Appendix F
Noise

F.1 INTRODUCTION

This appendix assesses the potential for noise impacts due to operation of the Proposed Action. Since the changes in the operation of the Proposed Action would only affect auto/truck vehicular traffic rather than rail traffic, it is expected to have no significant impact in terms of vibration. Potential noise and vibration impacts during construction are assessed separately in Chapter 3, “Environmental Analysis.”

With the Proposed Action, future traffic volumes on the access roads and in the station parking facilities would increase. Thus, noise levels at receptor locations adjacent to feeder roadways and parking facilities would also be expected to increase. This appendix includes: a discussion of noise fundamentals, standards, and impact criteria; a discussion of the analysis methodology; an evaluation of existing conditions; and an assessment of potential noise impacts for future conditions with the Proposed Action.

F.2 NOISE FUNDAMENTALS, STANDARDS, AND IMPACT CRITERIA

F.2.1 NOISE FUNDAMENTALS

Quantitative information on the effects of airborne noise on people is well documented. If sufficiently loud, noise may adversely affect people in several ways. For example, noise may interfere with human activities, such as sleep, speech communication, and tasks requiring concentration or coordination. It may also cause annoyance, hearing damage, and other physiological problems. Several noise scales and rating methods are used to quantify the effects of noise on people. These scales and methods consider such factors as loudness, duration, time of occurrence, and changes in noise level with time. It must be remembered that all the stated effects of noise on people vary greatly with the individual.

Sound is a fluctuation in air pressure. Sound pressure levels are measured in units called “decibels” (dB). The particular character of the noise that we hear (a whistle compared with a French horn, for example) is determined by the speed, or “frequency,” at which the air pressure fluctuates, or “oscillates.” Frequency defines the oscillation of sound pressure in terms of cycles per second. One cycle per second is known as one Hertz (Hz). People can hear over a relatively limited range of sound frequencies, generally between 20 and 20,000 Hz, and the ear does not perceive all frequencies equally. High frequencies (that whistle, for example) are more easily discerned and therefore more intrusive than many of the lower frequencies (the lower notes on the French horn, for example).

F.2.1.1 "A-WEIGHTED" SOUND LEVEL (DBA)

To have a uniform noise measurement that simulates people's perception of loudness and annoyance, the decibel measurement is weighted to account for those frequencies most audible to the human ear. This is known as the A-weighted sound level, or "dBA," and it is the most often used descriptor of noise levels where community noise is the issue. As shown in Table F-1, the threshold of human hearing is defined as 0 dBA; very quiet conditions (as in a library, for example) are approximately 40 dBA; levels between 50 dBA and 70 dBA define the range of acceptable daily activity; levels above 70 dBA would be considered noisy, loud, intrusive, and deafening as we move up the scale to 130 dBA. For most people to perceive an increase in noise, it must be at least 3 dBA. A change of 5 dBA is generally readily noticeable.[1] An increase of 10 dBA is generally perceived as a doubling of loudness.

It is also important to understand that combinations of different noise sources are not added in an arithmetic manner, because of the dBA scale's logarithmic nature. For example, two noise sources—a vacuum cleaner operating at approximately 72 dBA and a telephone ringing at approximately 58 dBA—do not combine to create a noise level of 130 dBA, the equivalent of a jet airplane or air raid siren (see Table F-1). In fact, the noise produced by the telephone ringing may be masked by the noise of the vacuum cleaner and not be heard. The logarithmic combination of these two noise sources would yield a noise level of 72.2 dBA (an increase of 0.2 dBA would be an imperceptible change in noise level).

F.2.1.2 EFFECTS OF DISTANCE ON NOISE

Noise varies with distance. For example, highway traffic 50 feet away from a receptor (such as a person listening to the noise) typically produces sound levels of approximately 70 dBA. The same highway noise measures 66 dBA at a distance of 100 feet, assuming soft ground conditions. This decrease is known as "drop-off." The outdoor drop-off rate for line sources, such as traffic, is a decrease of approximately 4.5 dBA (for soft ground) for every doubling of distance between the noise source and receiver (for hard ground the outdoor drop-off rate is 3 dBA for line sources). Assuming soft ground, for point sources, such as amplified rock music, the outdoor drop-off rate is a decrease of approximately 7.5 dBA for every doubling of distance between the noise source and receiver (for hard ground the outdoor drop-off rate is 6 dBA for point sources).

F.2.1.3 NOISE DESCRIPTORS USED IN IMPACT ASSESSMENT

Because the sound pressure level unit of dBA describes a noise level at just one moment and very few noises are constant, other ways of describing noise over more extended periods have been developed. One way of describing fluctuating sound is to describe the fluctuating noise heard over a specific period as if it had been a steady, unchanging sound. For this condition, a descriptor called the "equivalent sound level," L_{eq}, can be computed. L_{eq} is the constant sound level that, in a given situation and period (e.g., 1 hour, denoted by $L_{eq(1)}$, or 24 hours, denoted as $L_{eq(24)}$), conveys the same sound energy as the actual time-varying sound. Statistical sound level

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[1] Average ability to perceive changes in noise levels from Bolt Beranek and Newman, Inc., *Fundamental and Abatement of Highway Traffic Noise, Report No. PB-222-703.* Prepared for the Federal Highway Administration, June 1973.

descriptors such as L_1, L_{10}, L_{50}, L_{90}, and L_x are sometimes used to indicate noise levels that have exceeded 1, 10, 50, 90, and x percent of the time, respectively.

Table F-1
Common Noise Levels

Sound Source	(dBA)
Military jet, air raid siren	130
Amplified rock music	110
Jet takeoff at 500 meters	100
Freight train at 30 meters	95
Train horn at 30 meters	90
Heavy truck at 15 meters	
Busy city street, loud shout	80
Busy traffic intersection	
Highway traffic at 15 meters, train	70
Predominantly industrial area	60
Light car traffic at 15 meters, city or commercial areas or residential areas close to industry	
Background noise in an office	50
Suburban areas with medium density transportation	
Public library	40
Soft whisper at 5 meters	30
Threshold of human hearing	0

Notes: A 10 dBA increase in level appears to double the loudness, and a 10 dBA decrease halves the apparent loudness.

Sources: Cowan, James P. Handbook of Environmental, Acoustics. Van Nostrand Reinhold, New York, 1994. Egan, M. David, Architectural Acoustics. McGraw-Hill Book Company, 1988.

A descriptor for cumulative 24-hour exposure is the day–night sound level, abbreviated as L_{dn}. This is a 24-hour measure that accounts for the moment-to-moment fluctuations in A-weighted noise levels due to all sound sources during 24 hours, combined. Mathematically, the L_{dn} noise level is the average of all $L_{eq(1)}$ noise levels over a 24-hour period, where nighttime noise levels (10 PM to 7 AM) are increased by 10 dBA before averaging to account for increased sensitivity during sleeping hours.

For transit projects subject to Federal Transit Administration (FTA) review, the maximum 1-hour equivalent sound level ($L_{eq(1)}$) or the day–night sound level (L_{dn}) is used for impact assessment, depending on land use category as described below.

F.2.2 NOISE STANDARDS AND CRITERIA

F.2.2.1 FEDERAL TRANSIT ADMINISTRATION (FTA) CRITERIA

In May 2006, FTA issued its report *Transit Noise and Vibration Impact Assessment* as a guideline for the evaluation of noise and vibration levels resulting from mass transit projects, and the assessment of impacts that result. The noise analysis methodology in the FTA report determines operational noise impacts that result from mass transit projects based on peak-hour $L_{eq(1)}$ and 24-hour L_{dn} noise levels, depending on the land use category of the affected areas near mass transit projects. As described in Table F-2, Categories 1 and 3, which include land uses that are noise sensitive but where people do not sleep, require examination of a one-hour L_{eq} for the noisiest peak hour. For Category 2, which includes residences, hospitals, and other locations where nighttime sensitivity to noise is very important, use of L_{dn} is required.

Table F-2
FTA's Land Use Category and Metrics for Transit Noise Impact Criteria

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor $L_{eq(h)}$[1]	Tracts of land in which quiet is an essential element in the intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls.
2	Outdoor $L_{dn(h)}$	Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels, where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor $L_{eq(h)}$	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

Note: [1]L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity. The (h) subscript represents the duration of time of measurement. For this analysis the duration of time of measure is the one-hour measurement, represented as $L_{eq(1)}$.
Source: *Transit Noise and Vibration Impact Assessment,* FTA, May 2006.

Figure F-1 shows FTA's noise impact criteria for transit projects. The FTA impact criteria are keyed to the noise level generated by the project (called "project noise exposure") in locations of varying existing noise levels. Two types of impacts—moderate and severe—are defined for each land use category, depending on existing noise levels. Thus, where existing noise levels are 40 dBA, for land use Categories 1 and 2, the respective L_{eq} and L_{dn} noise exposure from the project would create moderate impacts if they were above approximately 50 dBA, and would create severe impacts if they were above approximately 55 dBA. For Category 3, a project noise exposure level above approximately 55 dBA would be considered a moderate impact, and above approximately 60 dBA would be considered a severe impact. The difference between "severe impact" and "moderate impact" is that a severe impact occurs when a change in noise level occurs that a significant percentage of people would find annoying, while a moderate impact occurs when a change in noise level occurs that is noticeable to most people but not necessarily sufficient to result in strong adverse reactions from the community.

F.3 ANALYSIS METHODOLOGY

F.3.1 INTRODUCTION

Two modeling techniques were used to assess project impacts—the FTA parking lot/parking garage general noise assessment technique, and the FHWA Traffic Noise Model (TNM, version 2.5, 2004). Each of these techniques is discussed below.

F.3.2 FTA PARKING LOT/GARAGE MODELING

The FTA guidance manual *Transit Noise and Vibration Impact Assessment*, May 2006, provides methodologies for determining noise levels at locations adjacent to parking lots and parking garages.

The general noise assessment procedure in the FTA guidance manual gives the following formulas for computing noise levels:

$L_{eq(1)} = 101 + 10 \log [(N_A/2000) + (N_B/24)] - 15 \log (D/50) - 35.6$ for parking lots

$L_{eq(1)} = 92 + 10 \log [N_A/1000] - 15 \log (D/50) - 35.6$ for parking garages

Where:

N_A = number of automobiles per hour;

N_B = number of buses per hour; and,

D = distance in feet.

In general, the FTA methodology was used following the procedures listed below:

(1) Existing noise levels were determined by field measurements;

(2) The parking lot component of the existing noise levels was calculated using the FTA parking lot formula shown above and existing parking lot traffic;

(3) The component of the noise due to rail noise was determined by subtracting the calculated parking lot component from the measured (total) noise levels; and

(4) Future noise levels were determined by adding the calculated parking lot or parking garage component of the noise, obtained using the appropriate parking lot/parking garage formulas shown above, and appropriate traffic volumes along with the rail noise calculated in step (3).

It was assumed that rail noise for future conditions would remain similar to the calculated values based upon 2006 baseline conditions, except for locations where shielding due to the proposed parking garage would occur. In those cases a shielding factor of 10 dBA was assumed.

F.3.3 FHWA TRAFFIC NOISE MODEL (TNM)

At locations where noise from the immediately adjacent roadway segment is not the only major noise source (i.e., where rail noise or noise from nearby roadways is a significant contributor to the total noise level), the TNM was used to determine the noise component due to roadway traffic. The FHWA Traffic Noise Model, (TNM, version 2.5), calculates the noise contribution of each roadway segment for a given noise receptor. The noise from each vehicle type is determined as a function of the reference energy-mean emission level, corrected for vehicle volume, speed, roadway grade, roadway segment length, and source-receptor distance. Further adjustments needed to model the propagation path include shielding provided by rows of buildings, the effects of different ground types, source and receptor elevations, and effect of any intervening noise barriers.

In general, the TNM was used following the procedures listed below:

(1) Existing noise levels were determined by field measurements;

(2) The traffic component(s) of the existing noise levels was calculated based on traffic on adjacent streets using the TNM and existing traffic conditions;

(3) The component of the noise due to other sources (i.e., rail noise, existing parking garage noise) was determined by subtracting the TNM calculated traffic component(s) from the measured (total) noise levels; and

(4) Future noise levels were determined by adding the calculated component of the noise from other sources obtained in step (3) to TNM calculated traffic component(s), based on future traffic levels.

It was assumed that rail noise for future conditions would remain similar to the calculated values based upon baseline conditions.

F.4 EXISTING CONDITIONS

In order to assess project impacts, six noise receptor sites were selected. These noise receptors locations were selected based upon a consideration of locations where maximum impacts of the Proposed Action were likely to occur, and on locations where sensitive land uses occur (see Table F-3). At each receptor location noise measurements were performed to establish existing conditions.

F.4.1 SELECTION OF NOISE RECEPTORS

Noise is both site-specific and time-dependent. Therefore, specific analysis locations (referred to as “receptors”) were chosen throughout the study area. Six receptor locations were chosen for the Proposed Action. Information on land use and traffic was used to identify those locations that would be particularly sensitive to noise increases (e.g., residences, parkland, etc.) or that would be likely to experience the greatest increases in noise from the project. (Information regarding the location of residences, institutions, historic resources, and other sensitive receptors is provided in Chapter 3 of this document.) The selected receptor locations are representative of other receptor locations and were selected to provide sufficient geographic coverage throughout the study area to assess all locations where potential impacts are likely to occur. The locations chosen as noise receptors are summarized in Table F-4 (which also indicates each site’s study area zone and FTA land use category), and are also shown in Figure F-2.

F.4.2 NOISE MONITORING

Noise monitoring was conducted at all six noise receptors sites on June 26, 2008. As shown in Table F-3, at Site 1 20-minute measurements were made on a weekday for the AM and PM peak periods, and at the remaining five sites 20-minute measurements were made on a weekday for the AM peak, midday, PM peak, and nighttime periods. Based upon past experience at similar locations, 20-minute measured noise levels are representative of 1-hour measured levels. (At Sites 2 through 6 the measured values were used to calculate L_{dn} values.)

Measurements were performed on weekdays (i.e., generally Tuesday, Wednesday, or Thursday) to avoid weekend and holiday conditions which might bias the measurements. Measurements were taking using a Brüel & Kjær Noise Level Meter Type 2260, a Brüel & Kjær Sound Level Calibrator Type 4231, and a Brüel & Kjær ½-inch microphone Type 4189. The instrument was mounted at a height of 5 feet above the ground on a tripod. The meter was calibrated before and after readings with a Brüel & Kjær Type 4231 sound level calibrator using the appropriate adaptor. The data were digitally recorded by the sound meter and displayed at the end of the measurement period in units of dBA. Measured quantities included L_{eq}, L_1, L_{10}, L_{50}, and L_{90}. A windscreen was used during all sound measurements except for calibration. All measurement procedures conformed to the requirements of ANSI Standard S1.13-2005.

Table F-3
Noise Receptor Sites and Locations

Site	Location	FTA Land Use Category	Type of Measurement
1	Fisher Lane between Bronx River Parkway and Haarlem Avenue	1	AM/PM 20 minute
2	Holland Avenue between Route 22 and Haarlem Avenue	2	AM/MD/PM/LN 20 minute
3	Route 22 between Archer and McBride Avenues	2	AM/MD/PM/LN 20 minute
4	Glenn Street between Route 22 and Haarlem Avenue	2	AM/MD/PM/LN 20 minute
5	Haarlem Avenue between Bond Street and Fisher Lane	2	AM/MD/PM/LN 20 minute
6	Route 22 between Brookdale Avenue and Glenn Street	2	AM/MD/PM/LN 20 minute

Notes: For definition of land use categories, see Table F-2.
AM = morning peak hour; MD = midday; PM = evening peak hour; LN = late night

F.4.3 CALCULATION OF L_{DN} NOISE LEVELS

The FTA guidance manual provides information on several ways of calculating approximate L_{dn} noise levels when 24-hour noise levels are not available. Equations are available to approximate the L_{dn} noise level based on a combination of peak, midday, and nighttime hourly L_{eq} noise level, as well as based upon daytime, early nighttime, or late nighttime L_{eq} values. These methods were used to calculate L_{dn} noise levels at land use Category 2 receptor site locations.

Option 3 from Appendix D in the FTA guidance manual gives the following formula for computing L_{dn} noise levels when the hourly L_{eq} was measured for the peak hour, midday, and late night. The equation was adapted to compute the L_{dn} noise level based upon hourly L_{eq} values measured for the AM, midday, PM, and late night:

$$L_{dn} = 10 \log [(2)x10^{(Leq(AM\ peak\ hour)-2)/10)} + (11)x10^{(Leq(midday)-2)/10)} + (2)x10^{(Leq\ (PM\ peak\ hour)-2)/10)} + (9)x10^{(Leq\ (late\ night\ peak\ hour)+8)/10)}] - 13.8$$

F.4.4 EXISTING NOISE LEVELS

Table F-4 shows existing noise levels at each receptor site. The $L_{eq(1)}$ values shown are the highest measured one-hour values. The L_{dn} values shown are the calculated values. Noise levels at each site are a function of traffic on the adjacent roadways and train noise. Existing L_{eq}/L_{dn} values at sites 1, 3, 5, and 6 are relatively high. (Existing L_{eq}/L_{dn} values at sites 2 and 4 are relatively low and, in general, reflect the lower traffic levels on the roadways near and adjacent to these sites.) Based upon FTA noise impact criteria, when existing noise levels are high the allowable increase in noise level and project-generated noise level must be relatively small to avoid a potential impact or severe impact.

Table F-4
Existing Noise Levels

Site	Location	FTA Land Use Category	Noise Descriptor	Noise Level (dBA)
1	Fisher Lane between Bronx River Parkway and Haarlem Avenue	1	L_{eq}	69.1
2	Holland Avenue between Route 22 and Haarlem Avenue	2	L_{dn}	59.0
3	Route 22 between Archer and McBride Avenues	2	L_{dn}	74.4
4	Glenn Street between Route 22 and Haarlem Avenue	2	L_{dn}	60.3
5	Haarlem Avenue between Bond Street and Fisher Lane	2	L_{dn}	71.0
6	Route 22 between Brookdale Avenue and Glenn Street	2	L_{dn}	75.2

Note: For definition of land use categories, see Table F-2.

F.5 NO BUILD SCENARIO

Table F-5 shows the results of the noise impact assessment analysis performed for the No Build Scenario. Figure F-2 indicates the locations of the noise receptors. Based upon existing noise levels, the allowable project-generated noise levels to avoid impacts and/or severe impacts were calculated based upon the FTA guidance document cited above. Next, future No Build noise levels (i.e., the total noise level in the No Build Scenario) were calculated using the methodologies previously described. Then, No Build-generated noise levels were determined by subtracting existing noise levels from total noise levels with the No Build Scenario. Finally, the No Build-generated noise levels were compared to the allowable project-generated noise levels to avoid a moderate impact or severe impact, to determine whether a moderate impact or severe impact would be predicted to occur.

As shown in Table F-5, based upon FTA impact criteria, the No Build Scenario would not result in any significant change from the existing condition at any of the six receptor sites. The maximum increase in L_{eq}/L_{dn} noise levels would be 0.2 dBA. Changes of this magnitude would not be perceptible.

Table F-5
2015 Noise Impact Evaluation of No Build Condition

Noise Receptor Site	Land Use Category	Noise Descriptor	Existing Noise Level	Allowable Project-Generated Noise Levels*		No Build-Generated Noise Level	Total Noise Level with No Build	Impact Assessment
				Moderate Impact	Severe Impact			
1	1	L_{eq}	69.1	68.7	73.9	52.8	69.2	No Impact
2	2	L_{dn}	59.0	57.3	62.9	42.4	59.1	No Impact
3	2	L_{dn}	74.4	67.8	72.7	61.5	74.6	No Impact
4	2	L_{dn}	60.3	58.0	63.6	43.1	60.4	No Impact
5	2	L_{dn}	71.0	65.0	70.2	58.6	71.2	No Impact
6	2	L_{dn}	75.2	68.6	73.4	56.1	75.3	No Impact

Notes: For definition of land use categories, see Table F-2. Noise levels in dBA.
* - Threshold of new noise levels at which a moderate impact or severe impact would occur. Compare to actual project-generated noise levels.

F.6 POTENTIAL IMPACTS OF THE PROPOSED ACTION

The following discussion analyzes possible noise impacts that could result from operation of the Proposed Action (Build with Mitigation Scenario) in 2015. The year 2015 was chosen for the analysis because it represents the year the project will reach maximum capacity and have the greatest potential for noise impacts.

Table F-6 shows the results of the noise impact assessment analysis performed for the Proposed Action. Based upon existing noise levels, the allowable project-generated noise levels to avoid moderate impacts and/or severe impacts were calculated. Next, future noise levels for the Proposed Action (i.e., the total noise level with the Proposed Action) were calculated using the methodologies previously described. Then, the Proposed Action's project-generated noise levels were determined by subtracting existing noise levels from total noise levels with the Proposed Action. Finally, the Proposed Action's project-generated noise levels were compared to the allowable project-generated noise levels to avoid a moderate impact or severe impact, to determine whether a moderate impact or severe impact would be predicted to occur.

Table F-6
Noise Impact Evaluation of Proposed Action

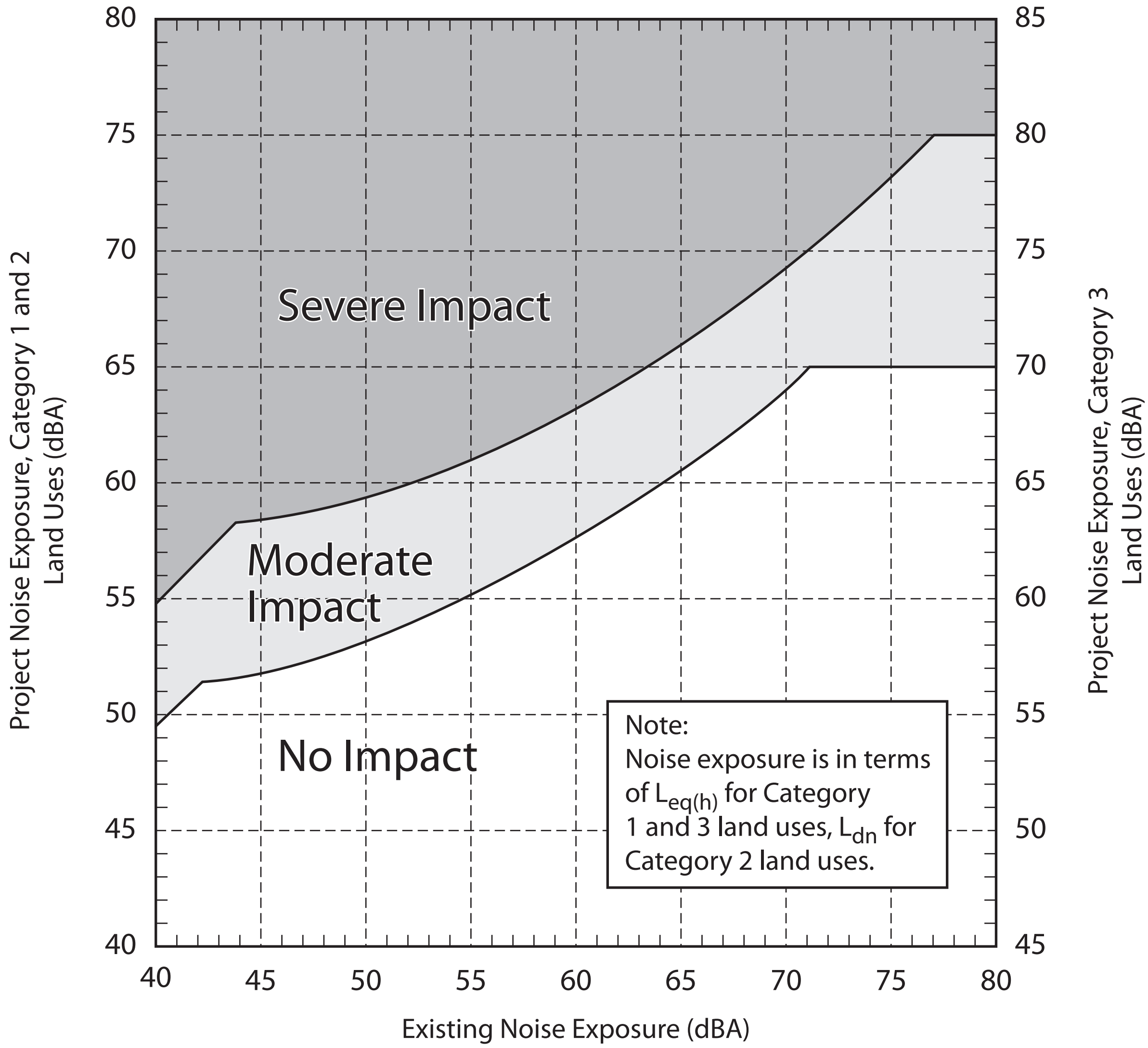
Noise Receptor Site	Land Use Category	Noise Descriptor	Existing Noise Level	Allowable Project-Generated Noise Levels*		Proposed Action Project-Generated Noise Level	Total Noise Level with Proposed Action	Impact Assessment
				Moderate Impact	Severe Impact			
1	1	L_{eq}	69.1	68.7	73.9	55.8	69.3	No Impact
2	2	L_{dn}	59.0	57.3	62.9	45.6	59.2	No Impact
3	2	L_{dn}	74.4	67.8	72.7	61.5	74.6	No Impact
4	2	L_{dn}	60.3	58.0	63.6	48.6	60.6	No Impact
5	2	L_{dn}	71.0	65.0	70.2	61.3	71.4	No Impact
6	2	L_{dn}	75.2	68.6	73.4	65.7	75.7	No Impact

Notes: For definition of land use categories, see Table F-2. Noise levels in dBA.
* - Threshold of new noise levels at which a moderate impact or severe impact would occur. Compare to actual project-generated noise levels.

As shown in Table F-6, based upon FTA impact criteria, the Proposed Action would not result in any moderate impacts or severe impacts at any of the six receptor sites. The maximum increase in L_{eq}/L_{dn} noise level would be 0.5 dBA from existing conditions and 0.4 dBA from the No-Build Scenario. Changes of this magnitude would not be perceptible and would not exceed any FTA impact criteria. Consequently, the Proposed Action would result in no noise impacts.

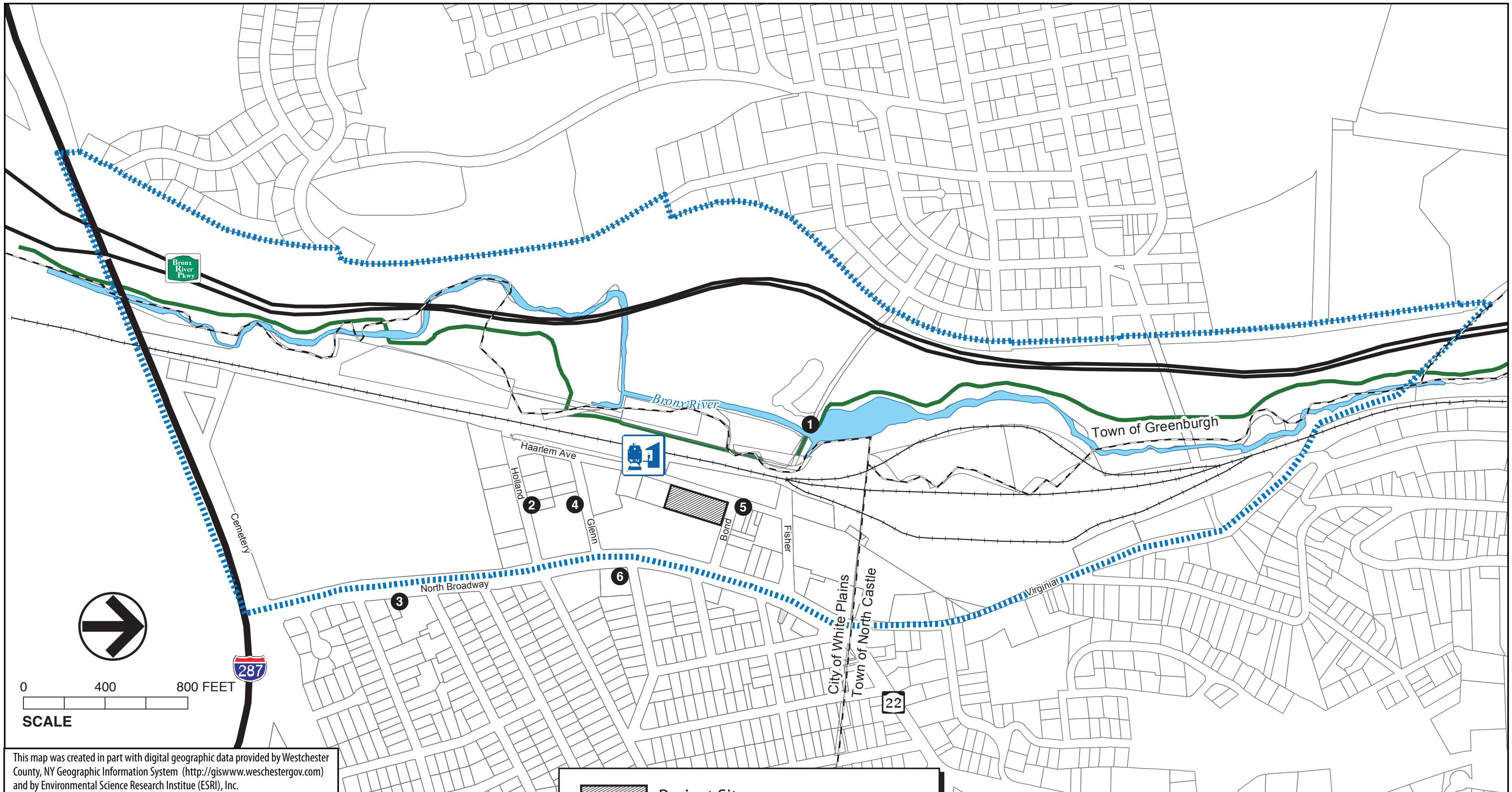
F.7 CONCLUSION

Based upon FTA impact criteria, the Proposed Action would not result in any noise-related moderate or severe impacts. ✷



Source: Transit Noise and Vibration Impact Assessment, May 2006

Figure F-1
FTA Noise Impact Criteria for Transit Projects



- Project Site
- Municipal Boundaries
- Study Area
- North White Plains Station
- Bike Path
- Noise Receptor Locations

Noise Receptor Locations

1. Fisher Lane between Bronx River Parkway and Haarlem Avenue
2. Holland Avenue between Haarlem Avenue and North Broadway
3. North Broadway between McBride and Archer Avenues
4. Glenn Street between North Broadway and Haarlem Avenue
5. Haarlem Avenue between Bond Street and Fisher Lane
6. North Broadway between Brookdale Avenue and Glenn Street

METRO-NORTH RAILROAD PARKING GARAGE
50 HAARLEM AVENUE, WHITE PLAINS, NY

MTA Metro-North Railroad

Figure F-2
Noise Receptor Locations