell time updates, bottleneck improvements, etc. moving forward.
5. Continue evaluating and reducing dwell times.
6. Determine how analysis set forth in this report could be applicable for Metro-North and the Long Island Rail Road.

1. SCOPE OF WORK: METHODOLOGY

The scope of work for the MTA NYCT Subway Speed and Capacity Review project is described below:

1.1 TASK 1 – REVIEW AND EVALUATION OF EXISTING STANDARDS

STV, in cooperation with NYCT Division managers, has reviewed and documented existing NYCT standards and practices relating to train speed and system capacity. This covered track and civil elements, safe braking parameters, signals, localized analyses, station dwell times, vehicles and operations.

Consultant Evaluation and Comment on NYCT Work

NYCT has already spent, and is currently expending, considerable effort looking into the possibility of increasing train speeds at curves. This work includes:

- Evaluation of all posted 30-mph civil speed curves without Grade Time (GT) signals (those that generally govern speed in areas with curves or changes in grade). 50 candidates were identified for potential improvements and associated operating schedules were reviewed as well.
- Review of curves posted at 30 to 35 mph.
- Identification of 25 "quick-win" locations where speeds have already been increased.

- Identification by NYCT Rapid Transit Operations (RTO) of numerous locations where posted speeds through curves appear to have room for improvement.

NYCT is currently reviewing speeds through switches (turnouts). If a speed is not posted, the operating rule requires a 10-mph speed limit on turnouts. Evaluations show that given proper maintenance including a thorough inspection of the switch points, frogs and ties, some turnout configurations may allow for up to 25-mph operation and all that is currently limiting speeds may be the lack of signage at these locations.

STV has raised the possibility of posting speeds higher than the current V4 speeds (for example, the use of V6 speeds instead) at curves; a V6 speed is a normal high operating speed or Comfort Level Speed. Curves posted at V4 speeds (normal average operating speeds) provide optimal passenger comfort. V4 speeds are based on .07 g ft/sec^2 uncompensated lateral acceleration while V6 speeds are based on .1 g ft/sec^2 lateral acceleration.

NYCT has expressed several concerns about posting higher V6 speeds at curves. The first concern is vehicle center-of-gravity and its effect on passenger comfort relating to curve speeds. In other words, the higher the center-of-gravity, the greater the effect. The second concerns the ability of Communications-Based Train Control (CBTC) signal systems to achieve comfort speed levels well below the V11 Not-to-Exceed Safe Speed.

1.2 TASK 2 – ANALYSIS OF POTENTIAL REVISIONS TO SELECTED TRACK, SIGNAL AND TRAIN OPERATIONS STANDARDS TO SAFELY INCREASE TRAIN SPEEDS AND REDUCE OVERALL RUNNING TIMES

Meetings were held with NYCT's senior management team and leaders of Transport Workers Union Local 100 to review and discuss the findings of Task 1. The goal was to reach consensus on actions that could be taken take to revise selected standards for track, signal, and train operation relating to safely increasing train speeds and reducing overall running times without decreasing passenger comfort below acceptable levels.

Focus areas of this task included the NYCT practice of posting speed limits at the V4 level, which is lower than the V6 and V11 speed levels. The rationale for this practice is that long before a train speed reaches the level that presents technical challenges such as excessive wheel/rail wear or an increased potential for wheel climb and possible derailment, passengers may be subjected to conditions that can be perceived as uncomfortable or cause them to lose their balance. It has been shown that train operators overcompensate by operating trains at much lower speeds than V4 to avoid being charged with operating trains at speeds exceeding those posted and possibly facing disciplinary action as a result.

1.3 TASK 3 – REVIEW OF GRADE TIME (GT) AND STATION TIME (ST) SIGNALS; REVIEW OF TRAIN MOVEMENTS AT CRITICAL LOCATIONS; RECOMMENDATIONS FOR NEAR-TERM IMPROVEMENTS

Improvements to GT and ST signals throughout the system would produce significant improvements in trip time and, therefore, capacity. STV has reviewed these timed signals extensively and performed static testing in the field with NYCT, yielding important findings and producing recommendations that are included in this report. Similarly, STV has reviewed train movements along the 7th Avenue Line and curves along the Flushing Line, and acceleration along the 4th Avenue Line, producing significant data from these efforts. STV has also reviewed new technology that NYCT could employ at critical bottlenecks short of waiting to implement CBTC across the subway system. One of these is the use of modern axle counters, which NYCT is already evaluating for use on CBTC-equipped lines. Axle counters are introduced as a Study Area in paragraph 3.6. Axle counters are a type of train detection system that can be mounted to the web of the rail and detect trains as they pass by. STV's findings on potential uses of axle counters appear in paragraph 4.6, and our recommendations appear in paragraph 5.3. For additional details please refer to Appendix "O."

1.4 TASK 4 – GENERAL PLAN (SCOPE, SCHEDULE AND BUDGET) TO IMPLEMENT THE RECOMMENDED CHANGES

Revised signal standards will only be applicable on those portions of the NYCT system that continue to use wayside block signaling technology for an extended period. NYCT should prioritize those lines that are not included in the next two capital programs and evaluate the cost-benefits of the recommended traditional signaling system model and equipment modifications given the schedule for rolling out more modern technologies at the locations being considered.

Section 5, "Recommendations," of this report discusses some "quick wins" that would afford meaningful improvements in speed and capacity that do not have to wait for implementation of CBTC.

1.5 TASK 5 – PRODUCE FINAL REPORT

This Final Report marks the fulfillment of Task 5.

2. BACKGROUND

Two incidents in the 1990s led to a transformation of NYCT signal systems design and strengthening operating rules. Both may have contributed ultimately to slowing down the NYCT signal system. The first was the Union Square derailment on August 28, 1991 and the second was the rear-end collision of two trains on the Williamsburg Bridge on June 5, 1995. A brief discussion of these incidents is key to understanding how train speeds might be increased safely. This and actions taken by NYCT since then are essential background for this study.

2.1 UNION SQUARE DERAILMENT

A. Shortly after midnight on August 28, 1991, a southbound No. 4 Lexington Avenue Express train derailed as it was about to enter 14th Street – Union Square station, killing five people. A total of 33 structural support columns were destroyed as were three subway cars. The street above dropped a total of one-half inch. It took seven days for the damaged cars to be removed and repairs to be made to the tunnel structure. Full service on the Lexington Avenue Line through that area was suspended for that entire week. It was the worst accident on the subway system since the 1928 Times Square derailment. The motorman was found at fault for intoxication and excessive speed and served time in prison for manslaughter. The train heading southbound was going at nearly 50 mph, too fast for a trip stop activation to stop the train in time and its overspeed condition resulting in it derailing immediately north of the station.

B. The switches and tracks that were damaged or destroyed in the derailment were rebuilt, and NYCT added diverging GT signals to require trains to slow down before crossing over from one track to the other.

C. A 1992 study commissioned after the accident by NYCT found that some signals in the subway system, including several on the Lexington Avenue Line, were spaced too closely for a train traveling at maximum speed to have time to stop, confirming the finding of safety investigators immediately after the crash; the issue resurfaced after a rear-end collision on the Williamsburg Bridge in 1995, described below.

D. The National Transportation Safety Board (NTSB) recommended that speed indication systems be installed on subway cars. NYCT had been testing speed indication systems since 1990. By May 1994, gear unit type speed indication systems were installed on the R44 and R46 class cars, and ring type speed indication systems were purchased for installation on 40 percent of R62A class cars. In May 1994, a contract was awarded for the procurement of 132 Doppler radar type speed indication systems for the R62 class cars, the train type damaged in the derailment.

2.2 WILLIAMSBURG BRIDGE COLLISION

A. Both the NTSB and NYCT performed a detailed analysis of the 1995 collision between two trains on the Williamsburg Bridge in which the operator of the colliding train was killed. The NYCT report is entitled "Strategic Plan to Address Safety Issues Resulting from the Investigation of the Williamsburg Bridge Collision," dated August 27, 1996 (the "Strategic Plan"). One paragraph in particular in the Strategic Plan's Executive Summary sets the stage for the work at hand here:

> *The integrity of a fixed block wayside signal system is entirely dependent upon the car performance remaining within the bounds of the performance assumed in the signal design. Since this condition no longer exists, many signal locations throughout the NYCT system no longer provide the design standard of emergency braking distance plus a 35% safety margin for signals between stations. Furthermore, a significant number of signal locations between stations do not provide even 100% of the required emergency braking distance.*

B. Actions Taken After the Williamsburg Bridge Collision.

1. The Strategic Plan included the following options for corrective action:

   (a) Option I – No additional modifications except for the addition of speed limit signs. The Strategic Plan concluded that Option I was not an acceptable long-term solution "because it does not provide automatic train protection (ATP) and instead relies almost entirely on train operators' constant adherence to posted speeds and the operating Book of Rules."

   (b) Option II – Modify signal system. This option considered lengthening signal control lines and including Grade Time (GT) and Station Time (ST) signaling

"to mitigate the capacity impacts which result in critical areas when control lines are extended." The Strategic Plan dropped Option II from consideration.

(c) *Option III – Reduce Acceleration Performance - Modify car performance to 71% field strength (Option III-A) and 100% field strength (Option III-B).*

2. The Strategic Plan recommended adoption of Option III-B, summarized as follows:

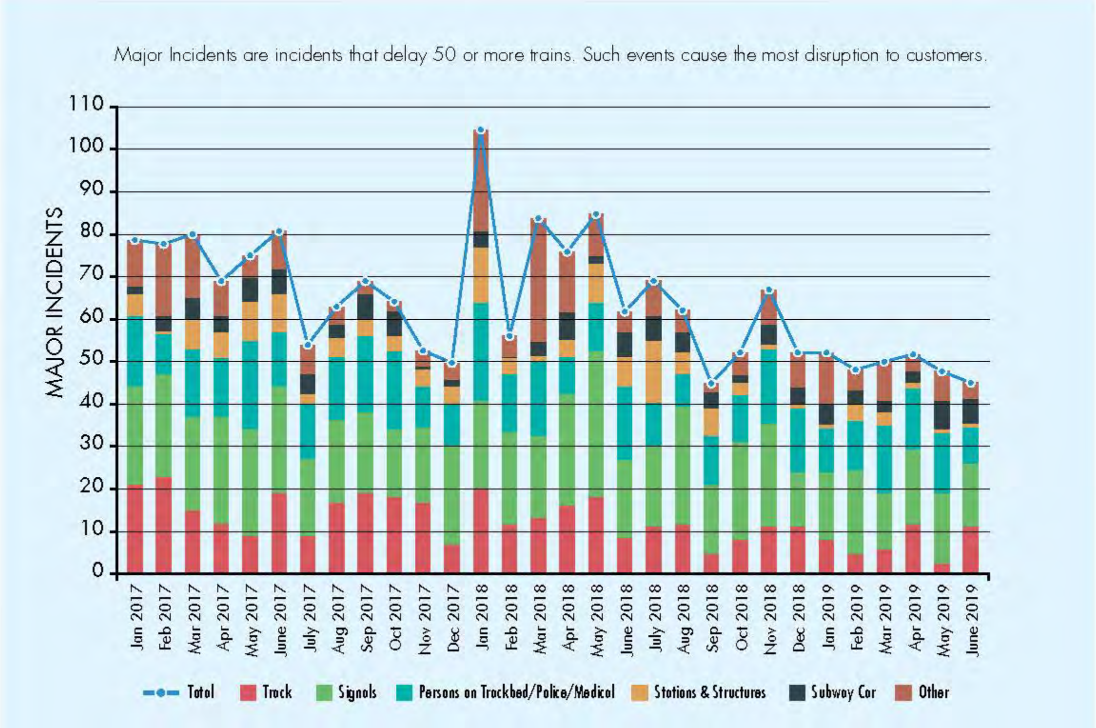
   In order to restore [NYCT's] original design standards of providing emergency braking distance plus a 35% Safety Margin at all signal locations between stations:

   (a) *Modify the car acceleration performance for Subdivisions A and B to 100% field strength operation.*

   (b) *Modify any signal locations between stations, which do not meet the 35% safety margin design criteria based on 100% field strength operation of cars beginning with those locations that have less than 100% emergency braking distance.*

C. System safety has been enhanced since the Williamsburg Bridge collision and this relies on, among other things, regular maintenance of wayside signal equipment. Signal-related issues (shown in light green) have been consistently at or near the top causes of delayed trains, as the following chart from the MTA's web site shows.

Figure 1: Major Incidents Since January 2017



Major Incidents are incidents that delay 50 or more trains. Such events cause the most disruption to customers.

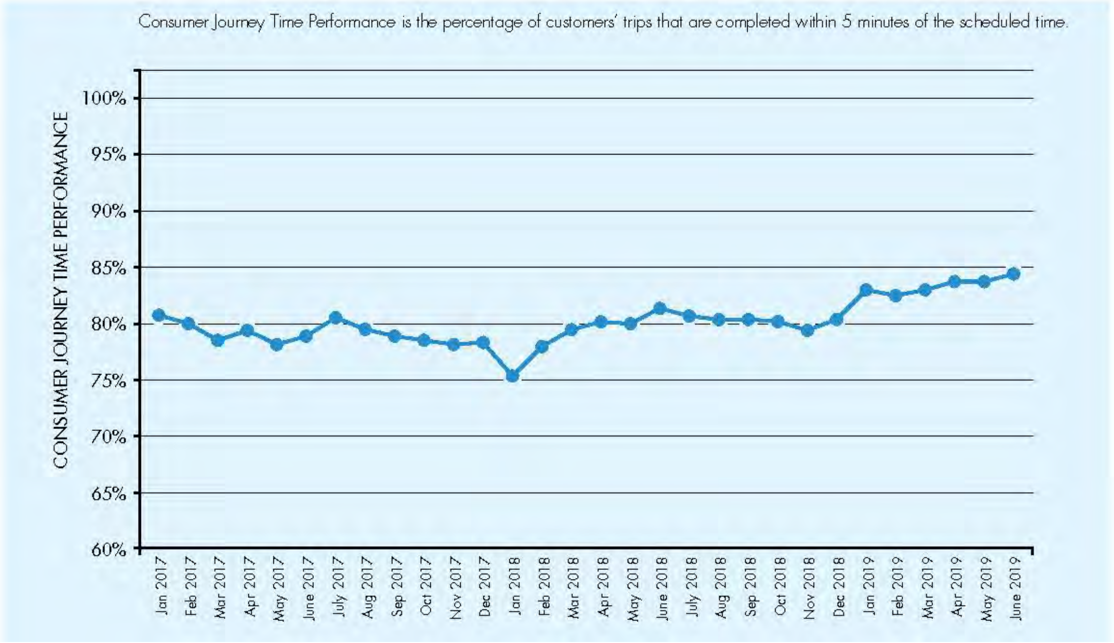
D. For a full discussion of this topic please refer to Appendix "B."

2.3 NYCT EFFORTS TO IMPROVE PERFORMANCE AND SAFETY

A. As Figure 1 shows, there are many factors that contribute to subway service delays. This study focuses on near-term, cost-effective improvements to train control that can increase safe operating speeds, building on the Save Safe Seconds campaign, thereby increasing capacity on trains and reducing the overcrowding at many stations that has occurred despite the decline in ridership.

B. Signal failures and other factors have reduced on-time performance, which has improved since the inception of the Subway Action Plan and the Save Safe Seconds campaign, as shown in Figure 2, also taken from the MTA's web site. On-time performance reached a several-year high of 84.3 percent in June 2019.

Figure 2: Customer Journey On-Time Performance Since January 2017



C. Nevertheless, service delays have contributed to some loss of customer confidence and ridership in the system from the 2015 peak. MTA data for 2018 in Figure 3 show a decrease of over 200,000 riders each weekday and over 500,000 riders each weekend. During this same period, use of app-based for-hire car services (Lyft, Uber) and street congestion has increased.

Figure 3: Average Subway Ridership, 2013-2018

Year	Average Weekday	Average Saturday	Average Sunday	Average Weekend	Annual Total
2013	5,465,034	3,243,495	2,563,022	5,806,517	1,707,555,714
2014	5,597,551	3,323,110	2,662,795	5,985,905	1,751,287,621
2015	5,650,610	3,309,731	2,663,418	5,943,149	1,762,565,419
2016	5,655,755	3,202,388	2,555,814	5,758,201	1,756,814,800
2017	5,580,845	3,156,673	2,525,481	5,682,154	1,727,366,607
2018	5,437,587	3,046,289	2,392,658	5,438,947	1,680,060,402

3. METHODOLOGY EMPLOYED IN THIS STUDY

3.1 OVERVIEW OF EXISTING STANDARDS AND PRACTICES

A. As noted above, existing NYCT standards and practices were reviewed and documented in cooperation with NYCT Division managers. For a list of documents reviewed by STV for this report please refer to Appendix "B." For details of the 1994 policy review and NYCT's 1998 Speed Policy Standards, please refer to Appendix "C."

3.2 STUDY AREA: TRACK/CIVIL

A. The NYCT Speed Policy provides for safe operating speeds throughout the system. All signal modernization projects and retrofits since 1988 have been undertaken subject to the approval of the NYCT Speed Policy Committee composed of senior level technical managers from these NYCT departments: Rapid Transit Operations (RTO), the Signals group of Capital Program Management (CPM Signals), Car Equipment, Track, System Safety and Operations Planning. The Speed Policy has been updated starting with Proposed changes in 1994 based on the Committee's experience, operational speed test results, and recommendations from Toronto Transit Consultants Ltd. (TTCL). TTCL also performed a study of the signal system with those findings and recommendations being included in the 1994 Speed Policy. The policy recommended revisions to the speed parameters with the intent on eliminating unwarranted speed limitations, decreasing track and signal maintenance costs, and maximizing passenger comfort. The proposed changes introduced the concept of minimum speeds on curves mitigating track deterioration and unsafe conditions and improving ride quality.

B. STV reviewed the current (December 2018) NYCT Speed Policy Standard and curve geometry and speeds provided by NYCT for the 7th Avenue and Flushing lines. STV also verified and calculated proposed Maximum Allowable Speed on tangent track and standard turnouts and diverging routes (Track Standards).

C. STV studied the application and effect of Normal Average Operating Speed (V4) and Normal High Operating Speed (Comfort Limit Speed – V6) in posting and controlling speed limits (Signal Standards). This included an independent curve analysis documenting potential increases in speeds between V4 and V6. The analysis proposes increasing the speeds by V4 plus one-third of the difference between V4 and V6 speeds (V4.66) and increasing speeds by V4 plus 50 percent of the difference between V4 and V6 speeds (V5). Please refer to Appendix "E." STV is following the same approach used on the NYCT A-Division Line Capacity Study (WA#5) performed by STV under separate contract, and concurred with by NYCT Engineering.

D. As requested, STV performed a more targeted analysis trying to capture candidate groupings of delta speed increases or ranges for implementation between V4, 4.66, V5, and V6 based on existing curve radius and superelevation. Please refer to Appendix "F" for a delta speed analysis and Section 4.1 for recommendations.

E. Also as requested, STV performed a similar curve and speed analysis for the #7 Flushing Line and include the findings in the Final Report. Please refer to Appendix "G" – Curve and Speeds, V4/V6 Analysis #7 Flushing Line – "A" Division (IRT).

3.3 STUDY AREA: FIXED BLOCK DESIGN AND SAFE BRAKING

A. STV has analyzed the safe braking methodology and generalized considerations including the 135 percent safe braking factor.

B. STV has also studied the general impacts of a 20 percent train acceleration increase on a small segment of the 7th Avenue Line.

C. Research, Meetings, Reviews

1. STV met at NYCT Headquarters on July 25, 2019 with senior engineers from the Signal Engineering group of NYCT Capital Program Management (CPM Signal Engineering).
2. STV has studied the National Transportation Safety Board (NTSB) investigation report of the 1995 Williamsburg Bridge collision and the NYCT document entitled "Strategic Plan to Address Safety Issues Resulting from the Investigation of the Williamsburg Bridge Collision," dated August 27, 1996 (the "Strategic Plan").

3. STV has reviewed NYCT's Signal Operational Design Manual and the document entitled "Locating of Block Signals for Rapid Transit Railroads and Location of Signs and Repeater Signals; Description of Time – Signal Systems, Methods of Calculations; Signal Operation Tests" developed by the Board of Transportation of the City of New York (the "Ferreri Report" authored by Peter Ferreri).

3.4 STUDY AREA: SIGNALING SYSTEM AND RELATED PROCEDURES AND POLICIES

A. A basic understanding of NYCT's fixed-block signal system is essential for understanding the findings and recommendations in this report.

High-Level Summary of the NYCT Fixed Block System

- The tracks are divided into fixed segments used by the system to estimate train position.
- Trains are separated using these segments such that trains travelling at Maximum Attainable Speeds will be safely separated:
    - The Maximum Attainable Speed is calculated based on the vehicle's top acceleration rate as it travels towards a red signal and the distance it needs to travel to reach the signal.
    - The safe braking distance is calculated based on the speed the train reaches prior to emergency brake application at the red signal, along with the braking characteristics of the vehicle. A safety factor is added to this calculated distance to handle hazards such as slip-slide, which are impossible to precisely quantify for all conditions.
- Where speed restrictions around curves and into stations are enforced, the system allows trains to be safely moved closer together.
    - Timers are used to control if and when a train is permitted to proceed through these areas, causing the signal to "clear" from red to a permissive aspect such as yellow or green. These timers are set based on the travel distance and design speeds. If the train is not on the segment long enough, the system assumes it is moving too fast and the signal does not clear.

High-Level Design Concept Example

In an area that does not have any speed control, calculations may show that Train A can reach a maximum of 32 mph before it reaches the first red signal between segments 3 and 4. The train must stop before it reaches the second red signal between segments 4 and 5 to keep it from colliding with Train B. The signals and segments of a fixed block system are placed according to these calculations and operational headway requirements as shown below:

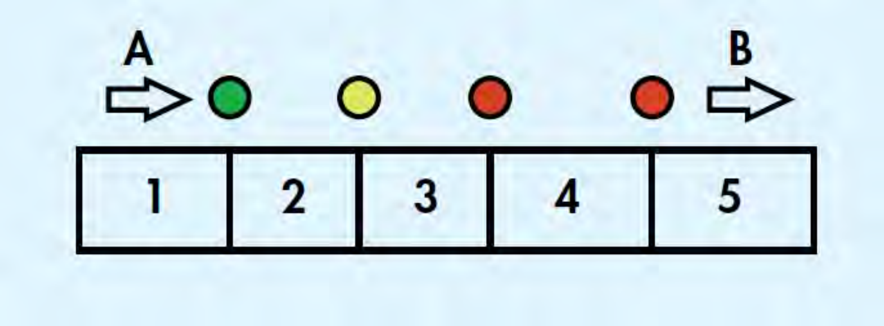


Diagram I – Train A is traveling toward Train B, which is stopped (e.g. at a station)

If Train A is made to accelerate faster or existing track conditions allow for higher top speeds, segment 4 may need to be lengthened by modifying the rail and associated insulation to accommodate these changes. Since there is a signal present in this example, the associated signal, trip stop and cables would also need to be relocated. Trains can move faster now, but Train A and Train B are now separated further:

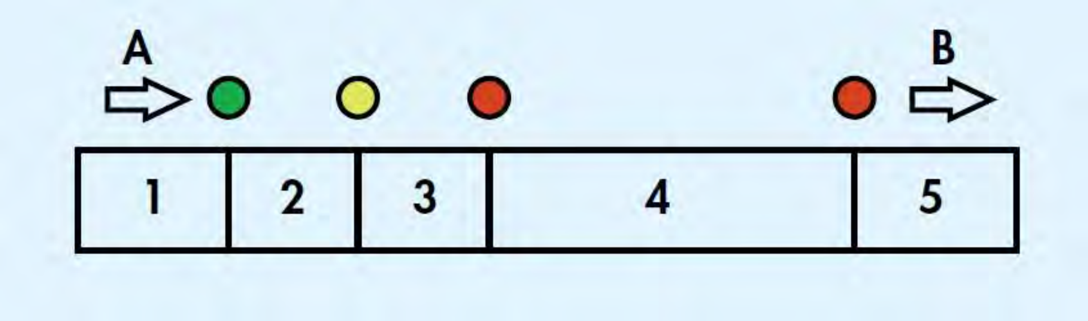


Diagram II – Train A can travel faster toward Train B, which is stopped (e.g. at a station). Segment 4 has to be lengthened.

If speed control is now added, the system can then use timers to verify that the train is moving slower than the calculated top speed to get Train A safely closer to train B. In this example, we can break segment 4 into 4A and 4B, and add a timing element to the first red signal that clears when the train is moving at under 25 mph:

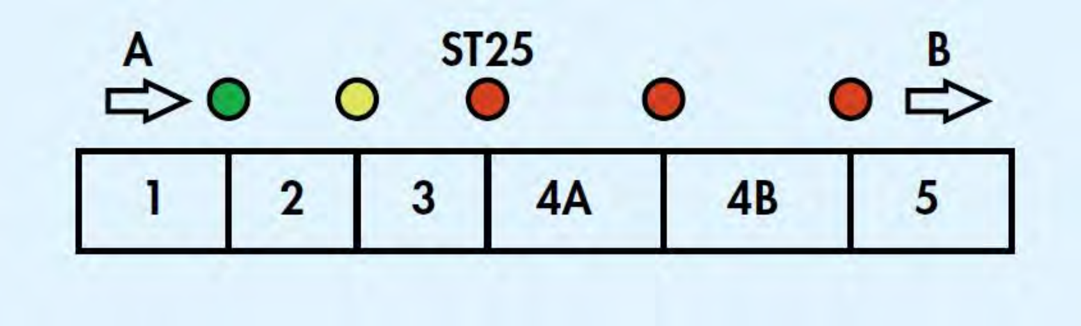


Diagram III –Segment 4 is broken into two segments, and the speed of the train is checked at the ST25 signal.

Segment 4 is just divided into 4A and 4B. So, if the train is moving at its Maximum Attainable Speed, it will reach the same red signal and safely stop before reaching segment 5/Train B (as originally).

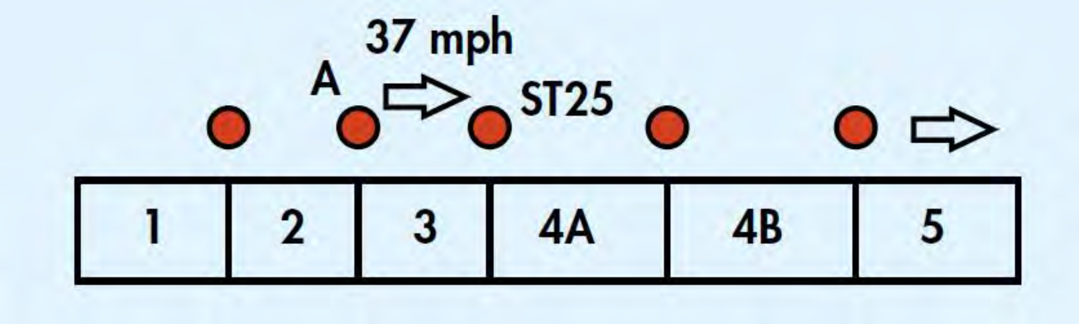


Diagram IV –The signal does not clear for a train that is moving too fast. This provides the same braking distance as in diagram II.

However, if the train remains on segment 3 for long enough, demonstrating that it is moving under 25 mph (based on the calculations), the associated signal will clear. There will be enough safe braking distance in segment 4B to fully stop a train moving 25 mph before it reaches segment 5:

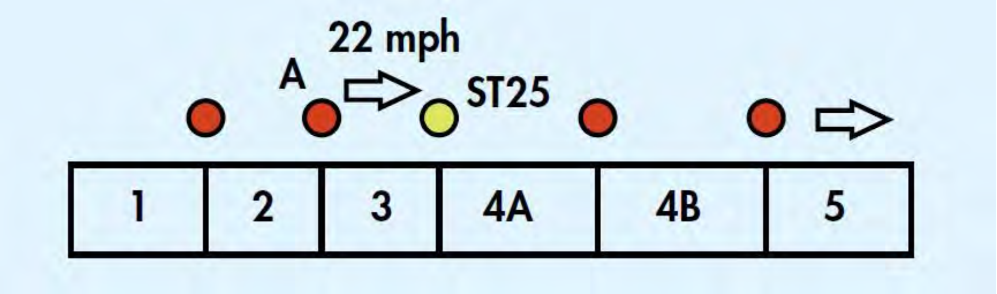


Diagram V –The signal clears for a train moving under 25 mph, allowing the train to move closer to Train B as in diagram I.

Train A is now able to progress through segment 4A and wait at the next red signal for train B to move onward. This is how trains are safely kept moving when they are not able to travel at Maximum Attainable Speeds (e.g. during rush hour at critical bottleneck stations and interlockings).

To summarize: the lengths of fixed block segments at NYCT are based on the Maximum Attainable Speed of trains. The faster the train moves, the longer the segments become. Speed control through use of timers and additional signals may be used to check actual average speeds and bring trains closer together when there is congestion or to enforce speeds through curves. Signaling system design at NYCT is an iterative balancing act between speed, capacity and equipment costs, performed while maintaining the required safety margins throughout.

Please refer to Appendix "H" for a further overview.

B. STV has developed general recommendations with respect to the signaling system and associated operating procedures/policies.

C. Research, Meetings, Reviews

1. STV has reviewed NYCT speed policy standards and bulletins.
2. STV has reviewed Operator and CR Induction Manuals.
3. STV took part in a ride-along on the 7th Avenue Line on July 24, 2019.

3.5 STUDY AREA: LOCALIZED ANALYSIS OF BOTTLENECKS

A. STV identified three representative bottleneck locations in discussion with NYCT and performed a detailed analysis with respect to signal layouts, force-lock operation and potential automatic routing adjustments. A comprehensive simulation analysis should be performed as a next step to assess the system holistically and identify all bottleneck locations and how they interrelate.

B. Research, Meetings, Reviews

1. STV has reviewed layout drawings and service timetables for all identified locations.
2. STV has observed rush hour operations at all identified locations.

3. STV has discussed auto-routing and intermediate/end station terminal operation with a senior engineer from CPM Signal Engineering.

3.6 STUDY AREA: STATION TIME SIGNAL TESTING; COUNTDOWN TIMERS

A. When a train occupies a timed section of track, it activates a circuit that includes a timer which begins to run. Since the length of the section is known, a basic formula can be utilized to figure out how long the train needs to be on that section to meet an average speed limit. If all the involved equipment and circuits operated and could be calibrated perfectly, the timer would be set for exactly this calculated value. However, in practice there is a tolerance window. The goal is to quantify and minimize this window to the greatest extent possible under the limitations of the fixed block signaling system.

B. STV has developed detailed recommendations and procedures with respect to GT and ST testing, and has evaluated adding countdown timers. Countdown timers are similar to "Countdown Pedestrian Signals" defined by MUTCD 4E.07. They detect trains as they pass by and serve as a display of time remaining until the timer value elapses; this information is updated each second.

C. Research, Meetings, Reviews

1. STV has reviewed NYCT timer signal functionality and circuits.
2. Prior to issuance of the initial draft version of this report, STV contacted Frauscher (the axle counter vendor) and had a discussion with them to review technologies in service and on the horizon. Axle counters are a type of train detection system that can be mounted to the web of the rail and detect trains as they pass by. Although the concept and associated patent have existed since 1960, modern axle counter technologies utilize compact field enclosures that house wheel sensors, illustrated in Figure 4. These are connected to backend microprocessors (called "evaluators" by some vendors) to provide fail-safe detection and that have been certified up to Safety Integrity Level (SIL) 4. "Safety Integrity Level" as it relates to railways is a device or system's relative measure of resilience to failures based on event frequency and severity. It is further defined, with levels 0 to 4 specified, in the EN 50129 / IEC 62278 standard (Railway Applications, Safety Related Electronic Systems for Signaling). A SIL 4 level is the highest (safest) category of safety hazard mitigation that an equipment device or system can achieve.

Figure 4: Frauscher Axle Counter Enclosure

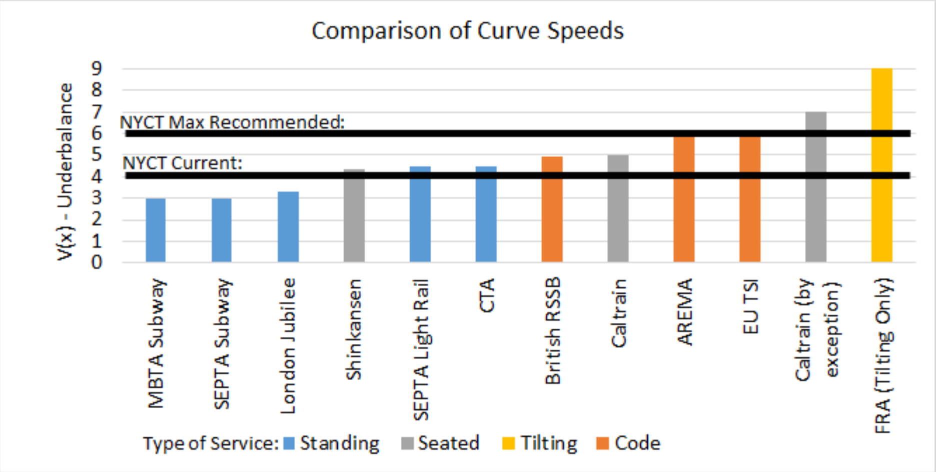
Axle counter technology is explored in this report as a possible alternative for NYCT to modifying existing track circuits where necessary moving forward, as it is significantly less expensive, disrupts fewer signaling system elements (e.g. insulated joints are not needed) and is more rapidly deployed. This is not being approached as a "quick win," but an alternate, detailed design option that would need to be tied into the existing signaling system and may be considered in targeted areas/bottlenecks of NYCT requiring relief. Since NYCT is already considering implementation of axle counters as part of its CBTC design moving forward, this evaluation makes even more sense. Axle counter equipment installed now to enhance fixed-block functionality may be utilized by future CBTC systems, whereas changing traditional block signaling system elements is costlier, with no opportunity for continued use or re-purposing under a later CBTC implementation.

After issuance of the draft version of this report, engineers from STV, NYCT Maintenance of Way (MoW) and CPM, and Frauscher have worked together to develop a detailed design concept for potential use at 149th Street – Grand Concourse. The current proposal implements axle counters in a non-conventional manner that continues to be adapted for effective and safe tie-in to existing NYCT circuits.

3.7 STUDY AREA: VEHICLES

A. STV has performed an initial analysis of the NYCT Subway Cars and consider them to be in line with industry standards. The normal acceleration, braking, and curving speeds are similar to rates at other steel-wheel agencies. These rates are largely set to minimize risk of injury to standing passengers, due to quick changes in velocity causing passengers to lose their balance. Figure 5 offers a comparison of curve speeds at several agencies along with the AREMA standard. The blue bars represent agencies with many standees, while the gray bars represent agencies where passengers are usually seated. Data provided by NYCT show that acceleration performance of the DC propulsion equipped vehicles was reduced circa 1996 in the aftermath of an accident investigation. Propulsion was decreased so that maximum acceleration values could not exceed the maximum values assumed by the signaling system design that drive the safe braking distances and associated signal spacing. Changing the acceleration characteristics of the propulsion system, particularly the rate of change of acceleration (also known as "jerk") can have an adverse impact on perceived passenger comfort, particularly for standing passengers as a feeling of imbalance. Adverse perception by standing passengers can also arise with increasing speed through curves from V4 to V6, although V6 is an accepted industry standard limiting speed for passenger comfort at some transit systems. Increases implemented in acceleration and curving speed increase the probability of standing passengers experiencing unbalance.

Figure 5. Comparison of Curve Speeds



B. STV received and has examined test data from actual testing of car acceleration for the entire DC powered fleet. STV understands that this testing was mostly performed in 1996 to 1997 immediately before and immediately after the adjustment was made to reduce acceleration rates. Refer to Appendix "I." STV also received event recorder ("black box") data for an R160 car in May 2019; refer to Figure 6. The test data confirms that the vehicles do not exceed the maximum safe acceleration allowed by the existing signal system. Due to the lack of event recorders on the older cars, STV was unable to validate that those fleets have not degraded in performance since 1997. To this end, STV and NYCT performed acceleration and brake testing on two fleets: a new R160 train (with additional weight to simulate passenger load) and a legacy R46 train (with no additional weight). Refer to Appendix "P" for details.

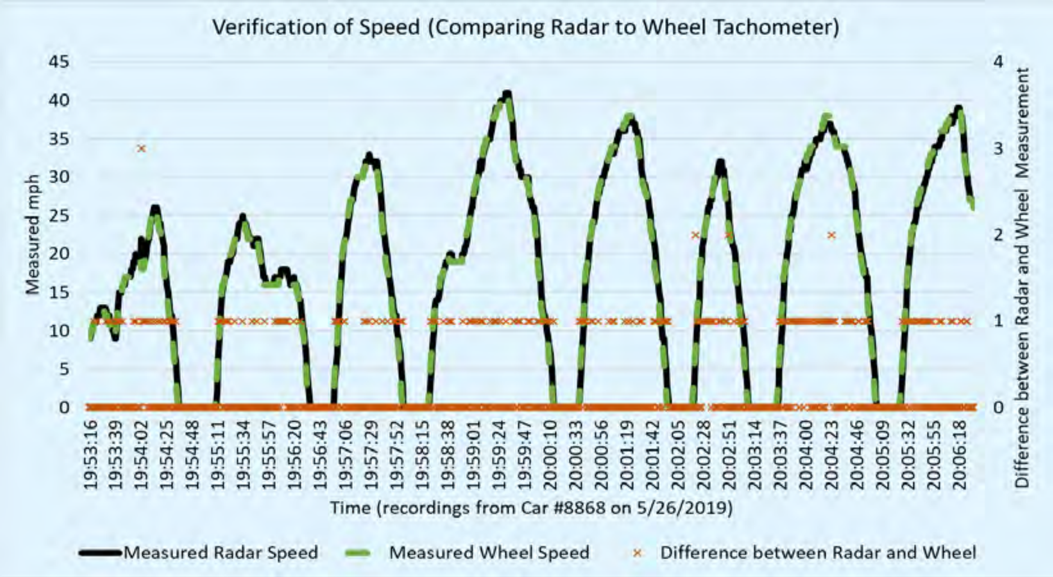
C. Both the R160 and R46 trains met the NYCT braking distance requirements. STV did not measure sufficient safety margin to justify a shortening/improvement to NYCT's braking distance design criteria.

The R160 acceleration was verified to comply with the NYCT signal design guidelines. The R160 is capable of even higher acceleration when in CBTC territory, but this could not be verified in the non-CBTC test territory. The acceleration of the older R46 consist is substantially less than the R160.

D. Without an in-depth analysis of the vehicle's propulsion system, it is unclear if the acceleration of the R46 and other legacy fleets could be improved to match the R160. STV recommends that NYCT continue to specify that any new vehicles be capable of higher acceleration in CBTC mode, which will continue to improve the fleet performance as older vehicles are replaced and retired.

E. The accuracy of the R46 and R160 test car speedometers were also validated to be within 1 mph of actual track speed via the above-mentioned testing and a sampling of R160 event recorder data, as shown in Figure 6.

Figure 6: Speedometer Performance, R160 Car 8868



4. FINDINGS

4.1 FINDINGS: TRACK/CIVIL

A. Any study of increasing speeds on a rapid transit system must consider curve speeds. To increase the comfort speed and vehicle stability through some curves, railroads raise the rail on the outside of a curve so that the train leans into a curve, thereby reducing the amount of uncompensated lateral acceleration experienced by the car and its occupants. The tilt is termed superelevation. If a train is going around a curve faster than the speed correlated with its superelevation and curve radius, the resulting unbalanced speed is called the V-speed. A V0 speed is where the superelevation and the train speed cancel out the uncompensated lateral acceleration. A V4 speed is the speed at which the existing superelevation would need to be increased by 4 inches for the lateral acceleration to be kept at a small acceptable value. All railroads allow operation at speeds above V0, as this improves service while not being uncomfortable for passengers.

NYCT's comfort speed for curves is currently set at V4. This was based on tests by NYCT's Speed Policy Committee over 25 years ago; these tests were conducted at different speeds over well-maintained track and sharp curves. The consensus at that time was that speeds over V4 were perceived as being somewhat uncomfortable for standing passengers. STV's report recommends that NYCT reconsider increasing the allowable speed in certain curves from V4 to V6.

NYCT Speed Policy Committee Standards currently set the comfort speed for curves at V4 which is the normal average operating speed. This is the speed above the balanced speed for a curve of a specific radius and actual superelevation that is equivalent to adding 4 inches of unbalanced superelevation. V6 is the normal high operating speed (comfort limit speed) that causes the passenger perceived uncompensated lateral acceleration to be equal to or less than .1 g ft/sec2 with 6 inches of unbalanced superelevation. V5 is a proposed speed between V4 and V6 that would be balanced based on adding 5 inches of superelevation.

B. The results of STV's speed curve analysis on both the 7th Avenue and Flushing Lines show that speeds on certain curves could be increased on average between 1 and 8 mph, depending on the radius of the curve and existing actual superelevation. This incremental approach calculates the curves at V4.66 (one-third of the difference between V4 and V6) and V5 speeds. STV recommends that this approach be considered as part of a detailed, case-by-case review of curve speeds. Appendix F illustrates these factors on the Seventh Avenue Line.

C. An additional analysis was performed on curves with radii between 750 ft. and 2,500 ft. that had no superelevation. Curves with radii less than 750 ft. typically have guard rails and are without spirals; they are not ideal candidates for future investigation and were therefore excluded from the study. Refer to Table 1.

Table 1: STV Speed Curve Analysis

		V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5]	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5]**	**V5 Speed Calculated V.5 = *((5+Ea)*R)^.5]**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5]**	**Delta between V4 and V4.66**	**Delta between V4 and V5**	**Delta between V4 and V6**
Radius (ft.)	Superelevation (in.)	mph	(mph)	mph	mph	mph	mph	mph
750	0	27.38612788	29.55926251	30.61862178	33.54101966	2.173134632	3.23249391	6.154891787
800	0	28.28427125	30.52867504	31.6227766	34.64101615	2.244403797	3.338505354	6.356744904
900	0	30	32.38054972	33.54101966	36.74234614	2.380549717	3.541019662	6.742346142
1000	0	31.6227766	34.13209633	35.35533906	38.72983346	2.50931973	3.732562458	7.10705686
1100	0	33.1662479	35.79804464	37.08099244	40.62019202	2.631796736	3.914744532	7.45394412
1200	0	34.64101615	37.38983819	38.72983346	42.42640687	2.74882204	4.088817311	7.78539072
1300	0	36.05551275	38.91657744	40.31128874	44.15880433	2.86106469	4.255775987	8.103291577
1400	0	37.41657387	40.38564101	41.83300133	45.82575695	2.969067145	4.416427459	8.409183082
1500	0	38.72983346	41.80310993	43.30127019	47.4341649	3.07327647	4.571436727	8.70433144
1600	0	40	43.17406629	44.72135955	48.98979486	3.17406629	4.72135955	8.989794856
1700	0	41.23105626	44.5028089	46.09772229	50.49752469	3.271752644	4.86666603	9.266468436
1800	0	42.42640687	45.79301257	47.4341649	51.96152423	3.366605696	5.007758031	9.535117356
1900	0	43.58898944	47.04784798	48.73397172	53.38539126	3.458858549	5.144982289	9.796401825
2000	0	44.72135955	48.27007354	50	54.77225575	3.548713995	5.27864045	10.0508962
2100	0	45.82575695	49.46210671	51.23475383	56.1248608	3.636349759	5.40899688	10.29910385
2200	0	46.9041576	50.62608024	52.44044241	57.44562647	3.721922637	5.53628481	10.54146887
2300	0	47.95831523	51.76388703	53.61902647	58.73670062	3.805571792	5.660711241	10.77838539
2400	0	48.98979486	52.87721627	54.77225575	60	3.88742141	5.782460895	11.01020514
2500	0	50	53.96758286	55.90169944	61.23724357	3.967582862	5.901699437	11.23724357

The findings of this preliminary analysis have important implications for curves with common characteristics across the NYCT system:

1. Curves with radii between 750 ft. and 1,600 ft. are candidates for speed increases based on V6 up to the Maximum Attainable Speed of 50 mph.

2. Curves with radii between 1,600 ft. and 2,000 ft. are candidates for speed increases based on V5 up to the Maximum Attainable Speed of 50 mph.

Curves with radii of 2,500 ft. were not included in the analysis because speeds up to 50 mph at V4 can already be achieved. Also excluded were curves with radii greater than 2,000 ft. where the Maximum Attainable Speed of 50 mph would be exceeded at V6.

The results imply that there is the potential to increase speeds on curves with common characteristics systemwide. This would require a case-by-case engineering review and additional operational testing to confirm safety and passenger comfort at these potential speeds.

4.2 FINDINGS: FIXED BLOCK DESIGN AND SAFE BRAKING METHODOLOGY

A. The Strategic Plan discussed in Section 2.2 notes that the data gathered from retrofitted trains were inconclusive versus CPM Signals' running time estimates. It also acknowledges, in NYCT's endorsement of Option III-B, that not all signals would be brought to the 135 percent standard, only those deemed critical.

B. Except for the CBTC-equipped L Canarsie and #7 Flushing Lines, NYCT utilizes a traditional fixed block signaling system, physically segmenting the track in blocks so to determine train position along the alignment and using this information to keep trains operating at safe speeds depending upon the type of track they are on (tangent, curve, switches and grades) and safely separated. At NYCT, signals with trip stops are placed at critical locations that will activate the braking of trains well enough in advance to mitigate the risk of collision or derailments due to excessive speed or encroaching on the train ahead. The safe braking model and associated calculations are used to determine where these signals are placed along the track and the length of the blocks they control.

C. The safe braking model is developed by analyzing train equipment parameters, environmental factors and operational characteristics, considering how these elements can fail, then combining test results and assumptions to provide a calculable braking distance given the speed of the train. Following are just some examples of what is considered in addition to the more obvious factors such as maximum possible acceleration and deceleration of the train, grade and curvature of the track:

   1. **Brake Build-Up** – brake applications are not instantaneous; they take time to start. This is essentially the transition time between when train propulsion is cut off and the brakes are applied.
   2. **Rail Adhesion** – this is a factor used to reflect the assumed slip-slide conditions (e.g. due to water, grease, leaves) when the brakes are applied. This is one of

the best examples of where safety risk assessment applies. In theory, the train may slide forever because the brakes simply cannot take hold. The model cannot be based on the absolute "worst-case" condition for this factor, and NYCT needed to determine what the proper balance is between reasonable safety and operational impact based on the operating environment, established rules, historical collision/derailment analysis, and maintenance.

3. **Brake Cut-Out Percentage** – the assumed percentage of failed or disabled brakes on a train. Similar to rail adhesion this is an indeterminate factor, but one that may be more heavily offset by associated rules and periodic maintenance.

4. **Runaway Acceleration** – this is a valid concern and a valid failure mode. It is a true worst-case whereby a train may enter a block, travel the length of that block, and apply maximum acceleration before being tripped at the next red signal. While some may discount this occurrence as being relatively rare or occurring so infrequently such that it does not need to be considered or factored in; recent examples of its occurrence in incidents where the Train Operator or Locomotive Engineer was impaired because of fatigue or the influence of drugs or alcohol, have reinforced the need to actively consider the runaway scenario. Unintended human behavior that is the result of fatigue needs to be taken into consideration when making assumptions concerning safe braking rates. The underlying cause of such is fatigue and the engineer/train operator falling asleep and not taking appropriate action to stop the train. Whether due to intentional violation of rules or due to illness or distraction, the standard for signal design assumes the maximum speed that a train can achieve at all points. The Williamsburg Bridge Collision is a clear example of why considering runaway acceleration as a valid failure mode is a good idea, though attributed to the vehicle's acceleration capability. The train moved faster than the signaling system design assumed it could, causing the safe braking distance to be further than assumed, causing the collision.

   These and other considerations are further described in IEEE Standard 1698-2009 (IEEE Guide for the Calculation of Braking Distances for Rail Transit Vehicles), which provides a complete, technically detailed engineering guideline to agencies.

D. In summary, there is a combination of concrete factors and mathematics that go into determining the safe braking model, but also some factors that are transit agency specific and require a safety risk analysis to finalize. According to IEEE 1698-2009, for the allowance of these latter safety factors such as rail adhesion, a "typical safety factor is 35%" on top of the normally calculated safe braking distance ("based upon the application of friction brakes only, applied through fail-safe or safety critical circuits").

E. Once this model is created, it is utilized by signal engineers along with headway requirements in calculating block and signal layouts. For fixed block signaling systems, the model necessarily must reflect the worst-case braking assumptions and maximum acceleration/speeds attainable by any train operating on the alignment. This is because a train that can achieve a higher speed more quickly as compared to other vehicles in the fleet will enter a signal block at a higher rate of speed than that for which the signal system is designed. Such circumstances require additional safe braking to account for instances when brakes do not perform as designed. The signaling layout is based on one, global set of calculations that need to provide the required safety protection for all trains that operate on that section of track. This is why train acceleration is necessarily shunted or derated for fixed block signaling systems to match the slowest train on the alignment. One alternative is to limit the operation of trains on a given segment of track to only those cars that have the same performance (acceleration and deceleration rates) characteristics. However, this severely hampers interoperability and may have significant operational ramifications. For moving block systems such as CBTC, where it is vitally known which type of train is operating and exactly where that train is located at any time, this is not necessary because the models can be tailored for individual vehicle classes. Any approach that is taken must be accompanied by a thorough safety analysis.

F. "NYCT Design Methodology and Safe Braking Model Assumptions"

1. By comparison and in-line with the IEEE standard, the final report produced by NYCT under contract D32393 on December 31, 1996 states "It has been customary, and is prudent, to add a safety factor to calculated (or test determined) emergency braking distances… How much of a factor to add is somewhat subjective. When the local tracks of the IRT were signalized the safety factor was set at 35%…" The same report also notes:

   > *…Using a blanket safety factor to provide 135% of emergency braking distance from maximum attainable speed posed serious design problems around stations for the headways required…in other cases, it was not possible to meet both the design headway and provide 135% of emergency braking distance at maximum attainable speed. Designers made reasonable compromises to provide a sound operational and maintainable system, at reasonable cost, with adequate levels of safety. This included reducing the safety factor below 35%, to as low as 10%, based on maximum attainable speed and 35% based on operating speeds around station areas where speeds were lower and various means of speed control or operating rule requirements were in effect. History has proven that adequate safety has been provided.…*

2. Technical details for the block design methodology, calculations used, and assumptions made by NYCT can be found in the "Locating of Block Signals for Rapid Railroads" report (authored by Peter Ferreri) and the Signal Operational Design Manual provided under the NYCT Contract #S-32730 (8th Avenue Line (IND)). Formulas utilized therein and the reasoning behind their application are industry standard.

3. The chosen safety factors summarized above are also addressed in the following excerpts taken verbatim from the Signal Operational Design Manual:
   (a) *3.1.1. Safety*
   The NYCT signal safety standards are set to provide a 35% (minimum) safety margin. This factor is to account for potential deviations from nominal train performance. This safety margin means a minimum of 135% Emergency Braking Distance (EBD) for all signals between stations. Under controlled conditions in station areas, a gradual reduction in safety margins to 115% is acceptable. The MAS computation should be based on leaving a station at a skip-stop speed of 15 mph. Skipping a station (RRB Rule 2.39(j)) represents the worst-case condition for design.

   (b) *3.3.1.2. Station Time Signal Safety…*
   Similar to automatic signal design, the safety margins should be 35% (minimum). In a station area, a gradual reduction in the safety margin from 35% to 15% is acceptable.

   (c) *2.10. Key-By Only Signals…*
   The key-by only signals are located on main line storage tracks to provide safety (110%) to the bumping post.

G. Case Study: The Impacts of a 20% Train Acceleration Capability Increase on Runtime and the Existing NYCT Signaling System. This study represents a short, high-level evaluation of a small segment of track with the intent of identifying potential gains and limiting factors. Detailed designs and modeling would be required to ascertain full benefits.

1. The Train Operations Model (TOM) Simulation software tool was utilized to provide operating speeds and total runtime for northbound trains traveling on the express tracks of the 7th Avenue line between 14th Street and 34th Street. One simulation was performed based on the current NYCT acceleration curves and the other reflects a 20 percent increase in train acceleration capability. *This 20 percent increase is not achievable with the current fleet, but was chosen to represent an optimistic value of new vehicles' performance*. Similarly, existing NYCT control lines and safe braking analysis data were utilized to extrapolate the impacts of this 20 percent hypothetical vehicle performance increase on safe braking distances.

2. The TOM tool revealed that a maximum of 3.6 seconds of runtime improvement would be achieved under ideal acceleration and braking operation. For the location chosen, the limiting factors are the acceleration rate and the short distances between stations with relation to the required braking distances. In short, for this particular section of track, the train will need to begin braking before it has a chance to benefit from increased acceleration.

Table 2: Summary of Run Time Improvement Using TOM, 7th Avenue Line, Express Tracks, 14th Street – 34th Street

Total Runtime Reduction Achieved by a 20% Acceleration Increase:	3.6 seconds
Number of Signals that Would Not Require Relocation (≥ 135% SBD Provided):	3 signals
Number of Signals that May Likely Require Relocation (<135% SBD Provided):	6 signals
Number of Signals that Would Certainly Require Relocation (<100% SBD Provided):	4 Signals

(a) This particular run was chosen due to its relatively level, tangent track with a minimal number of curves. The assumption was that such a layout would realize the most significant runtime benefit from vehicle acceleration improvements.

(b) This analysis assumed a completely clear track for the simulated trains.

(c) Tables 3 and 4, on the following pages, show emergency braking distances and safety percentages at MAS, together with calculate Safe Braking Distance (SBD) margins for a 20 percent acceleration increase. A detailed analysis with the TOM tool outputs may be found in Appendix "J."

Table 3: Emergency Braking Distances and Safety Percentages at MAS

In order of track position, Track V3

Control Line		Train accelerates		Train is tripped							
For Signal	With Conditions	From Platform, Signal or Timing Section	With Initial Speed (mph)	At Signal	With Speed (mph)	Train Must Stop Before	Simulated Braking Distance (feet)	Safety Margin (%)	Impact Speed (mph)	Speed for 100% Safety Margin (mph)	Trip Location
V3-791 (V2-796)	MAS	14TH_ST	15	V3-691	33.6	V3-641	299.1	170.9	n/a	n/a	OS
V3-691	MAS	14TH_ST	15	V3-641	36.1	V3-571	346.5	193.1	n/a	n/a	OS
V3-641	MAS	14TH_ST	15	V3-571	39	V3-511	412.6	156.3	n/a	n/a	OS
V3-571	MAS	14TH_ST	15	V3-511	40.8	V3-441	442.8	151.8	n/a	n/a	OS
V3-511	MAS	14TH_ST	15	V3-441	41.7	V3-361	468.3	161.9	n/a	n/a	OS
V3-441	MAS	14TH_ST	15	V3-401	42.2	V3-331	481.3	141.7	n/a	n/a	OS
V3-401	MAS	14TH_ST	15	V3-381	42.5	V3-311	483.8	133.5	n/a	n/a	OS
V3-381	MAS	14TH_ST	15	V3-361	42.7	V3-301	480.2	133.3	n/a	n/a	OS
V3-361	MAS	14TH_ST	15	V3-341	42.9	V3-281	476.5	125.3	n/a	n/a	OS
V3-341	MAS	14TH_ST	15	V3-331	42.8	V3-271	476.3	117.6	n/a	n/a	OS
V3-331	MAS	14TH_ST	15	V3-311	42.5	V3-261	476.8	103.2	n/a	n/a	IS
V3-311	MAS	14TH_ST	15	V3-301	42.2	V3-261	478.2	68.4	25.1	35.1	IS
V3-301	MAS	14TH_ST	15	V3-271	42.2	V3-251	480.3	42.9	34.5	27.1	IS

Table 4: Tabulation of the Calculated SBD Margins by Signal Given a 20% Vehicle Acceleration Capability Increase

	Signal on Cut Section (name)	Signal on Cut Section (sta)	+20% Acceleration Performance (ft/s^2)	Tripped with Speed (mph)	Average Grade in Section (%)	Estimated SBD Required (ft)	Safety Margin (%)	Safety Under 135% (Y/N)	Safety Under 100% (Y/N)
Home	V3-791	79+24	1.2438	36.1905	0.32	347.74	146.9954	N	N
Approach	V3-691	69+86	0.9506	38.9725	0.28	406.51	164.5941	N	N
Approach	V3-641	64+60	0.7787	42.1924	0.08	486.068	132.6756	Y	N
Approach	V3-571	57+76	0.6617	44.1879	0.375	525.32	127.9545	Y	N
Approach	V3-511	51+16	0.5591	45.1848	0.24	556.278	136.2947	N	N
Approach	V3-441	44+29	0.5165	45.7385	0.21	572.1125	119.2077	Y	N
Approach	V3-401	40+36	0.4994	46.0706	0.42	572.547	112.807	Y	N
Approach	V3-381	38+37	0.4833	46.2920	0.59	570.823	112.1375	Y	N
Home	V3-361	36+56	0.4704	46.5134	0.838	565.97	105.4923	Y	N
Approach	V3-341	34+92	0.4523	46.4027	0.774	565.926	98.97563	Y	Y
Approach	V3-331	33+39	0.4298	46.0706	0.55	567.129	86.76291	Y	Y
Approach	V3-311	31+76	0.4087	45.7385	0.3	568.31	57.55464	Y	Y
Approach	V3-301	30+11	0.3892	45.2773	0.25	558.511	36.89251	Y	Y
Cut Section	V3-281	28+80							
Home	V3-271	27+64							
Cut Section	V3-261	26+69							
Cut Section	V3-251	25+53							

3. To provide a safe braking distance of 135 percent or more, SBD analysis of the northbound run has shown that a 20% increase in vehicle acceleration capabilities would require the relocation of a minimum of 10 out of 13 signals and their respective insulated joints. A similar, cascading impact on the track STV analyzed would be expected to extend beyond the analyzed limits, as the entire line would be affected by this acceleration increase.
4. The result of this small study is that on this specific segment, many signals, and their associated insulated joints, trip stops, cabling, etc., would have to be relocated. It is recommended that the entire system be studied to see if greater benefit can be achieved elsewhere, for instance, where stations are further apart.

4.3 FINDINGS: SIGNALING SYSTEM AND RELATED PROCEDURES AND POLICIES

A. Posted signs and signaling consistency.

1. During the ride-along on the 7th Avenue Line, STV noticed that posted speed signs were placed inconsistently, and some were very difficult to see (dark areas, dirty signage). The combination of these conditions limits the ability of train operators to effectively operate trains at the most efficient and safe speeds.
2. Posted speeds via lunar lights are often washed out and difficult to read, especially from afar. They are small and posted right at signals where it may be difficult to read. Inexperienced operators and operators not familiar with the line will find this challenging as they may not have sufficient time to react appropriately when they see the sign.
3. For specific recommendations, please refer to sub-paragraph 5.2.1.

B. Reinforcing good practices through policy.

1. In discussions with NYCT staff during kickoff meetings, it was stressed that one key challenge is getting the Train Operators to trust the signaling system and timers, so that if they proceed at the posted sign speed limit the train should not be tripped at signals. The necessary first step in rebuilding this trust is the recalibration of any timers on the system where trains now will trip at the signal even when the Train Operator is obeying the posted speeds. In some instances, operators have reacted to this situation by further reducing speeds well below the posted speed limit, which negatively affects running time and throughput. The process of recalibrating GT locations is ongoing at NYCT, and discussion of a similar process for ST locations is described in paragraph 4.5 and sub-paragraph 5.2.2 below.

2. Minimizing related disciplinary action. Given the importance of obeying posted speeds and signals, and NYCT's experience with serious incidents and accidents, the maintenance of a strong discipline policy is obviously key in enforcing safe practices. In reviewing information about discipline policies related to Safety Rules Compliance Programs (Efficiency Testing Program at NYCT) at other North American agencies, STV notes that all agencies with such programs have enforced some level of discipline when speed and/or signal violations have occurred. The definition of discipline in these instances has ranged from a low level of reinstruction or retraining, through the issuance of warnings, unpaid time off, and up to and including dismissal. Some agencies have adopted an approach that focuses on affecting behavioral change rather than applying punitive measures. In those instances, first-time occurrences of a minor nature are dealt with through retraining and reinstruction while egregious or repetitive violations are strongly considered for unpaid time off or dismissal.

   NYCT has recently implemented a policy (Optimal Operation Bulletin 92-19, "Optimal Operation – Plan of Action", June 20, 2019) that aims to improve operator confidence in the system by reducing or eliminating disciplinary action in circumstances where a signal violation occurs despite the operator's effort to comply with all established requirements. The policy establishes that disciplinary action will not be initiated, provided all of the following criteria occur:

   - The incident is reported immediately;
   - The incident is reported truthfully, completely, and accurately;
   - The incident is handled in accordance will applicable rule and procedures; and
   - The employee is deemed fit for duty.

This policy should serve to increase operator confidence in the system by ensuring them that they will not be subject to discipline if they follow the operating rules as presented by NYCT.

3. Training. The first steps in building trust in the signal system begin when Train Operators complete their induction training and learn the functionality of the signal system. Train Operators are instructed in the purpose and function of the signal timers and learn the importance of obeying posted speeds. They are also made aware of the disciplinary consequences of violating posted speeds and signals.

   In reviewing information about training programs for Train Operators, as obtained previously by STV, it is apparent that NYCT's training programs are consistent with industry practice. Specifically, the duration of the testing program both in the classroom and in the field, class size and instructor ratios, and testing requirements and passing scores are all comparable to, or exceed, the identified peer systems.

4.4 FINDINGS: LOCALIZED ANALYSIS OF BOTTLENECKS

A. When examining train capacity and throughput at specific "bottleneck" locations on the system, it first important to note that capacity is influenced by a complex relationship between track speeds, train performance, signal and station locations, train routing systems (the auto-routing triggers programmed in the Automatic Train Supervision (ATS) system), and scheduled service plans. Following are three key factors to be considered:

1. Increasing track speeds and improving train performance shorten running times and potentially allow trains to run closer together. However, headways are often constrained by the slowest segments of the line, such that improvements to individual locations do not automatically result in systemic improvements.
2. System design elements (including signal locations, signal timing, signal block layouts and coding, and auto routing triggers) must be evaluated to allow the system to take advantage of the potential maximum track speed and train performance. For vehicles in particular (see the "Findings: Vehicles" section below) a fixed block signal system must be designed around the lowest performing vehicle in the fleet to ensure safety and reliability.
3. Station dwell times directly affect throughput and capacity as following trains must always maintain a safe distance away from the station when a train is ahead in the station; lengthening dwell times will lengthen headways and reduce capacity. There is a potential for a negative feedback loop here, where reductions in capacity cause dwell times to increase, thereby increasing running time and reducing on-time performance.

The scheduled service plan must be synchronized with the signal system and the auto-routing triggers in the ATS system to ensure that the planned trips can be operated in the correct pattern in a timely fashion.

Merely improving one element will not automatically improve capacity, and in some cases may work against our goals. For example, increasing track speeds without adjusting service plans system-wide could result in trains waiting at red signals more frequently; passengers will become more aware of being "stuck on a train" and not moving where previously slower train speeds may not have been noticed.

B. Track speeds, train performance, and signal timing performance are being addressed in the other sections of this report. This Localized Analysis includes observations about the structure of the service plan and the relation to the ATS system auto-routing triggers at the identified bottleneck locations.

C. In reviewing the relationship between the service plan and the auto-routing triggers in the ATS system, it was observed that the auto-routing triggers were programmed and have not been modified since the conclusion of the ATS project for the "A" Division. These triggers should be reviewed and updated to accommodate schedule and operational changes since that time. This additional task can and should occur in the near term, with the performance of the system and signal clearance times at the identified bottleneck locations to determine if the ATS system can currently support the desired service plan. Similarly, the current automatic route selection provisions within the "B" Division should also be reviewed against the current operational needs considering the Signal Modernization Program and modified accordingly, where it is cost effective. STV can assist with this as part of a longer-term exercise.

D. During the ride-along on July 24, 2019, the train had to wait on the tower operator at Unionport Master Tower to line a route at the intermediate terminal (East 180th Street).

East 180th Street is extremely complex and could warrant a separate study. It has a junction to the north, a sharp curve to the south, multiple crossovers, and is flanked by two yards (East 180th Street and Unionport), neither of which has a long yard lead from the main line. It was not designed that way; it just evolved that way. It is worth noting here as it might very well be one of the locations along the route where meaningful time savings (and capacity improvements) can be achieved.

1. It was explained that the automatic routing function is disabled for intermediate terminals such as East 180th Street due to the complexity of moves and the possible routing of trains that are entering "dark" (unsignaled) territory.
2. This practice should be re-evaluated for straight through routes and standard moves by 2 Line and 5 Line trains. This re-evaluation was recommended by a Senior Manager from CPM Signal Engineering because he believed manual routing of the train was difficult to manage due to system control complexity and the time it takes to accomplish transfer. The operational procedure should be looked at, as should the functional design.

E. In addition to evaluating the auto-routing triggers, the scheduled service plan at each location was reviewed. Three major bottlenecks identified by NYCT are negatively affected by conflicting train movements that occur due to the complex interlining of routes at each location. Short-term solutions are not simple or obvious at these locations, as the service plans for these locations are routinely refined by NYCT and the fundamental conflicting movements will need to be eliminated or mitigated with new infrastructure or the reorganization of certain routes. NYCT has examined these infrastructure solutions on many occasions over the last several decades (e.g. the 2009 conceptual design study of Nostrand Junction Interlocking) and such projects should be considered in the long term.

1. Nostrand Junction Interlocking

   (a) At Nostrand Junction Interlocking, 5 Line trains moving from the Nostrand Avenue branch to the express tracks under Eastern Parkway must cross through switches also used by 2 Line and 3 Line trains in each direction.

   (b) STV examined the combined timetable for 2, 3, 4, and 5 Line trains in both directions at this location, to determine how frequently the conflicts identified above may be causing issues. As shown in Appendix "K," during the 7 AM hour Northbound, 9 of 39 trips involve a 2, 3, or 5 Line train following

behind another 2, 3, or 5 Line train with a gap of one minute or less. During the 5 PM hour Southbound, 6 of 42 trips involve a 2, 3, or 5 Line train following behind another 2, 3, or 5 Line train with a gap of one minute or less.

2. 142nd Street Interlocking

    (a) *This interlocking controls the flat junction of the 2 Line to and from The Bronx and the 3 Line to and from Lenox Terminal. Northbound 3 Line trains heading towards Harlem - 148th Street must cross in front of Southbound 2 Line trains. This limits (slows down) train movements that contribute to increased running times.*

    (b) *During the 7 AM hour, STV identified 6 Southbound 3 Line train trips passing through the junction in front of 2 Line trains. Only one of these trips occurred one minute or less before or after a 2 Line train trip.*

3. 149th Street - Grand Concourse

    (a) *Immediately south of the lower level platforms of this station complex is a grade-separated junction of the 2 and 5 Lines. The upper level platforms and tracks are used by the 4 Line.*

    (b) *Conflicts occur at Grand Concourse when 5 Line trains make the slow movement between lines and attempt to match open slots between 2 Line and 4 Line trains. Any delay on either line is transmitted to the other line by 5 Line trains. The complexity of the auto-routing triggers at this location has the potential to further delay 5 Line trains requesting the connecting route.*

    (c) *Switches at this location are "forced and locked" in the normal position to allow trains to safely approach the station at higher speeds. An ASR timer limits releasing of interlocking switches after a route has been cancelled to prevent a train that is moving towards the interlocking and unable to stop from having a switch thrown underneath it. At this location the timer is set to the AREMA minimum value of 30 seconds. The aforementioned axle counter solution being evaluated seeks to verify when Southbound trains on Track 1 are berthed at the platform, allowing a bypass of this timer and a safe, early release of the switches. The goal is to eliminate the need for trains to extend their dwell times unnecessarily, which could currently occur every time a train needs to diverge.*

4.5 FINDINGS: GT AND ST SIGNALS

A. Equipment Settings and Delay. With shorter sections of track, small variations between timer settings and actual circuit/equipment performance (on the order of even a half a second) can make a significant difference in the speed that the circuit measures. The ability to set timer values precisely and measure equipment delays is a function of variables such as the equipment being used, the complexity of the individual circuit, and the age/condition of all elements. Some of these factors can be quantified better with modern measurement equipment and methods and then accounted for in the signal design, within a range of tolerance.

For the safety-based reason of ensuring that a train can never exceed Maximum Attainable Speeds, the design assumes the quickest possible operation within this tolerance. Therefore, the engineering goal to deal with this is comprised of:

1. Minimizing the tolerance as much as possible and design out of what can be safely designed out; and
2. Keeping the equipment in a state of good repair to keep the circuit working within that tolerance and to minimize malfunctions.

These are efforts NYCT is already undertaking. The signal design already accounts for some of this, NYCT is developing procedures and methods using modern tools and methodologies to better gauge tolerance, and NYCT is replacing older and more difficult to calibrate relays as the budget allows. However, after these efforts are complete, real-life operation will still have some variation within this tolerance level and can be calculated and tested for what the associated impacts might be.

B. NYCT has explained that GT signal functionality is currently being verified via dynamic testing across the system by using trains and radar guns to yield accurate determinations on whether maintaining posted speeds would result in trains being tripped at signals. NYCT has also expressed difficulties with respect to testing of ST signal functionality.

C. The NYCT Department of Subways Engineering Division has developed a prototype timer relay that is portable and will allow their maintainers to provide far more accurate checks of timers on site. Additionally, they have developed a highly accurate method of field-testing timers utilizing photosensors at the entry point of a block and just in advance of the associated trip stop. This has helped them successfully analyze the most problematic timing areas, especially those that involve solid state interlockings. The tools and methodology will be extremely helpful for commissioning activities moving forward but are not suitable for periodic maintenance checks due to the setup, data collection and analysis time required.

D. On August 23 and 24, 2019 STV, with the cooperation of NYCT, performed static testing of GT and ST signals at the 59th Street – Columbus Circle station. This testing was focused on helping NYCT find an alternate, more accurate way to measure total equipment delays without the cumbersome use of a test train. STV sought to characterize the current difference between a sample of timer settings and real-life equipment operation. The test results and analysis form a baseline that reflect the current state of these particular tested signals, prior to most or all the actions described above being taken or completed. This re-affirms what NYCT already knows and is working on, with some "outside the box" ideas added to help facilitate field verifications and finding safe calibration levels that may be used to minimize variation between settings and actual operation. STV also sought to keep expectations in check, noting there will always be some level of tolerance in this method of speed control under a fixed block signal system. This tolerance may turn out to have operational impacts and there are always failure modes that may be minimized through maintenance, but not eliminated. In all cases, however, safety is maintained, and failure modes result in the train being brought to a stop.

Please refer to Appendix "L" for STV's detailed findings and a recommended testing regime.

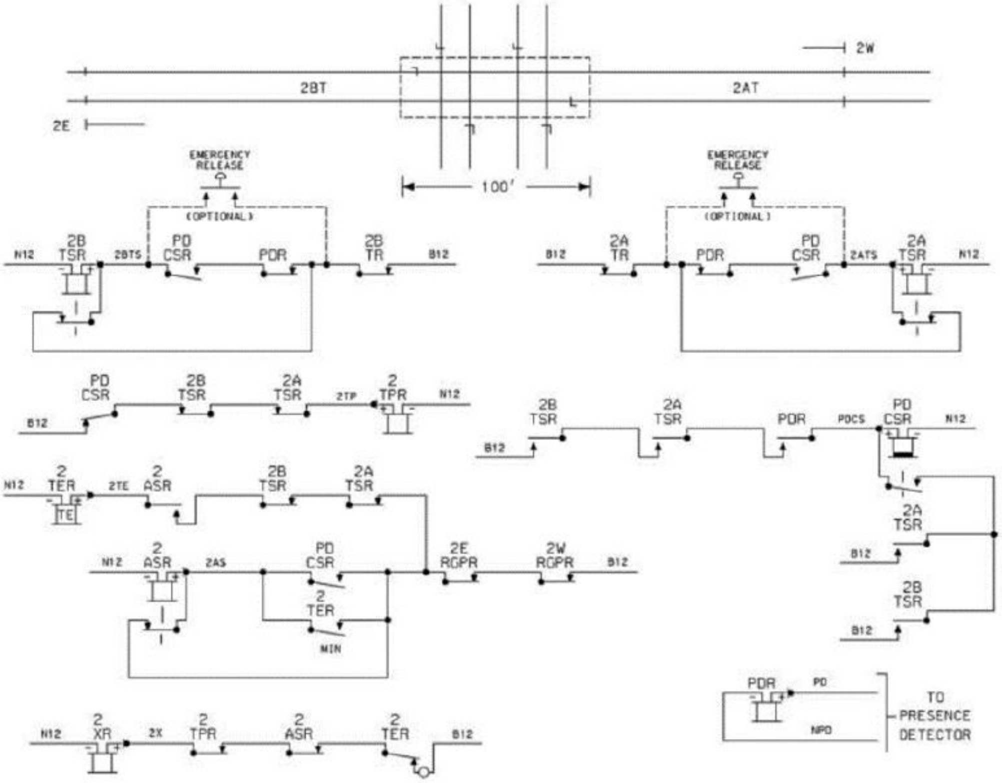
Since issuance of the draft version of this report, NYCT has incorporated many of the associated recommendations into further development of their prototype test equipment. The most recent iteration of the device is highly suitable for periodic maintenance activities and measures the full equipment delay in the circuit by incorporating a shunt to simulate train occupancy, eliminating the need for post-test analysis. NYCT has also added overload/shock hazard protection elements to the circuit and a strobing light to warn train operators of the device's presence on the track. NYCT and STV tested this device on December 3, 2019 and the measured values were found to be consistent with the values found during the testing on August 23 and 24 by testing with video-based post analysis. This device will continue to be developed and ruggedized for maintainer use.

4.6 FINDINGS: POTENTIAL USES OF AXLE COUNTER TECHNOLOGY AT NYCT

A. Vital, SIL 4 axle counters are utilized throughout the world as replacements for track circuits where train detection is necessary. While they do not provide continuous detection (e.g. which could be used for broken rail indication), they work well for the purposes of accomplishing tasks such as train tracking and standard interlocking protections/functionality. Houston Metro is an example of a US agency that has successfully deployed these axle counters on a mass scale (>600 units) for both vital (interlocking protection) and non-vital (train tracking) purposes.

B. Axle counters are functionally similar to trap circuits as defined in AREMA 16.4.9 (and as shown in Figure 7), which are traditionally used to protect dead sections within interlockings over 35 feet. In effect, these are check in, check out circuits.

Figure 7: Trap Circuits (from AREMA 16.4.9)



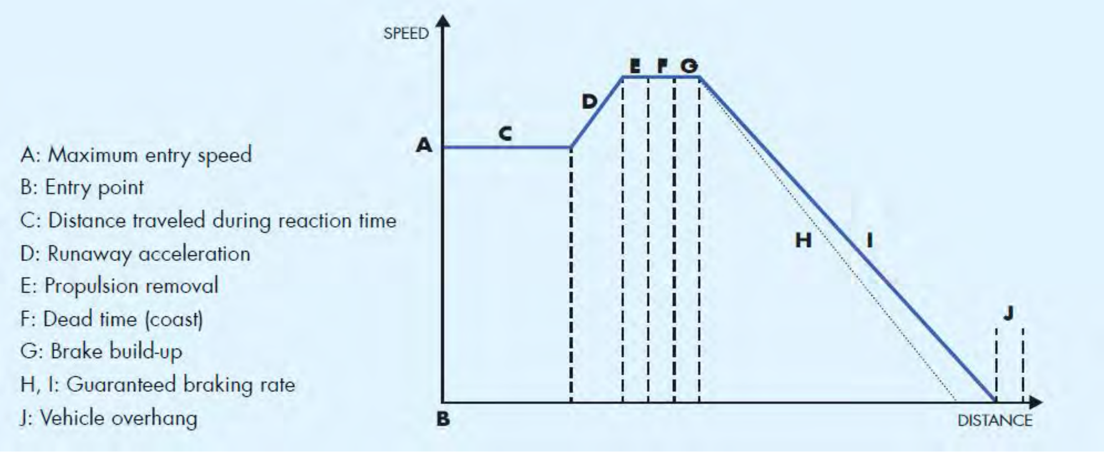
Circuit and application logic follow the same design concepts when utilizing axle counter systems to vitally protect interlockings, as any trap circuit would. Two axle counters may also be placed relatively close to each other to form timing circuits in this manner.

C. Axle counters would act as a timing circuit for clearing of ST and GT signals, with potentially more predictable equipment circuit delay, no susceptibility to loss-of-shunt delays, and less reliance on average speeds. This benefit may also allow for control line cutbacks due to reduced runaway speed values for Maximum Attainable Speed calculations through timing sections.

4.7 FINDINGS: VEHICLE DESIGN IMPACT ON SIGNAL SYSTEM

A. The IEEE Brake Distance Guide (IEEE 1698-2009 - IEEE Guide for the Calculation of Braking Distances for Rail Transit Vehicles, 2009) was developed to detail the method of determining the safe spacing between two trains with specific performance. While NYCT has developed a more comprehensive Signal Operational Design Manual, IEEE P1698 is still applicable and will be used as a simple reference. As shown in Figure 8, the design of the vehicle controls the maximum allowed acceleration rate (Section D), maximum allowed speed (Sections E, F, G), and minimum allowed deceleration rate (Section H).

Figure 8: IEEE 1698 Braking Model

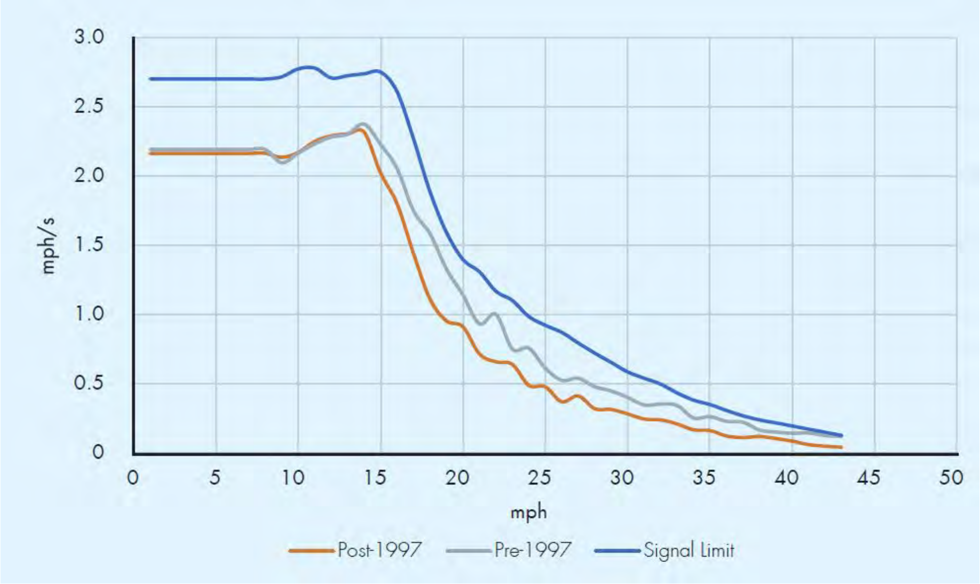


The IEEE Braking model assumes that the train will be improperly commanded to accelerate, because of the Train Operator becoming disabled at the worst possible time upon entering the signal block. While this is an uncommon condition, it has historically occurred and has resulted in collisions. Specific recent examples of highly visible train derailments (Metro North Spuyten Duyvil) and train collisions (New Jersey Transit Hoboken Terminal and Long Island Rail Road Atlantic Terminal) that were strongly influenced by locomotive engineers affected by Sleep Apnea reinforce their likelihood and the need to include it as a factor. Please refer to Appendix 1 – in the IEEE Brake Distance Guide, “Why Improper Train Operation is Assumed” in the for further discussion. If the vehicle and signal system thresholds are not aligned, the system is at increased risk derailments and/or collisions. To this end, NYCT has defined design guidelines and performance requirements for the vehicle portions of the braking model. Alertness detection is not perfect. The Operator may be near unconscious, but still doing enough to be detected as “at the controls.” Referring back to the Williamsburg Bridge collision, it is prudent to continue to make this assumption.

B. Current Acceleration Rates

1. Following NYCT’s 1995 Williamsburg Bridge collision, the NYCT Division of Car Equipment performed acceleration testing on all fleets to verify compliance with the signal system’s maximum allowed acceleration. The cars that were involved in that accident had acceleration capability that was determined to exceed the design limits used by the Signal Design group when the signal design for that section of the system was originally completed (i.e. cars accelerated faster than the original design assumption). Subsequent modification was performed on all DC propulsion equipped car fleets to reduce their acceleration rate to a level no greater than the original design assumption of the signal system. Car fleet testing in 1997 verified that car acceleration rates were reduced to be within the limits. The performance comparison for the R68 fleet is shown in Figure 9.

Figure 9: R68 Acceleration versus Signal Design Limit



2. Because a fixed block signal system cannot distinguish acceleration or braking rates of a particular car series, signal systems on lines utilizing different car classes must be designed to either the higher or lower rate of acceleration. If designed to the lower acceleration rate, cars with enhanced acceleration must be limited (shunted) to conform to the lower acceleration rate cars. If designed to the higher acceleration rate, all the signal lines and track circuits will have to be revised (lengthened) to provide adequate protection. This would entail significant cost and time to effectuate and would also serve to slow down the trains with the lower acceleration rates.

3. To examine the potential benefits of removing the shunting and restoring the performance of the R68 fleet, STV developed an operations model of a sample segment (N Line express trains between Atlantic Avenue - Barclays Center and 59th Street stations) to calculate travel time savings. The operations model incorporated vehicle performance for the R68 fleet in these scenarios; current performance and "full" performance to the design basis of the signal system; horizontal and vertical alignment on the N Line express tracks; and civil speed restrictions on the N Line express tracks. Using a station spacing of 0.5 miles with level-tangent track as an example, and current braking rates, the ideal station-to-station duration is calculated as shown in Appendix "M."

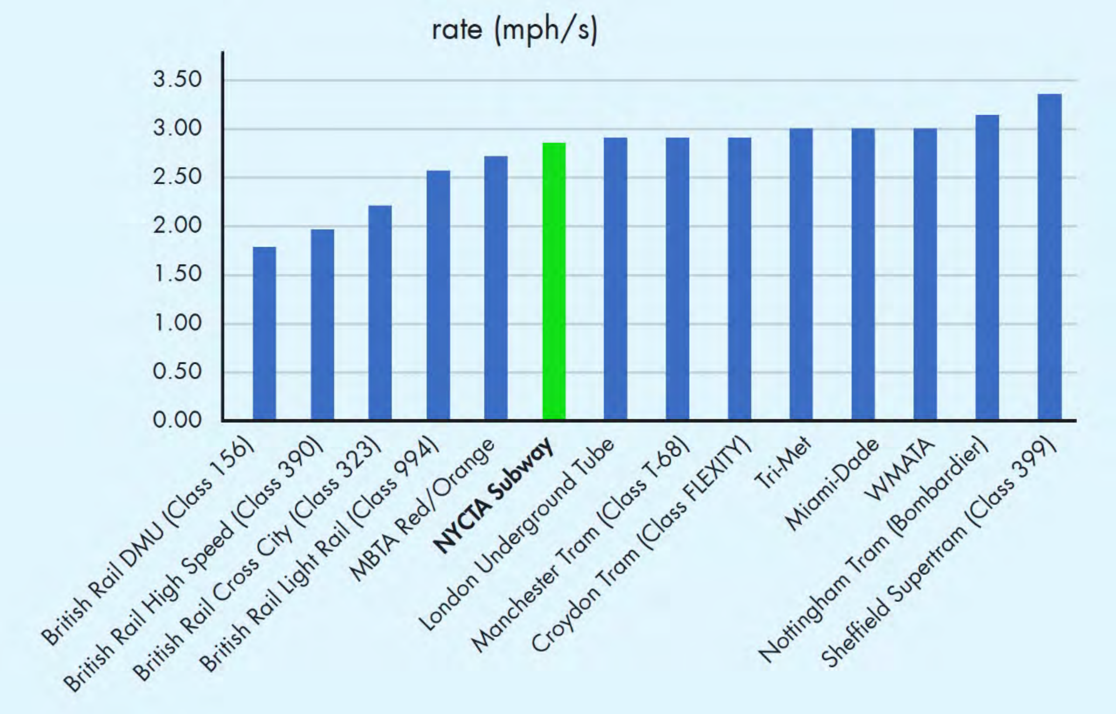
   The model results show an estimated travel time savings of roughly 20 seconds per station stop. This result should be considered as the high end of potential per-stop travel time savings. The per-stop travel time savings would potentially be lower for local trips with more frequent stopping patterns or track segments with lower speed limits where the acceleration improvement has a smaller benefit. However, even with a smaller per-stop travel time savings, the total savings when accumulated over the entire route may be substantial.

   Additionally, we do not know whether the average performance of the vehicles has not further degraded due to wear and since the 1997 testing.

C. Current Braking Rates

1. Current braking rates are comparable with other agencies. When compared to other transit systems, NYCT maximum service braking rates are in the middle of the range. Please refer to Figure 10 and the paragraph below entitled "Adhesion Improvements" for more information.

Figure 10: Maximum Rates (J. P. Powell, 2015, Vol 1, Issue 2)



* Note that the rates shown above are maximum rates. Typical rates are always lower.

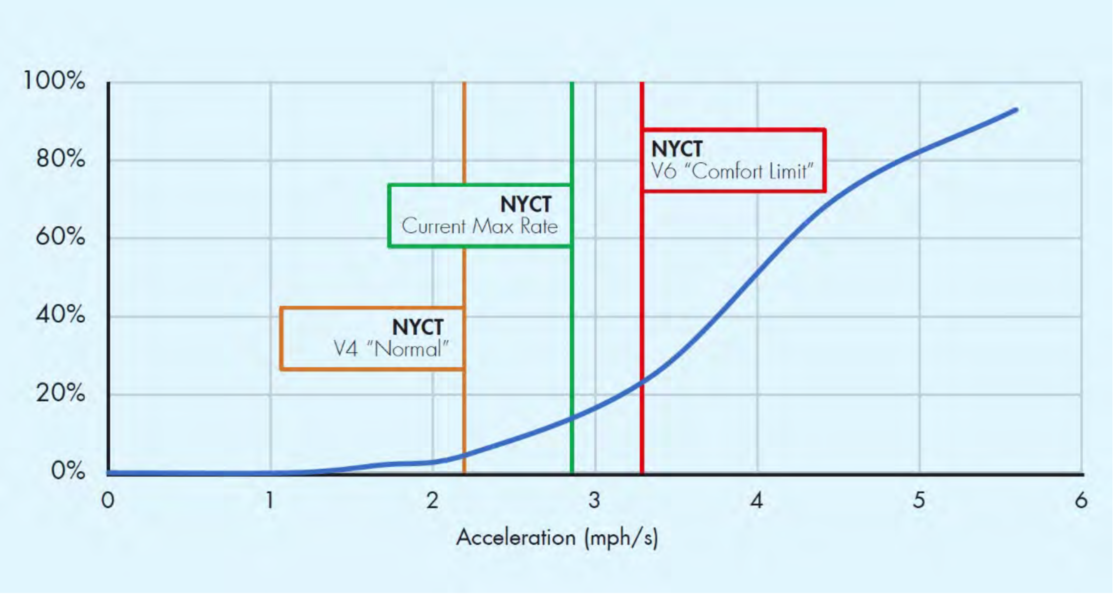
2. For further analysis of vehicle braking and acceleration from STV testing of R46 and R160 consists in emergency braking, please refer to Appendix "P."

D. Current Comfort Levels

1. While increasing the acceleration and braking rates may potentially improve travel time, it might also degrade passenger comfort and even safety if the increased rates result in an increased number of passengers losing their balance, falling and becoming injured. This is especially important for NYCT, where as compared to many other rail transit systems, a larger percentage of passengers are expected to be standing.
2. NYCT's design rates in the longitudinal direction are currently between the 'V4 Normal Operating Speed' and 'V6 Comfort Speed' lateral rates identified in the NYCT Speed Policy Standards revised December 13, 2018. These rates are also nearly identical to the London Underground. A proposal is made elsewhere in this report to evaluate a value closer to V6.
3. Sufficient research has not been performed to equate rate increases directly with increased injuries, but generic 'acceptability of acceleration' has been

measured. An increase in acceleration is expected to decrease the perceived passenger acceptability, as shown in Figure 11 below.

Figure 11: Participants rating acceleration as unacceptable



E. Derailment Risk on Curves

1. Increasing the allowed comfort speed may also allow the rail vehicles to operate through curves at higher speed. Any recommendation for an increase in speed in curves will keep curve speed at or below the comfort limit speed V6.

F. Potential for Speed Improvements

1. Five primary constraints on maximum acceleration exist:

   (a) The trade-off between acceleration and risk of degraded passenger comfort or injury;

   (b) The level of adhesion available;

   (c) Improvement to existing vehicles acceleration performance;

   (d) The design of the signal system as discussed elsewhere in this report; and

   (e) Speed indication validity.

2. Potential for Further Improvement in the Longer Term

   (a) Examination of the potential for achieving reduced running times on specific system sections (express track and branches) through the assignment of higher performance car fleets with the implementation of better "choke point" and "bottleneck" improvements.

G. Decrease in Comfort Level

1. As discussed in the paragraph entitled Current Comfort Levels, increasing the level of acceleration and braking also increases the risk that individuals standing in the train lose their balance risking dissatisfaction or injury to riders.
2. As noted, increasing the curve speed above V4 may decrease the level of comfort that passengers experience. Additionally, increased curve speeds will increase the risk of passengers losing their balance and/or grips on the handholds. As shown in sub-paragraph 3.7.A, trains with standing passengers typically have lower allowable unbalance in the V3 to V4 range. There are two primary ways that NYCT can test allowing higher curving speeds:
    a) *NYCT can calculate the acceptable higher curving speeds and operate test trains at these higher speeds. The subjective opinions of the occupants of the train would be used to determine if the higher curving speed was acceptable.*
    b) *A third party, such as ENSCO, could then use data from the NYCT geometry car to simulate the accelerate and jerk on the carbody at the higher curving speeds. NYCT would need to provide information on acceptable acceleration jerk rates. NYCT could opt to use the longitudinal jerk limits already in the vehicle specifications.*

H. Adhesion Improvements

1. Any acceleration or braking of the train is limited by how much grip exists between the wheels and the rail. This is calculated as a percentage of the train weight and is called “adhesion.” As subway cars use metal wheels on metal rails and there is a small surface contact area (approximately the size of a dime), the wheel-to-rail interface is affected to a greater degree when subjected to slippery conditions due to moisture and other contaminants. This results in the adhesion of trains being considerably lower than rubber-tired vehicles on concrete or asphalt.
2. The existing NYCT vehicle and signal system designs require a minimum rail adhesion coefficient of 0.13. The introduction of leaves, moisture or grease on the rails can reduce the available adhesion to 0.05. NYCT operates a gel train outdoors during periods when fallen leaves are present.
3. Rail agencies have taken a variety of steps to mitigate low adhesion. Some subway systems, most notably RATP (Paris Metro) and STM (Montréal Metro), operate rubber-tired vehicles. RATP stopped converting lines to rubber-tire operation in 1974, except for the fully automated Line 14 inaugurated in the 1990s, due to the increased energy consumption, decreased tunnel air quality, regular occurrences of flat tires, and overall increased cost. The Montréal Metro fleet has been 100 percent rubber-tired from the beginning, and STM is replacing its original fleet with a new fleet employing this auxiliary rubber tire technology. Such technology is extremely costly to deploy for a legacy fleet, especially one as extensive as NYCT. For these reasons, STV does not recommend rubber tires as a method to improve train operations.

Figure 12: Paris Metro Truck, with Rubber Tires Installed

4. As noted above, increasing the adhesion level does not provide any improvement to acceleration or braking unless comfort level is also decreased.

I. Improvements of Existing Vehicle Systems

1. The existing vehicles have been designed and maintained, to ensure that they continue to perform at the reduced acceleration introduced in 1996 and meet nominal design brake rates. However, NYCT has identified that the R68 fleet acceleration is well below the acceleration design criteria limit and can be increased without exceeding the limits of the existing signal system. NYCT has already begun the engineering effort required to improve the R68 fleet acceleration.
2. Increasing acceleration performance on the fleet beyond the limits of the existing signal system cannot be safely accomplished in the short term. For the DC propulsion fleets an in-depth review of the propulsion system of each fleet type would be required, and hardware changes may be required to achieve higher performance. More importantly, allowing the vehicles to exceed the current acceleration limits will invalidate the safe braking distances currently built into the system. Review and possible modification would be needed for every trip-stop and insulated joint within the system.
3. The newly ordered AC propulsion fleets are being delivered with modifiable acceleration. This will allow NYCT to operate at the lower accelerations required by the current signal system, while increasing acceleration in areas where CBTC is installed.
4. STV notes that higher acceleration comes with various increased costs, which NYCT will need to account for, including increased energy usage, increased risk of passenger falls and increased wheel/rail wear.

J. Speed Indication Validity.

1. STV understands that a compounding issue with achieving actual full authorized speed is a distrust of the speed indication (speedometer) that is provided in the operator cabs of subway cars. This issue, combined with the expectation that timers which operate in the signal system are out of calibration, leads operators to take a very conservative approach to speed management, maintaining actual speeds well below what would be accepted by the system.
2. STV recommended that NYCT sample random trains from each fleet to assess actual in-service accuracy of the speedometers. This can be performed most efficiently using a hand-held radar gun. During the development of this report, NYCT initiated this recommended testing.

5. RECOMMENDATIONS

Based on the findings of this study, STV's recommendations are set forth below. If implemented, these actions would safely increase train speeds and reduce overall running times. These recommendations are accompanied by targeted assessments of representative sections of the subway network. Also highlighted are the interrelationships that affect train service capacity. The goal will be to increase speed but avoid any decrease in capacity.

5.1 SIGNALING SYSTEM "QUICK WINS"

With respect to the signaling system, STV recommends several areas of improvement that may benefit NYCT capacity with minimal time, material and manpower requirements.

5.1.1 Posted Speeds and Timing Section Indications

A. In line with the current effort at NYCT to address the "human factor" with respect to Train Operators, it is important to ensure signage related to the signaling system is clearly visible. Missing or poorly visible speed signs may cause Train Operators to slow operation excessively; especially Operators who are unfamiliar with the territory; they may even trip at the associated signal and trigger line delays.

B. During STV's cabin ride-along on a local 2 Line train on the 7th Avenue Line, it was noted that speed signs are inconsistently placed throughout (likely sometimes due to civil/clearance constraints. Some signs needed maintenance, while other signs were not in the line of sight or in the area sufficiently brightened by the headlights and thus were difficult to both find and read. Replacing these signs with high reflectivity signage, simply cleaning the existing signs more regularly and/or adding some illumination (even a small lunar LED) would help draw operator attention to them. Advance warning signs (e.g. "25 MPH ahead") may also be considered at select locations, where visibility is an issue, or a major change of speed is required and at staggered speed for smooth transition to the intended restriction. This will enhance Train Operator confidence approach the restriction at optimum speed and avoid infringement.

C. Some lunar lights displaying speed limits appeared small, washed out and difficult to read from a distance; while it was clear station time was in effect, the specific speed was difficult to make out. It was noted by the NYCT personnel accompanying STV that the countdown timers recently added were similarly difficult to see. The recommendation in this case is to consider modifying these circuits to flash the light while the station or grade timer is running. If a solid-state device with a variable flash rate could be utilized at NYCT, increasing the flash rate as the timer gets closer to expiring may be considered as well. This would also be a solution that can be extended to dwell timers where they are utilized. For additional information on lunar aspect displays please refer to Appendix "N."

D. NYCT also mentioned that not all ST signals have lunar indications that let the Operator know the associated signal is running time. This means Operators will always have to assume the lower speed, even if this is not required because no train is in advance of their position that would necessitate a reduced speed through the area. Though a longer-term effort than the former suggestions, adding these indications would be of very significant benefit for the time and cost involved.

5.1.2 VERIFICATION OF ST AND GT SIGNALS

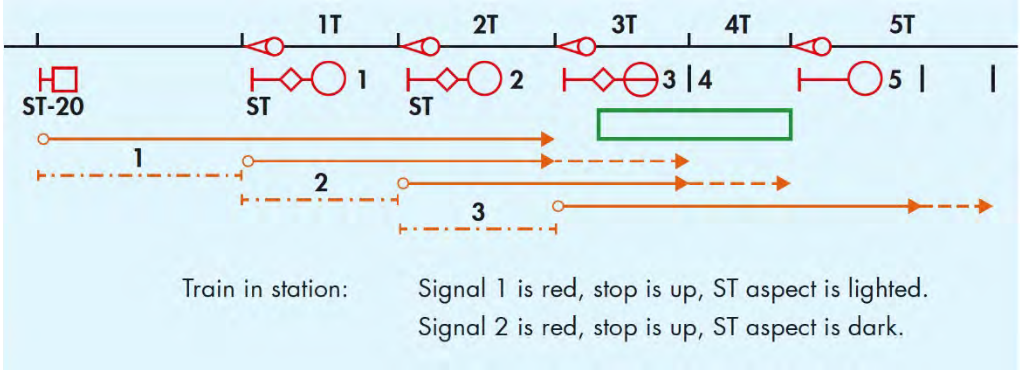
A. Overall Recommendations.

1. STV recommends that NYCT continue down the road it is already on with respect to GT/ST signals by finding ways to quantify and minimize the tolerance level described in paragraph 4.5 to the best of its capabilities while maintaining safety.
2. To be sure, this is an isolated element in this report, representing an isolated set of conditions. Another approach would be where analysis of a particular GT signal indicates that a train with a 25 mph posted speed will trip at 23 mph, after all calibration efforts have been exhausted; another finding by the task force may be that the associated segment of track can support a train moving through at 27 mph and so posted speeds do not need to change at all.
3. Either way, STV believes that the trains would still move faster, safely, through areas with GT/ST signaling due to reduced risk of Operators artificially slowing down or tripping and causing major delays. This recommendation would produce a net gain in speed.

B. Specific Technical Recommendations

1. For areas that require review of GT and ST signals alike, STV recommends a process beginning with design and field condition re-verification (timer calculations and I J -to- I J lengths, respectively). If possible, to avoid manual verification of block lengths using a measurement wheel, STV has discussed the possibility of utilizing the track geometry car videos to check these lengths with NYCT. A test location of 59th Street – Columbus Circle station area was chosen and NYCT will compare videos to design values. A team consisting of STV engineers and NYCT Subway Engineering manually verified the same block lengths in the field and compared these with the other two values.
2. STV also recommends a field procedure referred to as a static test for both initial verification and longer-term periodic maintenance checks beyond just the annual timer setting checks already performed. The goal is to provide a balance between accuracy and efficient use of manpower. Referring to the diagram below (taken from the NYCT Signal Operational Design Manual) as a simple visual example, the field test procedure for an ST signal is shown in Figure 13.

Figure 13: Typical Station Time Signal



Train in station: Signal 1 is red, stop is up, ST aspect is lighted.
Signal 2 is red, stop is up, ST aspect is dark.

- *a. Drop a first shunt at the station (3T) to cut back Signal 1 and activate station time.*
- *b. Begin recording a video that captures both the second shunt (see #3) and the trip stop (which is a simple way to achieve relatively high accuracy of timing upon review) or start a stopwatch as #3 is performed.*
- *c. Drop a shunt on the track circuit in approach to Signal 1/1T. This can be done just on the other side of the I J in advance of the trip stop.*
- *d. Stop the video after the time expires and the trip stop at Signal 1 drives down or stop the stopwatch as the trip stop completes its motion.*
- *e. Divide the block length of the associated section by the measured time and compare it to the posted speed.*
- *f. If the posted speed exceeds the calculated value (within a tolerance determined by NYCT based on how the measurement was taken), re-*

evaluate. If the same result is achieved, design review and/or timer element re-calibration/replacement may be required.

3. This procedure would be best performed with a crew of three and may be conducted between trains at night without affecting revenue service. STV and NYCT Subway Engineering conducted a field test/verification of this procedure at 59th Street – Columbus Circle on the overnight of August 23 - 24, 2019. The results of this test and verification may be found in Appendix "L."
4. Continued discrepancies between the results of the suggested static procedure or due to train operator reports will necessitate further testing on a case-by-case basis. The photosensor test methodology developed by NYCT would be a prudent next step. If dynamic testing is required/requested by operational divisions, this can be conducted similarly to the way GT testing is being conducted today with a minor addition. The relay corresponding to the cut back track circuit would need to be dropped at the associated relay room prior to a test train approaching the timing section. This can be coordinated over the radio between personnel onboard the train and in the relay room, along with observation of the local control panel where applicable.
5. Since issuance of the draft version of this report to NYCT, the aforementioned improvements to the NYCT prototype equipment should be used in lieu of video recording equipment. The recommend procedure and process otherwise remains the same, with details requiring engineering input and finalization (e.g. how many measurements will be required to determine a timer value and any offsets required based on variable conditions).

5.2 SAFELY INCREASE SPEEDS ON CURVES

A. Employ the curve analysis methodology used in the study to review curve speeds on NYCT lines not yet studied.

B. Identify and prioritize candidate curves for further investigation to determine where speeds could be safely increased. The 7th Avenue and Flushing lines should be considered priorities for this effort.

C. More rigorously analyze candidate curves following the NYCT Civil Speed Restriction Check-in meeting format.

1. Evaluate curves by direction in order of their track position along each track and line.
2. Obtain existing signal arrangement drawings showing the location of curves with respect to current infrastructure.
3. Evaluate each curve for the following characteristics:
    a. *Proximity to a station*
    b. *Location within GT signal territory:*
        i. *Other nearby signals*

            ii *Other signal or timing issues*
        c. *Signal control line issues:*
            i. *Maximum Attainable Speed lower than existing V4 comfort speed*
            ii. *Adequate braking distance and safety margin*
        d. *Location near turnout or crossover, or within an interlocking*
        e. *Proximity to adjacent curves or reverse curves or are part of a compound curve*
        f. *Other physical, maintenance, or operational constraints*
    4. Curves not constrained by the criteria listed above would be recommended for further review by the Speed Team.
    5. Conduct further testing (by NYCT) on the Flushing Line to gauge comfort levels up to V6 speeds in Automatic Train Protection Mode (ATPM).

D. Analyze passenger comfort levels at potential speeds identified in the study:

    1. Operate test trains at higher curve speeds calculated by NYCT and elicit opinions of test train occupants.
    2. Operate a geometry car to generate data concerning track condition and geometry data in areas of interest.
    3. Provide track condition and geometry data to a third party (such as ENSCO) to simulate acceleration and jerk on the carbody at higher curve speeds and evaluate them against jerk rates acceptable to NYCT or longitudinal jerk limits already in the vehicle specifications.

E. Fixed block lines should be modeled in parallel with corresponding curve analysis efforts, using an industry standard signaling system software block design package. This will create design baselines that can be dynamically updated with any recommended parameter changes. STV recommends this work start with the 7th Avenue Line, with prioritization of subsequent choices determined by congestion levels and planned modernization efforts.

    1. Update the existing design speeds as determined by the recommendations above.
    2. Re-calculate the safe braking margins and determine which control lines would need to be extended and which signals would need to be relocated.
    3. Iteratively repeat step c until safe braking margins meet all required design standards.
    4.. Model and simulate the associated runtime and capacity impacts and only implement speed changes if line capacity is not reduced.
    5. This process and baseline may be also used to demonstrate the effect of any vehicle performance improvements, dwell time updates, bottleneck improvements, etc. moving forward.

5.3 OTHER POSSIBLE ACTIONS BY NYCT

A. In lieu of just countdown timers, which might be difficult to see, NYCT should actively consider using flashing lunars to show the progress of timers, e.g. progressively increase the rate of flashing as the timer runs, going solid when the timer is expired. This can be used for both station holding lights and GT/ST indications.

B. Axle Counters

1. STV proposes the use of axle counter technologies at NYCT primarily in the following manner:
    - *(a) Subdivision of long track circuits to allow for control line cutbacks, allowing trains to move closer together where needed.*
    - *(b) As a timing circuit for clearing of ST and GT signals, with potentially more predictable equipment circuit delay, no susceptibility to loss-of-shunt delays and less reliance on average speeds. This last benefit may also allow for control line cutbacks due to reduced runaway speed values for MAS calculations through timing sections.*
    - *(c) As a timing circuit for shorting out approach/time locking elements in advance of interlocking switches if the train is stopped between a nearby pair of axle counters for a sufficient, but much shorter length of time than the typical 40 seconds required. This will greatly help with managing unscheduled (or accidental) routes that need to be changed when there are trains on approach to an interlocking and could provide some relief at bottlenecks, especially where there are switches close to the platform such as 149th Street - Grand Concourse.*
2. Please refer to Appendix "O" for a detailed discussion of STV's recommendations concerning axle counters.

C. Initial and Periodic Static Testing. STV recommends that NYCT conduct initial, then periodic, testing of STs statically (e.g. along with interlocking timer tests such as performed for approach, time, route locking, etc.), as follows:

1. Verify that timing devices are set and are performing properly.
2. Capture average/worst case equipment response time from the shunting of the track to the associated trip stop driving separately from the time to clear checks, which can then be done just by dropping relays in the Relay Room accordingly and summing the values to provide a "real-world" timer setting.
3. Update discrepancies with calculated timer values on drawings/tables.

D. Dynamic Testing

1. Spot check reported problem areas where STs are not clearing. This will minimize the time required to coordinate this complex testing.
2. Testing may be performed by a combination of static and dynamic means, i.e. dropping a relay to simulate advance occupancy in front of approaching trains under test so that the timer runs as required; this will need to be coordinated via radio communications between personnel onboard the train and in the relay room.

E. Improvements of Existing Vehicle Systems

1. NYCT should continue field testing speedometer accuracy to ensure the speed is being correctly displayed to the operators.
2. When procuring new vehicles and performing overhauls of existing vehicles, continue to investigate cost effective ways of specifying higher acceleration and braking performance with operated in CBTC territory.

F. Operations

1. Discipline and Training Policies. The recent introduction of the "Optimal Operation – Plan of Action" operating bulletin is a positive step towards improving operator confidence in the signal system and operation rules and towards shaping the agency's discipline policy to focus on true safety violations. NYCT should continue with this specific and other similar policies and should ensure that the training curriculum is updated to reflect these changes as they are implemented.
2. The auto-routing triggers for the system, which have not been updated since the conclusion of the A Division ATS project, should be reviewed and updated as required to accommodate the service plan at each location.
3. Operations at Nostrand Junction Interlocking
   - *(a) As a short-term opportunity, schedule timetables could be adjusted to provide additional distance between these trains in both directions. While the potential conflicts would still exist, and would still cause issues during delay scenarios, by adjusting the base schedule such scenarios hopefully would occur less frequently.*
   - *(b) As a longer-term opportunity, NYCT has considered several variations on major infrastructure projects to reorganize the junction and eliminate conflicting movements. One of the more recent studies is the conceptual engineering study completed in February 2009. Improvements are also being evaluated as part of the ongoing Utica Avenue Line Study.*
   - *(c) Another consideration would be the reorganization of route pairings on these two branches. For example, assigning 2 Line and 3 Line trains to the Nostrand Avenue Line and 4 Line and 5 Line trains to the New Lots Line*

would reduce the number of conflicting movements and potentially reduce the infrastructure required.

4. Operations at 142nd Street Interlocking

   (a) *As a short-term opportunity, schedule timetables could be adjusted to provide additional distance between these trains in both directions. While the potential conflicts would still exist, and would still cause issues during delay scenarios, by adjusting the base schedule such scenarios hopefully would occur less frequently.*

   (b) *As a longer-term opportunity, infrastructure solutions could be applied to mitigate the conflict. A flyover/under would eliminate the conflict entirely, but would be costly, complex, and time consuming.*

   (c) *Another option could be to utilize the middle track at 135th Street as a pocket track for 3 Line trains (not serving that station) to hold and wait for their slot to open. Some new crossovers would be required.*

5. Operations at 149th Street – Grand Concourse

   (a) *NYCT may consider aligning 2 Line and 4 Line schedules to meet at 149th Street - Grand Concourse Station. This would align the open slots on both main lines, and potentially allow 5 Line trains to move unencumbered between the two lines. Additionally, the correspondence of the scheduled timetable to the auto routing triggers for the 5 Line should be examined and potentially updated to ensure the connecting movements are being operated as efficiently as possible.*

   (b) *As an additional short-term consideration, the recommendations for implementing axle counters at Grand Concourse Station described in Appendix "O" should be considered as a supplement to the review of the auto-routing triggers to further improve the efficiency of connecting movements for 5 trains.*

   (c) *Long-term, reconsideration of the route and branch pairings could reduce the number of conflicting moves. Such a routing change (reducing or eliminating connecting 5 Line train movements, while bolstering mainline 2 Line and 4 Line train movements) would likely necessitate station improvements to 149th Street - Grand Concourse to improve the ease of transferring between the upper level and lower level platforms.*

   (d) *If the axle counter design under development is proven to be safe and effective through engineering review and testing, utilize this to minimize delays due to routing changes.*

5.4 DWELL TIMES

Following a similar process determine which Next Steps are appropriate for increasing speeds on Metro-North and Long Island Rail Road.

5.5 SIMULATE IMPACTS ON SYSTEM

A comprehensive simulation analysis should be performed as a next step to assess the system holistically and identify all bottleneck locations and how they interrelate.

Fixed block lines should be modeled in parallel with corresponding curve analysis efforts, using an industry standard signaling system software block design package. This will create design baselines that can be dynamically updated with any recommended parameter changes. STV recommends this work start with the 7th Avenue Line, with prioritization of subsequent choices determined by congestion levels and planned modernization efforts.

Update the existing design speeds as determined by the recommendations above. Iteratively re-calculate the safe braking margins and determine which control lines would need to be extended and which signals would need to be relocated. Model and simulate the associated runtime and capacity impacts and only implement speed changes if line capacity is not reduced.

5.6 DETERMINE NEXT STEPS FOR METRO-NORTH AND LONG ISLAND RAIL ROAD

Following a similar process, determine which next steps are appropriate to study potential speed increases for Metro-North and the Long Island Rail Road.

APPENDICES

APPENDIX "A"

DEFINITIONS

Balanced Speed – The speed at which for a given superelevation and radius of a curve the resultant force of the weight of the vehicle and horizontal centrifugal force is perpendicular to the track causing the wheels to bear equally on both running rails with no lateral thrust.

Civil Speed – That speed at which the track is designed utilizing maximum allowable actual and unbalanced superelevations. Curves are designed with the highest permissible superelevation the type of vehicle and system will permit. The higher the actual elevation the higher the maximum safe speed. The closer to balance speed that a vehicle can travel the more comfort is experienced by the passengers and the less wear and tear on the equipment and track because of less lateral acceleration caused by centrifugal force.

Maximum Attainable Speed – The highest speed that a train can achieve in a specific segment of track and is a function of the track geometry characteristics and mechanical capabilities of the vehicle.

Maximum Attainable Transient Speed (MATS) – The highest speed that a vehicle can achieve in a specific segment of track during short periods of time.

Overturning Speed – That speed at which the vehicle will derail or overturn because centrifugal force overcomes gravity. When the horizontal centrifugal forces of velocity and the effects of curvature overcome the vertical forces of weight and gravity so as to cause the resultant force to rotate about the center of gravity of the vehicle and pass beyond the bearing point of the track, overturning of the vehicle will occur.

Safe Speed – The speed limit above which the vehicle becomes unstable and in danger of derailment upon the introduction of nay anomaly in the track. Safe speed is the condition where the resultant force stays within the one-third point of bearing distance between the rails and is dependent on the location of the vehicle center of gravity above the top of rail.

Signal Speed – That speed for which the signal speed control system is designed, ideally a little faster than an experienced operator would operate a rail car so that the automatic overspeed penalty braking system would not be unnecessarily deployed. Typically signal speed is quite a bit less than maximum safe speed and a little less than civil speed.

Superelevation – Or banking of curves refers to the practice of raising the outside rail of the track a vertical distance in a curve to reduce wear and increase comfort by setting the bank angle so that the sum of the resultant force of the weight and centrifugal force vectors is perpendicular to the track to partially overcome the effects of curvature and speed.

Transition Spiral – Track paths that introduce both curvature and superelevation gradually to avoid high lateral or vertical accelerations. In a properly designed spiral, there are no unbalanced forces at any time when traveling at equilibrium speed. New York Transit historically used Crandall's Transition Curves where the curvature increased directly as the distance from the PTC from a zero curvature at the tangent to that of a circular curve (PC). Traditionally the transition length was divided into 10 equal parts.

Unbalanced Speed – Any speed other than the balanced speed. When the unbalanced speed is greater than the balanced speed it is called overbalanced speed. Overbalance speed causes the vehicle to have an uncompensated lateral acceleration towards the outside of the curve due to centrifugal force. Underbalance speed causes the vehicle to lean or bear against the inner or low rail.

Unbalanced Superelevation – Defined as the difference between actual superelevation and the superelevation required for true equilibrium of a vehicle traversing a curve. Unbalance is designated as Eu and the actual superelevation is designated as Ea. Total Equilibrium Elevation is applied as E = Ea + Eu. Allowable unbalance varies railroad to railroad and from transit agency to transit agency

APPENDIX "B"

WILLIAMSBURG BRIDGE COLLISION AND ANALYSIS

Both the National Transportation Safety Board (NTSB) and NYCT performed a detailed analysis of the 1995 collision between two trains on the Williamsburg Bridge in which the operator of the colliding train was killed. The NYCT report is entitled "Strategic Plan to Address Safety Issues Resulting from the Investigation of the Williamsburg Bridge Collision," dated August 27, 1996 (the "Strategic Plan"). One paragraph in particular in the Strategic Plan's Executive Summary sets the stage for the work at hand here:

The integrity of a fixed block wayside signal system is entirely dependent upon the car performance remaining within the bounds of the performance assumed in the signal design. Since this condition no longer exists, many signal locations throughout the NYCT system no longer provide the design standard of emergency braking distance plus a 35% safety margin for signals between stations. Furthermore, a significant number of signal locations between stations do not provide even 100% of the required emergency braking distance.

A. The Strategic Plan included the following options for corrective action:

1. **Option I** – No additional modifications except for the addition of speed limit signs. The report noted "Because the incompatibility between the current car performance and the existing signal system was so significant, and was present at so many locations throughout the system, speed limits were established at speeds which would provide 100% of the emergency braking distance without any safety margin for compromised braking ability …". (Emphasis original.) The Strategic Plan continued, "The use of speed limits relies entirely upon train operators' constant adherence to the posted speeds to ensure the emergency braking distances. Therefore, much of the automatic element of the automatic train protection (ATP) system is lost." (Emphasis original.) The Strategic Plan concluded that Option I was not an acceptable long-term solution "because it does not provide automatic train protection (ATP) and instead relies almost entirely on train operators' constant adherence to posted speeds and the operating Book of Rules."

2. **Option II** – Modify signal system. This option considered lengthening signal control lines and including Grade Time (GT) and Station Time (ST) signaling "to mitigate the capacity impacts which result in critical areas when control lines are extended." An intermittent speed control (ISC) overlay on the existing signal system, having both wayside and car-borne elements, was also considered. NYCT noted that ISC was "new to NYCT, and all the implications of deploying such a system here are not well understood." The Strategic Plan dropped Option II from consideration; "… whether a traditional signal modification solution or an ISC overlay were to be used, the initial cost would be very high and implementation would take 10 years at the earliest."

3. **Option III** – Modify car performance to 71% field strength (Option III-A) and 100% field strength (Option III-B). Table 3 in the Strategic Plan indicated that to bring signals to the NYCT standard of 135 percent emergency braking distance:

	Option III-A	Option III-B
Total signals requiring modification, system-wide	1,488	499
Of which: total signals in high priority category, i.e. less than 125 percent safety margin	743	203
Total estimated signal modification cost	$148.8M	$49.9M
Total estimated car modification cost	$3.342M	$0.883M

4. The Executive Summary of the Strategic Plan noted with regard to the signals in the high priority category, "These numbers are manageable for in-house modification of the most critical locations in a short time period." The Strategic Plan also noted,

   > The service impacts which will be experienced from implementation of either option result from increased trip time because of lower speeds. The increase in travel time has been estimated to be between 3 – 6% of the current trip time. Option III-B will result in a larger increase than Option III-A. However, the increased travel time is not expected to be uniform throughout the system.

5. The Strategic Plan also noted car equipment costs to maintain existing levels of service, mostly by the acquisition of new rolling stock, and energy savings that would result from running fewer trains at slower speeds.

B. The Strategic Plan recommended adoption of Option III-B, summarized as follows:

> In order to restore [NYCT's] original design standards of providing emergency braking distance plus a 35% Safety Margin at all signal locations between stations:
>
> (a) Modify the car acceleration performance for Subdivisions A and B to 100% field strength operation.
>
> (b) Modify any signal locations between stations which do not meet the 35% safety margin design criteria based on 100% field strength operation of cars beginning with those locations which have less than 100% emergency braking distance.

C. System safety has been enhanced since the Williamsburg Bridge collision and this relies on, among other things, regular maintenance of wayside signal equipment. Signal issues (shown in light green) have been consistently at or near the top causes of delayed trains, as Figure 1 in the study report shows.

APPENDIX "C"
DOCUMENTS REVIEWED

Documents for Task 1A	Owner	Description/Notes	Received	Date Received
Signal Design Guidelines	S.Libera	Step by Step guide to NYCT's operational signal design	Y	7/16/2019
Speed Policy Committee Recommendations	B. Samuel	NYCT Speed Policy Standards	Y	7/16/2019
PB Speed Study	C. Patel		Y	8/7/2019
General Signal Arrangement Drawings (GSA)	K. Mooney	Contains signal locations and control lines	Y	7/25/2019
Curve data and Grade data	Mooney Cabrera	Curve data (radii & super elevation, PC, PT, etc.) and Grade data	Y	7/22/2019
Standard Speed Distance Curves for Acceleration and Emergency Braking	K. Mooney	Curve guidelines and speed information	Y	7/25/2019
Switch Information	Mooney Cabrera	Switch Location, Configuration, Hand, Type, etc.	Y	7/22/2019
Signal Curve Drawings	K. Mooney	Contains signal locations, controls lines, speed information, etc.	Y	7/22/2019
List of Civil Speeds – 7th Ave. Line	Mooney Cabrera	Contains track, sta., curve point, curved length, radius, superelevation, normal avg. operating speed, normal high operating speed, not to exceed speed	Y	7/22/2019
Curve data and Grade data	Mooney Cabrera	Curve data (radii & super elevation, PC, PT, etc.) and Grade data	Y	5/21/2019
List of Civil Speeds	Mooney Cabrera	Contains track, sta., curve point, curved length, radius, superelevation, normal avg. operating speed, normal high operating speed, not to exceed speed	Y	5/21/2019
Stationing/Inventory of Signal Assets in excel or a database	K. Mooney	Signal Location, Control Line length, signal type, etc.	Y	5/29/2019
1997 Signaling Reports by PB	K. Mooney	1997 PB Reports – Study of Existing Signaling System		
Signal Operational Design Manual	K. Mooney	Step by Step guide to NYCT's operational signal design	Y	7/16/2019
Single Line Drawings	K. Mooney	7th Ave. Single Line Drawings	Y	7/25/2019
Double Line Drawings	K. Mooney	7th Ave. Double Line Drawings	Y	7/25/2019
Car Specific Data-	J. Santamaria			
• Acceleration/Deceleration/Jerk rates	J. Santamaria		Y	7/16/2019
• Emergency Brake Test Data & Test Reports	J. Santamaria		Y	7/16/2019
• Emergency Brake Stopping Dustance Data Sheet Results	J. Santamaria		Y	7/16/2019
• General Vehicle Information (e.g., vehicle weights, general outline)	J. Santamaria	R160 TS Sect 2; R142 Contract Specs; R179 Sect 2; TR 97-05 Phase 2 Acceleration; & TR 96-02 Phase 1 Acceleration Testing	Y	7/31/2019
Operating Rules & Special Instructions	B. Greenblatt		Y	7/17/2019
Speed Sign List	B. Greenblatt		Y	7/19/2019
Bulletins – Compendium of Optimal operational Bulletins; Door operational Bulletins	B. Greenblatt	Operational Bulletins in Service Delivery	Y	7/17/2019
2017 AM & PM Peak Load Summary	G. Lunden		Y	7/19/2019
Fast Forward Lines Summary	G. Lunden		Y	7/19/2019
Capacity Constraints	G. Lunden		Y	7/19/2019
AM & PM On-Off Charts by Train	G. Lunden	9-25-15 Draft	Y	7/19/2019
Comparative Running Time Chart & Analysis R68 vs R160	G. Lunden		Y	7/19/2019
NTSB Final Report	S. Libera	Williamsburg Bridge Accident	Y	7/16/2019
Williamsburg Br. Collision Investigation	S. Libera		Y	7/16/2019
Train Schedules/Service Plan (to inform current service headways)	B. Greenblatt			

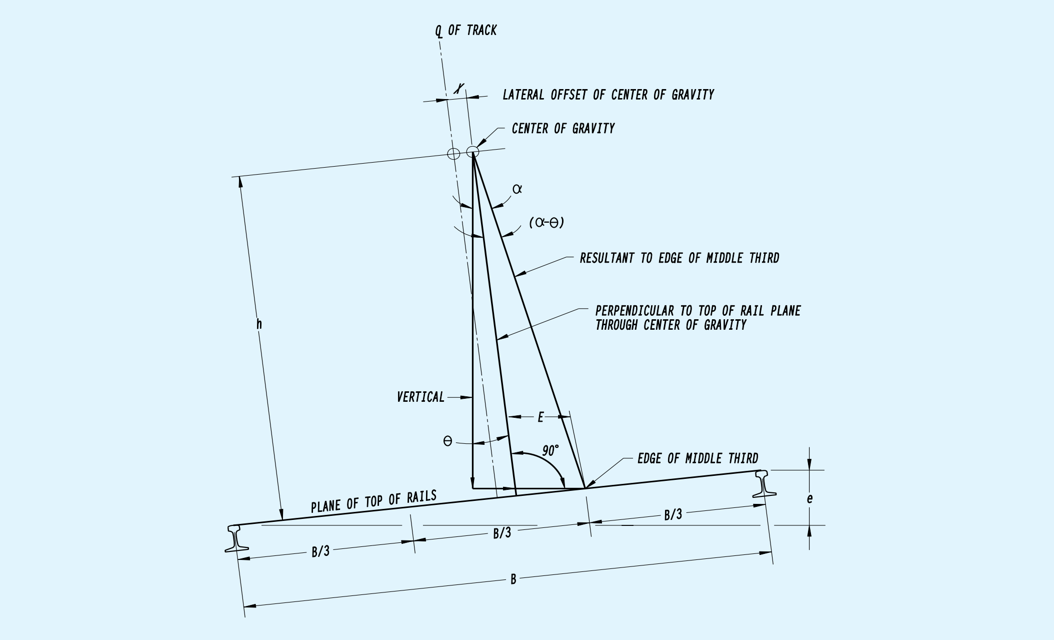
APPENDIX "D"

MAXIMUM ALLOWABLE SPEEDS IN CURVES

The 1994 Policy review developed by Toronto Transit Consultants Ltd. (TTCL) studied Maximum Allowable Speeds (MAS) in Curves. The following standards were defined:

1. Derailment Safety Speed: Defined by the ratio of lateral to vertical forces (L/V) acting on the guiding wheels. For the case of wheel climb, the TTCL study determined that the minimum Derailment Speed to be equivalent to a V29 speed (29-inch unbalance) for 51-foot long equipment.

Figure D-1. Illustration of "One-Third" Rule.



2. Vehicle Overturning/Lateral Stability Safety Speed: This is based on the one-third rule with the resultant of the vertical (gravitational) and lateral (Centrifugal) forces remaining within the middle third of the distance between the gauge of the rails. This provides a margin of safety against physical overturning of the rolling stock which theoretically occurs when the resultant force passes through the gauge point of the high rail (V33 speed). Application of this rule to NYCT passenger speeds then yielded the following Lateral Stability Speeds:
   a. 75-foot long cars with a center-of-gravity height of 56" at "crush load" – V10.7
   b. 60-foot long cars with a center-of-gravity height of 54" at "crush load" – V11.1
   c. 51-foot long cars with a center-of-gravity height of 52" at "crush load" – V11.5

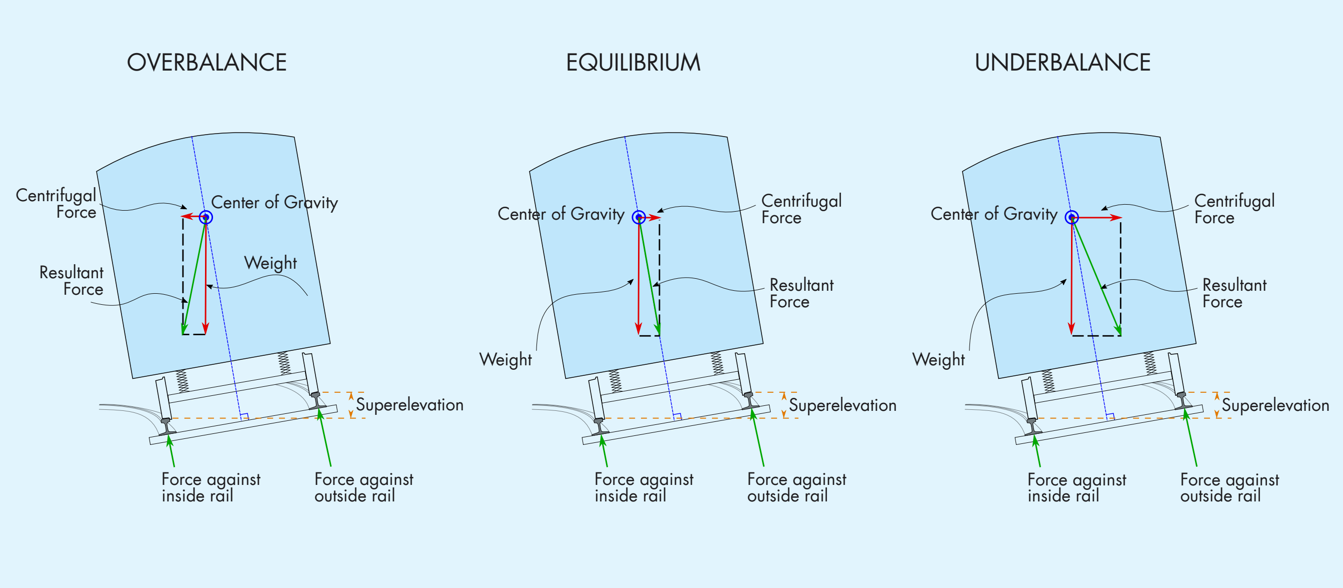
3. Passenger Comfort Speed: North American Railroads and Transit Agencies typically use 0.1 g as the maximum uncompensated lateral acceleration force experienced by passengers which yields a Passenger Comfort Speed equivalent to V6. The 1988 Track & Structures Department of NYCT used a more conservative 0.0625 g uncompensated lateral acceleration deriving a Passenger Comfort Speed of V3.

The policy also stated that V6 may be unacceptable for standing passengers in sharp radius curves. Several references cited in the Speed Policy state that passenger trains can comfortable negotiate curves with 4 inches of unbalance (V4). The Speed Policy Committee performed a test of V4 and V6 speeds on the White Plains Road (Subdivision A) line in 1994 on curves north of Simpson Street and north of Bronx Park East. Results revealed that V6 is acceptable for GT signal settings but a V4 is more appropriate for passenger comfort and that V11 would be the Maximum Allowable Transient Speed) (MATS) of a train on a curve.

The December 2018 NYCT Speed Policy Standards list speeds as follows:

1. Normal Average Operating Speed as the speed that provides optimal passenger comfort limiting the passenger-perceived uncompensated lateral acceleration (Au) to always be less than the Comfort Limit Speed or V4.
2. Normal High Operating Speed (Comfort Limit Speed) as the speed that causes passenger perceived uncompensated lateral acceleration to be equal to or less than 0.1 g ft/sec2 or V6.
3. Not-To-Exceed Safe Speed in Curves is the speed where the resultant force of the weight of the vehicle and centrifugal force experienced by the vehicle passes through a point located within the middle third distance between the running rails or V11.
4. Train Stability Limiting Speed is the speed that causes the resultant force of the weight of the vehicle and centrifugal force experienced by the vehicle to pass through a point outside the middle third distance between the rails causing the vehicle to lean or bare excessively against the outer rail. The speed greater than V11 induces potential rail climbing forces.
5. Derailment Speed is the theoretical speed at which the resultant force of the weight of the vehicle and centrifugal force experienced by the vehicle to pass through the field side of the outer or high running rail resulting in wheel climb. (V29 speed).

Figure D-2. Balance and Superelevation.



Train operations are governed by "posted speeds" or "civil speeds" in curves and are comprised of curve characteristics such as curve radius, actual superelevation (Ea) and allowable unbalance (Eu) and engineering practices used by NYCT's predecessor companies and current Speed policy Standards. The radius of the curve and superelevation is dictated by the horizontal alignment of the tracks and infrastructure clearances. Please refer to Figure D-2 and Table D-1. Signal speed design is also based on balanced speeds for each curve. Fixed-block (conventional) signal design is based on optimum passenger comfort with the operating speed of a train through a curve not to exceed V4. Speed limit signs are posted in 1-mph increments for V4 speeds having a MAS between V4 and V6. Curves having a MAS equal to or higher than V6 have GT signals installed to limit the speed for the trains through the curve. GT signs are posted for V4 speeds and GT timer settings are set or calibrated so that the speed of the train does not exceed V6 speed. Testing and calibration of the GT signal is addressed in Sections 4 and 5 of this report.

Table D-1. Speed Policy Summary Standards
(NYCT Speed Policy Standards Revised Dec 13, 2018)

Speed Policy Standards Summary:

Summary of Speed Policy Standards for Curves and Turnouts			
	Normal Average Operating Speed	Normal High Operating Speed Limit (*)	Not-To-Exceed Speed (*) (Safe Speed Absolute Limit)
Regular Curves	V4	V6	V11
Standard AREMA Turnouts	V1.5	V6	V9
Tangential NYCT Turnouts	V3	V6	V9

(*) If the actual speed of the train exceeds the Normal High Operating Speed Limit and is not immediately reduced below that limit by Service Brakes, an Emergency Brake application shall already have been called for. The Emergency Brake application shall be triggered at a predetermined CBTC-designed speed-threshold (i.e. the Vital Civil Speed). In NO CASE shall the actual speed of the train be allowed to exceed the Not-To-Exceed (NTE) Safe Speed Limit. CBTC Train Control System parameters shall be adjusted to Vitally Ensure this requirement.

An analysis of speeds on the 7th Avenue line is briefly described in Section 5 of this report with the results included in Appendix G.

Pertinent AREMA Standards:

The maximum acceleration rate acceptable of cant deficiency or Eu (unbalance) for passenger comfort is .10g. The rate of change of lateral acceleration on a passenger shoulder cannot exceed .03 g/sec. The time to attain maximum. lateral acceleration = .10g/.03 g/sec = 3.33 sec. The length of spiral formula = Ls = V x (5280/3600) x 3.33 = 4.89V. If Eu = 3" then Ls = 4.89/3 x Eu x V = 1.63 EuV.

Due to curve realignments and if there are tight constraints, AREMA permits a max. rate of change of unbalanced lateral acceleration on a passenger shoulder of .04 g/sec. The time to attain maximum lateral acceleration = .10g/.04 g/sec = 2.5 sec. The length of spiral formula = Ls = V x (5280/3600) x 2.5 = 3.67V. If Eu = 3" then Ls = 3.67/3 x Eu x V = 1.22 EuV.

APPENDIX “E”

CURVES AND SPEEDS, V4/V6 ANALYSIS 7TH AVENUE LINE, “A” DIVISION (IRT)

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	7AV	V4A	222+44	T/C		6500		0.00	(1)	50	55											
IRT	7AV	V4A	217+71	C/S		6500		0.00	(1)	50	55											
IRT	7AV	V4A	217+00	S/C		450		2.00	26	30	38	25.994	30.016	38.263	27.387	28.077						
IRT	7AV	V4A	215+63	C/S		450		2.00	26	30	38	25.994	30.016	38.263	27.387	28.077						
IRT	7AV	V4A	215+17	S/S		16000		0.68	(1)	50	55											
IRT	7AV	V4A	214+96	S/C		Sw. 407B	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	7AV	V4A	214+50	C/S		Sw. 407B	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	7AV	V4A	214+34	S/T	810	Sw. 407B	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	7AV	V4A	213+25	T/S		438		******	26	30	38											
IRT	7AV	V4A	212+96	S/C		438		2.00	26	30	38	25.636	29.602	37.736	27.009	27.690						
IRT	7AV	V4A	211+30	C/S		438		2.00	26	30	38	25.636	29.602	37.736	27.009	27.690						
IRT	7AV	V4A	210+47	S/T	278	438		******	26	30	38											
IRT	7AV	V4	220+63	T/S		346		2.09	23	26	34	22.941	26.441	33.634	24.152	24.753						
IRT	7AV	V4	219+92	S/C		346		2.09	23	26	34	22.941	26.441	33.634	24.152	24.753						
IRT	7AV	V4	219+26	C/S		346		2.09	23	26	34	22.941	26.441	33.634	24.152	24.753						
IRT	7AV	V4	218+85	S/C		568		2.86	31	35	44	31.198	35.455	44.345	32.664	33.394						
IRT	7AV	V4	217+48	C/S		568		2.86	31	35	44	31.198	35.455	44.345	32.664	33.394						
IRT	7AV	V4	216+48	S/T	415	568		2.86	31	35	44	31.198	35.455	44.345	32.664	33.394						
IRT	7AV	V4	215+03	T/S		763		2.68	36	41	51	35.689	40.682	51.073	37.411	38.267						
IRT	7AV	V4	213+55	S/C		763		2.68	36	41	51	35.689	40.682	51.073	37.411	38.267						
IRT	7AV	V4	212+65	C/S		763		2.68	36	41	51	35.689	40.682	51.073	37.411	38.267						
IRT	7AV	V4	210+25	S/S		1975		-0.38	(1)	50	55											
IRT	7AV	V4	210+15	S/C		Sw. 435	942	0.00	26.5	37.5	46						26.580	37.590	46.038			
IRT	7AV	V4	209+60	C/S		Sw. 435	942	0.00	26.5	37.5	46						26.580	37.590	46.038			
IRT	7AV	V4	209+24	S/T	579	Sw. 435	942	0.00	26.5	37.5	46						26.580	37.590	46.038			
IRT	7AV	V4	189+47	T/S		-1335		******	40	48	55											
IRT	7AV	V4	188+32	S/C		-1335		-0.88	40	48	55											
IRT	7AV	V4	187+68	C/S		-1335		-0.88	40	48	55											
IRT	7AV	V4	186+64	S/T	283	-1335		******	40	48	55											
IRT	7AV	V4	184+91	T/S		2574		******	(1)	50	55											
IRT	7AV	V4	184+67	S/C		2574		0.00	(1)	50	55											
IRT	7AV	V4	182+22	C/S		2574		0.00	(1)	50	55											
IRT	7AV	V4	181+85	S/C		624		2.00	31	35	45	30.595	35.328	45.034	32.234	33.046						
IRT	7AV	V4	179+98	C/S		624		2.00	31	35	45	30.595	35.328	45.034	32.234	33.046						
IRT	7AV	V4	178+96	S/T	595	624		******	31	35	45											
IRT	7AV	V4	178+71	T/S		-1287.05		******	41	48	55											
IRT	7AV	V4	177+54	S/C		-1287.05		-1.13	41	48	55											
IRT	7AV	V4	176+82	C/S		-1287.05		-1.13	41	48	55											
IRT	7AV	V4	175+52	S/T	319	-1287.05		******	41	48	55											
IRT	7AV	V4	172+37	T/S		-1872.08		******	(1)	50	55											
IRT	7AV	V4	171+91	S/C		-1872.08		-1.00	(1)	50	55											
IRT	7AV	V4	171+13	C/S		-1872.08		-1.00	(1)	50	55											
IRT	7AV	V4	170+63	S/T	174	-1872.08		******	(1)	50	55											
IRT	7AV	V4	166+40	T/S		-942		******	32	38	55											
IRT	7AV	V4	165+78	S/C		-942		-0.26	32	38	55											
IRT	7AV	V4	165+31	C/S		-942		-0.26	32	38	55											
IRT	7AV	V4	164+07	S/S		677		1.94	32	37	47	31.702	36.652	46.790	33.416	34.266						
IRT	7AV	V4	163+53	S/T	287	677		******	32	37	47											
IRT	7AV	V4	157+33	T/S		-483.72		******	30	34	42											
IRT	7AV	V4	156+63	S/C		-483.72		-3.64	30	34	42											
IRT	7AV	V4	155+32	C/S		-483.72		-3.64	30	34	42											
IRT	7AV	V4	154+77	S/T	256	-483.72		******	30	34	42											
IRT	7AV	V4	129+41	T/S		-10000.00		******	(1)	50	55											
IRT	7AV	V4	129+10	S/C		-10000.00		0.00	(1)	50	55											
IRT	7AV	V4	128+56	C/S		-10000.00		0.00	(1)	50	55											
IRT	7AV	V4	128+33	S/T	108	-10000.00		******	(1)	50	55											
IRT	7AV	V4	117+25	T/S		1264		******	(1)	50	55											
IRT	7AV	V4	115+86	S/C		1264		3.70	(1)	50	55	49.337	55.375	68.168	51.408	52.443						
IRT	7AV	V4	114+08	C/S		1264		3.70	(1)	50	55	49.337	55.375	68.168	51.408	52.443						
IRT	7AV	V4	112+19	S/T	506	1264		******	(1)	50	55											
IRT	7AV	V4	87+34	T/S		714		******	32	37	48											
IRT	7AV	V4	86+24	S/C		714		1.87	32	37	48	32.361	37.470	47.917	34.132	35.009						
IRT	7AV	V4	85+81	C/S		714		1.87	32	37	48	32.361	37.470	47.917	34.132	35.009						
IRT	7AV	V4	84+31	S/C		-1108.85		-0.27	34	42	55											
IRT	7AV	V4	83+72	C/S		-1108.85		-0.27	34	42	55											
IRT	7AV	V4	83+46	S/T	388	-1108.85		******	34	42	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	7AV	V4	78+67	T/S		-1126.17		******	40	46	55											
IRT	7AV	V4	77+27	S/C		-1126.17		-1.58	40	46	55											
IRT	7AV	V4	76+73	C/S		-1126.17		-1.58	40	46	55											
IRT	7AV	V4	75+88	S/S		394		1.54	23	27	35	23.356	27.247	35.139	24.708	25.376						
IRT	7AV	V4	75+57	S/T	310	394		******	23	27	35											
IRT	7AV	V4	34+96	T/S		974		******	33	40	53											
IRT	7AV	V4	34+11	S/C		974		0.52	33	40	53	33.175	39.845	52.963	35.515	36.662						
IRT	7AV	V4	34+03	C/S		974		0.52	33	40	53	33.175	39.845	52.963	35.515	36.662						
IRT	7AV	V4	33+64	S/T	132	974		******	33	40	53											
IRT	7AV	V4	33+25	T/S		-1108.85		******	35	42	55											
IRT	7AV	V4	32+94	S/C		-1108.85		-0.44	35	42	55											
IRT	7AV	V4	32+25	C/S		-1108.85		-0.44	35	42	55											
IRT	7AV	V4	32+09	S/T	116	-1108.85		******	35	42	55											
IRT	7AV	V4	25+58	T/S		-1676.16		******	41	50	55											
IRT	7AV	V4	25+35	S/C		-1676.16		-0.02	41	50	55											
IRT	7AV	V4	24+57	C/S		-1676.16		-0.02	41	50	55											
IRT	7AV	V4	23+88	S/S		Sw. 131B	763	0.00	17	35	42									16.915	33.830	41.434
IRT	7AV	V4	23+41	S/T	217	Sw. 131B	763	******	17	35	42											
IRT	7AV	V4	14+19	T/S		1373		******	39	47	55											
IRT	7AV	V4	13+57	S/C		1373		0.54	39	47	55	39.474	47.377	62.934	42.246	43.605						
IRT	7AV	V4	13+26	C/S		1373		0.54	39	47	55	39.474	47.377	62.934	42.246	43.605						
IRT	7AV	V4	11+40	S/S		-1135.04		-0.54	36	43	55											
IRT	7AV	V4	11+01	S/T	318	-1135.04		******	36	43	55											
IRT	7AV	V4	3+10	T/S		Sw. 203	235	******	10	19	24											
IRT	7AV	V4	2+30	S/S		Sw. 203	235	0.00	10	19	24									9.387	18.775	22.995
IRT	7AV	V4	1+78	S/C		524		1.14	26	31	40	25.953	30.589	39.886	27.569	28.366						
IRT	7AV	V4	1+10	C/S		524		1.14	26	31	40	25.953	30.589	39.886	27.569	28.366						
IRT	7AV	V4	-1+41	S/T	451	524		******	26	31	40											
IRT	7AV	V2	2+13	T/S		755		******	29	35	46											
IRT	7AV	V2	2+83	S/S		755		0.43	29	35	46	28.911	34.831	46.439	30.990	32.008						
IRT	7AV	V2	3+76	S/T	163	755		******	29	35	46											
IRT	7AV	V2	3+83	T/S		-868.37		******	33	39	51											
IRT	7AV	V2	4+07	S/C		-868.37		-0.87	33	39	51											
IRT	7AV	V2	4+53	C/S		-868.37		-0.87	33	39	51											
IRT	7AV	V2	5+07	S/T	124	-868.37		******	33	39	51											
IRT	7AV	V2	10+78	T/S		-954.64		******	31	38	51											
IRT	7AV	V2	11+63	S/S		954.64		0.00	31	38	51	30.897	37.841	51.237	33.349	34.544						
IRT	7AV	V2	12+10	S/S		981		0.00	32	39	52	31.315	38.353	51.930	33.800	35.011						
IRT	7AV	V2	13+18	S/T	240	981		******	32	39	52											
IRT	7AV	V2	24+65	T/S		1696		******	45	50	55											
IRT	7AV	V2	24+89	S/S		1696		0.86	45	50	55	45.393	53.930	70.910	48.377	49.844						
IRT	7AV	V2	25+66	S/T	101	1696		******	45	50	55											
IRT	7AV	V2	32+09	T/S		1008		******	33	40	53											
IRT	7AV	V2	32+48	S/S		1008		0.34	33	40	53	33.072	39.972	53.458	35.497	36.684						
IRT	7AV	V2	33+88	S/C		-1947.97		-1.98	(1)	50	55											
IRT	7AV	V2	34+34	C/S		-1947.97		-1.98	(1)	50	55											
IRT	7AV	V2	34+81	S/T	272	-1947.97		******	(1)	50	55											
IRT	7AV	V2	84+70	T/S		3067		******	(1)	50	55											
IRT	7AV	V2	85+16	S/C		3067		2.04	(1)	50	55	68.053	78.516	99.992	71.675	73.471						
IRT	7AV	V2	87+57	C/S		3067		2.04	(1)	50	55	68.053	78.516	99.992	71.675	73.471						
IRT	7AV	V2	87+88	S/T	318	3067		******	(1)	50	55											
IRT	7AV	V2	113+00	T/S		955		******	(1)	50	55											
IRT	7AV	V2	114+32	S/C		955		5.54	(1)	50	55	47.716	52.480	62.828	49.339	50.154						
IRT	7AV	V2	116+18	C/S		955		5.54	(1)	50	55	47.716	52.480	62.828	49.339	50.154						
IRT	7AV	V2	116+65	S/T	365	955		******	(1)	50	55											
IRT	7AV	V2	154+37	T/S		-618.67		******	38	42	51											
IRT	7AV	V2	155+89	S/C		-618.67		-5.52	38	42	51											
IRT	7AV	V2	156+90	C/S		-618.67		-5.52	38	42	51											
IRT	7AV	V2	158+06	S/T	369	-618.67		******	38	42	51											
IRT	7AV	V3	157+60	T/S		-558.72		******	33	37	45											
IRT	7AV	V3	156+57	S/C		-558.72		-3.64	33	37	45											
IRT	7AV	V3	155+18	C/S		-558.72		-3.64	33	37	45											
IRT	7AV	V3	154+49	S/T	311	-558.72		******	33	37	45											
IRT	7AV	V3	127+96	T/S		-6006.25		******	(1)	50	55											
IRT	7AV	V3	127+88	S/C		-6006.25		-0.24	(1)	50	55											
IRT	7AV	V3	127+80	C/S		-6006.25		-0.24	(1)	50	55											
IRT	7AV	V3	127+72	S/T	24	-6006.25		******	(1)	50	55											
IRT	7AV	V3	116+99	T/S		1126		******	(1)	50	55											
IRT	7AV	V3	115+63	S/C		1126		4.83	(1)	50	55	49.860	55.219	66.759	51.690	52.608						
IRT	7AV	V3	113+77	C/S		1126		4.83	(1)	50	55	49.860	55.219	66.759	51.690	52.608						
IRT	7AV	V3	112+51	S/T	448	1126		******	(1)	50	55											
IRT	7AV	V3	87+69	T/S		2720		******	(1)	50	55											
IRT	7AV	V3	86+59	S/C		2720		0.00	(1)	50	55	52.152	63.873	86.484	56.290	58.307						
IRT	7AV	V3	84+76	C/S		2720		0.00	(1)	50	55	52.152	63.873	86.484	56.290	58.307						
IRT	7AV	V3	84+55	S/T	314	2720		******	(1)	50	55											
IRT	7AV	V3	34+80	T/S		848		******	33	39	50											
IRT	7AV	V3	33+79	S/S		848		1.01	33	39	50	32.589	38.549	50.457	34.669	35.694						
IRT	7AV	V3	33+33	S/T	147	848		******	33	39	50											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	7AV	V3	33+10	T/S		-1162.50		******	40	46	55											
IRT	7AV	V3	32+48	S/C		-1162.50		-1.38	40	46	55											
IRT	7AV	V3	32+17	C/S		-1162.50		-1.38	40	46	55											
IRT	7AV	V3	31+62	S/T	148	-1162.50		******	40	46	55											
IRT	7AV	V3	25+97	T/S		-1359.91		******	37	45	55											
IRT	7AV	V3	25+35	S/C		1359.91		-0.08	37	45	55	36.506	44.863	60.931	39.460	40.898						
IRT	7AV	V3	24+88	C/S		-1359.91		-0.08	37	45	55											
IRT	7AV	V3	24+73	S/T	124	-1359.91		******	37	45	55											
IRT	7AV	V3	24+65	T/S		1100		******	36	43	55											
IRT	7AV	V3	24+26	S/C		1100		0.67	36	43	55	35.843	42.836	56.660	38.292	39.494						
IRT	7AV	V3	24+03	C/S		1100		0.67	36	43	55	35.843	42.836	56.660	38.292	39.494						
IRT	7AV	V3	23+56	S/T	109	1100		******	36	43	55											
IRT	7AV	V3	12+71	T/S		-1100.38		******	35	42	55											
IRT	7AV	V3	12+40	S/C		1100.38		0.41	35	42	55	34.831	41.992	56.025	37.346	38.578						
IRT	7AV	V3	11+86	C/S		1100.38		0.41	35	42	55	34.831	41.992	56.025	37.346	38.578						
IRT	7AV	V3	11+24	S/C		667		0.16	26	32	43	26.345	32.058	43.150	28.358	29.341						
IRT	7AV	V3	11+09	C/S		667		0.16	26	32	43	26.345	32.058	43.150	28.358	29.341						
IRT	7AV	V3	10+85	S/T	186	667		******	26	32	43											
IRT	7AV	V3	2+46	T/S		-608.23		******	29	33	43											
IRT	7AV	V3	1+83	S/S		608.23		1.35	29	33	43	28.522	33.431	43.335	30.230	31.073						
IRT	7AV	V3	0+75	S/S		890		0.76	33	39	51	32.540	38.779	51.147	34.723	35.796						
IRT	7AV	V3	0+13	S/T	233	890		******	33	39	51											
IRT	7AV	V1	4+08	T/S		6552		******	(1)	50	55											
IRT	7AV	V1	4+75	S/C		6552		-0.02	(1)	50	55	80.743	98.973	134.112	87.182	90.319						
IRT	7AV	V1	5+51	C/S		6552		-0.02	(1)	50	55	80.743	98.973	134.112	87.182	90.319						
IRT	7AV	V1	5+93	S/T	185	6552		******	(1)	50	55											
IRT	7AV	V1	10+63	T/S		652		******	26	32	43											
IRT	7AV	V1	10+99	S/C		652		0.20	26	32	43	26.170	31.796	42.736	28.151	29.119						
IRT	7AV	V1	11+22	C/S		652		0.20	26	32	43	26.170	31.796	42.736	28.151	29.119						
IRT	7AV	V1	12+19	S/C		873.64		0.92	33	39	51	32.781	38.877	51.024	34.910	35.958						
IRT	7AV	V1	12+54	C/S		873.64		0.92	33	39	51	32.781	38.877	51.024	34.910	35.958						
IRT	7AV	V1	13+20	S/T	257	-873.64		******	33	39	51											
IRT	7AV	V1	23+91	T/S		-2288		******	(1)	50	55											
IRT	7AV	V1	24+22	S/S		2288.10		0.52	(1)	50	55	50.848	61.070	81.177	54.434	56.192						
IRT	7AV	V1	24+69	S/C		2826		-0.20	(1)	50	55	51.818	64.019	87.358	56.138	58.239						
IRT	7AV	V1	25+23	C/S		2826		-0.20	(1)	50	55	51.818	64.019	87.358	56.138	58.239						
IRT	7AV	V1	25+54	S/T	163	2826		******	(1)	50	55											
IRT	7AV	V1	31+76	T/S		942		******	37	43	55											
IRT	7AV	V1	33+05	S/S		942		1.77	37	43	55	36.865	42.780	54.844	38.917	39.932						
IRT	7AV	V1	34+58	S/S		1386.06		1.53	44	50	55	43.775	51.081	65.893	46.313	47.568						
IRT	7AV	V1	34+93	S/T	317	-1386.06		******	44	50	55											
IRT	7AV	V1	75+31	T/S		-693.03		******	31	36	47											
IRT	7AV	V1	75+77	S/C		693.03		1.52	31	36	47	30.925	36.096	46.574	32.722	33.610						
IRT	7AV	V1	76+16	C/S		693.03		1.52	31	36	47	30.925	36.096	46.574	32.722	33.610						
IRT	7AV	V1	76+95	S/C		961		0.49	33	39	53	32.844	39.487	52.540	35.175	36.318						
IRT	7AV	V1	77+24	C/S		961		0.49	33	39	53	32.844	39.487	52.540	35.175	36.318						
IRT	7AV	V1	78+77	S/T	346	961		******	33	39	53											
IRT	7AV	V1	83+43	T/S		1045		******	37	44	55											
IRT	7AV	V1	84+39	S/S		1045		1.35	37	44	55	37.378	43.811	56.790	39.616	40.722						
IRT	7AV	V1	85+58	S/T	215	1045		******	37	44	55											
IRT	7AV	V1	113+45	T/S		907		******	40	45	55											
IRT	7AV	V1	114+07	S/C		907		3.03	40	45	55	39.917	45.240	56.391	41.749	42.662						
IRT	7AV	V1	116+00	C/S		907		3.03	40	45	55	39.917	45.240	56.391	41.749	42.662						
IRT	7AV	V1	116+78	S/T	333	907		******	40	45	55											
IRT	7AV	V1	154+21	T/S		-689.71		******	36	40	50											
IRT	7AV	V1	155+76	S/C		689.71		3.34	36	40	50	35.576	40.131	49.725	37.141	37.922						
IRT	7AV	V1	156+85	C/S		689.71		3.34	36	40	50	35.576	40.131	49.725	37.141	37.922						
IRT	7AV	V1	158+32	S/T	411	-689.71		******	36	40	50											
IRT	7AV	V1	163+46	T/S		-787.70		******	33	38	50											
IRT	7AV	V1	164+33	S/S		787.70		1.52	33	38	50	32.970	38.482	49.654	34.886	35.832						
IRT	7AV	V1	165+62	S/S		810		-0.11	29	35	47	28.064	34.532	46.955	30.351	31.465						
IRT	7AV	V1	166+70	S/T	324	810		******	29	35	47											
IRT	7AV	V1	170+64	T/S		1922		******	(1)	50	55											
IRT	7AV	V1	170+88	S/C		1922		2.50	(1)	50	55	55.886	63.908	80.540	58.655	60.031						
IRT	7AV	V1	171+68	C/S		1922		2.50	(1)	50	55	55.886	63.908	80.540	58.655	60.031						
IRT	7AV	V1	171+96	S/T	132	1922		******	(1)	50	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	7AV	V1	174+11	T/S		-1201.25		******	42	49	55											
IRT	7AV	V1	175+49	S/C		1201.25		1.88	42	49	55	42.022	48.646	62.193	44.318	45.455						
IRT	7AV	V1	177+47	C/S		1201.25		1.88	42	49	55	42.022	48.646	62.193	44.318	45.455						
IRT	7AV	V1	178+74	S/T	463	-1201.25		******	42	49	55											
IRT	7AV	V1	179+11	T/S		561		******	29	33	43											
IRT	7AV	V1	180+13	S/C		561		2.00	29	33	43	29.006	33.493	42.696	30.560	31.330						
IRT	7AV	V1	181+81	C/S		561		2.00	29	33	43	29.006	33.493	42.696	30.560	31.330						
IRT	7AV	V1	182+05	S/C		2363		0.12	(1)	50	55	49.336	60.130	81.052	53.141	54.998						
IRT	7AV	V1	184+78	C/S		2363		0.12	(1)	50	55	49.336	60.130	81.052	53.141	54.998						
IRT	7AV	V1	184+93	S/T	582	2363		******	(1)	50	55											
IRT	7AV	V1	186+44	T/S		-1372.86		******	41	49	55											
IRT	7AV	V1	187+90	S/C		1372.86		0.88	41	49	55	40.925	48.593	63.854	43.605	44.923						
IRT	7AV	V1	188+43	C/S		1372.86		0.88	41	49	55	40.925	48.593	63.854	43.605	44.923						
IRT	7AV	V1	189+83	S/T	339	-1372.86		******	41	49	55											
IRT	7AV	V1	208+78	T/S		Sw. 425	942	0	26.5	37.5	46						26.580	37.590	46.038			
IRT	7AV	V1	209+33	S/C		Sw. 425	942	0	26.5	37.5	46						26.580	37.590	46.038			
IRT	7AV	V1	209+69	C/S		Sw. 425	942	0	26.5	37.5	46						26.580	37.590	46.038			
IRT	7AV	V1	209+93	S/S		1975		0.18	45	50	55	45.426	55.234	74.291	48.881	50.569						
IRT	7AV	V1	210+21	S/C		728		1.27	31	36	47	30.971	36.376	47.257	32.853	33.781						
IRT	7AV	V1	211+15	C/S		728		1.27	31	36	47	30.971	36.376	47.257	32.853	33.781						
IRT	7AV	V1	212+87	S/T	409	728		1.27	31	36	47	30.971	36.376	47.257	32.853	33.781						
IRT	7AV	V1	215+25	T/S		1171.95		0.43	36	43	55	36.027	43.404	57.869	38.617	39.886						
IRT	7AV	V1	215+96	S/C		1171.95		0.43	36	43	55	36.027	43.404	57.869	38.617	39.886						
IRT	7AV	V1	216+66	C/S		1171.95		0.43	36	43	55	36.027	43.404	57.869	38.617	39.886						
IRT	7AV	V1	217+05	S/C	180	1360		0.45	39	47	55	38.896	46.828	62.392	41.681	43.045						
IRT	7AV	V1A	211+87	T/S		435		******	26	30	38											
IRT	7AV	V1A	212+74	S/C		435		2.00	26	30	38	25.559	29.513	37.621	26.928	27.607						
IRT	7AV	V1A	214+35	C/S		435		2.00	26	30	38	25.559	29.513	37.621	26.928	27.607						
IRT	7AV	V1A	214+56	S/T	269	435		******	26	30	38											
IRT	7AV	V1A	216+45	T/S		407		******	25	29	36											
IRT	7AV	V1A	216+93	S/C		407		2.00	25	29	36	24.708	28.531	36.370	26.032	26.688						
IRT	7AV	V1A	218+55	C/S		407		2.00	25	29	36	24.708	28.531	36.370	26.032	26.688						
IRT	7AV	V1A	224+35	S/T	790	5000		0.00	(1)	50	55											
IRT	Broadway	B4	197+03	T/S		-1108.85		******	38	45	55											
IRT	Broadway	B4	195+68	S/C		1108.85		1.19	38	45	55	37.931	44.645	58.131	40.270	41.424						
IRT	Broadway	B4	194+62	C/S		1108.85		1.19	38	45	55	37.931	44.645	58.131	40.270	41.424						
IRT	Broadway	B4	193+02	S/T	401	-1108.85		******	38	45	55											
IRT	Broadway	B4	206+89	T/S		1758		******	(1)	50	55											
IRT	Broadway	B4	207+28	S/C		1758		1.37	(1)	50	55	48.580	56.912	73.732	51.479	52.910						
IRT	Broadway	B4	210+59	C/S		1758		1.37	(1)	50	55	48.580	56.912	73.732	51.479	52.910						
IRT	Broadway	B4	210+93	S/T	404	1758		******	(1)	50	55											
IRT	Broadway	B4	217+47	T/S		-3003.13		******	(1)	50	55											
IRT	Broadway	B4	218+13	S/C		3003.13		1.41	(1)	50	55	63.732	74.587	96.526	67.507	69.372						
IRT	Broadway	B4	219+08	C/S		3003.13		1.41	(1)	50	55	63.732	74.587	96.526	67.507	69.372						
IRT	Broadway	B4	220+04	S/T	257	-3003.13		******	(1)	50	55											
IRT	Broadway	B4	220+47	T/S		-3133.70		******	(1)	50	55											
IRT	Broadway	B4	223+02	S/C		3133.70		1.28	(1)	50	55	64.315	75.520	98.084	68.217	70.142						
IRT	Broadway	B4	230+35	C/S		3133.70		1.28	(1)	50	55	64.315	75.520	98.084	68.217	70.142						
IRT	Broadway	B4	230+63	S/T	1016	-3133.70		******	(1)	50	55											
IRT	Broadway	B4	233+86	T/S		-1264.47		******	44	50	55											
IRT	Broadway	B4	235+63	S/C		1264.47		2.00	44	50	55	43.551	50.289	64.106	45.884	47.041						
IRT	Broadway	B4	238+61	C/S		1264.47		2.00	44	50	55	43.551	50.289	64.106	45.884	47.041						
IRT	Broadway	B4	239+95	S/T	609	-1264.47		******	44	50	55											
IRT	Broadway	B4	240+94	T/S		1373		******	(1)	50	55											
IRT	Broadway	B4	242+40	S/C		1373		2.46	(1)	50	55	47.087	53.885	67.968	49.434	50.600						
IRT	Broadway	B4	243+63	C/S		1373		2.46	(1)	50	55	47.087	53.885	67.968	49.434	50.600						
IRT	Broadway	B4	245+20	S/T	426	1373		******	(1)	50	55											
IRT	Broadway	B4	265+87	T/S		Sw. 211	942	******	19	37.5	46											
IRT	Broadway	B4	266+25	S/C		Sw. 211	942	0.00	19	37.5	46									18.795	37.590	46.038
IRT	Broadway	B4	266+74	C/S		Sw. 211	942	0.00	19	37.5	46									18.795	37.590	46.038
IRT	Broadway	B4	267+34	S/C		1022.34		0.26	33	40	54	32.997	40.000	53.646	35.461	36.666						
IRT	Broadway	B4	267+74	C/S		1022.34		0.26	33	40	54	32.997	40.000	53.646	35.461	36.666						
IRT	Broadway	B4	269+00	S/T	313	-1022.34		******	33	40	54											
IRT	Broadway	B4	271+84	T/S		4368		******	(1)	50	55											
IRT	Broadway	B4	272+44	S/C		4368		0.08	(1)	50	55	66.750	81.484	109.999	71.946	74.482						
IRT	Broadway	B4	275+24	C/S		4368		0.08	(1)	50	55	66.750	81.484	109.999	71.946	74.482						
IRT	Broadway	B4	275+55	S/T	371	4368		******	(1)	50	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	Broadway	B4	276+77	T/S		-1201.25		******	35	43	55											
IRT	Broadway	B4	277+65	S/S		1201.25		0.06	35	43	55	34.918	42.660	57.632	37.649	38.982						
IRT	Broadway	B4	279+08	S/C		1008		0.15	32	39	53	32.340	39.368	53.009	34.816	36.026						
IRT	Broadway	B4	279+59	C/S		1008		0.15	32	39	53	32.340	39.368	53.009	34.816	36.026						
IRT	Broadway	B4	280+14	S/C		4119		0.11	(1)	50	55	65.053	79.317	106.955	70.081	72.536						
IRT	Broadway	B4	280+84	C/S		4119		0.11	(1)	50	55	65.053	79.317	106.955	70.081	72.536						
IRT	Broadway	B4	281+08	S/T	431	4119		******	(1)	50	55											
IRT	Broadway	B4	284+96	T/S		3604		******	(1)	50	55											
IRT	Broadway	B4	286+44	S/C		3604		0.03	(1)	50	55	60.256	73.707	99.686	65.003	67.318						
IRT	Broadway	B4	286+77	C/S		3604		0.03	(1)	50	55	60.256	73.707	99.686	65.003	67.318						
IRT	Broadway	B4	287+59	S/T	263	3604		******	(1)	50	55											
IRT	Broadway	B4	290+34	T/S		2288		******	(1)	50	55											
IRT	Broadway	B4	291+26	S/C		2288		1.35	(1)	50	55	55.320	64.841	84.051	58.633	60.269						
IRT	Broadway	B4	296+04	C/S		2288		1.35	(1)	50	55	55.320	64.841	84.051	58.633	60.269						
IRT	Broadway	B4	296+62	S/T	628	2288		******	(1)	50	55											
IRT	Broadway	B4	308+83	T/S		6170		******	(1)	50	55											
IRT	Broadway	B4	309+68	S/C		6170		0.04	(1)	50	55	78.941	96.523	130.496	85.145	88.171						
IRT	Broadway	B4	311+70	C/S		6170		0.04	(1)	50	55	78.941	96.523	130.496	85.145	88.171						
IRT	Broadway	B4	312+24	S/T	341	6170		******	(1)	50	55											
IRT	Broadway	B4	316+35	T/S		-4980.00		******	(1)	50	55											
IRT	Broadway	B4	317+98	S/C		4980.00		0.13	(1)	50	55	71.707	87.360	117.715	77.224	79.918						
IRT	Broadway	B4	319+99	C/S		4980.00		0.13	(1)	50	55	71.707	87.360	117.715	77.224	79.918						
IRT	Broadway	B4	320+38	S/C		3352.33		0.05	(1)	50	55	58.260	71.207	96.233	62.828	65.056						
IRT	Broadway	B4	320+69	C/S		3352.33		0.05	(1)	50	55	58.260	71.207	96.233	62.828	65.056						
IRT	Broadway	B4	320+77	S/C		7586.84		0.13	(1)	50	55	88.507	107.828	145.294	95.317	98.641						
IRT	Broadway	B4	321+23	C/S		7586.84		0.13	(1)	50	55	88.507	107.828	145.294	95.317	98.641						
IRT	Broadway	B4	321+31	S/T	496	-7586.84		******	(1)	50	55											
IRT	Broadway	B4	334+33	T/S		2720		******	(1)	50	55											
IRT	Broadway	B4	334+56	S/C		2720		0.00	(1)	50	55	52.152	63.873	86.484	56.290	58.307						
IRT	Broadway	B4	335+80	C/S		2720		0.00	(1)	50	55	52.152	63.873	86.484	56.290	58.307						
IRT	Broadway	B4	337+43	S/S		1359.91		0.03	37	45	55	37.015	45.278	61.237	39.931	41.353						
IRT	Broadway	B4	338+90	S/T	457	-1359.91		******	37	45	55											
IRT	Broadway	BB4	341+23	T/S		-2151.49		******	(1)	50	55											
IRT	Broadway	BB4	341+46	S/C		2151.49		0.09	(1)	50	55	46.903	57.233	77.233	50.546	52.324						
IRT	Broadway	BB4	0+44	C/S		2151.49		0.09	(1)	50	55	46.903	57.233	77.233	50.546	52.324						
IRT	Broadway	BB4	0+59	S/T	82	-2151.49		******	(1)	50	55											
IRT	Broadway	BB4	0+83	T/S		1602		******	41	50	55											
IRT	Broadway	BB4	1+37	S/C		1602		0.15	41	50	55	40.764	49.624	66.818	43.886	45.411						
IRT	Broadway	BB4	1+83	C/S		1602		0.15	41	50	55	40.764	49.624	66.818	43.886	45.411						
IRT	Broadway	BB4	2+30	S/T	147	1602		******	41	50	55											
IRT	Broadway	BB4	18+03	T/S		-1399.51		******	44	50	55											
IRT	Broadway	BB4	18+91	S/C		1399.51		1.53	44	50	55	43.987	51.328	66.212	46.538	47.799						
IRT	Broadway	BB4	23+84	C/S		1399.51		1.53	44	50	55	43.987	51.328	66.212	46.538	47.799						
IRT	Broadway	BB4	25+42	S/T	739	-1399.51		******	44	50	55											
IRT	Broadway	BB4	28+81	T/S		1567		******	(1)	50	55											
IRT	Broadway	BB4	30+29	S/C		1567		1.42	(1)	50	55	46.077	53.912	69.750	48.802	50.148						
IRT	Broadway	BB4	34+78	C/S		1567		1.42	(1)	50	55	46.077	53.912	69.750	48.802	50.148						
IRT	Broadway	BB4	36+28	S/T	747	1567		******	(1)	50	55											
IRT	Broadway	BB4	66+86	T/S		-3432.14		******	(1)	50	55											
IRT	Broadway	BB4	67+63	S/C		3432.14		0.11	(1)	50	55	59.385	72.406	97.636	63.975	66.216						
IRT	Broadway	BB4	68+33	C/S		3432.14		0.11	(1)	50	55	59.385	72.406	97.636	63.975	66.216						
IRT	Broadway	BB4	68+87	S/T	201	-3432.14		******	(1)	50	55											
IRT	Broadway	BB4	69+18	T/S		2529		******	(1)	50	55											
IRT	Broadway	BB4	69+88	S/S		2529		-0.06	(1)	50	55	49.910	61.282	83.167	53.929	55.886						
IRT	Broadway	BB4	71+27	S/T	209	2529		******	(1)	50	55											
IRT	Broadway	BB4	106+77	T/S		1696		******	41	50	55											
IRT	Broadway	BB4	107+91	S/S		1696		0.02	41	50	55	41.284	50.520	68.353	44.544	46.134						
IRT	Broadway	BB4	108+71	S/C		1736.75		0.72	45	50	55	45.270	54.016	71.335	48.331	49.835						
IRT	Broadway	BB4	109+26	C/S		1736.75		0.72	45	50	55	45.270	54.016	71.335	48.331	49.835						
IRT	Broadway	BB4	109+57	S/T	280	-1736.75		******	45	50	55											
IRT	Broadway	BB4	132+81	T/S		-485		******	23	28	37											
IRT	Broadway	BB4	133+54	S/S		485.35		0.27	23	28	37	22.762	27.582	36.980	24.458	25.287						
IRT	Broadway	BB4	134+36	S/C		Sw. 113	603	0.00	15	30	37									15.037	30.075	36.834
IRT	Broadway	BB4	134+75	C/S		Sw. 113	603	0.00	15	30	37									15.037	30.075	36.834
IRT	Broadway	BB4	134+98	S/T	217	Sw. 113	603	0.00	15	30	37									15.037	30.075	36.834
IRT	Broadway	BB4	274+66	T/S		868		******	34	40	52											
IRT	Broadway	BB4	276+03	S/C		868		1.47	34	40	52	34.460	40.270	52.030	36.480	37.478						
IRT	Broadway	BB4	279+87	C/S		868		1.47	34	40	52	34.460	40.270	52.030	36.480	37.478						
IRT	Broadway	BB4	281+28	S/T	662	868		******	34	40	52											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	Broadway	BB4	291+26	T/S		-626.74		******	33	38	47											
IRT	Broadway	BB4	292+36	S/C		626.74		2.98	33	38	47	33.071	37.510	46.802	34.599	35.360						
IRT	Broadway	BB4	294+88	C/S		626.74		2.98	33	38	47	33.071	37.510	46.802	34.599	35.360						
IRT	Broadway	BB4	296+20	S/T	494	-626.74		******	33	38	47											
IRT	Broadway	BB4	324+18	T/S		2529		******	(1)	50	55											
IRT	Broadway	BB4	324+54	S/C		2529		2.03	(1)	50	55	61.745	71.252	90.764	65.036	66.668						
IRT	Broadway	BB4	329+21	C/S		2529		2.03	(1)	50	55	61.745	71.252	90.764	65.036	66.668						
IRT	Broadway	BB4	330+01	S/T	583	2529		******	(1)	50	55											
IRT	Broadway	BB4	333+04	T/S		3696		******	(1)	50	55											
IRT	Broadway	BB4	334+02	S/S		3696		0.29	(1)	50	55	62.961	76.238	102.139	67.631	69.915						
IRT	Broadway	BB4	334+78	S/T	174	3696		******	(1)	50	55											
IRT	Broadway	BB4	339+73	T/S		2002		******	(1)	50	55											
IRT	Broadway	BB4	340+77	S/S		2002		0.45	(1)	50	55	47.194	56.819	75.703	50.573	52.229						
IRT	Broadway	BB4	342+17	S/T	244	2002		******	(1)	50	55											
IRT	Broadway	BB4	342+49	T/S		-1848.08		******	43	50	55											
IRT	Broadway	BB4	343+46	S/C		1848.08		0.09	43	50	55	43.470	53.044	71.581	46.846	48.494						
IRT	Broadway	BB4	343+81	C/S		1848.08		0.09	43	50	55	43.470	53.044	71.581	46.846	48.494						
IRT	Broadway	BB4	344+83	S/T	234	-1848.08		******	43	50	55											
IRT	Broadway	BB4	349+55	T/S		1052		******	44	50	55											
IRT	Broadway	BB4	350+51	S/C		1052		3.38	44	50	55	44.060	49.673	61.503	45.988	46.950						
IRT	Broadway	BB4	351+55	C/S		1052		3.38	44	50	55	44.060	49.673	61.503	45.988	46.950						
IRT	Broadway	BB4	352+43	S/T	288	1052		******	44	50	55											
IRT	Broadway	BB4	353+55	T/S		-833.24		******	43	48	55											
IRT	Broadway	BB4	354+99	S/C		833.24		4.90	43	48	55	43.058	47.651	57.551	44.626	45.412						
IRT	Broadway	BB4	357+26	C/S		833.24		4.90	43	48	55	43.058	47.651	57.551	44.626	45.412						
IRT	Broadway	BB4	358+86	S/T	531	-833.24		******	43	48	55											
IRT	Broadway	BB4	380+27	T/S		-1922.00		******	(1)	50	55											
IRT	Broadway	BB4	381+35	S/C		1922.00		1.88	(1)	50	55	53.154	61.533	78.669	56.058	57.496						
IRT	Broadway	BB4	381+66	C/S		1922.00		1.88	(1)	50	55	53.154	61.533	78.669	56.058	57.496						
IRT	Broadway	BB4	382+36	S/T	209	-1922.00		******	(1)	50	55											
IRT	Broadway	BB4	387+16	T/S		-1896.71		******	(1)	50	55											
IRT	Broadway	BB4	387+94	S/C		1896.71		1.45	(1)	50	55	50.836	59.436	76.834	53.826	55.303						
IRT	Broadway	BB4	388+64	C/S		1896.71		1.45	(1)	50	55	50.836	59.436	76.834	53.826	55.303						
IRT	Broadway	BB4	389+18	S/T	202	-1896.71		******	(1)	50	55											
IRT	Broadway	BB4	394+06	T/S		-2719.81		******	(1)	50	55											
IRT	Broadway	BB4	394+84	S/C		2719.81		0.76	(1)	50	55	56.891	67.797	89.422	60.707	62.582						
IRT	Broadway	BB4	395+38	C/S		2719.81		0.76	(1)	50	55	56.891	67.797	89.422	60.707	62.582						
IRT	Broadway	BB4	395+61	S/T	155	-2719.81		******	(1)	50	55											
IRT	Broadway	BB4	395+69	T/S		2184		******	(1)	50	55											
IRT	Broadway	BB4	396+23	S/C		2184		1.13	(1)	50	55	52.925	62.395	81.383	56.227	57.854						
IRT	Broadway	BB4	396+39	C/S		2184		1.13	(1)	50	55	52.925	62.395	81.383	56.227	57.854						
IRT	Broadway	BB4	396+70	S/T	101	2184		******	(1)	50	55											
IRT	Broadway	B2	322+37	T/S		-7207.50		******	(1)	50	55											
IRT	Broadway	B2	320+57	S/C		7207.50		0.47	(1)	50	55	89.746	107.973	143.762	96.144	99.279						
IRT	Broadway	B2	317+70	C/S		7207.50		0.47	(1)	50	55	89.746	107.973	143.762	96.144	99.279						
IRT	Broadway	B2	317+16	S/T	521	-7207.50		******	(1)	50	55											
IRT	Broadway	B2	313+53	T/S		4805		******	(1)	50	55											
IRT	Broadway	B2	311+71	S/C		4805		1.14	(1)	50	55	78.578	92.612	120.761	83.470	85.882						
IRT	Broadway	B2	309+90	C/S		4805		1.14	(1)	50	55	78.578	92.612	120.761	83.470	85.882						
IRT	Broadway	B2	307+52	S/T	601	4805		******	(1)	50	55											
IRT	Broadway	B2	297+50	T/S		2030		******	(1)	50	55											
IRT	Broadway	B2	295+67	S/C		2030		2.24	(1)	50	55	56.278	64.671	81.977	59.180	60.620						
IRT	Broadway	B2	291+58	C/S		2030		2.24	(1)	50	55	56.278	64.671	81.977	59.180	60.620						
IRT	Broadway	B2	289+96	S/T	754	2030		******	(1)	50	55											
IRT	Broadway	B2	287+64	T/S		3516		******	(1)	50	55											
IRT	Broadway	B2	287+02	S/C		3516		0.19	(1)	50	55	60.687	73.762	99.175	65.291	67.541						
IRT	Broadway	B2	285+47	C/S		3516		0.19	(1)	50	55	60.687	73.762	99.175	65.291	67.541						
IRT	Broadway	B2	285+16	S/T	248	3516		******	(1)	50	55											
IRT	Broadway	B2	281+69	T/S		3352		******	(1)	50	55											
IRT	Broadway	B2	280+90	S/C		3352		0.10	(1)	50	55	58.619	71.500	96.451	63.161	65.377						
IRT	Broadway	B2	278+12	C/S		3352		0.10	(1)	50	55	58.619	71.500	96.451	63.161	65.377						
IRT	Broadway	B2	277+38	S/T	431	3352		******	(1)	50	55											
IRT	Broadway	B2	276+01	T/S		3352		******	(1)	50	55											
IRT	Broadway	B2	275+10	S/C		3352		0.03	(1)	50	55	58.116	71.089	96.146	62.695	64.927						
IRT	Broadway	B2	272+66	C/S		3352		0.03	(1)	50	55	58.116	71.089	96.146	62.695	64.927						
IRT	Broadway	B2	271+48	S/T	453	3352		******	(1)	50	55											
IRT	Broadway	B2	263+99	T/S		7587		******	(1)	50	55											
IRT	Broadway	B2	263+34	S/C		7587		0.17	(1)	50	55	88.934	108.179	145.555	95.714	99.025						
IRT	Broadway	B2	258+13	C/S		7587		0.17	(1)	50	55	88.934	108.179	145.555	95.714	99.025						
IRT	Broadway	B2	256+35	S/T	764	7587		******	(1)	50	55											
IRT	Broadway	B2	245+08	T/S		1299		******	(1)	50	55											
IRT	Broadway	B2	243+67	S/C		1299		2.62	(1)	50	55	46.360	52.902	66.497	48.616	49.739						
IRT	Broadway	B2	241+79	C/S		1299		2.62	(1)	50	55	46.360	52.902	66.497	48.616	49.739						
IRT	Broadway	B2	241+20	S/T	388	1299		******	(1)	50	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	Broadway	B2	239+81	T/S		-1334.72		******	(1)	50	55											
IRT	Broadway	B2	238+38	S/C		1334.72		3.10	(1)	50	55	48.674	55.104	68.592	50.886	51.989						
IRT	Broadway	B2	235+67	C/S		1334.72		3.10	(1)	50	55	48.674	55.104	68.592	50.886	51.989						
IRT	Broadway	B2	234+16	S/T	565	-1334.72		******	(1)	50	55											
IRT	Broadway	B2	230+75	T/S		-3895.95		******	(1)	50	55											
IRT	Broadway	B2	229+66	S/C		3895.95		1.88	(1)	50	55	75.677	87.607	112.004	79.811	81.860						
IRT	Broadway	B2	222+01	C/S		3895.95		1.88	(1)	50	55	75.677	87.607	112.004	79.811	81.860						
IRT	Broadway	B2	221+45	S/T	930	-3895.95		******	(1)	50	55											
IRT	Broadway	B2	219+70	T/S		-3696.15		******	(1)	50	55											
IRT	Broadway	B2	219+31	S/C		3696.15		1.50	(1)	50	55	71.290	83.248	107.473	75.446	77.500						
IRT	Broadway	B2	218+15	C/S		3696.15		1.50	(1)	50	55	71.290	83.248	107.473	75.446	77.500						
IRT	Broadway	B2	217+76	S/T	194	-3696.15		******	(1)	50	55											
IRT	Broadway	B2	211+00	T/S		1820		******	(1)	50	55											
IRT	Broadway	B2	210+45	S/C		1820		1.83	(1)	50	55	51.504	59.688	76.405	54.341	55.746						
IRT	Broadway	B2	207+35	C/S		1820		1.83	(1)	50	55	51.504	59.688	76.405	54.341	55.746						
IRT	Broadway	B2	206+73	S/T	427	1820		******	(1)	50	55											
IRT	Broadway	B2	201+77	T/S		-936.04		******	40	46	55											
IRT	Broadway	B2	200+08	S/C		936.04		2.95	40	46	55	40.328	45.764	57.135	42.200	43.132						
IRT	Broadway	B2	199+29	C/S		936.04		2.95	40	46	55	40.328	45.764	57.135	42.200	43.132						
IRT	Broadway	B2	198+05	S/T	372	-936.04		******	40	46	55											
IRT	Broadway	B3	197+82	T/S		-1126.17		******	43	49	55											
IRT	Broadway	B3	198+92	S/C		1126.17		2.61	43	49	55	43.139	49.235	61.902	45.242	46.288						
IRT	Broadway	B3	200+04	C/S		1126.17		2.61	43	49	55	43.139	49.235	61.902	45.242	46.288						
IRT	Broadway	B3	201+14	S/T	332	-1126.17		******	43	49	55											
IRT	Broadway	B3	206+15	T/S		1872		******	(1)	50	55											
IRT	Broadway	B3	207+23	S/C		1872		2.13	(1)	50	55	53.563	61.685	78.391	56.372	57.767						
IRT	Broadway	B3	209+87	C/S		1872		2.13	(1)	50	55	53.563	61.685	78.391	56.372	57.767						
IRT	Broadway	B3	210+72	S/T	457	1872		******	(1)	50	55											
IRT	Broadway	B3	217+07	T/S		-2883.00		******	(1)	50	55											
IRT	Broadway	B3	217+52	S/C		2883.00		0.56	(1)	50	55	57.329	68.761	91.279	61.338	63.304						
IRT	Broadway	B3	218+74	C/S		2883.00		0.56	(1)	50	55	57.329	68.761	91.279	61.338	63.304						
IRT	Broadway	B3	219+44	S/T	237	-2883.00		******	(1)	50	55											
IRT	Broadway	B3	220+77	T/S		-3203.33		******	(1)	50	55											
IRT	Broadway	B3	221+05	S/C		3203.33		1.48	(1)	50	55	66.246	77.397	99.972	70.122	72.037						
IRT	Broadway	B3	229+72	C/S		3203.33		1.48	(1)	50	55	66.246	77.397	99.972	70.122	72.037						
IRT	Broadway	B3	230+48	S/T	971	-3203.33		******	(1)	50	55											
IRT	Broadway	B3	233+47	T/S		-1232.05		******	(1)	50	55											
IRT	Broadway	B3	235+07	S/C		1232.05		3.02	(1)	50	55	46.500	52.709	65.714	49.702	49.702						
IRT	Broadway	B3	238+21	C/S		1232.05		3.02	(1)	50	55	46.500	52.709	65.714	49.702	49.702						
IRT	Broadway	B3	238+99	S/T	552	-1232.05		******	(1)	50	55											
IRT	Broadway	B3	240+39	T/S		1360		******	(1)	50	55											
IRT	Broadway	B3	241+96	S/C		1360		3.01	(1)	50	55	48.818	55.346	69.015	51.065	52.184						
IRT	Broadway	B3	243+41	C/S		1360		3.01	(1)	50	55	48.818	55.346	69.015	51.065	52.184						
IRT	Broadway	B3	244+22	S/T	383	1360		******	(1)	50	55											
IRT	Broadway	B3	257+76	T/S		7208		******	(1)	50	55											
IRT	Broadway	B3	258+30	S/S		7208		0.40	(1)	50	55	89.041	107.387	143.323	95.486	98.641						
IRT	Broadway	B3	259+08	S/T	132	7208		******	(1)	50	55											
IRT	Broadway	B3	260+32	T/S		-9009.38		******	(1)	50	55											
IRT	Broadway	B3	261+09	S/S		9009.38		0.07	(1)	50	55	95.745	116.926	157.903	103.216	106.862						
IRT	Broadway	B3	261+25	S/S		3516		0.06	(1)	50	55	59.738	72.983	98.597	64.410	66.690						
IRT	Broadway	B3	261+40	S/T	108	3516		******	(1)	50	55											
IRT	Broadway	B3	261+71	T/S		7208		******	(1)	50	55											
IRT	Broadway	B3	261+79	S/S		7208		0.57	(1)	50	55	90.745	108.804	144.387	97.076	100.182						
IRT	Broadway	B3	261+87	S/T	16	7208		******	(1)	50	55											
IRT	Broadway	B3	270+94	T/S		3516		******	(1)	50	55											
IRT	Broadway	B3	272+10	S/C		3516		0.45	(1)	50	55	62.541	75.295	100.320	67.019	69.212						
IRT	Broadway	B3	274+81	C/S		3516		0.45	(1)	50	55	62.541	75.295	100.320	67.019	69.212						
IRT	Broadway	B3	275+04	S/T	410	3516		******	(1)	50	55											
IRT	Broadway	B3	276+31	T/S		3696		******	(1)	50	55											
IRT	Broadway	B3	278+04	S/C		3696		0.93	(1)	50	55	67.495	80.022	104.994	71.871	74.024						
IRT	Broadway	B3	280+14	C/S		3696		0.93	(1)	50	55	67.495	80.022	104.994	71.871	74.024						
IRT	Broadway	B3	281+16	S/T	485	3696		******	(1)	50	55											
IRT	Broadway	B3	284+38	T/S		3896		******	(1)	50	55											
IRT	Broadway	B3	285+25	S/C		3896		0.55	(1)	50	55	66.571	79.872	106.064	71.235	73.523						
IRT	Broadway	B3	286+74	C/S		3896		0.55	(1)	50	55	66.571	79.872	106.064	71.235	73.523						
IRT	Broadway	B3	287+18	S/T	280	3896		******	(1)	50	55											
IRT	Broadway	B3	289+71	T/S		2030		******	(1)	50	55											
IRT	Broadway	B3	290+79	S/C		2030		1.56	(1)	50	55	53.123	61.945	79.844	56.188	57.703						
IRT	Broadway	B3	295+56	C/S		2030		1.56	(1)	50	55	53.123	61.945	79.844	56.188	57.703						
IRT	Broadway	B3	296+30	S/T	659	2030		******	(1)	50	55											
IRT	Broadway	B3	307+99	T/S		5339		******	(1)	50	55											
IRT	Broadway	B3	308+47	S/C		5339		-0.09	(1)	50	55	72.241	88.816	120.672	78.100	80.954						
IRT	Broadway	B3	311+48	C/S		5339		-0.09	(1)	50	55	72.241	88.816	120.672	78.100	80.954						
IRT	Broadway	B3	312+13	S/T	414	5339		******	(1)	50	55											
IRT	Broadway	B3	316+10	T/S		-5148.21		******	(1)	50	55											
IRT	Broadway	B3	317+82	S/C		5148.21		0.16	(1)	50	55	73.172	89.041	119.848	78.763	81.494						
IRT	Broadway	B3	319+96	C/S		5148.21		0.16	(1)	50	55	73.172	89.041	119.848	78.763	81.494						
IRT	Broadway	B3	321+82	S/T	572	-5148.21		******	(1)	50	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	Broadway	BB1	394+92	T/S		1737		******	45	50	55											
IRT	Broadway	BB1	393+99	S/S		1737		0.68	45	50	55	45.078	53.855	71.213	48.151	49.661						
IRT	Broadway	BB1	393+68	S/T	124	1737		******	45	50	55											
IRT	Broadway	BB1	393+13	T/S		-1298.65		******	36	45	55											
IRT	Broadway	BB1	392+75	S/S		1298.65		0.10	36	45	55	36.484	44.502	60.031	39.311	40.691						
IRT	Broadway	BB1	391+97	S/T	116	-1298.65		******	36	45	55											
IRT	Broadway	BB1	387+24	T/S		-2252.34		******	(1)	50	55											
IRT	Broadway	BB1	386+31	S/C		2252.34		0.90	(1)	50	55	52.527	62.332	81.858	55.953	57.639						
IRT	Broadway	BB1	385+62	C/S		2252.34		0.90	(1)	50	55	52.527	62.332	81.858	55.953	57.639						
IRT	Broadway	BB1	385+00	S/T	224	-2252.34		******	(1)	50	55											
IRT	Broadway	BB1	380+19	T/S		-2030.28		******	(1)	50	55											
IRT	Broadway	BB1	379+26	S/C		2030.28		1.43	(1)	50	55	52.499	61.410	79.430	55.598	57.129						
IRT	Broadway	BB1	379+11	C/S		2030.28		1.43	(1)	50	55	52.499	61.410	79.430	55.598	57.129						
IRT	Broadway	BB1	378+10	S/T	209	-2030.28		******	(1)	50	55											
IRT	Broadway	BB1	357+31	T/S		-823.71		******	41	45	55											
IRT	Broadway	BB1	355+24	S/C		823.71		4.01	41	45	55	40.614	45.402	55.597	42.254	43.075						
IRT	Broadway	BB1	353+00	C/S		823.71		4.01	41	45	55	40.614	45.402	55.597	42.254	43.075						
IRT	Broadway	BB1	351+59	S/T	572	-824		******	41	45	55											
IRT	Broadway	BB1	350+91	T/S		1092		******	43	49	55											
IRT	Broadway	BB1	349+26	S/C		1092		2.66	43	49	55	42.641	48.624	61.068	44.704	45.730						
IRT	Broadway	BB1	347+98	C/S		1092		2.66	43	49	55	42.641	48.624	61.068	44.704	45.730						
IRT	Broadway	BB1	347+62	S/T	329	1092		******	43	49	55											
IRT	Broadway	BB1	342+80	T/S		-2217.69		******	(1)	50	55											
IRT	Broadway	BB1	341+71	S/C		2217.69		0.72	(1)	50	55	51.155	61.039	80.609	54.615	56.314						
IRT	Broadway	BB1	341+00	C/S		2217.69		0.72	(1)	50	55	51.155	61.039	80.609	54.615	56.314						
IRT	Broadway	BB1	340+78	S/T	202	-2217.69		******	(1)	50	55											
IRT	Broadway	BB1	339+90	T/S		2059		******	(1)	50	55											
IRT	Broadway	BB1	339+55	S/C		2059		0.52	(1)	50	55	48.239	57.936	77.011	51.641	53.309						
IRT	Broadway	BB1	338+90	C/S		2059		0.52	(1)	50	55	48.239	57.936	77.011	51.641	53.309						
IRT	Broadway	BB1	337+38	S/T	252	2059		******	(1)	50	55											
IRT	Broadway	BB1	332+37	T/S		3203		******	(1)	50	55											
IRT	Broadway	BB1	332+22	S/C		3203		0.39	(1)	50	55	59.293	71.535	95.507	63.594	65.700						
IRT	Broadway	BB1	331+91	C/S		3203		0.39	(1)	50	55	59.293	71.535	95.507	63.594	65.700						
IRT	Broadway	BB1	331+83	S/C		5766		0.21	(1)	50	55	77.902	94.614	127.119	83.786	86.661						
IRT	Broadway	BB1	331+44	C/S		5766		0.21	(1)	50	55	77.902	94.614	127.119	83.786	86.661						
IRT	Broadway	BB1	330+82	S/T	155	5766		******	(1)	50	55											
IRT	Broadway	BB1	327+97	T/S		2151		******	(1)	50	55											
IRT	Broadway	BB1	326+90	S/C		2151		2.09	(1)	50	55	57.233	65.965	83.909	60.255	61.754						
IRT	Broadway	BB1	322+40	C/S		2151		2.09	(1)	50	55	57.233	65.965	83.909	60.255	61.754						
IRT	Broadway	BB1	322+02	S/T	595	2151		******	(1)	50	55											
IRT	Broadway	BB1	294+21	T/S		-626.74		******	32	37	46											
IRT	Broadway	BB1	292+84	S/C		626.74		2.56	32	37	46	32.060	36.623	46.094	33.634	34.417						
IRT	Broadway	BB1	290+48	C/S		626.74		2.56	32	37	46	32.060	36.623	46.094	33.634	34.417						
IRT	Broadway	BB1	289+21	S/T	500	-626.74		******	32	37	46											
IRT	Broadway	BB1	279+43	T/S		833		******	37	43	53											
IRT	Broadway	BB1	277+94	S/C		833		2.68	37	43	53	37.303	42.522	53.382	39.102	39.998						
IRT	Broadway	BB1	274+21	C/S		833		2.68	37	43	53	37.303	42.522	53.382	39.102	39.998						
IRT	Broadway	BB1	272+88	S/T	655	833		******	37	43	53											
IRT	Broadway	BB1	107+31	T/S		-1716.07		******	42	50	55											
IRT	Broadway	BB1	106+77	S/C		1716.07		0.05	42	50	55	41.684	50.947	68.852	44.952	46.546						
IRT	Broadway	BB1	106+46	C/S		1716.07		0.05	42	50	55	41.684	50.947	68.852	44.952	46.546						
IRT	Broadway	BB1	105+76	S/C		2772		0.16	(1)	50	55	53.694	65.338	87.944	57.796	59.800						
IRT	Broadway	BB1	105+30	C/S		2772		0.16	(1)	50	55	53.694	65.338	87.944	57.796	59.800						
IRT	Broadway	BB1	104+45	S/T	286	2772		******	(1)	50	55											
IRT	Broadway	BB1	68+49	T/S		1456		******	39	47	55											
IRT	Broadway	BB1	67+87	S/S		1456		0.11	39	47	55	38.679	47.161	63.594	41.670	43.129						
IRT	Broadway	BB1	67+32	S/T	117	1456		******	39	47	55											
IRT	Broadway	BB1	67+01	T/S		-2288.10		******	(1)	50	55											
IRT	Broadway	BB1	66+32	S/S		2288.10		0.19	(1)	50	55	48.957	59.505	80.006	52.672	54.487						
IRT	Broadway	BB1	65+39	S/T	162	-2288.10		******	(1)	50	55											
IRT	Broadway	BB1	34+30	T/S		1471		******	(1)	50	55											
IRT	Broadway	BB1	33+01	S/C		1471		2.17	(1)	50	55	47.633	54.812	69.592	50.116	51.348						
IRT	Broadway	BB1	28+03	C/S		1471		2.17	(1)	50	55	47.633	54.812	69.592	50.116	51.348						
IRT	Broadway	BB1	26+72	S/T	758	1471		******	(1)	50	55											
IRT	Broadway	BB1	23+20	T/S		-1486.08		******	44	50	55											
IRT	Broadway	BB1	21+49	S/C		1486.08		1.28	44	50	55	44.290	52.006	67.545	46.977	48.303						
IRT	Broadway	BB1	17+22	C/S		1486.08		1.28	44	50	55	44.290	52.006	67.545	46.977	48.303						
IRT	Broadway	BB1	15+85	S/T	735	-1486.08		******	44	50	55											
IRT	Broadway	BB1	11+19	T/S		-1322.48		******	38	46	55											
IRT	Broadway	BB1	10+67	S/S		1322.48		0.38	38	46	55	38.054	45.928	61.339	40.821	42.175						
IRT	Broadway	BB1	7+41	S/S		1736.75		0.35	43	50	55	43.459	52.508	70.200	46.640	48.196						
IRT	Broadway	BB1	7+15	S/T	404	1736.75		******	43	50	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	Broadway	BB1	0+04	T/S		-1359.91		******	37	45	55											
IRT	Broadway	BB1	0+74	S/C		1359.91		0.06	37	45	55	37.152	45.390	61.320	40.059	41.476						
IRT	Broadway	BB1	0+13	C/S		1359.91		0.06	37	45	55	37.152	45.390	61.320	40.059	41.476						
IRT	Broadway	BB1	342+27	S/T	100	-1359.91		******	37	45	55											
IRT	Broadway	B1	341+95	T/S		2403		******	(1)	50	55											
IRT	Broadway	B1	340+39	S/S		2403		0.10	(1)	50	55	49.624	60.529	81.651	53.469	55.346						
IRT	Broadway	B1	339+68	S/T	227	2403		******	(1)	50	55											
IRT	Broadway	B1	337+52	T/S		1948		******	45	50	55											
IRT	Broadway	B1	336+58	S/C		1948		0.10	45	50	55	44.684	54.504	73.523	48.147	49.836						
IRT	Broadway	B1	336+09	C/S		1948		0.10	45	50	55	44.684	54.504	73.523	48.147	49.836						
IRT	Broadway	B1	334+02	S/S		1619.66		0.09	41	50	55	40.695	49.658	67.011	43.856	45.398						
IRT	Broadway	B1	333+00	S/T	452	-1619.66		******	41	50	55											
IRT	Broadway	B1	321+03	T/S		-6267.39		******	(1)	50	55											
IRT	Broadway	B1	320+10	S/C		6267.39		0.22	(1)	50	55	81.315	98.721	132.590	87.443	90.438						
IRT	Broadway	B1	316+75	C/S		6267.39		0.22	(1)	50	55	81.315	98.721	132.590	87.443	90.438						
IRT	Broadway	B1	315+55	S/T	548	-6267.39		******	(1)	50	55											
IRT	Broadway	B1	310+98	T/S		4971		******	(1)	50	55											
IRT	Broadway	B1	310+67	S/C		4971		0.07	(1)	50	55	71.117	86.851	117.288	76.667	79.375						
IRT	Broadway	B1	307+80	C/S		4971		0.07	(1)	50	55	71.117	86.851	117.288	76.667	79.375						
IRT	Broadway	B1	307+17	S/T	381	4971		******	(1)	50	55											
IRT	Broadway	B1	295+41	T/S		2059		******	(1)	50	55											
IRT	Broadway	B1	294+96	S/C		2059		0.18	(1)	50	55	46.389	56.406	75.866	49.917	51.641						
IRT	Broadway	B1	290+01	C/S		2059		0.18	(1)	50	55	46.389	56.406	75.866	49.917	51.641						
IRT	Broadway	B1	288+95	S/T	646	2059		******	(1)	50	55											
IRT	Broadway	B1	287+94	T/S		Sw. 265	1139	******	21	41	51											
IRT	Broadway	B1	287+47	S/C		Sw. 265	1139	0.00	21	41	51									20.667	41.334	50.624
IRT	Broadway	B1	286+80	C/S		Sw. 265	1139	0.00	21	41	51									20.667	41.334	50.624
IRT	Broadway	B1	286+34	S/C		1211		0.44	37	44	55	36.669	44.162	58.860	39.300	40.589						
IRT	Broadway	B1	285+26	C/S		1211		0.44	37	44	55	36.669	44.162	58.860	39.300	40.589						
IRT	Broadway	B1	284+20	S/T	374	1211		******	37	44	55											
IRT	Broadway	B1	280+28	T/S		3516		******	(1)	50	55											
IRT	Broadway	B1	279+14	S/C		3516		0.00	(1)	50	55	59.295	72.621	98.329	64.000	66.293						
IRT	Broadway	B1	277+22	C/S		3516		0.00	(1)	50	55	59.295	72.621	98.329	64.000	66.293						
IRT	Broadway	B1	275+67	S/T	461	3516		******	(1)	50	55											
IRT	Broadway	B1	275+12	T/S		677		******	27	32	43											
IRT	Broadway	B1	274+43	S/S		677		0.16	27	32	43	26.530	32.283	43.453	28.557	29.547						
IRT	Broadway	B1	273+36	S/C		1253.48		0.14	36	44	55	36.019	43.864	59.084	38.784	40.134						
IRT	Broadway	B1	272+91	C/S		1253.48		0.14	36	44	55	36.019	43.864	59.084	38.784	40.134						
IRT	Broadway	B1	272+42	S/C		3067		0.15	(1)	50	55	56.410	68.670	92.463	60.730	62.839						
IRT	Broadway	B1	271+72	C/S		3067		0.15	(1)	50	55	56.410	68.670	92.463	60.730	62.839						
IRT	Broadway	B1	269+99	S/T	513	3067		******	(1)	50	55											
IRT	Broadway	B1	261+08	T/S		7208		******	(1)	50	55											
IRT	Broadway	B1	260+93	S/C		7208		0.07	(1)	50	55	85.637	104.582	141.233	92.319	95.580						
IRT	Broadway	B1	260+23	C/S		7208		0.07	(1)	50	55	85.637	104.582	141.233	92.319	95.580						
IRT	Broadway	B1	260+15	S/T	93	7208		******	(1)	50	55											
IRT	Broadway	B1	258+53	T/S		8008		******	(1)	50	55											
IRT	Broadway	B1	258+45	S/C		8008		0.02	(1)	50	55	89.713	109.784	148.536	96.797	100.252						
IRT	Broadway	B1	257+60	C/S		8008		0.02	(1)	50	55	89.713	109.784	148.536	96.797	100.252						
IRT	Broadway	B1	257+52	S/T	101	8008		******	(1)	50	55											
IRT	Broadway	B1	243+65	T/S		1264		******	44	50	55											
IRT	Broadway	B1	242+33	S/C		1264		2.05	44	50	55	43.732	50.446	64.229	46.056	47.208						
IRT	Broadway	B1	241+01	C/S		1264		2.05	44	50	55	43.732	50.446	64.229	46.056	47.208						
IRT	Broadway	B1	240+93	S/S		1153		1.88	41	48	55	41.173	47.663	60.937	43.422	44.537						
IRT	Broadway	B1	239+69	S/T	396	1153		******	41	48	55											
IRT	Broadway	B1	239+00	T/S		-5148.21		******	(1)	50	55											
IRT	Broadway	B1	238+38	S/C		5148.21		0.09	(1)	50	55	72.554	88.533	119.471	78.189	80.939						
IRT	Broadway	B1	237+91	C/S		5148.21		0.09	(1)	50	55	72.554	88.533	119.471	78.189	80.939						
IRT	Broadway	B1	237+37	S/C		1287.05		2.03	44	50	55	44.048	50.831	64.750	46.396	47.560						
IRT	Broadway	B1	234+35	C/S		1287.05		2.03	44	50	55	44.048	50.831	64.750	46.396	47.560						
IRT	Broadway	B1	232+72	S/T	628	-1287.05		******	44	50	55											
IRT	Broadway	B1	229+93	T/S		-3460.00		******	(1)	50	55											
IRT	Broadway	B1	228+07	S/C		3460.00		2.20	(1)	50	55	73.233	84.220	106.855	77.032	78.918						
IRT	Broadway	B1	220+47	C/S		3460.00		2.20	(1)	50	55	73.233	84.220	106.855	77.032	78.918						
IRT	Broadway	B1	220+40	S/T	953	-3460.00		******	(1)	50	55											
IRT	Broadway	B1	218+92	T/S		-2772.12		******	(1)	50	55											
IRT	Broadway	B1	216+83	S/S		2772.12		0.02	(1)	50	55	52.782	64.591	87.391	56.951	58.983						
IRT	Broadway	B1	216+44	S/T	248	-2772.12		******	(1)	50	55											
IRT	Broadway	B1	210+06	T/S		1848		******	(1)	50	55											
IRT	Broadway	B1	209+36	S/C		1848		1.41	(1)	50	55	49.995	58.511	75.721	52.957	54.420						
IRT	Broadway	B1	206+22	C/S		1848		1.41	(1)	50	55	49.995	58.511	75.721	52.957	54.420						
IRT	Broadway	B1	205+87	S/T	419	1848		******	(1)	50	55											
IRT	Broadway	B1	200+32	T/S		-1100.38		******	41	47	55											
IRT	Broadway	B1	199+72	S/C		1100.38		2.16	41	47	55	41.165	47.379	60.169	43.315	44.381						
IRT	Broadway	B1	198+07	C/S		1100.38		2.16	41	47	55	41.165	47.379	60.169	43.315	44.381						
IRT	Broadway	B1	196+96	S/T	336	-1100.38		******	41	47	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	Broadway	BBM	15+90	T/S		-1372.86		******	40	47	55											
IRT	Broadway	BBM	17+15	S/C		1372.86		0.55	40	47	55	39.517	47.414	62.961	42.286	43.644						
IRT	Broadway	BBM	21+59	C/S		1372.86		0.55	40	47	55	39.517	47.414	62.961	42.286	43.644						
IRT	Broadway	BBM	23+01	S/T	711	-1372.86		******	40	47	55											
IRT	Broadway	BBM	26+82	T/S		1517		******	(1)	50	55											
IRT	Broadway	BBM	27+63	S/C		1517		2.00	(1)	50	55	47.708	55.088	70.224	50.263	51.531						
IRT	Broadway	BBM	32+64	C/S		1517		2.00	(1)	50	55	47.708	55.088	70.224	50.263	51.531						
IRT	Broadway	BBM	34+01	S/T	719	1517		******	(1)	50	55											
IRT	Broadway	BBM	65+12	T/S		-2485.34		******	(1)	50	55											
IRT	Broadway	BBM	65+69	S/C		2485.34		0.03	(1)	50	55	50.040	61.210	82.785	53.982	55.905						
IRT	Broadway	BBM	66+35	C/S		2485.34		0.03	(1)	50	55	50.040	61.210	82.785	53.982	55.905						
IRT	Broadway	BBM	66+74	S/T	162	-2485.34		******	(1)	50	55											
IRT	Broadway	BBM	67+13	T/S		2151		******	(1)	50	55											
IRT	Broadway	BBM	67+52	S/C		2151		0.11	(1)	50	55	47.018	57.327	77.303	50.652	52.426						
IRT	Broadway	BBM	67+90	C/S		2151		0.11	(1)	50	55	47.018	57.327	77.303	50.652	52.426						
IRT	Broadway	BBM	68+19	S/T	106	2151		******	(1)	50	55											
IRT	Broadway	BBM	103+99	T/S		2363		******	(1)	50	55											
IRT	Broadway	BBM	105+21	S/C		2363		0.48	(1)	50	55	51.446	61.873	82.354	55.105	56.899						
IRT	Broadway	BBM	105+54	C/S		2363		0.48	(1)	50	55	51.446	61.873	82.354	55.105	56.899						
IRT	Broadway	BBM	106+11	S/C		1135.04		0.80	37	44	55	36.906	43.927	57.865	39.362	40.569						
IRT	Broadway	BBM	106+38	C/S		1135.04		0.80	37	44	55	36.906	43.927	57.865	39.362	40.569						
IRT	Broadway	BBM	106+98	S/T	299	-1135.04		******	37	44	55											
IRT	Broadway	BBM	288+34	T/S		-598.13		******	34	38	47											
IRT	Broadway	BBM	289+91	S/C		598.13		3.64	34	38	47	33.800	37.967	46.789	35.230	35.944						
IRT	Broadway	BBM	292+16	C/S		598.13		3.64	34	38	47	33.800	37.967	46.789	35.230	35.944						
IRT	Broadway	BBM	293+44	S/T	510	-598.13		******	34	38	47											
IRT	Broadway	BBM	321+04	T/S		2443		******	(1)	50	55											
IRT	Broadway	BBM	321+53	S/C		2443		2.58	(1)	50	55	63.396	72.393	91.075	66.500	68.043						
IRT	Broadway	BBM	326+22	C/S		2443		2.58	(1)	50	55	63.396	72.393	91.075	66.500	68.043						
IRT	Broadway	BBM	327+30	S/T	626	2443		******	(1)	50	55											
IRT	Broadway	BBM	330+17	T/S		4650		******	(1)	50	55											
IRT	Broadway	BBM	331+14	S/S		4650		0.02	(1)	50	55	68.361	83.656	113.185	73.760	76.392						
IRT	Broadway	BBM	331+57	S/T	140	4650		******	(1)	50	55											
IRT	Broadway	BBM	336+94	T/S		2252		******	(1)	50	55											
IRT	Broadway	BBM	337+45	S/C		2252		0.54	(1)	50	55	50.561	60.684	80.610	54.111	55.852						
IRT	Broadway	BBM	338+03	C/S		2252		0.54	(1)	50	55	50.561	60.684	80.610	54.111	55.852						
IRT	Broadway	BBM	339+10	S/T	216	2252		******	(1)	50	55											
IRT	Broadway	BBM	339+55	T/S		-1191.32		******	35	43	55											
IRT	Broadway	BBM	340+69	S/S		1191.32		0.19	35	43	55	35.326	42.937	57.730	38.006	39.316						
IRT	Broadway	BBM	341+93	S/T	238	-1191.32		******	35	43	55											
IRT	Broadway	BBM	346+29	T/S		1001.04		******	44	49	55											
IRT	Broadway	BBM	347+62	S/C		1001		3.64	44	49	55	43.726	49.117	60.529	45.576	46.500						
IRT	Broadway	BBM	348+16	C/S		1001		3.64	44	49	55	43.726	49.117	60.529	45.576	46.500						
IRT	Broadway	BBM	349+59	S/T	330	1001		******	44	49	55											
IRT	Broadway	BBM	350+43	T/S		-792.03		******	42	47	55											
IRT	Broadway	BBM	351+93	S/C		792.03		4.97	42	47	55	42.144	46.606	56.233	43.667	44.431						
IRT	Broadway	BBM	354+18	C/S		792.03		4.97	42	47	55	42.144	46.606	56.233	43.667	44.431						
IRT	Broadway	BBM	355+85	S/T	542	-792.03		******	42	47	55											
IRT	Broadway	BBM	377+30	T/S		-1486.08		******	(1)	50	55											
IRT	Broadway	BBM	377+64	S/S		1486.08		1.93	(1)	50	55	46.937	54.279	69.309	49.481	50.741						
IRT	Broadway	BBM	379+33	S/T	203	-1486.08		******	(1)	50	55											
IRT	Broadway	BBM	383+41	T/S		-2151.49		******	(1)	50	55											
IRT	Broadway	BBM	384+72	S/C		2151.49		2.19	(1)	50	55	57.701	66.372	84.229	60.700	62.188						
IRT	Broadway	BBM	385+28	C/S		2151.49		2.19	(1)	50	55	57.701	66.372	84.229	60.700	62.188						
IRT	Broadway	BBM	386+12	S/T	271	-2151.49		******	(1)	50	55											
IRT	Broadway	BBM	390+66	T/S		-2883.00		******	(1)	50	55											
IRT	Broadway	BBM	391+47	S/C		2883.00		1.00	(1)	50	55	60.031	71.030	93.000	63.871	65.761						
IRT	Broadway	BBM	392+00	C/S		2883.00		1.00	(1)	50	55	60.031	71.030	93.000	63.871	65.761						
IRT	Broadway	BBM	392+82	S/S		1948		0.52	(1)	50	55	46.917	56.349	74.901	50.226	51.848						
IRT	Broadway	BBM	393+53	S/T	287	1948		******	(1)	50	55											
IRT	Clark St.	K2	173+01	T/S		194		******	20	23	27											
IRT	Clark St.	K2	173+70	S/C		194		4.52	20	23	27	20.328	22.589	27.437	21.101	21.488						
IRT	Clark St.	K2	174+59	C/S		194		4.52	20	23	27	20.328	22.589	27.437	21.101	21.488						
IRT	Clark St.	K2	174+97	S/C		259		3.33	22	25	30	21.777	24.569	30.449	22.736	23.215						
IRT	Clark St.	K2	176+58	C/S		259		3.33	22	25	30	21.777	24.569	30.449	22.736	23.215						
IRT	Clark St.	K2	177+21	S/T	420	259		******	22	25	30											
IRT	Clark St.	K2	182+51	T/S		-321.05		******	21	24	32											
IRT	Clark St.	K2	183+22	S/C		321.05		1.45	21	24	32	20.915	24.453	31.611	22.145	22.753						
IRT	Clark St.	K2	184+50	C/S		321.05		1.45	21	24	32	20.915	24.453	31.611	22.145	22.753						
IRT	Clark St.	K2	184+85	S/C		550		0.65	25	30	40	25.290	30.244	40.030	27.026	27.877						
IRT	Clark St.	K2	185+18	C/S		550		0.65	25	30	40	25.290	30.244	40.030	27.026	27.877						
IRT	Clark St.	K2	186+25	S/T	374	550		******	25	30	40											
IRT	Clark St.	K2	187+65	T/S		2151		******	(1)	50	55											
IRT	Clark St.	K2	188+22	S/C		2151		0.79	(1)	50	55	50.758	60.433	79.634	54.142	55.806						
IRT	Clark St.	K2	188+90	C/S		2151		0.79	(1)	50	55	50.758	60.433	79.634	54.142	55.806						
IRT	Clark St.	K2	189+20	S/T	155	2151		******	(1)	50	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	Clark St.	K2	191+17	T/S		-196.93		******	22	24	29											
IRT	Clark St.	K2	192+34	S/C		196.93		5.52	22	24	29	21.649	23.815	28.519	22.387	22.758						
IRT	Clark St.	K2	194+26	C/S		196.93		5.52	22	24	29	21.649	23.815	28.519	22.387	22.758						
IRT	Clark St.	K2	195+04	S/C		895		0.58	32	38	51	32.018	38.378	50.912	34.248	35.341						
IRT	Clark St.	K2	195+46	C/S		895		0.58	32	38	51	32.018	38.378	50.912	34.248	35.341						
IRT	Clark St.	K2	195+70	S/T	453	895		******	32	38	51											
IRT	Clark St.	K2	199+64	T/S		918		******	32	38	51											
IRT	Clark St.	K2	200+30	S/S		918		0.39	32	38	51	31.744	38.298	51.132	34.047	35.174						
IRT	Clark St.	K2	201+05	S/S		717.16		0.63	29	34	46	28.812	34.478	45.663	30.797	31.771						
IRT	Clark St.	K2	201+63	S/T	199	-717.16		******	29	34	46											
IRT	Clark St.	K2	205+62	T/S		-833.24		******	32	38	50											
IRT	Clark St.	K2	206+04	S/S		833.24		0.82	32	38	50	31.687	37.692	49.621	33.787	34.819						
IRT	Clark St.	K2	206+87	S/S		907		0.06	30	37	50	30.335	37.061	50.068	32.708	33.865						
IRT	Clark St.	K2	207+40	S/T	178	907		******	30	37	50											
IRT	Clark St.	K2	208+10	T/S		3352		******	(1)	50	55											
IRT	Clark St.	K2	208+42	S/C		3352		0.08	(1)	50	55	58.475	71.383	96.364	63.028	65.249						
IRT	Clark St.	K2	208+99	C/S		3352		0.08	(1)	50	55	58.475	71.383	96.364	63.028	65.249						
IRT	Clark St.	K2	209+28	S/T	118	3352		******	(1)	50	55											
IRT	Clark St.	K2	210+53	T/S		792		******	28	35	47											
IRT	Clark St.	K2	211+10	S/C		792		0.03	28	35	47	28.248	34.554	46.734	30.474	31.559						
IRT	Clark St.	K2	211+72	C/S		792		0.03	28	35	47	28.248	34.554	46.734	30.474	31.559						
IRT	Clark St.	K2	212+01	S/C		2485		0.15	(1)	50	55	50.779	61.816	83.234	54.668	56.567						
IRT	Clark St.	K2	212+69	C/S		2485		0.15	(1)	50	55	50.779	61.816	83.234	54.668	56.567						
IRT	Clark St.	K2	213+17	S/C		644		2.21	32	36	46	31.608	36.343	46.100	33.245	34.058						
IRT	Clark St.	K2	214+12	C/S		644		2.21	32	36	46	31.608	36.343	46.100	33.245	34.058						
IRT	Clark St.	K2	214+41	S/C		1264		4.89	(1)	50	55	53.012	58.673	70.874	54.945	55.914						
IRT	Clark St.	K2	215+02	C/S		1264		4.89	(1)	50	55	53.012	58.673	70.874	54.945	55.914						
IRT	Clark St.	K2	215+40	S/C		241		5.97	25	27	32	24.512	26.858	31.979	25.310	25.712						
IRT	Clark St.	K2	216+25	C/S		241		5.97	25	27	32	24.512	26.858	31.979	25.310	25.712						
IRT	Clark St.	K2	216+71	S/C		616		3.54	34	38	47	34.077	38.330	47.321	35.537	36.266						
IRT	Clark St.	K2	218+10	C/S		616		3.54	34	38	47	34.077	38.330	47.321	35.537	36.266						
IRT	Clark St.	K2	218+45	S/C		2883		1.51	(1)	50	55	63.019	73.572	94.956	66.686	68.499						
IRT	Clark St.	K2	218+92	C/S		2883		1.51	(1)	50	55	63.019	73.572	94.956	66.686	68.499						
IRT	Clark St.	K2	219+20	S/T	867	2883		******	(1)	50	55											
IRT	Clark St.	K2	227+89	T/S		2443		******	(1)	50	55											
IRT	Clark St.	K2	228+40	S/C		2443		2.34	(1)	50	55	62.229	71.373	90.267	65.388	66.958						
IRT	Clark St.	K2	236+97	C/S		2443		2.34	(1)	50	55	62.229	71.373	90.267	65.388	66.958						
IRT	Clark St.	K2	238+35	S/T	1046	2443		******	(1)	50	55											
IRT	Clark St.	K2	259+18	T/S		5766		******	(1)	50	55											
IRT	Clark St.	K2	259+53	S/C		5766		0.60	(1)	50	55	81.430	97.539	129.311	87.076	89.847						
IRT	Clark St.	K2	262+58	C/S		5766		0.60	(1)	50	55	81.430	97.539	129.311	87.076	89.847						
IRT	Clark St.	K2	262+88	S/T	370	5766		******	(1)	50	55											
IRT	Clark St.	K2	275+54	T/S		-278.82		******	26	28	34											
IRT	Clark St.	K2	276+29	S/C		278.82		5.56	26	28	34	25.814	28.386	33.975	26.691	27.131						
IRT	Clark St.	K2	278+87	C/S		278.82		5.56	26	28	34	25.814	28.386	33.975	26.691	27.131						
IRT	Clark St.	K2	279+59	S/T	405	-278.82		******	26	28	34											
IRT	Clark St.	K2	280+10	T/S		462		******	25	30	38											
IRT	Clark St.	K2	280+83	S/C		462		1.59	25	30	38	25.410	29.609	38.134	26.868	27.589						
IRT	Clark St.	K2	281+38	C/S		462		1.59	25	30	38	25.410	29.609	38.134	26.868	27.589						
IRT	Clark St.	K2	282+51	S/T	241	462		******	25	30	38											
IRT	Clark St.	K2	287+56	T/S		930		******	35	41	53											
IRT	Clark St.	K2	287+89	S/S		930		1.25	35	41	53	34.937	41.056	53.368	37.069	38.120						
IRT	Clark St.	K2	288+63	S/T	107	930		******	35	41	53											
IRT	Clark St.	K2	293+73	T/S		243		******	21	24	30											
IRT	Clark St.	K2	294+33	S/C		243		3.58	21	24	30	21.463	24.129	29.767	22.378	22.835						
IRT	Clark St.	K2	294+70	C/S		243		3.58	21	24	30	21.463	24.129	29.767	22.378	22.835						
IRT	Clark St.	K2	295+06	S/C		670		3.76	36	40	50	36.065	40.447	49.739	37.568	38.319						
IRT	Clark St.	K2	296+60	C/S		670		3.76	36	40	50	36.065	40.447	49.739	37.568	38.319						
IRT	Clark St.	K2	297+53	S/T	380	670		******	36	40	50											
IRT	Clark St.	K3	294+34	T/S		277		******	21	24	30											
IRT	Clark St.	K3	293+97	S/C		277		3.88	21	24	30	23.369	26.167	32.113	24.328	24.807						
IRT	Clark St.	K3	293+09	C/S		277		3.88	21	24	30	23.369	26.167	32.113	24.328	24.807						
IRT	Clark St.	K3	292+76	S/T	158	277		******	21	24	30											
IRT	Clark St.	K3	288+94	T/S		1022		******	38	44	55											
IRT	Clark St.	K3	288+41	S/C		1022		1.67	38	44	55	38.068	44.276	56.906	40.223	41.289						
IRT	Clark St.	K3	287+34	C/S		1022		1.67	38	44	55	38.068	44.276	56.906	40.223	41.289						
IRT	Clark St.	K3	286+25	S/C		2030.28		1.22	(1)	50	55	51.473	60.536	78.756	54.631	56.188						
IRT	Clark St.	K3	284+38	C/S		2030.28		1.22	(1)	50	55	51.473	60.536	78.756	54.631	56.188						
IRT	Clark St.	K3	284+05	S/T	489	-2030.28		******	(1)	50	55											
IRT	Clark St.	K3	282+65	T/S		477		******	29	33	41											
IRT	Clark St.	K3	281+57	S/C		477		3.01	29	33	41	28.922	32.790	40.888	30.253	30.916						
IRT	Clark St.	K3	281+00	C/S		477		3.01	29	33	41	28.922	32.790	40.888	30.253	30.916						
IRT	Clark St.	K3	278+82	S/C		304.76		5.70	27	30	36	27.185	29.857	35.670	28.095	28.552						
IRT	Clark St.	K3	276+37	C/S		304.76		5.70	27	30	36	27.185	29.857	35.670	28.095	28.552						
IRT	Clark St.	K3	275+41	S/T	724	-304.76		******	27	30	36											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	Clark St.	K3	262+92	T/S		4505		******	(1)	50	55											
IRT	Clark St.	K3	262+59	S/C		4505		1.05	(1)	50	55	75.413	89.104	116.492	80.190	82.543						
IRT	Clark St.	K3	259+88	C/S		4505		1.05	(1)	50	55	75.413	89.104	116.492	80.190	82.543						
IRT	Clark St.	K3	259+54	S/T	338	4505		******	(1)	50	55											
IRT	Clark St.	K3	238+57	T/S		2574		******	(1)	50	55											
IRT	Clark St.	K3	237+99	S/C		2574		1.43	(1)	50	55	59.113	69.148	89.437	62.603	64.326						
IRT	Clark St.	K3	228+67	C/S		2574		1.43	(1)	50	55	59.113	69.148	89.437	62.603	64.326						
IRT	Clark St.	K3	227+91	S/T	1066	2574		******	(1)	50	55											
IRT	Clark St.	K3	223+83	T/S		-973.99		******	37	43	55											
IRT	Clark St.	K3	222+73	S/C		973.99		1.76	37	43	55	37.451	43.469	55.741	39.538	40.571						
IRT	Clark St.	K3	222+31	C/S		973.99		1.76	37	43	55	37.451	43.469	55.741	39.538	40.571						
IRT	Clark St.	K3	221+87	S/T	196	-973.99		******	37	43	55											
IRT	Clark St.	K3	218+69	T/S		369		******	25	28	36											
IRT	Clark St.	K3	218+45	S/C		369		2.80	25	28	36	25.035	28.479	35.664	26.222	26.812						
IRT	Clark St.	K3	217+72	C/S		369		2.80	25	28	36	25.035	28.479	35.664	26.222	26.812						
IRT	Clark St.	K3	217+37	S/C		677		5.41	40	44	53	39.901	43.937	52.692	41.276	41.967						
IRT	Clark St.	K3	216+84	C/S		677		5.41	40	44	53	39.901	43.937	52.692	41.276	41.967						
IRT	Clark St.	K3	216+49	S/C		227		6.07	24	26	31	23.906	26.172	31.125	24.677	25.065						
IRT	Clark St.	K3	215+79	C/S		227		6.07	24	26	31	23.906	26.172	31.125	24.677	25.065						
IRT	Clark St.	K3	215+21	S/C		771		2.09	34	39	50	34.258	39.485	50.226	36.067	36.964						
IRT	Clark St.	K3	213+15	C/S		771		2.09	34	39	50	34.258	39.485	50.226	36.067	36.964						
IRT	Clark St.	K3	212+80	S/S		4650		0.24	(1)	50	55	70.207	85.170	114.309	75.474	78.048						
IRT	Clark St.	K3	212+36	S/C		Sw. 307A	603	0.17	15	30	37									15.867	30.498	37.180
IRT	Clark St.	K3	212+01	C/S		Sw. 307A	603	0.17	15	30	37									15.867	30.498	37.180
IRT	Clark St.	K3	211+72	S/T	697	Sw. 307A	603	******	15	30	37											
IRT	Clark St.	K3	209+54	T/S		3793		******	(1)	50	55											
IRT	Clark St.	K3	209+19	S/C		3793		0.03	(1)	50	55	61.821	75.621	102.276	66.692	69.067						
IRT	Clark St.	K3	208+61	C/S		3793		0.03	(1)	50	55	61.821	75.621	102.276	66.692	69.067						
IRT	Clark St.	K3	208+29	S/T	125	3793		******	(1)	50	55											
IRT	Clark St.	K3	207+62	T/S		-713.61		******	27	33	44											
IRT	Clark St.	K3	207+09	S/S		713.61		0.05	27	33	44	26.880	32.853	44.400	28.988	30.016						
IRT	Clark St.	K3	206+25	S/S		810		0.98	32	38	49	31.753	37.592	49.249	33.791	34.795						
IRT	Clark St.	K3	205+78	S/C		4805		0.00	(1)	50	55	69.318	84.897	114.951	74.819	77.500						
IRT	Clark St.	K3	205+23	C/S		4805		0.00	(1)	50	55	69.318	84.897	114.951	74.819	77.500						
IRT	Clark St.	K3	204+97	S/T	265	4805		******	(1)	50	55											
IRT	Clark St.	K3	202+26	T/S		1264		******	38	45	55											
IRT	Clark St.	K3	201+92	S/C		1264		0.48	38	45	55	37.633	45.260	60.242	40.309	41.621						
IRT	Clark St.	K3	201+48	C/S		1264		0.48	38	45	55	37.633	45.260	60.242	40.309	41.621						
IRT	Clark St.	K3	200+99	S/C		980.61		0.76	34	41	54	34.160	40.709	53.694	36.452	37.578						
IRT	Clark St.	K3	200+69	C/S		980.61		0.76	34	41	54	34.160	40.709	53.694	36.452	37.578						
IRT	Clark St.	K3	200+26	S/T	200	-980.61		******	34	41	54											
IRT	Clark St.	K3	195+45	T/S		-215.15		******	22	24	29											
IRT	Clark St.	K3	194+10	S/C		215.15		5.10	22	24	29	22.124	24.434	29.427	22.912	23.308						
IRT	Clark St.	K3	192+13	C/S		215.15		5.10	22	24	29	22.124	24.434	29.427	22.912	23.308						
IRT	Clark St.	K3	191+63	S/T	382	-215.15		******	22	24	29											
IRT	Clark St.	K3	190+18	T/S		2574		******	(1)	50	55											
IRT	Clark St.	K3	189+75	S/C		2574		1.02	(1)	50	55	56.838	67.213	87.950	60.459	62.242						
IRT	Clark St.	K3	188+67	C/S		2574		1.02	(1)	50	55	56.838	67.213	87.950	60.459	62.242						
IRT	Clark St.	K3	188+32	S/T	186	2574		******	(1)	50	55											
IRT	Clark St.	K3	186+33	T/S		584		******	29	33	43											
IRT	Clark St.	K3	185+56	S/C		584		1.59	29	33	43	28.558	33.277	42.859	30.197	31.008						
IRT	Clark St.	K3	185+27	C/S		584		1.59	29	33	43	28.558	33.277	42.859	30.197	31.008						
IRT	Clark St.	K3	184+33	S/C		407.20		2.86	26	30	38	26.426	30.033	37.563	27.668	28.287						
IRT	Clark St.	K3	182+82	C/S		407.20		2.86	26	30	38	26.426	30.033	37.563	27.668	28.287						
IRT	Clark St.	K3	182+19	S/T	414	-407.20		******	26	30	38											
IRT	Clark St.	K3	176+87	T/S		204		******	20	23	28											
IRT	Clark St.	K3	176+56	S/C		204		4.10	20	23	28	20.319	22.690	27.743	21.131	21.537						
IRT	Clark St.	K3	173+97	C/S		204		4.10	20	23	28	20.319	22.690	27.743	21.131	21.537						
IRT	Clark St.	K3	173+20	S/T	367	204		******	20	23	28											
IRT	E. Parkway	E1	133+94	T/S		8008		******	(1)	50	55											
IRT	E. Parkway	E1	134+25	S/C		8008		0.35	(1)	50	55	93.322	112.753	150.744	100.152	103.495						
IRT	E. Parkway	E1	134+33	C/S		8008		0.35	(1)	50	55	93.322	112.753	150.744	100.152	103.495						
IRT	E. Parkway	E1	134+64	S/T	70	8008		******	(1)	50	55											
IRT	E. Parkway	E1	142+55	T/S		-171.00		******	18	20	25											
IRT	E. Parkway	E1	143+24	S/C		171.00		3.19	18	20	25	17.532	19.821	24.629	18.319	18.711						
IRT	E. Parkway	E1	143+63	C/S		171.00		3.19	18	20	25	17.532	19.821	24.629	18.319	18.711						
IRT	E. Parkway	E1	144+17	S/T	162	-171.00		******	18	20	25											
IRT	E. Parkway	E1	144+56	T/S		1030		******	36	42	55											
IRT	E. Parkway	E1	145+10	S/S		1030		0.96	36	42	55	35.732	42.327	55.485	38.035	39.168						
IRT	E. Parkway	E1	146+03	S/T	147	1030		******	36	42	55											
IRT	E. Parkway	E1	147+45	T/S		1037		******	35	41	55											
IRT	E. Parkway	E1	148+30	S/C		1037		0.60	35	41	55	34.534	41.366	54.840	36.929	38.103						
IRT	E. Parkway	E1	149+04	C/S		1037		0.60	35	41	55	34.534	41.366	54.840	36.929	38.103						
IRT	E. Parkway	E1	149+76	S/C		640.67		1.11	29	34	44	28.609	33.746	44.041	30.400	31.283						
IRT	E. Parkway	E1	150+05	C/S		640.67		1.11	29	34	44	28.609	33.746	44.041	30.400	31.283						
IRT	E. Parkway	E1	150+47	S/T	302	-640.67		******	29	34	44											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (^{1}) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (^{2}) below) (mph)	NOT TO EXCEED SPEED (see Note (^{3}) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (^{4}) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (^{5}) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	Clark St.	K3	262+92	T/S		4505		******	(1)	50	55											
IRT	Clark St.	K3	262+59	S/C		4505		1.05	(1)	50	55	75.413	89.104	116.492	80.190	82.543						
IRT	Clark St.	K3	259+88	C/S		4505		1.05	(1)	50	55	75.413	89.104	116.492	80.190	82.543						
IRT	Clark St.	K3	259+54	S/T	338	4505		******	(1)	50	55											
IRT	Clark St.	K3	238+57	T/S		2574		******	(1)	50	55											
IRT	Clark St.	K3	237+99	S/C		2574		1.43	(1)	50	55	59.113	69.148	89.437	62.603	64.326						
IRT	Clark St.	K3	228+67	C/S		2574		1.43	(1)	50	55	59.113	69.148	89.437	62.603	64.326						
IRT	Clark St.	K3	227+91	S/T	1066	2574		******	(1)	50	55											
IRT	Clark St.	K3	223+83	T/S		-973.99		******	37	43	55											
IRT	Clark St.	K3	222+73	S/C		973.99		1.76	37	43	55	37.451	43.469	55.741	39.538	40.571						
IRT	Clark St.	K3	222+31	C/S		973.99		1.76	37	43	55	37.451	43.469	55.741	39.538	40.571						
IRT	Clark St.	K3	221+87	S/T	196	-973.99		******	37	43	55											
IRT	Clark St.	K3	218+69	T/S		369		******	25	28	36											
IRT	Clark St.	K3	218+45	S/C		369		2.80	25	28	36	25.035	28.479	35.664	26.222	26.812						
IRT	Clark St.	K3	217+72	C/S		369		2.80	25	28	36	25.035	28.479	35.664	26.222	26.812						
IRT	Clark St.	K3	217+37	S/C		677		5.41	40	44	53	39.901	43.937	52.692	41.276	41.967						
IRT	Clark St.	K3	216+84	C/S		677		5.41	40	44	53	39.901	43.937	52.692	41.276	41.967						
IRT	Clark St.	K3	216+49	S/C		227		6.07	24	26	31	23.906	26.172	31.125	24.677	25.065						
IRT	Clark St.	K3	215+79	C/S		227		6.07	24	26	31	23.906	26.172	31.125	24.677	25.065						
IRT	Clark St.	K3	215+21	S/C		771		2.09	34	39	50	34.258	39.485	50.226	36.067	36.964						
IRT	Clark St.	K3	213+15	C/S		771		2.09	34	39	50	34.258	39.485	50.226	36.067	36.964						
IRT	Clark St.	K3	212+80	S/S		4650		0.24	(1)	50	55	70.207	85.170	114.309	75.474	78.048						
IRT	Clark St.	K3	212+36	S/C		Sw. 307A	603	0.17	15	30	37									15.867	30.498	37.180
IRT	Clark St.	K3	212+01	C/S		Sw. 307A	603	0.17	15	30	37									15.867	30.498	37.180
IRT	Clark St.	K3	211+72	S/T	697	Sw. 307A	603	******	15	30	37											
IRT	Clark St.	K3	209+54	T/S		3793		******	(1)	50	55											
IRT	Clark St.	K3	209+19	S/C		3793		0.03	(1)	50	55	61.821	75.621	102.276	66.692	69.067						
IRT	Clark St.	K3	208+61	C/S		3793		0.03	(1)	50	55	61.821	75.621	102.276	66.692	69.067						
IRT	Clark St.	K3	208+29	S/T	125	3793		******	(1)	50	55											
IRT	Clark St.	K3	207+62	T/S		-713.61		******	27	33	44											
IRT	Clark St.	K3	207+09	S/S		713.61		0.05	27	33	44	26.880	32.853	44.400	28.988	30.016						
IRT	Clark St.	K3	206+25	S/S		810		0.98	32	38	49	31.753	37.592	49.249	33.791	34.795						
IRT	Clark St.	K3	205+78	S/C		4805		0.00	(1)	50	55	69.318	84.897	114.951	74.819	77.500						
IRT	Clark St.	K3	205+23	C/S		4805		0.00	(1)	50	55	69.318	84.897	114.951	74.819	77.500						
IRT	Clark St.	K3	204+97	S/T	265	4805		******	(1)	50	55											
IRT	Clark St.	K3	202+26	T/S		1264		******	38	45	55											
IRT	Clark St.	K3	201+92	S/C		1264		0.48	38	45	55	37.633	45.260	60.242	40.309	41.621						
IRT	Clark St.	K3	201+48	C/S		1264		0.48	38	45	55	37.633	45.260	60.242	40.309	41.621						
IRT	Clark St.	K3	200+99	S/C		980.61		0.76	34	41	54	34.160	40.709	53.694	36.452	37.578						
IRT	Clark St.	K3	200+69	C/S		980.61		0.76	34	41	54	34.160	40.709	53.694	36.452	37.578						
IRT	Clark St.	K3	200+26	S/T	200	-980.61		******	34	41	54											
IRT	Clark St.	K3	195+45	T/S		-215.15		******	22	24	29											
IRT	Clark St.	K3	194+10	S/C		215.15		5.10	22	24	29	22.124	24.434	29.427	22.912	23.308						
IRT	Clark St.	K3	192+13	C/S		215.15		5.10	22	24	29	22.124	24.434	29.427	22.912	23.308						
IRT	Clark St.	K3	191+63	S/T	382	-215.15		******	22	24	29											
IRT	Clark St.	K3	190+18	T/S		2574		******	(1)	50	55											
IRT	Clark St.	K3	189+75	S/C		2574		1.02	(1)	50	55	56.838	67.213	87.950	60.459	62.242						
IRT	Clark St.	K3	188+67	C/S		2574		1.02	(1)	50	55	56.838	67.213	87.950	60.459	62.242						
IRT	Clark St.	K3	188+32	S/T	186	2574		******	(1)	50	55											
IRT	Clark St.	K3	186+33	T/S		584		******	29	33	43											
IRT	Clark St.	K3	185+56	S/C		584		1.59	29	33	43	28.558	33.277	42.859	30.197	31.008						
IRT	Clark St.	K3	185+27	C/S		584		1.59	29	33	43	28.558	33.277	42.859	30.197	31.008						
IRT	Clark St.	K3	184+33	S/C		407.20		2.86	26	30	38	26.426	30.033	37.563	27.668	28.287						
IRT	Clark St.	K3	182+82	C/S		407.20		2.86	26	30	38	26.426	30.033	37.563	27.668	28.287						
IRT	Clark St.	K3	182+19	S/T	414	-407.20		******	26	30	38											
IRT	Clark St.	K3	176+87	T/S		204		******	20	23	28											
IRT	Clark St.	K3	176+56	S/C		204		4.10	20	23	28	20.319	22.690	27.743	21.131	21.537						
IRT	Clark St.	K3	173+97	C/S		204		4.10	20	23	28	20.319	22.690	27.743	21.131	21.537						
IRT	Clark St.	K3	173+20	S/T	367	204		******	20	23	28											
IRT	E. Parkway	E1	133+94	T/S		8008		******	(1)	50	55											
IRT	E. Parkway	E1	134+25	S/C		8008		0.35	(1)	50	55	93.322	112.753	150.744	100.152	103.495						
IRT	E. Parkway	E1	134+33	C/S		8008		0.35	(1)	50	55	93.322	112.753	150.744	100.152	103.495						
IRT	E. Parkway	E1	134+64	S/T	70	8008		******	(1)	50	55											
IRT	E. Parkway	E1	142+55	T/S		-171.00		******	18	20	25											
IRT	E. Parkway	E1	143+24	S/C		171.00		3.19	18	20	25	17.532	19.821	24.629	18.319	18.711						
IRT	E. Parkway	E1	143+63	C/S		171.00		3.19	18	20	25	17.532	19.821	24.629	18.319	18.711						
IRT	E. Parkway	E1	144+17	S/T	162	-171.00		******	18	20	25											
IRT	E. Parkway	E1	144+56	T/S		1030		******	36	42	55											
IRT	E. Parkway	E1	145+10	S/S		1030		0.96	36	42	55	35.732	42.327	55.485	38.035	39.168						
IRT	E. Parkway	E1	146+03	S/T	147	1030		******	36	42	55											
IRT	E. Parkway	E1	147+45	T/S		1037		******	35	41	55											
IRT	E. Parkway	E1	148+30	S/C		1037		0.60	35	41	55	34.534	41.366	54.840	36.929	38.103						
IRT	E. Parkway	E1	149+04	C/S		1037		0.60	35	41	55	34.534	41.366	54.840	36.929	38.103						
IRT	E. Parkway	E1	149+76	S/C		640.67		1.11	29	34	44	28.609	33.746	44.041	30.400	31.283						
IRT	E. Parkway	E1	150+05	C/S		640.67		1.11	29	34	44	28.609	33.746	44.041	30.400	31.283						
IRT	E. Parkway	E1	150+47	S/T	302	-640.67		******	29	34	44											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	E. Parkway	E2	169+06	T/S		-1696.00		******	(1)	50	55											
IRT	E. Parkway	E2	169+87	S/S		1696.00		0.96	(1)	50	55	45.859	54.323	71.211	48.815	50.270						
IRT	E. Parkway	E2	171+85	S/S		1676		0.86	45	50	55	45.126	53.613	70.494	48.092	49.551						
IRT	E. Parkway	E2	172+36	S/T	330	1676		******	45	50	55											
IRT	E. Parkway	E2	205+95	T/S		739		******	37	42	52											
IRT	E. Parkway	E2	207+51	S/C		739		3.54	37	42	52	37.323	41.982	51.829	38.922	39.721						
IRT	E. Parkway	E2	211+56	C/S		739		3.54	37	42	52	37.323	41.982	51.829	38.922	39.721						
IRT	E. Parkway	E2	213+03	S/T	708	739		******	37	42	52											
IRT	E. Parkway	E2	231+58	T/S		1676		******	41	50	55											
IRT	E. Parkway	E2	232+13	S/S		1676		0.09	41	50	55	41.397	50.514	68.167	44.612	46.181						
IRT	E. Parkway	E2	233+63	S/T	205	1676		******	41	50	55											
IRT	E. Parkway	E2	248+63	T/S		2059		******	(1)	50	55											
IRT	E. Parkway	E2	249+41	S/C		2059		0.80	(1)	50	55	49.707	59.163	77.936	53.014	54.640						
IRT	E. Parkway	E2	253+24	C/S		2059		0.80	(1)	50	55	49.707	59.163	77.936	53.014	54.640						
IRT	E. Parkway	E2	253+48	S/T	485	2059		******	(1)	50	55											
IRT	E. Parkway	E2	257+01	T/S		544		******	25	30	40											
IRT	E. Parkway	E2	257+30	S/C		544		0.52	25	30	40	24.794	29.778	39.582	26.542	27.399						
IRT	E. Parkway	E2	257+73	C/S		544		0.52	25	30	40	24.794	29.778	39.582	26.542	27.399						
IRT	E. Parkway	E2	258+32	S/C		577.00		1.70	29	33	43	28.674	33.328	42.802	30.289	31.088						
IRT	E. Parkway	E2	258+68	C/S		577.00		1.70	29	33	43	28.674	33.328	42.802	30.289	31.088						
IRT	E. Parkway	E2	259+08	S/T	207	-577.00		******	29	33	43											
IRT	E. Parkway	E2	309+30	T/S		603		******	27	32	42											
IRT	E. Parkway	E2	309+92	S/S		603		0.77	27	32	42	26.816	31.946	42.123	28.611	29.493						
IRT	E. Parkway	E2	310+31	S/T	101	603		******	27	32	42											
IRT	E. Parkway	E2	310+62	T/S		-534		******	23	28	38											
IRT	E. Parkway	E2	310+93	S/S		534.00		-0.08	23	28	38	22.876	28.113	38.181	24.727	25.628						
IRT	E. Parkway	E2	311+47	S/T	85	-534.00		******	23	28	38											
IRT	E. Parkway	E3	251+16	T/S		2184		******	(1)	50	55											
IRT	E. Parkway	E3	251+08	S/C		2184		0.65	(1)	50	55	50.387	60.257	79.755	53.845	55.542						
IRT	E. Parkway	E3	247+21	C/S		2184		0.65	(1)	50	55	50.387	60.257	79.755	53.845	55.542						
IRT	E. Parkway	E3	246+35	S/T	481	2184		******	(1)	50	55											
IRT	E. Parkway	E3	231+24	T/S		2669		******	(1)	50	55											
IRT	E. Parkway	E3	230+62	S/C		2669		0.82	(1)	50	55	56.711	67.458	88.808	60.469	62.317						
IRT	E. Parkway	E3	230+08	C/S		2669		0.82	(1)	50	55	56.711	67.458	88.808	60.469	62.317						
IRT	E. Parkway	E3	228+84	S/T	240	2669		******	(1)	50	55											
IRT	E. Parkway	E3	211+01	T/S		667		******	35	40	49											
IRT	E. Parkway	E3	209+31	S/C		667		3.51	35	40	49	35.388	39.822	49.189	36.910	37.670						
IRT	E. Parkway	E3	206+05	C/S		667		3.51	35	40	49	35.388	39.822	49.189	36.910	37.670						
IRT	E. Parkway	E3	204+58	S/T	643	667		******	35	40	49											
IRT	E. Parkway	E3	170+79	T/S		-3696.00		******	(1)	50	55											
IRT	E. Parkway	E3	169+47	S/S		3696.00		0.81	(1)	50	55	66.667	79.325	104.463	71.093	73.270						
IRT	E. Parkway	E3	168+31	S/C		3276		0.89	(1)	50	55	63.284	75.119	98.681	67.420	69.454						
IRT	E. Parkway	E3	167+38	C/S		3276		0.89	(1)	50	55	63.284	75.119	98.681	67.420	69.454						
IRT	E. Parkway	E3	167+23	S/T	356	3276		******	(1)	50	55											
IRT	E. Parkway	E3	159+63	T/S		-2772.00		******	(1)	50	55											
IRT	E. Parkway	E3	159+17	S/C		2772.00		0.01	(1)	50	55	52.716	64.536	87.349	56.889	58.923						
IRT	E. Parkway	E3	158+78	C/S		2772.00		0.01	(1)	50	55	52.716	64.536	87.349	56.889	58.923						
IRT	E. Parkway	E3	158+70	S/T	93	-2772.00		******	(1)	50	55											
IRT	E. Parkway	E3	158+31	T/S		901		******	31	38	50											
IRT	E. Parkway	E3	158+00	S/S		901		0.32	31	38	50	31.194	37.730	50.496	33.492	34.617						
IRT	E. Parkway	E3	157+54	S/T	77	901		******	31	38	50											
IRT	E. Parkway	E3	144+21	T/S		-300.00		******	20	23	30											
IRT	E. Parkway	E3	143+98	S/C		300.00		1.20	20	23	30	19.748	23.238	30.249	20.964	21.564						
IRT	E. Parkway	E3	142+97	C/S		300.00		1.20	20	23	30	19.748	23.238	30.249	20.964	21.564						
IRT	E. Parkway	E3	141+96	S/T	225	-300.00		******	20	23	30											
IRT	E. Parkway	E3	118+92	T/S		-1030.00		******	38	44	55											
IRT	E. Parkway	E3	116+91	S/C		1030.00		1.50	38	44	55	37.633	43.946	56.734	39.827	40.911						
IRT	E. Parkway	E3	115+67	C/S		1030.00		1.50	38	44	55	37.633	43.946	56.734	39.827	40.911						
IRT	E. Parkway	E3	114+06	S/T	486	-1030.00		******	38	44	55											
IRT	E. Parkway	E4	367+66	T/S		302		5.25	26	29	35	26.436	29.154	35.038	27.362	27.828						
IRT	E. Parkway	E4	365+87	S/C		302		5.25	26	29	35	26.436	29.154	35.038	27.362	27.828						
IRT	E. Parkway	E4	364+43	C/S		302		5.25	26	29	35	26.436	29.154	35.038	27.362	27.828						
IRT	E. Parkway	E4	362+68	S/T	498	302		5.25	26	29	35	26.436	29.154	35.038	27.362	27.828						
IRT	E. Parkway	E4	342+39	T/S		568		4.92	36	39	48	35.575	39.362	47.526	36.867	37.516						
IRT	E. Parkway	E4	341+42	S/C		568		4.92	36	39	48	35.575	39.362	47.526	36.867	37.516						
IRT	E. Parkway	E4	340+29	C/S		568		4.92	36	39	48	35.575	39.362	47.526	36.867	37.516						
IRT	E. Parkway	E4	338+94	S/T	345	568		4.92	36	39	48	35.575	39.362	47.526	36.867	37.516						
IRT	E. Parkway	E4	336+68	T/S		624.03		3.12	33	38	47	33.328	37.720	46.934	34.839	35.592						
IRT	E. Parkway	E4	336+16	S/C		624.03		3.12	33	38	47	33.328	37.720	46.934	34.839	35.592						
IRT	E. Parkway	E4	332+43	C/S		624.03		3.12	33	38	47	33.328	37.720	46.934	34.839	35.592						
IRT	E. Parkway	E4	331+89	S/C		390.65		3.91	28	31	38	27.794	31.110	38.160	28.930	29.499						
IRT	E. Parkway	E4	330+82	C/S		390.65		3.91	28	31	38	27.794	31.110	38.160	28.930	29.499						
IRT	E. Parkway	E4	329+69	S/T	699	390.65		3.91	28	31	38	27.794	31.110	38.160	28.930	29.499						

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	E. Parkway	E4	309+58	T/S		955		1.04	35	41	54	34.682	40.990	53.605	36.883	37.967						
IRT	E. Parkway	E4	309+08	S/C		955		1.04	35	41	54	34.682	40.990	53.605	36.883	37.967						
IRT	E. Parkway	E4	308+82	C/S		955		1.04	35	41	54	34.682	40.990	53.605	36.883	37.967						
IRT	E. Parkway	E4	308+18	S/C		1201.25		0.29	36	43	55	35.893	43.462	58.228	38.556	39.858						
IRT	E. Parkway	E4	307+62	C/S		1201.25		0.29	36	43	55	35.893	43.462	58.228	38.556	39.858						
IRT	E. Parkway	E4	307+25	S/T	233	1201.25		0.29	36	43	55	35.893	43.462	58.228	38.556	39.858						
IRT	E. Parkway	E4	251+24	T/S		655		1.26	29	34	45	29.353	34.485	44.814	31.141	32.022						
IRT	E. Parkway	E4	250+91	S/C		655		1.26	29	34	45	29.353	34.485	44.814	31.141	32.022						
IRT	E. Parkway	E4	249+56	C/S		655		1.26	29	34	45	29.353	34.485	44.814	31.141	32.022						
IRT	E. Parkway	E4	248+49	S/S		805.31		0.93	32	37	49	31.505	37.352	49.008	33.547	34.552						
IRT	E. Parkway	E4	247+94	S/T	330	805.31		0.93	32	37	49	31.505	37.352	49.008	33.547	34.552						
IRT	E. Parkway	E4	246+81	T/S		621		0.41	26	32	42	26.173	31.555	42.099	28.063	28.989						
IRT	E. Parkway	E4	246+08	S/S		621		0.41	26	32	42	26.173	31.555	42.099	28.063	28.989						
IRT	E. Parkway	E4	244+61	S/S		509.36		1.01	25	30	39	25.258	29.877	39.107	26.870	27.664						
IRT	E. Parkway	E4	244+42	S/T	239	509.36		1.01	25	30	39	25.258	29.877	39.107	26.870	27.664						
IRT	E. Parkway	E4	239+51	T/S		504.02		0.52	24	29	38	23.865	28.663	38.100	25.548	26.373						
IRT	E. Parkway	E4	238+79	S/S		504.02		0.52	24	29	38	23.865	28.663	38.100	25.548	26.373						
IRT	E. Parkway	E4	237+84	S/C		707		0.75	29	35	46	28.967	34.531	45.560	30.914	31.871						
IRT	E. Parkway	E4	237+45	C/S		707		0.75	29	35	46	28.967	34.531	45.560	30.914	31.871						
IRT	E. Parkway	E4	236+90	S/T	261	707		0.75	29	35	46	28.967	34.531	45.560	30.914	31.871						
IRT	E. Parkway	E4	233+67	T/S		581		1.01	27	32	42	26.982	31.916	41.776	28.704	29.552						
IRT	E. Parkway	E4	233+23	S/C		581		1.01	27	32	42	26.982	31.916	41.776	28.704	29.552						
IRT	E. Parkway	E4	233+06	C/S		581		1.01	27	32	42	26.982	31.916	41.776	28.704	29.552						
IRT	E. Parkway	E4	231+84	S/C		696		0.98	29	35	46	29.445	34.859	45.669	31.335	32.266						
IRT	E. Parkway	E4	231+54	C/S		696		0.98	29	35	46	29.445	34.859	45.669	31.335	32.266						
IRT	E. Parkway	E4	231+24	S/C		3276		0.06	(1)	50	55	57.665	70.451	95.176	62.176	64.376						
IRT	E. Parkway	E4	229+79	C/S		3276		0.06	(1)	50	55	57.665	70.451	95.176	62.176	64.376						
IRT	E. Parkway	E4	229+59	S/T	408	3276		0.06	(1)	50	55	57.665	70.451	95.176	62.176	64.376						
IRT	E. Parkway	E4	211+15	T/S		619		2.48	32	36	46	31.658	36.216	45.661	33.231	34.013						
IRT	E. Parkway	E4	209+59	S/C		619		2.48	32	36	46	31.658	36.216	45.661	33.231	34.013						
IRT	E. Parkway	E4	206+41	C/S		619		2.48	32	36	46	31.658	36.216	45.661	33.231	34.013						
IRT	E. Parkway	E4	204+81	S/T	634	619		2.48	32	36	46	31.658	36.216	45.661	33.231	34.013						
IRT	E. Parkway	E4	198+00	T/S		1502		******	39	48	55											
IRT	E. Parkway	E4	197+67	S/C		1502		0.11	39	48	55	39.279	47.892	64.580	42.316	43.798						
IRT	E. Parkway	E4	197+05	C/S		1502		0.11	39	48	55	39.279	47.892	64.580	42.316	43.798						
IRT	E. Parkway	E4	195+96	S/C		2217.69		0.32	(1)	50	55	48.940	59.194	79.222	52.545	54.310						
IRT	E. Parkway	E4	195+34	C/S		2217.69		0.32	(1)	50	55	48.940	59.194	79.222	52.545	54.310						
IRT	E. Parkway	E4	194+05	S/T	395	-2217.69		******	(1)	50	55											
IRT	E. Parkway	E4	170+08	T/S		-2941.84		******	(1)	50	55											
IRT	E. Parkway	E4	169+92	S/C		2941.84		1.13	(1)	50	55	61.424	72.414	94.452	65.256	67.144						
IRT	E. Parkway	E4	169+30	C/S		2941.84		1.13	(1)	50	55	61.424	72.414	94.452	65.256	67.144						
IRT	E. Parkway	E4	168+84	S/T	124	-2941.84		******	(1)	50	55											
IRT	E. Parkway	E4	168+61	T/S		2443		******	(1)	50	55											
IRT	E. Parkway	E4	167+29	S/S		2443		1.91	(1)	50	55	60.082	69.509	88.800	63.348	64.967						
IRT	E. Parkway	E4	166+20	S/T	241	2443		******	(1)	50	55											
IRT	E. Parkway	E4	150+92	T/S		2669		******	(1)	50	55											
IRT	E. Parkway	E4	150+24	S/C		2669		1.06	(1)	50	55	58.111	68.641	89.713	61.784	63.594						
IRT	E. Parkway	E4	148+33	C/S		2669		1.06	(1)	50	55	58.111	68.641	89.713	61.784	63.594						
IRT	E. Parkway	E4	147+66	S/S		873.64		0.47	31	38	50	31.246	37.591	50.051	33.473	34.564						
IRT	E. Parkway	E4	146+76	S/T	416	-873.64		******	31	38	50											
IRT	E. Parkway	E4	144+06	T/S		-205.93		******	20	22	27											
IRT	E. Parkway	E4	143+05	S/S		205.93		3.52	20	22	27	19.676	22.138	27.341	20.521	20.943						
IRT	E. Parkway	E4	142+04	S/T	202	-205.93		******	20	22	27											
IRT	E. Parkway	E4	117+85	T/S		310		******	24	27	33											
IRT	E. Parkway	E4	116+94	S/S		310		3.20	24	27	33	23.622	26.702	33.174	24.681	25.209						
IRT	E. Parkway	E4	116+63	S/S		1163		4.57	(1)	50	55	49.906	55.425	67.268	51.793	52.738						
IRT	E. Parkway	E4	116+03	S/T	182	1163		******	(1)	50	55											
IRT	Lenox	F1	168+86	T/S		-182.01		******	17	20	25											
IRT	Lenox	F1	168+25	S/C		182.01		2.65	17	20	25	17.395	19.839	24.922	18.238	18.657						
IRT	Lenox	F1	165+73	C/S		182.01		2.65	17	20	25	17.395	19.839	24.922	18.238	18.657						
IRT	Lenox	F1	165+31	S/T	355	-182.01		******	17	20	25											
IRT	Lenox	F1	162+91	T/S		-621.34		******	30	35	45											
IRT	Lenox	F1	162+53	S/C		621.34		1.78	30	35	45	29.964	34.763	44.555	31.628	32.453						
IRT	Lenox	F1	161+29	C/S		621.34		1.78	30	35	45	29.964	34.763	44.555	31.628	32.453						
IRT	Lenox	F1	160+98	S/T	193	-621.34		******	30	35	45											
IRT	Lenox	F1	160+59	T/S		616		******	28	33	43											
IRT	Lenox	F1	160+28	S/C		616		1.23	28	33	43	28.381	33.369	43.399	30.118	30.975						
IRT	Lenox	F1	159+04	C/S		616		1.23	28	33	43	28.381	33.369	43.399	30.118	30.975						
IRT	Lenox	F1	158+73	S/T	186	616		******	28	33	43											
IRT	Lenox	F4	159+55	T/S		481		1.50	26	30	39											
IRT	Lenox	F4	159+86	S/C		481		1.50	26	30	39	25.704	30.016	38.750	27.202	27.943						
IRT	Lenox	F4	160+77	C/S		481		1.50	26	30	39	25.704	30.016	38.750	27.202	27.943						
IRT	Lenox	F4	161+10	S/T	155	481		1.50	26	30	39											
IRT	Lenox	F4	161+65	T/S		600.63		2.00	30	35	44	30.016	34.659	44.182	31.623	32.421						
IRT	Lenox	F4	162+03	S/C		600.63		2.00	30	35	44	30.016	34.659	44.182	31.623	32.421						
IRT	Lenox	F4	163+28	C/S		600.63		2.00	30	35	44	30.016	34.659	44.182	31.623	32.421						
IRT	Lenox	F4	163+71	S/C		1372.86		0.25	38	46	55	38.192	46.315	62.138	41.051	42.448						
IRT	Lenox	F4	164+14	C/S		1372.86		0.25	38	46	55	38.192	46.315	62.138	41.051	42.448						
IRT	Lenox	F4	164+43	S/S		487		0.25	23	28	37	22.747	27.585	37.009	24.450	25.282						
IRT	Lenox	F4	164+74	S/T	309	487		0.25	23	28	37	22.747	27.585	37.009	24.450	25.282						

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	**LINE**	**TRACK**	**APPROX. STA.**	**CURVE POINT**	**CURVED LENGTH**	**RADIUS (ft.)**	**Turnout RADIUS (ft.)**	**SUPER-ELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**	**Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)**	**Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)**	**Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)**	**Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)**
IRT	Lenox	F4	166+25	T/S		Sw. 125		-2.00	9	19	23											
IRT	Lenox	F4	166+68	S/C		Sw. 125		-2.00	9	19	23											
IRT	Lenox	F4	166+99	C/S		Sw. 125		-2.00	9	19	23											
IRT	Lenox	F4	167+23	S/C		179.96		4.50	20	22	26	19.556	21.735	26.407	20.301	20.674						
IRT	Lenox	F4	169+31	C/S		179.96		4.50	20	22	26	19.556	21.735	26.407	20.301	20.674						
IRT	Lenox	F4	169+71	S/T	346	179.96		4.50	20	22	26	19.556	21.735	26.407	20.301	20.674						
IRT	LWP	W2	615+87	T/S		1602		0.10	41	49	55	40.518	49.422	66.668	43.658	45.190						
IRT	LWP	W2	614+71	S/C		1602		0.10	41	49	55	40.518	49.422	66.668	43.658	45.190						
IRT	LWP	W2	613+57	C/S		1602		0.10	41	49	55	40.518	49.422	66.668	43.658	45.190						
IRT	LWP	W2	612+31	S/T	356	1602		0.10	41	49	55	40.518	49.422	66.668	43.658	45.190						
IRT	LWP	W2	611+76	T/S		2325.00		0.28	(1)	50	55	49.877	60.417	80.972	53.585	55.399						
IRT	LWP	W2	610+57	S/C		2325.00		0.28	(1)	50	55	49.877	60.417	80.972	53.585	55.399						
IRT	LWP	W2	607+17	C/S		2325.00		0.28	(1)	50	55	49.877	60.417	80.972	53.585	55.399						
IRT	LWP	W2	606+91	S/T	485	2325.00		0.28	(1)	50	55	49.877	60.417	80.972	53.585	55.399						
IRT	LWP	W2	596+25	T/S		1045		2.50	41	47	55	41.200	47.114	59.375	43.241	44.256						
IRT	LWP	W2	595+42	S/C		1045		2.50	41	47	55	41.200	47.114	59.375	43.241	44.256						
IRT	LWP	W2	594+57	C/S		1045		2.50	41	47	55	41.200	47.114	59.375	43.241	44.256						
IRT	LWP	W2	593+46	S/T	279	1045		2.50	41	47	55	41.200	47.114	59.375	43.241	44.256						
IRT	LWP	W2	536+21	T/S		-1470.92		******	45	50	55											
IRT	LWP	W2	534+27	S/C		1470.92		1.40	45	50	55	44.562	52.165	67.527	47.206	48.513						
IRT	LWP	W2	533+96	C/S		1470.92		1.40	45	50	55	44.562	52.165	67.527	47.206	48.513						
IRT	LWP	W2	532+65	S/C		1657		0.90	45	50	55	45.052	53.462	70.209	47.990	49.436						
IRT	LWP	W2	532+49	C/S		1657		0.90	45	50	55	45.052	53.462	70.209	47.990	49.436						
IRT	LWP	W2	531+02	S/T	519	1657		******	45	50	55											
IRT	LWP	W2	515+66	T/S		606		******	33	37	46											
IRT	LWP	W2	514+79	S/C		606		3.15	33	37	46	32.903	37.222	46.288	34.389	35.129						
IRT	LWP	W2	513+42	C/S		606		3.15	33	37	46	32.903	37.222	46.288	34.389	35.129						
IRT	LWP	W2	511+63	S/T	403	606		******	33	37	46											
IRT	LWP	W2	418+06	T/S		-497.07		******	32	35	43											
IRT	LWP	W2	416+16	S/S		497.07		4.00	32	35	43	31.530	35.252	43.174	32.805	33.443						
IRT	LWP	W2	414+27	S/T	379	-497.07		******	32	35	43											
IRT	LWP	W2	406+26	T/S		930		******	37	43	55											
IRT	LWP	W2	404+84	S/S		930		1.90	37	43	55	37.037	42.857	54.765	39.054	40.053						
IRT	LWP	W2	403+60	S/T	266	930		******	37	43	55											
IRT	LWP	W2	396+22	T/S		-1201.25		******	(1)	50	55											
IRT	LWP	W2	395+03	S/C		1201.25		3.20	(1)	50	55	46.500	52.563	65.303	48.585	49.624						
IRT	LWP	W2	391+09	C/S		1201.25		3.20	(1)	50	55	46.500	52.563	65.303	48.585	49.624						
IRT	LWP	W2	390+51	S/T	571	-1201.25		******	(1)	50	55											
IRT	LWP	W2	388+68	T/S		-2669.44		******	(1)	50	55											
IRT	LWP	W2	388+36	S/C		2669.44		0.09	(1)	50	55	52.245	63.751	86.029	56.302	58.283						
IRT	LWP	W2	387+36	C/S		2669.44		0.09	(1)	50	55	52.245	63.751	86.029	56.302	58.283						
IRT	LWP	W2	386+73	S/T	195	-2669.44		******	(1)	50	55											
IRT	LWP	W2	386+35	T/S		2059		******	(1)	50	55											
IRT	LWP	W2	385+71	S/C		2059		0.07	(1)	50	55	45.775	55.901	75.492	49.347	51.090						
IRT	LWP	W2	385+02	C/S		2059		0.07	(1)	50	55	45.775	55.901	75.492	49.347	51.090						
IRT	LWP	W2	384+63	S/T	172	2059		******	(1)	50	55											
IRT	LWP	W2	379+96	T/S		-320.33		******	22	25	32											
IRT	LWP	W2	379+21	S/C		320.33		2.00	22	25	32	21.920	25.311	32.266	23.094	23.677						
IRT	LWP	W2	378+20	C/S		320.33		2.00	22	25	32	21.920	25.311	32.266	23.094	23.677						
IRT	LWP	W2	377+03	S/T	293	-320.33		******	22	25	32											
IRT	LWP	W2	373+83	T/S		-847.94		******	35	41	52											
IRT	LWP	W2	372+85	S/C		847.94		1.90	35	41	52	35.365	40.923	52.294	37.291	38.245						
IRT	LWP	W2	372+39	C/S		847.94		1.90	35	41	52	35.365	40.923	52.294	37.291	38.245						
IRT	LWP	W2	371+83	S/C		514.82		2.60	29	33	42	29.145	33.270	41.838	30.568	31.276						
IRT	LWP	W2	370+03	C/S		514.82		2.60	29	33	42	29.145	33.270	41.838	30.568	31.276						
IRT	LWP	W2	368+74	S/T	509	-514.82		******	29	33	42											
IRT	LWP	W2	367+46	T/S		179		******	17	20	25											
IRT	LWP	W2	367+11	S/C		179		2.68	17	20	25	17.293	19.712	24.747	18.127	18.542						
IRT	LWP	W2	364+90	C/S		179		2.68	17	20	25	17.293	19.712	24.747	18.127	18.542						
IRT	LWP	W2	364+55	S/T	291	179		******	17	20	25											
IRT	LWP	F2	362+34	T/S		-554.42		******	25	30	40											
IRT	LWP	F2	361+61	S/C		554.42		0.59	25	30	40	25.223	30.223	40.080	26.976	27.835						
IRT	LWP	F2	360+15	C/S		554.42		0.59	25	30	40	25.223	30.223	40.080	26.976	27.835						
IRT	LWP	F2	357+13	S/C		800.83		3.70	39	44	54	39.263	44.068	54.250	40.911	41.735						
IRT	LWP	F2	355+53	C/S		800.83		3.70	39	44	54	39.263	44.068	54.250	40.911	41.735						
IRT	LWP	F2	353+94	S/T	840	-800.83		******	39	44	54											
IRT	LWP	F2	353+24	T/S		1153		******	44	50	55											
IRT	LWP	F2	351+79	S/C		1153		2.67	44	50	55	43.852	49.996	62.778	45.970	47.024						
IRT	LWP	F2	346+54	C/S		1153		2.67	44	50	55	43.852	49.996	62.778	45.970	47.024						
IRT	LWP	F2	345+24	S/T	800	1153		******	44	50	55											
IRT	LWP	F2	339+10	T/S		735		******	33	38	49											
IRT	LWP	F2	337+96	S/C		735		2.06	33	38	49	33.380	38.496	49.003	35.151	36.029						
IRT	LWP	F2	335+69	C/S		735		2.06	33	38	49	33.380	38.496	49.003	35.151	36.029						
IRT	LWP	F2	334+44	S/T	466	735		******	33	38	49											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	LWP	F2	314+73	T/S		1253		******	42	49	55											
IRT	LWP	F2	313+02	S/C		1253		1.51	42	49	55	41.553	48.512	62.612	43.971	45.167						
IRT	LWP	F2	309+69	C/S		1253		1.51	42	49	55	41.553	48.512	62.612	43.971	45.167						
IRT	LWP	F2	307+91	S/T	682	1253		******	42	49	55											
IRT	LWP	F2	290+13	T/S		-252.89		******	20	23	29											
IRT	LWP	F2	288+87	S/C		252.89		2.60	20	23	29	20.427	23.318	29.323	21.424	21.920						
IRT	LWP	F2	287+82	C/S		252.89		2.60	20	23	29	20.427	23.318	29.323	21.424	21.920						
IRT	LWP	F2	286+52	S/T	361	-252.89		******	20	23	29											
IRT	LWP	F2	251+84	T/S		-1566.85		******	44	50	55											
IRT	LWP	F2	250+78	S/S		1566.85		0.94	44	50	55	43.989	52.139	68.389	46.836	48.237						
IRT	LWP	F2	249+64	S/T	220	-1566.85		******	44	50	55											
IRT	LWP	F2	244+32	T/S		1948		******	(1)	50	55											
IRT	LWP	F2	243+88	S/C		1948		2.32	(1)	50	55	55.478	63.654	80.540	58.303	59.706						
IRT	LWP	F2	242+14	C/S		1948		2.32	(1)	50	55	55.478	63.654	80.540	58.303	59.706						
IRT	LWP	F2	241+65	S/T	267	1948		******	(1)	50	55											
IRT	LWP	F2	234+69	T/S		-626.74		******	30	35	44											
IRT	LWP	F2	232+83	S/C		626.74		1.60	30	35	44	29.622	34.508	44.432	31.318	32.158						
IRT	LWP	F2	230+98	C/S		626.74		1.60	30	35	44	29.622	34.508	44.432	31.318	32.158						
IRT	LWP	F2	229+51	S/C		3276.14		0.05	(1)	50	55	57.594	70.393	95.133	62.110	64.313						
IRT	LWP	F2	226+25	C/S		3276.14		0.05	(1)	50	55	57.594	70.393	95.133	62.110	64.313						
IRT	LWP	F2	225+32	S/T	937	-3276.14		******	(1)	50	55											
IRT	LWP	F2	225+09	T/S		-2030.28		******	(1)	50	55											
IRT	LWP	F2	224+08	S/C		2030.28		0.14	(1)	50	55	45.840	55.825	75.195	49.359	51.078						
IRT	LWP	F2	223+85	C/S		2030.28		0.14	(1)	50	55	45.840	55.825	75.195	49.359	51.078						
IRT	LWP	F2	222+77	S/C		3134		0.85	(1)	50	55	61.641	73.256	96.351	65.701	67.698						
IRT	LWP	F2	222+53	C/S		3134		0.85	(1)	50	55	61.641	73.256	96.351	65.701	67.698						
IRT	LWP	F2	221+53	S/T	356	3134		******	(1)	50	55											
IRT	LWP	F2	219+59	T/S		439		******	29	32	40											
IRT	LWP	F2	217+81	S/C		439		3.45	29	32	40	28.610	32.222	39.845	29.850	30.470						
IRT	LWP	F2	217+03	C/S		439		3.45	29	32	40	28.610	32.222	39.845	29.850	30.470						
IRT	LWP	F2	215+33	S/T	426	439		******	29	32	40											
IRT	LWP	F2	215+17	T/S		-554.42		******	32	36	44											
IRT	LWP	F2	213+00	S/C		554.42		3.20	32	36	44	31.591	35.710	44.364	33.007	33.713						
IRT	LWP	F2	210+68	C/S		554.42		3.20	32	36	44	31.591	35.710	44.364	33.007	33.713						
IRT	LWP	F2	208+66	S/T	651	-554.42		******	32	36	44											
IRT	LWP	F2	204+94	T/S		6552		******	(1)	50	55											
IRT	LWP	F2	203+67	S/S		6552		0.81	(1)	50	55	88.764	105.618	139.088	94.659	97.556						
IRT	LWP	F2	202+27	S/T	267	6552		******	(1)	50	55											
IRT	LWP	F2	205+04	T/S		3696		******	(1)	50	55											
IRT	LWP	F2	203+42	S/C		3696		0.86	(1)	50	55	67.014	79.617	104.686	71.419	73.586						
IRT	LWP	F2	203+11	C/S		3696		0.86	(1)	50	55	67.014	79.617	104.686	71.419	73.586						
IRT	LWP	F2	202+72	S/T	232	3696		******	(1)	50	55											
IRT	LWP	F2	177+34	T/S		2720		******	(1)	50	55											
IRT	LWP	F2	175+19	S/C		2720		0.88	(1)	50	55	57.604	68.396	89.877	61.375	63.231						
IRT	LWP	F2	165+73	C/S		2720		0.88	(1)	50	55	57.604	68.396	89.877	61.375	63.231						
IRT	LWP	F2	165+34	S/T	1200	2720		******	(1)	50	55											
IRT	LWP	F2	154+45	T/S		581		1.19	27	32	42	27.462	32.323	42.088	29.156	29.991						
IRT	LWP	F2	153+12	S/C		581		1.19	27	32	42	27.462	32.323	42.088	29.156	29.991						
IRT	LWP	F2	147+61	C/S		Sw. 65	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	LWP	F2	147+38	S/T	707	Sw. 65	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	LWP	F2	71+67	T/S		-1896.71		******	44	50	55											
IRT	LWP	F2	71+05	S/C		1896.71		0.05	44	50	55	43.823	53.561	72.386	47.259	48.935						
IRT	LWP	F2	70+58	C/S		1896.71		0.05	44	50	55	43.823	53.561	72.386	47.259	48.935						
IRT	LWP	F2	70+43	S/T	124	-1896.71		******	44	50	55											
IRT	LWP	F2	68+80	T/S		-2002.08		******	45	50	55											
IRT	LWP	F2	68+49	S/C		2002.08		0.04	45	50	55	44.968	54.983	74.335	48.502	50.226						
IRT	LWP	F2	67+95	C/S		2002.08		0.04	45	50	55	44.968	54.983	74.335	48.502	50.226						
IRT	LWP	F2	67+64	S/T	116	-2002.08		******	45	50	55											
IRT	LWP	F2	66+63	T/S		-800.83		******	31	37	49											
IRT	LWP	F2	66+32	S/C		800.83		0.76	31	37	49	30.871	36.789	48.523	32.941	33.959						
IRT	LWP	F2	64+92	C/S		800.83		0.76	31	37	49	30.871	36.789	48.523	32.941	33.959						
IRT	LWP	F2	64+46	S/C		363.10		0.95	21	25	33	21.198	25.117	32.936	22.566	23.240						
IRT	LWP	F2	63+14	C/S		363.10		0.95	21	25	33	21.198	25.117	32.936	22.566	23.240						
IRT	LWP	F2	62+91	S/T	372	-363.10		******	21	25	33											
IRT	LWP	F2	44+22	T/S		-598.13		******	34	38	47											
IRT	LWP	F2	42+67	S/C		598.13		3.59	34	38	47	33.689	37.869	46.709	35.123	35.840						
IRT	LWP	F2	39+60	C/S		598.13		3.59	34	38	47	33.689	37.869	46.709	35.123	35.840						
IRT	LWP	F2	38+18	S/T	604	-598.13		******	34	38	47											
IRT	LWP	F2	22+14	T/S		341		******	26	29	36											
IRT	LWP	F2	20+60	S/C		341		4.18	26	29	36	26.399	29.450	35.962	27.443	27.966						
IRT	LWP	F2	16+34	C/S		341		4.18	26	29	36	26.399	29.450	35.962	27.443	27.966						
IRT	LWP	F2	15+66	S/T	648	341		******	26	29	36											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	LWP	F3	15+60	T/S		344		******	26	29	36											
IRT	LWP	F3	16+63	S/C		344		3.79	26	29	36	25.884	29.018	35.666	26.959	27.496						
IRT	LWP	F3	20+63	C/S		344		3.79	26	29	36	25.884	29.018	35.666	26.959	27.496						
IRT	LWP	F3	22+25	S/T	665	344		******	26	29	36											
IRT	LWP	F3	38+45	T/S		-624.03		******	34	38	47											
IRT	LWP	F3	39+27	S/C		624.03		3.23	34	38	47	33.585	37.947	47.117	35.084	35.832						
IRT	LWP	F3	42+97	C/S		624.03		3.23	34	38	47	33.585	37.947	47.117	35.084	35.832						
IRT	LWP	F3	44+16	S/T	571	-624.03		******	34	38	47											
IRT	LWP	F3	63+77	T/S		-248.96		******	19	22	28											
IRT	LWP	F3	64+00	S/C		248.96		2.03	19	22	28	19.373	22.356	28.478	20.406	20.918						
IRT	LWP	F3	65+01	C/S		248.96		2.03	19	22	28	19.373	22.356	28.478	20.406	20.918						
IRT	LWP	F3	65+32	S/C		1347.20		2.46	(1)	50	55	46.645	53.379	67.330	48.969	50.125						
IRT	LWP	F3	66+10	C/S		1347.20		2.46	(1)	50	55	46.645	53.379	67.330	48.969	50.125						
IRT	LWP	F3	66+95	S/C		1253.48		0.16	36	44	55	36.106	43.936	59.137	38.864	40.212						
IRT	LWP	F3	68+27	C/S		1253.48		0.16	36	44	55	36.106	43.936	59.137	38.864	40.212						
IRT	LWP	F3	68+58	S/T	481	-1253.48		******	36	44	55											
IRT	LWP	F3	126+47	T/S		895		******	30	37	50											
IRT	LWP	F3	126+70	S/C		895		-0.02	30	37	50	29.847	36.586	49.575	32.227	33.387						
IRT	LWP	F3	127+32	C/S		895		-0.02	30	37	50	29.847	36.586	49.575	32.227	33.387						
IRT	LWP	F3	128+02	S/C		1029.64		0.12	33	40	54	32.566	39.691	53.501	35.077	36.303						
IRT	LWP	F3	128+56	C/S		1029.64		0.12	33	40	54	32.566	39.691	53.501	35.077	36.303						
IRT	LWP	F3	129+18	S/T	271	-1029.64		******	33	40	54											
IRT	LWP	F3	134+30	T/S		-1162.50		******	35	43	55											
IRT	LWP	F3	134+61	S/C		1162.50		0.28	35	43	55	35.269	42.721	57.256	37.890	39.173						
IRT	LWP	F3	135+61	C/S		1162.50		0.28	35	43	55	35.269	42.721	57.256	37.890	39.173						
IRT	LWP	F3	135+69	S/T	139	-1162.50		******	35	43	55											
IRT	LWP	F3	135+85	T/S		Sw. 33	942	******	19	37.5	46											
IRT	LWP	F3	136+08	S/C		Sw. 33	942	0.00	19	37.5	46									18.795	37.590	46.038
IRT	LWP	F3	136+78	C/S		Sw. 33	942	0.00	19	37.5	46									18.795	37.590	46.038
IRT	LWP	F3	136+93	S/T	108	Sw. 33	942	******	19	37.5	46											
IRT	LWP	F3	147+58	T/S		Sw. 59	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	LWP	F3	147+97	S/C		Sw. 59	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	LWP	F3	153+33	C/S		601		2.01	30	35	44	30.041	34.681	44.199	31.647	32.444						
IRT	LWP	F3	154+70	S/T	712	601		2.01	30	35	44	30.041	34.681	44.199	31.647	32.444						
IRT	LWP	F3	165+56	T/S		2942		******	(1)	50	55											
IRT	LWP	F3	165+99	S/C		2942		1.04	(1)	50	55	60.883	71.956	94.101	64.747	66.650						
IRT	LWP	F3	176+01	C/S		2942		1.04	(1)	50	55	60.883	71.956	94.101	64.747	66.650						
IRT	LWP	F3	176+73	S/T	1117	2942		******	(1)	50	55											
IRT	LWP	F3	203+12	T/S		2574		******	(1)	50	55											
IRT	LWP	F3	203+97	S/S		2574		0.73	(1)	50	55	55.171	65.810	86.883	58.895	60.724						
IRT	LWP	F3	204+43	S/T	131	2574		******	(1)	50	55											
IRT	LWP	F3	202+79	T/S		4505		******	(1)	50	55											
IRT	LWP	F3	203+02	S/C		4505		0.05	(1)	50	55	67.537	82.546	111.557	72.833	75.416						
IRT	LWP	F3	203+64	C/S		4505		0.05	(1)	50	55	67.537	82.546	111.557	72.833	75.416						
IRT	LWP	F3	203+87	S/T	108	4505		******	(1)	50	55											
IRT	LWP	F3	209+01	T/S		-554.00		******	31	35	44											
IRT	LWP	F3	210+19	S/C		554.00		2.90	31	35	44	30.914	35.109	43.877	32.358	33.078						
IRT	LWP	F3	213+26	C/S		554.00		2.90	31	35	44	30.914	35.109	43.877	32.358	33.078						
IRT	LWP	F3	214+56	S/T	555	-554.00		******	31	35	44											
IRT	LWP	F3	215+13	T/S		415		******	25	29	37											
IRT	LWP	F3	216+16	S/C		415		2.00	25	29	37	24.950	28.810	36.725	26.286	26.949						
IRT	LWP	F3	217+70	C/S		415		2.00	25	29	37	24.950	28.810	36.725	26.286	26.949						
IRT	LWP	F3	218+42	S/T	329	415		******	25	29	37											
IRT	LWP	F3	221+49	T/S		-961.00		******	32	39	52											
IRT	LWP	F3	222+26	S/C		961.00		0.33	32	39	52	32.253	38.997	52.173	34.624	35.785						
IRT	LWP	F3	222+73	C/S		961.00		0.33	32	39	52	32.253	38.997	52.173	34.624	35.785						
IRT	LWP	F3	223+07	S/C		1153		0.02	34	42	55	34.041	41.657	56.361	36.729	38.040						
IRT	LWP	F3	223+46	C/S		1153		0.02	34	42	55	34.041	41.657	56.361	36.729	38.040						
IRT	LWP	F3	223+97	S/T	248	1153		******	34	42	55											
IRT	LWP	F3	224+74	T/S		-2218.00		******	(1)	50	55											
IRT	LWP	F3	226+52	S/C		2218.00		0.77	(1)	50	55	51.429	61.270	80.787	54.872	56.564						
IRT	LWP	F3	227+69	C/S		2218.00		0.77	(1)	50	55	51.429	61.270	80.787	54.872	56.564						
IRT	LWP	F3	228+62	S/T	388	-2218.00		******	(1)	50	55											
IRT	LWP	F3	229+00	T/S		-627.00		******	32	37	46											
IRT	LWP	F3	230+63	S/C		627.00		2.60	32	37	46	32.164	36.716	46.171	33.734	34.515						
IRT	LWP	F3	233+19	C/S		627.00		2.60	32	37	46	32.164	36.716	46.171	33.734	34.515						
IRT	LWP	F3	234+43	S/T	543	-627.00		******	32	37	46											
IRT	LWP	F3	241+41	T/S		2218		******	(1)	50	55											
IRT	LWP	F3	242+58	S/C		2218		1.32	(1)	50	55	54.313	63.710	82.653	57.584	59.198						
IRT	LWP	F3	243+57	C/S		2218		1.32	(1)	50	55	54.313	63.710	82.653	57.584	59.198						
IRT	LWP	F3	245+17	S/T	376	2218		******	(1)	50	55											
IRT	LWP	F3	250+14	T/S		-961.00		******	37	43	55											
IRT	LWP	F3	250+59	S/S		961.00		1.80	37	43	55	37.329	43.289	55.454	39.396	40.419						
IRT	LWP	F3	252+10	S/T	196	-961.00		******	37	43	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	LWP	F3	285+80	T/S		-277.00		******	22	25	31											
IRT	LWP	F3	287+97	S/C		277.00		2.90	22	25	31	21.859	24.826	31.025	22.881	23.390						
IRT	LWP	F3	288+74	C/S		277.00		2.90	22	25	31	21.859	24.826	31.025	22.881	23.390						
IRT	LWP	F3	290+52	S/T	472	-277.00		******	22	25	31											
IRT	LWP	F3	306+51	T/S		1211		******	38	45	55											
IRT	LWP	F3	307+73	S/C		1211		0.83	38	45	55	38.240	45.473	59.846	40.769	42.012						
IRT	LWP	F3	310+74	C/S		1211		0.83	38	45	55	38.240	45.473	59.846	40.769	42.012						
IRT	LWP	F3	312+33	S/T	582	1211		******	38	45	55											
IRT	LWP	F3	334+34	T/S		680		******	32	37	47											
IRT	LWP	F3	335+76	S/C		680		1.85	32	37	47	31.536	36.531	46.739	33.267	34.125						
IRT	LWP	F3	337+50	C/S		680		1.85	32	37	47	31.536	36.531	46.739	33.267	34.125						
IRT	LWP	F3	339+24	S/T	490	680		******	32	37	47											
IRT	LWP	F3	345+41	T/S		1117		******	44	50	55											
IRT	LWP	F3	346+52	S/C		1117		2.78	44	50	55	43.512	49.516	62.033	45.581	46.611						
IRT	LWP	F3	351+70	C/S		1117		2.78	44	50	55	43.512	49.516	62.033	45.581	46.611						
IRT	LWP	F3	352+96	S/T	755	1117		******	44	50	55											
IRT	LWP	F3	353+80	T/S		-801.00		******	37	42	53											
IRT	LWP	F3	355+51	S/C		801.00		2.80	37	42	53	36.901	41.979	52.569	38.651	39.522						
IRT	LWP	F3	357+06	C/S		801.00		2.80	37	42	53	36.901	41.979	52.569	38.651	39.522						
IRT	LWP	F3	358+83	S/T	503	-801.00		******	37	42	53											
IRT	LWP	F3	359+55	T/S		-497.00		******	25	29	39											
IRT	LWP	F3	360+51	S/C		497.00		0.96	25	29	39	24.825	29.407	38.549	26.425	27.213						
IRT	LWP	F3	361+62	C/S		497.00		0.96	25	29	39	24.825	29.407	38.549	26.425	27.213						
IRT	LWP	F3	362+65	S/T	310	-497.00		******	25	29	39											
IRT	LWP	F3	365+36	T/S		178		******	17	20	25											
IRT	LWP	F3	365+79	S/C		178		2.75	17	20	25	17.331	19.733	24.736	18.159	18.571						
IRT	LWP	F3	367+88	C/S		178		2.75	17	20	25	17.331	19.733	24.736	18.159	18.571						
IRT	LWP	F3	368+43	S/T	307	178		******	17	20	25											
IRT	LWP	W3	369+58	T/S		-534.00		******	31	35	44											
IRT	LWP	W3	370+42	S/C		534.00		3.20	31	35	44	31.003	35.046	43.540	32.393	33.086						
IRT	LWP	W3	372+82	C/S		534.00		3.20	31	35	44	31.003	35.046	43.540	32.393	33.086						
IRT	LWP	W3	374+64	S/T	506	-534.00		******	31	35	44											
IRT	LWP	W3	378+49	T/S		-283.00		******	21	24	30											
IRT	LWP	W3	380+20	S/C		283.00		2.00	21	24	30	20.603	23.791	30.327	21.707	22.254						
IRT	LWP	W3	380+82	C/S		283.00		2.00	21	24	30	20.603	23.791	30.327	21.707	22.254						
IRT	LWP	W3	381+17	S/T	268	-283.00		******	21	24	30											
IRT	LWP	W3	388+47	T/S		-4368.00		******	(1)	50	55											
IRT	LWP	W3	389+97	S/C		4368.00		0.21	(1)	50	55	67.804	82.349	110.640	72.925	75.428						
IRT	LWP	W3	391+07	C/S		4368.00		0.21	(1)	50	55	67.804	82.349	110.640	72.925	75.428						
IRT	LWP	W3	391+40	S/T	293	-4368.00		******	(1)	50	55											
IRT	LWP	W3	393+18	T/S		-848.00		******	30	36	49											
IRT	LWP	W3	393+41	S/C		848.00		0.23	30	36	49	29.946	36.342	48.793	32.198	33.298						
IRT	LWP	W3	394+89	C/S		848.00		0.23	30	36	49	29.946	36.342	48.793	32.198	33.298						
IRT	LWP	W3	396+77	C/S		1030.00		1.50	38	44	55	37.633	43.946	56.734	39.827	40.911						
IRT	LWP	W3	397+39	S/T	421	-1030.00		******	38	44	55											
IRT	LWP	W3	405+23	T/S		2252		******	(1)	50	55											
IRT	LWP	W3	405+97	S/C		2252		1.00	(1)	50	55	53.057	62.777	82.195	56.450	58.121						
IRT	LWP	W3	407+29	C/S		2252		1.00	(1)	50	55	53.057	62.777	82.195	56.450	58.121						
IRT	LWP	W3	407+83	S/T	260	2252		******	(1)	50	55											
IRT	LWP	W3	417+29	T/S		-534.00		******	29	34	42											
IRT	LWP	W3	418+29	S/C		534.00		2.50	29	34	42	29.458	33.686	42.453	30.917	31.643						
IRT	LWP	W3	419+23	C/S		534.00		2.50	29	34	42	29.458	33.686	42.453	30.917	31.643						
IRT	LWP	W3	420+33	S/T	304	-534.00		******	29	34	42											
IRT	LWP	W3	516+06	T/S		693		******	37	41	51											
IRT	LWP	W3	518+00	S/C		693		3.80	37	41	51	36.761	41.205	50.637	38.284	39.046						
IRT	LWP	W3	519+01	C/S		693		3.80	37	41	51	36.761	41.205	50.637	38.284	39.046						
IRT	LWP	W3	520+40	S/T	434	693		******	37	41	51											
IRT	LWP	W3	537+82	T/S		-1201.00		******	39	46	55											
IRT	LWP	W3	538+46	S/C		1201.00		-0.95	39	46	55	30.262	38.939	54.932	33.376	34.871						
IRT	LWP	W3	539+43	C/S		1201.00		-0.95	39	46	55	30.262	38.939	54.932	33.376	34.871						
IRT	LWP	W3	539+64	S/C		1534		0.75	43	50	55	42.680	50.879	67.128	45.549	46.959						
IRT	LWP	W3	540+52	C/S		1534		0.75	43	50	55	42.680	50.879	67.128	45.549	46.959						
IRT	LWP	W3	540+74	S/T	292	1534		******	43	50	55											
IRT	LWP	W3	595+88	T/S		1517		2.75	(1)	50	55	50.602	57.613	72.222	53.018	54.221						
IRT	LWP	W3	596+57	S/C		1517		2.75	(1)	50	55	50.602	57.613	72.222	53.018	54.221						
IRT	LWP	W3	598+64	C/S		1517		2.75	(1)	50	55	50.602	57.613	72.222	53.018	54.221						
IRT	LWP	W3	598+95	S/T	342	1517		2.75	(1)	50	55	50.602	57.613	72.222	53.018	54.221						
IRT	LWP	W3	604+05	T/S		Sw. 907	603	0.00	15	30	37									15.037	30.075	36.834
IRT	LWP	W3	604+32	S/C		Sw. 907	603	0.00	15	30	37									15.037	30.075	36.834
IRT	LWP	W3	604+67	C/S		Sw. 907	603	0.00	15	30	37									15.037	30.075	36.834
IRT	LWP	W3	605+18	S/C		520.40		0.05	23	28	38	22.954	28.055	37.916	24.754	25.632						
IRT	LWP	W3	605+47	C/S		520.40		0.05	23	28	38	22.954	28.055	37.916	24.754	25.632						
IRT	LWP	W3	605+97	S/C		7207.50		0.09	(1)	50	55	85.847	104.754	141.361	92.514	95.768						
IRT	LWP	W3	607+62	C/S		7207.50		0.09	(1)	50	55	85.847	104.754	141.361	92.514	95.768						
IRT	LWP	W3	607+91	S/T	386	7207.50		0.09	(1)	50	55	85.847	104.754	141.361	92.514	95.768						

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	**LINE**	**TRACK**	**APPROX. STA.**	**CURVE POINT**	**CURVED LENGTH**	**RADIUS (ft.)**	**Turnout RADIUS (ft.)**	**SUPER-ELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**	**Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)**	**Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)**	**Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)**	**Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)**
IRT	LWP	W3	608+71	T/S		1736.75		1.05	(1)	50	55	46.826	55.326	72.332	49.792	51.253						
IRT	LWP	W3	609+61	S/C		1736.75		1.05	(1)	50	55	46.826	55.326	72.332	49.792	51.253						
IRT	LWP	W3	611+48	C/S		1736.75		1.05	(1)	50	55	46.826	55.326	72.332	49.792	51.253						
IRT	LWP	W3	612+36	S/T	365	1736.75		1.05	(1)	50	55	46.826	55.326	72.332	49.792	51.253						
IRT	LWP	W3	614+60	T/S		5766		0.08	(1)	50	55	76.690	93.618	126.380	82.660	85.573						
IRT	LWP	W3	614+97	S/S		5766		0.08	(1)	50	55	76.690	93.618	126.380	82.660	85.573						
IRT	LWP	W3	616+26	S/T		5766		0.08	(1)	50	55	76.690	93.618	126.380	82.660	85.573						
IRT	LWP	W3	616+73	T/S		Sw. 987B		0.00	19	37.5	46											
IRT	LWP	W3	617+10	S/C		Sw. 987B		0.00	19	37.5	46											
IRT	LWP	W3	617+37	C/S		Sw. 987B		0.00	19	37.5	46											
IRT	LWP	W3	617+57	S/T	84	Sw. 987B		0.00	19	37.5	46											
IRT	LWP	WM	615+87	C/S		Sw. 997		0.00	18.5	26	32											
IRT	LWP	WM	615+57	S/C		Sw. 997		0.00	18.5	26	32											
IRT	LWP	WM	615+30	C/S		974.00		0.00	31	38	52	31.209	38.223	51.754	33.685	34.893						
IRT	LWP	WM	614+77	S/C		974.00		0.00	31	38	52	31.209	38.223	51.754	33.685	34.893						
IRT	LWP	WM	614+37	S/T	150	974.00		0.00	31	38	52	31.209	38.223	51.754	33.685	34.893						
IRT	LWP	WM	613+01	T/S		-2720.00		******	(1)	50	55											
IRT	LWP	WM	612+07	S/C		2720.00		0.27	(1)	50	55	53.885	65.296	87.542	57.900	59.863						
IRT	LWP	WM	608+68	C/S		2720.00		0.27	(1)	50	55	53.885	65.296	87.542	57.900	59.863						
IRT	LWP	WM	607+47	S/T	554	-2720.00		******	(1)	50	55											
IRT	LWP	WM	597+69	T/S		1253		******	(1)	50	55											
IRT	LWP	WM	596+83	S/C		1253		3.55	(1)	50	55	48.632	54.695	67.511	50.713	51.752						
IRT	LWP	WM	595+68	C/S		1253		3.55	(1)	50	55	48.632	54.695	67.511	50.713	51.752						
IRT	LWP	WM	594+57	S/T	312	1253		******	(1)	50	55											
IRT	LWP	WM	536+36	T/S		-3603.75		******	(1)	50	55											
IRT	LWP	WM	535+27	S/C		3603.75		0.13	(1)	50	55	60.999	74.315	100.137	65.692	67.984						
IRT	LWP	WM	534+89	C/S		3603.75		0.13	(1)	50	55	60.999	74.315	100.137	65.692	67.984						
IRT	LWP	WM	533+65	S/T	271	-3603.75		******	(1)	50	55											
IRT	LWP	WM	514+77	T/S		591		******	35	39	48											
IRT	LWP	WM	513+77	S/C		591		4.45	35	39	48	35.334	39.294	47.778	36.688	37.366						
IRT	LWP	WM	512+76	C/S		591		4.45	35	39	48	35.334	39.294	47.778	36.688	37.366						
IRT	LWP	WM	511+27	S/T	350	591		******	35	39	48											
IRT	LWP	WM	418+40	T/S		-505		******	33	37	45											
IRT	LWP	WM	417+00	S/C		505.00		4.80	33	37	45	33.332	36.926	44.663	34.559	35.175						
IRT	LWP	WM	416+39	C/S		505.00		4.80	33	37	45	33.332	36.926	44.663	34.559	35.175						
IRT	LWP	WM	415+03	S/T	337	-505		******	33	37	45											
IRT	LWP	WM	407+15	T/S		2002		******	(1)	50	55											
IRT	LWP	WM	404+83	S/C		2002		1.84	(1)	50	55	54.065	62.643	80.167	57.038	58.511						
IRT	LWP	WM	404+44	C/S		2002		1.84	(1)	50	55	54.065	62.643	80.167	57.038	58.511						
IRT	LWP	WM	402+81	S/T	434	2002		******	(1)	50	55											
IRT	LWP	WM	397+07	T/S		-1037		******	44	49	55											
IRT	LWP	WM	395+60	S/C		1037.00		3.40	44	49	55	43.800	49.365	61.100	45.712	46.666						
IRT	LWP	WM	392+19	C/S		1037.00		3.40	44	49	55	43.800	49.365	61.100	45.712	46.666						
IRT	LWP	WM	391+03	S/T	604	-1037		******	44	49	55											
IRT	LWP	WM	380+88	T/S		-306.70		******	22	26	32											
IRT	LWP	WM	380+10	S/C		306.70		2.50	22	26	32	22.325	25.529	32.173	23.431	23.981						
IRT	LWP	WM	379+48	C/S		306.70		2.50	22	26	32	22.325	25.529	32.173	23.431	23.981						
IRT	LWP	WM	378+01	S/T	287	-306.70		******	22	26	32											
IRT	LWP	WM	373+70	T/S		-514.82		******	30	34	42											
IRT	LWP	WM	371+82	S/C		514.82		2.80	30	34	42	29.584	33.654	42.144	30.986	31.684						
IRT	LWP	WM	369+72	C/S		514.82		2.80	30	34	42	29.584	33.654	42.144	30.986	31.684						
IRT	LWP	WM	368+58	S/T	512	-514.82		******	30	34	42											
IRT	LWP	WM	367+32	T/S		175		******	17	20	25											
IRT	LWP	WM	367+00	S/C		175		2.91	17	20	25	17.387	19.744	24.669	18.199	18.603						
IRT	LWP	WM	364+83	C/S		175		2.91	17	20	25	17.387	19.744	24.669	18.199	18.603						
IRT	LWP	WM	364+44	S/T	288	175		******	17	20	25											
IRT	LWP	FM	362+54	T/S		-497.07		******	29	33	42											
IRT	LWP	FM	361+24	S/C		497.07		2.90	29	33	42	29.282	33.256	41.561	30.651	31.332						
IRT	LWP	FM	360+32	C/S		497.07		2.90	29	33	42	29.282	33.256	41.561	30.651	31.332						
IRT	LWP	FM	359+32	S/T	322	-497.07		******	29	33	42											
IRT	LWP	FM	357+85	T/S		-800.83		******	37	42	52											
IRT	LWP	FM	356+92	S/C		800.83		2.70	37	42	52	36.625	41.735	52.372	38.387	39.263						
IRT	LWP	FM	355+38	C/S		800.83		2.70	37	42	52	36.625	41.735	52.372	38.387	39.263						
IRT	LWP	FM	353+52	S/T	433	-800.83		******	37	42	52											
IRT	LWP	FM	353+07	T/S		1135		******	(1)	50	55											
IRT	LWP	FM	351+40	S/C		1135		3.67	(1)	50	55	46.652	52.383	64.519	48.618	49.600						
IRT	LWP	FM	345+98	C/S		1135		3.67	(1)	50	55	46.652	52.383	64.519	48.618	49.600						
IRT	LWP	FM	344+91	S/T	816	1135		******	(1)	50	55											
IRT	LWP	FM	339+33	T/S		728		******	37	42	52											
IRT	LWP	FM	337+47	S/C		728		3.72	37	42	52	37.485	42.061	51.761	39.054	39.838						
IRT	LWP	FM	335+77	C/S		728		3.72	37	42	52	37.485	42.061	51.761	39.054	39.838						
IRT	LWP	FM	333+99	S/T	534	728		******	37	42	52											
IRT	LWP	FM	312+66	T/S		1201		******	(1)	50	55											
IRT	LWP	FM	309+60	S/C		1201		2.96	(1)	50	55	45.718	51.873	64.748	47.837	48.893						
IRT	LWP	FM	307+46	C/S		1201		2.96	(1)	50	55	45.718	51.873	64.748	47.837	48.893						
IRT	LWP	FM	305+58	S/T	708	1201		******	(1)	50	55											

												Check of NYCT Speeds			Proposed Increase	Proposed Increase	Check of NYCT Speeds Tangential Turnouts			Check of NYCT Speeds AREMA Turnouts		
DIV.	LINE	TRACK	APPROX. STA.	CURVE POINT	CURVED LENGTH	RADIUS (ft.)	Turnout RADIUS (ft.)	SUPER-ELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)	Normal Operating Speed Tangential V3 Speed Calculated V3 = .5*((3+Ea)*R)^.5] (mph)	Normal High Operating Speed Tangential V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed Tangential V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)	Normal Operating Speed AREMA V1.5 Speed Calculated V1.5 = .5*((1.5+Ea)*R)^.5] (mph)	Normal High Operating Speed AREMA V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	Not-To-Exceed Speed AREMA V9 Speed Calculated V9 = .5*((9+Ea)*R)^.5] (mph)
IRT	LWP	FM	289+85	T/S		-252.89		******	21	24	30											
IRT	LWP	FM	288+30	S/C		252.89		3.00	21	24	30	21.037	23.854	29.751	22.007	22.490						
IRT	LWP	FM	287+43	C/S		252.89		3.00	21	24	30	21.037	23.854	29.751	22.007	22.490						
IRT	LWP	FM	285+97	S/T	388	-252.89		******	21	24	30											
IRT	LWP	FM	251+56	T/S		-1501.56		******	(1)	50	55											
IRT	LWP	FM	250+49	S/S		1501.56		1.70	(1)	50	55	46.257	53.763	69.047	48.862	50.151						
IRT	LWP	FM	249+41	S/T	215	-1501.56		******	(1)	50	55											
IRT	LWP	FM	244+68	T/S		1922		******	(1)	50	55											
IRT	LWP	FM	243+53	S/C		1922		1.43	(1)	50	55	51.079	59.750	77.283	54.095	55.584						
IRT	LWP	FM	241+86	C/S		1922		1.43	(1)	50	55	51.079	59.750	77.283	54.095	55.584						
IRT	LWP	FM	241+46	S/T	322	1922		******	(1)	50	55											
IRT	LWP	FM	234+26	T/S		-600.63		******	31	36	45											
IRT	LWP	FM	232+67	S/C		600.63		2.50	31	36	45	31.241	35.726	45.023	32.789	33.558						
IRT	LWP	FM	230+27	C/S		600.63		2.50	31	36	45	31.241	35.726	45.023	32.789	33.558						
IRT	LWP	FM	228+98	S/T	528	-600.63		******	31	36	45											
IRT	LWP	FM	228+39	T/S		-2363.11		******	(1)	50	55											
IRT	LWP	FM	227+48	S/C		2363.11		0.07	(1)	50	55	49.035	59.883	80.870	52.862	54.729						
IRT	LWP	FM	226+81	C/S		2363.11		0.07	(1)	50	55	49.035	59.883	80.870	52.862	54.729						
IRT	LWP	FM	226+58	S/C		626.74		0.20	26	31	42	25.653	31.168	41.891	27.595	28.544						
IRT	LWP	FM	225+96	C/S		626.74		0.20	26	31	42	25.653	31.168	41.891	27.595	28.544						
IRT	LWP	FM	225+21	S/C		838		0.48	31	37	49	30.637	36.847	49.044	32.817	33.885						
IRT	LWP	FM	224+93	C/S		838		0.48	31	37	49	30.637	36.847	49.044	32.817	33.885						
IRT	LWP	FM	224+55	S/T	384	838		******	31	37	49											
IRT	Nostrand	D2	257+91	T/S		Sw. 411	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	Nostrand	D2	258+38	S/C		Sw. 411	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	Nostrand	D2	258+85	C/S		Sw. 411	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	Nostrand	D2	259+49	S/S		481		0.00	22	27	36	21.920	26.847	36.351	23.660	24.508						
IRT	Nostrand	D2	260+84	S/C		356.81		4.30	27	30	37	27.210	30.311	36.943	28.271	28.802						
IRT	Nostrand	D2	265+61	C/S		356.81		4.30	27	30	37	27.210	30.311	36.943	28.271	28.802						
IRT	Nostrand	D2	266+52	S/T	861	356.81		4.30	27	30	37	27.210	30.311	36.943	28.271	28.802						
IRT	Nostrand	D2	271+52	T/S		1471		0.62	41	49	55	41.218	49.339	65.368	44.064	45.460						
IRT	Nostrand	D2	272+08	S/C		1471		0.62	41	49	55	41.218	49.339	65.368	44.064	45.460						
IRT	Nostrand	D2	272+67	C/S		1471		0.62	41	49	55	41.218	49.339	65.368	44.064	45.460						
IRT	Nostrand	D2	273+23	S/C		1232.05		1.05	39	47	55	39.439	46.599	60.923	41.937	43.168						
IRT	Nostrand	D2	273+82	C/S		1232.05		1.05	39	47	55	39.439	46.599	60.923	41.937	43.168						
IRT	Nostrand	D2	274+05	S/T	253	1232.05		1.05	39	47	55	39.439	46.599	60.923	41.937	43.168						
IRT	Nostrand	D2	280+42	T/S		2403		1.50	(1)	50	55	57.476	67.117	86.648	60.826	62.482						
IRT	Nostrand	D2	281+35	S/C		2403		1.50	(1)	50	55	57.476	67.117	86.648	60.826	62.482						
IRT	Nostrand	D2	284+01	C/S		2403		1.50	(1)	50	55	57.476	67.117	86.648	60.826	62.482						
IRT	Nostrand	D2	284+53	S/T	411	2403		1.50	(1)	50	55	57.476	67.117	86.648	60.826	62.482						
IRT	Nostrand	D3	283+60	T/S		2403		0.50	(1)	50	55	51.989	62.482	83.109	55.671	57.476						
IRT	Nostrand	D3	283+31	S/C		2403		0.50	(1)	50	55	51.989	62.482	83.109	55.671	57.476						
IRT	Nostrand	D3	280+60	C/S		2403		0.50	(1)	50	55	51.989	62.482	83.109	55.671	57.476						
IRT	Nostrand	D3	280+37	S/T	323	2403		0.50	(1)	50	55	51.989	62.482	83.109	55.671	57.476						
IRT	Nostrand	D3	273+51	T/S		994		0.75	34	41	54	34.359	40.959	54.040	36.668	37.803						
IRT	Nostrand	D3	272+93	S/C		994		0.75	34	41	54	34.359	40.959	54.040	36.668	37.803						
IRT	Nostrand	D3	272+69	C/S		994		0.75	34	41	54	34.359	40.959	54.040	36.668	37.803						
IRT	Nostrand	D3	272+41	S/T	110	994		0.75	34	41	54	34.359	40.959	54.040	36.668	37.803						
IRT	Nostrand	D3	272+22	T/S		1153.20		1.01	38	45	55	38.005	44.955	58.843	40.431	41.626						
IRT	Nostrand	D3	272+01	S/C		1153.20		1.01	38	45	55	38.005	44.955	58.843	40.431	41.626						
IRT	Nostrand	D3	271+60	C/S		1153.20		1.01	38	45	55	38.005	44.955	58.843	40.431	41.626						
IRT	Nostrand	D3	271+01	S/T	121	1153.20		1.01	38	45	55	38.005	44.955	58.843	40.431	41.626						
IRT	Nostrand	D3	265+97	T/S		360.38		4.28	27	30	37	27.313	30.433	37.103	28.380	28.915						
IRT	Nostrand	D3	265+01	S/C		360.38		4.28	27	30	37	27.313	30.433	37.103	28.380	28.915						
IRT	Nostrand	D3	260+15	C/S		360.38		4.28	27	30	37	27.313	30.433	37.103	28.380	28.915						
IRT	Nostrand	D3	259+07	S/C		747		0.61	29	35	47	29.339	35.132	46.560	31.369	32.365						
IRT	Nostrand	D3	258+57	C/S		747		0.61	29	35	47	29.339	35.132	46.560	31.369	32.365						
IRT	Nostrand	D3	257+80	S/C		Sw. 431	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	Nostrand	D3	257+50	C/S		Sw. 431	603	0.00	21	30	37						21.266	30.075	36.834			
IRT	Nostrand	D3	257+25	S/T	872	Sw. 431	603	0.00	21	30	37						21.266	30.075	36.834			

(1) On tangent track and in some large radius curves, in the absence of any other speed restriction, the Average Normal Operating Speed is the highest speed that will allow service braking to limit the High Normal Operating Speed to 50 mph without experiencing Emergency Brake Applications to enforce the Not-To-Exceed (NTE) Speed

(2) CBTC shall enforce a Normal High Operating Speed limit equal to the V6 speed in curves and equal to 50 mph in tangent track and large radius curves, using service braking without incurring an Emergency Brake application. In ATPM, if the Train Operator does not reduce the speed as the Normal High Operating Speed limit is approached, the CBTC system will automatically apply service brakes to avoid exceeding this limit.

(3) CBTC must Vitally Ensure that the Not-To-Exceed (NTE) Safe Speed of V11 in curves, or 55 mph in tangent track or large radius curves, is never exceeded by any part of a train, even under slight and temporary degradation of track geometry conditions. If the actual speed of the train exceeds the Normal High Operating Speed, and is not immediately reduced below that limit by Service Brakes, an Emergency Brake application shall already have been called for. The Emergency Brake application shall be triggered at a predetermined CBTC designed speed-threshold (i.e. the Vital Civil Speed). In NO CASE shall the actual speed of the train be allowed to exceed the NTE Safe Speed (V11). CBTC Train Control System parameters shall be adjusted to Vitally Ensure this requirement.

APPENDIX "F"

SEVENTH AVENUE LINE CURVE ANALYSIS: DELTA SPEED INCREASES

Radius (feet)	Super-elevation	V4 Speed Calculated V4 = .5*((4+Ea) *R)^.5] mph	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea) *R)^.5] mph	V5 Speed Calculated V5 = .5*((5+Ea) *R)^.5] mph	V6 Speed Calculated V6 = .5*((6+Ea) *R)^.5] mph	Delta between V4 and V4.66 mph	Delta between V4 and V5 mph	Delta between V4 and V6 mph
175	2.91	17.38713605	18.19855764	18.60275517	19.74366987	0.811421586	1.215619123	2.356533822
178	2.75	17.33133001	18.15888212	18.57081043	19.73258726	0.827552112	1.239480417	2.401257248
179	2.68	17.28959225	18.12360339	18.53860836	19.70862755	0.834011149	1.249016117	2.419035307
179.96	4.5	19.55543403	20.3004532	20.67377566	21.73464976	0.74501917	1.118341632	2.179215728
182.01	2.65	17.39516097	18.23796247	18.65728075	19.83926977	0.842801503	1.262119785	2.444108805
196.93	5.52	21.64932793	22.38720282	22.75798541	23.81508765	0.737874884	1.108657478	2.165759721
204	4.1	20.32486162	21.13669794	21.5429803	22.69581459	0.811836321	1.218118672	2.370952969
205.93	3.52	19.67608701	20.52137544	20.9435169	22.13850492	0.845288432	1.267429887	2.462417909
215	2.63	18.87756605	19.7948857	20.25123453	21.53746735	0.917319652	1.37366848	2.659901303
241	5.97	24.50902895	25.3072618	25.70880199	26.85502746	0.798232855	1.199773046	2.345998514
243	3.58	21.45891423	22.37364521	22.83057161	24.12436528	0.914730979	1.371657378	2.665451045
248.96	2.03	19.37284698	20.40552866	20.91762893	22.35592092	1.032681685	1.544781952	2.983073939
252.89	2.6	20.42715105	21.42417676	21.92010493	23.31766498	0.997025714	1.492953877	2.890513928
277	3.88	23.36000856	24.31861427	24.79798379	26.15702582	0.958605708	1.437975227	2.797017263
278.82	5.56	25.81433323	26.69054327	27.13088277	28.3864369	0.876210041	1.316549544	2.572103674
283	2	20.60339778	21.70702651	22.25421308	23.79075451	1.103628734	1.650815306	3.187356729
300	1.2	19.74841766	20.96425529	21.56385865	23.23790008	1.215837635	1.815440995	3.489482419
306.7	2.5	22.32459406	23.43059965	23.9804608	25.52915001	1.10600559	1.655866735	3.204555944
315	4.87	26.42938705	27.39502692	27.8794279	29.2576913	0.965639868	1.450040846	2.828304243
320.33	2	21.92019617	23.0943597	23.6765179	25.31126232	1.174163534	1.756321736	3.391066148
341	4.18	26.40729066	27.45195804	27.97489946	29.45920909	1.044667376	1.567608804	3.051918426
344	3.79	25.88319918	26.95737376	27.49436306	29.01620237	1.074174575	1.611163875	3.133003186
346	2.09	22.95179732	24.16350554	24.76459166	26.45344968	1.211708225	1.812794343	3.501652365
369	2.8	25.04595776	26.23328039	26.82442916	28.49210417	1.187322632	1.778471407	3.446146412
390.65	3.91	27.79407086	28.93039276	29.49869277	31.11005264	1.136321895	1.704621907	3.315981775
394	1.54	23.36000856	24.71234509	25.38089833	27.25233935	1.352336531	2.020889768	3.892330787
407	2	24.7082982	26.03180747	26.68801229	28.53068524	1.323509266	1.979714089	3.822387034
415	2	24.9499499	26.28640333	26.94902596	28.80972058	1.33645343	1.999076057	3.859770682
430	0.62	22.2856456	23.82435728	24.57946297	26.67676892	1.53871168	2.293817368	4.391123316
435	2	25.54407955	26.91235776	27.59075932	29.49576241	1.368278207	2.046679774	3.951682859
438	2	25.63201124	27.00499954	27.6857364	29.59729717	1.372988301	2.053725164	3.965285938

Radius (feet)	Super-elevation	V4 Speed Calculated V4 = .5*((4+Ea) *R)^.5] mph	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea) *R)^.5] mph	V5 Speed Calculated V5 = .5*((5+Ea) *R)^.5] mph	V6 Speed Calculated V6 = .5*((6+Ea) *R)^.5] mph	Delta between V4 and V4.66 mph	Delta between V4 and V5 mph	Delta between V4 and V6 mph
439	3.45	28.59436133	29.83408286	30.45303762	32.20461923	1.239721526	1.858676283	3.610257902
450	2	25.98076211	27.37243139	28.0624304	30	1.391669273	2.081668287	4.019237886
462	1.59	25.40954545	26.86773158	27.58885645	29.60819143	1.458186125	2.179310996	4.198645984
477	3.01	28.91267023	30.24313972	30.9061887	32.77868972	1.330469485	1.993518468	3.866019491
481	1.5	25.71721214	27.21653909	27.95755712	30.03123374	1.499326954	2.240344983	4.314021606
485.35	0.27	22.7620545	24.45800227	25.28732143	27.58235169	1.695947771	2.525266929	4.820297196
487	0.25	22.74725258	24.4497955	25.28215774	27.58509561	1.702542919	2.534905159	4.837843032
497	0.96	24.82498741	26.42508278	27.21268087	29.40714199	1.600095369	2.387693456	4.582154578
497.07	4	31.52998573	32.8048251	33.44260008	35.25159571	1.274839375	1.91261435	3.721609981
504	4.5	32.72613634	33.9729304	34.59768778	36.37306696	1.246794057	1.87155144	3.646930615
504.02	0.52	23.86509166	25.54810952	26.37323643	28.66273888	1.683017858	2.508144773	4.797647217
505	4.8	33.33166662	34.55900751	35.17456467	36.92560088	1.227340884	1.842898049	3.59393425
509.36	1.01	25.25813532	26.87038891	27.66429829	29.87730577	1.612253584	2.406162969	4.619170446
513	0.25	23.34657362	25.09397338	25.94826584	28.31187913	1.747399756	2.601692214	4.965305508
514.82	2.6	29.14537699	30.56792927	31.27551758	33.26955064	1.42255228	2.13014059	4.124173651
520.4	0.05	22.95441134	24.75421176	25.63210877	28.05539164	1.799800422	2.677697429	5.100980298
524	1.14	25.94879573	27.56446988	28.36088856	30.58332879	1.615674151	2.412092828	4.634533059
534	-0.08	22.87618849	24.72711063	25.62849976	28.11263061	1.850922134	2.752311267	5.23644212
534	3.2	31.00322564	32.39305481	33.08625092	35.04568447	1.389829173	2.083025282	4.042458832
544	0.52	24.79354755	26.54204212	27.39927006	29.77784411	1.748494574	2.605722516	4.984296565
561	2	29.00861941	30.56247699	31.33289007	33.49626845	1.553857585	2.324270659	4.48764904
568	2.86	31.21089553	32.67782122	33.40838218	35.46998731	1.466925691	2.197486648	4.25909178
568	4.92	35.5898862	36.88305844	37.53185314	39.37816654	1.293172238	1.941966935	3.788280336
577	1.7	28.67446599	30.28910695	31.08818103	33.32754116	1.61464096	2.413715041	4.65307517
581	1.01	26.97596152	28.69786577	29.54576958	31.90928548	1.721904253	2.569808057	4.933323961
581	1.19	27.45628343	29.14982847	29.98495456	32.31636582	1.693545039	2.528671127	4.860082389
584	1.59	28.5681641	30.20761493	31.01838165	33.28873683	1.639450835	2.450217548	4.720572735
591	4.45	35.3339426	36.68790673	37.36626152	39.29360635	1.353964122	2.032318915	3.959663745
598.13	3.59	33.68904384	35.12325618	35.8397011	37.86841263	1.434212342	2.150657259	4.179368786
601	2.01	30.05	31.65702924	32.45385185	34.69153355	1.607029235	2.403851852	4.641533549
603	0.77	26.81562045	28.61070604	29.49283811	31.94647868	1.79508559	2.677217666	5.130858231
606	3.15	32.91238369	34.39789238	35.13865393	37.23204265	1.48550869	2.226270242	4.319658964
608.23	1.35	28.52205506	30.23020964	31.07354381	33.43086336	1.708154579	2.551488749	4.908808297
616	1.23	28.37992248	30.11743681	30.97450565	33.36794869	1.737514329	2.594583165	4.988026213
616	3.54	34.07579786	35.53589734	36.26513477	38.32962301	1.46009948	2.189336909	4.253825146
619	2.48	31.66670175	33.24026173	34.02249256	36.22540545	1.573559977	2.355790806	4.558703695

Radius (feet)	Super-elevation	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] mph	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] mph	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] mph	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] mph	Delta between V4 and V4.66 mph	Delta between V4 and V5 mph	Delta between V4 and V6 mph
621	0.41	26.16586517	28.05561441	28.98107141	31.54603779	1.889749243	2.815206241	5.380172618
621.34	1.78	29.96391663	31.62842709	32.45260082	34.7635772	1.664510454	2.488684187	4.799660571
624	2	30.59411708	32.23290244	33.04542328	35.32704347	1.638785363	2.451306202	4.732926384
624.03	3.12	33.32826728	34.83874782	35.59186564	37.71986744	1.510480543	2.263598362	4.391600162
626.74	2.56	32.06015596	33.63429351	34.41712655	36.62271972	1.574137554	2.356970593	4.562563767
626.74	2.98	33.07055034	34.59874853	35.36023614	37.51041589	1.528198189	2.289685799	4.439865544
640.67	1.11	28.6086687	30.4001065	31.28295742	33.74597643	1.791437793	2.674288717	5.137307723
641	0.91	28.05044563	29.87628658	30.77462429	33.27653077	1.825840954	2.724178658	5.226085139
644	2.21	31.6197723	33.2576307	34.07066187	36.35670502	1.637858408	2.450889571	4.736932726
652	0.2	26.16486193	28.14569239	29.11357072	31.78993551	1.980830454	2.948708785	5.625073581
655	1.26	29.34833896	31.1351891	32.01679247	34.47934164	1.78685013	2.668453504	5.131002676
667	0.16	26.33780553	28.35022046	29.33308712	32.04964898	2.01241493	2.995281593	5.711843457
667	3.51	35.38774505	36.90999187	37.67018051	39.82201025	1.522246818	2.282435461	4.434265192
670	3.76	36.05273915	37.55462688	38.30535211	40.43266007	1.501887732	2.252612959	4.379920919
677	0.16	26.53450584	28.56195021	29.55215728	32.28900742	2.027444377	3.017651445	5.754501581
677	1.94	31.70717584	33.42229795	34.27236496	36.65849151	1.715122102	2.565189117	4.951315669
680	1.85	31.53569406	33.26710087	34.12477106	36.53080892	1.731406803	2.589076999	4.995114853
689.71	3.34	35.57552319	37.14054388	37.9215684	40.1306971	1.565020697	2.346045215	4.555173917
693	3.8	36.76071272	38.2843963	39.04612657	41.20497543	1.523683575	2.285413844	4.444262703
693.03	1.52	30.92541673	32.72203157	33.61010116	36.09565625	1.796614838	2.684684429	5.170239517
696	0.98	29.43671177	31.32666596	32.25709224	34.84996413	1.889954184	2.820380471	5.413252359
707	0.75	28.97520492	30.92276669	31.87965652	34.54073682	1.947561777	2.904451605	5.565531902
714	1.87	32.36966172	34.14095781	35.01849511	37.48059498	1.771296085	2.648833391	5.110933257
717.16	0.63	28.81167645	30.79681964	31.7710985	34.47742305	1.985143189	2.959422049	5.665746595
728	1.27	30.96998547	32.85209278	33.78076376	36.37499141	1.88210731	2.810778287	5.405005939
735	2.06	33.36952202	35.13972111	36.01770398	38.48408762	1.770199092	2.648181958	5.114565598
739	3.54	37.32311616	38.92235861	39.72109012	41.98231771	1.599242452	2.397973955	4.659201545
755	0.43	28.91647454	30.99576584	32.01425464	34.83765922	2.079291297	3.097780095	5.921184678
763	2.68	35.69607822	37.41797696	38.27479588	40.69041656	1.721898747	2.578717669	4.994338346
721	2.5	34.22900817	35.92478253	36.76785281	39.14236835	1.695774367	2.538844641	4.913360184
728	3.72	37.48386319	39.05329692	39.83767061	42.0599572	1.569433721	2.35380742	4.576094009
787.7	1.52	32.97007734	34.88547692	35.832262	38.48215171	1.915399578	2.862184657	5.512074364

Radius (feet)	Super-elevation	V4 Speed Calculated V4 = .5*((4+Ea) *R)^.5] mph	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea) *R)^.5] mph	V5 Speed Calculated V5 = .5*((5+Ea) *R)^.5] mph	V6 Speed Calculated V6 = .5*((6+Ea) *R)^.5] mph	Delta between V4 and V4.66 mph	Delta between V4 and V5 mph	Delta between V4 and V6 mph
792	0.03	28.24783178	30.47326697	31.55851708	34.55343688	2.225435198	3.3106853	6.305605102
792.03	4.97	42.14412504	43.6670611	44.43123648	46.60624717	1.522936063	2.287111443	4.462122132
801	2.8	36.90121949	38.6505498	39.52151313	41.97856596	1.74933031	2.620293637	5.077346467
810	-0.11	28.06643903	30.35415952	31.46784073	34.53585094	2.287720484	3.401401694	6.469411905
810	0.98	31.75610178	33.79497004	34.79870687	37.59587743	2.038868264	3.042605097	5.839775658
823.71	4.01	40.61378184	42.25389242	43.07443296	45.40191929	1.640110589	2.460651126	4.788137452
833	2.68	37.29758705	39.09673899	39.9919992	42.51599699	1.799151941	2.694412147	5.218409936
833.25	4.9	43.05788255	44.62586134	45.41248452	47.6508788	1.567978783	2.354601963	4.592996242
838	0.48	30.63592662	32.81508799	33.8830341	36.84508108	2.179161371	3.24710748	6.209154461
847.94	1.9	35.36539976	37.29103914	38.24521539	40.92287258	1.925639381	2.87981563	5.55747282
848	1.01	32.59018257	34.67044851	35.69481755	38.55022698	2.080265941	3.10463498	5.960044406
858	1.36	33.90752129	35.93452379	36.93534892	39.73310962	2.0270025	3.027827633	5.82558833
868	1.47	34.45272123	36.47204409	37.46985455	40.26152009	2.019322861	3.017133322	5.808798863
873.64	0.92	32.78074435	34.91028215	35.95813121	38.87669225	2.129537805	3.177386861	6.095947898
890	0.76	32.54381662	34.72679081	35.79944134	38.78272811	2.182974194	3.255624719	6.238911497
895	0.58	32.01210708	34.24105723	35.33447325	38.37023586	2.228950142	3.322366167	6.358128776
895	1	33.4477204	35.58686555	36.64014192	39.57587649	2.139145154	3.19242152	6.12815609
901	0.32	31.19423024	33.49246184	34.61690339	37.73035913	2.298231603	3.42267315	6.536128893
907	0.06	30.34147327	32.71482844	33.87262907	37.06892229	2.373355175	3.531155802	6.727449027
907	3.03	39.92558703	41.75772384	42.67086242	45.2498895	1.832136803	2.74527539	5.324302469
918	0.39	31.74121926	34.04372189	35.17108187	38.29497356	2.30250263	3.429862613	6.553754302
930	1.25	34.9374441	37.06851764	38.1198767	41.0563637	2.131073543	3.182432608	6.1189196
936.04	2.95	40.32827172	42.19971682	43.1321168	45.76450043	1.871445103	2.803845083	5.436228713
942	1.77	36.8623792	38.91355805	39.92912471	42.77657069	2.051178852	3.066745513	5.914191494
954.64	0	30.89724907	33.34899699	34.54417462	37.84124734	2.451747918	3.646925549	6.943998268
955	1.04	34.68861485	36.89003931	37.97433344	40.9975609	2.201424459	3.28571859	6.308946056
961	0.49	32.84391116	35.17509773	36.31766099	39.48699153	2.33118657	3.473749837	6.643080373
961	1.8	37.32894319	39.39562158	40.41905491	43.28914414	2.06667839	3.090111718	5.960200941
974	0.52	33.17559344	35.51520801	36.66224216	39.84494949	2.339614572	3.486648719	6.669356053
981	0	31.32091953	33.8062864	35.01785259	38.36013556	2.485366871	3.696933063	7.039216031
1001	3.64	43.72539308	45.57493829	46.49903225	49.11629058	1.849545208	2.773639168	5.390897497
1008	0.15	32.33883115	34.81551378	36.02499133	39.36749929	2.476682636	3.686160178	7.028668138
1008	0.34	33.07083307	35.4964787	36.68351128	39.97098948	2.425645628	3.612678211	6.900156409
1022	1.67	38.06159482	40.21585508	41.28177564	44.26832954	2.154260265	3.220180823	6.20673472

Radius (feet)	Super-elevation	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] mph	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] mph	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] mph	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] mph	Delta between V4 and V4.66 mph	Delta between V4 and V5 mph	Delta between V4 and V6 mph
1022.34	0.26	32.99684985	35.46093907	36.66574832	39.99952625	2.464089224	3.668898472	7.002676398
1030	0.96	35.73793503	38.04142479	39.17524729	42.33438319	2.303489762	3.43731226	6.596448162
1045	1.35	37.38565902	39.62464511	40.73005647	43.81994409	2.238986094	3.344397454	6.434285074
1045	2.5	41.20831227	43.24985549	44.26482802	47.12350793	2.041543223	3.056515756	5.915195666
1052	3.38	44.0561006	45.98391023	46.94613935	49.66829975	1.92780963	2.890038752	5.61219915
1092	2.66	42.64012195	44.70302003	45.7294216	48.62283414	2.062898081	3.08929965	5.982712191
1100	0.67	35.83643397	38.2851146	39.48733974	42.82814495	2.448680626	3.650905769	6.991710977
1100.38	0.41	34.83057493	37.34610622	38.57802418	41.99236776	2.515531292	3.747449254	7.161792828
1100.38	2.16	41.16533979	43.31452297	44.3810793	47.37905867	2.149183179	3.215739512	6.213718876
1108.85	1.19	37.93063241	40.27025112	41.42397102	44.64479673	2.339618707	3.49333861	6.71416432
1117	2.78	43.51223966	45.58091706	46.61078201	49.51580556	2.068677402	3.098542357	6.0035659
1126	4.83	49.85624334	51.68592652	52.60365957	55.21453613	1.829683178	2.747416228	5.358292789
1126.17	2.61	43.13926199	45.24172825	46.28756231	49.23495633	2.10246626	3.148300325	6.095694342
1135.04	0.8	36.90593448	39.36152436	40.56855925	43.92684828	2.455589879	3.662624773	7.0209138
1153	0.02	34.04063748	36.72887148	38.03965037	41.6565121	2.688233998	3.999012887	7.615874617
1171.95	0.43	36.02685977	38.61743615	39.88636515	43.40402775	2.590576381	3.85950538	7.377167979
1191.32	0.19	35.32573708	38.00625606	39.31587084	42.93678726	2.680518987	3.990133765	7.611050181
1201.25	0.06	34.91802901	37.64936918	38.98180665	42.66021273	2.731340174	4.063777643	7.742183717
1201.25	1.88	42.02186931	44.31753321	45.45492273	48.64629996	2.295663906	3.433053419	6.624430656
1211	0.44	36.66346956	39.29408352	40.58275496	44.15552061	2.630613967	3.919285401	7.492051049
1253	1.51	41.54524642	43.9630811	45.1581388	48.50265457	2.417834683	3.612892383	6.957408148
1253.48	0.14	36.01877011	38.78370792	40.13379872	43.86447082	2.764937813	4.115028617	7.84570071
1264	3.7	49.32747713	51.39805444	52.43281415	55.36424839	2.070577308	3.105337023	6.036771262
1264.47	2	43.55117679	45.88401192	47.04064732	50.28856729	2.332835129	3.489470525	6.737390497
1287.05	2.03	44.04801783	46.39602488	47.56038662	50.8306293	2.348007051	3.512368783	6.782611467
1298.65	0.1	36.48446587	39.31149323	40.69126135	44.50214882	2.827027358	4.206795474	8.017682952
1322.48	1.28	41.78125896	44.3157173	45.56636479	49.06030575	2.534458345	3.785105831	7.27904679
1334.72	3.1	48.67368899	50.88572295	51.9885372	55.1043374	2.212033958	3.314848207	6.430648406
1359.91	-0.08	36.50632548	39.46006779	40.89852442	44.86275515	2.953742311	4.392198944	8.356429675
1360	0.45	38.89730068	41.68213046	43.0464865	46.8294779	2.784829786	4.149185823	7.932177218
1372.86	0.55	39.51744235	42.28652445	43.64450996	47.41369264	2.769082098	4.127067613	7.896250291
1372.86	0.88	40.9254102	43.60517286	44.92331466	48.59340696	2.679762659	3.99790446	7.667996761
1373	0.54	39.47600537	42.24807688	43.60739616	47.3799008	2.772071509	4.131390791	7.903895432
1373	2.46	47.08922382	49.43622154	50.60281613	53.8878001	2.346997718	3.513592307	6.798576283

Radius (feet)	Super-elevation	V4 Speed Calculated V4 = .5*((4+Ea) *R)^.5] mph	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea) *R)^.5] mph	V5 Speed Calculated V5 = .5*((5+Ea) *R)^.5] mph	V6 Speed Calculated V6 = .5*((6+Ea) *R)^.5] mph	Delta between V4 and V4.66 mph	Delta between V4 and V5 mph	Delta between V4 and V6 mph
1386.06	1.53	43.774741	46.31336578	47.56829774	51.08089614	2.538624777	3.793556737	7.306155131
1399.51	1.53	43.98661814	46.53753028	47.79853633	51.32813629	2.550912149	3.811918191	7.341518154
1442	0.05	38.21027349	41.20624953	42.66761067	46.70144537	2.995976038	4.457337179	8.491171886
1456	0.11	38.6786763	41.66869328	43.12818104	47.15972858	2.990016988	4.449504746	8.481052287
1486.08	1.28	44.29024272	46.97689645	48.30264589	52.00639961	2.686653731	4.012403172	7.716156888
1517	2	47.70220121	50.25738752	51.52426613	55.08175742	2.55518631	3.822064921	7.379556209
1567	1.42	46.07911675	48.80409819	50.15012463	53.91460841	2.724981444	4.071007881	7.835491665
1602	0.15	40.76855406	43.89083048	45.41558103	49.62937638	3.122276419	4.647026969	8.860822323
1657	0.9	45.05357921	47.9919785	49.43758692	53.46330517	2.938399282	4.384007701	8.409725959
1696	0.86	45.39427277	48.37850762	49.84616334	53.9318088	2.984234858	4.451890576	8.537536029
1716.07	0.05	41.6835804	44.95189012	46.54608872	50.94659827	3.268309716	4.862508318	9.263017867
1737	0.68	45.08092723	48.15490629	49.66427287	53.85898254	3.073979061	4.583345642	8.778055307
1758	1.37	48.58101481	51.47994755	52.91138819	56.91322342	2.898932742	4.330373378	8.332208609
1848.08	0.09	43.4702404	46.84650467	48.49414191	53.04433806	3.376264277	5.023901519	9.574097663
1896.71	1.45	50.83568997	53.82587226	55.30320854	59.43586775	2.990182291	4.467518569	8.600177776
1922	1.88	53.15392742	56.05773809	57.49643467	61.53324305	2.903810674	4.342507254	8.37931563
1922	2.5	55.88604477	58.65475258	60.03124187	63.9081372	2.768707808	4.145197097	8.022092427
1975	0.18	45.42989104	48.8850693	50.57296709	55.23925235	3.455178254	5.143076046	9.809361307
2002	0.45	47.19348472	50.57227501	52.22762679	56.8174709	3.378790293	5.034142069	9.623986185
2030.28	1.43	52.49861998	55.59767351	57.12858391	61.41046409	3.099053531	4.629963932	8.91184411
2059	0.18	46.38593537	49.91382574	51.63724431	56.4017287	3.527890372	5.251308942	10.01579333
2059	0.52	48.23556779	51.63724431	53.30497163	57.93246068	3.401676521	5.069403836	9.696892886
2151.49	0.09	46.90307586	50.54596299	52.32371379	57.23323794	3.642887135	5.420637933	10.33016208
2217.69	0.72	51.15539268	54.61495262	56.31426729	61.03866971	3.459559945	5.158874609	9.883277033
2288	1.35	55.31907447	58.63207313	60.26773598	64.83980259	3.312998666	4.948661511	9.520728123
2288.1	0.52	50.84833331	54.4342677	56.19233044	61.07047568	3.585934394	5.343997132	10.22214238
2252.34	0.9	52.52729291	55.9531286	57.63854179	62.33206639	3.425835693	5.111248887	9.804773481
2363	0.12	49.33447071	53.13929808	54.99672718	60.12811323	3.804827368	5.662256468	10.79364252
2529	2.03	61.745182	65.03654742	66.66871455	71.25284205	3.291365419	4.923532554	9.50766005
2720	0	52.15361924	56.29209536	58.30951895	63.87487769	4.138476118	6.155899707	11.72125845
2826	-0.2	51.81409075	56.13367973	58.23401068	64.01327987	4.319588982	6.419919933	12.19918912
3003.13	1.41	63.73172934	67.50740533	69.37229869	74.58752124	3.775675992	5.640569344	10.8557919
3133.7	1.28	64.31550357	68.21689307	70.14206299	75.52042108	3.901389495	5.826559412	11.20491751

APPENDIX “G” CURVES AND SPEEDS, V4/V6 ANALYSIS, FLUSHING LINE, “A” DIVISION (IRT)

G-1: FLUSHING LINE CM – CURVE ANALYSIS

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	**GRADE (%)**	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
CM	Point of Vertical Curve (PVC)	184+64			(1)	50	55	0.00					
CM	Point of Vertical Intersection of Grades (PVI)	185+65			(1)	50	55	2.88					
CM	Point of Vertical Tangent (PVT)	186+66			(1)	50	55	2.88					
CM	REFLECTOR TAG	187+04			(1)	50	55	2.88					
CM	Start >>> TURNOUT	187+04			(1)	50	55	2.88					
CM	Point of Vertical Curve (PVC)	187+19			(1)	50	55	2.88					
CM	Spiral/Tangent	187+76	950	0.0	30	37	51	2.88	30.822	37.749	51.113	33.268	34.460
CM	Curve/Spiral	188+03	950	0.0	30	37	51	2.88	30.822	37.749	51.113	33.268	34.460
CM	Point of Vertical Intersection of Grades (PVI)	188+21	950	0.0	30	37	51	-3.38	30.822	37.749	51.113	33.268	34.460
CM	Spiral/Curve	188+30	950	0.0	30	37	51	-3.38	30.822	37.749	51.113	33.268	34.460
CM	Tangent/Spiral	188+58	950	0.0	30	37	51	-3.38	30.822	37.749	51.113	33.268	34.460
CM	Spiral/Tangent	188+92	900	0.0	30	36	49	-3.38	30.000	36.742	49.749	32.381	33.541
CM	Curve/Spiral	189+10	900	0.0	30	36	49	-3.38	30.000	36.742	49.749	32.381	33.541
CM	REFLECTOR TAG	189+19	900	0.0	30	36	49	-3.38	30.000	36.742	49.749	32.381	33.541
CM	Point of Vertical Tangent (PVT)	189+23	900	0.0	30	36	49	-3.38	30.000	36.742	49.749	32.381	33.541
CM	Spiral/Curve	189+33	900	0.0	30	36	49	-3.38	30.000	36.742	49.749	32.381	33.541
CM	Tangent/Spiral	189+90	900	0.0	30	36	49	-3.38	30.000	36.742	49.749	32.381	33.541
CM	Point of Vertical Curve (PVC)	190+36			(1)	50	55	-3.38					
CM	Start >>> TURNOUT	190+64			(1)	50	55	-3.38					
CM	End >>> TURNOUT (117)	191+42			(1)	50	55	-3.38					
CM	REFLECTOR TAG	191+42			(1)	50	55	-3.38					
CM	Point of Vertical Intersection of Grades (PVI)	193+39			(1)	50	55	3.00					
CM	Tangent/Spiral	194+36	500	5.0	33	37	44	3.00	33.541	37.081	44.721	34.749	35.355
CM	Spiral/Curve	196+09	500	5.0	33	37	44	3.00	33.541	37.081	44.721	34.749	35.355
CM	Point of Vertical Tangent (PVT)	196+42	500	5.0	33	37	44	3.00	33.541	37.081	44.721	34.749	35.355
CM	Curve/Spiral	198+16	500	5.0	33	37	44	3.00	33.541	37.081	44.721	34.749	35.355
CM	Point of Vertical Curve (PVC)	198+35	500	5.0	33	37	44	3.00	33.541	37.081	44.721	34.749	35.355
CM	>>> SIGNAL	198+35	500	5.0	33	37	44	3.00	33.541	37.081	44.721	34.749	35.355
CM	Point of Vertical Intersection of Grades (PVI)	199+73	500	5.0	33	37	44	0.50	33.541	37.081	44.721	34.749	35.355
CM	Spiral/Tangent	199+84	500	5.0	33	37	44	0.50	33.541	37.081	44.721	34.749	35.355
CM	Point of Vertical Tangent (PVT)	201+10			(1)	50	55	0.50					
CM	T: 33RD ST	203+37			(1)	50	55	0.50					
CM	Point of Vertical Curve (PVC)	204+81			(1)	50	55	0.50					
CM	Point of Vertical Intersection of Grades (PVI)	205+46			(1)	50	55	1.64					
CM	Point of Vertical Tangent (PVT)	206+11			(1)	50	55	1.64					
CM	>>> SIGNAL	207+60			(1)	50	55	1.64					
CM	Point of Vertical Curve (PVC)	211+91			(1)	50	55	1.64					
CM	Point of Vertical Intersection of Grades (PVI)	212+65			(1)	50	55	3.00					
CM	>>> SIGNAL	213+22			(1)	50	55	3.00					
CM	Point of Vertical Tangent (PVT)	213+39			(1)	50	55	3.00					
CM	Point of Vertical Curve (PVC)	218+04			(1)	50	55	3.00					
CM	Point of Vertical Intersection of Grades (PVI)	219+31			(1)	50	55	0.50					
CM	>>> SIGNAL	219+46			(1)	50	55	0.50					
CM	T: 40TH ST	220+46			(1)	50	55	0.50					
CM	Point of Vertical Tangent (PVT)	220+58			(1)	50	55	0.50					
CM	Point of Vertical Curve (PVC)	223+89			(1)	50	55	0.50					
CM	Point of Vertical Intersection of Grades (PVI)	224+89			(1)	50	55	-1.46					
CM	Point of Vertical Tangent (PVT)	225+89			(1)	50	55	-1.46					
CM	>>> SIGNAL	226+12			(1)	50	55	-1.46					
CM	Point of Vertical Curve (PVC)	228+43			(1)	50	55	-1.46					
CM	Point of Vertical Intersection of Grades (PVI)	229+84			(1)	50	55	1.25					
CM	Point of Vertical Tangent (PVT)	231+25			(1)	50	55	1.25					
CM	>>> SIGNAL	232+42			(1)	50	55	1.25					
CM	Point of Vertical Curve (PVC)	235+37			(1)	50	55	1.25					
CM	Point of Vertical Intersection of Grades (PVI)	236+17			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	236+97			(1)	50	55	0.00					
CM	T: 46TH ST	238+11			(1)	50	55	0.00					
CM	>>> SIGNAL	240+65			(1)	50	55	0.00					
CM	Point of Vertical Curve (PVC)	240+73			(1)	50	55	0.00					
CM	REFLECTOR TAG	240+91			(1)	50	55	0.00					
CM	Point of Vertical Intersection of Grades (PVI)	240+93			(1)	50	55	0.10					
CM	Point of Vertical Tangent (PVT)	241+13			(1)	50	55	0.10					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	Event	True Stationing	RADIUS (ft.)	SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
CM	Tangent/Spiral	241+34	510	6.0	35	39	46	0.10	35.707	39.115	46.556	36.867	37.450
CM	Point of Vertical Curve (PVC)	242+03	510	6.0	35	39	46	0.10	35.707	39.115	46.556	36.867	37.450
CM	Point of Vertical Intersection of Grades (PVI)	242+36	510	6.0	35	39	46	0.24	35.707	39.115	46.556	36.867	37.450
CM	Point of Vertical Tangent (PVT)	242+69	510	6.0	35	39	46	0.24	35.707	39.115	46.556	36.867	37.450
CM	Point of Vertical Curve (PVC)	242+96	510	6.0	35	39	46	0.24	35.707	39.115	46.556	36.867	37.450
CM	Spiral/Curve	243+18	510	6.0	35	39	46	0.24	35.707	39.115	46.556	36.867	37.450
CM	Point of Vertical Intersection of Grades (PVI)	243+72	510	6.0	35	39	46	-0.16	35.707	39.115	46.556	36.867	37.450
CM	Curve/Spiral	243+76	510	6.0	35	39	46	-0.16	35.707	39.115	46.556	36.867	37.450
CM	Point of Vertical Tangent (PVT)	244+48	510	6.0	35	39	46	-0.16	35.707	39.115	46.556	36.867	37.450
CM	Spiral/Tangent	245+85	510	6.0	35	39	46	-0.16	35.707	39.115	46.556	36.867	37.450
CM	Point of Vertical Curve (PVC)	246+58			(1)	50	55	-0.16					
CM	Point of Vertical Intersection of Grades (PVI)	247+56			(1)	50	55	3.01					
CM	Point of Vertical Tangent (PVT)	248+54			(1)	50	55	3.01					
CM	>>> SIGNAL	248+92			(1)	50	55	3.01					
CM	Point of Vertical Curve (PVC)	252+48			(1)	50	55	3.01					
CM	Point of Vertical Intersection of Grades (PVI)	253+13			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	253+78			(1)	50	55	0.00					
CM	REFLECTOR TAG	254+46			(1)	50	55	0.00					
CM	REFLECTOR TAG	255+03			(1)	50	55	0.00					
CM	>>> SIGNAL	255+53			(1)	50	55	0.00					
CM	REFLECTOR TAG	255+53			(1)	50	55	0.00					
CM	T: 52ND ST	256+14			(1)	50	55	0.00					
CM	REFLECTOR TAG	258+48			(1)	50	55	0.00					
CM	REFLECTOR TAG	258+99			(1)	50	55	0.00					
CM	Point of Vertical Curve (PVC)	259+53			(1)	50	55	0.00					
CM	Tangent/Spiral	259+82	2250	1.0	(1)	50	55	0.00	53.033	62.750	82.158	56.425	58.095
CM	Spiral/Curve	260+36	2250	1.0	(1)	50	55	0.00	53.033	62.750	82.158	56.425	58.095
CM	Point of Vertical Intersection of Grades (PVI)	261+06	2250	1.0	(1)	50	55	-3.00	53.033	62.750	82.158	56.425	58.095
CM	>>> SIGNAL	261+68	2250	1.0	(1)	50	55	-3.00	53.033	62.750	82.158	56.425	58.095
CM	Point of Vertical Tangent (PVT)	262+59	2250	1.0	(1)	50	55	-3.00	53.033	62.750	82.158	56.425	58.095
CM	Curve/Spiral	262+96	2250	1.0	(1)	50	55	-3.00	53.033	62.750	82.158	56.425	58.095
CM	Spiral/Tangent	264+05	2250	1.0	(1)	50	55	-3.00	53.033	62.750	82.158	56.425	58.095
CM	>>> SIGNAL	265+79			(1)	50	55	-3.00					
CM	REFLECTOR TAG	268+71			(1)	50	55	-3.00					
CM	>>> SIGNAL	268+78			(1)	50	55	-3.00					
CM	Tangent/Spiral	269+68	1250	3.5	48	50	55	-3.00	48.412	54.486	67.315	50.498	51.539
CM	Point of Vertical Curve (PVC)	269+88	1250	3.5	48	50	55	-3.00	48.412	54.486	67.315	50.498	51.539
CM	Point of Vertical Intersection of Grades (PVI)	270+08	1250	3.5	48	50	55	-2.76	48.412	54.486	67.315	50.498	51.539
CM	Point of Vertical Tangent (PVT)	270+28	1250	3.5	48	50	55	-2.76	48.412	54.486	67.315	50.498	51.539
CM	Spiral/Curve	270+82	1250	3.5	48	50	55	-2.76	48.412	54.486	67.315	50.498	51.539
CM	>>> SIGNAL	271+55	1250	3.5	48	50	55	-2.76	48.412	54.486	67.315	50.498	51.539
CM	Curve/Spiral	271+79	1250	3.5	48	50	55	-2.76	48.412	54.486	67.315	50.498	51.539
CM	Point of Vertical Curve (PVC)	271+91	1250	3.5	48	50	55	-2.76	48.412	54.486	67.315	50.498	51.539
CM	Point of Vertical Intersection of Grades (PVI)	273+22	1250	3.5	48	50	55	0.00	48.412	54.486	67.315	50.498	51.539
CM	>>> SIGNAL	273+90	1250	3.5	48	50	55	0.00	48.412	54.486	67.315	50.498	51.539
CM	Spiral/Tangent	274+09	1250	3.5	48	50	55	0.00	48.412	54.486	67.315	50.498	51.539
CM	Point of Vertical Tangent (PVT)	274+53			(1)	50	55	0.00					
CM	Tangent/Spiral	274+72	2100	2.0	(1)	50	55	0.00	56.125	64.807	82.614	59.131	60.622
CM	Spiral/Curve	275+36	2100	2.0	(1)	50	55	0.00	56.125	64.807	82.614	59.131	60.622
CM	>>> SIGNAL	276+88	2100	2.0	(1)	50	55	0.00	56.125	64.807	82.614	59.131	60.622
CM	Curve/Spiral	277+46	2100	2.0	(1)	50	55	0.00	56.125	64.807	82.614	59.131	60.622
CM	Spiral/Tangent	278+10	2100	2.0	(1)	50	55	0.00	56.125	64.807	82.614	59.131	60.622
CM	REFLECTOR TAG	279+63			(1)	50	55	0.00					
CM	>>> SIGNAL	279+80			(1)	50	55	0.00					
CM	>>> S.E.PLATFORM	280+04			(1)	50	55	0.00					
CM	REFLECTOR TAG	280+14			(1)	50	55	0.00					
CM	REFLECTOR TAG	281+16			(1)	50	55	0.00					
CM	T: WOODSIDE	284+18			(1)	50	55	0.00					
CM	REFLECTOR TAG	284+23			(1)	50	55	0.00					
CM	>>> N.E.PLATFORM	285+68			(1)	50	55	0.00					
CM	REFLECTOR TAG	285+78			(1)	50	55	0.00					
CM	Point of Vertical Curve (PVC)	285+82			(1)	50	55	0.00					
CM	>>> SIGNAL	286+12			(1)	50	55	0.00					
CM	Point of Vertical Intersection of Grades (PVI)	286+39			(1)	50	55	-2.98					
CM	Point of Vertical Tangent (PVT)	286+96			(1)	50	55	-2.98					
CM	REFLECTOR TAG	287+72			(1)	50	55	-2.98					
CM	Point of Vertical Curve (PVC)	291+08			(1)	50	55	-2.98					
CM	Point of Vertical Intersection of Grades (PVI)	293+49			(1)	50	55	1.67					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	Event	True Stationing	RADIUS (ft.)	SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
CM	>>> SIGNAL	294+13			(1)	50	55	1.67					
CM	Point of Vertical Tangent (PVT)	295+90			(1)	50	55	1.67					
CM	Point of Vertical Curve (PVC)	296+94			(1)	50	55	1.67					
CM	Point of Vertical Intersection of Grades (PVI)	297+99			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	299+04			(1)	50	55	0.00					
CM	T: 69TH ST	300+20			(1)	50	55	0.00					
CM	>>> SIGNAL	301+15			(1)	50	55	0.00					
CM	REFLECTOR TAG	301+87			(1)	50	55	0.00					
CM	Point of Vertical Curve (PVC)	303+92			(1)	50	55	0.00					
CM	Point of Vertical Intersection of Grades (PVI)	304+95			(1)	50	55	1.75					
CM	Point of Vertical Tangent (PVT)	305+98			(1)	50	55	1.75					
CM	>>> SIGNAL	307+21			(1)	50	55	1.75					
CM	Start >>> TURNOUT	307+39			(1)	50	55	1.75					
CM	End >>> TURNOUT (98)	308+37			(1)	50	55	1.75					
CM	Start >>> TURNOUT	309+47			(1)	50	55	1.75					
CM	Point of Vertical Curve (PVC)	310+41			(1)	50	55	1.75					
CM	End >>> TURNOUT (136)	310+83			(1)	50	55	1.75					
CM	Point of Vertical Intersection of Grades (PVI)	311+35			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	312+29			(1)	50	55	0.00					
CM	REFLECTOR TAG	313+38			(1)	50	55	0.00					
CM	T: 74TH ST	313+49			(1)	50	55	0.00					
CM	REFLECTOR TAG	314+93			(1)	50	55	0.00					
CM	>>> SIGNAL	314+96			(1)	50	55	0.00					
CM	REFLECTOR TAG	315+70			(1)	50	55	0.00					
CM	REFLECTOR TAG	317+29			(1)	50	55	0.00					
CM	>>> SIGNAL	317+34			(1)	50	55	0.00					
CM	Point of Vertical Curve (PVC)	318+09			(1)	50	55	0.00					
CM	>>> SIGNAL	318+26			(1)	50	55	0.00					
CM	Point of Vertical Intersection of Grades (PVI)	318+74			(1)	50	55	-1.20					
CM	Point of Vertical Tangent (PVT)	319+39			(1)	50	55	-1.20					
CM	Start >>> TURNOUT	319+79			(1)	50	55	-1.20					
CM	End >>> TURNOUT (116)	320+95			(1)	50	55	-1.20					
CM	REFLECTOR TAG	321+01			(1)	50	55	-1.20					
CM	Start >>> TURNOUT	322+03			(1)	50	55	-1.20					
CM	REFLECTOR TAG	322+50			(1)	50	55	-1.20					
CM	End >>> TURNOUT (116)	323+19			(1)	50	55	-1.20					
CM	REFLECTOR TAG	323+22			(1)	50	55	-1.20					
CM	>>> SIGNAL	323+77			(1)	50	55	-1.20					
CM	Point of Vertical Curve (PVC)	326+29			(1)	50	55	-1.20					
CM	Point of Vertical Intersection of Grades (PVI)	327+79			(1)	50	55	1.70					
CM	REFLECTOR TAG	328+48			(1)	50	55	1.70					
CM	Point of Vertical Tangent (PVT)	329+29			(1)	50	55	1.70					
CM	Point of Vertical Curve (PVC)	332+28			(1)	50	55	1.70					
CM	REFLECTOR TAG	332+65			(1)	50	55	1.70					
CM	>>> SIGNAL	332+88			(1)	50	55	1.70					
CM	Point of Vertical Intersection of Grades (PVI)	333+13			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	333+98			(1)	50	55	0.00					
CM	REFLECTOR TAG	336+04			(1)	50	55	0.00					
CM	T: 82ND ST	336+77			(1)	50	55	0.00					
CM	Point of Vertical Curve (PVC)	339+19			(1)	50	55	0.00					
CM	Point of Vertical Intersection of Grades (PVI)	339+65			(1)	50	55	-0.67					
CM	Point of Vertical Tangent (PVT)	340+11			(1)	50	55	-0.67					
CM	>>> SIGNAL	340+97			(1)	50	55	-0.67					
CM	REFLECTOR TAG	341+17			(1)	50	55	-0.67					
CM	Point of Vertical Curve (PVC)	348+70			(1)	50	55	-0.67					
CM	>>> SIGNAL	349+24			(1)	50	55	-0.67					
CM	REFLECTOR TAG	349+37			(1)	50	55	-0.67					
CM	Point of Vertical Intersection of Grades (PVI)	349+46			(1)	50	55	0.72					
CM	Point of Vertical Tangent (PVT)	350+22			(1)	50	55	0.72					
CM	Point of Vertical Curve (PVC)	353+12			(1)	50	55	0.72					
CM	Point of Vertical Intersection of Grades (PVI)	354+04			(1)	50	55	0.00					
CM	T: 90TH ST	354+78			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	354+96			(1)	50	55	0.00					
CM	REFLECTOR TAG	356+75			(1)	50	55	0.00					
CM	>>> SIGNAL	358+14			(1)	50	55	0.00					
CM	REFLECTOR TAG	358+35			(1)	50	55	0.00					
CM	Point of Vertical Curve (PVC)	359+40			(1)	50	55	0.00					
CM	Point of Vertical Intersection of Grades (PVI)	360+39			(1)	50	55	-1.15					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	Event	True Stationing	RADIUS (ft.)	SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
CM	Point of Vertical Tangent (PVT)	361+38			(1)	50	55	-1.15					
CM	>>> SIGNAL	363+58			(1)	50	55	-1.15					
CM	REFLECTOR TAG	363+58			(1)	50	55	-1.15					
CM	Point of Vertical Curve (PVC)	364+28			(1)	50	55	-1.15					
CM	Point of Vertical Intersection of Grades (PVI)	365+56			(1)	50	55	1.22					
CM	Point of Vertical Tangent (PVT)	366+84			(1)	50	55	1.22					
CM	REFLECTOR TAG	368+04			(1)	50	55	1.22					
CM	>>> SIGNAL	368+09			(1)	50	55	1.22					
CM	REFLECTOR TAG	371+01			(1)	50	55	1.22					
CM	>>> SIGNAL	371+07			(1)	50	55	1.22					
CM	Point of Vertical Curve (PVC)	373+06			(1)	50	55	1.22					
CM	REFLECTOR TAG	373+45			(1)	50	55	1.22					
CM	>>> SIGNAL	373+47			(1)	50	55	1.22					
CM	>>> S.E.PLATFORM	373+61			(1)	50	55	1.22					
CM	Point of Vertical Intersection of Grades (PVI)	373+74			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	374+42			(1)	50	55	0.00					
CM	T: JUNCTION BLVD	374+93			(1)	50	55	0.00					
CM	>>> N.E.PLATFORM	379+18			(1)	50	55	0.00					
CM	>>> SIGNAL	379+62			(1)	50	55	0.00					
CM	REFLECTOR TAG	379+79			(1)	50	55	0.00					
CM	Point of Vertical Curve (PVC)	381+18			(1)	50	55	0.00					
CM	Point of Vertical Intersection of Grades (PVI)	382+07			(1)	50	55	-1.67					
CM	REFLECTOR TAG	382+69			(1)	50	55	-1.67					
CM	Point of Vertical Tangent (PVT)	382+96			(1)	50	55	-1.67					
CM	REFLECTOR TAG	385+01			(1)	50	55	-1.67					
CM	>>> SIGNAL	387+93			(1)	50	55	-1.67					
CM	REFLECTOR TAG	388+05			(1)	50	55	-1.67					
CM	Point of Vertical Curve (PVC)	391+63			(1)	50	55	-1.67					
CM	Point of Vertical Intersection of Grades (PVI)	392+61			(1)	50	55	0.00					
CM	REFLECTOR TAG	393+07			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	393+59			(1)	50	55	0.00					
CM	>>> SIGNAL	395+71			(1)	50	55	0.00					
CM	REFLECTOR TAG	395+81			(1)	50	55	0.00					
CM	Tangent/Spiral	397+62	2000	1.5	(1)	50	55	0.00	52.440	61.237	79.057	55.498	57.009
CM	T: 103ST	397+81	2000	1.5	(1)	50	55	0.00	52.440	61.237	79.057	55.498	57.009
CM	Spiral/Curve	398+33	2000	1.5	(1)	50	55	0.00	52.440	61.237	79.057	55.498	57.009
CM	Point of Vertical Curve (PVC)	398+99	2000	1.5	(1)	50	55	0.00	52.440	61.237	79.057	55.498	57.009
CM	Point of Vertical Intersection of Grades (PVI)	399+42	2000	1.5	(1)	50	55	0.26	52.440	61.237	79.057	55.498	57.009
CM	Point of Vertical Tangent (PVT)	399+85	2000	1.5	(1)	50	55	0.26	52.440	61.237	79.057	55.498	57.009
CM	Curve/Spiral	402+50	2000	1.5	(1)	50	55	0.26	52.440	61.237	79.057	55.498	57.009
CM	Point of Vertical Curve (PVC)	403+03	2000	1.5	(1)	50	55	0.26	52.440	61.237	79.057	55.498	57.009
CM	Spiral/Tangent	403+15	2000	1.5	(1)	50	55	0.26	52.440	61.237	79.057	55.498	57.009
CM	>>> SIGNAL	403+64			(1)	50	55	0.26					
CM	Point of Vertical Intersection of Grades (PVI)	403+71			(1)	50	55	3.02					
CM	REFLECTOR TAG	403+73			(1)	50	55	3.02					
CM	Point of Vertical Tangent (PVT)	404+39			(1)	50	55	3.02					
CM	Point of Vertical Curve (PVC)	410+48			(1)	50	55	3.02					
CM	Point of Vertical Intersection of Grades (PVI)	411+18			(1)	50	55	-0.50					
CM	Point of Vertical Tangent (PVT)	411+88			(1)	50	55	-0.50					
CM	>>> SIGNAL	411+91			(1)	50	55	-0.50					
CM	REFLECTOR TAG	412+02			(1)	50	55	-0.50					
CM	T: 111 ST ST	417+03			(1)	50	55	-0.50					
CM	>>> SIGNAL	419+20			(1)	50	55	-0.50					
CM	REFLECTOR TAG	419+30			(1)	50	55	-0.50					
CM	Point of Vertical Curve (PVC)	419+99			(1)	50	55	-0.50					
CM	Point of Vertical Intersection of Grades (PVI)	420+72			(1)	50	55	-3.01					
CM	Point of Vertical Tangent (PVT)	421+45			(1)	50	55	-3.01					
CM	REFLECTOR TAG	425+61			(1)	50	55	-3.01					
CM	>>> SIGNAL	425+68			(1)	50	55	-3.01					
CM	REFLECTOR TAG	429+26			(1)	50	55	-3.01					
CM	>>> SIGNAL	429+33			(1)	50	55	-3.01					
CM	REFLECTOR TAG	433+24			(1)	50	55	-3.01					
CM	>>> SIGNAL	433+30			(1)	50	55	-3.01					
CM	REFLECTOR TAG	434+78			(1)	50	55	-3.01					
CM	>>> SIGNAL	434+88			(1)	50	55	-3.01					
CM	>>> SIGNAL	435+93			(1)	50	55	-3.01					
CM	REFLECTOR TAG	435+96			(1)	50	55	-3.01					
CM	Point of Vertical Curve (PVC)	436+59			(1)	50	55	-3.01					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
CM	Point of Vertical Intersection of Grades (PVI)	437+33			(1)	50	55	-0.48					
CM	Start >>> TURNOUT	437+70			(1)	50	55	-0.48					
CM	REFLECTOR TAG	438+05			(1)	50	55	-0.48					
CM	Point of Vertical Tangent (PVT)	438+07			(1)	50	55	-0.48					
CM	End >>> TURNOUT (61)	438+31			(1)	50	55	-0.48					
CM	Start >>> TURNOUT	438+46			(1)	50	55	-0.48					
CM	Tangent/Spiral	439+13	1500	0.0	38	47	55	-0.48	38.730	47.434	64.226	41.803	43.301
CM	End >>> TURNOUT (78)	439+24	1500	0.0	38	47	55	-0.48	38.730	47.434	64.226	41.803	43.301
CM	REFLECTOR TAG	439+36	1500	0.0	38	47	55	-0.48	38.730	47.434	64.226	41.803	43.301
CM	Spiral/Curve	439+83	1500	0.0	38	47	55	-0.48	38.730	47.434	64.226	41.803	43.301
CM	>>> SIGNAL	440+23	1500	0.0	38	47	55	-0.48	38.730	47.434	64.226	41.803	43.301
CM	REFLECTOR TAG	440+28	1500	0.0	38	47	55	-0.48	38.730	47.434	64.226	41.803	43.301
CM	Curve/Spiral	440+37	1500	0.0	38	47	55	-0.48	38.730	47.434	64.226	41.803	43.301
CM	Start >>> TURNOUT	440+62	1500	0.0	38	47	55	-0.48	38.730	47.434	64.226	41.803	43.301
CM	Point of Vertical Curve (PVC)	440+63	1500	0.0	38	47	55	-0.48	38.730	47.434	64.226	41.803	43.301
CM	Point of Vertical Intersection of Grades (PVI)	440+93	1500	0.0	38	47	55	-0.90	38.730	47.434	64.226	41.803	43.301
CM	REFLECTOR TAG	440+93	1500	0.0	38	47	55	-0.90	38.730	47.434	64.226	41.803	43.301
CM	Point of Vertical Tangent (PVT)	441+23	1500	0.0	38	47	55	-0.90	38.730	47.434	64.226	41.803	43.301
CM	End >>> TURNOUT (65)	441+27	2000	0.0	44	50	55	-0.90	44.721	54.772	74.162	48.270	50.000
CM	Spiral/Curve	441+30	2000	0.0	44	50	55	-0.90	44.721	54.772	74.162	48.270	50.000
CM	Start >>> TURNOUT	441+38	2000	0.0	44	50	55	-0.90	44.721	54.772	74.162	48.270	50.000
CM	REFLECTOR TAG	441+60	2000	0.0	44	50	55	-0.90	44.721	54.772	74.162	48.270	50.000
CM	Curve/Spiral	441+61	2000	0.0	44	50	55	-0.90	44.721	54.772	74.162	48.270	50.000
CM	Point of Vertical Curve (PVC)	441+72	2000	0.0	44	50	55	-0.90	44.721	54.772	74.162	48.270	50.000
CM	Point of Vertical Intersection of Grades (PVI)	441+97	2000	0.0	44	50	55	-0.45	44.721	54.772	74.162	48.270	50.000
CM	End >>> TURNOUT (67)	442+05	2000	0.0	44	50	55	-0.45	44.721	54.772	74.162	48.270	50.000
CM	Point of Vertical Tangent (PVT)	442+22	2000	0.0	44	50	55	-0.45	44.721	54.772	74.162	48.270	50.000
CM	REFLECTOR TAG	442+30	2000	0.0	44	50	55	-0.45	44.721	54.772	74.162	48.270	50.000
CM	Start >>> TURNOUT	442+50	2000	0.0	44	50	55	-0.45	44.721	54.772	74.162	48.270	50.000
CM	Spiral/Tangent	442+69	2000	0.0	44	50	55	-0.45	44.721	54.772	74.162	48.270	50.000
CM	End >>> TURNOUT (73)	443+23			(1)	50	55	-0.45					
CM	>>> SIGNAL	443+47			(1)	50	55	-0.45					
CM	>>> S.E.PLATFORM	443+53			(1)	50	55	-0.45					
CM	Point of Vertical Curve (PVC)	444+90			(1)	50	55	-0.45					
CM	Point of Vertical Intersection of Grades (PVI)	445+10			(1)	50	55	-0.66					
CM	Point of Vertical Tangent (PVT)	445+30			(1)	50	55	-0.66					
CM	T: WILLETS PT	445+33			(1)	50	55	-0.66					
CM	Point of Vertical Curve (PVC)	445+86			(1)	50	55	-0.66					
CM	Point of Vertical Intersection of Grades (PVI)	446+14			(1)	50	55	-0.43					
CM	Point of Vertical Tangent (PVT)	446+42			(1)	50	55	-0.43					
CM	REFLECTOR TAG	446+58			(1)	50	55	-0.43					
CM	Point of Vertical Curve (PVC)	447+75			(1)	50	55	-0.43					
CM	Point of Vertical Intersection of Grades (PVI)	448+46			(1)	50	55	0.18					
CM	>>> N.E.PLATFORM	448+99			(1)	50	55	0.18					
CM	>>> SIGNAL	449+13			(1)	50	55	0.18					
CM	Point of Vertical Tangent (PVT)	449+17			(1)	50	55	0.18					
CM	Start >>> TURNOUT	449+28			(1)	50	55	0.18					
CM	REFLECTOR TAG	449+30			(1)	50	55	0.18					
CM	End >>> TURNOUT (66)	449+94			(1)	50	55	0.18					
CM	REFLECTOR TAG	452+02			(1)	50	55	0.18					
CM	Point of Vertical Curve (PVC)	452+69			(1)	50	55	0.18					
CM	Start >>> TURNOUT	453+23			(1)	50	55	0.18					
CM	Point of Vertical Intersection of Grades (PVI)	453+73			(1)	50	55	2.90					
CM	End >>> TURNOUT (98)	454+21			(1)	50	55	2.90					
CM	REFLECTOR TAG	454+22			(1)	50	55	2.90					
CM	Point of Vertical Tangent (PVT)	454+77			(1)	50	55	2.90					
CM	REFLECTOR TAG	455+74			(1)	50	55	2.90					
CM	Point of Vertical Curve (PVC)	455+98			(1)	50	55	2.90					
CM	Tangent/Spiral	456+13	1600	3.0	(1)	50	55	2.90	52.915	60.000	74.833	55.353	56.569
CM	Point of Vertical Intersection of Grades (PVI)	456+31	1600	3.0	(1)	50	55	3.40	52.915	60.000	74.833	55.353	56.569
CM	Point of Vertical Tangent (PVT)	456+64	1600	3.0	(1)	50	55	3.40	52.915	60.000	74.833	55.353	56.569
CM	Point of Vertical Curve (PVC)	457+17	1600	3.0	(1)	50	55	3.40	52.915	60.000	74.833	55.353	56.569
CM	Point of Vertical Intersection of Grades (PVI)	457+80	1600	3.0	(1)	50	55	0.55	52.915	60.000	74.833	55.353	56.569
CM	Spiral/Curve	458+03	1600	3.0	(1)	50	55	0.55	52.915	60.000	74.833	55.353	56.569
CM	Point of Vertical Tangent (PVT)	458+43	1600	3.0	(1)	50	55	0.55	52.915	60.000	74.833	55.353	56.569
CM	Curve/Spiral	458+77	1600	3.0	(1)	50	55	0.55	52.915	60.000	74.833	55.353	56.569
CM	Spiral/Tangent	459+42	1600	3.0	(1)	50	55	0.55	52.915	60.000	74.833	55.353	56.569
CM	REFLECTOR TAG	461+70			(1)	50	55	0.55					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	**GRADE (%)**	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
CM	>>> SIGNAL	461+76			(1)	50	55	0.55					
CM	Point of Vertical Curve (PVC)	464+93			(1)	50	55	0.55					
CM	Point of Vertical Intersection of Grades (PVI)	465+32			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	465+71			(1)	50	55	0.00					
CM	Point of Vertical Curve (PVC)	468+90			(1)	50	55	0.00					
CM	Point of Vertical Intersection of Grades (PVI)	469+58			(1)	50	55	-3.40					
CM	Point of Vertical Tangent (PVT)	470+26			(1)	50	55	-3.40					
CM	>>> SIGNAL	470+74			(1)	50	55	-3.40					
CM	Tangent/Spiral	471+11	1000	3.0	41	47	55	-3.40	41.833	47.434	59.161	43.761	44.721
CM	Spiral/Curve	472+48	1000	3.0	41	47	55	-3.40	41.833	47.434	59.161	43.761	44.721
CM	Point of Vertical Curve (PVC)	473+61	1000	3.0	41	47	55	-3.40	41.833	47.434	59.161	43.761	44.721
CM	Point of Vertical Intersection of Grades (PVI)	473+91	1000	3.0	41	47	55	-3.98	41.833	47.434	59.161	43.761	44.721
CM	Point of Vertical Tangent (PVT)	474+21	1000	3.0	41	47	55	-3.98	41.833	47.434	59.161	43.761	44.721
CM	Curve/Spiral	474+42	1000	3.0	41	47	55	-3.98	41.833	47.434	59.161	43.761	44.721
CM	REFLECTOR TAG	474+56	1000	3.0	41	47	55	-3.98	41.833	47.434	59.161	43.761	44.721
CM	>>> SIGNAL	474+62	1000	3.0	41	47	55	-3.98	41.833	47.434	59.161	43.761	44.721
CM	Point of Vertical Curve (PVC)	474+87	1000	3.0	41	47	55	-3.98	41.833	47.434	59.161	43.761	44.721
CM	Spiral/Tangent	474+88	1000	3.0	41	47	55	-3.98	41.833	47.434	59.161	43.761	44.721
CM	Point of Vertical Intersection of Grades (PVI)	475+60			(1)	50	55	-3.18					
CM	Point of Vertical Tangent (PVT)	476+33			(1)	50	55	-3.18					
CM	REFLECTOR TAG	476+74			(1)	50	55	-3.18					
CM	>>> SIGNAL	476+81			(1)	50	55	-3.18					
CM	REFLECTOR TAG	478+43			(1)	50	55	-3.18					
CM	>>> SIGNAL	478+53			(1)	50	55	-3.18					
CM	Point of Vertical Curve (PVC)	479+09			(1)	50	55	-3.18					
CM	>>> PORTAL/ABUT.	479+13			(1)	50	55	-3.18					
CM	Tangent/Spiral	479+20	1100	2.0	40	46	55	-3.18	40.620	46.904	59.791	42.796	43.875
CM	Point of Vertical Intersection of Grades (PVI)	479+32	1100	2.0	40	46	55	-3.50	40.620	46.904	59.791	42.796	43.875
CM	Point of Vertical Tangent (PVT)	479+55	1100	2.0	40	46	55	-3.50	40.620	46.904	59.791	42.796	43.875
CM	Spiral/Curve	480+28	1100	2.0	40	46	55	-3.50	40.620	46.904	59.791	42.796	43.875
CM	>>> SIGNAL	480+47	1100	2.0	40	46	55	-3.50	40.620	46.904	59.791	42.796	43.875
CM	Point of Vertical Curve (PVC)	480+49	1100	2.0	40	46	55	-3.50	40.620	46.904	59.791	42.796	43.875
CM	Curve/Spiral	481+13	1100	2.0	40	46	55	-3.50	40.620	46.904	59.791	42.796	43.875
CM	Point of Vertical Intersection of Grades (PVI)	481+23	1100	2.0	40	46	55	-2.00	40.620	46.904	59.791	42.796	43.875
CM	>>> SIGNAL	481+51	1100	2.0	40	46	55	-2.00	40.620	46.904	59.791	42.796	43.875
CM	REFLECTOR TAG	481+56	1100	2.0	40	46	55	-2.00	40.620	46.904	59.791	42.796	43.875
CM	Point of Vertical Tangent (PVT)	481+97	1100	2.0	40	46	55	-2.00	40.620	46.904	59.791	42.796	43.875
CM	Spiral/Tangent	482+68	1100	2.0	40	46	55	-2.00	40.620	46.904	59.791	42.796	43.875
CM	Start >>> TURNOUT	483+84			(1)	50	55	-2.00					
CM	End >>> TURNOUT (66)	484+50			(1)	50	55	-2.00					
CM	Start >>> TURNOUT	484+71			(1)	50	55	-2.00					
CM	End >>> TURNOUT (72)	485+43			(1)	50	55	-2.00					
CM	Start >>> TURNOUT	485+87			(1)	50	55	-2.00					
CM	Point of Vertical Curve (PVC)	486+35			(1)	50	55	-2.00					
CM	End >>> TURNOUT (73)	486+60			(1)	50	55	-2.00					
CM	Start >>> TURNOUT	486+77			(1)	50	55	-2.00					
CM	REFLECTOR TAG	486+94			(1)	50	55	-2.00					
CM	Point of Vertical Intersection of Grades (PVI)	486+96			(1)	50	55	0.00					
CM	End >>> TURNOUT (76)	487+53			(1)	50	55	0.00					
CM	Point of Vertical Tangent (PVT)	487+57			(1)	50	55	0.00					
CM	Tangent/Spiral	487+57	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	Spiral/Curve	487+73	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	REFLECTOR TAG	488+13	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	Start >>> TURNOUT	488+53	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	Curve/Spiral	488+66	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	Spiral/Tangent	489+06	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	End >>> TURNOUT (111)	489+64			(1)	50	55	0.00					
CM	REFLECTOR TAG	490+03			(1)	50	55	0.00					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
CM	Tangent/Spiral	487+57	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	Spiral/Curve	487+73	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	REFLECTOR TAG	488+13	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	Start >>> TURNOUT	488+53	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	Curve/Spiral	488+66	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	Spiral/Tangent	489+06	2500	0.0	(1)	50	55	0.00	50.000	61.237	82.916	53.968	55.902
CM	End >>> TURNOUT (111)	489+64			(1)	50	55	0.00					
CM	REFLECTOR TAG	490+03			(1)	50	55	0.00					
CM	Tangent/Spiral	490+08	2400	0.0	48	50	55	0.00	48.990	60.000	81.240	52.877	54.772
CM	>>> SIGNAL	490+10	2400	0.0	48	50	55	0.00	48.990	60.000	81.240	52.877	54.772
CM	>>> S.E.PLATFORM	490+24	2400	0.0	48	50	55	0.00	48.990	60.000	81.240	52.877	54.772
CM	Spiral/Curve	490+46	2400	0.0	48	50	55	0.00	48.990	60.000	81.240	52.877	54.772
CM	T: MAIN ST	490+80	2400	0.0	48	50	55	0.00	48.990	60.000	81.240	52.877	54.772
CM	>>> SIGNAL	493+60	2400	0.0	48	50	55	0.00	48.990	60.000	81.240	52.877	54.772
CM	Curve/Spiral	493+66	2400	0.0	48	50	55	0.00	48.990	60.000	81.240	52.877	54.772
CM	Spiral/Tangent	494+29	2400	0.0	48	50	55	0.00	48.990	60.000	81.240	52.877	54.772

(1) On tangent track and in some large radius curves, in the absence of any other speed restriction, the Average Normal Operating Speed is the highest speed that will allow service braking to limit the High Normal Operating Speed to 50 mph without experiencing Emergency Brake Applications to enforce the Not-To-Exceed (NTE) Speed

(2) CBTC shall enforce a Normal High Operating Speed limit equal to the V6 speed in curves and equal to 50 mph in tangent track and large radius curves, using service braking without incurring an Emergency Brake application. In ATPM, if the Train Operator does not reduce the speed as the Normal High Operating Speed limit is approached, the CBTC system will automatically apply service brakes to avoid exceeding this limit.

(3) CBTC must Vitally Ensure that the Not-To-Exceed (NTE) Safe Speed of V11 in curves, or 55 mph in tangent track or large radius curves, is never exceeded by any part of a train, even under slight and temporary degradation of track geometry conditions. If the actual speed of the train exceeds the Normal High Operating Speed, and is not immediately reduced below that limit by Service Brakes, an Emergency Brake application shall already have been called for. The Emergency Brake application shall be triggered at a predetermined CBTC designed speed-threshold (i.e. the Vital Civil Speed). In NO CASE shall the actual speed of the train be allowed to exceed the NTE Safe Speed (V11). CBTC Train Control System parameters shall be adjusted to Vitally Ensure this requirement.

G-2: FLUSHING LINE C1 – CURVE ANALYSIS

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**		**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C1	T: MAIN ST.	493+78							0.00					
C1	Tangent/Spiral	493+75	1975		0	44	50	55	0.00	44.437	54.424	73.691	47.963	49.682
C1	Spiral/Curve	492+67	1975		0	44	50	55	0.00	44.437	54.424	73.691	47.963	49.682
C1	Curve/Spiral	489+80	1975		0	44	50	55	0.00	44.437	54.424	73.691	47.963	49.682
C1	T: T1	489+64	1975		0	44	50	55	0.00	44.437	54.424	73.691	47.963	49.682
C1	>>> SIGNAL C1-4884	489+48	1975		0	44	50	55	0.00	44.437	54.424	73.691	47.963	49.682
C1	Point of Vertical Tangent (PVT)	488+84	1975		0	44	50	55	0.00	44.437	54.424	73.691	47.963	49.682
C1	Start >>> TURNOUT	488+82	1975		0	44	50	55	0.00	44.437	54.424	73.691	47.963	49.682
C1	Point of Vertical Intersection of Grades (PVI)	488+58	1975		0	44	50	55	0.00	44.437	54.424	73.691	47.963	49.682
C1	Point of Vertical Curve (PVC)	488+32	1975		0	44	50	55	0.19	44.437	54.424	73.691	47.963	49.682
C1	End >>> TURNOUT (80)	488+02	1975		0	44	50	55	0.19	44.437	54.424	73.691	47.963	49.682
C1	Start >>> TURNOUT	487+22	1975		0	44	50	55	0.19	44.437	54.424	73.691	47.963	49.682
C1	Spiral/Curve	487+09	-2290	2290	0	47	50	55	0.19	47.854	58.609	79.357	51.651	53.502
C1	Point of Vertical Tangent (PVT)	487+04	-2290	2290	0	47	50	55	0.19	47.854	58.609	79.357	51.651	53.502
C1	Curve/Spiral	486+47	-2290	2290	0	47	50	55	0.19	47.854	58.609	79.357	51.651	53.502
C1	Point of Vertical Intersection of Grades (PVI)	486+36	-2290	2290	0	47	50	55	0.19	47.854	58.609	79.357	51.651	53.502
C1	End >>> TURNOUT (91)	486+31	-2290	2290	0	47	50	55	-2.05	47.854	58.609	79.357	51.651	53.502
C1	Point of Vertical Curve (PVC)	485+68	-2290	2290	0	47	50	55	-2.05	47.854	58.609	79.357	51.651	53.502
C1	Spiral/Tangent	485+46	-2290	2290	0	47	50	55	-2.05	47.854	58.609	79.357	51.651	53.502
C1	Start >>> TURNOUT	483+26				(1)	50	55	-2.05					
C1	End >>> TURNOUT (62)	482+64				(1)	50	55	-2.05					
C1	>>> SIGNAL C1-4814	482+25				(1)	50	55	-2.05					
C1	Tangent/Spiral	482+36	-1390	1390	1.875	45	50	55	-2.05	45.184	52.312	66.888	47.654	48.878
C1	T: T2	481+81	-1390	1390	1.875	45	50	55	-2.05	45.184	52.312	66.888	47.654	48.878
C1	Point of Vertical Tangent (PVT)	481+50	-1390	1390	1.875	45	50	55	-2.05	45.184	52.312	66.888	47.654	48.878
C1	Point of Vertical Intersection of Grades (PVI)	480+97	-1390	1390	1.875	45	50	55	-2.05	45.184	52.312	66.888	47.654	48.878
C1	Spiral/Curve	480+58	-1390	1390	1.875	45	50	55	-3.28	45.184	52.312	66.888	47.654	48.878
C1	Point of Vertical Curve (PVC)	480+46	-1390	1390	1.875	45	50	55	-3.28	45.184	52.312	66.888	47.654	48.878
C1	Curve/Spiral	479+80	-1390	1390	1.875	45	50	55	-3.28	45.184	52.312	66.888	47.654	48.878
C1	T: T1	478+88	-1390	1390	1.875	45	50	55	-3.28	45.184	52.312	66.888	47.654	48.878
C1	>>> PORTAL/ABUT.	478+69	-1390	1390	1.875	45	50	55	-3.28	45.184	52.312	66.888	47.654	48.878
C1	Spiral/Tangent	477+73	-1390	1390	1.875	45	50	55	-3.28	45.184	52.312	66.888	47.654	48.878
C1	Point of Vertical Tangent (PVT)	475+51				(1)	50	55	-3.28					
C1	Point of Vertical Intersection of Grades (PVI)	474+91				(1)	50	55	-3.28					
C1	Point of Vertical Curve (PVC)	474+31				(1)	50	55	-4.26					
C1	Tangent/Spiral	473+99	760		4.75	40	45	54	-4.26	40.774	45.194	54.704	42.284	43.041
C1	Point of Vertical Tangent (PVT)	473+90	760		4.75	40	45	54	-4.26	40.774	45.194	54.704	42.284	43.041
C1	Point of Vertical Intersection of Grades (PVI)	473+47	760		4.75	40	45	54	-4.26	40.774	45.194	54.704	42.284	43.041
C1	Spiral/Curve	473+47	760		4.75	40	45	54	-3.34	40.774	45.194	54.704	42.284	43.041
C1	Point of Vertical Curve (PVC)	473+04	760		4.75	40	45	54	-3.34	40.774	45.194	54.704	42.284	43.041
C1	Curve/Spiral	472+04	760		4.75	40	45	54	-3.34	40.774	45.194	54.704	42.284	43.041
C1	Spiral/Tangent	471+35	760		4.75	40	45	54	-3.34	40.774	45.194	54.704	42.284	43.041
C1	>>> SIGNAL C1-4694	470+45				(1)	50	55	-3.34					
C1	Point of Vertical Tangent (PVT)	469+67				(1)	50	55	-3.34					
C1	Point of Vertical Intersection of Grades (PVI)	468+95				(1)	50	55	-3.34					
C1	Point of Vertical Curve (PVC)	468+23				(1)	50	55	0.00					
C1	Point of Vertical Tangent (PVT)	464+99				(1)	50	55	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	464+66				(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	464+33				(1)	50	55	0.56					
C1	>>> SIGNAL C1-4634	464+26				(1)	50	55	0.56					
C1	>>> SIGNAL C1-4584	459+00				(1)	50	55	0.56					
C1	Tangent/Spiral	458+46	-1320	1320	2.75	47	50	55	0.56	47.196	53.735	67.361	49.450	50.572
C1	Spiral/Curve	458+23	-1320	1320	2.75	47	50	55	0.56	47.196	53.735	67.361	49.450	50.572
C1	Point of Vertical Tangent (PVT)	457+88	-1320	1320	2.75	47	50	55	0.56	47.196	53.735	67.361	49.450	50.572
C1	Curve/Spiral	457+29	-1320	1320	2.75	47	50	55	0.56	47.196	53.735	67.361	49.450	50.572
C1	Point of Vertical Intersection of Grades (PVI)	457+23	-1320	1320	2.75	47	50	55	0.56	47.196	53.735	67.361	49.450	50.572
C1	Spiral/Tangent	455+97	-1320	1320	2.75	47	50	55	3.30	47.196	53.735	67.361	49.450	50.572

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**		**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C1	>>> SIGNAL C1-4564	456+71				(1)	50	55	3.30					
C1	Point of Vertical Curve (PVC)	456+58				(1)	50	55	3.30					
C1	Point of Vertical Tangent (PVT)	456+11				(1)	50	55	3.30					
C1	Point of Vertical Intersection of Grades (PVI)	455+78				(1)	50	55	3.30					
C1	Point of Vertical Curve (PVC)	455+46				(1)	50	55	2.82					
C1	>>> SIGNAL C1-4544	455+21				(1)	50	55	2.82					
C1	Point of Vertical Tangent (PVT)	454+03				(1)	50	55	2.82					
C1	Point of Vertical Intersection of Grades (PVI)	453+19				(1)	50	55	2.82					
C1	Point of Vertical Curve (PVC)	452+35				(1)	50	55	0.20					
C1	>>> N.E.PLATFORM	452+10				(1)	50	55	0.20					
C1	>>> SIGNAL C1-4504	451+23				(1)	50	55	0.20					
C1	>>> SIGNAL C1-4484	449+27				(1)	50	55	0.20					
C1	Point of Vertical Tangent (PVT)	448+15				(1)	50	55	0.20					
C1	T: METS - WILLETS POINT	447+52				(1)	50	55	0.20					
C1	Point of Vertical Intersection of Grades (PVI)	447+41				(1)	50	55	0.20					
C1	Point of Vertical Curve (PVC)	446+67				(1)	50	55	-0.57					
C1	>>> SIGNAL C1-4444	444+78				(1)	50	55	-0.57					
C1	>>> SIGNAL C1-4434	443+83				(1)	50	55	-0.57					
C1	>>> S.E.PLATFORM	442+97				(1)	50	55	-0.57					
C1	>>> SIGNAL C1-4424	442+81				(1)	50	55	-0.57					
C1	Start >>> TURNOUT	441+78				(1)	50	55	-0.57					
C1	Tangent/Spiral	441+61	-850	850	0	29	35	48	-0.57	29.155	35.707	48.348	31.468	32.596
C1	End >>> TURNOUT (68)	441+10	-850	850	0	29	35	48	-0.57	29.155	35.707	48.348	31.468	32.596
C1	Start >>> TURNOUT	440+94	-850	850	0	29	35	48	-0.57	29.155	35.707	48.348	31.468	32.596
C1	Spiral/Curve	440+80	-850	850	0	29	35	48	-0.57	29.155	35.707	48.348	31.468	32.596
C1	Curve/Spiral	440+63	-850	850	0	29	35	48	-0.57	29.155	35.707	48.348	31.468	32.596
C1	Spiral/Tangent	440+44	-850	850	0	29	35	48	-0.57	29.155	35.707	48.348	31.468	32.596
C1	End >>> TURNOUT (67)	440+27				(1)	50	55	-0.57					
C1	Tangent/Spiral	440+16	2350		0.25	49	50	55	-0.57	49.969	60.596	81.298	53.709	55.537
C1	Spiral/Curve	439+73	2350		0.25	49	50	55	-0.57	49.969	60.596	81.298	53.709	55.537
C1	Curve/Spiral	438+96	2350		0.25	49	50	55	-0.57	49.969	60.596	81.298	53.709	55.537
C1	Spiral/Tangent	438+78	2350		0.25	49	50	55	-0.57	49.969	60.596	81.298	53.709	55.537
C1	Point of Vertical Tangent (PVT)	437+32				(1)	50	55	-0.57					
C1	Point of Vertical Intersection of Grades (PVI)	436+68				(1)	50	55	-0.57					
C1	Point of Vertical Curve (PVC)	436+04				(1)	50	55	1.66					
C1	>>> SIGNAL C1-4334	433+90				(1)	50	55	1.66					
C1	Point of Vertical Tangent (PVT)	433+07				(1)	50	55	1.66					
C1	Point of Vertical Intersection of Grades (PVI)	432+26				(1)	50	55	1.66					
C1	Point of Vertical Curve (PVC)	431+45				(1)	50	55	-3.00					
C1	>>> SIGNAL C1-4274	428+54				(1)	50	55	-3.00					
C1	>>> SIGNAL C1-4254	426+00				(1)	50	55	-3.00					
C1	>>> SIGNAL C1-4224	422+86				(1)	50	55	-3.00					
C1	Start >>> TURNOUT	421+24				(1)	50	55	-3.00					
C1	Point of Vertical Tangent (PVT)	420+82				(1)	50	55	-3.00					
C1	End >>> TURNOUT (46)	420+78				(1)	50	55	-3.00					
C1	Start >>> TURNOUT	420+52				(1)	50	55	-3.00					
C1	Point of Vertical Intersection of Grades (PVI)	420+10				(1)	50	55	-3.00					
C1	Point of Vertical Curve (PVC)	419+38				(1)	50	55	-0.50					
C1	End >>> TURNOUT (58)	419+94				(1)	50	55	-0.50					
C1	>>> SIGNAL C1-4194	419+62				(1)	50	55	-0.50					
C1	>>> N.E.PLATFORM	419+44				(1)	50	55	-0.50					
C1	T: 111TH ST.	417+03				(1)	50	55	-0.50					
C1	>>> S.E.PLATFORM	413+75				(1)	50	55	-0.50					
C1	>>> SIGNAL C1-4134	413+50				(1)	50	55	-0.50					
C1	Point of Vertical Tangent (PVT)	411+16				(1)	50	55	-0.50					
C1	Point of Vertical Intersection of Grades (PVI)	410+59				(1)	50	55	-0.50					
C1	Point of Vertical Curve (PVC)	410+02				(1)	50	55	0.24					
C1	>>> SIGNAL C1-4024	402+94				(1)	50	55	0.24					
C1	Tangent/Spiral	401+93	-1720	1720	1.625	49	50	55	0.24	49.181	57.260	73.680	51.986	53.374
C1	Spiral/Curve	401+15	-1720	1720	1.625	49	50	55	0.24	49.181	57.260	73.680	51.986	53.374

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	Event	True Stationing	RADIUS (ft.)		SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C1	>>> SIGNAL C1-4004	401+13	-1720	1720	1.625	49	50	55	0.24	49.181	57.260	73.680	51.986	53.374
C1	>>> SIGNAL C1-3994	399+68	-1720	1720	1.625	49	50	55	0.24	49.181	57.260	73.680	51.986	53.374
C1	Point of Vertical Tangent (PVT)	399+44	-1720	1720	1.625	49	50	55	0.24	49.181	57.260	73.680	51.986	53.374
C1	Point of Vertical Intersection of Grades (PVI)	398+92	-1720	1720	1.625	49	50	55	0.24	49.181	57.260	73.680	51.986	53.374
C1	Point of Vertical Curve (PVC)	398+40	-1720	1720	1.625	49	50	55	0.00	49.181	57.260	73.680	51.986	53.374
C1	>>> SIGNAL C1-3974	398+23	-1720	1720	1.625	49	50	55	0.00	49.181	57.260	73.680	51.986	53.374
C1	>>> N.E.PLATFORM	397+99	-1720	1720	1.625	49	50	55	0.00	49.181	57.260	73.680	51.986	53.374
C1	Curve/Spiral	397+58	-1720	1720	1.625	49	50	55	0.00	49.181	57.260	73.680	51.986	53.374
C1	Spiral/Tangent	397+31	-1720	1720	1.625	49	50	55	0.00	49.181	57.260	73.680	51.986	53.374
C1	T: 103RD ST. - CORONA PLAZA	396+54				(1)	50	55	0.00					
C1	Point of Vertical Tangent (PVT)	393+01				(1)	50	55	0.00					
C1	>>> S.E.PLATFORM	392+31				(1)	50	55	0.00					
C1	>>> SIGNAL C1-3914	392+14				(1)	50	55	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	392+06				(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	391+11				(1)	50	55	-1.70					
C1	Tangent/Spiral	382+62	-2250	2250	0.5	(1)	50	55	-1.70	50.312	60.467	80.429	53.875	55.621
C1	Point of Vertical Tangent (PVT)	382+45	-2250	2250	0.5	(1)	50	55	-1.70	50.312	60.467	80.429	53.875	55.621
C1	Spiral/Curve	381+95	-2250	2250	0.5	(1)	50	55	-1.70	50.312	60.467	80.429	53.875	55.621
C1	>>> SIGNAL C1-3814	381+85	-2250	2250	0.5	(1)	50	55	-1.70	50.312	60.467	80.429	53.875	55.621
C1	Point of Vertical Intersection of Grades (PVI)	381+48	-2250	2250	0.5	(1)	50	55	-1.70	50.312	60.467	80.429	53.875	55.621
C1	Curve/Spiral	381+15	-2250	2250	0.5	(1)	50	55	0.00	50.312	60.467	80.429	53.875	55.621
C1	Point of Vertical Curve (PVC)	380+51	2030		1	(1)	50	55	0.00	50.377	59.607	78.044	53.599	55.185
C1	>>> SIGNAL C1-3804	380+43	2030		1	(1)	50	55	0.00	50.377	59.607	78.044	53.599	55.185
C1	Spiral/Curve	380+03	2030		1	(1)	50	55	0.00	50.377	59.607	78.044	53.599	55.185
C1	Curve/Spiral	379+30	2030		1	(1)	50	55	0.00	50.377	59.607	78.044	53.599	55.185
C1	>>> SIGNAL C1-3784	378+78	2030		1	(1)	50	55	0.00	50.377	59.607	78.044	53.599	55.185
C1	Spiral/Tangent	378+72	2030		1	(1)	50	55	0.00	50.377	59.607	78.044	53.599	55.185
C1	>>> N.E.PLATFORM	378+62				(1)	50	55	0.00					
C1	>>> SIGNAL C1-3764	377+13				(1)	50	55	0.00					
C1	T: JUNCTION BLVD.	375+01				(1)	50	55	0.00					
C1	Tangent/Spiral	374+05	2000		1	(1)	50	55	0.00	50.000	59.161	77.460	53.198	54.772
C1	Point of Vertical Tangent (PVT)	373+77	2000		1	(1)	50	55	0.00	50.000	59.161	77.460	53.198	54.772
C1	Point of Vertical Intersection of Grades (PVI)	373+10	2000		1	(1)	50	55	0.00	50.000	59.161	77.460	53.198	54.772
C1	>>> S.E.PLATFORM	372+99	2000		1	(1)	50	55	1.21	50.000	59.161	77.460	53.198	54.772
C1	Spiral/Curve	372+95	2000		1	(1)	50	55	1.21	50.000	59.161	77.460	53.198	54.772
C1	>>> SIGNAL C1-3724	372+60	2000		1	(1)	50	55	1.21	50.000	59.161	77.460	53.198	54.772
C1	Curve/Spiral	372+47	2000		1	(1)	50	55	1.21	50.000	59.161	77.460	53.198	54.772
C1	Point of Vertical Curve (PVC)	372+43	-1760	1760	1	46	50	55	1.21	46.904	55.498	72.664	49.904	51.381
C1	Spiral/Curve	371+15	-1760	1760	1	46	50	55	1.21	46.904	55.498	72.664	49.904	51.381
C1	Curve/Spiral	370+74	-1760	1760	1	46	50	55	1.21	46.904	55.498	72.664	49.904	51.381
C1	Spiral/Tangent	370+14	-1760	1760	1	46	50	55	1.21	46.904	55.498	72.664	49.904	51.381
C1	Point of Vertical Tangent (PVT)	366+04				(1)	50	55	1.21					
C1	Point of Vertical Intersection of Grades (PVI)	364+85				(1)	50	55	1.21					
C1	>>> SIGNAL C1-3634	363+97				(1)	50	55	-1.14					
C1	Point of Vertical Curve (PVC)	363+66				(1)	50	55	-1.14					
C1	>>> SIGNAL C1-3614	361+66				(1)	50	55	-1.14					
C1	Point of Vertical Tangent (PVT)	360+73				(1)	50	55	-1.14					
C1	Point of Vertical Intersection of Grades (PVI)	359+72				(1)	50	55	-1.14					
C1	>>> SIGNAL C1-3584	359+20				(1)	50	55	0.00					
C1	>>> N.E.PLATFORM	358+75				(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	358+71				(1)	50	55	0.00					
C1	T: 90TH ST. - ELMHURST AVE	356+84				(1)	50	55	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	353+33				(1)	50	55	0.00					
C1	>>> S.E.PLATFORM	353+04				(1)	50	55	0.71					
C1	>>> SIGNAL C1-3524	352+66				(1)	50	55	0.71					
C1	Point of Vertical Curve (PVC)	352+47				(1)	50	55	0.71					
C1	Point of Vertical Tangent (PVT)	349+57				(1)	50	55	0.71					
C1	Point of Vertical Intersection of Grades (PVI)	348+81				(1)	50	55	0.71					
C1	Point of Vertical Curve (PVC)	348+05				(1)	50	55	-0.68					
C1	>>> SIGNAL C1-3404	341+06				(1)	50	55	-0.68					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	Event	True Stationing	RADIUS (ft.)	SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C1	Point of Vertical Tangent (PVT)	339+57			(1)	50	55	-0.68					
C1	>>> SIGNAL C1-3384	339+26			(1)	50	55	-0.68					
C1	Point of Vertical Intersection of Grades (PVI)	338+97			(1)	50	55	-0.68					
C1	>>> N.E.PLATFORM	338+87			(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	338+37			(1)	50	55	0.00					
C1	T: 82ND ST. - JACKSON HEIGTHS	337+04			(1)	50	55	0.00					
C1	Point of Vertical Tangent (PVT)	333+28			(1)	50	55	0.00					
C1	>>> S.E.PLATFORM	333+21			(1)	50	55	0.00					
C1	>>> SIGNAL C1-3324	332+60			(1)	50	55	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	332+40			(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	331+52			(1)	50	55	1.70					
C1	Point of Vertical Tangent (PVT)	328+61			(1)	50	55	1.70					
C1	Point of Vertical Intersection of Grades (PVI)	327+10			(1)	50	55	1.70					
C1	>>> SIGNAL C1-3264	326+90			(1)	50	55	-1.17					
C1	Point of Vertical Curve (PVC)	325+59			(1)	50	55	-1.17					
C1	>>> SIGNAL C1-3244	324+43			(1)	50	55	-1.17					
C1	>>> SIGNAL	323+45			(1)	50	55	-1.17					
C1	Start >>> TURNOUT	321+36			(1)	50	55	-1.17					
C1	End >>> TURNOUT (100)	320+36			(1)	50	55	-1.17					
C1	>>> SIGNAL C1-3194	320+11			(1)	50	55	-1.17					
C1	Point of Vertical Tangent (PVT)	318+92			(1)	50	55	-1.17					
C1	Point of Vertical Intersection of Grades (PVI)	318+07			(1)	50	55	-1.17					
C1	>>> SIGNAL C1-3174	317+90			(1)	50	55	0.00					
C1	>>> N.E.PLATFORM	317+56			(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	317+22			(1)	50	55	0.00					
C1	>>> SIGNAL	315+09			(1)	50	55	0.00					
C1	T: 74TH ST. - BROADWAY	312+13			(1)	50	55	0.00					
C1	>>> S.E.PLATFORM	311+84			(1)	50	55	0.00					
C1	>>> SIGNAL C1-3114	311+53			(1)	50	55	0.00					
C1	Point of Vertical Tangent (PVT)	311+51			(1)	50	55	0.00					
C1	Start >>> TURNOUT	311+14			(1)	50	55	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	310+72			(1)	50	55	0.00					
C1	End >>> TURNOUT (103)	310+11			(1)	50	55	1.75					
C1	Point of Vertical Curve (PVC)	309+93			(1)	50	55	1.75					
C1	>>> SIGNAL C1-3074	307+37			(1)	50	55	1.75					
C1	>>> SIGNAL C1-3054	305+42			(1)	50	55	1.75					
C1	Point of Vertical Tangent (PVT)	305+25			(1)	50	55	1.75					
C1	Point of Vertical Intersection of Grades (PVI)	304+24			(1)	50	55	1.75					
C1	>>> SIGNAL C1-3034	303+84			(1)	50	55	0.00					
C1	>>> N.E.PLATFORM	303+55			(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	303+23			(1)	50	55	0.00					
C1	T: 69TH ST.-FISK AV	299+04			(1)	50	55	0.00					
C1	Point of Vertical Tangent (PVT)	298+33			(1)	50	55	0.00					
C1	>>> S.E.PLATFORM	297+91			(1)	50	55	0.00					
C1	>>> SIGNAL C1-2974	297+75			(1)	50	55	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	297+25			(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	296+17			(1)	50	55	1.70					
C1	Point of Vertical Tangent (PVT)	295+24			(1)	50	55	1.70					
C1	Point of Vertical Intersection of Grades (PVI)	292+85			(1)	50	55	1.70					
C1	Point of Vertical Curve (PVC)	290+46			(1)	50	55	-2.97					
C1	>>> SIGNAL C1-2894	289+40			(1)	50	55	-2.97					
C1	>>> SIGNAL C1-2874	287+41			(1)	50	55	-2.97					
C1	Tangent/Spiral	286+96	2120	0.75	(1)	50	55	-2.97	50.173	59.810	78.912	53.545	55.202
C1	Spiral/Curve	286+72	2120	0.75	(1)	50	55	-2.97	50.173	59.810	78.912	53.545	55.202
C1	Point of Vertical Tangent (PVT)	286+29	2120	0.75	(1)	50	55	-2.97	50.173	59.810	78.912	53.545	55.202
C1	Curve/Spiral	285+77	2120	0.75	(1)	50	55	-2.97	50.173	59.810	78.912	53.545	55.202
C1	Point of Vertical Intersection of Grades (PVI)	285+69	2120	0.75	(1)	50	55	-2.97	50.173	59.810	78.912	53.545	55.202
C1	>>> SIGNAL C1-2854	285+41	2120	0.75	(1)	50	55	0.00	50.173	59.810	78.912	53.545	55.202
C1	Spiral/Tangent	285+33	2120	0.75	(1)	50	55	0.00	50.173	59.810	78.912	53.545	55.202

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**		**SUPERELEVATION (in.)**	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	**GRADE (%)**	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C1	Point of Vertical Curve (PVC)	285+09				(1)	50	55	0.00					
C1	>>> N.E.PLATFORM	285+02				(1)	50	55	0.00					
C1	>>> SIGNAL C1-2824	283+10				(1)	50	55	0.00					
C1	T: 62ST ST.	281+56				(1)	50	55	0.00					
C1	Tangent/Spiral	280+57	1150		1	37	44	55	0.00	37.914	44.861	58.737	40.339	41.533
C1	Spiral/Curve	279+89	1150		1	37	44	55	0.00	37.914	44.861	58.737	40.339	41.533
C1	Curve/Spiral	279+55	1150		1	37	44	55	0.00	37.914	44.861	58.737	40.339	41.533
C1	>>> S.E.PLATFORM	279+45	1150		1	37	44	55	0.00	37.914	44.861	58.737	40.339	41.533
C1	>>> SIGNAL C1-2784	279+15	-1250	1250	0.5	37	45	55	0.00	37.500	45.069	59.948	40.156	41.458
C1	Spiral/Curve	278+41	-1250	1250	0.5	37	45	55	0.00	37.500	45.069	59.948	40.156	41.458
C1	Curve/Spiral	277+96	1250		0.5	37	45	55	0.00	37.500	45.069	59.948	40.156	41.458
C1	Spiral/Tangent	277+67	1250		0.5	37	45	55	0.00	37.500	45.069	59.948	40.156	41.458
C1	Tangent/Spiral	277+37	-2220	2220	1	(1)	50	55	0.00	52.678	62.330	81.609	56.047	57.706
C1	Spiral/Curve	277+06	-2220	2220	1	(1)	50	55	0.00	52.678	62.330	81.609	56.047	57.706
C1	Curve/Spiral	274+68	-2220	2220	1	(1)	50	55	0.00	52.678	62.330	81.609	56.047	57.706
C1	Spiral/Tangent	274+01	-2220	2220	1	(1)	50	55	0.00	52.678	62.330	81.609	56.047	57.706
C1	Point of Vertical Tangent (PVT)	273+89				(1)	50	55	0.00					
C1	Tangent/Spiral	272+61	1230		2.25	43	50	55	0.00	43.839	50.367	63.831	46.096	47.216
C1	Point of Vertical Intersection of Grades (PVI)	272+41	1230		2.25	43	50	55	0.00	43.839	50.367	63.831	46.096	47.216
C1	Spiral/Curve	272+05	1230		2.25	43	50	55	-3.00	43.839	50.367	63.831	46.096	47.216
C1	>>> SIGNAL C1-2714	271+89	1230		2.25	43	50	55	-3.00	43.839	50.367	63.831	46.096	47.216
C1	Point of Vertical Curve (PVC)	270+93	1230		2.25	43	50	55	-3.00	43.839	50.367	63.831	46.096	47.216
C1	Curve/Spiral	270+08	1230		2.25	43	50	55	-3.00	43.839	50.367	63.831	46.096	47.216
C1	Spiral/Tangent	269+33	1230		2.25	43	50	55	-3.00	43.839	50.367	63.831	46.096	47.216
C1	>>> SIGNAL C1-2654	265+36				(1)	50	55	-3.00					
C1	Tangent/Spiral	263+81	1920		1.25	(1)	50	55	-3.00	50.200	58.992	76.681	53.262	54.772
C1	Spiral/Curve	262+18	1920		1.25	(1)	50	55	-3.00	50.200	58.992	76.681	53.262	54.772
C1	Point of Vertical Tangent (PVT)	261+89	1920		1.25	(1)	50	55	-3.00	50.200	58.992	76.681	53.262	54.772
C1	Curve/Spiral	260+79	1920		1.25	(1)	50	55	-3.00	50.200	58.992	76.681	53.262	54.772
C1	>>> SIGNAL C1-2604	260+77	1920		1.25	(1)	50	55	-3.00	50.200	58.992	76.681	53.262	54.772
C1	Point of Vertical Intersection of Grades (PVI)	260+35	1920		1.25	(1)	50	55	-3.00	50.200	58.992	76.681	53.262	54.772
C1	Point of Vertical Curve (PVC)	258+81	1920		1.25	(1)	50	55	0.00	50.200	58.992	76.681	53.262	54.772
C1	>>> SIGNAL	258+06	1920		1.25	(1)	50	55	0.00	50.200	58.992	76.681	53.262	54.772
C1	Spiral/Tangent	257+92	1920		1.25	(1)	50	55	0.00	50.200	58.992	76.681	53.262	54.772
C1	>>> N.E.PLATFORM	257+58				(1)	50	55	0.00					
C1	T: 52ND ST. - LINCOLN AV	254+44				(1)	50	55	0.00					
C1	Point of Vertical Tangent (PVT)	253+17				(1)	50	55	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	252+43				(1)	50	55	0.00					
C1	>>> S.E.PLATFORM	251+93				(1)	50	55	3.02					
C1	Point of Vertical Curve (PVC)	251+69				(1)	50	55	3.02					
C1	>>> SIGNAL C1-2524	251+53				(1)	50	55	3.02					
C1	Point of Vertical Tangent (PVT)	247+85				(1)	50	55	3.02					
C1	Point of Vertical Intersection of Grades (PVI)	246+86				(1)	50	55	3.02					
C1	Point of Vertical Curve (PVC)	245+87				(1)	50	55	0.00					
C1	>>> SIGNAL C1-2454	245+59				(1)	50	55	0.00					
C1	Tangent/Spiral	245+18	-490	490	3.5	30	34	42	0.00	30.311	34.114	42.146	31.616	32.268
C1	Spiral/Curve	243+42	-490	490	3.5	30	34	42	0.00	30.311	34.114	42.146	31.616	32.268
C1	Curve/Spiral	242+73	-490	490	3.5	30	34	42	0.00	30.311	34.114	42.146	31.616	32.268
C1	>>> SIGNAL C1-2424	242+72	-490	490	3.5	30	34	42	0.00	30.311	34.114	42.146	31.616	32.268
C1	>>> SIGNAL C1-2404	240+95	-490	490	3.5	30	34	42	0.00	30.311	34.114	42.146	31.616	32.268
C1	>>> N.E.PLATFORM	240+75	-490	490	3.5	30	34	42	0.00	30.311	34.114	42.146	31.616	32.268
C1	Spiral/Tangent	240+57	-490	490	3.5	30	34	42	0.00	30.311	34.114	42.146	31.616	32.268
C1	T: 46TH ST. - BLISS ST.	238+45				(1)	50	55	0.00					
C1	Point of Vertical Tangent (PVT)	236+27				(1)	50	55	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	235+55				(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	234+83				(1)	50	55	1.27					
C1	>>> S.E.PLATFORM	234+80				(1)	50	55	1.27					
C1	>>> SIGNAL C1-2344	234+70				(1)	50	55	1.27					
C1	Point of Vertical Tangent (PVT)	230+58				(1)	50	55	1.27					
C1	Point of Vertical Intersection of Grades (PVI)	229+19				(1)	50	55	1.27					
C1	>>> SIGNAL C1-2284	229+06				(1)	50	55	-1.48					
C1	Point of Vertical Curve (PVC)	227+80				(1)	50	55	-1.48					

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**		**SUPERELEVATION (in.)**	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	**GRADE (%)**	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C1	>>> SIGNAL C1-2264	227+06				(1)	50	55	-1.48					
C1	Point of Vertical Tangent (PVT)	225+33				(1)	50	55	-1.48					
C1	>>> SIGNAL C1-2244	225+19				(1)	50	55	-1.48					
C1	>>> N.E.PLATFORM	224+98				(1)	50	55	-1.48					
C1	Point of Vertical Intersection of Grades (PVI)	224+26				(1)	50	55	-1.48					
C1	T: 40TH ST. - LOWERY ST.	223+22				(1)	50	55	0.51					
C1	Point of Vertical Curve (PVC)	223+19				(1)	50	55	0.51					
C1	Point of Vertical Tangent (PVT)	219+90				(1)	50	55	0.51					
C1	>>> S.E.PLATFORM	219+04				(1)	50	55	0.51					
C1	Point of Vertical Intersection of Grades (PVI)	218+64				(1)	50	55	0.51					
C1	>>> SIGNAL C1-2184	218+56				(1)	50	55	3.02					
C1	Point of Vertical Curve (PVC)	217+38				(1)	50	55	3.02					
C1	Point of Vertical Tangent (PVT)	212+79				(1)	50	55	3.02					
C1	Point of Vertical Intersection of Grades (PVI)	212+01				(1)	50	55	3.02					
C1	Point of Vertical Curve (PVC)	211+23				(1)	50	55	1.68					
C1	>>> SIGNAL C1-2114	211+16				(1)	50	55	1.68					
C1	>>> SIGNAL C1-2094	209+20				(1)	50	55	1.68					
C1	>>> SIGNAL C1-2074	207+65				(1)	50	55	1.68					
C1	>>> SIGNAL C1-2054	205+61				(1)	50	55	1.68					
C1	>>> N.E.PLATFORM	205+48				(1)	50	55	1.68					
C1	Point of Vertical Tangent (PVT)	205+45				(1)	50	55	1.68					
C1	Point of Vertical Intersection of Grades (PVI)	204+79				(1)	50	55	1.68					
C1	Point of Vertical Curve (PVC)	204+13				(1)	50	55	0.54					
C1	T: 33RD ST. - RAWSON ST.	202+10				(1)	50	55	0.54					
C1	Point of Vertical Tangent (PVT)	200+24				(1)	50	55	0.54					
C1	Tangent/Spiral	199+64	-470	470	4.875	32	35	43	0.54	32.293	35.747	43.189	33.472	34.063
C1	>>> S.E.PLATFORM	199+50	-470	470	4.875	32	35	43	0.54	32.293	35.747	43.189	33.472	34.063
C1	Point of Vertical Intersection of Grades (PVI)	198+93	-470	470	4.875	32	35	43	0.54	32.293	35.747	43.189	33.472	34.063
C1	>>> SIGNAL C1-1984	198+89	-470	470	4.875	32	35	43	2.95	32.293	35.747	43.189	33.472	34.063
C1	Point of Vertical Curve (PVC)	197+62	-470	470	4.875	32	35	43	2.95	32.293	35.747	43.189	33.472	34.063
C1	Spiral/Curve	197+15	-470	470	4.875	32	35	43	2.95	32.293	35.747	43.189	33.472	34.063
C1	Curve/Spiral	196+02	-470	470	4.875	32	35	43	2.95	32.293	35.747	43.189	33.472	34.063
C1	Point of Vertical Tangent (PVT)	195+50	-470	470	4.875	32	35	43	2.95	32.293	35.747	43.189	33.472	34.063
C1	Spiral/Tangent	193+52	-470	470	4.875	32	35	43	2.95	32.293	35.747	43.189	33.472	34.063
C1	>>> SIGNAL C1-1924	193+03				(1)	50	55	2.95					
C1	Point of Vertical Intersection of Grades (PVI)	192+73				(1)	50	55	2.95					
C1	Tangent/Spiral	191+03	-1080	1080	0.5	34	41	55	-3.28	34.857	41.893	55.723	37.326	38.536
C1	>>> SIGNAL C1-1904	190+81	-1080	1080	0.5	34	41	55	-3.28	34.857	41.893	55.723	37.326	38.536
C1	Spiral/Curve	190+65	-1080	1080	0.5	34	41	55	-3.28	34.857	41.893	55.723	37.326	38.536
C1	Curve/Spiral	190+32	-1080	1080	0.5	34	41	55	-3.28	34.857	41.893	55.723	37.326	38.536
C1	Point of Vertical Curve (PVC)	189+96	855		0	29	35	48	-3.28	29.240	35.812	48.490	31.561	32.692
C1	Spiral/Curve	189+36	855		0	29	35	48	-3.28	29.240	35.812	48.490	31.561	32.692
C1	Curve/Spiral	189+21	855		0	29	35	48	-3.28	29.240	35.812	48.490	31.561	32.692
C1	Spiral/Tangent	188+74	855		0	29	35	48	-3.28	29.240	35.812	48.490	31.561	32.692
C1	Point of Vertical Tangent (PVT)	188+54				(1)	50	55	-3.28					
C1	>>> SIGNAL C1-1884	188+66				(1)	50	55	-3.28					
C1	Tangent/Spiral	187+99	1170		0	34	41	55	-3.28	34.205	41.893	56.723	36.920	38.243
C1	Spiral/Curve	187+81	1170		0	34	41	55	-3.28	34.205	41.893	56.723	36.920	38.243
C1	Point of Vertical Intersection of Grades (PVI)	187+56	1170		0	34	41	55	-3.28	34.205	41.893	56.723	36.920	38.243
C1	Curve/Spiral	186+83	1170		0	34	41	55	2.78	34.205	41.893	56.723	36.920	38.243
C1	Point of Vertical Curve (PVC)	186+58	1170		0	34	41	55	2.78	34.205	41.893	56.723	36.920	38.243
C1	Start >>> TURNOUT	186+40	1170		0	34	41	55	2.78	34.205	41.893	56.723	36.920	38.243
C1	Spiral/Curve	186+18	-920	920	0	30	37	50	2.78	30.332	37.148	50.299	32.738	33.912
C1	Point of Vertical Tangent (PVT)	185+97	-920	920	0	30	37	50	2.78	30.332	37.148	50.299	32.738	33.912
C1	Curve/Spiral	185+59	-920	920	0	30	37	50	2.78	30.332	37.148	50.299	32.738	33.912
C1	End >>> TURNOUT (85)	185+55	-920	920	0	30	37	50	2.78	30.332	37.148	50.299	32.738	33.912
C1	Spiral/Tangent	185+29	-920	920	0	30	37	50	2.78	30.332	37.148	50.299	32.738	33.912
C1	Point of Vertical Intersection of Grades (PVI)	185+05				(1)	50	55	2.78					
C1	>>> SIGNAL C1-1842	184+51				(1)	50	55	0.00					
C1	Start >>> TURNOUT	184+31				(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	184+13				(1)	50	55	0.00					
C1	End >>> TURNOUT (74)	183+57				(1)	50	55	0.00					

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**		**SUPERELEVATION (in.)**	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	**GRADE (%)**	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C1	Start >>> TURNOUT	182+20				(1)	50	55	0.00					
C1	End >>> TURNOUT (71)	181+49				(1)	50	55	0.00					
C1	>>> SIGNAL C1-1792	179+23				(1)	50	55	0.00					
C1	Tangent/Spiral	178+61	1600		1	44	50	55	0.00	44.721	52.915	69.282	47.582	48.990
C1	Point of Vertical Tangent (PVT)	178+22	1600		1	44	50	55	0.00	44.721	52.915	69.282	47.582	48.990
C1	Point of Vertical Intersection of Grades (PVI)	177+47	1600		1	44	50	55	0.00	44.721	52.915	69.282	47.582	48.990
C1	Spiral/Curve	177+28	1600		1	44	50	55	3.41	44.721	52.915	69.282	47.582	48.990
C1	Point of Vertical Curve (PVC)	176+72	1600		1	44	50	55	3.41	44.721	52.915	69.282	47.582	48.990
C1	>>> SIGNAL C1-1762	176+16	1600		1	44	50	55	3.41	44.721	52.915	69.282	47.582	48.990
C1	>>> SIGNAL C1-1732	173+56	1600		1	44	50	55	3.41	44.721	52.915	69.282	47.582	48.990
C1	Curve/Spiral	172+71	1600		1	44	50	55	3.41	44.721	52.915	69.282	47.582	48.990
C1	Point of Vertical Tangent (PVT)	172+32	1600		1	44	50	55	3.41	44.721	52.915	69.282	47.582	48.990
C1	Point of Vertical Intersection of Grades (PVI)	171+82	1600		1	44	50	55	3.41	44.721	52.915	69.282	47.582	48.990
C1	>>> SIGNAL C1-1712	171+57	1600		1	44	50	55	-0.48	44.721	52.915	69.282	47.582	48.990
C1	>>> N.E.PLATFORM	171+42	1600		1	44	50	55	-0.48	44.721	52.915	69.282	47.582	48.990
C1	Point of Vertical Curve (PVC)	171+32	1600		1	44	50	55	-0.48	44.721	52.915	69.282	47.582	48.990
C1	Point of Vertical Tangent (PVT)	170+89	1600		1	44	50	55	-0.48	44.721	52.915	69.282	47.582	48.990
C1	Spiral/Tangent	170+69	1600		1	44	50	55	-0.48	44.721	52.915	69.282	47.582	48.990
C1	Point of Vertical Intersection of Grades (PVI)	170+63				(1)	50	55	-0.48					
C1	Point of Vertical Curve (PVC)	170+37				(1)	50	55	0.00					
C1	T: QUEENSBORO PLAZA	169+78				(1)	50	55	0.00					
C1	>>> SIGNAL C1-1692	169+24				(1)	50	55	0.00					
C1	>>> SIGNAL C1-1652	165+49				(1)	50	55	0.00					
C1	Point of Vertical Tangent (PVT)	165+11				(1)	50	55	0.00					
C1	>>> S.E.PLATFORM	165+06				(1)	50	55	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	164+58				(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	164+05				(1)	50	55	-2.54					
C1	Tangent/Spiral	163+81	205		3.5	19	22	27	-2.54	19.605	22.065	27.260	20.450	20.872
C1	Point of Vertical Tangent (PVT)	163+30	205		3.5	19	22	27	-2.54	19.605	22.065	27.260	20.450	20.872
C1	Spiral/Curve	163+10	205		3.5	19	22	27	-2.54	19.605	22.065	27.260	20.450	20.872
C1	Point of Vertical Intersection of Grades (PVI)	162+77	205		3.5	19	22	27	-2.54	19.605	22.065	27.260	20.450	20.872
C1	Point of Vertical Curve (PVC)	162+24	205		3.5	19	22	27	0.00	19.605	22.065	27.260	20.450	20.872
C1	Curve/Spiral	161+65	205		3.5	19	22	27	0.00	19.605	22.065	27.260	20.450	20.872
C1	Point of Vertical Tangent (PVT)	160+06	205		3.5	19	22	27	0.00	19.605	22.065	27.260	20.450	20.872
C1	Point of Vertical Intersection of Grades (PVI)	159+47	205		3.5	19	22	27	0.00	19.605	22.065	27.260	20.450	20.872
C1	Spiral/Tangent	159+16	205		3.5	19	22	27	1.18	19.605	22.065	27.260	20.450	20.872
C1	Point of Vertical Curve (PVC)	158+88				(1)	50	55	1.18					
C1	>>> SIGNAL C1-1562	156+93				(1)	50	55	1.18					
C1	>>> SIGNAL C1-1522	152+49				(1)	50	55	1.18					
C1	Tangent/Spiral	150+87	600		4	34	38	47	1.18	34.641	38.730	47.434	36.042	36.742
C1	>>> SIGNAL C1-1492	149+69	600		4	34	38	47	1.18	34.641	38.730	47.434	36.042	36.742
C1	Spiral/Curve	149+59	600		4	34	38	47	1.18	34.641	38.730	47.434	36.042	36.742
C1	Curve/Spiral	148+76	600		4	34	38	47	1.18	34.641	38.730	47.434	36.042	36.742
C1	Spiral/Tangent	147+46	600		4	34	38	47	1.18	34.641	38.730	47.434	36.042	36.742
C1	Point of Vertical Tangent (PVT)	147+42				(1)	50	55	1.18					
C1	>>> SIGNAL C1-1472	147+24				(1)	50	55	1.18					
C1	>>> N.E.PLATFORM	146+93				(1)	50	55	1.18					
C1	Point of Vertical Intersection of Grades (PVI)	146+81				(1)	50	55	1.18					
C1	Point of Vertical Curve (PVC)	146+20				(1)	50	55	0.00					
C1	T: COURT SQUARE	144+62				(1)	50	55	0.00					
C1	>>> S.E.PLATFORM	141+25				(1)	50	55	0.00					
C1	REFLECTOR TAG	140+55				(1)	50	55	0.00					
C1	>>> SIGNAL C1-1402	140+48				(1)	50	55	0.00					
C1	Tangent/Spiral	140+45	200		4.5	20	22	27	0.00	20.616	22.913	27.839	21.401	21.794
C1	Spiral/Curve	139+54	200		4.5	20	22	27	0.00	20.616	22.913	27.839	21.401	21.794
C1	Curve/Spiral	139+02	200		4.5	20	22	27	0.00	20.616	22.913	27.839	21.401	21.794
C1	Point of Vertical Tangent (PVT)	138+41	200		4.5	20	22	27	0.00	20.616	22.913	27.839	21.401	21.794
C1	Spiral/Tangent	137+97	200		4.5	20	22	27	0.00	20.616	22.913	27.839	21.401	21.794
C1	Point of Vertical Intersection of Grades (PVI)	137+40				(1)	50	55	0.00					
C1	Point of Vertical Curve (PVC)	136+39				(1)	50	55	2.95					
C1	Point of Vertical Tangent (PVT)	135+39				(1)	50	55	2.95					
C1	Point of Vertical Intersection of Grades (PVI)	134+63				(1)	50	55	2.95					
C1	Tangent/Spiral	134+14	-250	250	5.875	24	27	32	-0.20	24.843	27.243	32.476	25.660	26.071

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**		**SUPERELEVATION (in.)**	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	**GRADE (%)**	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C1	Point of Vertical Curve (PVC)	133+87	-250	250	5.875	24	27	32	-0.20	24.843	27.243	32.476	25.660	26.071
C1	Spiral/Curve	133+33	-250	250	5.875	24	27	32	-0.20	24.843	27.243	32.476	25.660	26.071
C1	>>> SIGNAL C1-1332	133+08	-250	250	5.875	24	27	32	-0.20	24.843	27.243	32.476	25.660	26.071
C1	Point of Vertical Tangent (PVT)	130+57	-250	250	5.875	24	27	32	-0.20	24.843	27.243	32.476	25.660	26.071
C1	Curve/Spiral	130+34	-250	250	5.875	24	27	32	-0.20	24.843	27.243	32.476	25.660	26.071
C1	Point of Vertical Intersection of Grades (PVI)	129+76	-250	250	5.875	24	27	32	-0.20	24.843	27.243	32.476	25.660	26.071
C1	Spiral/Tangent	129+43	-250	250	5.875	24	27	32	4.02	24.843	27.243	32.476	25.660	26.071
C1	REFLECTOR TAG	129+40				(1)	50	55	4.02					
C1	>>> SIGNAL C1-1292	129+37				(1)	50	55	4.02					
C1	Point of Vertical Curve (PVC)	128+95				(1)	50	55	4.02					
C1	Point of Vertical Tangent (PVT)	127+15				(1)	50	55	4.02					
C1	Point of Vertical Intersection of Grades (PVI)	127+01				(1)	50	55	4.02					
C1	Point of Vertical Curve (PVC)	126+87				(1)	50	55	4.19					
C1	REFLECTOR TAG	126+44				(1)	50	55	4.19					
C1	>>> SIGNAL C1-1263	126+33				(1)	50	55	4.19					
C1	Tangent/Spiral	126+05	-2500	2500	0	(1)	50	55	4.19	50.000	61.237	82.916	53.968	55.902
C1	T: T1	125+87	-2500	2500	0	(1)	50	55	4.19	50.000	61.237	82.916	53.968	55.902
C1	>>> SIGNAL C1-1253	125+34	-2500	2500	0	(1)	50	55	4.19	50.000	61.237	82.916	53.968	55.902
C1	REFLECTOR TAG	125+33	-2500	2500	0	(1)	50	55	4.19	50.000	61.237	82.916	53.968	55.902
C1	Spiral/Curve	124+95	-2500	2500	0	(1)	50	55	4.19	50.000	61.237	82.916	53.968	55.902
C1	Point of Vertical Tangent (PVT)	124+52	-2500	2500	0	(1)	50	55	4.19	50.000	61.237	82.916	53.968	55.902
C1	Point of Vertical Intersection of Grades (PVI)	123+94	-2500	2500	0	(1)	50	55	4.19	50.000	61.237	82.916	53.968	55.902
C1	>>> SIGNAL C1-1232	123+79	-2500	2500	0	(1)	50	55	3.69	50.000	61.237	82.916	53.968	55.902
C1	REFLECTOR TAG	123+78	-2500	2500	0	(1)	50	55	3.69	50.000	61.237	82.916	53.968	55.902
C1	Point of Vertical Curve (PVC)	123+36	-2500	2500	0	(1)	50	55	3.69	50.000	61.237	82.916	53.968	55.902
C1	Start >>> TURNOUT	123+21	-2500	2500	0	(1)	50	55	3.69	50.000	61.237	82.916	53.968	55.902
C1	REFLECTOR TAG	123+17	-2500	2500	0	(1)	50	55	3.69	50.000	61.237	82.916	53.968	55.902
C1	Point of Vertical Tangent (PVT)	122+87	-2500	2500	0	(1)	50	55	3.69	50.000	61.237	82.916	53.968	55.902
C1	End >>> TURNOUT (54)	122+67	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	Point of Vertical Intersection of Grades (PVI)	122+62	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	Start >>> TURNOUT	122+51	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	Point of Vertical Curve (PVC)	122+37	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	Point of Vertical Tangent (PVT)	121+99	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	End >>> TURNOUT (58)	121+93	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	REFLECTOR TAG	121+87	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	REFLECTOR TAG	121+56	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	>>> N.E.PLATFORM	121+49	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	>>> SIGNAL C1-1212	121+48	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	T: T2	121+27	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	Point of Vertical Intersection of Grades (PVI)	121+21	-2500	2500	0	(1)	50	55	4.16	50.000	61.237	82.916	53.968	55.902
C1	Curve/Spiral	120+99	-2500	2500	0	(1)	50	55	0.50	50.000	61.237	82.916	53.968	55.902
C1	REFLECTOR TAG	120+98	-2500	2500	0	(1)	50	55	0.50	50.000	61.237	82.916	53.968	55.902
C1	Spiral/Tangent	120+45	-2500	2500	0	(1)	50	55	0.50	50.000	61.237	82.916	53.968	55.902
C1	Point of Vertical Curve (PVC)	120+43				(1)	50	55	0.50					
C1	>>> SIGNAL C1-1192	120+11				(1)	50	55	0.50					
C1	REFLECTOR TAG	120+06				(1)	50	55	0.50					
C1	T: HUNTERS POINT	119+12				(1)	50	55	0.50					
C1	REFLECTOR TAG	117+39				(1)	50	55	0.50					
C1	Tangent/Spiral	116+66	-400	400	2	24	28	36	0.50	24.495	28.284	36.056	25.807	26.458
C1	>>> S.E.PLATFORM	115+80	-400	400	2	24	28	36	0.50	24.495	28.284	36.056	25.807	26.458
C1	>>> SIGNAL C1-1152	115+70	-400	400	2	24	28	36	0.50	24.495	28.284	36.056	25.807	26.458
C1	Spiral/Curve	115+69	-400	400	2	24	28	36	0.50	24.495	28.284	36.056	25.807	26.458
C1	REFLECTOR TAG	115+66	-400	400	2	24	28	36	0.50	24.495	28.284	36.056	25.807	26.458
C1	Curve/Spiral	114+38	-400	400	2	24	28	36	0.50	24.495	28.284	36.056	25.807	26.458
C1	Point of Vertical Tangent (PVT)	114+06	-400	400	2	24	28	36	0.50	24.495	28.284	36.056	25.807	26.458
C1	Point of Vertical Intersection of Grades (PVI)	113+79	-400	400	2	24	28	36	0.37	24.495	28.284	36.056	25.807	26.458
C1	Spiral/Tangent	113+60	-400	400	2	24	28	36	0.37	24.495	28.284	36.056	25.807	26.458
C1	Point of Vertical Curve (PVC)	113+52				(1)	50	55	0.37					
C1	REFLECTOR TAG	113+36				(1)	50	55	0.37					
C1	Point of Vertical Tangent (PVT)	111+49				(1)	50	55	0.37					
C1	>>> SIGNAL C1-1102	111+11				(1)	50	55	0.37					

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	Event	True Stationing	RADIUS (ft.)		SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C1	Point of Vertical Intersection of Grades (PVI)	110+98				(1)	50	55	0.37					
C1	Point of Vertical Curve (PVC)	110+47				(1)	50	55	0.20					
C1	Point of Vertical Tangent (PVT)	108+28				(1)	50	55	0.20					
C1	>>> SIGNAL C1-1082	109+02				(1)	50	55	0.20					
C1	Point of Vertical Intersection of Grades (PVI)	108+00				(1)	50	55	0.20					
C1	>>> N.E.PLATFORM	107+99				(1)	50	55	0.06					
C1	REFLECTOR TAG	107+83				(1)	50	55	0.06					
C1	Point of Vertical Curve (PVC)	107+72				(1)	50	55	0.06					
C1	>>> SIGNAL C1-1072	107+48				(1)	50	55	0.06					
C1	>>> SIGNAL	105+75				(1)	50	55	0.06					
C1	T: VERNON BLVD - JACKSON AV	105+42				(1)	50	55	0.06					
C1	Point of Vertical Tangent (PVT)	103+32				(1)	50	55	0.06					
C1	Point of Vertical Intersection of Grades (PVI)	102+25				(1)	50	55	0.06					
C1	>>> S.E.PLATFORM	102+01				(1)	50	55	4.50					
C1	REFLECTOR TAG	101+91				(1)	50	55	4.50					
C1	>>> SIGNAL C1-1012	101+72				(1)	50	55	4.50					
C1	Point of Vertical Curve (PVC)	101+18				(1)	50	55	4.50					
C1	Tangent/Spiral	99+28	-1470	1470	2.5	See Note (4) below	40	45	4.50	48.875	55.891	70.436	51.296	52.500
C1	Spiral/Curve	98+27	-1470	1470	2.5	See Note (4) below	40	45	4.50	48.875	55.891	70.436	51.296	52.500
C1	Curve/Spiral	95+79	-1470	1470	2.5	See Note (4) below	40	45	4.50	48.875	55.891	70.436	51.296	52.500
C1	Spiral/Tangent	94+86	-1470	1470	2.5	See Note (4) below	40	45	4.50	48.875	55.891	70.436	51.296	52.500
C1	REFLECTOR TAG	93+77				See Note (4) below	40	45	4.50					
C1	>>> SIGNAL C1-932	93+61				See Note (4) below	40	45	4.50					
C1	Point of Vertical Tangent (PVT)	90+21				See Note (4) below	40	45	4.50					
C1	Point of Vertical Intersection of Grades (PVI)	89+25				See Note (4) below	40	45	4.50					
C1	Point of Vertical Curve (PVC)	88+29				See Note (4) below	40	45	1.70					
C1	>>> SIGNAL C1-872	87+82				See Note (4) below	40	45	1.70					
C1	Point of Vertical Tangent (PVT)	84+13				See Note (4) below	40	45	1.70					
C1	Point of Vertical Intersection of Grades (PVI)	83+53				See Note (4) below	40	45	1.70					
C1	Point of Vertical Curve (PVC)	82+93				See Note (4) below	40	45	1.35					
C1	REFLECTOR TAG	82+66				See Note (4) below	40	45	1.35					
C1	>>> SIGNAL C1-832	82+34				See Note (4) below	40	45	1.35					
C1	Point of Vertical Tangent (PVT)	79+62				See Note (4) below	40	45	1.35					
C1	Point of Vertical Intersection of Grades (PVI)	79+35				See Note (4) below	40	45	1.35					
C1	Point of Vertical Curve (PVC)	79+08				See Note (4) below	40	45	1.70					
C1	Point of Vertical Tangent (PVT)	77+16				See Note (4) below	40	45	1.70					
C1	Point of Vertical Intersection of Grades (PVI)	76+98				See Note (4) below	40	45	1.70					
C1	Point of Vertical Curve (PVC)	76+80				See Note (4) below	40	45	1.52					
C1	Point of Vertical Tangent (PVT)	75+47				See Note (4) below	40	45	1.52					
C1	Point of Vertical Intersection of Grades (PVI)	74+92				See Note (4) below	40	45	1.52					
C1	REFLECTOR TAG	74+91				See Note (4) below	40	45	2.25					
C1	Point of Vertical Curve (PVC)	74+37				See Note (4) below	40	45	2.25					
C1	Point of Vertical Tangent (PVT)	73+90				See Note (4) below	40	45	2.25					
C1	Point of Vertical Intersection of Grades (PVI)	73+54				See Note (4) below	40	45	2.25					
C1	Point of Vertical Curve (PVC)	73+18				See Note (4) below	40	45	1.78					
C1	>>> SIGNAL C1-712	71+65				See Note (4) below	40	45	1.78					
C1	Point of Vertical Tangent (PVT)	67+45				See Note (4) below	40	45	1.78					
C1	Point of Vertical Intersection of Grades (PVI)	66+80				See Note (4) below	40	45	1.78					
C1	>>> SIGNAL C1-662	66+56				See Note (4) below	40	45	0.00					
C1	REFLECTOR TAG	66+49				See Note (4) below	40	45	0.00					
C1	Point of Vertical Curve (PVC)	66+15				See Note (4) below	40	45	0.00					
C1	Point of Vertical Tangent (PVT)	64+05				See Note (4) below	40	45	0.00					
C1	Point of Vertical Intersection of Grades (PVI)	63+59				See Note (4) below	40	45	0.00					
C1	Point of Vertical Curve (PVC)	63+13				See Note (4) below	40	45	-1.14					
C1	REFLECTOR TAG	62+14				See Note (4) below	40	45	-1.14					
C1	Point of Vertical Tangent (PVT)	61+28				See Note (4) below	40	45	-1.14					
C1	Point of Vertical Intersection of Grades (PVI)	60+54				See Note (4) below	40	45	-1.14					
C1	>>> SIGNAL C1-592	59+98				See Note (4) below	40	45	-2.80					
C1	Point of Vertical Curve (PVC)	59+80				See Note (4) below	40	45	-2.80					

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**		**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C1	REFLECTOR TAG	59+73				See Note (4) below	40	45	-2.80					
C1	Start >>> TURNOUT	59+67				See Note (4) below	40	45	-2.80					
C1	End >>> TURNOUT (55)	59+12				See Note (4) below	40	45	-2.80					
C1	Start >>> TURNOUT	58+33				See Note (4) below	40	45	-2.80					
C1	REFLECTOR TAG	57+73				See Note (4) below	40	45	-2.80					
C1	End >>> TURNOUT (67)	57+66				See Note (4) below	40	45	-2.80					
C1	Point of Vertical Tangent (PVT)	57+66				See Note (4) below	40	45	-2.80					
C1	Point of Vertical Intersection of Grades (PVI)	57+32				See Note (4) below	40	45	-2.80					
C1	Point of Vertical Curve (PVC)	56+98				See Note (4) below	40	45	-3.00					
C1	>>> SIGNAL C1-502	50+84				See Note (4) below	40	45	-3.00					
C1	>>> SIGNAL C1-432	43+85				See Note (4) below	40	45	-3.00					
C1	>>> SIGNAL C1-4024	41+20				See Note (4) below	40	45	-3.00					
C1	>>> SIGNAL C1-392	38+97				See Note (4) below	40	45	-3.00					
C1	>>> N.E.PLATFORM	37+70				(1)	50	55	-3.00					
C1	>>> SIGNAL C1-272	37+67				(1)	50	55	-3.00					
C1	Point of Vertical Tangent (PVT)	36+69				(1)	50	55	-3.00					
C1	Point of Vertical Intersection of Grades (PVI)	36+14				(1)	50	55	-3.00					
C1	>>> SIGNAL C1-362	36+04				(1)	50	55	-0.16					
C1	Point of Vertical Curve (PVC)	35+59				(1)	50	55	-0.16					
C1	>>> SIGNAL C1-342	34+73				(1)	50	55	-0.16					
C1	T: 42ND ST.-GRAND CENTRAL	32+73				(1)	50	55	-0.16					
C1	>>> S.E.PLATFORM	31+34				(1)	50	55	-0.16					
C1	REFLECTOR TAG	30+97				(1)	50	55	-0.16					
C1	Point of Vertical Tangent (PVT)	30+90				(1)	50	55	-0.16					
C1	Tangent/Spiral	30+86	2050		1.25	(1)	50	55	-0.16	51.871	60.956	79.235	55.035	56.596
C1	>>> SIGNAL C1-302	30+76	2050		1.25	(1)	50	55	-0.16	51.871	60.956	79.235	55.035	56.596
C1	Spiral/Curve	30+50	2050		1.25	(1)	50	55	-0.16	51.871	60.956	79.235	55.035	56.596
C1	Point of Vertical Intersection of Grades (PVI)	29+60	2050		1.25	(1)	50	55	-0.16	51.871	60.956	79.235	55.035	56.596
C1	Curve/Spiral	28+90	2050		1.25	(1)	50	55	-4.54	51.871	60.956	79.235	55.035	56.596
C1	Spiral/Tangent	28+56	2050		1.25	(1)	50	55	-4.54	51.871	60.956	79.235	55.035	56.596
C1	Point of Vertical Curve (PVC)	28+30	2050		1.25	(1)	50	55	-4.54	51.871	60.956	79.235	55.035	56.596
C1	Tangent/Spiral	28+09	-2180	2180	1.5	(1)	50	55	-4.54	54.749	63.934	82.538	57.941	59.519
C1	Spiral/Curve	27+84	-2180	2180	1.5	(1)	50	55	-4.54	54.749	63.934	82.538	57.941	59.519
C1	Point of Vertical Tangent (PVT)	27+23	-2180	2180	1.5	(1)	50	55	-4.54	54.749	63.934	82.538	57.941	59.519
C1	Point of Vertical Intersection of Grades (PVI)	26+80	-2180	2180	1.5	(1)	50	55	-4.54	54.749	63.934	82.538	57.941	59.519
C1	Point of Vertical Curve (PVC)	26+37	-2180	2180	1.5	(1)	50	55	-3.81	54.749	63.934	82.538	57.941	59.519
C1	Curve/Spiral	25+96	-2180	2180	1.5	(1)	50	55	-3.81	54.749	63.934	82.538	57.941	59.519
C1	Spiral/Tangent	25+69	-2180	2180	1.5	(1)	50	55	-3.81	54.749	63.934	82.538	57.941	59.519
C1	>>> SIGNAL C1-232	23+81				(1)	50	55	-3.81					
C1	Point of Vertical Tangent (PVT)	23+27				(1)	50	55	-3.81					
C1	Point of Vertical Intersection of Grades (PVI)	22+82				(1)	50	55	-3.81					
C1	Point of Vertical Curve (PVC)	22+37				(1)	50	55	-4.30					
C1	Point of Vertical Tangent (PVT)	21+91				(1)	50	55	-4.30					
C1	Point of Vertical Intersection of Grades (PVI)	21+59				(1)	50	55	-4.30					
C1	Tangent/Spiral	21+49	625		1.5	29	34	44	-3.93	29.315	34.233	44.194	31.024	31.869
C1	Point of Vertical Curve (PVC)	21+27	625		1.5	29	34	44	-3.93	29.315	34.233	44.194	31.024	31.869
C1	Spiral/Curve	20+94	625		1.5	29	34	44	-3.93	29.315	34.233	44.194	31.024	31.869
C1	Point of Vertical Tangent (PVT)	20+80	625		1.5	29	34	44	-3.93	29.315	34.233	44.194	31.024	31.869
C1	>>> SIGNAL C1-202	20+78	625		1.5	29	34	44	-3.93	29.315	34.233	44.194	31.024	31.869
C1	Point of Vertical Intersection of Grades (PVI)	20+52	625		1.5	29	34	44	-3.93	29.315	34.233	44.194	31.024	31.869
C1	Curve/Spiral	20+48	625		1.5	29	34	44	-4.28	29.315	34.233	44.194	31.024	31.869
C1	Point of Vertical Curve (PVC)	20+24	625		1.5	29	34	44	-4.28	29.315	34.233	44.194	31.024	31.869
C1	Spiral/Tangent	19+81	625		1.5	29	34	44	-4.28	29.315	34.233	44.194	31.024	31.869
C1	Tangent/Spiral	19+53	-590	590	1.25	27	32	42	-4.28	27.828	32.701	42.507	29.525	30.362
C1	Spiral/Curve	19+08	-590	590	1.25	27	32	42	-4.28	27.828	32.701	42.507	29.525	30.362
C1	>>> SIGNAL C1-182	18+70	-590	590	1.25	27	32	42	-4.28	27.828	32.701	42.507	29.525	30.362
C1	Curve/Spiral	18+68	-590	590	1.25	27	32	42	-4.28	27.828	32.701	42.507	29.525	30.362
C1	>>> N.E.PLATFORM	18+48	-590	590	1.25	27	32	42	-4.28	27.828	32.701	42.507	29.525	30.362
C1	Spiral/Tangent	17+98	-590	590	1.25	27	32	42	-4.28	27.828	32.701	42.507	29.525	30.362
C1	Point of Vertical Tangent (PVT)	17+96				(1)	50	55	-4.28					
C1	>>> SIGNAL C1-162	16+49				(1)	50	55	-4.28					

										Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	Event	True Stationing	RADIUS (ft.)		SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C1	Point of Vertical Intersection of Grades (PVI)	15+62				(1)	50	55	-4.28					
C1	Tangent/Spiral	15+54	1490		0.25	39	48	55	2.81	39.789	48.251	64.735	42.767	44.222
C1	T: 5TH AVE. - BRYANT PARK	15+19	1490		0.25	39	48	55	2.81	39.789	48.251	64.735	42.767	44.222
C1	Spiral/Curve	15+01	1490		0.25	39	48	55	2.81	39.789	48.251	64.735	42.767	44.222
C1	Curve/Spiral	13+34	1490		0.25	39	48	55	2.81	39.789	48.251	64.735	42.767	44.222
C1	Point of Vertical Curve (PVC)	13+28	1490		0.25	39	48	55	2.81	39.789	48.251	64.735	42.767	44.222
C1	>>> S.E.PLATFORM	12+90	1490		0.25	39	48	55	2.81	39.789	48.251	64.735	42.767	44.222
C1	>>> SIGNAL C1-122	12+63	310		2.5	22	25	32	2.81	22.444	25.666	32.346	23.556	24.109
C1	Spiral/Curve	12+48	310		2.5	22	25	32	2.81	22.444	25.666	32.346	23.556	24.109
C1	Point of Vertical Tangent (PVT)	12+27	310		2.5	22	25	32	2.81	22.444	25.666	32.346	23.556	24.109
C1	Point of Vertical Intersection of Grades (PVI)	11+69	310		2.5	22	25	32	2.81	22.444	25.666	32.346	23.556	24.109
C1	Curve/Spiral	11+42	310		2.5	22	25	32	3.02	22.444	25.666	32.346	23.556	24.109
C1	Point of Vertical Curve (PVC)	11+11	310		2.5	22	25	32	3.02	22.444	25.666	32.346	23.556	24.109
C1	Spiral/Tangent	10+97	310		2.5	22	25	32	3.02	22.444	25.666	32.346	23.556	24.109
C1	Tangent/Spiral	10+43	-300	300	3	22	25	32	3.02	22.913	25.981	32.404	23.969	24.495
C1	Spiral/Curve	9+62	-300	300	3	22	25	32	3.02	22.913	25.981	32.404	23.969	24.495
C1	>>> SIGNAL C1-92	8+93	-300	300	3	22	25	32	3.02	22.913	25.981	32.404	23.969	24.495
C1	Curve/Spiral	8+46	-300	300	3	22	25	32	3.02	22.913	25.981	32.404	23.969	24.495
C1	>>> SIGNAL C1-82	7+86	-300	300	3	22	25	32	3.02	22.913	25.981	32.404	23.969	24.495
C1	Spiral/Tangent	7+10	-300	300	3	22	25	32	3.02	22.913	25.981	32.404	23.969	24.495
C1	>>> SIGNAL C1-62	6+68				(1)	50	55	3.02					
C1	Point of Vertical Tangent (PVT)	6+31				(1)	50	55	3.02					
C1	>>> SIGNAL C1-52	5+71				(1)	50	55	3.02					
C1	Point of Vertical Intersection of Grades (PVI)	5+47				(1)	50	55	3.02					
C1	Start >>> TURNOUT	4+96				(1)	50	55	0.97					
C1	Point of Vertical Curve (PVC)	4+63				(1)	50	55	0.97					
C1	End >>> TURNOUT (76)	4+20				(1)	50	55	0.97					
C1	Start >>> TURNOUT	3+95				(1)	50	55	0.97					
C1	End >>> TURNOUT (70)	3+25				(1)	50	55	0.97					
C1	Point of Vertical Tangent (PVT)	3+19				(1)	50	55	0.97					
C1	Point of Vertical Intersection of Grades (PVI)	2+06				(1)	50	55	0.97					
C1	>>> SIGNAL C1-22	1+96				(1)	50	55	0.04					
C1	Tangent/Spiral	1+58				(1)	50	55	0.04					
C1	Spiral/Curve	1+42	3200		0	(1)	50	55	0.04	56.569	69.282	93.808	61.057	63.246
C1	>>> N.E.PLATFORM	1+27	3200		0	(1)	50	55	0.04	56.569	69.282	93.808	61.057	63.246
C1	Point of Vertical Curve (PVC)	0+93				(1)	50	55	0.04					
C1	T: TIMES SQUARE	0+30				(1)	50	55	0.04					
C1	Curve/Spiral	0+24				(1)	50	55	0.04					
C1	Spiral/Tangent	0+13				(1)	50	55	0.04					

(1) On tangent track and in some large radius curves, in the absence of any other speed restriction, the Average Normal Operating Speed is the highest speed that will allow service braking to limit the High Normal Operating Speed to 50 mph without experiencing Emergency Brake Applications to enforce the Not-To-Exceed (NTE) Speed

(2) CBTC shall enforce a Normal High Operating Speed limit equal to the V6 speed in curves and equal to 50 mph in tangent track and large radius curves, using service braking without incurring an Emergency Brake application. In ATPM, if the Train Operator does not reduce the speed as the Normal High Operating Speed limit is approached, the CBTC system will automatically apply service brakes to avoid exceeding this limit.

(3) CBTC must Vitally Ensure that the Not-To-Exceed (NTE) Safe Speed of V11 in curves, or 55 mph in tangent track or large radius curves, is never exceeded by any part of a train, even under slight and temporary degradation of track geometry conditions. If the actual speed of the train exceeds the Normal High Operating Speed, and is not immediately reduced below that limit by Service Brakes, an Emergency Brake application shall already have been called for. The Emergency Brake application shall be triggered at a predetermined CBTC designed speed-threshold (i.e. the Vital Civil Speed). In NO CASE shall the actual speed of the train be allowed to exceed the NTE Safe Speed (V11). CBTC Train Control System parameters shall be adjusted to Vitally Ensure this requirement.

(4): Speeds through the Steinway Tunnel shall be as follows: Normal High Operating Speed (Allowed Speed Limit): 40 mph, and Not-To-Exceed Speed (NTE): 45 mph. CBTC shall enforce both the Allowed Speed Limit and the NTE Speed throughout the Steinway Tunnel.

G-3: FLUSHING LINE C2 – CURVE ANALYSIS

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	Event	True Stationing	RADIUS (ft.)	SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
CC2	T: TIMES SQ	3+27			(1)	50	55	-0.02					
CC2	REFLECTOR TAG	2+87			(1)	50	55	-0.02					
CC2	REFLECTOR TAG	1+24			(1)	50	55	-0.02					
C2	REFLECTOR TAG	0+00			(1)	50	55	-0.02					
C2	Tangent/Spiral	0+52	1800	0.375	44	50	55	-0.02	44.371	53.561	71.545	47.600	49.181
C2	Spiral/Curve	1+26	1800	0.375	44	50	55	-0.02	44.371	53.561	71.545	47.600	49.181
C2	>>> N.E.PLATFORM	1+27	1800	0.375	44	50	55	-0.02	44.371	53.561	71.545	47.600	49.181
C2	Point of Vertical Curve (PVC)	1+34	1800	0.375	44	50	55	-0.02	44.371	53.561	71.545	47.600	49.181
C2	Point of Vertical Intersection of Grades (PVI)	1+79	1800	0.375	44	50	55	0.70	44.371	53.561	71.545	47.600	49.181
C2	>>> SIGNAL C2-2	1+94	1800	0.375	44	50	55	0.70	44.371	53.561	71.545	47.600	49.181
C2	Curve/Spiral	2+04	1800	0.375	44	50	55	0.70	44.371	53.561	71.545	47.600	49.181
C2	REFLECTOR TAG	2+14	1800	0.375	44	50	55	0.70	44.371	53.561	71.545	47.600	49.181
C2	Point of Vertical Tangent (PVT)	2+24	1800	0.375	44	50	55	0.70	44.371	53.561	71.545	47.600	49.181
C2	Spiral/Tangent	2+46	1800	0.375	44	50	55	0.70	44.371	53.561	71.545	47.600	49.181
C2	Point of Vertical Curve (PVC)	2+63			(1)	50	55	0.70					
C2	Point of Vertical Intersection of Grades (PVI)	2+93			(1)	50	55	1.10					
C2	Tangent/Spiral	3+01	Sw. 5B	#8 Tangential	21	30	37	1.10					
C2	Start >>> TURNOUT	3+21	Sw. 5B	#8 Tangential	21	30	37	1.10					
C2	Point of Vertical Tangent (PVT)	3+23	Sw. 5B	#8 Tangential	21	30	37	1.10					
C2	REFLECTOR TAG	3+23	Sw. 5B	#8 Tangential	21	30	37	1.10					
C2	Spiral/Curve	3+29	Sw. 5B	#8 Tangential	21	30	37	1.10					
C2	Curve/Spiral	3+62	Sw. 5B	#8 Tangential	21	30	37	1.10					
C2	End >>> TURNOUT (66)	3+87	Sw. 5B	#8 Tangential	21	30	37	1.10					
C2	Spiral/Tangent	3+94	Sw. 5B	#8 Tangential	21	30	37	1.10					
C2	REFLECTOR TAG	3+98			(1)	50	55	1.10					
C2	Start >>> TURNOUT	4+18			(1)	50	55	1.10					
C2	Point of Vertical Curve (PVC)	4+85			(1)	50	55	1.10					
C2	REFLECTOR TAG	4+84			(1)	50	55	1.10					
C2	End >>> TURNOUT (67)	4+85			(1)	50	55	1.10					
C2	REFLECTOR TAG	5+56			(1)	50	55	1.10					
C2	Point of Vertical Intersection of Grades (PVI)	5+60			(1)	50	55	3.00					
C2	Point of Vertical Tangent (PVT)	6+35			(1)	50	55	3.00					
C2	Tangent/Spiral	7+18	315	3.25	23	26	33	3.00	23.894	26.990	33.499	24.958	25.489
C2	>>> SIGNAL C2-8	8+18	315	3.25	23	26	33	3.00	23.894	26.990	33.499	24.958	25.489
C2	Spiral/Curve	8+33	315	3.25	23	26	33	3.00	23.894	26.990	33.499	24.958	25.489
C2	>>> SIGNAL	9+54	315	3.25	23	26	33	3.00	23.894	26.990	33.499	24.958	25.489
C2	REFLECTOR TAG	9+75	315	3.25	23	26	33	3.00	23.894	26.990	33.499	24.958	25.489
C2	Curve/Spiral	9+77	315	3.25	23	26	33	3.00	23.894	26.990	33.499	24.958	25.489
C2	Point of Vertical Curve (PVC)	10+61	315	3.25	23	26	33	3.00	23.894	26.990	33.499	24.958	25.489
C2	Point of Vertical Intersection of Grades (PVI)	10+91	315	3.25	23	26	33	3.29	23.894	26.990	33.499	24.958	25.489
C2	Point of Vertical Tangent (PVT)	11+21	315	3.25	23	26	33	3.29	23.894	26.990	33.499	24.958	25.489
C2	>>> SIGNAL C2-11	11+26	315	3.25	23	26	33	3.29	23.894	26.990	33.499	24.958	25.489
C2	Spiral/Curve	11+38	310	2.75	22	26	32	3.29	22.872	26.041	32.644	23.964	24.508
C2	Curve/Spiral	12+44	310	2.75	22	26	32	3.29	22.872	26.041	32.644	23.964	24.508
C2	REFLECTOR TAG	12+44	310	2.75	22	26	32	3.29	22.872	26.041	32.644	23.964	24.508
C2	>>> SIGNAL	12+63	310	2.75	22	26	32	3.29	22.872	26.041	32.644	23.964	24.508
C2	Point of Vertical Curve (PVC)	12+89	310	2.75	22	26	32	3.29	22.872	26.041	32.644	23.964	24.508
C2	>>> S.E.PLATFORM	12+93	310	2.75	22	26	32	3.29	22.872	26.041	32.644	23.964	24.508
C2	Spiral/Curve	12+97	1500	0.625	41	49	55	3.29	41.646	49.844	66.026	44.518	45.928
C2	>>> SIGNAL	14+32	1500	0.625	41	49	55	3.29	41.646	49.844	66.026	44.518	45.928
C2	Curve/Spiral	14+87	1500	0.625	41	49	55	3.29	41.646	49.844	66.026	44.518	45.928
C2	Spiral/Tangent	15+38	1500	0.625	41	49	55	3.29	41.646	49.844	66.026	44.518	45.928
C2	Point of Vertical Intersection of Grades (PVI)	15+39			(1)	50	55	-4.15					
C2	T: 5TH AVE	15+62			(1)	50	55	-4.15					
C2	REFLECTOR TAG	17+04			(1)	50	55	-4.15					
C2	Tangent/Spiral	17+09	690	1.125	29	35	45	-4.15	29.733	35.058	45.734	31.590	32.505
C2	Spiral/Curve	17+51	690	1.125	29	35	45	-4.15	29.733	35.058	45.734	31.590	32.505
C2	Point of Vertical Tangent (PVT)	17+89	690	1.125	29	35	45	-4.15	29.733	35.058	45.734	31.590	32.505
C2	Curve/Spiral	18+06	690	1.125	29	35	45	-4.15	29.733	35.058	45.734	31.590	32.505

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C2	Spiral/Tangent	18+42	690	1.125	29	35	45	-4.15	29.733	35.058	45.734	31.590	32.505
C2	>>> N.E.PLATFORM	18+49			(1)	50	55	-4.15					
C2	REFLECTOR TAG	18+69			(1)	50	55	-4.15					
C2	>>> SIGNAL	18+83			(1)	50	55	-4.15					
C2	Tangent/Spiral	19+13	650	1.875	30	35	45	-4.15	30.898	35.773	45.740	32.587	33.424
C2	Spiral/Curve	19+77	650	1.875	30	35	45	-4.15	30.898	35.773	45.740	32.587	33.424
C2	Curve/Spiral	20+15	650	1.875	30	35	45	-4.15	30.898	35.773	45.740	32.587	33.424
C2	Spiral/Tangent	20+75	650	1.875	30	35	45	-4.15	30.898	35.773	45.740	32.587	33.424
C2	>>> SIGNAL	22+50			(1)	50	55	-4.15					
C2	Point of Vertical Curve (PVC)	22+63			(1)	50	55	-4.15					
C2	Point of Vertical Intersection of Grades (PVI)	23+13			(1)	50	55	-3.80					
C2	REFLECTOR TAG	23+47			(1)	50	55	-3.80					
C2	Point of Vertical Tangent (PVT)	23+63			(1)	50	55	-3.80					
C2	>>> SIGNAL	23+81			(1)	50	55	-3.80					
C2	>>> SIGNAL	25+04			(1)	50	55	-3.80					
C2	>>> SIGNAL C2-26	26+36			(1)	50	55	-3.80					
C2	Point of Vertical Curve (PVC)	26+42			(1)	50	55	-3.80					
C2	Point of Vertical Intersection of Grades (PVI)	26+87			(1)	50	55	-4.55					
C2	Point of Vertical Tangent (PVT)	27+32			(1)	50	55	-4.55					
C2	>>> SIGNAL C2-27	28+01			(1)	50	55	-4.55					
C2	Point of Vertical Curve (PVC)	28+51			(1)	50	55	-4.55					
C2	Tangent/Spiral	28+85	2100	2.0	(1)	50	55	-4.55	56.125	64.807	82.614	59.131	60.622
C2	Point of Vertical Intersection of Grades (PVI)	29+56	2100	2.0	(1)	50	55	-0.20	56.125	64.807	82.614	59.131	60.622
C2	>>> SIGNAL C2-29	29+73	2100	2.0	(1)	50	55	-0.20	56.125	64.807	82.614	59.131	60.622
C2	Spiral/Curve	29+78	2100	2.0	(1)	50	55	-0.20	56.125	64.807	82.614	59.131	60.622
C2	Point of Vertical Tangent (PVT)	30+61	2100	2.0	(1)	50	55	-0.20	56.125	64.807	82.614	59.131	60.622
C2	Curve/Spiral	30+71	2100	2.0	(1)	50	55	-0.20	56.125	64.807	82.614	59.131	60.622
C2	REFLECTOR TAG	30+88	2100	2.0	(1)	50	55	-0.20	56.125	64.807	82.614	59.131	60.622
C2	>>> SIGNAL C2-30	30+91	2100	2.0	(1)	50	55	-0.20	56.125	64.807	82.614	59.131	60.622
C2	>>> S.E.PLATFORM	31+29	2100	2.0	(1)	50	55	-0.20	56.125	64.807	82.614	59.131	60.622
C2	REFLECTOR TAG	31+30	2100	2.0	(1)	50	55	-0.20	56.125	64.807	82.614	59.131	60.622
C2	Spiral/Curve	32+34	2300	1.5	(1)	50	55	-0.20	56.236	65.670	84.779	59.515	61.135
C2	>>> SIGNAL	32+57	2300	1.5	(1)	50	55	-0.20	56.236	65.670	84.779	59.515	61.135
C2	Curve/Spiral	33+27	2300	1.5	(1)	50	55	-0.20	56.236	65.670	84.779	59.515	61.135
C2	>>> SIGNAL	33+88	2300	1.5	(1)	50	55	-0.20	56.236	65.670	84.779	59.515	61.135
C2	T: GRAND CENTRAL	34+17	2300	1.5	(1)	50	55	-0.20	56.236	65.670	84.779	59.515	61.135
C2	Spiral/Tangent	34+43	2300	1.5	(1)	50	55	-0.20	56.236	65.670	84.779	59.515	61.135
C2	Point of Vertical Curve (PVC)	35+44			(1)	50	55	-0.20					
C2	REFLECTOR TAG	35+78			(1)	50	55	-0.20					
C2	Point of Vertical Intersection of Grades (PVI)	36+04			(1)	50	55	-3.00					
C2	Point of Vertical Tangent (PVT)	36+64			(1)	50	55	-3.00					
C2	REFLECTOR TAG	37+33			(1)	50	55	-3.00					
C2	>>> SIGNAL	37+51			(1)	50	55	-3.00					
C2	>>> N.E.PLATFORM	37+75			(1)	50	55	-3.00					
C2	REFLECTOR TAG	37+87			See Note (4) below	40	45	-3.00					
C2	>>> SIGNAL	45+84			See Note (4) below	40	45	-3.00					
C2	REFLECTOR TAG	46+19			See Note (4) below	40	45	-3.00					
C2	>>> SIGNAL	51+81			See Note (4) below	40	45	-3.00					
C2	REFLECTOR TAG	52+14			See Note (4) below	40	45	-3.00					
C2	REFLECTOR TAG	55+19			See Note (4) below	40	45	-3.00					
C2	>>> SIGNAL	57+25			See Note (4) below	40	45	-3.00					
C2	Point of Vertical Curve (PVC)	57+32			See Note (4) below	40	45	-3.00					
C2	Point of Vertical Intersection of Grades (PVI)	57+52			See Note (4) below	40	45	-2.80					
C2	Start >>> TURNOUT	57+59			See Note (4) below	40	45	-2.80					
C2	REFLECTOR TAG	57+69			See Note (4) below	40	45	-2.80					
C2	Point of Vertical Tangent (PVT)	57+72			See Note (4) below	40	45	-2.80					
C2	End >>> TURNOUT (58)	58+17			See Note (4) below	40	45	-2.80					
C2	Start >>> TURNOUT	58+91			See Note (4) below	40	45	-2.80					
C2	Point of Vertical Curve (PVC)	59+43			See Note (4) below	40	45	-2.80					
C2	End >>> TURNOUT (71)	59+62			See Note (4) below	40	45	-2.80					
C2	REFLECTOR TAG	59+71			See Note (4) below	40	45	-2.80					
C2	Point of Vertical Intersection of Grades (PVI)	59+93			See Note (4) below	40	45	-1.55					
C2	REFLECTOR TAG	60+42			See Note (4) below	40	45	-1.55					
C2	Point of Vertical Tangent (PVT)	60+43			See Note (4) below	40	45	-1.55					
C2	Point of Vertical Curve (PVC)	61+53			See Note (4) below	40	45	-1.55					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	Event	True Stationing	RADIUS (ft.)	SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C2	Point of Vertical Intersection of Grades (PVI)	61+83			See Note (4) below	40	45	-1.05					
C2	Point of Vertical Tangent (PVT)	62+13			See Note (4) below	40	45	-1.05					
C2	Point of Vertical Curve (PVC)	62+66			See Note (4) below	40	45	-1.05					
C2	Point of Vertical Intersection of Grades (PVI)	63+16			See Note (4) below	40	45	-0.25					
C2	Point of Vertical Tangent (PVT)	63+66			See Note (4) below	40	45	-0.25					
C2	Point of Vertical Curve (PVC)	64+71			See Note (4) below	40	45	-0.25					
C2	REFLECTOR TAG	65+20			See Note (4) below	40	45	-0.25					
C2	>>> SIGNAL	65+59			See Note (4) below	40	45	-0.25					
C2	Point of Vertical Intersection of Grades (PVI)	65+71			See Note (4) below	40	45	1.20					
C2	Point of Vertical Tangent (PVT)	66+71			See Note (4) below	40	45	1.20					
C2	Point of Vertical Curve (PVC)	67+95			See Note (4) below	40	45	1.20					
C2	Point of Vertical Intersection of Grades (PVI)	68+60			See Note (4) below	40	45	2.07					
C2	Point of Vertical Tangent (PVT)	69+25			See Note (4) below	40	45	2.07					
C2	Point of Vertical Curve (PVC)	69+68			See Note (4) below	40	45	2.07					
C2	Point of Vertical Intersection of Grades (PVI)	69+98			See Note (4) below	40	45	1.64					
C2	Point of Vertical Tangent (PVT)	70+28			See Note (4) below	40	45	1.64					
C2	Point of Vertical Curve (PVC)	71+80			See Note (4) below	40	45	1.64					
C2	Point of Vertical Intersection of Grades (PVI)	72+10			See Note (4) below	40	45	1.89					
C2	Point of Vertical Tangent (PVT)	72+40			See Note (4) below	40	45	1.89					
C2	Point of Vertical Curve (PVC)	73+97			See Note (4) below	40	45	1.89					
C2	Point of Vertical Intersection of Grades (PVI)	74+32			See Note (4) below	40	45	1.53					
C2	Point of Vertical Tangent (PVT)	74+67			See Note (4) below	40	45	1.53					
C2	REFLECTOR TAG	75+31			See Note (4) below	40	45	1.53					
C2	Point of Vertical Curve (PVC)	75+45			See Note (4) below	40	45	1.53					
C2	>>> SIGNAL	75+65			See Note (4) below	40	45	1.53					
C2	Point of Vertical Intersection of Grades (PVI)	75+85			See Note (4) below	40	45	1.87					
C2	Point of Vertical Tangent (PVT)	76+25			See Note (4) below	40	45	1.87					
C2	Point of Vertical Curve (PVC)	77+15			See Note (4) below	40	45	1.87					
C2	Point of Vertical Intersection of Grades (PVI)	77+70			See Note (4) below	40	45	1.32					
C2	Point of Vertical Tangent (PVT)	78+25			See Note (4) below	40	45	1.32					
C2	Point of Vertical Curve (PVC)	78+81			See Note (4) below	40	45	1.32					
C2	Point of Vertical Intersection of Grades (PVI)	79+11			See Note (4) below	40	45	1.52					
C2	Point of Vertical Tangent (PVT)	79+41			See Note (4) below	40	45	1.52					
C2	REFLECTOR TAG	81+82			See Note (4) below	40	45	1.52					
C2	Tangent/Spiral	84+42	2600	0.0	See Note (4) below	40	45	1.52	50.990	62.450	84.558	55.036	57.009
C2	Point of Vertical Curve (PVC)	84+96	2600	0.0	See Note (4) below	40	45	1.52	50.990	62.450	84.558	55.036	57.009
C2	Spiral/Curve	85+02	2600	0.0	See Note (4) below	40	45	1.52	50.990	62.450	84.558	55.036	57.009
C2	Point of Vertical Intersection of Grades (PVI)	85+11	2600	0.0	See Note (4) below	40	45	1.67	50.990	62.450	84.558	55.036	57.009
C2	>>> SIGNAL	85+19	2600	0.0	See Note (4) below	40	45	1.67	50.990	62.450	84.558	55.036	57.009
C2	Point of Vertical Tangent (PVT)	85+27	2600	0.0	See Note (4) below	40	45	1.67	50.990	62.450	84.558	55.036	57.009
C2	Curve/Spiral	85+36	2600	0.0	See Note (4) below	40	45	1.67	50.990	62.450	84.558	55.036	57.009
C2	Spiral/Curve	85+71	3000	0.0	See Note (4) below	40	45	1.67	54.772	67.082	90.830	59.119	61.237
C2	Curve/Spiral	85+83	3000	0.0	See Note (4) below	40	45	1.67	54.772	67.082	90.830	59.119	61.237
C2	Spiral/Tangent	86+18	3000	0.0	See Note (4) below	40	45	1.67	54.772	67.082	90.830	59.119	61.237
C2	Point of Vertical Curve (PVC)	88+20			See Note (4) below	40	45	1.67					
C2	Point of Vertical Intersection of Grades (PVI)	89+20			See Note (4) below	40	45	4.50					
C2	Point of Vertical Tangent (PVT)	90+20			See Note (4) below	40	45	4.50					
C2	T: STEINWAY TUBE	91+45			See Note (4) below	40	45	4.50					
C2	>>> SIGNAL	91+49			See Note (4) below	40	45	4.50					
C2	Tangent/Spiral	94+39	1350	1.625	See Note (4) below	40	45	4.50	43.571	50.729	65.276	46.056	47.286
C2	Spiral/Curve	94+94	1350	1.625	See Note (4) below	40	45	4.50	43.571	50.729	65.276	46.056	47.286
C2	REFLECTOR TAG	96+44	1350	1.625	See Note (4) below	40	45	4.50	43.571	50.729	65.276	46.056	47.286
C2	>>> SIGNAL	96+69	1350	1.625	See Note (4) below	40	45	4.50	43.571	50.729	65.276	46.056	47.286
C2	Curve/Spiral	97+76	1350	1.625	See Note (4) below	40	45	4.50	43.571	50.729	65.276	46.056	47.286
C2	Spiral/Tangent	98+61	1350	1.625	See Note (4) below	40	45	4.50	43.571	50.729	65.276	46.056	47.286
C2	>>> SIGNAL	99+37			(1)	50	55	4.50					
C2	Point of Vertical Curve (PVC)	101+17			(1)	50	55	4.50					
C2	REFLECTOR TAG	101+73			(1)	50	55	4.50					
C2	>>> SIGNAL	101+74			(1)	50	55	4.50					
C2	>>> S.E.PLATFORM	101+88			(1)	50	55	4.50					
C2	Point of Vertical Intersection of Grades (PVI)	102+20			(1)	50	55	0.10					
C2	T: VERNON JACKSON	102+71			(1)	50	55	0.10					
C2	Point of Vertical Tangent (PVT)	103+23			(1)	50	55	0.10					
C2	>>> SIGNAL	107+89			(1)	50	55	0.10					
C2	REFLECTOR TAG	107+91			(1)	50	55	0.10					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C2	>>> N.E.PLATFORM	108+17			(1)	50	55	0.10					
C2	Point of Vertical Curve (PVC)	109+00			(1)	50	55	0.10					
C2	Point of Vertical Intersection of Grades (PVI)	109+16			(1)	50	55	0.26					
C2	Point of Vertical Tangent (PVT)	109+32			(1)	50	55	0.26					
C2	REFLECTOR TAG	112+26			(1)	50	55	0.26					
C2	>>> SIGNAL	112+38			(1)	50	55	0.26					
C2	Point of Vertical Curve (PVC)	112+95			(1)	50	55	0.26					
C2	Point of Vertical Intersection of Grades (PVI)	113+60			(1)	50	55	0.53					
C2	REFLECTOR TAG	113+44			(1)	50	55	0.53					
C2	>>> SIGNAL	113+55			(1)	50	55	0.53					
C2	Tangent/Spiral	113+69	375	3.25	26	29	36	0.53	26.071	29.448	36.550	27.232	27.811
C2	Point of Vertical Tangent (PVT)	114+25	375	3.25	26	29	36	0.53	26.071	29.448	36.550	27.232	27.811
C2	Spiral/Curve	114+61	375	3.25	26	29	36	0.53	26.071	29.448	36.550	27.232	27.811
C2	Curve/Spiral	115+68	375	3.25	26	29	36	0.53	26.071	29.448	36.550	27.232	27.811
C2	REFLECTOR TAG	115+77	375	3.25	26	29	36	0.53	26.071	29.448	36.550	27.232	27.811
C2	>>> S.E.PLATFORM	115+84	375	3.25	26	29	36	0.53	26.071	29.448	36.550	27.232	27.811
C2	>>> SIGNAL	115+86	375	3.25	26	29	36	0.53	26.071	29.448	36.550	27.232	27.811
C2	Spiral/Tangent	116+67	375	3.25	26	29	36	0.53	26.071	29.448	36.550	27.232	27.811
C2	REFLECTOR TAG	117+13			(1)	50	55	0.53					
C2	>>> SIGNAL	118+26			(1)	50	55	0.53					
C2	REFLECTOR TAG	118+20			(1)	50	55	0.53					
C2	T: HUNTERS PT	118+49			(1)	50	55	0.53					
C2	Tangent/Spiral	119+94	2400	0.0	48	50	55	0.53	48.990	60.000	81.240	52.877	54.772
C2	REFLECTOR TAG	119+95	2400	0.0	48	50	55	0.53	48.990	60.000	81.240	52.877	54.772
C2	>>> SIGNAL	120+01	2400	0.0	48	50	55	0.53	48.990	60.000	81.240	52.877	54.772
C2	Point of Vertical Curve (PVC)	120+60	2400	0.0	48	50	55	0.53	48.990	60.000	81.240	52.877	54.772
C2	REFLECTOR TAG	121+09	2400	0.0	48	50	55	0.53	48.990	60.000	81.240	52.877	54.772
C2	>>> SIGNAL	121+20	2400	0.0	48	50	55	0.53	48.990	60.000	81.240	52.877	54.772
C2	Point of Vertical Intersection of Grades (PVI)	121+25	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	>>> N.E.PLATFORM	121+58	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	T: PORTAL	121+59	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	>>> SIGNAL	121+65	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	REFLECTOR TAG	121+68	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	>>> PORTAL/ABUT.	121+76	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	Spiral/Curve	121+77	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	Point of Vertical Tangent (PVT)	121+90	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	Start >>> TURNOUT	121+91	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	End >>> TURNOUT (57)	122+48	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	Start >>> TURNOUT	122+66	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	End >>> TURNOUT (58)	123+24	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	Curve/Spiral	124+52	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	Spiral/Tangent	126+28	2400	0.0	48	50	55	4.02	48.990	60.000	81.240	52.877	54.772
C2	Point of Vertical Curve (PVC)	129+11			(1)	50	55	4.02					
C2	Tangent/Spiral	129+57	250	5.0	23	26	31	4.02	23.717	26.220	31.623	24.571	25.000
C2	Point of Vertical Intersection of Grades (PVI)	129+86	250	5.0	23	26	31	0.10	23.717	26.220	31.623	24.571	25.000
C2	Spiral/Curve	130+64	250	5.0	23	26	31	0.10	23.717	26.220	31.623	24.571	25.000
C2	Point of Vertical Tangent (PVT)	130+61	250	5.0	23	26	31	0.10	23.717	26.220	31.623	24.571	25.000
C2	>>> SIGNAL	131+00	250	5.0	23	26	31	0.10	23.717	26.220	31.623	24.571	25.000
C2	Curve/Spiral	133+58	250	5.0	23	26	31	0.10	23.717	26.220	31.623	24.571	25.000
C2	Point of Vertical Curve (PVC)	134+30	250	5.0	23	26	31	0.10	23.717	26.220	31.623	24.571	25.000
C2	Spiral/Tangent	134+43	250	5.0	23	26	31	0.10	23.717	26.220	31.623	24.571	25.000
C2	>>> SIGNAL C2-133	134+50			(1)	50	55	0.10					
C2	Point of Vertical Intersection of Grades (PVI)	135+05			(1)	50	55	3.00					
C2	Point of Vertical Tangent (PVT)	135+80			(1)	50	55	3.00					
C2	Point of Vertical Curve (PVC)	136+65			(1)	50	55	3.00					
C2	Point of Vertical Intersection of Grades (PVI)	137+73			(1)	50	55	0.00					
C2	>>> SIGNAL C2-137	137+82			(1)	50	55	0.00					
C2	Tangent/Spiral	138+20	265	4.25	23	26	31	0.00	23.379	26.059	31.785	24.296	24.755
C2	Point of Vertical Tangent (PVT)	138+81	265	4.25	23	26	31	0.00	23.379	26.059	31.785	24.296	24.755
C2	Spiral/Curve	138+88	265	4.25	23	26	31	0.00	23.379	26.059	31.785	24.296	24.755
C2	Curve/Spiral	140+18	265	4.25	23	26	31	0.00	23.379	26.059	31.785	24.296	24.755
C2	REFLECTOR TAG	140+66	265	4.25	23	26	31	0.00	23.379	26.059	31.785	24.296	24.755
C2	Spiral/Tangent	140+75	265	4.25	23	26	31	0.00	23.379	26.059	31.785	24.296	24.755
C2	>>> SIGNAL	140+77			(1)	50	55	0.00					
C2	>>> S.E.PLATFORM	141+56			(1)	50	55	0.00					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (^{1}) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (^{2}) below) (mph)**	**NOT TO EXCEED SPEED (see Note (^{3}) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (^{4}) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (^{5}) below) (mph)**
C2	T: COURT SQ	143+30			(^{1})	50	55	0.00					
C2	Point of Vertical Curve (PVC)	146+32			(^{1})	50	55	0.00					
C2	Point of Vertical Intersection of Grades (PVI)	147+02			(^{1})	50	55	1.30					
C2	>>> N.E.PLATFORM	147+12			(^{1})	50	55	1.30					
C2	Tangent/Spiral	147+57	770	2.5	35	40	50	1.30	35.373	40.451	50.978	37.125	37.997
C2	Point of Vertical Tangent (PVT)	147+72	770	2.5	35	40	50	1.30	35.373	40.451	50.978	37.125	37.997
C2	>>> SIGNAL C2-147	147+82	770	2.5	35	40	50	1.30	35.373	40.451	50.978	37.125	37.997
C2	Spiral/Curve	148+94	770	2.5	35	40	50	1.30	35.373	40.451	50.978	37.125	37.997
C2	Curve/Spiral	149+93	770	2.5	35	40	50	1.30	35.373	40.451	50.978	37.125	37.997
C2	Point of Vertical Curve (PVC)	150+17	770	2.5	35	40	50	1.30	35.373	40.451	50.978	37.125	37.997
C2	Point of Vertical Intersection of Grades (PVI)	150+67	770	2.5	35	40	50	2.95	35.373	40.451	50.978	37.125	37.997
C2	Point of Vertical Tangent (PVT)	151+17	770	2.5	35	40	50	2.95	35.373	40.451	50.978	37.125	37.997
C2	Spiral/Tangent	151+43	770	2.5	35	40	50	2.95	35.373	40.451	50.978	37.125	37.997
C2	>>> SIGNAL	157+73			(^{1})	50	55	2.95					
C2	Point of Vertical Curve (PVC)	159+05			(^{1})	50	55	2.95					
C2	Point of Vertical Intersection of Grades (PVI)	159+70			(^{1})	50	55	0.29					
C2	Tangent/Spiral	160+25	200	3.75	19	22	27	0.29					
C2	Point of Vertical Tangent (PVT)	160+35	200	3.75	19	22	27	0.29	19.685	22.079	27.157	20.506	20.917
C2	>>> SIGNAL	160+90	200	3.75	19	22	27	0.29	19.685	22.079	27.157	20.506	20.917
C2	Spiral/Curve	160+90	200	3.75	19	22	27	0.29	19.685	22.079	27.157	20.506	20.917
C2	Curve/Spiral	162+67	200	3.75	19	22	27	0.29	19.685	22.079	27.157	20.506	20.917
C2	Point of Vertical Curve (PVC)	162+38	200	3.75	19	22	27	0.29	19.685	22.079	27.157	20.506	20.917
C2	Spiral/Curve	162+84	235	3.5	20	23	29	0.29	20.991	23.625	29.187	21.895	22.347
C2	Point of Vertical Intersection of Grades (PVI)	163+08	235	3.5	20	23	29	-2.53	20.991	23.625	29.187	21.895	22.347
C2	Curve/Spiral	163+51	235	3.5	20	23	29	-2.53	20.991	23.625	29.187	21.895	22.347
C2	Point of Vertical Tangent (PVT)	163+78	235	3.5	20	23	29	-2.53	20.991	23.625	29.187	21.895	22.347
C2	Spiral/Tangent	163+86	235	3.5	20	23	29	-2.53	20.991	23.625	29.187	21.895	22.347
C2	>>> SIGNAL	164+26			(^{1})	50	55	-2.53					
C2	Point of Vertical Curve (PVC)	164+35			(^{1})	50	55	-2.53					
C2	>>> S.E.PLATFORM	164+61			(^{1})	50	55	-2.53					
C2	Point of Vertical Intersection of Grades (PVI)	165+00			(^{1})	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	165+65			(^{1})	50	55	0.00					
C2	>>> SIGNAL	166+60			(^{1})	50	55	0.00					
C2	T: QUEENSBORO PLAZA	166+93			(^{1})	50	55	0.00					
C2	>>> SIGNAL C2-1681	168+92			(^{1})	50	55	0.00					
C2	Tangent/Spiral	170+14	630	0	25	30	41	0.00	25.100	30.741	41.623	27.092	28.062
C2	>>> N.E.PLATFORM	170+21	630	0	25	30	41	0.00	25.100	30.741	41.623	27.092	28.062
C2	>>> SIGNAL C2-1691	170+31	630	0	25	30	41	0.00	25.100	30.741	41.623	27.092	28.062
C2	Spiral/Curve	170+43	630	0	25	30	41	0.00	25.100	30.741	41.623	27.092	28.062
C2	Start >>> TURNOUT	170+49	630	0	25	30	41	0.00	25.100	30.741	41.623	27.092	28.062
C2	Curve/Spiral	170+54	630	0	25	30	41	0.00	25.100	30.741	41.623	27.092	28.062
C2	End >>> TURNOUT (52)	171+01	630	0	25	30	41	0.00	25.100	30.741	41.623	27.092	28.062
C2	Spiral/Tangent	171+13	630	0	25	30	41	0.00	25.100	30.741	41.623	27.092	28.062
C2	Start >>> TURNOUT	172+06			(^{1})	50	55	0.00					
C2	Tangent/Spiral	172+80	1760	1.25	48	50	55	0.00	48.062	56.480	73.417	50.994	52.440
C2	End >>> TURNOUT (78)	172+84	1760	1.25	48	50	55	0.00	48.062	56.480	73.417	50.994	52.440
C2	Spiral/Curve	173+01	1760	1.25	48	50	55	0.00	48.062	56.480	73.417	50.994	52.440
C2	Point of Vertical Curve (PVC)	173+30	1760	1.25	48	50	55	0.00	48.062	56.480	73.417	50.994	52.440
C2	Point of Vertical Intersection of Grades (PVI)	173+95	1760	1.25	48	50	55	0.95	48.062	56.480	73.417	50.994	52.440
C2	Point of Vertical Tangent (PVT)	174+60	1760	1.25	48	50	55	0.95	48.062	56.480	73.417	50.994	52.440
C2	Curve/Spiral	174+91	1760	1.25	48	50	55	0.95	48.062	56.480	73.417	50.994	52.440
C2	Spiral/Curve	175+07	905	1.25	34	40	52	0.95	34.465	40.501	52.646	36.567	37.604
C2	Curve/Spiral	175+88	905	1.25	34	40	52	0.95	34.465	40.501	52.646	36.567	37.604
C2	Point of Vertical Curve (PVC)	175+75	905	1.25	34	40	52	0.95	34.465	40.501	52.646	36.567	37.604
C2	>>> SIGNAL C2-1751	176+01	905	1.25	34	40	52	0.95	34.465	40.501	52.646	36.567	37.604
C2	Point of Vertical Intersection of Grades (PVI)	176+25	905	1.25	34	40	52	0.00	34.465	40.501	52.646	36.567	37.604
C2	Point of Vertical Tangent (PVT)	176+75	905	1.25	34	40	52	0.00	34.465	40.501	52.646	36.567	37.604
C2	Spiral/Tangent	177+59	905	1.25	34	40	52	0.00	34.465	40.501	52.646	36.567	37.604
C2	>>> SIGNAL C2-1791	180+02			(^{1})	50	55	0.00					
C2	Start >>> TURNOUT	181+52			(^{1})	50	55	0.00					
C2	End >>> TURNOUT (70)	182+22			(^{1})	50	55	0.00					
C2	Start >>> TURNOUT	183+57			(^{1})	50	55	0.00					
C2	Point of Vertical Curve (PVC)	184+13			(^{1})	50	55	0.00					
C2	End >>> TURNOUT (83)	184+40			(^{1})	50	55	0.00					
C2	Point of Vertical Intersection of Grades (PVI)	185+13			(^{1})	50	55	2.92					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C2	Point of Vertical Tangent (PVT)	186+13			(1)	50	55	2.92					
C2	>>> SIGNAL C2-1851	186+15			(1)	50	55	2.92					
C2	Point of Vertical Curve (PVC)	186+60			(1)	50	55	2.92					
C2	Point of Vertical Intersection of Grades (PVI)	187+60			(1)	50	55	-3.31					
C2	Start >>> TURNOUT	187+93			(1)	50	55	-3.31					
C2	Point of Vertical Tangent (PVT)	188+60			(1)	50	55	-3.31					
C2	Tangent/Spiral	188+70	1170	0.25	35	42	55	-3.31	35.258	42.757	57.364	37.897	39.187
C2	End >>> TURNOUT (106)	188+99	1170	0.25	35	42	55	-3.31	35.258	42.757	57.364	37.897	39.187
C2	Spiral/Curve	189+21	1170	0.25	35	42	55	-3.31	35.258	42.757	57.364	37.897	39.187
C2	Curve/Spiral	189+64	1170	0.25	35	42	55	-3.31	35.258	42.757	57.364	37.897	39.187
C2	Point of Vertical Curve (PVC)	190+26	1170	0.25	35	42	55	-3.31	35.258	42.757	57.364	37.897	39.187
C2	Spiral/Curve	190+34	1115	0.25	34	41	55	-3.31	34.419	41.740	55.999	36.995	38.255
C2	Curve/Spiral	190+72	1115	0.25	34	41	55	-3.31	34.419	41.740	55.999	36.995	38.255
C2	Spiral/Tangent	191+08	1115	0.25	34	41	55	-3.31	34.419	41.740	55.999	36.995	38.255
C2	Point of Vertical Intersection of Grades (PVI)	192+26			(1)	50	55	1.62					
C2	>>> SIGNAL C2-1923	192+50			(1)	50	55	1.62					
C2	Point of Vertical Tangent (PVT)	194+26			(1)	50	55	1.62					
C2	Tangent/Spiral	194+50	515	4.25	32	36	44	1.62	32.591	36.328	44.311	33.870	34.510
C2	Point of Vertical Curve (PVC)	194+55	515	4.25	32	36	44	1.62	32.591	36.328	44.311	33.870	34.510
C2	Spiral/Curve	195+18	515	4.25	32	36	44	1.62	32.591	36.328	44.311	33.870	34.510
C2	Point of Vertical Intersection of Grades (PVI)	195+40	515	4.25	32	36	44	2.98	32.591	36.328	44.311	33.870	34.510
C2	>>> SIGNAL C2-1953	196+13	515	4.25	32	36	44	2.98	32.591	36.328	44.311	33.870	34.510
C2	Point of Vertical Tangent (PVT)	196+25	515	4.25	32	36	44	2.98	32.591	36.328	44.311	33.870	34.510
C2	Point of Vertical Curve (PVC)	198+00	515	4.25	32	36	44	2.98	32.591	36.328	44.311	33.870	34.510
C2	Curve/Spiral	198+27	515	4.25	32	36	44	2.98	32.591	36.328	44.311	33.870	34.510
C2	Spiral/Tangent	199+19	515	4.25	32	36	44	2.98	32.591	36.328	44.311	33.870	34.510
C2	Point of Vertical Intersection of Grades (PVI)	199+45			(1)	50	55	0.53					
C2	>>> SIGNAL C2-1993	199+52			(1)	50	55	0.53					
C2	>>> S.E.PLATFORM	199+74			(1)	50	55	0.53					
C2	Point of Vertical Tangent (PVT)	200+90			(1)	50	55	0.53					
C2	T: 33RD ST. -RAWSON ST.	203+84			(1)	50	55	0.53					
C2	Point of Vertical Curve (PVC)	204+30			(1)	50	55	0.53					
C2	Point of Vertical Intersection of Grades (PVI)	205+10			(1)	50	55	1.69					
C2	>>> N.E.PLATFORM	205+78			(1)	50	55	1.69					
C2	Point of Vertical Tangent (PVT)	205+90			(1)	50	55	1.69					
C2	>>> SIGNAL C2-2053	205+98			(1)	50	55	1.69					
C2	Point of Vertical Curve (PVC)	211+60			(1)	50	55	1.69					
C2	Point of Vertical Intersection of Grades (PVI)	212+30			(1)	50	55	3.02					
C2	Point of Vertical Tangent (PVT)	213+00			(1)	50	55	3.02					
C2	>>> SIGNAL C2-2153	216+17			(1)	50	55	3.02					
C2	Point of Vertical Curve (PVC)	217+65			(1)	50	55	3.02					
C2	Point of Vertical Intersection of Grades (PVI)	218+95			(1)	50	55	0.52					
C2	>>> SIGNAL C2-2183	219+18			(1)	50	55	0.52					
C2	>>> S.E.PLATFORM	219+31			(1)	50	55	0.52					
C2	Point of Vertical Tangent (PVT)	220+25			(1)	50	55	0.52					
C2	T: 40TH ST. -LOWERY ST.	222+16			(1)	50	55	0.52					
C2	Point of Vertical Curve (PVC)	223+56			(1)	50	55	0.52					
C2	Point of Vertical Intersection of Grades (PVI)	224+56			(1)	50	55	-1.46					
C2	>>> N.E.PLATFORM	225+33			(1)	50	55	-1.46					
C2	>>> SIGNAL C2-2243	225+47			(1)	50	55	-1.46					
C2	Point of Vertical Tangent (PVT)	225+56			(1)	50	55	-1.46					
C2	Point of Vertical Curve (PVC)	228+15			(1)	50	55	-1.46					
C2	Point of Vertical Intersection of Grades (PVI)	229+55			(1)	50	55	1.26					
C2	Point of Vertical Tangent (PVT)	230+95			(1)	50	55	1.26					
C2	>>> SIGNAL C2-2303	231+07			(1)	50	55	1.26					
C2	>>> SIGNAL C2-2323	233+05			(1)	50	55	1.26					
C2	>>> SIGNAL C2-2343	235+10			(1)	50	55	1.26					
C2	>>> S.E.PLATFORM	235+10			(1)	50	55	1.26					
C2	Point of Vertical Curve (PVC)	235+22			(1)	50	55	1.26					
C2	Point of Vertical Intersection of Grades (PVI)	235+87			(1)	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	236+52			(1)	50	55	0.00					
C2	T: 46TH ST. -BLISS ST.	237+81			(1)	50	55	0.00					
C2	>>> N.E.PLATFORM	241+05			(1)	50	55	0.00					
C2	>>> SIGNAL C2-2403	241+67			(1)	50	55	0.00					
C2	Tangent/Spiral	241+72	510	4.375	32	36	44	0.00	32.677	36.370	44.275	33.941	34.573

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C2	Spiral/Curve	242+16	510	4.375	32	36	44	0.00	32.677	36.370	44.275	33.941	34.573
C2	Curve/Spiral	244+34	510	4.375	32	36	44	0.00	32.677	36.370	44.275	33.941	34.573
C2	Spiral/Tangent	245+14	510	4.375	32	36	44	0.00	32.677	36.370	44.275	33.941	34.573
C2	Point of Vertical Curve (PVC)	246+48			(1)	50	55	0.00					
C2	Point of Vertical Intersection of Grades (PVI)	247+38			(1)	50	55	3.05					
C2	Point of Vertical Tangent (PVT)	248+28			(1)	50	55	3.05					
C2	>>> SIGNAL C2-2483	249+12			(1)	50	55	3.05					
C2	REFLECTOR TAG	251+98			(1)	50	55	3.05					
C2	>>> SIGNAL C2-2513	252+11			(1)	50	55	3.05					
C2	Point of Vertical Curve (PVC)	252+12			(1)	50	55	3.05					
C2	>>> S.E.PLATFORM	252+39			(1)	50	55	3.05					
C2	Point of Vertical Intersection of Grades (PVI)	252+87			(1)	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	253+62			(1)	50	55	0.00					
C2	T: 52ND ST. - LINCOLN AVE.	254+71			(1)	50	55	0.00					
C2	>>> N.E.PLATFORM	258+03			(1)	50	55	0.00					
C2	Point of Vertical Curve (PVC)	259+31			(1)	50	55	0.00					
C2	>>> SIGNAL C2-2583	259+37			(1)	50	55	0.00					
C2	Tangent/Spiral	259+60	2290	1	(1)	50	55	0.00	53.502	63.305	82.885	56.924	58.609
C2	Spiral/Curve	260+24	2290	1	(1)	50	55	0.00	53.502	63.305	82.885	56.924	58.609
C2	Point of Vertical Intersection of Grades (PVI)	260+86	2290	1	(1)	50	55	-3.00	53.502	63.305	82.885	56.924	58.609
C2	Point of Vertical Tangent (PVT)	262+41	2290	1	(1)	50	55	-3.00	53.502	63.305	82.885	56.924	58.609
C2	Curve/Spiral	263+25	2290	1	(1)	50	55	-3.00	53.502	63.305	82.885	56.924	58.609
C2	Spiral/Tangent	263+65	2290	1	(1)	50	55	-3.00	53.502	63.305	82.885	56.924	58.609
C2	>>> SIGNAL C2-2673	267+99			(1)	50	55	-3.00					
C2	Tangent/Spiral	269+05	1075	3	43	49	55	-3.00	43.373	49.181	61.339	45.372	46.368
C2	Point of Vertical Curve (PVC)	269+67	1075	3	43	49	55	-3.00	43.373	49.181	61.339	45.372	46.368
C2	Point of Vertical Intersection of Grades (PVI)	269+82	1075	3	43	49	55	-2.79	43.373	49.181	61.339	45.372	46.368
C2	Point of Vertical Tangent (PVT)	269+97	1075	3	43	49	55	-2.79	43.373	49.181	61.339	45.372	46.368
C2	>>> SIGNAL C2-2703	270+99	1075	3	43	49	55	-2.79	43.373	49.181	61.339	45.372	46.368
C2	Spiral/Curve	271+04	1075	3	43	49	55	-2.79	43.373	49.181	61.339	45.372	46.368
C2	Point of Vertical Curve (PVC)	271+40	1075	3	43	49	55	-2.79	43.373	49.181	61.339	45.372	46.368
C2	Curve/Spiral	271+48	1075	3	43	49	55	-2.79	43.373	49.181	61.339	45.372	46.368
C2	Point of Vertical Intersection of Grades (PVI)	272+90	1075	3	43	49	55	0.00	43.373	49.181	61.339	45.372	46.368
C2	Spiral/Tangent	273+88	1075	3	43	49	55	0.00	43.373	49.181	61.339	45.372	46.368
C2	Tangent/Spiral	274+28	1950	1	49	50	55	0.00	49.371	58.417	76.485	52.529	54.083
C2	Point of Vertical Tangent (PVT)	274+40	1950	1	49	50	55	0.00	49.371	58.417	76.485	52.529	54.083
C2	>>> SIGNAL C2-2733	274+57	1950	1	49	50	55	0.00	49.371	58.417	76.485	52.529	54.083
C2	Spiral/Curve	275+42	1950	1	49	50	55	0.00	49.371	58.417	76.485	52.529	54.083
C2	Curve/Spiral	277+18	1950	1	49	50	55	0.00	49.371	58.417	76.485	52.529	54.083
C2	>>> SIGNAL C2-2763	277+26	1950	1	49	50	55	0.00	49.371	58.417	76.485	52.529	54.083
C2	Spiral/Tangent	277+82	1950	1	49	50	55	0.00	49.371	58.417	76.485	52.529	54.083
C2	Tangent/Spiral	278+05	910	0.5	31	38	51	0.00	31.996	38.455	51.149	34.262	35.373
C2	Spiral/Curve	278+43	910	0.5	31	38	51	0.00	31.996	38.455	51.149	34.262	35.373
C2	Curve/Spiral	278+70	910	0.5	31	38	51	0.00	31.996	38.455	51.149	34.262	35.373
C2	>>> SIGNAL C2-2783	279+56	910	0.5	31	38	51	0.00	31.996	38.455	51.149	34.262	35.373
C2	>>> S.E.PLATFORM	279+81	910	0.5	31	38	51	0.00	31.996	38.455	51.149	34.262	35.373
C2	Spiral/Curve	279+94	1135	1	37	44	55	0.00	37.666	44.567	58.352	40.075	41.261
C2	Curve/Spiral	280+30	1135	1	37	44	55	0.00	37.666	44.567	58.352	40.075	41.261
C2	Spiral/Tangent	280+89	1135	1	37	44	55	0.00	37.666	44.567	58.352	40.075	41.261
C2	>>> SIGNAL C2-2813	281+88			(1)	50	55	0.00					
C2	T: 61ST ST - ROOSEVELT AV.	284+85			(1)	50	55	0.00					
C2	>>> N.E.PLATFORM	285+50			(1)	50	55	0.00					
C2	Point of Vertical Curve (PVC)	285+59			(1)	50	55	0.00					
C2	Tangent/Spiral	285+65	2365	0	48	50	55	0.00	48.631	59.561	80.646	52.490	54.371
C2	>>> SIGNAL C2-2853	285+90	2365	0	48	50	55	0.00	48.631	59.561	80.646	52.490	54.371
C2	Point of Vertical Intersection of Grades (PVI)	286+14	2365	0	48	50	55	-2.98	48.631	59.561	80.646	52.490	54.371
C2	Spiral/Curve	286+21	2365	0	48	50	55	-2.98	48.631	59.561	80.646	52.490	54.371
C2	Point of Vertical Tangent (PVT)	286+69	2365	0	48	50	55	-2.98	48.631	59.561	80.646	52.490	54.371
C2	Curve/Spiral	287+15	2365	0	48	50	55	-2.98	48.631	59.561	80.646	52.490	54.371
C2	Spiral/Curve	288+19	2770	0.5	(1)	50	55	-2.98	55.823	67.091	89.240	59.777	61.715
C2	Curve/Spiral	289+54	2770	0.5	(1)	50	55	-2.98	55.823	67.091	89.240	59.777	61.715
C2	Spiral/Tangent	289+67	2770	0.5	(1)	50	55	-2.98	55.823	67.091	89.240	59.777	61.715
C2	Point of Vertical Curve (PVC)	290+81			(1)	50	55	-2.98					
C2	>>> SIGNAL C2-2903	291+31			(1)	50	55	-2.98					
C2	>>> SIGNAL C2-2913	292+68			(1)	50	55	-2.98					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	Event	True Stationing	RADIUS (ft.)	SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C2	Point of Vertical Intersection of Grades (PVI)	293+21			(1)	50	55	1.65					
C2	Point of Vertical Tangent (PVT)	295+61			(1)	50	55	1.65					
C2	>>> SIGNAL C2-2953	296+15			(1)	50	55	1.65					
C2	Point of Vertical Curve (PVC)	296+70			(1)	50	55	1.65					
C2	Point of Vertical Intersection of Grades (PVI)	297+80			(1)	50	55	0.00					
C2	>>> SIGNAL C2-2973	298+16			(1)	50	55	0.00					
C2	>>> S.E.PLATFORM	298+29			(1)	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	298+90			(1)	50	55	0.00					
C2	T: 69TH ST. - FISK AVE.	300+27			(1)	50	55	0.00					
C2	Point of Vertical Curve (PVC)	303+74			(1)	50	55	0.00					
C2	>>> N.E.PLATFORM	303+95			(1)	50	55	0.00					
C2	>>> SIGNAL C2-3033	304+29			(1)	50	55	0.00					
C2	Point of Vertical Intersection of Grades (PVI)	304+74			(1)	50	55	1.76					
C2	Point of Vertical Tangent (PVT)	305+74			(1)	50	55	1.76					
C2	Start >>> TURNOUT	308+42			(1)	50	55	1.76					
C2	End >>> TURNOUT (93)	309+35			(1)	50	55	1.76					
C2	>>> SIGNAL C2-3083	309+87			(1)	50	55	1.76					
C2	Point of Vertical Curve (PVC)	310+25			(1)	50	55	1.76					
C2	Point of Vertical Intersection of Grades (PVI)	311+15			(1)	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	312+05			(1)	50	55	0.00					
C2	>>> SIGNAL C2-3113	312+13			(1)	50	55	0.00					
C2	>>> S.E.PLATFORM	312+25			(1)	50	55	0.00					
C2	T: 74TH ST. B'DWY	314+14			(1)	50	55	0.00					
C2	Point of Vertical Curve (PVC)	317+85			(1)	50	55	0.00					
C2	>>> N.E.PLATFORM	318+02			(1)	50	55	0.00					
C2	>>> SIGNAL C2-3173	318+20			(1)	50	55	0.00					
C2	Point of Vertical Intersection of Grades (PVI)	318+55			(1)	50	55	-1.20					
C2	Start >>> TURNOUT	318+71			(1)	50	55	-1.20					
C2	Point of Vertical Tangent (PVT)	319+25			(1)	50	55	-1.20					
C2	End >>> TURNOUT (91)	319+62			(1)	50	55	-1.20					
C2	REFLECTOR TAG	321+64			(1)	50	55	-1.20					
C2	REFLECTOR TAG	323+12			(1)	50	55	-1.20					
C2	Point of Vertical Curve (PVC)	326+05			(1)	50	55	-1.20					
C2	Point of Vertical Intersection of Grades (PVI)	327+55			(1)	50	55	1.74					
C2	>>> SIGNAL C2-3263	327+91			(1)	50	55	1.74					
C2	REFLECTOR TAG	327+93			(1)	50	55	1.74					
C2	Point of Vertical Tangent (PVT)	329+05			(1)	50	55	1.74					
C2	REFLECTOR TAG	330+83			(1)	50	55	1.74					
C2	>>> SIGNAL C2-3293	330+91			(1)	50	55	1.74					
C2	Point of Vertical Curve (PVC)	331+94			(1)	50	55	1.74					
C2	Point of Vertical Intersection of Grades (PVI)	332+89			(1)	50	55	0.00					
C2	REFLECTOR TAG	333+15			(1)	50	55	0.00					
C2	>>> SIGNAL C2-3323	333+23			(1)	50	55	0.00					
C2	>>> S.E.PLATFORM	333+69			(1)	50	55	0.00					
C2	REFLECTOR TAG	333+70			(1)	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	333+84			(1)	50	55	0.00					
C2	T: 82ND ST. - JACKSON HEIGHTS	335+33			(1)	50	55	0.00					
C2	REFLECTOR TAG	335+86			(1)	50	55	0.00					
C2	REFLECTOR TAG	337+82			(1)	50	55	0.00					
C2	Point of Vertical Curve (PVC)	339+03			(1)	50	55	0.00					
C2	>>> N.E.PLATFORM	339+35			(1)	50	55	0.00					
C2	Point of Vertical Intersection of Grades (PVI)	339+43			(1)	50	55	-0.68					
C2	REFLECTOR TAG	339+69			(1)	50	55	-0.68					
C2	>>> SIGNAL C2-3383	339+82			(1)	50	55	-0.68					
C2	Point of Vertical Tangent (PVT)	339+83			(1)	50	55	-0.68					
C2	REFLECTOR TAG	341+43			(1)	50	55	-0.68					
C2	REFLECTOR TAG	348+01			(1)	50	55	-0.68					
C2	>>> SIGNAL C2-3473	348+05			(1)	50	55	-0.68					
C2	Point of Vertical Curve (PVC)	348+50			(1)	50	55	-0.68					
C2	Point of Vertical Intersection of Grades (PVI)	349+25			(1)	50	55	0.71					
C2	Point of Vertical Tangent (PVT)	350+00			(1)	50	55	0.71					
C2	REFLECTOR TAG	350+64			(1)	50	55	0.71					
C2	>>> SIGNAL C2-3493	350+66			(1)	50	55	0.71					
C2	REFLECTOR TAG	352+97			(1)	50	55	0.71					
C2	>>> SIGNAL C2-3513	353+01			(1)	50	55	0.71					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C2	Point of Vertical Curve (PVC)	353+11			(1)	50	55	0.71					
C2	>>> S.E.PLATFORM	353+52			(1)	50	55	0.71					
C2	REFLECTOR TAG	353+57			(1)	50	55	0.71					
C2	Point of Vertical Intersection of Grades (PVI)	353+91			(1)	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	354+71			(1)	50	55	0.00					
C2	REFLECTOR TAG	356+60			(1)	50	55	0.00					
C2	REFLECTOR TAG	357+74			(1)	50	55	0.00					
C2	T: 90TH ST. - ELMHURST AVE.	358+43			(1)	50	55	0.00					
C2	Point of Vertical Curve (PVC)	359+24			(1)	50	55	0.00					
C2	>>> N.E.PLATFORM	359+25			(1)	50	55	0.00					
C2	>>> SIGNAL C2-3583	359+90			(1)	50	55	0.00					
C2	Point of Vertical Intersection of Grades (PVI)	360+24			(1)	50	55	-1.17					
C2	Point of Vertical Tangent (PVT)	361+24			(1)	50	55	-1.17					
C2	REFLECTOR TAG	361+74			(1)	50	55	-1.17					
C2	Point of Vertical Curve (PVC)	364+07			(1)	50	55	-1.17					
C2	Point of Vertical Intersection of Grades (PVI)	365+37			(1)	50	55	1.22					
C2	Point of Vertical Tangent (PVT)	366+67			(1)	50	55	1.22					
C2	REFLECTOR TAG	367+13			(1)	50	55	1.22					
C2	REFLECTOR TAG	369+17			(1)	50	55	1.22					
C2	>>> SIGNAL C2-3683	369+26			(1)	50	55	1.22					
C2	Tangent/Spiral	370+22	2120	0.75	(1)	50	55	1.22	50.173	59.810	78.912	53.545	55.202
C2	REFLECTOR TAG	371+18	2120	0.75	(1)	50	55	1.22	50.173	59.810	78.912	53.545	55.202
C2	>>> SIGNAL C2-3703	371+26	2120	0.75	(1)	50	55	1.22	50.173	59.810	78.912	53.545	55.202
C2	Spiral/Curve	371+35	2120	0.75	(1)	50	55	1.22	50.173	59.810	78.912	53.545	55.202
C2	Curve/Spiral	371+88	2120	0.75	(1)	50	55	1.22	50.173	59.810	78.912	53.545	55.202
C2	Point of Vertical Curve (PVC)	373+04	2120	0.75	(1)	50	55	1.22	50.173	59.810	78.912	53.545	55.202
C2	>>> SIGNAL C2-3723	373+11	2120	0.75	(1)	50	55	1.22	50.173	59.810	78.912	53.545	55.202
C2	Spiral/Curve	373+18	1440	1	42	50	55	1.22	42.426	50.200	65.727	45.140	46.476
C2	REFLECTOR TAG	373+36	1440	1	42	50	55	1.22	42.426	50.200	65.727	45.140	46.476
C2	>>> S.E.PLATFORM	373+49	1440	1	42	50	55	1.22	42.426	50.200	65.727	45.140	46.476
C2	Curve/Spiral	373+53	1440	1	42	50	55	1.22	42.426	50.200	65.727	45.140	46.476
C2	Point of Vertical Intersection of Grades (PVI)	373+64	1440	1	42	50	55	0.00	42.426	50.200	65.727	45.140	46.476
C2	Point of Vertical Tangent (PVT)	374+24	1440	1	42	50	55	0.00	42.426	50.200	65.727	45.140	46.476
C2	Spiral/Tangent	374+24	1440	1	42	50	55	0.00	42.426	50.200	65.727	45.140	46.476
C2	REFLECTOR TAG	375+47			(1)	50	55	0.00					
C2	>>> SIGNAL C2-3743	375+53			(1)	50	55	0.00					
C2	REFLECTOR TAG	377+57			(1)	50	55	0.00					
C2	>>> N.E.PLATFORM	379+16			(1)	50	55	0.00					
C2	Tangent/Spiral	379+26	1975	1	49	50	55	0.00	49.687	58.790	76.974	52.864	54.429
C2	REFLECTOR TAG	379+27	1975	1	49	50	55	0.00	49.687	58.790	76.974	52.864	54.429
C2	>>> SIGNAL C2-3783	379+74	1975	1	49	50	55	0.00	49.687	58.790	76.974	52.864	54.429
C2	Spiral/Curve	379+89	1975	1	49	50	55	0.00	49.687	58.790	76.974	52.864	54.429
C2	Curve/Spiral	380+62	1975	1	49	50	55	0.00	49.687	58.790	76.974	52.864	54.429
C2	Spiral/Tangent	380+82	1975	1	49	50	55	0.00	49.687	58.790	76.974	52.864	54.429
C2	REFLECTOR TAG	380+88			(1)	50	55	0.00					
C2	Point of Vertical Curve (PVC)	380+95			(1)	50	55	0.00					
C2	Tangent/Spiral	381+23	2120	0.75	(1)	50	55	0.00	50.173	59.810	78.912	53.545	55.202
C2	Spiral/Curve	381+79	2120	0.75	(1)	50	55	0.00	50.173	59.810	78.912	53.545	55.202
C2	REFLECTOR TAG	381+84	2120	0.75	(1)	50	55	0.00	50.173	59.810	78.912	53.545	55.202
C2	Point of Vertical Intersection of Grades (PVI)	381+95	2120	0.75	(1)	50	55	-1.64	50.173	59.810	78.912	53.545	55.202
C2	Curve/Spiral	382+47	2120	0.75	(1)	50	55	-1.64	50.173	59.810	78.912	53.545	55.202
C2	Point of Vertical Tangent (PVT)	382+95	2120	0.75	(1)	50	55	-1.64	50.173	59.810	78.912	53.545	55.202
C2	Spiral/Tangent	383+42	2120	0.75	(1)	50	55	-1.64	50.173	59.810	78.912	53.545	55.202
C2	REFLECTOR TAG	386+34			(1)	50	55	-1.64					
C2	REFLECTOR TAG	387+74			(1)	50	55	-1.64					
C2	>>> SIGNAL C2-3863	387+79			(1)	50	55	-1.64					
C2	REFLECTOR TAG	389+72			(1)	50	55	-1.64					
C2	>>> SIGNAL C2-3883	389+73			(1)	50	55	-1.64					
C2	Point of Vertical Curve (PVC)	391+59			(1)	50	55	-1.64					
C2	REFLECTOR TAG	392+14			(1)	50	55	-1.64					
C2	>>> SIGNAL C2-3913	392+21			(1)	50	55	-1.64					
C2	Point of Vertical Intersection of Grades (PVI)	392+54			(1)	50	55	0.00					
C2	>>> S.E.PLATFORM	392+79			(1)	50	55	0.00					
C2	REFLECTOR TAG	392+83			(1)	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	393+49			(1)	50	55	0.00					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C2	T: 103RD ST. - CORONA PLAZA	394+67			(1)	50	55	0.00					
C2	Tangent/Spiral	397+99	1780	2.75	(1)	50	55	0.00	54.806	62.400	78.222	57.423	58.726
C2	>>> N.E.PLATFORM	398+50	1780	2.75	(1)	50	55	0.00	54.806	62.400	78.222	57.423	58.726
C2	REFLECTOR TAG	398+67	1780	2.75	(1)	50	55	0.00	54.806	62.400	78.222	57.423	58.726
C2	Point of Vertical Curve (PVC)	398+76	1780	2.75	(1)	50	55	0.00	54.806	62.400	78.222	57.423	58.726
C2	Spiral/Curve	398+91	1780	2.75	(1)	50	55	0.00	54.806	62.400	78.222	57.423	58.726
C2	>>> SIGNAL C2-3983	399+12	1780	2.75	(1)	50	55	0.00	54.806	62.400	78.222	57.423	58.726
C2	Point of Vertical Intersection of Grades (PVI)	399+29	1780	2.75	(1)	50	55	0.26	54.806	62.400	78.222	57.423	58.726
C2	Point of Vertical Tangent (PVT)	399+82	1780	2.75	(1)	50	55	0.26	54.806	62.400	78.222	57.423	58.726
C2	REFLECTOR TAG	400+81	1780	2.75	(1)	50	55	0.26	54.806	62.400	78.222	57.423	58.726
C2	Curve/Spiral	402+77	1780	2.75	(1)	50	55	0.26	54.806	62.400	78.222	57.423	58.726
C2	Spiral/Tangent	403+38	1780	2.75	(1)	50	55	0.26	54.806	62.400	78.222	57.423	58.726
C2	REFLECTOR TAG	409+97			(1)	50	55	0.26					
C2	>>> SIGNAL C2-4093	409+99			(1)	50	55	0.26					
C2	Point of Vertical Curve (PVC)	410+40			(1)	50	55	0.26					
C2	Point of Vertical Intersection of Grades (PVI)	411+00			(1)	50	55	-0.47					
C2	Point of Vertical Tangent (PVT)	411+60			(1)	50	55	-0.47					
C2	REFLECTOR TAG	412+31			(1)	50	55	-0.47					
C2	>>> SIGNAL C2-4113	412+35			(1)	50	55	-0.47					
C2	>>> SIGNAL C2-4123	414+09			(1)	50	55	-0.47					
C2	REFLECTOR TAG	414+11			(1)	50	55	-0.47					
C2	>>> S.E.PLATFORM	414+32			(1)	50	55	-0.47					
C2	REFLECTOR TAG	415+45			(1)	50	55	-0.47					
C2	REFLECTOR TAG	416+11			(1)	50	55	-0.47					
C2	T: 111TH ST.	417+67			(1)	50	55	-0.47					
C2	REFLECTOR TAG	419+21			(1)	50	55	-0.47					
C2	Point of Vertical Curve (PVC)	419+38			(1)	50	55	-0.47					
C2	Point of Vertical Intersection of Grades (PVI)	419+82			(1)	50	55	-1.32					
C2	>>> N.E.PLATFORM	420+04			(1)	50	55	-1.32					
C2	Point of Vertical Tangent (PVT)	420+26			(1)	50	55	-1.32					
C2	>>> SIGNAL C2-4193	420+32			(1)	50	55	-1.32					
C2	REFLECTOR TAG	420+37			(1)	50	55	-1.32					
C2	Point of Vertical Curve (PVC)	420+43			(1)	50	55	-1.32					
C2	Start >>> TURNOUT	420+52			(1)	50	55	-1.32					
C2	Point of Vertical Intersection of Grades (PVI)	420+89			(1)	50	55	-2.75					
C2	End >>> TURNOUT (50)	421+02			(1)	50	55	-2.75					
C2	Start >>> TURNOUT	421+28			(1)	50	55	-2.75					
C2	Point of Vertical Tangent (PVT)	421+35			(1)	50	55	-2.75					
C2	End >>> TURNOUT (53)	421+81			(1)	50	55	-2.75					
C2	Point of Vertical Curve (PVC)	421+92			(1)	50	55	-2.75					
C2	REFLECTOR TAG	422+19			(1)	50	55	-2.75					
C2	Point of Vertical Intersection of Grades (PVI)	422+97			(1)	50	55	2.93					
C2	Point of Vertical Tangent (PVT)	424+02			(1)	50	55	2.93					
C2	REFLECTOR TAG	424+76			(1)	50	55	2.93					
C2	Point of Vertical Curve (PVC)	425+44			(1)	50	55	2.93					
C2	Point of Vertical Intersection of Grades (PVI)	426+39			(1)	50	55	-2.98					
C2	Point of Vertical Tangent (PVT)	427+34			(1)	50	55	-2.98					
C2	REFLECTOR TAG	429+94			(1)	50	55	-2.98					
C2	REFLECTOR TAG	432+20			(1)	50	55	-2.98					
C2	>>> SIGNAL C2-4313	432+26			(1)	50	55	-2.98					
C2	REFLECTOR TAG	434+35			(1)	50	55	-2.98					
C2	>>> SIGNAL C2-4333	434+38			(1)	50	55	-2.98					
C2	REFLECTOR TAG	436+41			(1)	50	55	-2.98					
C2	>>> SIGNAL C2-4353	436+47			(1)	50	55	-2.98					
C2	Point of Vertical Intersection of Grades (PVI)	437+29			(1)	50	55	-0.51					
C2	>>> SIGNAL C2-4363	437+56			(1)	50	55	-0.51					
C2	REFLECTOR TAG	437+59			(1)	50	55	-0.51					
C2	Point of Vertical Tangent (PVT)	437+99			(1)	50	55	-0.51					
C2	Start >>> TURNOUT	439+74			(1)	50	55	-0.51					
C2	End >>> TURNOUT (56)	440+30			(1)	50	55	-0.51					
C2	Tangent/Spiral	440+32	920	0	30	37	50	-0.51	30.332	37.148	50.299	32.738	33.912
C2	Spiral/Curve	440+63	920	0	30	37	50	-0.51	30.332	37.148	50.299	32.738	33.912
C2	>>> SIGNAL C2-4393	440+74	920	0	30	37	50	-0.51	30.332	37.148	50.299	32.738	33.912
C2	Curve/Spiral	440+76	920	0	30	37	50	-0.51	30.332	37.148	50.299	32.738	33.912
C2	Start >>> TURNOUT	440+99	Sw. 723B	#6 Tangential	16	22.5	27	-0.51					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	Event	True Stationing	RADIUS (ft.)	SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
C2	Spiral/Curve	441+43	Sw. 723B	#6 Tangential	16	22.5	27	-0.51					
C2	Curve/Spiral	441+56	Sw. 723B	#6 Tangential	16	22.5	27	-0.51					
C2	End >>> TURNOUT (70)	441+69	Sw. 723B	#6 Tangential	16	22.5	27	-0.51					
C2	Spiral/Curve	441+94	1060	1.75	39	45	55	-0.51	39.035	45.318	58.127	41.215	42.294
C2	Curve/Spiral	443+05	1060	1.75	39	45	55	-0.51	39.035	45.318	58.127	41.215	42.294
C2	>>> SIGNAL C2-4423	443+42	1060	1.75	39	45	55	-0.51	39.035	45.318	58.127	41.215	42.294
C2	Spiral/Tangent	443+44	1060	1.75	39	45	55	-0.51	39.035	45.318	58.127	41.215	42.294
C2	>>> S.E.PLATFORM	443+53			(1)	50	55	-0.51					
C2	>>> SIGNAL	445+57			(1)	50	55	-0.51					
C2	Point of Vertical Curve (PVC)	446+33			(1)	50	55	-0.51					
C2	Point of Vertical Intersection of Grades (PVI)	446+50			(1)	50	55	-0.35					
C2	Point of Vertical Tangent (PVT)	446+67			(1)	50	55	-0.35					
C2	Tangent/Spiral	448+38	1275	1	39	47	55	-0.35	39.922	47.236	61.847	42.475	43.732
C2	Point of Vertical Curve (PVC)	448+78	1275	1	39	47	55	-0.35	39.922	47.236	61.847	42.475	43.732
C2	T: WILLETS POINT	448+96	1275	1	39	47	55	-0.35	39.922	47.236	61.847	42.475	43.732
C2	>>> N.E.PLATFORM	449+13	1275	1	39	47	55	-0.35	39.922	47.236	61.847	42.475	43.732
C2	Point of Vertical Intersection of Grades (PVI)	449+26	1275	1	39	47	55	0.27	39.922	47.236	61.847	42.475	43.732
C2	>>> SIGNAL C2-4483	449+27	1275	1	39	47	55	0.27	39.922	47.236	61.847	42.475	43.732
C2	Spiral/Curve	449+30	1275	1	39	47	55	0.27	39.922	47.236	61.847	42.475	43.732
C2	Point of Vertical Tangent (PVT)	449+74	1275	1	39	47	55	0.27	39.922	47.236	61.847	42.475	43.732
C2	Curve/Spiral	450+01	1275	1	39	47	55	0.27	39.922	47.236	61.847	42.475	43.732
C2	Spiral/Curve	450+21	625	1	27	33	43	0.27	27.951	33.072	43.301	29.738	30.619
C2	Curve/Spiral	450+41	625	1	27	33	43	0.27	27.951	33.072	43.301	29.738	30.619
C2	Start >>> TURNOUT	450+86	625	1	27	33	43	0.27	27.951	33.072	43.301	29.738	30.619
C2	Spiral/Curve	451+06	Sw. 755B	#6 Tangential	16	22.5	27	0.27					
C2	Curve/Spiral	451+25	Sw. 755B	#6 Tangential	16	22.5	27	0.27					
C2	End >>> TURNOUT (68)	451+54	Sw. 755B	#6 Tangential	16	22.5	27	0.27					
C2	Point of Vertical Curve (PVC)	451+63	Sw. 755B	#6 Tangential	16	22.5	27	0.27					
C2	Spiral/Tangent	451+69	Sw. 755B	#6 Tangential	16	22.5	27	0.27					
C2	Point of Vertical Intersection of Grades (PVI)	451+83			(1)	50	55	0.09					
C2	Point of Vertical Tangent (PVT)	452+03			(1)	50	55	0.09					
C2	Point of Vertical Curve (PVC)	452+78			(1)	50	55	0.09					
C2	Point of Vertical Intersection of Grades (PVI)	453+68			(1)	50	55	2.89					
C2	Point of Vertical Tangent (PVT)	454+58			(1)	50	55	2.89					
C2	Point of Vertical Curve (PVC)	456+15			(1)	50	55	2.89					
C2	Point of Vertical Intersection of Grades (PVI)	456+43			(1)	50	55	3.30					
C2	Point of Vertical Tangent (PVT)	456+71			(1)	50	55	3.30					
C2	Tangent/Spiral	457+01	1430	2.5	48	50	55	3.30	48.205	55.125	69.471	50.593	51.781
C2	Point of Vertical Curve (PVC)	457+26	1430	2.5	48	50	55	3.30	48.205	55.125	69.471	50.593	51.781
C2	Spiral/Curve	457+78	1430	2.5	48	50	55	3.30	48.205	55.125	69.471	50.593	51.781
C2	Point of Vertical Intersection of Grades (PVI)	457+86	1430	2.5	48	50	55	0.52	48.205	55.125	69.471	50.593	51.781
C2	Point of Vertical Tangent (PVT)	458+46	1430	2.5	48	50	55	0.52	48.205	55.125	69.471	50.593	51.781
C2	Curve/Spiral	458+88	1430	2.5	48	50	55	0.52	48.205	55.125	69.471	50.593	51.781
C2	Spiral/Tangent	459+21	1430	2.5	48	50	55	0.52	48.205	55.125	69.471	50.593	51.781
C2	>>> SIGNAL C2-4583	459+59			(1)	50	55	0.52					
C2	Point of Vertical Curve (PVC)	465+03			(1)	50	55	0.52					
C2	Point of Vertical Intersection of Grades (PVI)	465+33			(1)	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	465+63			(1)	50	55	0.00					
C2	>>> SIGNAL C2-4643	465+88			(1)	50	55	0.00					
C2	Point of Vertical Curve (PVC)	468+84			(1)	50	55	0.00					
C2	Point of Vertical Intersection of Grades (PVI)	469+62			(1)	50	55	-3.30					
C2	Point of Vertical Tangent (PVT)	470+40			(1)	50	55	-3.30					
C2	Tangent/Spiral	471+36	1230	2.75	45	50	55	-3.30	45.559	51.871	65.024	47.734	48.817
C2	Point of Vertical Curve (PVC)	471+66	1230	2.75	45	50	55	-3.30	45.559	51.871	65.024	47.734	48.817
C2	Spiral/Curve	471+90	1230	2.75	45	50	55	-3.30	45.559	51.871	65.024	47.734	48.817
C2	Point of Vertical Intersection of Grades (PVI)	472+16	1230	2.75	45	50	55	-3.57	45.559	51.871	65.024	47.734	48.817
C2	>>> SIGNAL C2-4713	472+58	1230	2.75	45	50	55	-3.57	45.559	51.871	65.024	47.734	48.817
C2	Point of Vertical Tangent (PVT)	472+65	1230	2.75	45	50	55	-3.57	45.559	51.871	65.024	47.734	48.817
C2	Point of Vertical Curve (PVC)	473+90	1230	2.75	45	50	55	-3.57	45.559	51.871	65.024	47.734	48.817
C2	Point of Vertical Intersection of Grades (PVI)	474+15	1230	2.75	45	50	55	-3.92	45.559	51.871	65.024	47.734	48.817
C2	Point of Vertical Tangent (PVT)	474+40	1230	2.75	45	50	55	-3.92	45.559	51.871	65.024	47.734	48.817
C2	Curve/Spiral	474+65	1230	2.75	45	50	55	-3.92	45.559	51.871	65.024	47.734	48.817
C2	Spiral/Tangent	474+86	1230	2.75	45	50	55	-3.92	45.559	51.871	65.024	47.734	48.817
C2	Point of Vertical Curve (PVC)	475+03			(1)	50	55	-3.92					
C2	T: T1	475+08			(1)	50	55	-3.92					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
TRACK	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
C2	Point of Vertical Intersection of Grades (PVI)	475+41			(1)	50	55	-3.25					
C2	>>> SIGNAL C2-4743	475+66			(1)	50	55	-3.25					
C2	Point of Vertical Tangent (PVT)	475+79			(1)	50	55	-3.25					
C2	>>> SIGNAL C2-4763	477+85			(1)	50	55	-3.25					
C2	>>> PORTAL/ABUT.	479+12			(1)	50	55	-3.25					
C2	>>> SIGNAL C2-4783	479+79			(1)	50	55	-3.25					
C2	Tangent/Spiral	480+08	560	3	31	35	44	-3.25	31.305	35.496	44.272	32.748	33.466
C2	T: T2	480+27	560	3	31	35	44	-3.25	31.305	35.496	44.272	32.748	33.466
C2	Point of Vertical Curve (PVC)	480+71	560	3	31	35	44	-3.25	31.305	35.496	44.272	32.748	33.466
C2	Spiral/Curve	480+83	560	3	31	35	44	-3.25	31.305	35.496	44.272	32.748	33.466
C2	Curve/Spiral	481+23	560	3	31	35	44	-3.25	31.305	35.496	44.272	32.748	33.466
C2	Point of Vertical Intersection of Grades (PVI)	481+39	560	3	31	35	44	-2.01	31.305	35.496	44.272	32.748	33.466
C2	>>> SIGNAL C2-4803	481+59	560	3	31	35	44	-2.01	31.305	35.496	44.272	32.748	33.466
C2	Spiral/Tangent	481+78	560	3	31	35	44	-2.01	31.305	35.496	44.272	32.748	33.466
C2	Point of Vertical Tangent (PVT)	482+07			(1)	50	55	-2.01					
C2	>>> SIGNAL C2-4813	483+01			(1)	50	55	-2.01					
C2	T: T1	483+96			(1)	50	55	-2.01					
C2	Start >>> TURNOUT	483+96			(1)	50	55	-2.01					
C2	End >>> TURNOUT (68)	484+64			(1)	50	55	-2.01					
C2	Point of Vertical Curve (PVC)	486+16			(1)	50	55	-2.01					
C2	Point of Vertical Intersection of Grades (PVI)	486+94			(1)	50	55	0.00					
C2	Start >>> TURNOUT	486+94			(1)	50	55	0.00					
C2	Point of Vertical Tangent (PVT)	487+72			(1)	50	55	0.00					
C2	End >>> TURNOUT (79)	487+73			(1)	50	55	0.00					
C2	>>> SIGNAL C2-4883	489+77			(1)	50	55	0.00					
C2	T: T2	490+32			(1)	50	55	0.00					
C2	>>> S.E.PLATFORM	490+35			(1)	50	55	0.00					
C2	T: MAIN ST.	491+43			(1)	50	55	0.00					
C2	Tangent/Spiral	492+00	2060	0	45	50	55	0.00	45.387	55.588	75.266	48.989	50.744
C2	Spiral/Curve	492+76	2060	0	45	50	55	0.00	45.387	55.588	75.266	48.989	50.744
C2	Curve/Spiral	494+18	2060	0	45	50	55	0.00	45.387	55.588	75.266	48.989	50.744
C2	Spiral/Tangent	494+32	2060	0	45	50	55	0.00	45.387	55.588	75.266	48.989	50.744

(1) On tangent track and in some large radius curves, in the absence of any other speed restriction, the Average Normal Operating Speed is the highest speed that will allow service braking to limit the High Normal Operating Speed to 50 mph without experiencing Emergency Brake Applications to enforce the Not-To-Exceed (NTE) Speed

(2) CBTC shall enforce a Normal High Operating Speed limit equal to the V6 speed in curves and equal to 50 mph in tangent track and large radius curves, using service braking without incurring an Emergency Brake application. In ATPM, if the Train Operator does not reduce the speed as the Normal High Operating Speed limit is approached, the CBTC system will automatically apply service brakes to avoid exceeding this limit.

(3) CBTC must Vitally Ensure that the Not-To-Exceed (NTE) Safe Speed of V11 in curves, or 55 mph in tangent track or large radius curves, is never exceeded by any part of a train, even under slight and temporary degradation of track geometry conditions. If the actual speed of the train exceeds the Normal High Operating Speed, and is not immediately reduced below that limit by Service Brakes, an Emergency Brake application shall already have been called for. The Emergency Brake application shall be triggered at a predetermined CBTC designed speed-threshold (i.e. the Vital Civil Speed). In NO CASE shall the actual speed of the train be allowed to exceed the NTE Safe Speed (V11). CBTC Train Control System parameters shall be adjusted to Vitally Ensure this requirement.

(4): Speeds through the Steinway Tunnel shall be as follows: Normal High Operating Speed (Allowed Speed Limit): 40 mph, and Not-To-Exceed Speed (NTE): 45 mph. CBTC shall enforce both the Allowed Speed Limit and the NTE Speed throughout the Steinway Tunnel.

G-4: FLUSHING LINE CC1 AND CC2 – CURVE SPEED ANALYSIS

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	Event	True Stationing	RADIUS (ft.)	SUPERELEVATION (in.)	NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)	NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)	NOT TO EXCEED SPEED (see Note (3) below) (mph)	GRADE (%)	V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)	V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)	V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)	V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)	V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)
CC1	Tangent/Curve	2+92	2000	0.0	44	50	55	0.00					
CC1	Curve/Tangent	3+62	2000	0.0	44	50	55	0.00	44.721	54.772	74.162	48.270	50.000
CC1	Point of Vertical Tangent (PVT)	3+81			(1)	50	55	0.00					
CC1	Tangent/Curve	4+01	2000	0.0	44	50	55	0.00	44.721	54.772	74.162	48.270	50.000
CC1	Point of Vertical Intersection of Grades (PVI)	4+06	2000	0.0	44	50	55	0.00	44.721	54.772	74.162	48.270	50.000
CC1	Point of Vertical Curve (PVC)	4+31	2000	0.0	44	50	55	-0.50	44.721	54.772	74.162	48.270	50.000
CC1	Curve/Tangent	4+71	2000	0.0	44	50	55	-0.50	44.721	54.772	74.162	48.270	50.000
CC1	Point of Vertical Tangent (PVT)	7+06			(1)	50	55	-0.50					
CC1	Point of Vertical Intersection of Grades (PVI)	7+61			(1)	50	55	-3.75					
CC1	Point of Vertical Curve (PVC)	8+16			(1)	50	55	-3.75					
CC1	Tangent/Curve	10+29	5000	0.0	(1)	50	55	-3.75	70.711	86.603	117.260	76.322	79.057
CC1	Curve/Tangent	11+18	5000	0.0	(1)	50	55	-3.75	70.711	86.603	117.260	76.322	79.057
CC1	Tangent/Curve	11+86	5000	0.0	(1)	50	55	-3.75	70.711	86.603	117.260	76.322	79.057
CC1	Curve/Tangent	12+73	5000	0.0	(1)	50	55	-3.75	70.711	86.603	117.260	76.322	79.057
CC1	Point of Vertical Tangent (PVT)	19+50			(1)	50	55	-3.75					
CC1	Point of Vertical Intersection of Grades (PVI)	20+10			(1)	50	55	-0.60					
CC1	Point of Vertical Curve (PVC)	20+70			(1)	50	55	-0.60					
CC1	Point of Vertical Tangent (PVT)	27+47			(1)	50	55	-0.60					
CC1	Point of Vertical Intersection of Grades (PVI)	28+01			(1)	50	55	-2.41					
CC1	Point of Vertical Curve (PVC)	28+55			(1)	50	55	-2.41					
CC1	Tangent/Spiral	29+34	650	5.0	38	42	50	-2.41	38.243	42.279	50.990	39.620	40.311
CC1	Spiral/Curve	31+34	650	5.0	38	42	50	-2.41	38.243	42.279	50.990	39.620	40.311
CC1	Curve/Spiral	39+55	650	5.0	38	42	50	-2.41	38.243	42.279	50.990	39.620	40.311
CC1	Spiral/Tangent	41+55	650	5.0	38	42	50	-2.41	38.243	42.279	50.990	39.620	40.311
CC1	Point of Vertical Tangent (PVT)	43+81			(1)	50	55	-2.41					
CC1	Point of Vertical Intersection of Grades (PVI)	44+41			(1)	50	55	-0.50					
CC1	Point of Vertical Curve (PVC)	45+01			(1)	50	55	-0.50					
CC1	Point of Vertical Tangent (PVT)	73+52			(1)	50	55	-0.50					
CC1	Point of Vertical Intersection of Grades (PVI)	73+92			(1)	50	55	0.50					
CC1	Point of Vertical Curve (PVC)	74+32			(1)	50	55	0.50					
CC2	Point of Vertical Curve (PVC)	73+49			(1)	50	55	0.50					
CC2	Point of Vertical Intersection of Grades (PVI)	73+09			(1)	50	55	-0.50					
CC2	Point of Vertical Tangent (PVT)	72+69			(1)	50	55	-0.50					
CC2	Point of Vertical Curve (PVC)	44+19			(1)	50	55	-0.50					
CC2	Point of Vertical Intersection of Grades (PVI)	43+59			(1)	50	55	-2.54					
CC2	Point of Vertical Tangent (PVT)	42+99			(1)	50	55	-2.54					
CC2	Spiral/Tangent	41+11	650	5.0	38	42	50	-2.54	38.243	42.279	50.990	39.620	40.311
CC2	Curve/Spiral	39+11	650	5.0	38	42	50	-2.54	38.243	42.279	50.990	39.620	40.311
CC2	Spiral/Curve	30+90	650	5.0	38	42	50	-2.54	38.243	42.279	50.990	39.620	40.311
CC2	Tangent/Spiral	28+90	650	5.0	38	42	50	-2.54	38.243	42.279	50.990	39.620	40.311
CC2	Point of Vertical Curve (PVC)	28+55			(1)	50	55	-2.54					
CC2	Point of Vertical Intersection of Grades (PVI)	28+01			(1)	50	55	-0.62					
CC2	Point of Vertical Tangent (PVT)	27+47			(1)	50	55	-0.62					
CC2	Point of Vertical Curve (PVC)	20+71			(1)	50	55	-0.62					

									Check of NYCT Speeds			Proposed Increase	Proposed Increase
Track	**Event**	**True Stationing**	**RADIUS (ft.)**	**SUPERELEVATION (in.)**	**NORMAL AVERAGE OPERATING SPEED (see Note (1) below) (mph)**	**NORMAL HIGH OPERATING SPEED (ALLOWED SPEED LIMIT) (see Note (2) below) (mph)**	**NOT TO EXCEED SPEED (see Note (3) below) (mph)**	**GRADE (%)**	**V4 Speed Calculated V4 = .5*((4+Ea)*R)^.5] (mph)**	**V6 Speed Calculated V6 = .5*((6+Ea)*R)^.5] (mph)**	**V11 Speed Calculated V11 = .5*((11+Ea)*R)^.5] (mph)**	**V4.66 Speed Calculated V4.66 = .5*((4.66+Ea)*R)^.5] (see note (4) below) (mph)**	**V5 Speed Calculated V5 = .5*((5+Ea)*R)^.5] (see note (5) below) (mph)**
CC2	Curve/Tangent	20+14	9000	0.0	(1)	50	55	-0.62	94.868	116.190	157.321	102.396	106.066
CC2	Point of Vertical Intersection of Grades (PVI)	20+11	9000	0.0	(1)	50	55	-3.75	94.868	116.190	157.321	102.396	106.066
CC2	Point of Vertical Tangent (PVT)	19+51			(1)	50	55	-3.75					
CC2	Tangent/Curve	18+34	9000	0.0	(1)	50	55	-3.75					
CC2	Curve/Tangent	16+90	9000	0.0	(1)	50	55	-3.75	94.868	116.190	157.321	102.396	106.066
CC2	Tangent/Curve	15+11	9000	0.0	(1)	50	55	-3.75	94.868	116.190	157.321	102.396	106.066
CC2	Curve/Tangent	13+93	3000	0.0	(1)	50	55	-3.75	54.772	67.082	90.830	59.119	61.237
CC2	Tangent/Curve	12+36	3000	0.0	(1)	50	55	-3.75	54.772	67.082	90.830	59.119	61.237
CC2	Curve/Tangent	11+10	3000	0.0	(1)	50	55	-3.75	54.772	67.082	90.830	59.119	61.237
CC2	Tangent/Curve	9+54	3000	0.0	(1)	50	55	-3.75	54.772	67.082	90.830	59.119	61.237
CC2	Point of Vertical Curve (PVC)	8+16			(1)	50	55	-3.75					
CC2	Point of Vertical Intersection of Grades (PVI)	7+61			(1)	50	55	-0.50					
CC2	Point of Vertical Tangent (PVT)	7+06			(1)	50	55	-0.50					
CC2	Curve/Tangent	5+88	625	1.0	27	33	43	-0.50	27.951	33.072	43.301	29.738	30.619
CC2	Tangent/Curve	5+12	625	1.0	27	33	43	-0.50	27.951	33.072	43.301	29.738	30.619
CC2	Curve/Tangent	4+75	1600	0.0	40	48	55	-0.50	40.000	48.990	66.332	43.174	44.721
CC2	Point of Vertical Curve (PVC)	4+31	1600	0.0	40	48	55	-0.50	40.000	48.990	66.332	43.174	44.721
CC2	Point of Vertical Intersection of Grades (PVI)	4+06	1600	0.0	40	48	55	0.00	40.000	48.990	66.332	43.174	44.721
CC2	Point of Vertical Tangent (PVT)	3+81	1600	0.0	40	48	55	0.00	40.000	48.990	66.332	43.174	44.721
CC2	Tangent/Curve	2+76	1600	0.0	40	48	55	0.0	40.000	48.990	66.332	43.174	44.721

(1) On tangent track and in some large radius curves, in the absence of any other speed restriction, the Average Normal Operating Speed is the highest speed that will allow service braking to limit the High Normal Operating Speed to 50 mph without experiencing Emergency Brake Applications to enforce the Not-To-Exceed (NTE) Speed

(2) CBTC shall enforce a Normal High Operating Speed limit equal to the V6 speed in curves and equal to 50 mph in tangent track and large radius curves, using service braking without incurring an Emergency Brake application. In ATPM, if the Train Operator does not reduce the speed as the Normal High Operating Speed limit is approached, the CBTC system will automatically apply service brakes to avoid exceeding this limit.

(3) CBTC must Vitally Ensure that the Not-To-Exceed (NTE) Safe Speed of V11 in curves, or 55 mph in tangent track or large radius curves, is never exceeded by any part of a train, even under slight and temporary degradation of track geometry conditions. If the actual speed of the train exceeds the Normal High Operating Speed, and is not immediately reduced below that limit by Service Brakes, an Emergency Brake application shall already have been called for. The Emergency Brake application shall be triggered at a predetermined CBTC designed speed-threshold (i.e. the Vital Civil Speed). In NO CASE shall the actual speed of the train be allowed to exceed the NTE Safe Speed (V11). CBTC Train Control System parameters shall be adjusted to Vitally Ensure this requirement.

APPENDIX "H"

NYCT FIXED BLOCK SIGNALING SYSTEM: BASIC PRINCIPLES

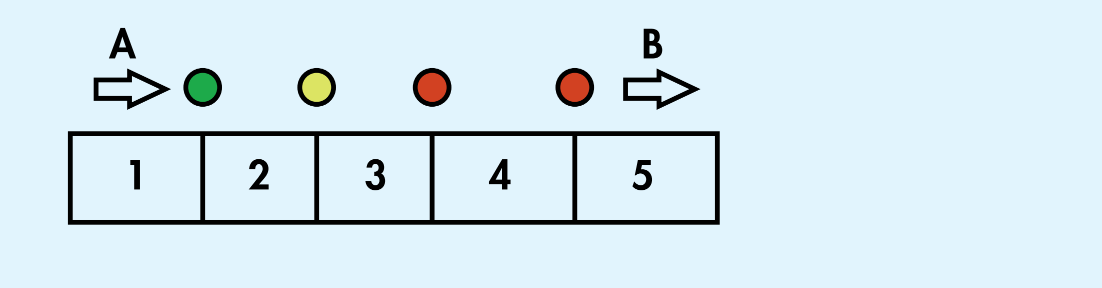
High-Level Summary of the NYCT Fixed Block System

- The tracks are divided into fixed segments used by the system to estimate train position.
- Trains are separated using these segments such that trains travelling at MAS will be safely separated.
    - The maximum attainable speed is calculated based on the vehicle's top acceleration rate as it travels towards a red signal and the distance it needs to travel to reach the signal.
    - The safe braking distance is calculated based on the speed the train reaches prior to emergency brake application at the red signal, along with the braking characteristics of the vehicle. A safety factor is added to this calculated distance to handle hazards such as slip-slide, which are impossible to quantify precisely for all conditions.
- Where speed restrictions around curves and into stations are enforced, the system allows trains to be safely moved closer together.
    - Timers are used to control when a train is permitted to proceed through these areas, causing the signal to "clear" from red to a permissive aspect such as yellow or green.
    - These timers are set based on the travel distance and design speeds. If the train is not on the segment long enough, the system assumes it is moving too fast and the signal does not clear.

High-Level Design Concept Example

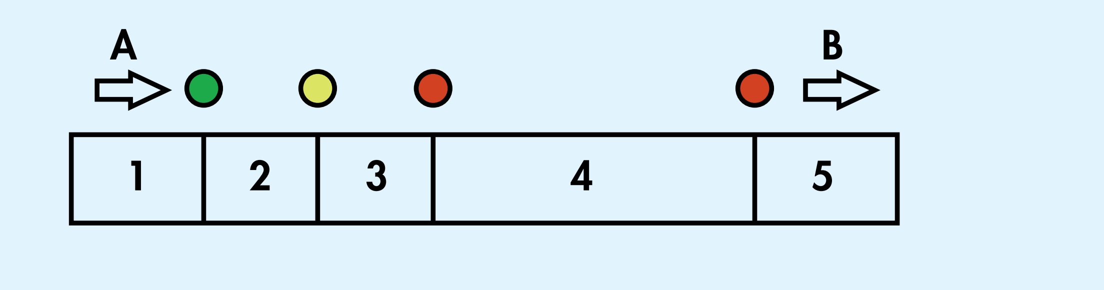
In an area that does not have any speed control, calculations may show that train A can reach a maximum of 32 mph before it reaches the first red signal between segments 3 and 4. The train must stop before it reaches the second red signal between segments 4 and 5 to keep it from colliding with train B. The signals and segments of a fixed block system are placed according to these calculations and operational headway requirements:

Figure H-1 – Train A is traveling toward Train B, which is stopped, e.g. at a station



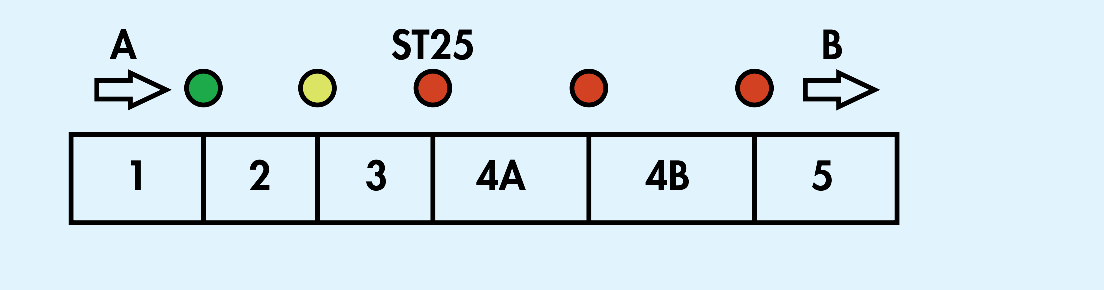
If the train is made to accelerate faster or track conditions allow for higher top speeds after the system is already in place, segment 4 may need to be lengthened by modifying the rail and associated insulation to accommodate these changes. Since there is a signal present in this example, the associated signal, trip stop and cables would also need to be relocated. Trains can move faster now, but Train A and Train B are now separated further:

Figure H-2 – Train A can travel faster toward Train B, which is stopped, e.g. at a station. Segment 4 has to be lengthened.



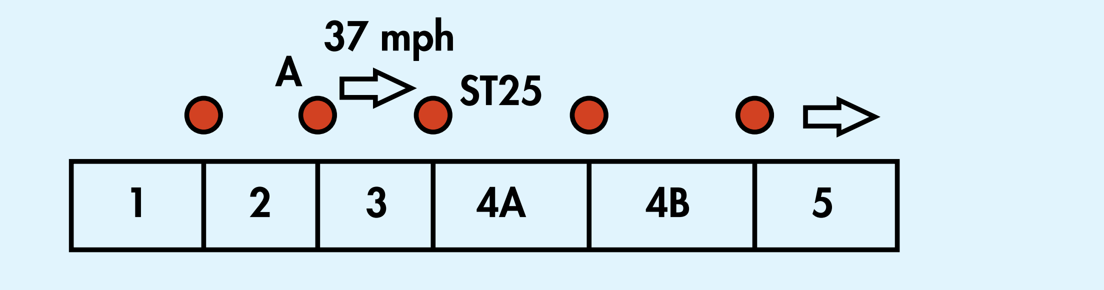
If speed control is now added, the system can then use timers to verify that the train is moving slower than the calculated top speed in order to get train A safely closer to train B. In this example, we can break segment 4 into 4A and 4B, and add a timing element to the first red signal that clears when the train is moving at under 25 mph:

Figure H-3 – Segment 4 is broken into two segments, and the speed of the train is checked at the ST25 signal.



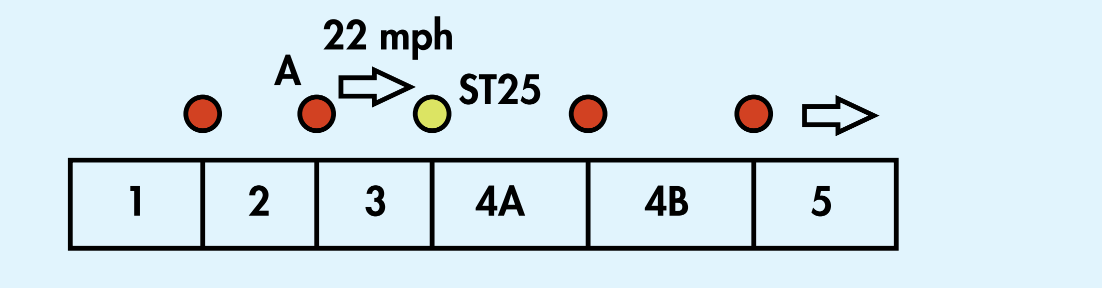
Segment 4 is just divided into 4A and 4B. So, if the train is moving at its maximum attainable speed, it will reach the same red signal and safely stop before reaching segment 5/train B (as originally).

Figure H-4 – The signal does not clear for a train that is moving too fast. This provides the same braking distance as in Figure H-2.



However, if the train remains on segment 3 for long enough, demonstrating that it is moving under 25 mph (based on the calculations), the associated signal will clear. There will be enough safe braking distance in segment 4B to fully stop a train moving 25 mph before it reaches segment 5:

Figure H-5 – The signal clears for a train moving under 25 mph, allowing the train to move closer to train B as in Figure H-1.



Train A is now able to progress through segment 4A and wait at the next red signal for train B to move onward. This is how trains are kept moving safely when they are not able to travel at MAS, e.g. during rush hour at critical bottleneck stations and interlockings.

To summarize: the lengths of fixed block segments at NYCT are based on the MAS of trains. The faster the train moves, the longer the segments become. Speed control through use of timers and additional signals may be used to check actual average speeds and bring trains closer together when there is congestion or to enforce speeds through curves. Signaling system design at NYCT is an iterative balancing act between speed, capacity and equipment costs, performed while maintaining the required safety margins throughout.

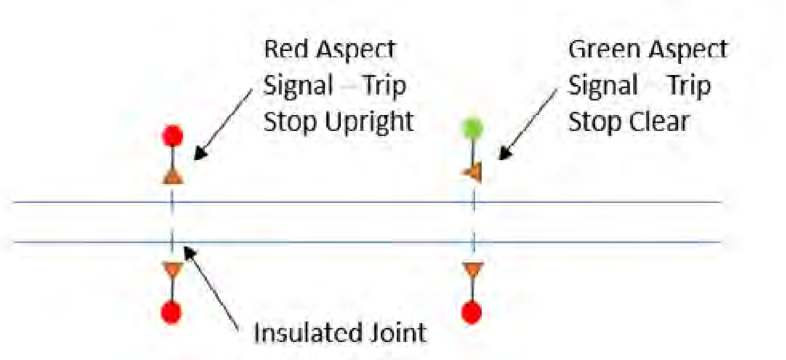
The fundamental objective of any signaling system is providing safe train travel along the tracks. Each signaling system is unique and designed based on the agency's approach to safety and/or enforce beyond train operator rules. At NYCT the signaling system keeps trains safely separated and keeps trains from over speeding by applying the emergency brakes as required. It greatly reduces the risk of collisions and derailments, even under worst-case conditions.

To keep trains safely separated the signaling system must always know train locations. To monitor train location, the track is separated into smaller sections known as track circuits. The track circuits are used to detect the absence of trains. Time signals, or block signals, on the New York system are of two varieties, Grade Time (GT) and Station Time (ST). The fundamental principle of both is the same: the speed of a train can be determined by measuring how long it takes to traverse a fixed distance.

At the beginning of each track circuit, there is a signal equipped with a trip stop. Trip stops are used to enforce the rules of the signal system, including both stopping at red signals and enforcement of speed (described elsewhere). The trip stops are upright when the signal aspect is red. In the event a train passes a red aspect signal, the trip stop automatically applies the train's emergency brakes. The trip stops clear immediately before the signal turns green.

Figure H-6 illustrates the track circuits/blocks, the placement of the insulated joints (gaps in the rail that mark the ends of each track circuit) and the signals, and the position of the trip stops with the associated signal aspect. Also shown are the insulated joints, which are gaps in the rail that mark the ends of each track circuit.

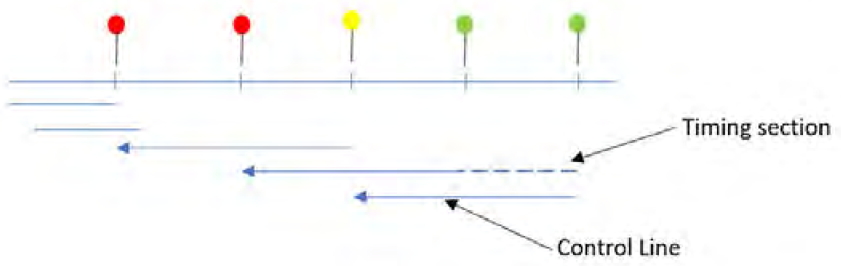
Figure H-6



For a signal to clear, the two track circuits immediately following the signal must be clear of a train. A signal control line is used to illustrate the area that must be vacant. This area is known as the control area. The control area consists of two parts: the area in which the train is authorized to proceed and the braking zone. In Figure H-7, the first track circuit following each signal is the authorized-to-proceed area and the second track circuit following each signal is the braking zone which is described in more detail below.

Figure H-7

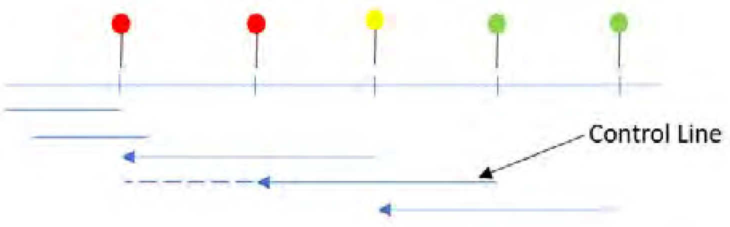
Figure H-8



Grade timers (GT) are utilized in the signal control system to enforce the speed the train operator can travel within the track circuit approaching the signal. Grade time control enforces an unconditional speed limit for trains on grades, or curves, or in approach to bumpers. In Figure H-8, the timing section is shown as the broken line segment in approach to the signal. In the event the operator travels over the maximum allowable speed, the signal will not clear, the trip stop will not disengage, and the emergency brakes will be tripped.

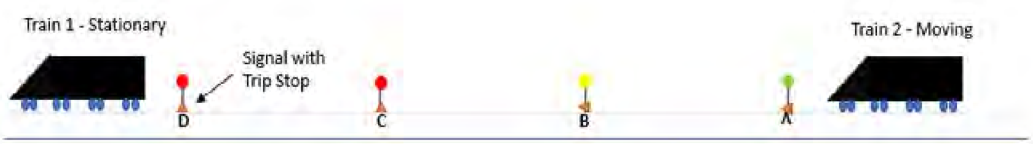
Station timers (ST) are a signal feature that allows trains to "close in" on each other if they sufficiently reduce speed and is typically used at stations to allow trains to slowly come closer to each other than would otherwise be allowed. Station time keeps trains moving and are utilized to regulate when a train can depart from the station. The portion of track that regulates how the signaling system handles the station timers is based on the control line. In Figure H-9, this section of track is shown as a broken line. If both the control line and the broken line portion are unoccupied, an approaching train will have enough buffer track if it were to overrun the next signal and therefore is permitted to proceed. If the broken line portion of the control line is occupied, the signal will clear when the timer in approach to the signal is complete.

Figure H-9



To prevent collisions, trains must be kept apart if they are travelling in the same direction on the same track. There must be enough space between them to allow the second train to stop when the first train stops. As mentioned previously, each signal requires a minimum of two track circuits, also known as blocks, to be clear for the signal to clear and ultimately permit the train to past the signal. In the event the two blocks are clear, but the third track circuit past the signal is occupied by a train, the signal will clear to yellow permitting the train to pass but alerting the operator the very next signal aspect will be red. In Figure H-10, Two-Block Clearing Example, Train 1 is stationary on the track just past signal D. Train 2 is approaching on the same track. Signal A has a green aspect indicating clear track circuits between signals A and D. Signal B has a yellow aspect indicating clear track circuits between B and D with a track circuit occupancy just past signal D. Signal C is red indicating a track circuit occupancy in either two track circuits just past the signal. The same applies to signal D, hence two-block clearing.

Figure H-10



Safe braking distance is the distance a train will travel from the point when its brakes are fully applied to when it comes to a complete stop. To ensure the train does not collide with another train, the safe braking distance is calculated, and a safety factor is added. The safety factor is used to capture a range of issues that may not be addressed in other components of the safe braking calculation. For example, adhesion levels must be considered. Factors such as wet rail, leaves or other contaminants are possible but challenging to quantify and therefore captured in the safety factor.

Additionally, when evaluating the safe braking distance, also taken into consideration are the speed when the brakes are applied, the track grade, frictional resistance or adhesion, the deceleration rate available with a full-service brake application, distance traveled during the operator's reaction time and brake delay time. If there are trains with different braking and performance characteristics, as well as, different consists, the distance must be the worst-case condition of all the trains. The distance between the front of a worst-case train and the rear of the train that is being followed must always be greater than the distance required for the worst-case train to stop before reaching the train it is following.

Any time there is a change involving a reduction in the train braking performance, track profile, signal locations or an increase in train speed, the safe braking calculation must be repeated.

In Figure H-11, Train 1 is stationary on the track just past signal D. Train 2 is approaching on the same track at maximum allowable speed (MAS), starting in advance of signal A as illustrated in Figure H-10. In the illustration the train has now travelled from the track circuit in advance of signal A and is approaching signal C. In the train's progression:

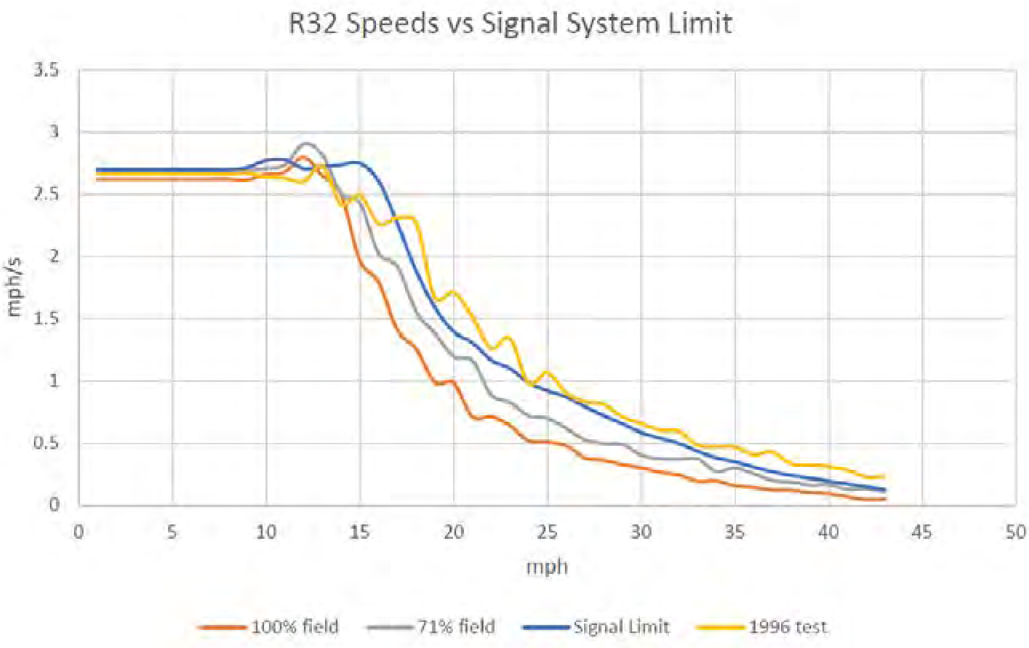
1. The green aspect on signal A returns to a red aspect and the trip stop reengages just after Train 2 passes.
2. The yellow aspect on signal B returns to a red aspect and the trip stop reengages just after Train 2 passes.
3. Signal C has a red aspect with the trip stop engaged. Train 2 passes the red signal and the trip stop triggers the emergency brakes.

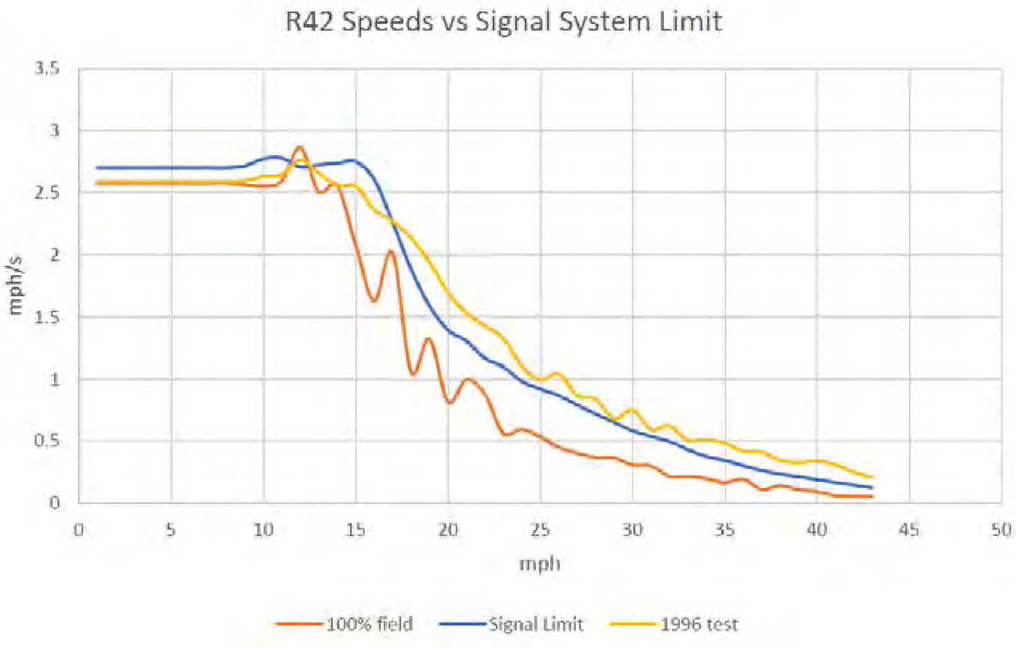
Safe braking distance in this example is calculated so that Train 2, travelling at MAS, comes to a complete stop before reaching signal D as illustrated by the brake curve.

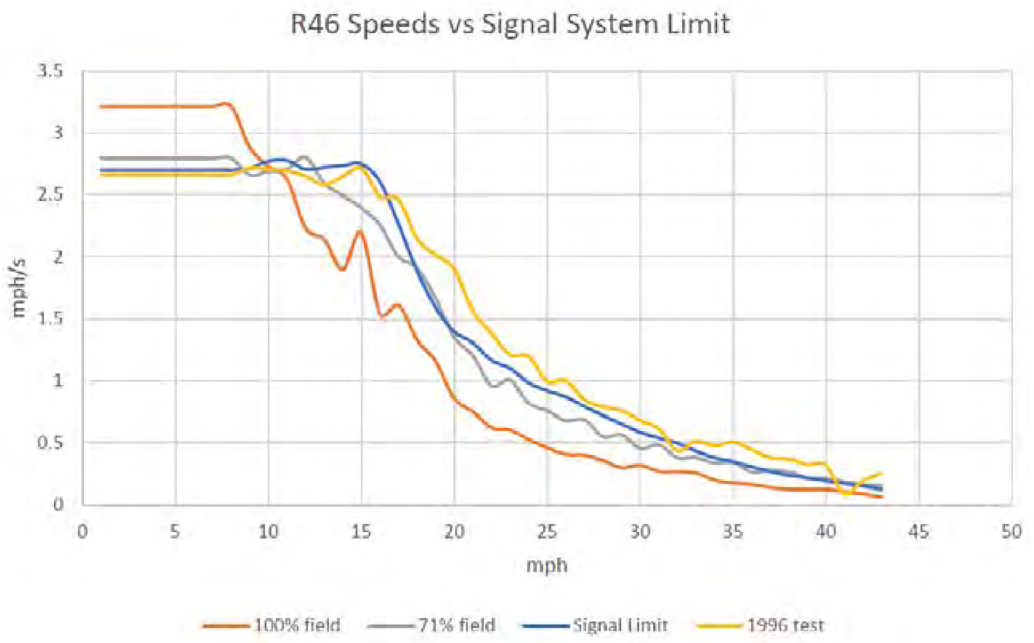
Figure H-11

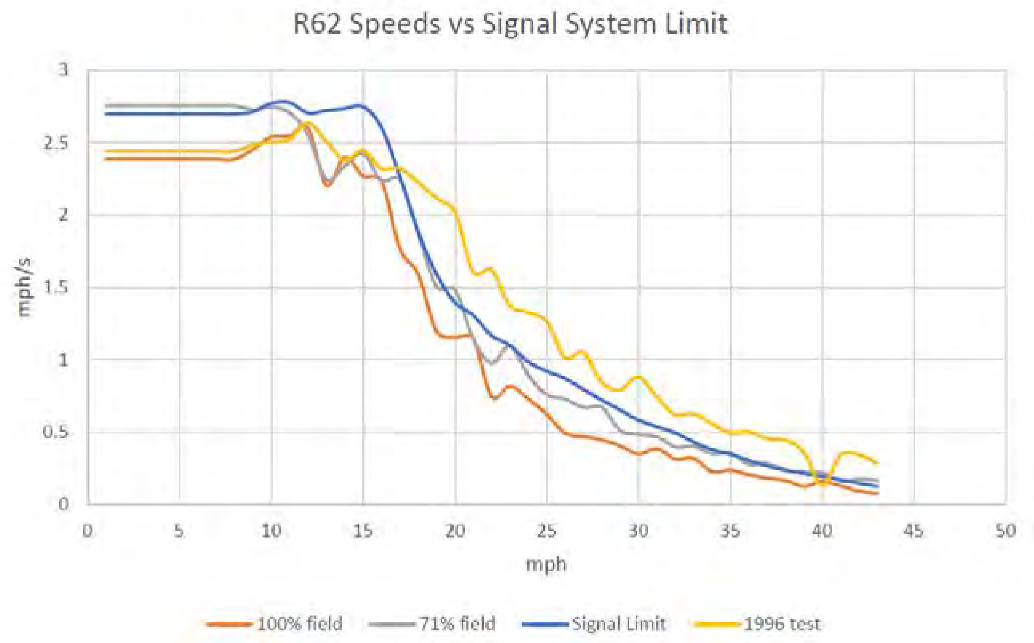
In summary, the signaling system is designed to allow trains to travel safely along the tracks through train separation, location determination, supervised/enforced authorized speed and safe braking. All of these factors considered provide an efficient signaling system.

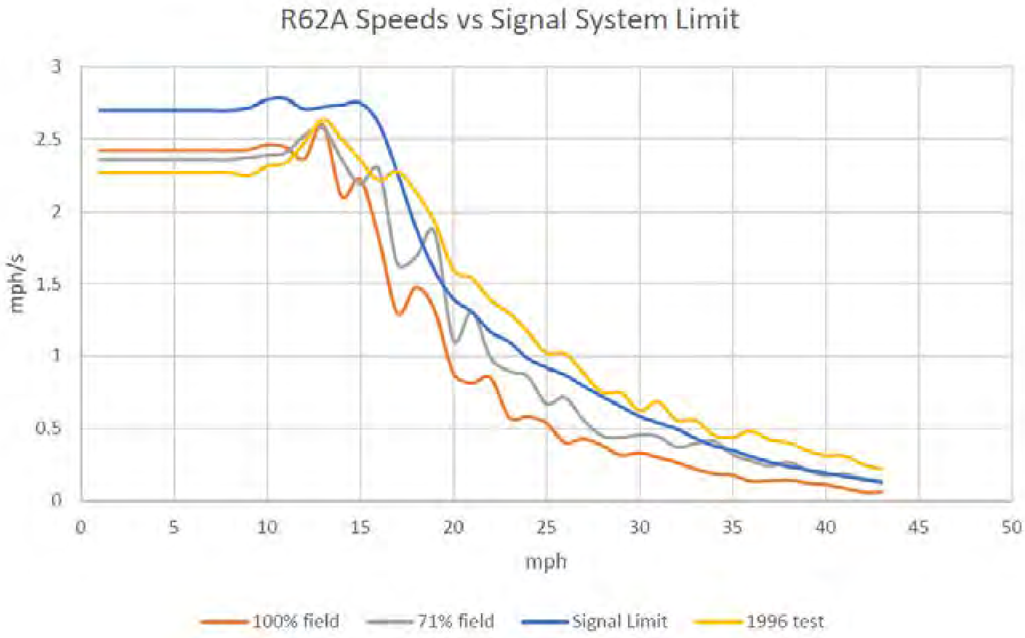
APPENDIX “I”
ACCELERATION CHARTS, DC-POWERED CAR CLASSES (1996 TEST DATA)

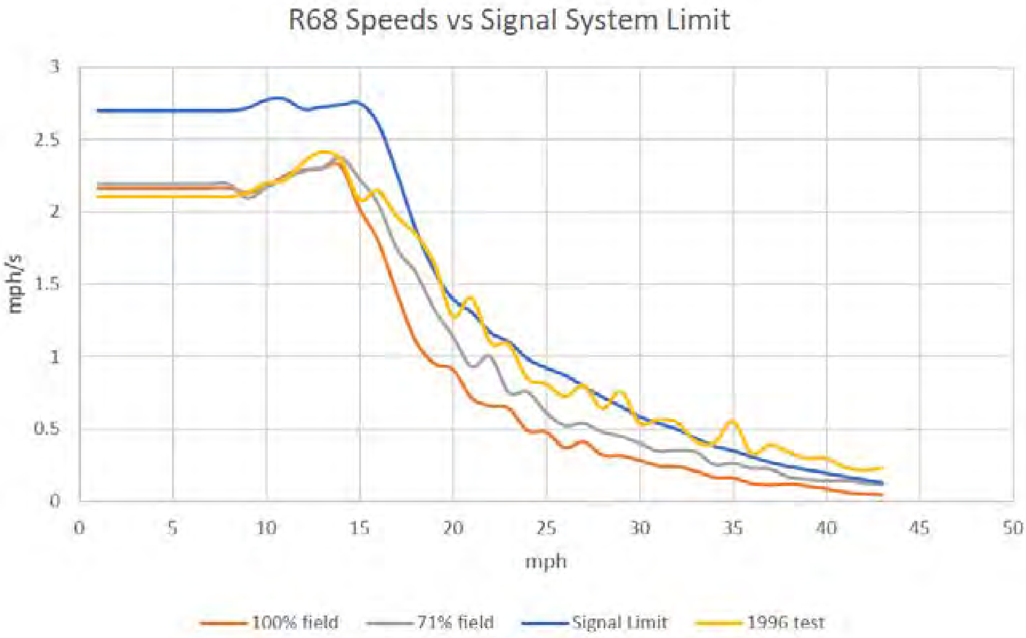


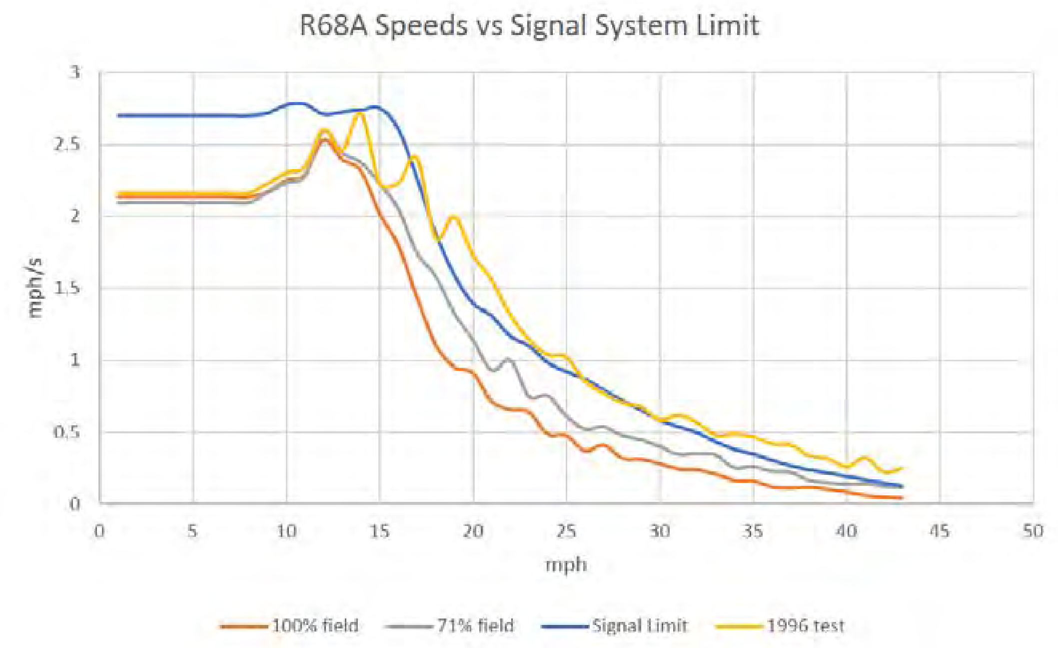



R46 Speeds vs Signal System Limit
3.5
3
2.5
2
1.5
1
0.5
0
mph/s
0
5
10
15
20
25
30
35
40
45
50
mph
100% field
71% field
Signal Limit
1996 test


R62 Speeds vs Signal System Limit
3
2.5
2
1.5
1
0.5
0
mph/s
0
5
10
15
20
25
30
35
40
45
50
mph
100% field
71% field
Signal Limit
1996 test


R62A Speeds vs Signal System Limit
mph/s
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
30
35
40
45
50
mph
100% field
71% field
Signal Limit
1996 test


R68 Speeds vs Signal System Limit
mph/s
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
30
35
40
45
50
mph
100% field
71% field
Signal Limit
1996 test


R68A Speeds vs Signal System Limit
mph/s
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
30
35
40
45
50
mph
100% field
71% field
Signal Limit
1996 test

APPENDIX "J"
TRAIN OPERATIONS MODEL RESULTS: 7TH AVENUE LINE, 14TH – 34TH STREETS

The STV team utilizes the Train Operations Model (TOM) software tool to conduct detailed operations modeling of rail systems. The primary element used within TOM is the Train Performance Simulator (TPS) module that models individual trips on a single line, including acceleration, deceleration, programmed civil and other speed restrictions, and station stops and dwell times. The train performance calculations embedded in TOM provide a more detailed analysis of train performance and a more accurate estimate of travel times along a line than more simplistic models based on average speeds and average acceleration and braking rates.

The TOM TPS takes into account actual vehicle performance in the form of tractive effort and braking effort curves, accurately modeling the acceleration and braking profiles of a vehicle to capture the change in effective acceleration as a vehicle speeds up. Typically in transit vehicles, the vehicle is able to achieve its maximum acceleration rates when starting from a stop, with acceleration rates decreasing over time as the vehicle speeds up. This is especially true in the case of NYCT, where the effective acceleration rates of the fleet begin to drop off greatly after passing speeds of 20-25 mph. To accurately model vehicle performance and estimate travel times, it is important to capture these types of performance variations.

In addition to detailed vehicle performance data, the TOM TPS also takes as inputs detailed alignment data, including horizontal curvature and vertical grades, to take into account the effect of the alignment on train performance. Grades have significant impacts on acceleration and deceleration, and horizontal curvature also provide a small increase in resistance which impacts performance and is captured by the model.

The TOM TPS can be provided with any set of speed restrictions, both civil speed restrictions and other policy or signal system speed restrictions, that trains must obey to model various operating scenarios. However, it is important to note that TOM is not a dynamic simulation model, and each scenario must be programmed individually to assess the impact of various civil or signal speed restrictions. As an example, if TOM is used to model trips arriving at a terminal station, where half of trains enter the maximum allowable speed on the straight move, and the other half of trains enter at a reduced speed through the terminal interlocking, both scenarios must be programmed and modeled separately and the resulting travel times compared to assess the impact. The TOM TPS is not used to model several trips in succession with alternating operating patterns.

Furthermore, it should be noted that the TOM TPS does not capture the impact of train interactions and signal system effects, as can be modeled using a network simulator. The TOM TPS only considers individual trips and the performance of trains for those trips based on variable inputs. While TOM produces accurate estimates of travel time based on detailed operating inputs, any assessment of train interactions or the calculation of delay and reliability statistics, requires the use of a more complex software tool.

NORTHBOUND RUN

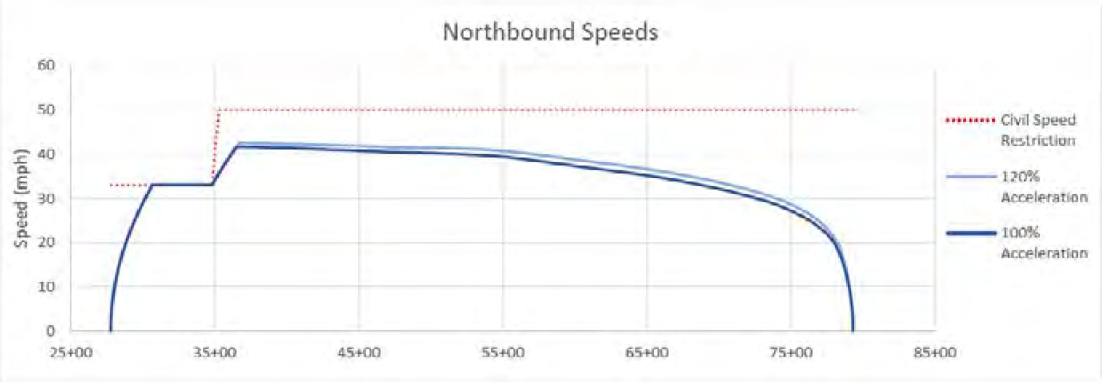
Vehicle Performance at Signal System Basis Ideal Acceleration / Braking (No Schedule Margin)							Improved Vehicle Performance (120%) Ideal Acceleration / Braking (No Schedule Margin)						
Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)	Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)
0	50	1.502	79+31	0.0	2.44	0.1	0	50	1.502	79+31	0.0	2.93	0.1
1	50	1.502	79+31	2.4	2.44	0.1	1	50	1.502	79+31	2.9	2.93	0.1
2	50	1.501	79+25	4.9	2.44	0.1	2	50	1.500	79+20	5.9	2.95	0.1
3	50	1.499	79+15	7.3	2.44	0.2	3	50	1.498	79+09	8.8	2.97	0.2
4	50	1.497	79+04	9.8	2.48	0.2	4	50	1.495	78+94	11.8	2.98	0.2
5	50	1.494	78+88	12.2	2.47	0.2	5	50	1.492	78+78	14.8	2.96	0.2
6	50	1.490	78+67	14.7	2.46	0.2	6	50	1.487	78+51	17.7	2.16	0.2
7	50	1.485	78+41	17.2	1.92	0.2	7	50	1.482	78+25	19.9	1.49	0.4
8	50	1.480	78+14	19.1	1.42	0.4	8	50	1.476	77+93	21.4	1.31	0.4
9	50	1.475	77+88	20.5	1.15	0.4	9	50	1.470	77+62	22.7	1.15	0.5
10	50	1.469	77+56	21.7	1.03	0.5	10	50	1.464	77+30	23.8	1.03	0.5
11	50	1.463	77+25	22.7	0.94	0.5	11	50	1.457	76+93	24.8	0.89	0.6
12	50	1.456	76+88	23.6	0.83	0.6	12	50	1.450	76+56	25.7	0.82	0.6
13	50	1.450	76+56	24.5	0.76	0.6	13	50	1.443	76+19	26.6	0.76	0.6
14	50	1.443	76+19	25.2	0.70	0.6	14	50	1.435	75+77	27.3	0.71	0.6
15	50	1.436	75+82	25.9	0.65	0.6	15	50	1.428	75+40	28.0	0.65	0.6
16	50	1.428	75+40	26.6	0.61	0.6	16	50	1.420	74+98	28.7	0.61	0.6
17	50	1.421	75+03	27.2	0.58	0.6	17	50	1.412	74+55	29.3	0.56	0.6
18	50	1.413	74+61	27.8	0.54	0.6	18	50	1.403	74+08	29.8	0.52	0.6
19	50	1.406	74+24	28.3	0.51	0.6	19	50	1.395	73+66	30.4	0.49	0.6
20	50	1.398	73+81	28.8	0.48	0.6	20	50	1.387	73+23	30.9	0.46	0.6
21	50	1.390	73+39	29.3	0.45	0.6	21	50	1.378	72+76	31.3	0.44	0.6
22	50	1.381	72+92	29.7	0.42	0.6	22	50	1.369	72+28	31.8	0.42	0.6
23	50	1.373	72+49	30.1	0.40	0.6	23	50	1.360	71+81	32.2	0.40	0.6
24	50	1.365	72+07	30.5	0.38	0.6	24	50	1.351	71+33	32.6	0.38	0.6
25	50	1.356	71+60	30.9	0.37	0.6	25	50	1.342	70+86	33.0	0.37	0.5
26	50	1.347	71+12	31.3	0.36	0.5	26	50	1.333	70+38	33.3	0.36	0.5
27	50	1.339	70+70	31.6	0.35	0.5	27	50	1.324	69+91	33.7	0.34	0.5
28	50	1.330	70+22	32.0	0.34	0.5	28	50	1.314	69+38	34.0	0.34	0.4
29	50	1.321	69+75	32.3	0.33	0.5	29	50	1.305	68+90	34.4	0.33	0.4

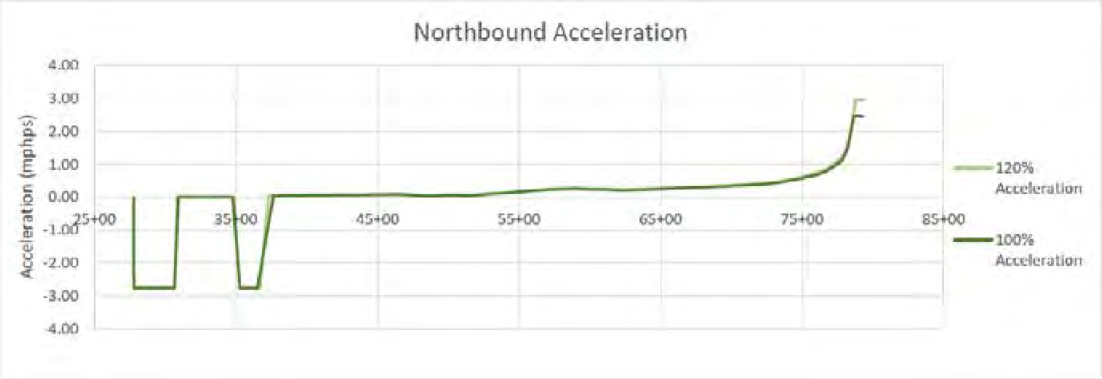
NORTHBOUND RUN													
Vehicle Performance at Signal System Basis Ideal Acceleration / Braking (No Schedule Margin)							Improved Vehicle Performance (120%) Ideal Acceleration / Braking (No Schedule Margin)						
Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)	Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)
30	50	1.312	69+27	32.7	0.32	0.4	30	50	1.295	68+38	34.7	0.31	0.4
31	50	1.303	68+80	33.0	0.32	0.4	31	50	1.285	67+85	35.0	0.30	0.3
32	50	1.294	68+32	33.3	0.31	0.4	32	50	1.276	67+37	35.3	0.30	0.3
33	50	1.284	67+80	33.6	0.30	0.3	33	50	1.266	66+84	35.6	0.29	0.3
34	50	1.275	67+32	33.9	0.30	0.3	34	50	1.256	66+32	35.9	0.28	0.3
35	50	1.265	66+79	34.2	0.29	0.3	35	50	1.246	65+79	36.2	0.27	0.3
36	50	1.256	66+32	34.5	0.27	0.3	36	50	1.236	65+26	36.5	0.26	0.3
37	50	1.246	65+79	34.8	0.26	0.3	37	50	1.226	64+73	36.7	0.26	0.3
38	50	1.237	65+31	35.0	0.25	0.3	38	50	1.215	64+15	37.0	0.25	0.3
39	50	1.227	64+79	35.3	0.24	0.3	39	50	1.205	63+62	37.2	0.24	0.3
40	50	1.217	64+26	35.5	0.24	0.3	40	50	1.195	63+10	37.5	0.23	0.3
41	50	1.207	63+73	35.8	0.23	0.3	41	50	1.184	62+52	37.7	0.22	0.3
42	50	1.197	63+20	36.0	0.22	0.3	42	50	1.174	61+99	37.9	0.23	0.2
43	50	1.187	62+67	36.2	0.22	0.3	43	50	1.163	61+41	38.2	0.22	0.2
44	50	1.177	62+15	36.4	0.21	0.3	44	50	1.153	60+88	38.4	0.23	0.1
45	50	1.167	61+62	36.6	0.22	0.2	45	50	1.142	60+30	38.6	0.24	0.0
46	50	1.157	61+09	36.9	0.23	0.1	46	50	1.131	59+72	38.9	0.25	0.0
47	50	1.146	60+51	37.1	0.24	0.0	47	50	1.120	59+14	39.1	0.24	0.0
48	50	1.136	59+98	37.3	0.24	0.0	48	50	1.109	58+56	39.4	0.25	-0.1
49	50	1.126	59+45	37.6	0.25	0.0	49	50	1.098	57+97	39.6	0.24	-0.1
50	50	1.115	58+87	37.8	0.26	-0.1	50	50	1.087	57+39	39.9	0.23	-0.1
51	50	1.105	58+34	38.1	0.25	-0.1	51	50	1.076	56+81	40.1	0.23	-0.1
52	50	1.094	57+76	38.3	0.24	-0.1	52	50	1.065	56+23	40.3	0.20	0.0
53	50	1.083	57+18	38.6	0.24	-0.1	53	50	1.054	55+65	40.5	0.17	0.0
54	50	1.073	56+65	38.8	0.21	0.0	54	50	1.043	55+07	40.7	0.15	0.1
55	50	1.062	56+07	39.0	0.21	0.0	55	50	1.031	54+44	40.8	0.13	0.2
56	50	1.051	55+49	39.2	0.18	0.0	56	50	1.020	53+86	41.0	0.12	0.2
57	50	1.040	54+91	39.4	0.16	0.1	57	50	1.008	53+22	41.1	0.10	0.3
58	50	1.029	54+33	39.6	0.14	0.2	58	50	0.997	52+65	41.2	0.07	0.4
59	50	1.018	53+75	39.7	0.12	0.3	59	50	0.986	52+04	41.3	0.05	0.5
60	50	1.007	53+17	39.8	0.11	0.3	60	50	0.974	51+43	41.3	0.03	0.6
61	50	0.996	52+58	39.9	0.09	0.4	61	50	0.963	50+83	41.3	0.05	0.5
62	50	0.985	52+00	40.0	0.07	0.5	62	50	0.951	50+22	41.4	0.05	0.5
63	50	0.974	51+41	40.1	0.05	0.6	63	50	0.940	49+62	41.4	0.04	0.5

NORTHBOUND RUN

Vehicle Performance at Signal System Basis Ideal Acceleration / Braking (No Schedule Margin)							Improved Vehicle Performance (120%) Ideal Acceleration / Braking (No Schedule Margin)						
Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)	Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)
64	50	0.963	50+82	40.1	0.06	0.5	64	50	0.928	49+01	41.5	0.04	0.5
65	50	0.951	50+23	40.2	0.06	0.5	65	50	0.917	48+40	41.5	0.02	0.6
66	50	0.940	49+64	40.3	0.06	0.5	66	50	0.905	47+79	41.5	0.04	0.5
67	50	0.929	49+05	40.3	0.04	0.6	67	50	0.894	47+18	41.6	0.06	0.4
68	50	0.918	48+46	40.4	0.04	0.6	68	50	0.882	46+57	41.6	0.07	0.3
69	50	0.907	47+87	40.4	0.05	0.5	69	50	0.870	45+96	41.7	0.07	0.3
70	50	0.895	47+27	40.5	0.07	0.4	70	50	0.859	45+34	41.8	0.07	0.3
71	50	0.884	46+68	40.5	0.09	0.3	71	50	0.847	44+73	41.9	0.07	0.3
72	50	0.873	46+08	40.6	0.09	0.3	72	50	0.836	44+12	41.9	0.06	0.3
73	50	0.862	45+49	40.7	0.08	0.3	73	50	0.824	43+50	42.0	0.06	0.3
74	50	0.850	44+89	40.8	0.08	0.3	74	50	0.812	42+89	42.0	0.06	0.3
75	50	0.839	44+29	40.9	0.08	0.3	75	50	0.801	42+27	42.1	0.06	0.3
76	50	0.828	43+69	41.0	0.08	0.3	76	50	0.789	41+65	42.2	0.05	0.3
77	50	0.816	43+09	41.0	0.07	0.3	77	50	0.777	41+04	42.2	0.05	0.3
78	50	0.805	42+49	41.1	0.07	0.3	78	50	0.765	40+41	42.3	0.05	0.3
79	50	0.793	41+89	41.2	0.07	0.3	79	50	0.754	39+80	42.3	0.05	0.3
80	50	0.782	41+28	41.2	0.07	0.3	80	50	0.742	39+17	42.4	0.04	0.3
81	50	0.770	40+68	41.3	0.06	0.3	81	50	0.730	38+55	42.4	0.04	0.3
82	50	0.759	40+07	41.4	0.06	0.3	82	50	0.718	37+93	42.4	0.03	0.3
83	50	0.747	39+46	41.4	0.06	0.3	83	50	0.707	37+31	42.5	0.05	0.3
84	50	0.736	38+86	41.5	0.06	0.3	84	50	0.695	36+70	42.5	-2.76	0.3
85	50	0.724	38+25	41.5	0.05	0.3	84.4	50	0.690	36+43	41.3	-2.76	0.3
86	50	0.713	37+64	41.6	0.04	0.3	85.4	50	0.679	35+85	38.5	-2.76	0.3
87.8	50	0.692	36+52	41.7	-2.76	0.3	86.4	50	0.669	35+30	35.8	-2.76	0.3
88	50	0.690	36+43	41.3	-2.76	0.3	87.4	33	0.659	34+80	33.0	0.00	0.3
89	50	0.679	35+85	38.5	-2.76	0.3	88.4	33	0.650	34+31	33.0	0.00	0.6
90	50	0.669	35+30	35.8	-2.76	0.3	89.4	33	0.641	33+83	33.0	0.00	1.0
91	33	0.659	34+80	33.0	0.00	0.3	90.4	33	0.632	33+34	33.0	0.00	0.7
92	33	0.650	34+31	33.0	0.00	0.6	91.4	33	0.622	32+86	33.0	0.00	1.0
93	33	0.641	33+83	33.0	0.00	1.0	92.4	33	0.613	32+38	33.0	0.00	1.0
94	33	0.632	33+34	33.0	0.00	0.7	93.4	33	0.604	31+89	33.0	0.00	1.0
95	33	0.622	32+86	33.0	0.00	1.0	94.4	33	0.595	31+41	33.0	0.00	1.0
96	33	0.613	32+38	33.0	0.00	1.0	95.4	33	0.586	30+92	33.0	0.00	1.0
97	33	0.604	31+89	33.0	0.00	1.0	95.9	33	0.581	30+67	33.0	-2.76	1.0

NORTHBOUND RUN													
Vehicle Performance at Signal System Basis Ideal Acceleration / Braking (No Schedule Margin)							Improved Vehicle Performance (120%) Ideal Acceleration / Braking (No Schedule Margin)						
Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)	Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)
98	33	0.595	31+41	33.0	0.00	1.0	96.9	33	0.572	30+22	30.4	-2.76	1.0
99	33	0.586	30+92	33.0	0.00	1.0	97.9	33	0.564	29+80	27.6	-2.76	1.0
99.5	33	0.581	30+67	33.0	-2.76	1.0	98.9	33	0.557	29+41	24.8	-2.76	0.7
100.5	33	0.572	30+22	30.4	-2.76	1.0	99.9	33	0.551	29+07	22.1	-2.76	0.7
101.5	33	0.564	29+80	27.6	-2.76	1.0	100.9	33	0.545	28+77	19.3	-2.76	0.3
102.5	33	0.557	29+41	24.8	-2.76	0.7	101.9	33	0.540	28+50	16.6	-2.76	0.3
103.5	33	0.551	29+07	22.1	-2.76	0.7	102.9	33	0.536	28+28	13.8	-2.76	0.3
104.5	33	0.545	28+77	19.3	-2.76	0.3	103.9	33	0.532	28+09	11.0	-2.76	0.3
105.5	33	0.540	28+50	16.6	-2.76	0.3	104.9	33	0.529	27+95	8.3	-2.76	0.3
106.5	33	0.536	28+28	13.8	-2.76	0.3	105.9	33	0.528	27+85	5.5	-2.76	0.3
107.5	33	0.532	28+09	11.0	-2.76	0.3	106.9	33	0.526	27+79	2.8	-2.76	0.3
108.5	33	0.529	27+95	8.3	-2.76	0.3	107.9	33	0.526	27+77	0.0	0.00	0.3
109.5	33	0.528	27+85	5.5	-2.76	0.3	109.5			00+00			
110.5	33	0.526	27+79	2.8	-2.76	0.3	110.5			00+00			
111.5	33	0.526	27+77	0.0	0.00	0.3	111.5			00+00			





SOUTHBOUND RUN

Vehicle Performance at Signal System Basis Ideal Acceleration / Braking (No Schedule Margin)							Improved Vehicle Performance (120%) Ideal Acceleration / Braking (No Schedule Margin)						
Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)	Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)
0	40	0.626	33+05	0.0	2.49	-0.3	0	40	0.626	33+05	0.0	2.98	-0.3
1	40	0.626	33+07	2.5	2.49	-0.3	1	40	0.626	33+07	3.0	2.98	-0.3
2	40	0.627	33+13	5.0	2.53	-0.3	2	40	0.628	33+14	6.0	3.03	-0.3
3	40	0.629	33+22	7.5	2.56	-0.3	3	40	0.630	33+25	9.0	3.08	-0.3
4	33	0.632	33+35	10.1	2.54	-0.3	4	33	0.633	33+41	12.1	3.04	-0.3
5	33	0.635	33+51	12.6	2.53	-0.3	5	33	0.636	33+60	15.1	2.99	-0.3
6	33	0.639	33+72	15.1	2.49	-0.3	6	33	0.641	33+85	18.1	2.10	-0.3
7	33	0.643	33+96	17.6	1.87	-0.3	7	33	0.646	34+13	20.2	1.59	-0.7
8	33	0.648	34+23	19.5	1.48	-0.7	8	33	0.652	34+44	21.8	1.42	-0.7
9	33	0.654	34+53	21.0	1.27	-0.7	9	33	0.659	34+77	23.2	1.27	-0.7
10	33	0.660	34+84	22.2	1.21	-0.7	10	33	0.665	35+12	24.5	1.26	-1.0
11	33	0.666	35+18	23.5	1.18	-1.0	11	33	0.672	35+49	25.7	1.16	-1.0
12	33	0.673	35+53	24.6	1.01	-0.7	12	33	0.679	35+87	26.9	1.07	-1.0
13	33	0.680	35+90	25.6	1.00	-1.0	13	33	0.687	36+27	28.0	0.92	-0.7
14	33	0.687	36+28	26.6	0.87	-0.7	14	33	0.695	36+69	28.9	0.92	-1.0
15	33	0.695	36+68	27.5	0.88	-1.0	15	33	0.703	37+12	29.8	0.85	-1.0
16	33	0.702	37+09	28.4	0.76	-0.7	16	33	0.711	37+56	30.7	0.80	-1.0
17	33	0.710	37+51	29.2	0.77	-1.0	17	33	0.720	38+02	31.5	0.75	-1.0
18	33	0.719	37+94	29.9	0.73	-1.0	18	33	0.729	38+49	32.2	0.65	-0.7
19	33	0.727	38+39	30.7	0.70	-1.0	19	33	0.738	38+96	32.9	0.69	-1.0
20	33	0.736	38+84	31.4	0.67	-1.0	19.2	33	0.740	39+07	33.0	0.69	-1.0
21	33	0.744	39+30	32.0	0.57	-0.7	19.2	33	0.740	39+07	33.0	0.00	-1.0
22	33	0.753	39+78	32.6	0.55	-0.7	20.2	33	0.749	39+55	33.0	0.00	-0.7
22.8	50	0.760	40+14	33.0	0.55	-0.3	21.2	50	0.758	40+03	33.0	0.54	-0.3
22.8	50	0.760	40+14	33.0	0.46	-0.3	22.2	50	0.767	40+52	33.5	0.51	-0.3
23.8	50	0.770	40+63	33.5	0.44	-0.3	23.2	50	0.777	41+02	34.1	0.49	-0.3
24.8	50	0.779	41+13	33.9	0.42	-0.3	24.2	50	0.786	41+52	34.5	0.46	-0.3
25.8	50	0.788	41+62	34.3	0.40	-0.3	25.2	50	0.796	42+03	35.0	0.44	-0.3
26.8	50	0.798	42+13	34.7	0.39	-0.3	26.2	50	0.806	42+55	35.4	0.43	-0.3

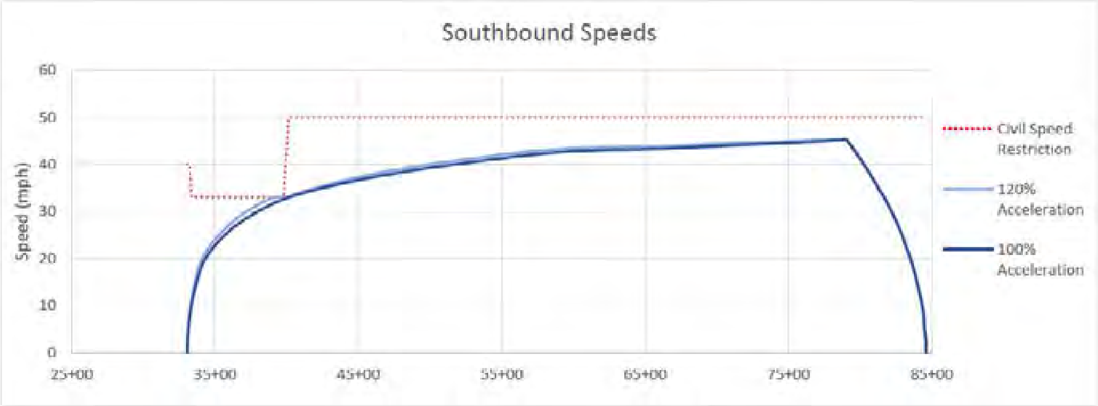
SOUTHBOUND RUN

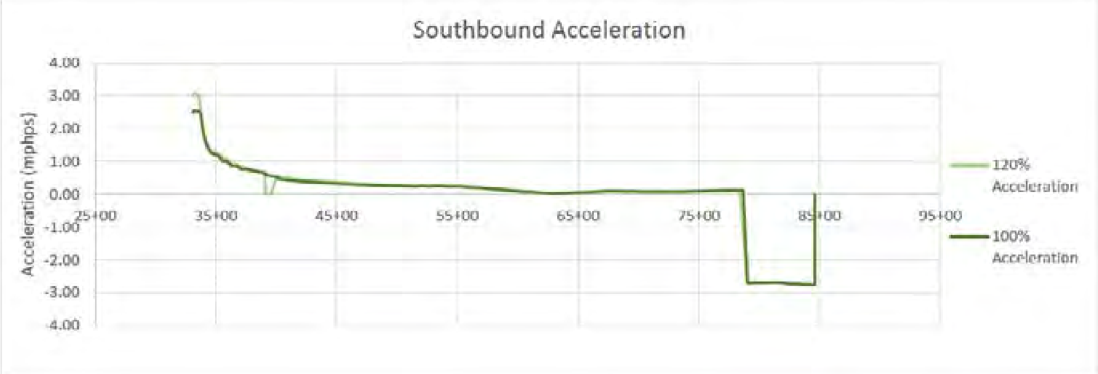
Vehicle Performance at Signal System Basis Ideal Acceleration / Braking (No Schedule Margin)							Improved Vehicle Performance (120%) Ideal Acceleration / Braking (No Schedule Margin)						
Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)	Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)
27.8	50	0.808	42+64	35.1	0.38	-0.3	27.2	50	0.816	43+07	35.9	0.41	-0.3
28.8	50	0.817	43+16	35.5	0.37	-0.3	28.2	50	0.826	43+60	36.3	0.39	-0.3
29.8	50	0.827	43+69	35.9	0.35	-0.3	29.2	50	0.836	44+14	36.7	0.38	-0.3
30.8	50	0.837	44+21	36.2	0.34	-0.3	30.2	50	0.846	44+67	37.1	0.36	-0.3
31.8	50	0.848	44+75	36.5	0.33	-0.3	31.2	50	0.856	45+22	37.4	0.35	-0.3
32.8	50	0.858	45+29	36.9	0.32	-0.3	32.2	50	0.867	45+77	37.8	0.34	-0.3
33.8	50	0.868	45+83	37.2	0.31	-0.3	33.2	50	0.877	46+33	38.1	0.33	-0.3
34.8	50	0.878	46+37	37.5	0.30	-0.3	34.2	50	0.888	46+89	38.4	0.32	-0.3
35.8	50	0.889	46+93	37.8	0.29	-0.3	35.2	50	0.899	47+46	38.8	0.31	-0.3
36.8	50	0.899	47+48	38.1	0.28	-0.3	36.2	50	0.910	48+03	39.1	0.30	-0.3
37.8	50	0.910	48+04	38.4	0.28	-0.3	37.2	50	0.921	48+60	39.4	0.29	-0.3
38.8	50	0.921	48+61	38.6	0.27	-0.3	38.2	50	0.931	49+18	39.7	0.28	-0.3
39.8	50	0.931	49+18	38.9	0.26	-0.3	39.2	50	0.943	49+76	39.9	0.27	-0.3
40.8	50	0.942	49+75	39.2	0.25	-0.3	40.2	50	0.954	50+35	40.2	0.26	-0.3
41.8	50	0.953	50+33	39.4	0.25	-0.3	41.2	50	0.965	50+94	40.5	0.25	-0.3
42.8	50	0.964	50+90	39.7	0.24	-0.3	42.2	50	0.976	51+54	40.7	0.24	-0.3
43.8	50	0.975	51+49	39.9	0.23	-0.3	43.2	50	0.987	52+13	40.9	0.25	-0.4
44.8	50	0.986	52+08	40.1	0.24	-0.4	44.2	50	0.999	52+74	41.2	0.23	-0.4
45.8	50	0.998	52+67	40.4	0.24	-0.4	45.2	50	1.010	53+33	41.4	0.24	-0.5
46.8	50	1.009	53+28	40.6	0.25	-0.5	46.2	50	1.022	53+96	41.7	0.23	-0.5
47.8	50	1.020	53+86	40.9	0.24	-0.5	47.2	50	1.033	54+54	41.9	0.22	-0.5
48.8	50	1.031	54+44	41.1	0.23	-0.5	48.2	50	1.045	55+18	42.1	0.23	-0.6
49.8	50	1.043	55+07	41.3	0.24	-0.6	49.2	50	1.057	55+81	42.3	0.22	-0.6
50.8	50	1.054	55+65	41.6	0.21	-0.5	50.2	50	1.069	56+44	42.6	0.20	-0.5
51.8	50	1.066	56+28	41.8	0.21	-0.5	51.2	50	1.080	57+02	42.8	0.19	-0.5
52.8	50	1.078	56+92	42.0	0.20	-0.5	52.2	50	1.092	57+66	43.0	0.16	-0.4
53.8	50	1.089	57+50	42.2	0.17	-0.4	53.2	50	1.104	58+29	43.1	0.13	-0.3
54.8	50	1.101	58+13	42.4	0.17	-0.4	54.2	50	1.116	58+92	43.2	0.13	-0.3
55.8	50	1.113	58+77	42.5	0.14	-0.3	55.2	50	1.128	59+56	43.4	0.10	-0.2
56.8	50	1.125	59+40	42.7	0.12	-0.2	56.2	50	1.140	60+19	43.5	0.08	-0.1
57.8	50	1.137	60+03	42.8	0.10	-0.1	57.2	50	1.152	60+83	43.6	0.06	0.0
58.8	50	1.148	60+61	42.9	0.08	0.0	58.2	50	1.165	61+51	43.6	0.04	0.0

SOUTHBOUND RUN

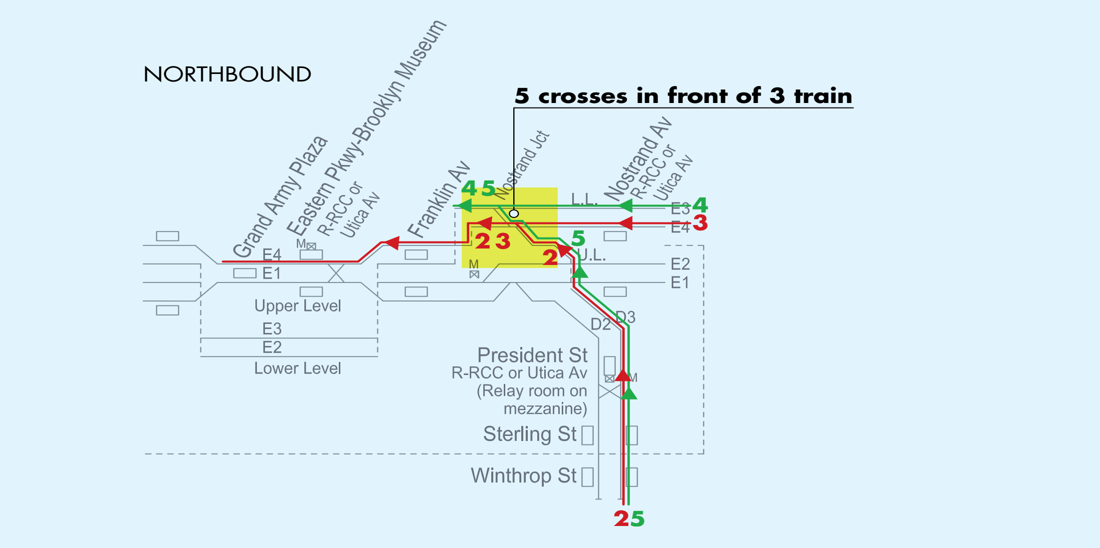
Vehicle Performance at Signal System Basis Ideal Acceleration / Braking (No Schedule Margin)							Improved Vehicle Performance (120%) Ideal Acceleration / Braking (No Schedule Margin)						
Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)	Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)
59.8	50	1.160	61+25	43.0	0.07	0.0	59.2	50	1.177	62+15	43.7	0.02	0.1
60.8	50	1.172	61+88	43.0	0.05	0.0	60.2	50	1.189	62+78	43.7	0.00	0.2
61.8	50	1.184	62+52	43.1	0.03	0.1	61.2	50	1.201	63+41	43.7	0.02	0.1
62.8	50	1.196	63+15	43.1	0.03	0.1	62.2	50	1.213	64+05	43.7	0.02	0.1
63.8	50	1.208	63+78	43.2	0.03	0.1	63.2	50	1.225	64+68	43.7	0.04	0.0
64.8	50	1.220	64+42	43.2	0.05	0.0	64.2	50	1.237	65+31	43.8	0.05	0.0
65.8	50	1.232	65+05	43.2	0.06	0.0	65.2	50	1.250	66+00	43.8	0.07	-0.1
66.8	50	1.244	65+68	43.3	0.06	0.0	66.2	50	1.262	66+63	43.9	0.08	-0.2
67.8	50	1.256	66+32	43.4	0.08	-0.1	67.2	50	1.274	67+27	44.0	0.10	-0.3
68.8	50	1.268	66+95	43.4	0.09	-0.2	68.2	50	1.286	67+90	44.1	0.09	-0.3
69.8	50	1.280	67+58	43.5	0.10	-0.3	69.2	50	1.298	68+53	44.2	0.09	-0.3
70.8	50	1.293	68+27	43.6	0.10	-0.3	70.2	50	1.311	69+22	44.2	0.08	-0.3
71.8	50	1.305	68+90	43.7	0.10	-0.3	71.2	50	1.323	69+85	44.3	0.08	-0.3
72.8	50	1.317	69+54	43.8	0.09	-0.3	72.2	50	1.335	70+49	44.4	0.08	-0.3
73.8	50	1.329	70+17	43.9	0.09	-0.3	73.2	50	1.348	71+17	44.5	0.07	-0.3
74.8	50	1.341	70+80	44.0	0.09	-0.3	74.2	50	1.360	71+81	44.6	0.07	-0.3
75.8	50	1.353	71+44	44.1	0.08	-0.3	75.2	50	1.372	72+44	44.6	0.07	-0.3
76.8	50	1.366	72+12	44.2	0.08	-0.3	76.2	50	1.385	73+13	44.7	0.07	-0.3
77.8	50	1.378	72+76	44.3	0.09	-0.3	77.2	50	1.397	73+76	44.8	0.08	-0.4
78.8	50	1.390	73+39	44.3	0.08	-0.3	78.2	50	1.410	74+45	44.9	0.09	-0.4
79.8	50	1.403	74+08	44.4	0.09	-0.4	79.2	50	1.422	75+08	44.9	0.09	-0.5
80.8	50	1.415	74+71	44.5	0.10	-0.4	80.2	50	1.435	75+77	45.0	0.10	-0.5
81.8	50	1.427	75+35	44.6	0.10	-0.5	81.2	50	1.447	76+40	45.1	0.10	-0.5
82.8	50	1.440	76+03	44.7	0.11	-0.5	82.2	50	1.460	77+09	45.2	0.11	-0.6
83.8	50	1.452	76+67	44.8	0.11	-0.6	83.2	50	1.472	77+72	45.3	0.12	-0.6
84.8	50	1.465	77+35	44.9	0.12	-0.6	84.2	50	1.485	78+41	45.5	0.12	-0.6
85.8	50	1.477	77+99	45.1	0.12	-0.6	85.1	50	1.496	78+99	45.6	-2.71	-0.6
86.8	50	1.490	78+67	45.2	0.12	-0.6	85.8	50	1.504	79+41	43.7	-2.70	-0.6
87.4	50	1.497	79+04	45.3	-2.71	-0.6	86.8	50	1.516	80+04	41.0	-2.70	-0.6
87.9	50	1.504	79+41	43.7	-2.70	-0.6	87.8	50	1.527	80+63	38.3	-2.70	-0.6
88.9	50	1.516	80+04	41.0	-2.70	-0.6	88.8	50	1.537	81+15	35.6	-2.69	-0.6
89.9	50	1.527	80+63	38.3	-2.70	-0.6	89.8	50	1.547	81+68	32.9	-2.69	-0.6

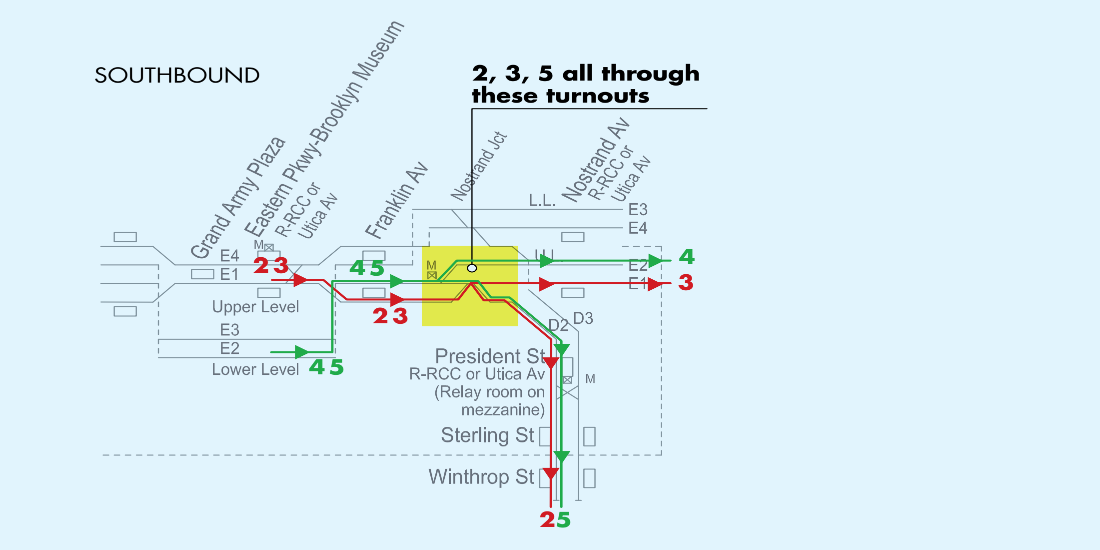
SOUTHBOUND RUN													
Vehicle Performance at Signal System Basis Ideal Acceleration / Braking (No Schedule Margin)							Improved Vehicle Performance (120%) Ideal Acceleration / Braking (No Schedule Margin)						
Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)	Time (sec)	Civil Speed Restriction (mph)	TOM Milepost (mile)	NYCT Station (mile)	Speed (mph)	Accel (mphps)	Grade (%)
90.9	50	1.537	81+15	35.6	-2.69	-0.6	90.8	50	1.556	82+16	30.2	-2.71	-0.6
91.9	50	1.547	81+68	32.9	-2.69	-0.6	91.8	50	1.564	82+58	27.5	-2.74	-0.5
92.9	50	1.556	82+16	30.2	-2.71	-0.6	92.8	50	1.571	82+95	24.8	-2.74	-0.4
93.9	50	1.564	82+58	27.5	-2.74	-0.5	93.8	50	1.577	83+27	22.0	-2.73	-0.4
94.9	50	1.571	82+95	24.8	-2.74	-0.4	94.8	50	1.583	83+58	19.3	-2.76	-0.4
95.9	50	1.577	83+27	22.0	-2.73	-0.4	95.8	50	1.588	83+85	16.6	-2.76	-0.2
96.9	50	1.583	83+58	19.3	-2.76	-0.4	96.8	50	1.592	84+06	13.8	-2.75	-0.2
97.9	50	1.588	83+85	16.6	-2.76	-0.2	97.8	50	1.596	84+27	11.0	-2.76	-0.2
98.9	50	1.592	84+06	13.8	-2.75	-0.2	98.8	50	1.599	84+43	8.3	-2.76	-0.1
99.9	50	1.596	84+27	11.0	-2.76	-0.2	99.8	50	1.600	84+48	5.5	-2.76	-0.1
100.9	50	1.599	84+43	8.3	-2.76	-0.1	100.8	50	1.602	84+59	2.8	-2.76	-0.1
101.9	50	1.600	84+48	5.5	-2.76	-0.1	101.8	50	1.602	84+59	0.0	0.00	-0.1
102.9	50	1.602	84+59	2.8	-2.76	-0.1							
103.9	50	1.602	84+59	0.0	0.00	-0.1							





APPENDIX "K"
RUSH HOUR SCHEDULING AND CONFLICTS AT NOSTRAND JUNCTION INTERLOCKING





As shown in the tables below, during the 7 AM hour Northbound, 9 of 39 trips involve a 2, 3, or 5 Line train following behind another 2, 3, or 5 Line train with a gap of one minute or less.

During the 5 PM hour Southbound, 6 of 42 trips involve a 2, 3, or 5 Line train following behind another 2, 3, or 5 Line train with a gap of one minute or less.

Table K-1. 7:00 – 8:00 AM Northbound

Route	Train	Flatbush Av	New Lots	Utica Av	Nostrand Av	Franklin Av	Gap at B
East Pk	4			7:01		7:05	
East Pk	4			7:04		7:08	
Nost Av	5	7:01				7:13	0:08
East Pk	4			7:11		7:15	
Nost Av	2	7:04				7:16	0:03
East Pk	4			7:13		7:17	
Nost Av	5	7:08				7:20	0:04
East Pk	3		7:02	7:14	7:18	7:21	0:01
East Pk	4			7:19		7:23	
Nost Av	2	7:13				7:25	0:04
East Pk	4			7:22		7:26	
East Pk	3		7:10	7:22	7:27	7:29	0:04
Nost Av	5	7:17				7:30	0:01
East Pk	4			7:28		7:32	
Nost Av	2	7:22				7:34	0:04
Nost Av	5		7:17	7:31		7:35	0:01
East Pk	3		7:19	7:31	7:35	7:36	0:01
East Pk	4			7:34		7:38	
Nost Av	2		7:21	7:33		7:40	0:04
Nost Av	5	7:27				7:40	0:00
East Pk	3		7:25	7:37	7:42	7:44	0:04
East Pk	4			7:41		7:45	
Nost Av	2	7:32				7:46	0:02
Nost Av	5	7:34				7:47	0:01
East Pk	4			7:46		7:50	
East Pk	3		7:33	7:45	7:50	7:51	0:04
East Pk	4			7:49		7:53	
Nost Av	2	7:40				7:54	0:03
Nost Av	5	7:43				7:56	0:02
East Pk	3		7:41	7:54	7:58	7:59	0:03
East Pk	4			7:56		7:59	
Nost Av	2	7:47				8:02	0:03
Nost Av	5	7:49				8:02	0:00
East Pk	3		7:47	7:59	8:04	8:06	0:04
Nost Av	5	7:54				8:07	0:01
Nost Av	2	7:55				8:08	0:01
East Pk	3		7:53	8:05	8:10	8:11	0:03
Nost Av	2	8:00				8:14	0:03
East Pk	3		7:59	8:11	8:16	8:18	0:04

Table K-2. 5:00 – 6:00 PM Southbound

Route	Train	Flatbush Av	New Lots	Utica Av	Nostrand Av	Franklin Av	Gap at B
Nost Av	5	17:00				17:13	
East Pk	3	17:01	17:02	17:06	17:18		0:01
East Pk	4	17:02		17:07			
Nost Av	2	17:03				17:16	0:02
Nost Av	5	17:05				17:18	0:02
East Pk	3	17:07	17:08	17:12	17:24		0:02
East Pk	4	17:07		17:11			
East Pk	4	17:09		17:13			
Nost Av	2	17:10				17:23	0:03
Nost Av	5	17:11				17:25	0:01
East Pk	4	17:13		17:17			
East Pk	3	17:14	17:15	17:22	17:34		0:03
Nost Av	2	17:17				17:33	0:03
Nost Av	5	17:20				17:35	0:03
East Pk	3	17:21	17:22	17:29	17:41		0:01
East Pk	4	17:22		17:26			
Nost Av	5	17:22		17:27			0:01
Nost Av	2	17:24				17:38	0:02
East Pk	4	17:24		17:29			
Nost Av	5	17:26				17:40	0:02
East Pk	3	17:28	17:29	17:37	17:49		0:02
East Pk	4	17:28		17:32			
Nost Av	2	17:30				17:45	0:02
East Pk	4	17:31		17:35			
Nost Av	5	17:33				17:47	0:03
East Pk	3	17:35	17:36	17:44	17:56		0:02
East Pk	4	17:35		17:39			
Nost Av	2	17:39				17:52	0:04
Nost Av	5	17:41				17:54	0:02
East Pk	3	17:42	17:43	17:48	18:00		0:01
East Pk	4	17:43		17:47			
Nost Av	2	17:44				17:57	0:02
Nost Av	5	17:46				17:59	0:02
Nost Av	2	17:48				18:03	0:02
East Pk	4	17:48		17:52			
East Pk	3	17:50	17:51	17:56	18:08		0:02
East Pk	4	17:50		17:54			
Nost Av	5	17:53		17:57			0:03
Nost Av	2	17:55				18:10	0:02
East Pk	4	17:56		18:00			
East Pk	3	17:57	17:58	18:03	18:15		0:02
Nost Av	5	17:58				18:12	0:01

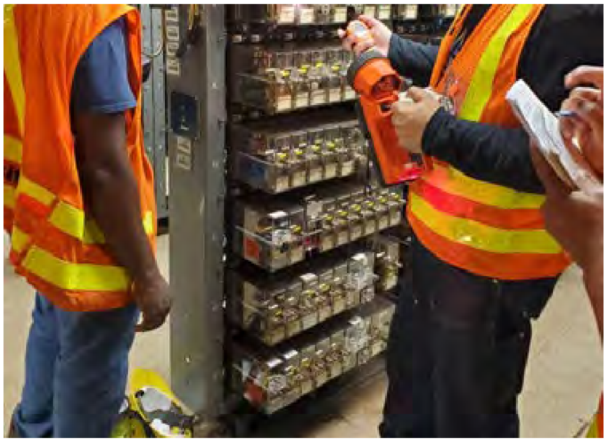
APPENDIX "L"

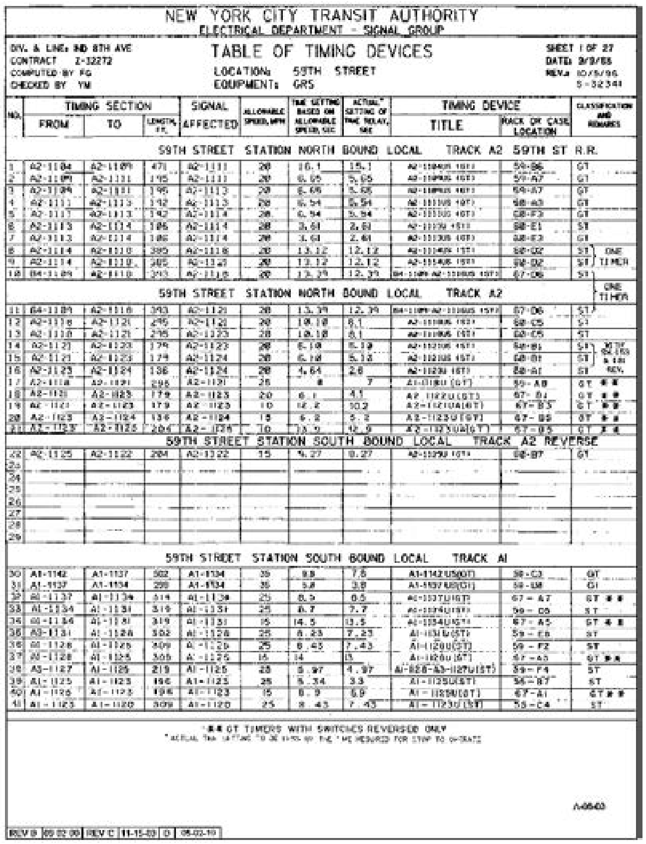
GRADE TIME / STATION TIME FIELD TEST REPORT, ANALYSIS, AND RECOMMENDATIONS

NOTE: work based on recommendations made in this section has occurred since issuance of the draft version of this report to nyct and is discussed at the end of the original text below

NYCT GRADE TIME (GT)/STATION TIME (ST) STATIC TEST DEMONSTRATION AND RESULTS (NYCT CURRENT TEST METHODOLOGY)

Current NYCT periodic, static verification of ST/GT signals is isolated to testing of timer relay settings/operability and comparison against the associated Table of Timing Devices. Relays are energized in between trains and a stopwatch is utilized to verify the time it takes for the relay to pick. During the field demonstration on August 23 - 24, 2019 at 59th Street-Columbus Circle Relay Room, GT and ST timers associated with the A1-1123 and A1-1125 signals were checked.





NEW YORK CITY TRANSIT AUTHORITY
ELECTRICAL DEPARTMENT - SIGNAL GROUP

TABLE OF TIMING DEVICES

DIV. & LINE: IND 8TH AVE
CONTRACT Z-32272
COMPUTED BY FG
CHECKED BY YM

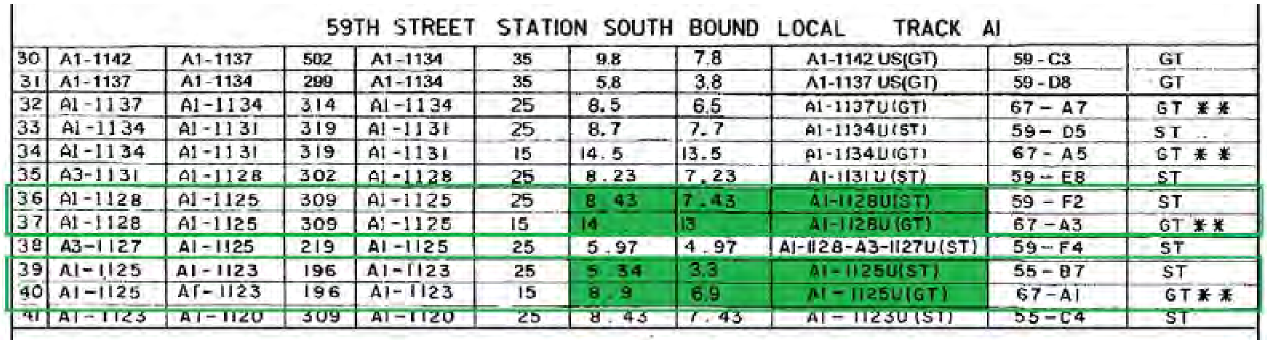
LOCATION: 59TH STREET
EQUIPMENT: GRS

SHEET 1 OF 27
DATE: 3/9/88
REV.: 10/6/96
S-32341

NO.	TIMING SECTION			SIGNAL AFFECTED	ALLOWABLE SPEED, MPH	TIME SETTING BASED ON ALLOWABLE SPEED, SEC	ACTUAL* SETTING OF TIME RELAY, SEC	TIMING DEVICE		CLASSIFICATION AND REMARKS
	FROM	TO	LENGTH, FT.					TITLE	RACK OR CASE LOCATION	
	59TH STREET STATION NORTH BOUND LOCAL TRACK A2 59TH ST R.R.									
1	A2-1104	A2-1109	471	A2-1111	20	16.1	15.1	[illegible]	59-B6	GT
2	A2-1109	A2-1111	195	A2-1111	20	6.65	5.65	[illegible]	59-A7	GT
3	A2-1109	A2-1111	195	A2-1113	20	6.65	5.65	[illegible]	59-A7	GT
4	A2-1111	A2-1113	192	A2-1113	20	6.54	5.54	[illegible]	58-A3	GT
5	A2-1111	A2-1113	192	A2-1114	20	6.54	5.54	[illegible]	58-F3	GT
6	A2-1113	A2-1114	106	A2-1114	20	3.61	2.61	[illegible]	58-E1	ST
7	A2-1113	A2-1114	106	A2-1114	20	3.61	2.61	[illegible]	58-E3	GT
8	A2-1114	A2-1118	385	A2-1118	20	13.12	12.12	[illegible]	58-D2	ST } ONE TIMER
9	A2-1114	A2-1118	385	A2-1121	20	13.12	12.12	[illegible]	58-D2	ST
10	B4-1109	A2-1118	393	A2-1118	20	13.39	12.39	[illegible]	67-D6	ST } ONE TIMER
	59TH STREET STATION NORTH BOUND LOCAL TRACK A2									
11	B4-1109	A2-1118	393	A2-1121	20	13.39	12.39	[illegible]	67-D6	ST
12	A2-1118	A2-1121	295	A2-1121	20	10.10	8.1	[illegible]	58-C5	ST
13	A2-1118	A2-1121	295	A2-1123	20	10.10	8.1	[illegible]	58-C5	ST
14	A2-1121	A2-1123	179	A2-1123	20	6.10	5.10	[illegible]	58-B1	ST } [illegible] REV.
15	A2-1121	A2-1123	179	A2-1124	20	6.10	5.10	[illegible]	58-B1	ST
16	A2-1123	A2-1124	136	A2-1124	20	4.64	2.8	[illegible]	58-A1	ST
17	A2-1118	A2-1121	295	A2-1121	25	8	7	A2-1118U (GT)	59-A8	GT **
18	A2-1121	A2-1123	179	A2-1123	20	6.1	4.1	A2-1122U(GT)	67-D4	GT **
19	A2-1121	A2-1123	179	A2-1123	10	12.2	10.2	A2-1121UA(GT)	67-B5	GT **
20	A2-1123	A2-1124	136	A2-1124	15	6.2	5.2	A2-1123U(GT)	67-B5	GT **
21	A2-1123	A2-1125	204	A2-1125	10	13.9	12.9	A2-1123UA(GT)	67-B5	GT **
	59TH STREET STATION SOUTH BOUND LOCAL TRACK A2 REVERSE									
22	A2-1125	A2-1122	204	A2-1122	15	9.27	8.27	[illegible]	58-B7	GT
23										
24										
25										
26										
27										
28										
29										
	59TH STREET STATION SOUTH BOUND LOCAL TRACK AI									
30	A1-1142	A1-1137	502	A1-1134	35	9.8	7.8	A1-1142 US(GT)	59-C3	GT
31	A1-1137	A1-1134	299	A1-1134	35	5.8	3.8	A1-1137 US(GT)	59-D8	GT
32	A1-1137	A1-1134	314	A1-1134	25	8.5	6.5	A1-1137U(GT)	67-A7	GT **
33	A1-1134	A1-1131	319	A1-1131	25	8.7	7.7	A1-1134U(ST)	59-D5	ST
34	A1-1134	A1-1131	319	A1-1131	15	14.5	13.5	A1-1134U(GT)	67-A5	GT **
35	A3-1131	A1-1128	302	A1-1128	25	8.23	7.23	A1-1131U(ST)	59-E8	ST
36	A1-1128	A1-1125	309	A1-1125	25	8.43	7.43	A1-1128U(ST)	59-F2	ST
37	A1-1128	A1-1125	309	A1-1125	15	14	13	A1-1128U(GT)	67-A3	GT **
38	A3-1127	A1-1125	219	A1-1125	25	5.97	4.97	A1-1128-A3-1127U(ST)	59-F4	ST
39	A1-1125	A1-1123	196	A1-1123	25	5.34	3.3	A1-1125U(ST)	55-B7	ST
40	A1-1125	A1-1123	196	A1-1123	15	8.9	6.9	A1-1125U(GT)	67-A1	GT **
41	A1-1123	A1-1120	309	A1-1120	25	8.43	7.43	A1-1123U(ST)	55-C4	ST

** GT TIMERS WITH SWITCHES REVERSED ONLY
* ACTUAL TIME SETTING TO BE [illegible] THE TIME REQUIRED FOR STOP TO OPERATE

REV B	09-22-00	REV C	11-15-03	D	05-02-10



	59TH STREET STATION SOUTH BOUND LOCAL TRACK AI									
30	A1-1142	A1-1137	502	A1-1134	35	9.8	7.8	A1-1142 US(GT)	59 - C3	GT
31	A1-1137	A1-1134	299	A1-1134	35	5.8	3.8	A1-1137 US(GT)	59 - D8	GT
32	A1-1137	A1-1134	314	A1-1134	25	8.5	6.5	A1-1137U(GT)	67 – A7	GT **
33	A1-1134	A1-1131	319	A1-1131	25	8.7	7.7	A1-1134U(ST)	59– D5	ST
34	A1-1134	A1-1131	319	A1-1131	15	14.5	13.5	A1-1134U(GT)	67 – A5	GT **
35	A3-1131	A1-1128	302	A1-1128	25	8.23	7.23	A1-1131U(ST)	59 – E8	ST
36	A1-1128	A1-1125	309	A1-1125	25	8.43	7.43	A1-1128U(ST)	59 – F2	ST
37	A1-1128	A1-1125	309	A1-1125	15	14	13	A1-1128U (GT)	67 – A3	GT **
38	A3-1127	A1-1125	219	A1-1125	25	5.97	4.97	A1-1128-A3-1127U(ST)	59– F4	ST
39	A1-1125	A1-1123	196	A1-1123	25	5.34	3.3	A1-1125U(ST)	55 – B7	ST
40	A1-1125	A1-1123	196	A1-1123	15	8.9	6.9	A1-1125U(GT)	67 – A1	GT **
41	A1-1123	A1-1120	309	A1-1120	25	8.43	7.43	A1-1123U(ST)	55 – C4	ST

The results of the static testing at the relay room were as follows:

Table L-1. Static Testing Results at 59th Street-Columbus Circle Relay Room.

Timing Device	Device Type	Timer Setting (seconds)	Time Recorded (seconds)		
			First Run	Second Run	Average
A1-1128U (GT)	Digital	13.0	13.65	13.65	13.65
A1-1125U (GT)	Analog	6.9	7.1	7.3	7.2
A1-1128U (ST)	Analog	7.43	7.5	7.43	7.465
A1-1125U (ST)	Analog	3.3	3.6	3.6	3.6

Due to the use of a stopwatch, this method will provide general assurance that the timer is set properly but cannot provide a great deal of accuracy. This is appropriate to ensure timers are not drastically malfunctioning but given that small variances in timer performance may translate to significant differences in operating speed required to clear a signal (depending on the timing section length), this can be improved upon. Recognizing this, NYCT is currently developing field test equipment to assist maintainers in obtaining accurate measurement resolution.

NYCT PROTOTYPE TESTING EQUIPMENT DEMONSTRATION (NYCT PLANNED TEST METHODOLOGY)

NYCT demonstrated their new field test equipment, called Time Capture Test Units (TCTUs). The Relay (TCTUR) version of this may be used to supplement or replace existing static test procedures and more precisely gauge timer relay performance when compared to the method described above. During the field demonstration on August 23 - 24, 2019, NYCT showed that different relay types have differing average offsets from the set times.

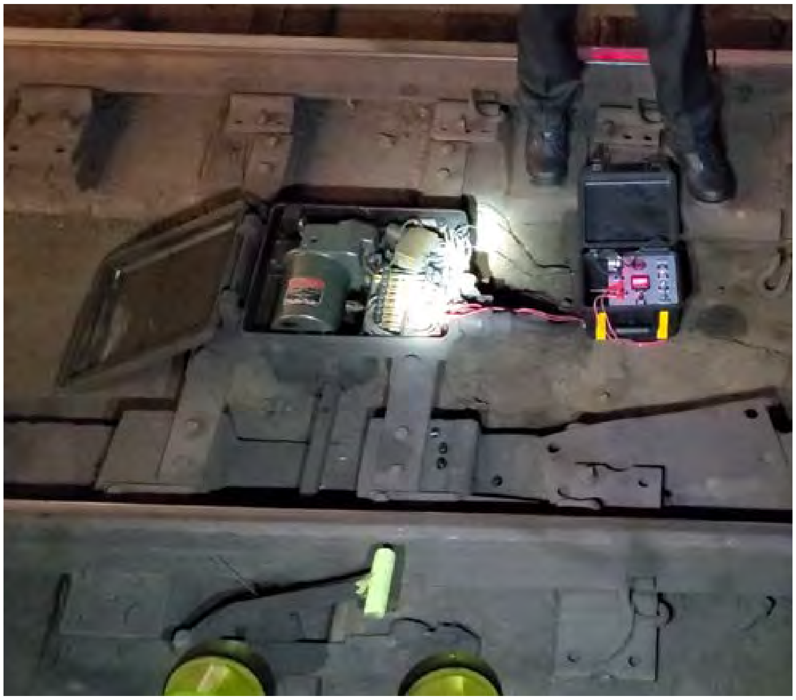
Figure L-1. NYCT TCTUR with Alstom B2 Micron Relay.

The Alstom B2 Micron relay, as illustrated in Figure L-1, was set to 4.5 seconds. The TCTU showed that the total time from when energy was provided to the relay until it picked was actually 5.085 seconds. This additional pick time of ~0.6 seconds was found by NYCT to be typical of the Alstom device and held true throughout the field demonstration.

Figure L-2. NYCTY TCTUR with Ansaldo PN-150 EVT Relay.

By comparison, the Ansaldo PN-150 EVT timer relay (illustrated above) performed much more closely to the timer setting. The Ansaldo relay appears to take equipment delays into account, unlike the Alstom relay. TCTUR measurements in this case averaged ~0.05 seconds from the timer setting value.

Figure L-3. NYCT TCTUS.



The TCTUS (Stop) was the other prototype field device demonstrated by NYCT (shown above). This was utilized to capture the total drive time of a trip stop. The typical drive time of a stop was shown to be ~0.71-0.75 seconds.

STV PROPOSED ST SIGNAL STATIC TEST PROCEDURE RESULTS

Static testing of the same ST and GT signals using the STV recommend procedure was also conducted overnight on August 23 - 24, 2019 between trains on Track 1 at 59th Street – Columbus Circle station.

Figure L-4. ST Signal at 59th Street-Columbus Circle Station.

Track shunts were used to simulate trains both on the timing and cutback sections of the control line for ST testing as shown above. Switches were set reverse to initiate the GTs as necessary for that portion of the testing. Video was taken of each test attempt. In the field, video review via an Android OS application provided a general estimate of what all signaling system element delays were combined. Results were as shown in Table L-2.

Table L-2. Simulation of Signaling System Element Delays.

Timing Device	Designed Time (seconds)	Timer Setting (seconds)	Time (seconds) from Shunt Placed to Trip Stop Driven Below Top of Rail	
			First Run	Second Run
A1-1128U (GT)	14	13	~16.5	~16.5
A1-1125U (GT)	8.9s	6.9	~10	~10
A1-1128U (ST)	8.43s	7.43	~10	~10
A1-1125U (ST)	5.34s	3.3	~6	~6

Following testing, video was downloaded to a PC in order to be able to carefully analyze the clearing times using an application that could step through the video frame by frame and reported timestamps more precisely.

TEST RESULTS – DETAILED ANALYSIS

It was found through use of the NYCT prototype TCTU device that while Ansaldo relay pick time was close to the set time, the Alstom relays had a 0.6 second pick delay. This can actually be quite significant. Taking the A1-1125U(ST) as an example, the design time is 5.34 seconds and the timing section is 196 feet long. (196ft/5.34s) x (15/22) = 25.02 mph. This closely matches the posted speed in the field. However, if it really takes 5.34+0.6 = 5.94 seconds for the timing circuit to clear, then (196ft/5.94s) x (15/22) = 22.27 mph.

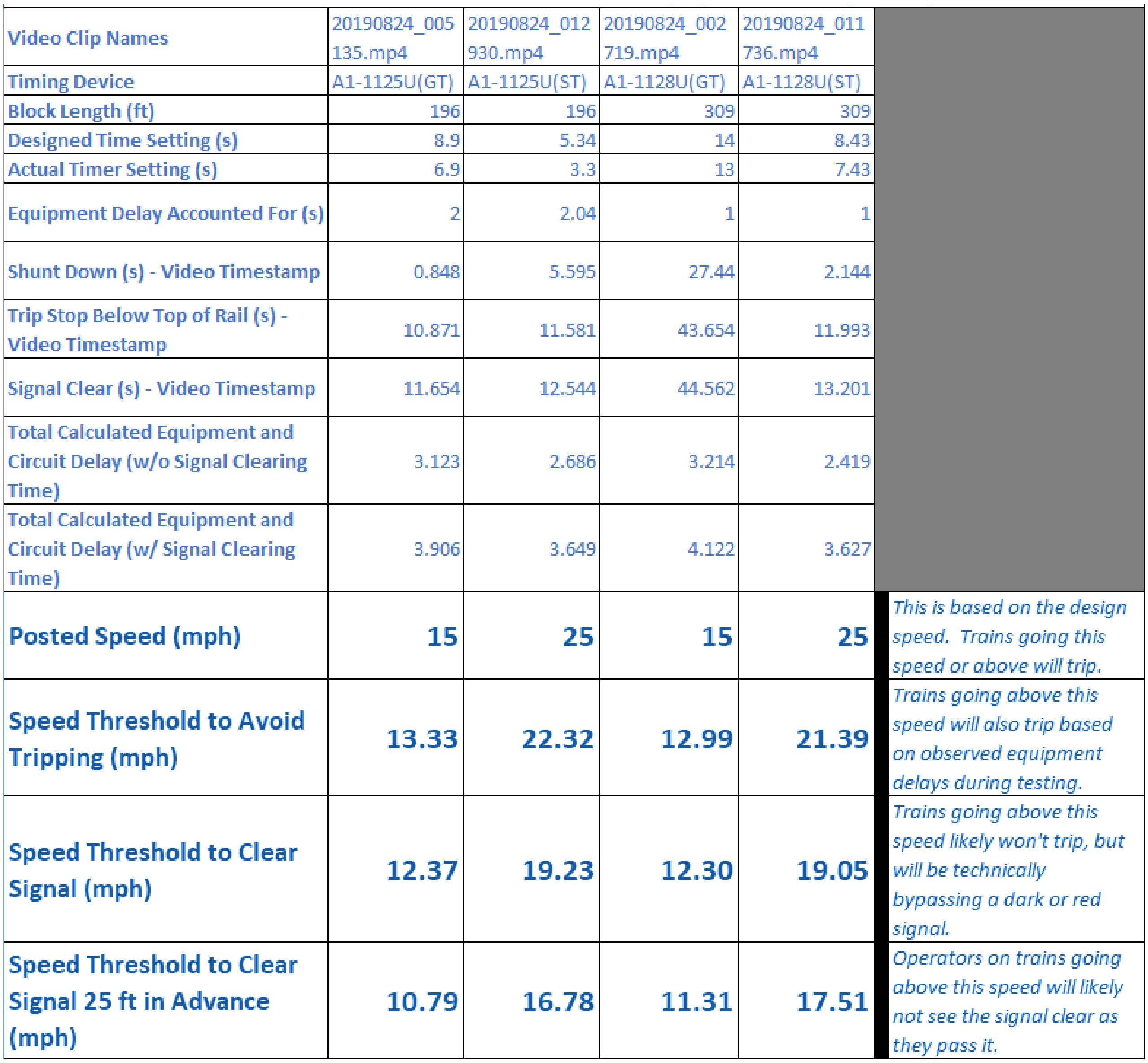
This means a train actually needs to travel slower than the posted speed to clear the timing section (and slower yet for an operator to see the signal clear). In the case of A1-1125U(ST), the NYCT table of timing devices for this circuit allow for 2 seconds of total equipment delay to account for this, along with the other delays in the circuits, trip stop, etc. Since there is a significant difference in the performance of the Ansaldo relay, however, it's important to note that the assumed delay is not typical and needs to be evaluated on a case by case basis both when equipment is commissioned and when it is replaced. For example, if an Alstom relay is replaced with an Ansaldo relay and the equipment delay has been reduced, this may need to be accounted for in the timer settings. It is never acceptable to overestimate the delay, as this can cause a train moving faster than the design speed to clear a timing section without being tripped.

The TCTUS device was able to account for another ~0.7s delay for the trip stop to drive. The mechanical portion of a trip stop is prone to having a higher drive time variation depending on maintenance and age.

When using the STV recommended test procedure, the circuit and signal clearing delays are also apparent. Maintaining the A1-1125U(ST) for detailed analysis, review of the video footage and associated calculations reveal the following:

- This particular ST element was set at 3.3 seconds in the relay room (a recently updated value from 4.3 seconds changed on May 2, 2019). The calculated design time per the table of timing devices is 5.34 seconds. NYCT is therefore assuming 2 seconds of total equipment delay. Our testing revealed a ~2.6 second delay until the trip stop drives sufficiently to not trip an approaching train but given that overestimating equipment delay may result in an unsafe condition, a 2 seconds setting is reasonable unless more extensive testing shows higher values (e.g. 2.4 seconds or more) is acceptable in all cases.
- The NYCT/STV joint testing provided clear illustration of the equipment delays involved and their substantial impacts. With such a short timing section, these small variances are impactful on maximum possible operating speeds when compared to posted speeds (which match the maximum allowable design speeds). Table L-3 summarizes this for each ST and GT element that was tested on August 23 - 24, 2019.

Table L-3. STV Recommended Test Procedure – Equipment Delay Analysis.



Video Clip Names	20190824_005 135.mp4	20190824_012 930.mp4	20190824_002 719.mp4	20190824_011 736.mp4	
Timing Device	A1-1125U(GT)	A1-1125U(ST)	A1-1128U(GT)	A1-1128U(ST)	
Block Length (ft)	196	196	309	309	
Designed Time Setting (s)	8.9	5.34	14	8.43	
Actual Timer Setting (s)	6.9	3.3	13	7.43	
Equipment Delay Accounted For (s)	2	2.04	1	1	
Shunt Down (s) - Video Timestamp	0.848	5.595	27.44	2.144	
Trip Stop Below Top of Rail (s) - Video Timestamp	10.871	11.581	43.654	11.993	
Signal Clear (s) - Video Timestamp	11.654	12.544	44.562	13.201	
Total Calculated Equipment and Circuit Delay (w/o Signal Clearing Time)	3.123	2.686	3.214	2.419	
Total Calculated Equipment and Circuit Delay (w/ Signal Clearing Time)	3.906	3.649	4.122	3.627	
Posted Speed (mph)	**15**	**25**	**15**	**25**	*This is based on the design speed. Trains going this speed or above will trip.*
Speed Threshold to Avoid Tripping (mph)	**13.33**	**22.32**	**12.99**	**21.39**	*Trains going above this speed will also trip based on observed equipment delays during testing.*
Speed Threshold to Clear Signal (mph)	**12.37**	**19.23**	**12.30**	**19.05**	*Trains going above this speed likely won't trip, but will be technically bypassing a dark or red signal.*
Speed Threshold to Clear Signal 25 ft in Advance (mph)	**10.79**	**16.78**	**11.31**	**17.51**	*Operators on trains going above this speed will likely not see the signal clear as they pass it.*

The critical thing to note here is that, based on testing and these calculations, if a train travels at the currently posted speed it will trip at the associated signal. The posted speeds do not reflect the speeds required to clear the signal in the field, they reflect the conservative design speeds meant to enforce speeds in a fail-safe manner. Timers are set in a manner that offsets some of this impact but cannot offset all of the impact without potentially compromising safety. Steps that NYCT has taken and continues to take in order to produce more accurate, safe offset values are prudent, but having some real-world delay is an unavoidable limitation of the traditional block signaling system.

To be clear: the NYCT signal system design does its job today: it protects trains from over-speeding, but sometimes too aggressively due to the nature of the design and equipment. The goal is to use newer technologies and adjust procedures to improve the accuracy of speed control as much as safely possible while waiting for CBTC modernization.

CONCLUSIONS AND RECOMMENDATIONS

The NYCT block signaling system effectively limits the speed around curves and allows trains to move closer together by way of GT and ST elements, respectively. However, these are subject to significant equipment and circuit tolerances that cause slower speeds to be enforced than the posted/design speeds. Particularly in shorter timing sections, this makes it difficult for train operators to be able to travel routinely at the currently posted speed limits with assurance that their train will not be tripped and induced into emergency braking. More accurate measurements of these equipment and circuit tolerances are possible, and adjustments to the timers may be made that allows train operation closer to the posted speed limits. On a case by case basis; areas with solid state interlockings, for example, may have even more delays to account for.

NYCT has already re-adjusted many timers based on testing and is replacing old (more difficult to set/adjust) timer relays. NYCT has also developed more accurate measurement methodologies and equipment employing modern technologies and tools that they will soon apply in practice. These efforts should be continued and expanded so that values may be determined that help safely minimize equipment delay/tolerance impacts on operations.

To be clear: while there is the potential for improvements, the tolerance characteristics described reflect a signaling system limitation under the existing signaling technologies being utilized by NYCT. Civil speed control enforcement tolerances are much smaller in systems that utilize car-borne equipment to perform these tasks, such as cab signaling, Positive Train Control (PTC), and CBTC, and there is no need for ST elements at all. Despite potential improvements under the existing signaling system, there are also always conditions, e.g. vehicles not immediately shunting as they enter a timing block, that may cause the circuit to not operate as designed even if the train is moving slowly. Along with the equipment/circuit tolerances, this is why it has been traditionally the convention to have operators wait for the signal to clear before proceeding, as the delay due to an accidental emergency brake application is counter-productive to the goal of speeding up train movement. Finally, it is not acceptable to over-estimate timer tolerances. If the elements involved ever operate more rapidly than the timer settings account for, the train will be able to travel at a faster speed than the design allows (potentially resulting in an unsafe condition).

Given these things, NYCT should consider the following recommendations for areas utilizing the traditional block signal system elements without CBTC modernization planned in the near future:

1. Continue to re-evaluate equipment and circuit tolerances using the new tools and methodologies already under development by NYCT, as well at the STV recommended test procedure to minimize the need for the use of test trains. Adjust timers where appropriate and safe.

2. As demonstrated elsewhere in this report, calculate the differences in speed between the necessarily conservative offset decided upon in recommendation no. #1 and the actual average performance of the system from the time the train normally shunts to the time the signal clears, allowing sufficient sighting distance for the operator (as determined by NYCT).

3. After all efforts are made to minimize tolerances, if there is still a discrepancy consider modifying the posted speed, rather than just continuing to use the design speed. NYCT will then be providing a target speed to train operators that (with the exception of rare extenuating circumstances such as loss of shunt or a slow to clear trip stop) corresponds to a properly clearing signal that an operator can see while still in the timing section. While

this value represents a slower speed, it is far more accurate to the actual performance of the system. STV believes that this will result in more consistent, higher average speeds that train operators can trust, with fewer accidental emergency brake applications and ensuing delays. This is not a recommendation for a reduction in speed; this is a recommendation to post speeds that match what the train can consistently achieve without tripping after first calibrating the timers as effectively as possible.

Actions on the recommendations above taken subsequent to the draft version of this report being issued to NYCT

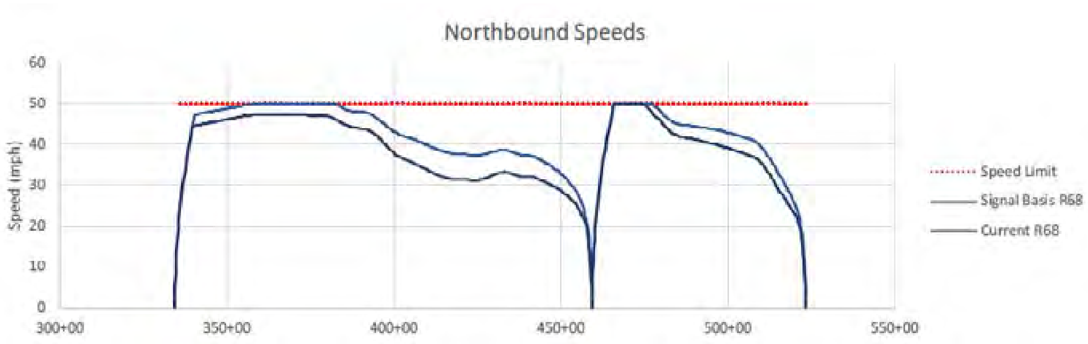
NYCT has incorporated many of the associated recommendations into further development of their prototype test equipment. The most recent iteration of the device is highly suitable for periodic maintenance activities and measures the full equipment delay in the circuit by incorporating a shunt to simulate train occupancy, eliminating the need for post-test analysis. NYCT has also added overload/shock hazard protection elements to the circuit and a strobe light to warn train operators of the device's presence on the track. NYCT and STV tested this device on December 3, 2019 and measured values were found to be consistent with the values found during the testing on August 23 and 24, 2019 via testing with video-based post analysis. This device will continue to be developed and ruggedized for maintainers' use.

APPENDIX "M"

OPERATIONS MODEL RESULTS, R68 CAR CLASS PERFORMANCE: N LINE EXPRESS TRIPS

- Northbound Travel Time Savings = 34 seconds
- Southbound Travel Time Savings = 46 seconds
- Total Travel Time Savings = 80 seconds
- Average Per-Stop Travel Time Savings (4 stops) = 20 seconds per station stop

Current Performance R68					Signal System Basis R68				
N Line Northbound in Brooklyn					N Line Northbound in Brooklyn				
From	To	Distance (mi)	Time (min)	Speed (mph)	From	To	Distance (mi)	Time (min)	Speed (mph)
59th St	36th St	1.21	2.14	34.0	59th St	36th St	1.21	2.00	36.4
36th St	Atlantic	2.36	4.05	35.0	36th St	Atlantic	2.36	3.64	39.0
Total		**3.58**	**6.17**	**34.7**	**Total**		**3.58**	**5.63**	**38.1**



Current Performance R68					Signal System Basis R68				
N Line Southbound in Brooklyn					N Line Southbound in Brooklyn				
From	To	Distance (mi)	Time (min)	Speed (mph)	From	To	Distance (mi)	Time (min)	Speed (mph)
Atlantic	36th St	2.37	4.02	35.3	Atlantic	36th St	2.37	3.65	38.9
36th St	59th St	1.21	2.75	26.4	36th St	59th St	1.21	2.35	30.9
Total		**3.58**	**6.77**	**31.7**	**Total**		**3.58**	**6.00**	**35.8**

APPENDIX "N"

LUNAR ASPECT DISPLAYS

Lunar aspect displays are placed on some signals to denote when a red signal is red not because of track occupancy ahead, but that the timer part of the circuit (either Grade Time or Station Time) is the reason for the signal being red. As a means of providing more information to the Train Operator the recommendation is being made to have the lunar signal flash and as the timer is counting down to zero speed up the frequency of the flashing to correspond with how close to the end of the timer cycle the circuit is in. In other words, it begins flashing slowly and speeds up as the cycle is running down to zero. This could be an alternative to, or designed to work in conjunction with, the countdown timers NYCT has recently been installing for GT signals (which have been reportedly difficult to see from a distance).

The Train Operator can gauge his/her train speed accordingly and not apply too much brake in anticipation of having to stop or further slowdown the train. It is akin to the "seconds displayed" at a street intersection letting pedestrians know how much time they have before the traffic light changes and they will need to be off the crosswalk.

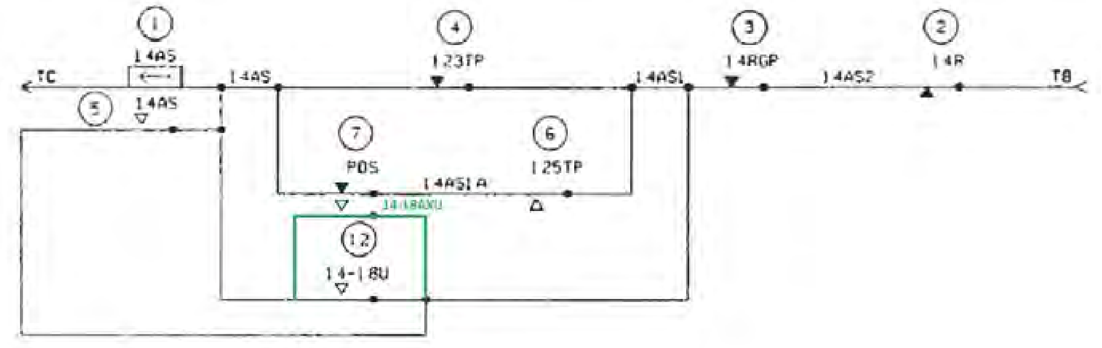
Flasher logic can be programmed into any solid-state controller on the lamp/LED output circuit for the ST lunar aspect, and for conventional circuit modifications multiple flasher relays would likely be required depending on the number of flash rates that are utilized.

APPENDIX "O"
POTENTIAL USES OF AXLE COUNTER TECHNOLOGY AT NYCT

STV proposes the use of axle counter technologies at NYCT primarily in the following manner:

1. Subdivision of long track circuits to allow for control line cutbacks, allowing trains to move closer together where needed.
2. As a timing circuit for clearing of ST and GT signals, with potentially more predictable equipment circuit delay, no susceptibility to loss-of-shunt delays and less reliance on average speeds. This last benefit may also allow for control line cutbacks due to reduced runaway speed values for MAS calculations through timing sections.
3. As a timing circuit for shorting out approach/time locking elements in advance of interlocking switches if the train is stopped between a nearby pair of axle counters for a sufficient, but much shorter length of time than the typical 40 seconds required. This will greatly help with managing unscheduled (or accidental) routes that need to be changed when there are trains on approach to an interlocking and could provide some relief at bottlenecks, especially where there are switches close to the platform such as 149th Street - Grand Concourse. For illustration purposes, Figure O-1 shows what could be a typical GRS style ASR circuit modification to accomplish this, with the associated relay being driven by the axle counter evaluator outputs directly:

Figure O-1. Possible GRS Style ASR Circuit Modification.



STV contacted the axle counter vendor Frauscher to discuss three of their current axle counter system solutions in detail and explain our idea for timing circuit implementation as described above. STV discussed three options with Frauscher.

Solution 1 consists of a RSR180 wheel sensor and a FAdC axle counter. The FAdC axle counting system is known to and being trialed at NYCT for axle counting and CBTC fallback. This is also the system currently in revenue service at Houston Metro. For timing circuits at NYCT as described above, it was explained to Frauscher that the goal is to develop a vital solution for speed measurement by cascading wheel sensors with a certain fixed distance to each other. Each RSR180 wheel sensor has two sensor systems. For each system a digital pulse will be created by the evaluation board AEB. These pulses are used within the system for axle counting. The output information provided by the system is safety integrity level (SIL) 4. The corresponding datasheet is attached hereto.

Solution 2 consists of a RSR123 wheel sensor and a VEB evaluation board. The VEB evaluation board outputs speed information via a Controller Area Network (CAN) interface. This option has been integrated in a SIL2 system that is deployed at ÖBB (Austrian Federal Railway) in Austria. Due to the SIL2 rating, STV does not consider this as a viable solution. The corresponding datasheet is attached hereto.

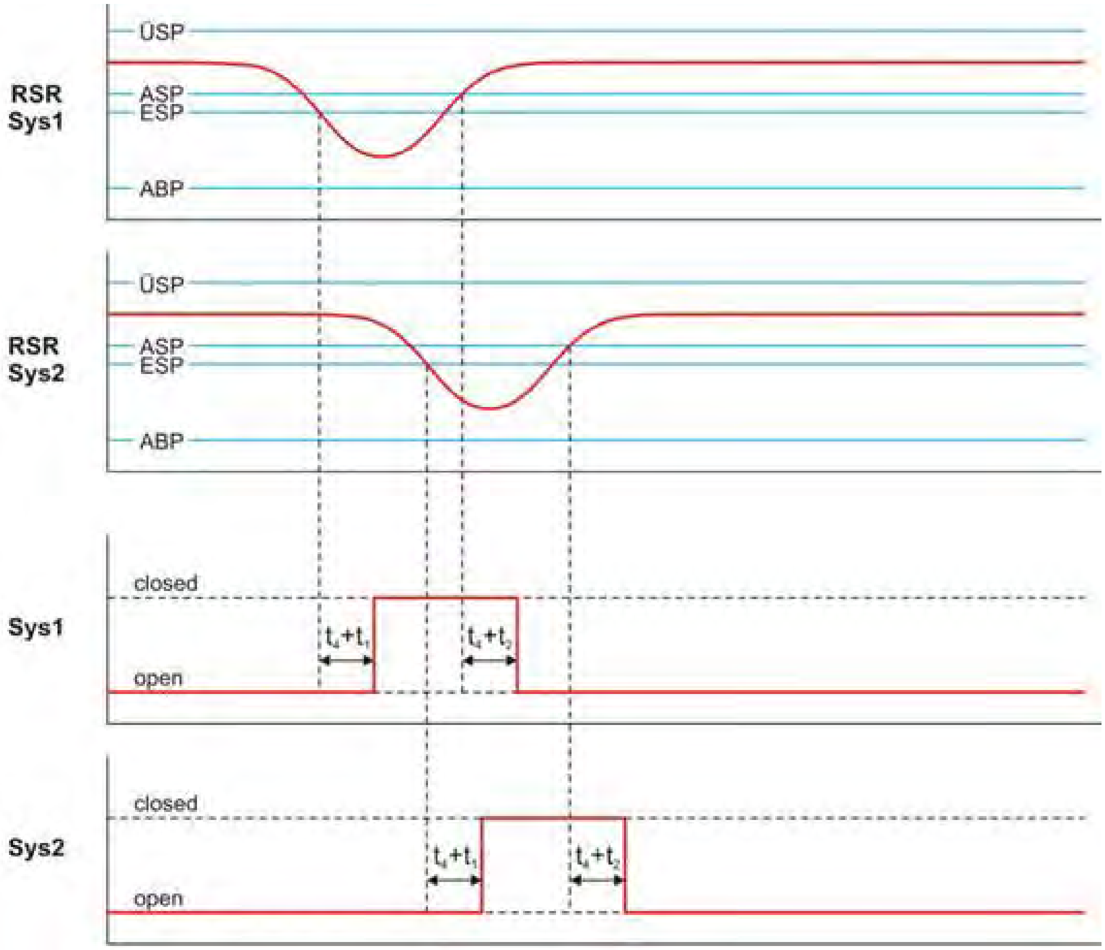
Solution 3 consists of a RSR110 wheel sensor and a wheel sensor signal converter (WSC). The WSC supplies the wheel sensors with voltage and converts the analog signals of the wheel sensors into digital signals. The digital signals are transmitted as digital switching signals to a higher-ranking system via optocoupler outputs. This reduces the number of hardware components, space requirements and power consumption. This solution will be used in Edmonton in conjunction with a Siemens track magnet and is rated as SIL0. Due to the SIL0 rating, STV does not consider this as a viable solution. The corresponding datasheet is attached hereto

Subsequent to our discussion, Frauscher engineers offered the following technical details and analysis for potentially implementing Solution #1 at NYCT:

Advantages of the RSR180 and FAdC solution are vital data transmission, simple integration and flexible interfaces. The digital pulses used within the axle counting system can be output via optocoupler, relay or Ethernet interface. Due to their quick reaction, using optocouplers may be the best solution for vital speed measurement.

Figure O-2 shows an example signal diagram of how the analog signal on the sensor (RSR Sys1 and RSR Sys2) being traversed by a wheel is converted into SIL4 optocoupler outputs (Sys1 and Sys2). A second sensor would create the same signals with a time delay that is defined by distance and speed. These outputs will switch for every axle of the train.

Figure O-2. Correct Traversing of One Wheel in Direction 1.



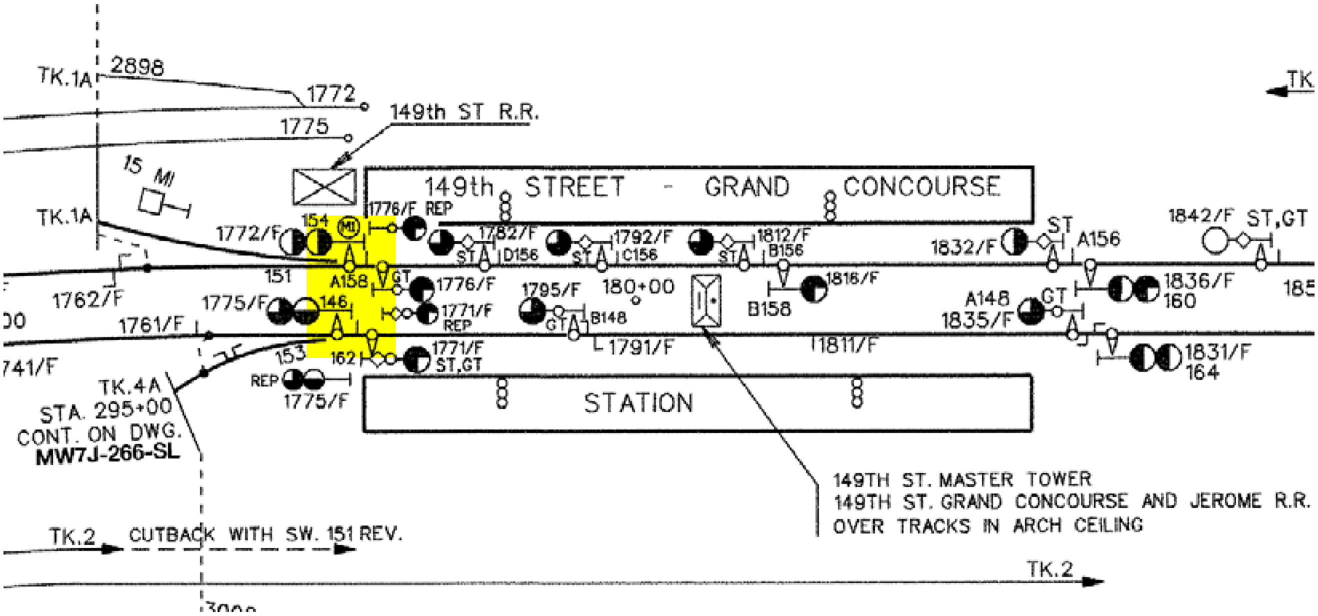
- Variables t1 and t2 can be configured.

- Variable t4 is 1.5ms.

- The maximum inaccuracy of the outputs switching according to those timings is 425 μs.

For the next step, STV recommends that NYCT consider detailed design and implementation of "Solution 1" (as described above) at a test location judged to have a potentially positive, significant impact. Further collaboration with Frauscher throughout the design, installation and testing process would be prudent. 149th Street - Grand Concourse was expressed to STV as a bottleneck, and A158 (highlighted in Figure O-3) appears to be a good candidate for a test location to reduce approach locking time using axle counters. The switch is directly in front of the signal, which means time locking impacts are very significant, and the relay room appears to also be in close proximity (which will minimize installation complexity / cable runs of newly installed equipment).

Figure O-3. Single Line Diagram, 149th Street-Grand Concourse Station (2 and 5 Lines).



Actions on the recommendations above taken subsequent to the draft version of this report being issued to NYCT

Engineers from STV, NYCT (MoW/CPM) and Frauscher have worked together to develop a detailed design concept for potential use at 149th Street – Grand Concourse. The current proposal implements axle counters in a non-conventional manner that continues to be adapted for effective and safe tie-in to existing NYCT circuits.

Switches at this location are "forced and locked" in the normal position to allow trains to safely approach the station at higher speeds. An ASR timer limits releasing of interlocking switches after a route has been cancelled to prevent a train that is moving towards the interlocking and unable to stop from having a switch thrown underneath it. At this location the timer is set to the AREMA minimum value of 30 seconds.

The axle counter solution being evaluated seeks to verify when southbound trains on track one are berthed at the platform, allowing a bypass of this timer and a safe, early release of the switches. The goal is to eliminate the need for trains to extend their dwell times unnecessarily, which could currently occur every time a train needs to diverge.

This solution requires further engineering design and is very site specific (though adaptable to conceptually similar locations with some amount of design re-use). While still expected to be less costly and more effective than a traditional block design change that modifies existing track circuits, it has required multiple engineering resources to design and will require operationally impactful work under flagging for field hardware installation, cable runs and testing. This implementation work will utilize both field personnel and further engineering resources to complete, and adjustments will likely be required to optimize the operational/diagnostic elements (e.g. timing, tie-ins with ATS alarms, event recorders, maintainer indications).

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SENSOR TECHNOLOGY

AXLE COUNTING

Frauscher Advanced Counter FAdC®

Thanks to the software interface, the axle counter FAdC can be optimally integrated into higher-level systems. This provides the highest flexibility in design. Both system integrators and railroad operators benefit equally from significant advantages.

INFORMATION

- Clear/occupied status (SIL 4)
- Direction (SIL 4)
- Number of axles
- Speed
- Wheel diameter
- Diagnostic data

APPLICATIONS

- Track vacancy detection
- CBTC fallback
- Grade crossing protection
- Switching point protection
- Yard Control Systems

BENEFITS

- Simple and flexible configuration
- Software interface
- Flexible architecture
- Low maintenance
- Simple project management

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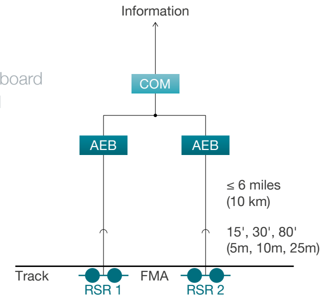
FRAUSCHER SENSOR TECHNOLOGY

FAdC®

Connection to a high-performance electronic interlocking is possible either via a vital, customer-specific interface or the Frauscher Safe Ethernet FSE protocol.

All processes – planning, engineering, configuration, diagnostics, maintenance and adaptation – are supported by innovative software tools. Software logic methods such as Supervisor Track Sections or Counting Head Control further increase system availability.

COM	Communication board
AEB	Evaluation board
FMA	Track section
RSR	Wheel sensor



Technical Data

	FAdC®
Interfaces	Vital, customer-specific protocol Frauscher Safe Ethernet FSE protocol and/or vital output via optocoupler or relay interface
Safety level	SIL 4 (communication according to EN 50159, category 2)
Temperature	Outdoor equipment: -40 °F to +185°F (-40 °C to +85 °C) ("outside" climatic class TX of EN 50125-3) Indoor equipment: -40 °F to +158°F (-40 °C to +70 °C) ("in cabinet" climatic class T2 of EN 50125-3)
Humidity	Outdoor equipment: 100%, IP68 Indoor equipment: up to 100% (without condensation or ice formation for the entire temperature range)
Electromagnetic compatibility	EN 50121-4
Mechanical stress	3M2 according to EN 60721-3-3 Suitable for use in compact outdoor cabinets close to the track
Speed	0 (static) to 280 mph (0 to 450 km/h)
Dimensions	Format: 19" housing for 4" (100 mm) x 7" (160 mm) boards Width: board rack with 42 or 84 width units Height: 3 height units
Power Supply	Voltage: +19 V DC bis +72 V DC Power: approx. 4.5 W per counting head Isolation voltage: 3,100 V

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WHEEL DETECTION

Wheel Sensor RSR110

The RSR110 wheel sensor is available in two models: the Single Wheel Sensor RSR110s and the Double Wheel Sensor RSR110d. With their open analog interface, both wheel sensors can be easily integrated into the electronics of any system. This enables system integrators to customize the evaluation of the information, in line with their individual requirements.

INFORMATION

Analog sensor signal for the evaluation of wheel detection (SIL 0), direction (SIL 0), speed, wheel diameter and wheel center

APPLICATIONS

Switching and triggering tasks such as hot box and flat wheel detection systems, lubrication systems, vision monitoring, wagon weighbridges, washing systems, automatic equipment identification, etc.

Speed measurement

BENEFITS

Open analog interface

Simple integration

High availability

Precise information

Convenient plug-in connection and rail claw

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RSR110

The RSR110 system variants are highly resistant to electromagnetic interference, caused for example by eddy current brakes or rail currents.

Single Wheel Sensor RSR110s: offers a one sensor system for direction-independent wheel detection.
Double Wheel Sensor RSR110d: two sensor systems for wheel detection, including directional information.

The analog current signal can be fully evaluated as desired using simple electronics, a PLC or a microcontroller. This reduces the number of hardware components, space requirements and power consumption.

For systems where tailored software integration is not required, the wheel sensor information can be digitalized using the Frauscher Wheel Sensor Signal Converter WSC.

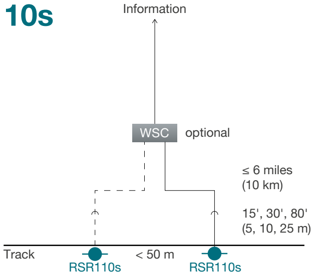
Technical Data

	RSR110
Interfaces	Open analog interface or optional Wheel Sensor Signal Converter WSC
Safety level	SIL 0
Output signal	Wheel sensor current: constant current (5 mA) Change in current (damping by train wheel)
Temperature	-40 °F to 185 °F (-40 °C to 85 °C)
Humidity	Up to 100%
Electromagnetic compatibility	EN 50121-4
Basic conditions	UV resistance: yes Protection class: IP65 / IP68 up to 8 kPa/60min Wheel diameter: 1‘ (300 mm) to 7‘ (2100 mm) Speed: 0 mph (static) to 280 mph (0 to 450 km/h)
Dimensions	Height: 2.4“ (60 mm) Width: 10.6“ (270 mm) Depth: 3“ (77 mm)
Power supply	Voltage: +8 V DC to +33 V DC

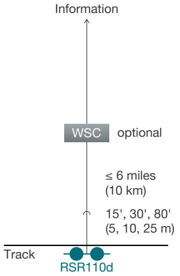
System Design

WSC	Wheel Sensor Converter
RSR	Wheel Sensor

RSR110s



RSR110d



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WHEEL DETECTION

Wheel Detection System RSR123v-VEB

The Wheel Detection System RSR123v-VEB consists of Wheel Sensor RSR123v combined with the evaluation board VEB. Specific software enables speed measurement of a passing train and provides appropriate data for related applications.

INFORMATION

Speed

APPLICATIONS

Speed measurement

Speed checking facility

BENEFITS

Accurate measurement of speed

Evaluation via only a wheel sensor

Simple and efficient

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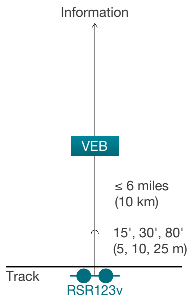
SENSOR TECHNOLOGY

RSR123v-VEB

The Wheel Detection System RSR123v-VEB provides speed, sensor status, and diagnostics in a simple and cost effective manner. It does this in real time via an open CAN interface.

The speed measurement provided by a single sensor has a tolerance of ± 3 %.

VEB Evaluation board
RSR Wheel sensor



Technical Data

	RSR123v (Type RSR123-004)	**VEB**
Interfaces		CAN interface
Speed		1 mph to 217 mph (1 km/h to 350 km/h)
Measurement tolerance		< ±3 % up to 99 mph (160 km/h)
Temperature	-40 F to +185 F (-40 °C to +85 °C)	-40 F to +158 F (-40 °C to +70 °C)
Humidity	Up to 100 %	Up to 100 % (without condensation or ice formation for the entire temperature range) Indoor equipment: -40 °F to +158 °F (-40 °C to +70 °C) ("in cabinet" climatic class T2 of EN 50125-3)
Electromagnetic compatibility	EN 50121-4	EN 50121-4
Conditions	UV resistance: yes Protection class: IP65 / IP68 to 8 kPa/60 min. Wheel diameter: 1' (300 mm) to 7' (2,100 mm)	Mechanical stress: 3M2 in accordance with EN 60721-3-3
Dimensions	Height: 2.4" (60 mm) Width: 10.6" (270 mm) Depth: 3" (77 mm)	Format: 19" housing for 4" (100 mm) to 7" (160 mm) boards Width: 4 width units Height: 3 height units
Power supply		Voltage: +19 V DC up to +72 V DC Power: approx. 4.5 W per counting head Isolation voltage: 3,100 V

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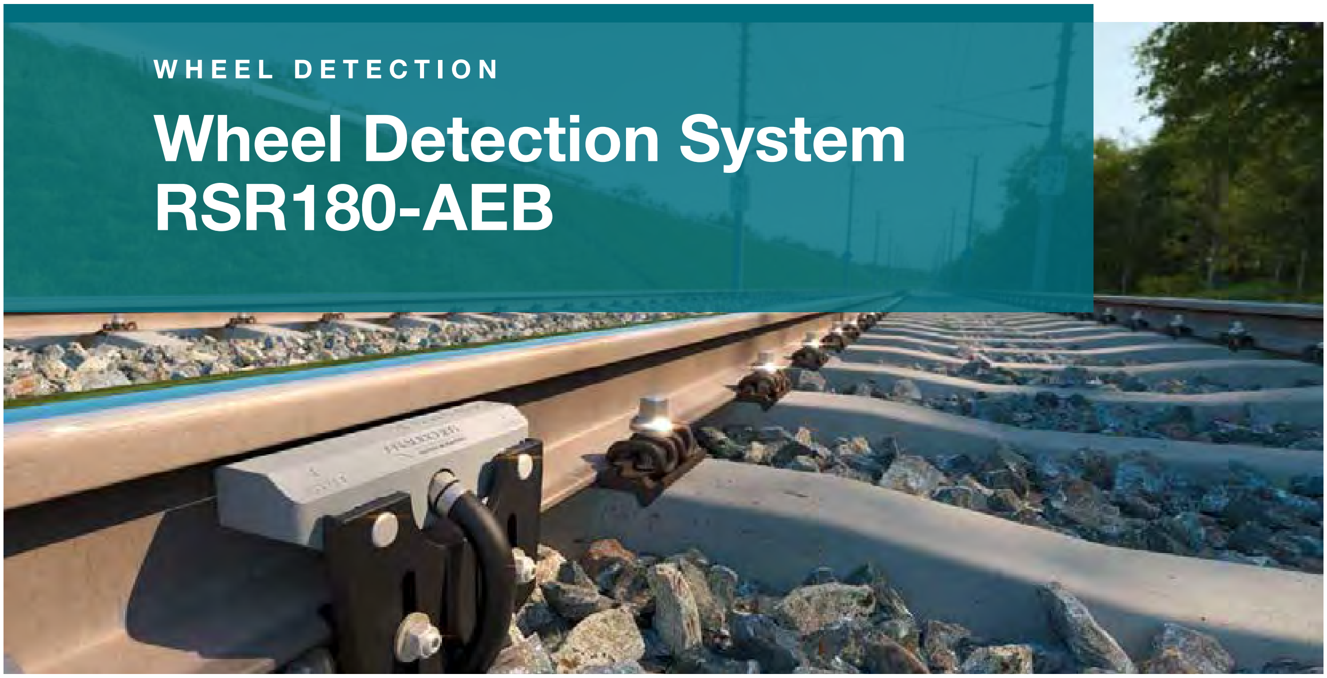
WHEEL DETECTION

Wheel Detection System RSR180-AEB



The Wheel Detection System RSR180-AEB can be used for a variety of different applications. A special feature is the flexible software interface, which can be extended by a hardware interface

INFORMATION

Wheel detection (SIL 4)

Direction (SIL 4)

Number of axles

Diagnostic data

APPLICATIONS

Track vacancy detection

Level crossing protection

Switching tasks

BENEFITS

Universally applicable

No need to adjust the wheel sensor

Software interface, optocoupler or relay

Suitable for grooved rail

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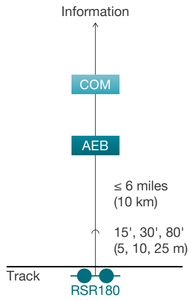
RSR180-AEB

Proven technology distinguishes the universal Wheel Sensor RSR180. It is not necessary to adjust the sensor. The Wheel Detection System RSR180-AEB is resistant to disturbances caused by magnetic track brakes and eddy currents, and can also be used in grooved rails.

The AEB evaluation board, in combination with a COM communication board, has a flexible software interface. This can be adapted to customer specific systems and can be extended by a hardware interface.

COM	Communication board
AEB	Evaluation board
RSR	Wheel sensor



Technical Data

	RSR180	AEB
Interfaces		Flexible software interface (COM) Optocoupler or relay via IO board
Safety level		SIL 4
Temperature	-40 F to +185 F (-40 C to +85 C)	-40 F to +158 F (-40 C to +70 C)
Humidity	Up to 100%	Up to 100% (without condensation or ice formation for the entire temperature range)
Electromagnetic compatibility	EN 50121-4	EN 50121-4
Further conditions	UV resistance: yes Protection class: IP65 / IP68 to 8 kPa/60 min. Wheel diameter: 1‘ (300 mm) to 7‘ (2100 mm) Speed: 0 mph (static) to 280 mph (0 km/h (static) to 450 km/h)	Mechanical stress: 3M2 in accordance with EN 60721-3-3
Dimensions	Height: 2.4“ (60 mm) Width: 9“ (230 mm) Depth: 3“ (77 mm)	Format: 19" housing for 4“ (100 mm) to 7“ (160 mm) boards Width: 4 width units Height: 3 height units

	Optocoupler	Relay
Signal limits	Max. C-E voltage: 72 V DC Max. switching current: 17 mA Insulation voltage : 2,500 V AC	Max. voltage: 110 V DC or 120 V AC Max. switching current: 50 mA (inductive at 110 V DC) depending on the max. switching voltage
Power supply	Voltage: +19 V DC to +72 V DC Power: approx. 3 W per counting head Insulation voltage: 3,100 V	Voltage: +19 V DC to +72 V DC Power: approx. 3 W per counting head Insulation voltage: 3,100 V

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APPENDIX "P"
VEHICLE BRAKING AND ACCELERATION

If existing vehicle braking and acceleration could both be improved, this might allow track speeds to be increased without moving signaling devices in the field. To validate this suggestion, STV performed field vehicle acceleration and braking testing in the field.

NYCT provided an empty legacy train (R46) and a new train (R160) loaded to simulate passengers. STV modified NYCT procedure ETP 97-02, Quality Control Emergency Braking Track Test Procedure, to incorporate testing at higher speed and using external radar gun validation.

R46 consist: Cars 6136, 6137, 6135, 6134, 6202, 6203, 6205, 6204.

R160 consist: Cars 8963, 8964, 8965, 8966, 8967, 9042, 9043, 9044, 9045, 9046.

STV found that the vehicle braking performance meets the current design criteria and could not be increased without vehicle modifications. Likewise, acceleration of the legacy cars (R46) could not be increased without vehicle modifications.

Details

Prior to the start of each test STV validated that the vehicle-based speedometer, NYCT radar gun, and STV radar gun where all showing the same speed.

Eighteen test runs were made, nine with each train. For each run, the train was reversed away from the trip stop to provide enough distance to get up to speed, accelerated toward the trip stop, and the resultant braking distance physically measured. This physical distance was compared to the radar data and GPS data; all three were found to be consistent.

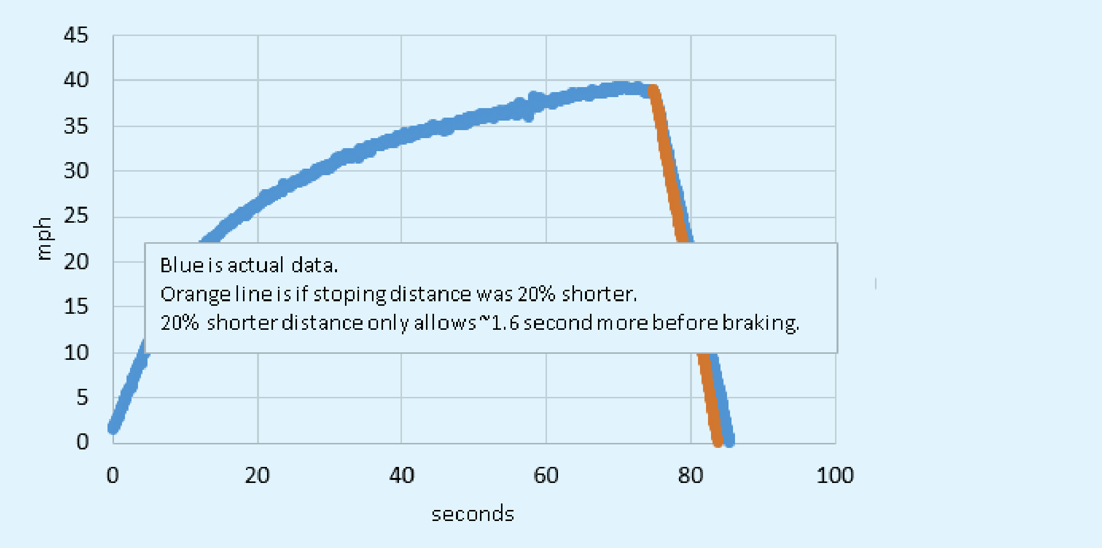
The STV radar data of five of these runs were either partially or completely excluded from analysis.

- The first three runs of the day were excluded due to the track potentially not having been operated over for a few days prior. The data show that the train had worse braking during these first three runs. In some in-service locations with grease or other issues, these emergency brake issues may be representative of actual service.
- Data for two other stops were excluded due to trains operating on adjacent track causing the radar guns to show incorrect speeds.

Braking Analysis

The stopping distance measured was per NYCT's requirements per drawing 103-9002, Emergency Brake Stopping Distance for Customer Cars. The R46 and R160 trains performed approximately the same. This can be seen in Exhibit 1. As varying braking delays and brake rates were seen across the varying test runs, a composite simulation of best cases and worst cases was also performed as a sanity check, as seen in Exhibit 2. This analysis shows that there is no additional safety factor available which can be used to modify NYCT drawing 103-9002.

More importantly, the braking is a very small portion of the overall run, compared to the acceleration. Even 20 percent better braking would allow only an extra second or two at speed before braking. Using one of the test runs as an example:



Acceleration Analysis

The acceleration rates of the R46 and R160 were tested to measure how the vehicles performance limits what maximum speed is achievable. The testing demonstrated that over approximately 20 mph, the acceleration of the vehicles accelerated much more slowly. Both fleets reach 20 mph within approximately 10 seconds, but then take another 16-26 seconds to reach 30 mph.

The R160 fleet was confirmed to comply with the R160 Train Specification released October 2002, which allows for reduced performance when the vehicle is carrying 25% more than normal passenger load. NYCT noted that these vehicles are capable of higher performance when not in trip stop mode.

The R46 fleet was found to be substantially slower than the R160 and slower than the safe acceleration allowed by NYCT. Improving acceleration performance of the R46 fleet is not expected to be feasible or worthwhile. These 40+ year old cars are nearing the end of their life. While motors and the propulsion system can probably be replaced, the cost would be expected to be a substantial fraction of purchasing new vehicles. Determining feasibility and an actual cost would require engineering effort outside the scope of this report and is most likely to result in overhaul program which requires prohibitively high time and effort.

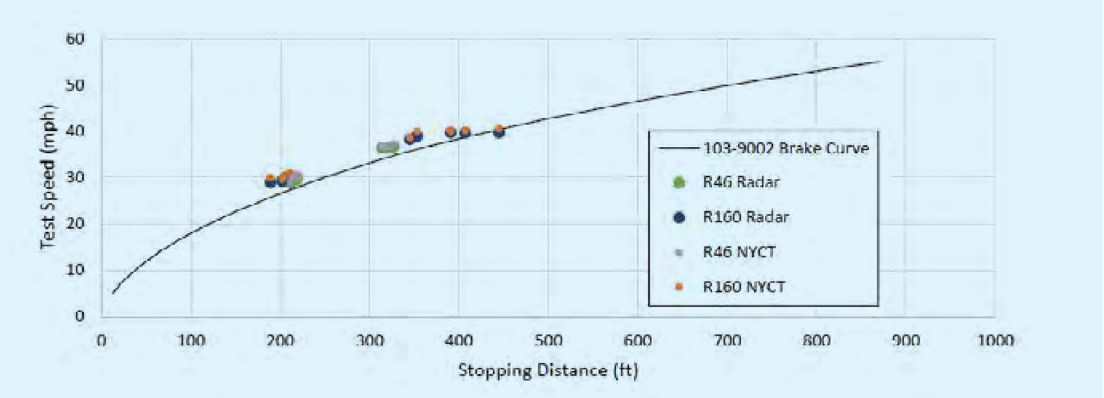
EXHIBIT P-1

Emergency Brake Testing - 11/02/2019 - Data

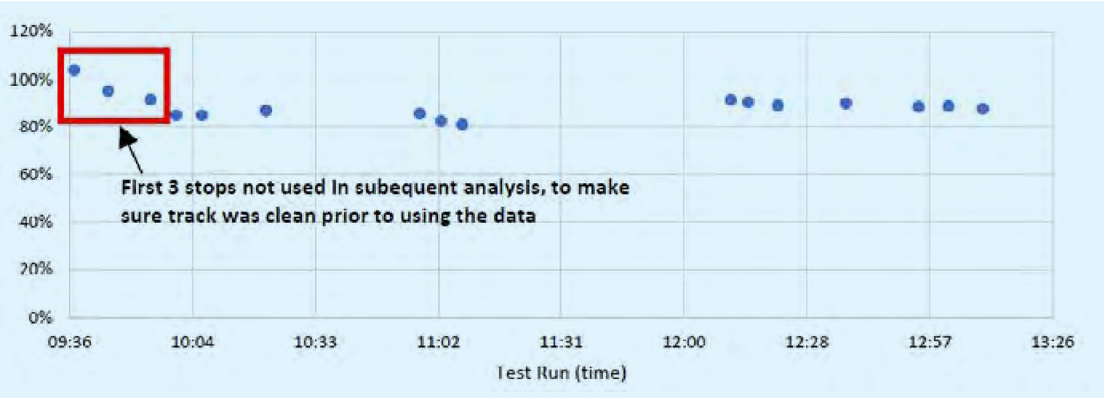
Data from NYCT test sheets									STV Radar Data					
Train	Run	Dir	Speed (mph)	Stop Dist (ft)	103-9002 Dist Req (ft)	% Used	Approx Time		Brake Lag (sec)	Avg Inst Rate (mph/s)	Speed (mph)	103-9002 Dist Req (ft)	% Used	Equiv Rate (mph/s)
R160	0	S	40.5	445	448.5	99%	09:37		1.60	-2.93	39.6	428.6	104%	-2.77
R160	1	S	29.5	202	242.5	83%	10:01		1.60	-3.87	29.2	238.0	85%	-3.50
R160	2	S	31	211	266	79%	10:07		1.63	-3.87	29.9	248.5	85%	-3.50
R160	3	S	40.1	407	439.3	93%	09:45		1.92	-3.35	39.6	428.2	95%	-3.10
R160	4	S	40	391	437	89%	09:55		1.66	-3.60	39.6	428.2	91%	-3.35
R160	5	N	30.4	205	256.4	80%	11:03		1.86	-3.89	29.9	248.8	82%	-3.47
R160	6	N	29.9	189	248.5	76%	11:08		1.63	-3.94	28.9	233.6	81%	-3.55
R160	7	N	38.6	345	406.2	85%	10:22		1.60	-3.48	38.2	397.4	87%	-3.24
R160	8	N	39.9	353	434.8	81%	10:58		1.63	-3.66	38.9	412.8	86%	-3.40
R46	0	S	29	212	235	90%	12:11		2.11	-3.73	28.8	232.2	91%	-3.28
R46	1	S	30.2	219	253.2	86%	12:15		2.05	-3.79	29.5	242.5	90%	-3.35
R46	2	S	30.6	213	259.6	82%	12:22		2.02	-3.82	29.3	239.5	89%	-3.37
R46	3	S	36.9	324	370	88%	12:31		N/A	N/A		N/A		N/A
R46	4	S	37.2	327	376.2	87%	12:38		2.30	-3.72	36.6	364.0	90%	-3.33
R46	5	N	30.4	221	256.4	86%	12:48		N/A	N/A		N/A		N/A
R46	6	N	30.3	217	254.8	85%	12:55		1.73	-3.89	29.7	245.5	88%	-3.49
R46	7	N	36.6	319	364	88%	13:02		2.05	-3.66	36.4	360.0	89%	-3.32
R46	8	N	36.7	314	366	86%	13:10		2.02	-3.69	36.3	358.5	88%	-3.35

Highlighted data either not used (rail surface condition unclear) or data not available (passing train skewed radar data).

Actual Performance vs Vehicle Design Guideline (dwg 103-9002)



% of Stop Distance Used



First 3 stops not used in subequent analysis, to make sure track was clean prior to using the data

EXHIBIT P-2

Emergency Brake Testing - 11/02/2019 - Comparison to Safety Factor

				BRAKE DISTANCES						
	Brake Delay (sec)	Full Emerg (mph/s)	Test Safety Factor	10 mph	15 mph	20 mph	25 mph	30 mph	35 mph	40 mph
R160 test	1.68	-3.79	109%	34	67	111	163	226	298	380
R46 test	2.04	-3.76	103%	36	72	117	172	237	312	396
R160 min	1.60	-3.94	114%	33	65	106	157	217	286	365
R46 min	1.73	-3.89	111%	34	67	109	161	223	293	374
R160 max	1.92	-3.48	99%	37	74	122	180	248	327	417
R46 max	2.30	-3.66	97%	38	76	124	181	249	327	415
			103-9002 ft limit	38	74	121	180	250	332	437

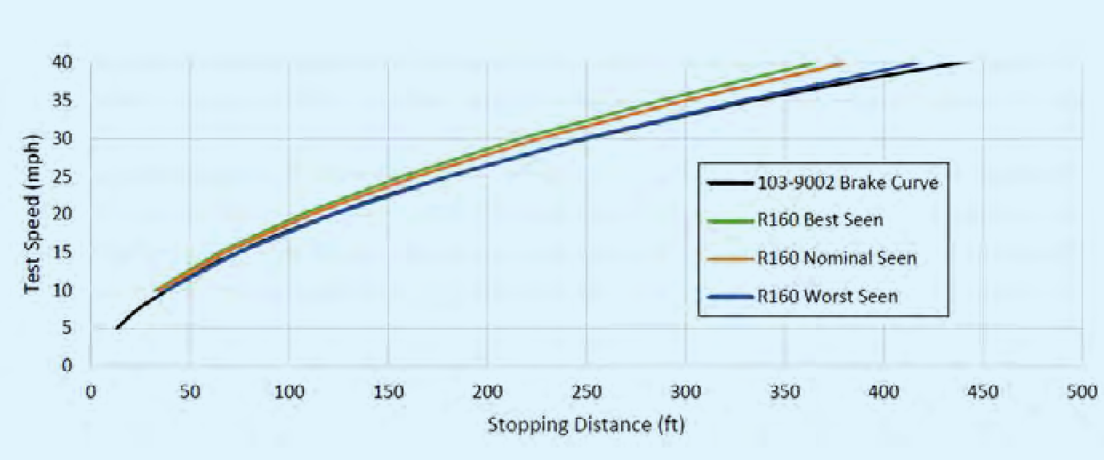
EQUATIONS

build up =1.46667 * delay*AVERAGE(mph,mph+delay*rate/2)

remainder =1.46667 * (mph/2)*(mph+delay*rate/2)/rate

total =1.46667 * delay*AVERAGE(mph,mph+delay*rate/2) + 1.46667 * (mph/2)*(mph+delay*rate/2)/rate

R160 Min/Max Performance vs Vehicle Design Guideline (dwg 103-9002)



R46 Min/Max Performance vs Vehicle Design Guideline (dwg 103-9002)

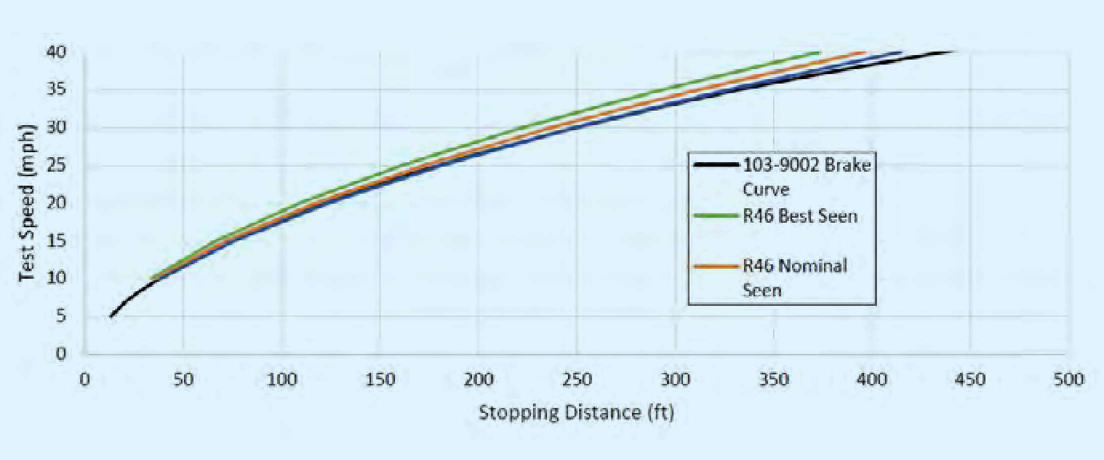
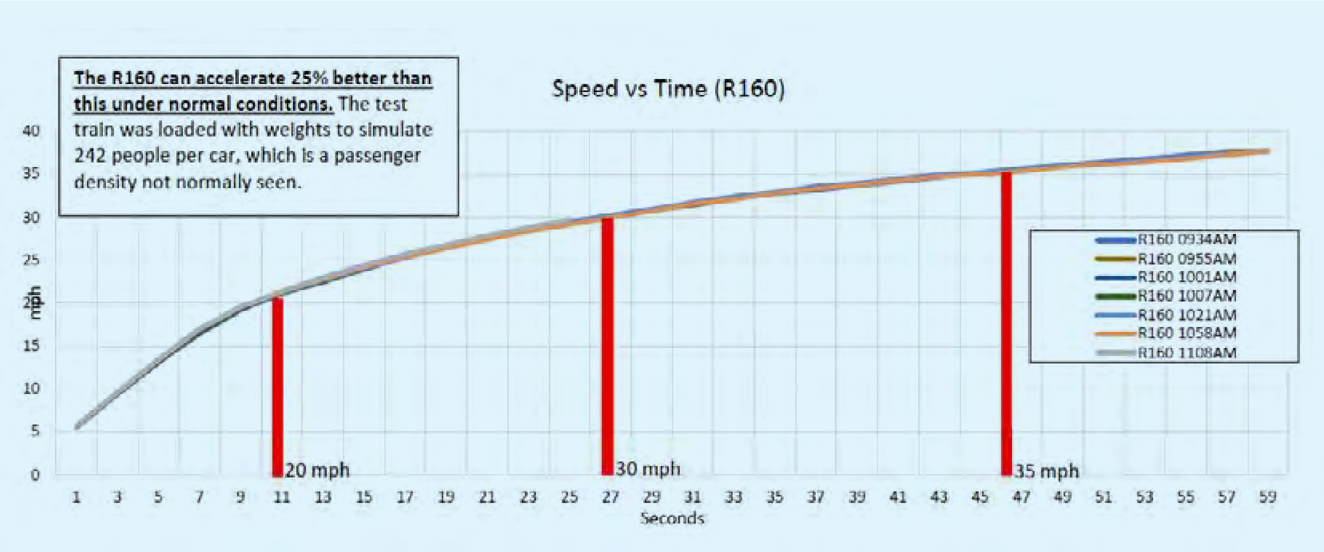
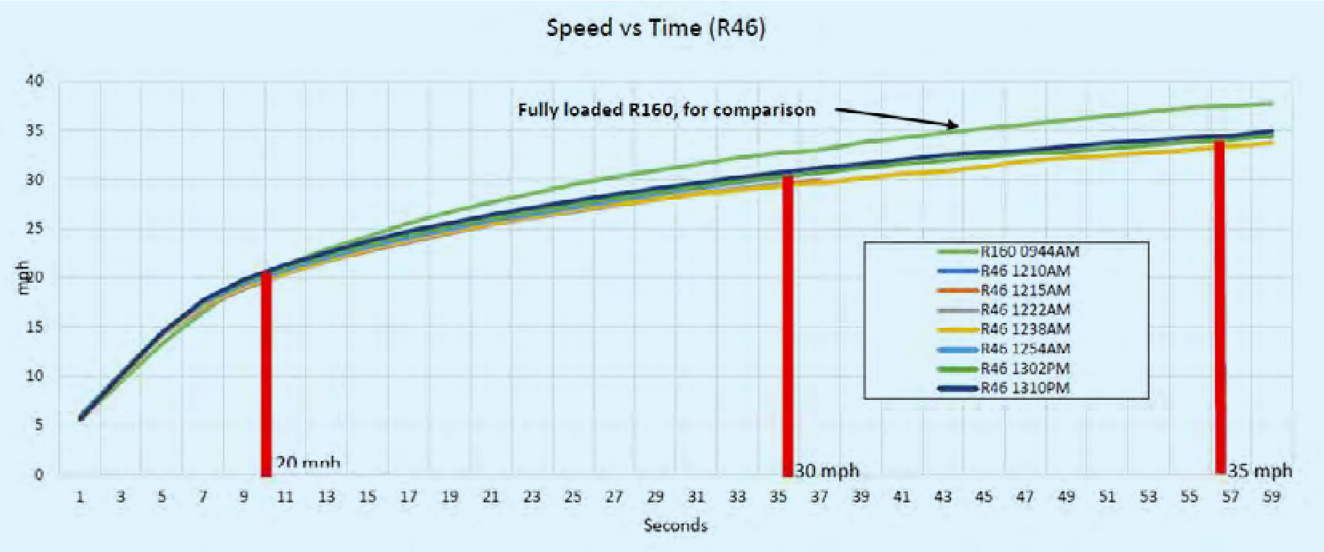


EXHIBIT P-3

Speed Versus Time


Speed vs Time (R160)

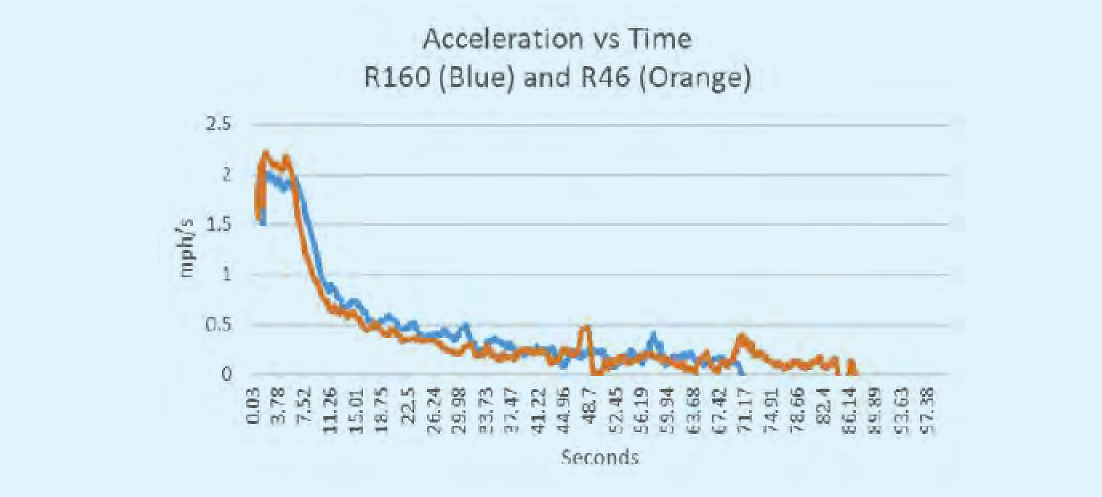
The R160 can accelerate 25% better than this under normal conditions. The test train was loaded with weights to simulate 242 people per car, which is a passenger density not normally seen.

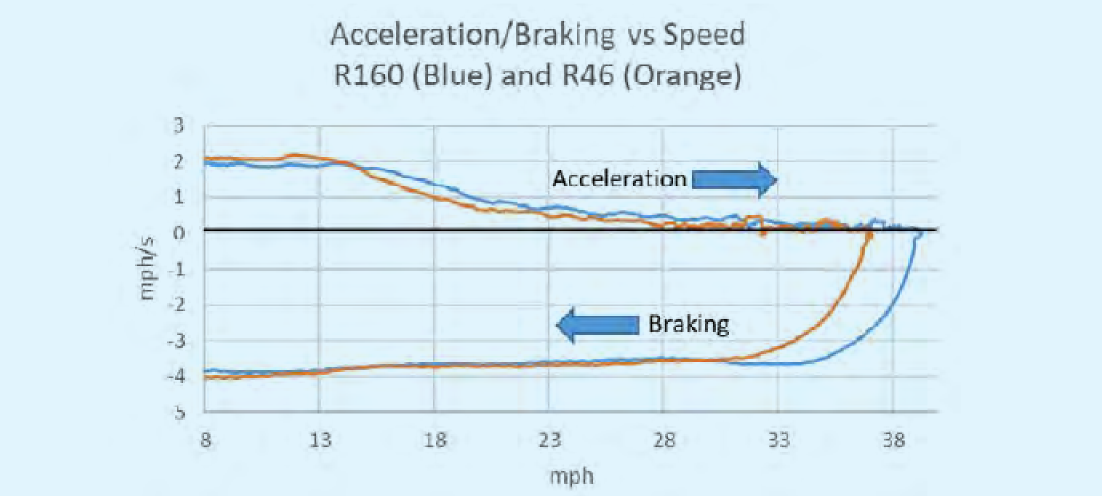

Speed vs Time (R46)

Fully loaded R160, for comparison

EXHIBIT P-4

Emergency Brake Testing - 11/02/2019 - Fleet Comparison





GLOSSARY

Balanced Speed – is the speed at which for a given superelevation and radius of a curve the resultant force of the weight of the vehicle and horizontal centrifugal force is perpendicular to the track causing the wheels to bear equally on both running rails with no lateral thrust.

Civil Speed – That speed at which the track is designed utilizing maximum allowable actual and unbalanced superelevations. Curves are designed with the highest permissible superelevation the type of vehicle and system will permit. The higher the actual elevation the higher the maximum safe speed. The closer to balance speed that a vehicle can travel the more comfort is experienced by the passengers and the less wear and tear on the equipment and track because of less lateral acceleration caused by centrifugal force.

Grade Timers (GT) – are utilized in the signal control system to enforce the speed the train operator can travel within the track circuit approaching the signal. Grade time control enforces an unconditional speed limit for trains on grades, or curves, or in approach to bumpers. In the event the operator travels over the maximum allowable speed, the signal will not clear, the trip stop will not disengage, and the emergency brakes will be tripped.

Maximum Attainable Speed (MAS) – highest speed that a train can achieve in a specific segment of track and is a function of the track geometry characteristics and mechanical capabilities of the vehicle.

Maximum Attainable Transient Speed (MATS) – is the highest speed that a vehicle can achieve in a specific segment of track during short periods of time.

Overturning Speed – That speed at which the vehicle will derail or overturn because centrifugal force overcomes gravity. When the horizontal centrifugal forces of velocity and the effects of curvature overcome the vertical forces of weight and gravity to cause the resultant force to rotate about the center of gravity of the vehicle and pass beyond the bearing point of the track, overturning of the vehicle will occur.

Passenger Comfort Speed – North American Railroads and Transit Agencies typically use 0.1 g as the maximum uncompensated lateral acceleration force experienced by passengers which yields a Passenger Comfort Speed equivalent to V6. NYCT uses a more conservative 0.07 g uncompensated lateral acceleration deriving a Passenger Comfort Speed of V4.

Safe Speed – The speed limit above which the vehicle becomes unstable and in danger of derailment upon the introduction of any anomaly in the track. Safe speed is the condition where the resultant force stays within the one-third point of bearing distance between the rails and is dependent on the location of the vehicle center of gravity above the top of rail.

Signal Speed – That speed for which the signal speed control system is designed, ideally a little faster than an experienced operator would operate a rail car so that the automatic overspeed penalty braking system would not be unnecessarily deployed. Typically signal speed is quite a bit less than maximum safe speed and a little less than civil speed.

Station timers (ST) – are a signal feature that allows trains to "close in" on each other if they sufficiently reduce speed and is typically used at stations to allow trains to slowly come closer to each other than would otherwise be allowed. Station time keeps trains moving and are utilized to regulate when a train can depart from the station.

Superelevation – or banking of curves refers to the practice of raising the outside rail of the track a vertical distance in a curve to reduce wear and increase comfort by setting the bank angle so that the sum of the resultant force of the weight and centrifugal force vectors is perpendicular to the track to partially overcome the effects of curvature and speed.

Transition Spiral – are track paths that introduce both curvature and superelevation gradually to avoid high lateral or vertical accelerations. In a properly designed spiral, there are no unbalanced forces at any time when traveling at equilibrium speed. NYCT historically used Crandall's Transition Curves where the curvature increased directly as the distance from the PTC from a zero curvature at the tangent to that of a circular curve (PC). Traditionally the transition length was divided into 10 equal parts.

Unbalanced Speed – is any speed other than the balanced speed. When the unbalanced speed is greater than the balanced speed it is called overbalanced speed. Overbalance speed causes the vehicle to have an uncompensated lateral acceleration towards the outside of the curve due to centrifugal force. Underbalance speed causes the vehicle to lean or bear against the inner or low rail.

Unbalanced Superelevation – is defined as the difference between actual superelevation and the superelevation required for true equilibrium of a vehicle traversing a curve. Unbalance is designated as Eu and the actual superelevation is designated as Ea. Total Equilibrium Elevation is applied as E = Ea + Eu. Allowable unbalance varies railroad to railroad and from transit agency to transit agency