Development of Noise Analysis for Assessing Traffic Noise in Certain Typical Conditions

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ABSTRACT

Assessing traffic noise is difficult in certain typical conditions in New York City due to changed street geometries, challenges of collection of non-traffic noise components, and levels of existing noise affected by heavy traffic at adjacent streets, among other variables. In general, a proportional model, i.e., a logarithmic equation to compute total passenger car equivalents (PCEs), is employed to assess traffic noise impacts based upon the noise methodology and the noise criteria under the City Environmental Quality Review (CEQR) guidelines[1]. However, in some typical conditions, such as significant changes in roadway or street geometry, roadways that currently carry no or very low traffic volumes, and existing noise levels that are the result of multiple sources, the FHWA Traffic Noise Model (TNM)[2] can be used to better compute project-generated traffic components. This paper presents a development of noise analysis method dealing with these conditions. Once a proportional model identifies any potential noise impacts for screening purposes, TNM computations can be conducted for more thorough and detailed noise analyses. The results demonstrate that while a proportional model provides a practical and convenient noise analysis for most situations, TNM can provide more accurate noise assessments for the conditions listed above.

INTRODUCTION

Traffic noise can cause stress-related illnesses, disrupt sleep, and interrupt activities requiring concentration. In New York City, with its high concentration of population and commercial activities, such problems are common. For most situations, traffic noise assessments can be conducted based upon the CEQR methodology summarized in the following procedure:

- Determine sensitive receptor locations where project-generated traffic would be significantly increased;

- Measure existing noise levels at sensitive receptor locations;

- Use the proportional model to predict Future noise levels;

- Compare Future noise levels with existing noise levels;

- Determine noise impacts under the CEQR noise criteria; and

- Provide mitigation measures if any noise impacts would occur.

By using the proportion model, assuming substantially all measured existing noise at a sensitive receptor site is associated with the vehicular traffic passing the site. This is a proper assumption as long as vehicular noise levels are at least 10 dBA above levels associated with all other noise sources. In addition, traffic data for both existing and project-generated must be provided. For most situations, the proportional model is considered as a practical and convenient model for traffic noise analysis, particularly for first level screening purposes. However, when vehicular noise is not a dominated noise source, or any typical conditions mentioned previously, using the proportional model for traffic noise assessment would be either inaccurate or impossible. For these certain typical conditions, TNM model can be conducted for more thorough and detailed noise analyses.

PROPORTIONAL MODELING TECHNIQUE

The proportional modeling technique is used as a screening mechanism to determine locations which had the potential for having significant noise impacts. Using this technique, typically, future traffic noise levels are estimated using the changes in traffic volumes to predict changes between No Build and Build noise levels. Vehicular traffic volumes can be converted into passenger car equivalent (PCE) values using the TNM model based on the *CEQR Technical Manual* revised October 2001. The passenger car equivalent (PCE) value for one medium-duty truck (having a gross weight between 9,900 and 26,400 pounds) is assumed to generate the noise equivalent of 13 cars, one bus (carrying more than nine passengers) is assumed to generate the noise equivalent of 18 cars, and one heavy-duty truck (having a gross weight of more than 26,400 pounds) is assumed to generate the noise equivalent of 47 cars. The change in future noise levels are calculated using the following equation:

F NL = E NL + 10 * $\log_{10}$ (F PCE / E PCE)
where:
F NL = Future Noise Level
E NL = Existing Noise Level
F PCE = Future PCEs
E PCE = Existing PCEs

Because sound levels use a logarithmic scale, this model calculates change in sound levels logarithmically, with traffic change ratios. For example, assume that traffic is the dominant noise source at a particular location. If the existing traffic volume on a street is 100 PCEs and if the future traffic were increased by 100 PCEs, or doubled to a total of 200 PCEs, the noise level would increase by 3.0 dBA.

This screening procedure was used to identify whether there were any locations in the vicinity of the proposed project where project-generated PCE values result in an increase of 3 dBA or more in vehicle-related noise levels from No Build to Build conditions (i.e., locations where there was a doubling of PCEs), and consequently where there is the potential for significant noise impacts.

TNM MODEL

The FHWA Traffic Noise Model can be used for traffic noise predictions, particularly for highway traffic noise assessment. TNM calculates the noise contribution of each roadway

segment to 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. The program then repeats this process for all roadway segments, summing their contributions to generate the predicted noise level at the given receptor.

DEVELOPING METHOD

A developing method can be used for traffic noise predictions in some certain typical conditions described previously. While the proportional modeling technique identifies locations where there would be a potential for having significant noise impacts, TNM model is used to compute noise levels generated by traffic presented below.

Ambient Noise Levels

Existing noise levels are determined by field measurements. These measured values are compared to modeling traffic noise levels determined using the TNM model and existing traffic data. Since the TNM model does not factor in additional noise sources, such as trains, airplanes, constructions, and other urban noise, ambient noise levels were added logarithmically to TNM predicted sound levels to obtain the total noise levels at noise receptor locations affected by these additional noise factors. Ambient levels are estimated using the following formula:

$$\text{Ambient Noise Level} = 10 \log(10^{\text{measured noise level}/10} - 10^{\text{TNM calculated noise level}/10})$$

To account for ambient noise contributing noise levels for Future conditions, these ambient noise levels are logarithmically added to noise levels of noise receptor locations. These ambient noise levels are assumed to remain relatively unchanged from the Existing condition.

NOISE PREDICTION

Existing, Future noise levels are calculated by TNM. The TNM model takes into account various factors due to traffic flow, including traffic volumes; vehicle mix (i.e., percentage of autos, light duty trucks, heavy duty trucks, buses, etc.); source/receptor geometry; shielding, including barriers and terrain, ground attenuation, etc. The predicted noise levels can be achieved by using the following formula:

$$\text{Predicted Noise Level} = 10 \log(10^{\text{TNM calculated noise level}/10} + 10^{\text{ambient noise level}/10})$$

The noise analysis can provide noise levels in locations where traffic sources are not the only dominant noise source. The TNM model is used to calculate traffic noise levels from on-site vehicle movements at receptor locations, and calculated noise levels are subtracted from measured noise levels to obtain ambient noise levels. To account for non-traffic components of the noise contributing noise levels for Future conditions, these ambient noise levels were logarithmically added to noise levels of each noise receptor locations.

It is difficult to obtain Existing traffic data in some conditions. For those conditions, Existing noise levels are determined by field measurements. The project-generated noise levels are calculated by TNM. Future noise levels can be achieved by using the following formula:

$$\text{Predicted Noise Level} = 10 \log(10^{\text{TNM calculated noise level}/10} + 10^{\text{ambient noise level}/10})$$

RESULTS

Using the developing model for traffic noise analysis in some typical condition, Table 11-9 shows the existing noise levels, TNM calculated existing and project noise levels, and cumulative Future noise levels.

Site 1 is located at a commercial area in Queens, immediately adjacent to an elevated subway line. The subway is the dominate noise source. Due to traffic-generated noise, the existing noise level and the future noise level are 66.7 dBA and 68.1 dBA, respectively. The maximum change in noise level would be 0.1 dBA compared to the existing noise level.

Site 2 is located at a commercial and residential area in Manhattan, adjacent to a highway. The highway traffic is the dominate noise source. Due to traffic-generated noise, the existing noise level and the future noise level are 65.3 dBA and 66.7 dBA, respectively. The maximum change in Future noise level would be 1.4 dBA compared to the existing noise level.

Site 3 is located at a quiet residential area in Queens with low traffic. The traffic is the dominate noise source. Due to traffic-generated noise, the existing noise level and the future noise level are 60.6 dBA and 62.4 dBA, respectively. The maximum change in Future noise level would be 1.8 dBA compared to the existing noise level.

Site 4 is located at a quiet residential area in Queens with low traffic. The traffic is the dominate noise source. The proposed project will change the street geometrics adjacent to the receptor location. Without the existing traffic data, the existing noise level by TNM is not applicable. The project-generated noise level is 50.4 dBA. The maximum change in Future noise level would be 0.3 dBA compared to the existing noise level.

Site 5 is located at an industrial area in Brooklyn, immediately adjacent to a highway. The highway traffic is the dominate noise source. The existing traffic data was not available, and then the second method was used. The project-generated noise level is 50.4 dBA. The maximum change in Future noise level would be 0.3 dBA compared to the existing noise level.

Site	Condition		Existing		Future	
		Measured	TNM	Ambient	Project-generated	Cumulative
1	Elevated Train (LIC)	82.3	66.7	82.2	68.1	82.4
2	Highway (ConE Midtown)	74.2	65.3	73.6	66.7	74.4
3	Low traffic (PS 263Q)	61.7	60.6	55.2	62.4	63.5
4	Changed street geometrics (Glen Oasks)	61.4	NA	NA	50.4	61.7
5	Without Existing traffic data (LaFarge)	74.2	NA	NA	55.2	74.3

CONCLUSIONS

A developing model can provide traffic noise assessments for the conditions due to changed street geometrics, challenges of collection of non-traffic noise components, and levels of existing noise affected by heavy traffic at adjacent streets, roadways that currently carry no or very low

traffic volumes, and existing noise levels that are the result of multiple sources, and among other variables. The proportion model is used to screen locations where had the potential for having significant noise impacts, and then the FHWA Traffic Noise Model (TNM) can be used to better compute project-generated traffic components. The results demonstrate that while a proportional model provides a practical and convenient noise analysis for most situations, TNM can provide more accurate noise assessments for the conditions listed above.

REFERENCES

[1] City environmental Quality Review (CEQR) Technical Manual, Chapter 3R Noise, New York, 2001. The CEQR Technical Manual is the City of New York's guidance document that assists City agencies, project sponsors, and the public in conducting environmental review of projects in the City.

[2] FHWA Highway Traffic Noise Prediction Model, TNM version 2.5, Federal Highway Administration, Washington, D.C., April, 2004.