APPLICATION OF THE RAILWAY NOISE MODEL FOR DETAILED NOISE ANALYSES FOR THE EAST SIDE ACCESS (ESA) PROJECT

Weixiong Wu and Stephen Rosen

Allee King Rosen & Fleming, Inc., 117 East 29th Street, New York, NY 10016

1. INTRODUCTION

This study presents the use of the Railway Noise Model (RWNM), developed by the University of Central Florida, for prediction of noise impacts at several sensitive receptor locations in the New York Metropolitan region that could be affected by the Long Island Rail Road's (LIRR) East Side Access (ESA) Project. During preparation of the East Side Access Environmental Impact Statement, a detailed noise analysis was made and implemented using the Federal Transit Administration (FTA) noise impact criteria. This study compares the modeling RWNM's sound levels with the FTA model's results. The RWNM simulates a 24-hour period of rail traffic and computes day/night sound pressure level (L_{dn}), maximum sound pressure level (L_{max}), sound exposure level (SEL), and equivalent sound pressure level (L_{eq}). The comparison indicates that the RWNM model is able to model typical railway projects, and is therefore applicable to projects subject to FTA review and/or funding.

2. OVERVIEW

The ESA project would provide direct access for LIRR passengers to Grand Central Terminal in Manhattan by the year 2020. ESA would use the lower level of the existing 63rd Street tunnel under the East River, which was built for LIRR trains (see Figure 1). It would increase LIRR's capacity into Manhattan by 45 percent; relieve crowding in Penn Station; strengthen ties between Manhattan and growing Nassau and Suffolk business centers; support regional employment growth; and reduce trip time by up to 30 minutes per day for 53 percent of LIRR riders. However, the new service network would increase train passbys along most branches, creating a potential for adverse noise impacts at sensitive locations along the right-of-way in Queens, Nassau, and Suffolk counties that many branches already have high noise levels due to existing rail service. This study compares the FTA results with the results from modeling done with the RWNM and examines the implications of relatively modest increases in rail service at sensitive locations.

The RWNM was developed at the University of Central Florida and is used to predict sound levels at receptors near railway operations for analysis in environmental noise assessments. It is a simulation model, and trains are modeled as moving point sources of sound. Using a mouse, the user can easily create model objects, tracks, barriers, and receptors. The RWNM can model light rail vehicles and some heavy freight vehicles, as specified by the FTA. The point sources supported by the RWNM are equivalent to those of the FTA manual, *Transit Noise and Vibration Impact Assessment* [1], and use the same maximum sound pressure level equations. However, the RWNM provides some features and capabilities not available in the current FTA model, such as noise modeling at locations where there are curves, multiple tracks, and barrier attenuation, and where trains sound their warning horns as they approach a crossing, etc.

The RWNM was applied to determine existing and project-generated noise levels at a variety of sensitive receptor locations, such as at a very dense urban area; at two-level tracks; at locations where warning horns are sounded at at-grade crossings; and at locations where houses shield the receptor sites. Geographical Information Systems (GIS), aerial photographs, and field studies were used to select these noise-sensitive receptor sites. Existing noise levels were established by noise measurements and compared to the RWNM's calculated noise levels. Project-generated noise levels were calculated using both the FTA model and the RWNM. Using the FTA noise criteria, noise levels that would result in impacts or severe impacts were determined, and project RWNM and FTA noise level results were compared. At locations where impacts or severe impacts were predicted to occur, the feasibility and effectiveness of implementing mitigation measures was explored.

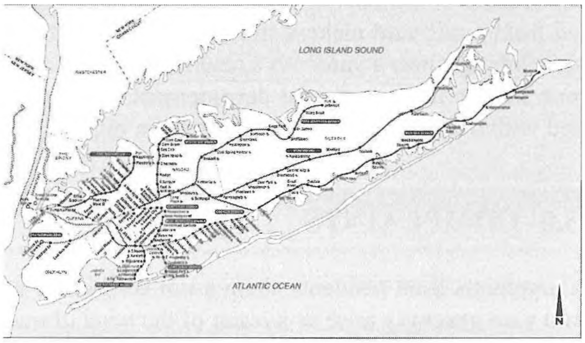

Figure 1: East Side Access Project–Long Island Rail Road Map

3. METHODOLOGY

Selection of Receptor Sites. Table 1 lists the locations of the five receptor sites selected for noise analysis. Noise measurements were made on public streets rather than on private residential property, and adjusted based upon distance from the track to reflect the noise levels at the closest appropriate receptor site to the railroad right-of-way. The receptor locations were selected based on an examination of GIS data for the rail segments that were previously identified as having the potential for project impacts. Field studies were then performed to confirm that each site had a sensitive land use (i.e., residences), that rail noise was the dominant noise source, and that each site was generally the closest sensitive receptor location to the rail tracks. In addition, the five sites were selected to provide geographic coverage of the areas that may potentially be affected

Site	Location	Land Condition	Track Condition
1	Woodside to Forest Hills	High-density residential	Ground-level
2	Jamaica to Floral Park	High-density residential	Two-level
3	Floral Park to Mineola	Mid-density residential	At grade
4	Mineola to Hicksville	Mid-density residential	At-grade crossing, warning horns
5	Huntington to Port Jefferson	Low-density residential	Ground-level, housing shielding

Table 1: Noise Receptor Sites and Locations

by the proposed project (i.e., they were spread over the various segments of the rail line potentially affected by the proposed project).

Noise Monitoring. At each of receptor sites, noise levels were measured to determine existing L_{dn} noise levels. Full 24-hour measurements were made during a typical weekday, between 12:00 Noon Monday and 12:00 Noon Friday. Noise monitoring was conducted using a Brüel & Kjær Noise Level Analyzer Type 4427, a Brüel & Kjær Sound Level Calibrator Type 4231, a Brüel & Kjær ½-inch microphone Type 4189, and a Brüel & Kjær microphone preamplifier Type 2669. Measurements were made on the A-scale (dBA) for a sampling period of 1 hour throughout a 24-hour measurement period. The analyzer was calibrated before and after each 24-hour reading., and a windscreen was used during all sound measurements, except for calibration. All measurement procedures conformed with the requirements of ANSI Standard S1.13-1971 (R1976). Measured quantities included L_{eq}, L_1, L_{10}, L_{50}, L_{90}, and L_{max}.

FTA Model. The noise analysis for the ESA project was performed using the procedures and modeling approach described in the FTA manual. This FTA guidance document provides a three-step process for analysis: a noise screening procedure, used to determine whether any receptors are within distances where impacts are likely to occur; a general noise assessment, used to determine locations where there is the potential for impacts; and a detailed noise analysis, used to predict the impact level and assess the effectiveness of mitigation with greater precision than can be achieved with the general noise assessment. Using FTA methodology, L_{dn} noise levels for free field acoustic conditions (no reflections above ground) from fixed-rail sources were determined based on a variety of factors, including the number of rail cars, train speed, distance to receptors, the surrounding terrain, and in the case of diesel trains, the number of locomotives [2].

Railway Noise Model. The RWNM simulates all daily train operations, followed by night operations. Night operations receive a 10-dB penalty, which is required for L_{dn} determination [3]. Train positions on the tracks are updated at a 1-second time period. This is constant speed simulation. Sound levels and energies from all sources are calculated at each receptor during each time period. The sound level calculation procedure follows the method of the following equation.

$$SPL = L_0 - A_s - A_g - A_e$$

SPL = sound pressure level, dBA,
L_0 = reference level at 15 meters (r_0),
A_s = attenuation as a result of the geometric spreading, $20\log(r_1/r_0)$,
r_1 = distance from source to receiver,
A_g = attenuation due to ground adsorption, and
A_e = diffraction effects due to barriers.

4. RESULTS

Existing noise levels at each location were monitored and calculated using measurements taken in the field and the RWNM model, respectively. Impacts and severe impacts were calculated based on measured levels. Project-generated noise levels were calculated using the RWNM and FTA model at each receptor location. Table 2 shows the existing calculated project-generated increment noise levels.

Based upon the noise impact analysis results, at all receptor locations the project-generated noise would result in noise impacts. The difference in the existing L_{dn} values when comparing measured and RWNM noise levels would be 0.4 dBA at Site 1, 1.5 dBA at Site 2, 0.9 dBA at Site 3, 5.2 dBA at Site 4, and 0.6 dBA at Site 5. The difference between the FTA and RWNM project-generated L_{dn} values would be 0.7 dBA at Site 1, 1.4 dBA at Site 2, 0.6 dBA at Site 3, and 1.8 dBA at Site 5. There would be no difference between the FTA and RWNM project-generated L_{dn} values at Site 4.

Site	Method	Existing Noise level	Allowable Project-generated Noise level		Method	Project Increm-ent Noise level	Result
			Impact	Severe Impact			
1	Measured	69.6	64.1	69.2	FTA	67.6	Impact
	RWNM	70.0			RWNM	66.9	Impact
2	Measured	76.7	65.0	74.5	FTA	70.6	Impact
	RWNM	78.2			RWNM	72.0	Impact
3	Measured	77.2	65.0	75.0	FTA	71.6	Impact
	RWNM	78.1			RWNM	72.2	Impact
4	Measured	75.6	65.0	73.7	FTA	71.4	Impact
	RWNM	80.8			RWNM	71.4	Impact
5	Measured	63.7	60.0	65.4	FTA	62.6	Impact
	RWNM	63.1			RWNM	60.8	Impact

Note: Noise impact analysis values calculated based on measured Existing noise levels.

Table 2: Impact Evaluation of Rail Noise in Ldn dB(A)

5. CONCLUSIONS

Based upon the results, the RWNM provides the capacity for detailed noise analysis of typical railroad projects, and it can meet the FTA model's sound level prediction needs. The evaluations have led to the following conclusions:

With the exception of conditions in which the warning horn is sounded, the existing RWNM values are very close to measured values;
At all sites, there is a maximum difference of 1.8 dBA between RWNM and FTA model project-generated noise levels;
RWNM is user friendly in the creation of sources, receiver, barriers, etc.;
In general, RWNM provides accurate sound level values at typical railway situations;
RWNM provides the ability to assess practical railway projects; and
Train horn results need additional validation with measured noise levels.

At Site 4, where warning horns are sounded at an at-grade crossing, the monitoring noise level is 5.2 dBA higher than RWNM's noise level. Based upon field observations, it is concluded that this difference is because the train engineer tends to blow the warning horn for a longer time period during the daytime than during the nighttime. Therefore, situations with warning horn noise levels need additional validation with measured sound levels.

[1] *Transit Noise and Vibration Impact Assessment.* Report DOT-T-95-16. FTA, U.S. Department of Transportation, April 1995.
[2] *MTA Long Island Rail Road East Side Access.* United States Department of Transportation, Federal Transit Administration, Prepared by Allee King Rosen & Fleming Inc, May 2000.
[3] John M. MacDonald and Roger L. Wayson. *Railway Noise Model.* Journal of the Transportation Research Board, No. 1670, 1999, pp. 76-80.