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Noise Assessments for Construction Noise Impacts

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ABSTRACT

Construction noise is one of the most disruptive noise sources in New York City. Large-scale projects especially can take more than a decade to complete, and often be located in areas with various sensitive noise receptors. When these projects are being built, on-site construction equipment operation along with construction vehicle movement on surrounding roadways can cause dramatic increases in ambient noise levels at near noise-sensitive receptors. In addition, construction activities would occurs not only during weekday daytime periods, but also sometimes in the weekday nighttime periods or weekends. To assess a potential construction noise impact, the *City Environmental Quality Review (CEQR) Technical Manual*[1] is used when preparing an environmental impact statement (EIS). For most cases, adverse noise impacts often occur at near noise receptors during the construction without implementing mitigation measures. To eliminate or minimize these impacts is among the most challenging noise issues for noise analyses. This paper will illustrate certain methods for construction noise mitigation measures for large-scale development projects, to meet the CEQR noise criteria. The purpose of this study is to present practical and feasible mitigation techniques to reduce construction noise levels. Finally, noise analysis results for a typical large-scale project (the Atlantic Yards Arena project) will be presented using these mitigation measures.

1 INTRODUCTION

Construction noise analyses were completed by using construction noise mitigation plans for typical large-scale construction projects in New York City, including First Avenue Properties in Midtown Manhattan, Fordham University Lincoln Center, Columbia University's proposed new campus in Manhattanville in West Harlem, the new Yankee Stadium in the Bronx, and the Atlantic Yards Arena in Brooklyn. All of these sites are located in areas with high population densities and many noise-sensitive receptors. When these projects are built, construction activities will occur during normal weekday daytime periods, and construction for some of the projects will occasionally take place during the nighttime and on weekends as well.

Noise analyses were performed to identify the potential for significant adverse impacts that could result from construction noise. In general, noise analyses are conducted by:

- Determining sensitive receptor locations where construction-generated noise will be significantly increased;
- Measuring existing noise levels at sensitive receptor locations;
- Using appropriate mathematical models to predict construction noise levels;
- Determining noise impacts based on related noise ordinance standards; and
- Providing mitigation measures if any noise impacts will occur.

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The analyses results show that noise levels associated with construction activities from the representative projects will significantly increase ambient noise levels at sensitive receptors adjacent to the construction sites. In addition, the predicted construction noise levels are expected to exceed related noise ordinance standards. Therefore, while performing EIS construction analyses, mitigation measures must be implemented to reduce noise levels from construction noise.

The following sections explain mitigation measure methods used to lessen construction noise impacts, describe construction noise analyses case study for the Atlantic Yards Arena project, and present the noise analyses results for this typical urban project.

2 METHODS TO MITIGATE CONSTRUCTION NOISE

Construction noise mitigation plans were implemented for the typical large-scale projects mentioned above. The plans employed a wide variety of measures that exceed standard construction practices, but whose implementation was considered feasible and practicable to minimize construction noise and reduce potential noise impacts. As described below, the plans include emission control, path control, and receptor control.

2.1 Emission Control

The following emission control (i.e., reducing noise levels at the noise source during construction), which go beyond typical construction techniques, will be implemented during construction:

- Construction schedules must be reviewed logistically and realistically from the start of construction activities.
- All equipment must meet the sound emission standards specified in Subchapter 5 of the New York City Noise Control Code[2] and Citywide Construction Noise Mitigation of Department of Environmental Protection of New York City[3].
- When the use of new equipment is not practical, old equipment must be made quieter by simple modifications, such as adding new mufflers or sound-absorbing materials.
- Since heavy trucks (i.e., dump trucks, concrete trucks, delivery trucks, trailers, etc.) are likely the major noise contributors during construction, quieter trucks will be used when feasible.
- Eliminate unnecessary equipment on site, and restrict heavy truck traffic during nighttime operations which will reduce the noise impacts at night to the area around the construction site and day time trucks are less noticeable on the roadway.
- As early in the construction period as possible, diesel-powered equipment will be replaced with electrical-powered equipment.
- Contractors and subcontractors will be required to properly maintain their equipment and have quality mufflers installed.

2.2 Path Control

During construction, the following path control (e.g., placing equipment away from sensitive receptors and installing barriers between equipment and sensitive receptors), which go beyond typical construction techniques, will be implemented to the extent feasible:

- Noisy equipment, such as generators, cranes, concrete pumps, concrete trucks, and delivery trucks, will be shielded and located away from sensitive receptor locations. For example, during the early construction phases, delivery and dump trucks, as well as many other construction equipment operations, will take place below grade to take advantage of shielding benefits. Once building foundations are completed, delivery trucks will operate behind noise barriers.

- Noise barriers will be used to provide shielding. For example, the construction sites will have a minimum 8-foot-high barrier, with a 15-foot-high barrier adjacent to residential and other sensitive locations. In addition, truck deliveries will take place behind these barriers once building foundations are completed.
- Noise curtains and equipment enclosures will be used to shield sensitive receptor locations.

Table 1 shows an example of equipment noise levels using the emission and the path control techniques for a noise analysis of the Fordham University Lincoln Center project. The emission noise levels came from the noise level standards specified in the Citywide Construction Noise Mitigation of the Department of Environmental Protection of New York City or the Transit Noise and Vibration Impact Assessment of Federal Transit Administration[4]. The mandated noise levels were achieved by using quieter equipment, better engine mufflers, and refinements in fan design and improved hydraulic systems. Noise levels with path control included using noise barriers, enclosures, acoustical panels, and curtains, whichever feasible and practical.

Table 1: Maximum Noise levels at 50 feet with emission and path control, dBA re 20μPa.

Equipment List	Emission Noise Level	Mandated Noise Level	Noise Level with Path Controls
Asphalt Paver	85	85	75
Asphalt Roller	85	74	
Backhoe/Loader	80	77	
Compressors	80	67	
Concrete Pump	82	79	
Concrete Trucks	85	79	
Cranes	85	77	
Cranes (Tower Cranes)	85	85	75
Delivery Trucks	84	79	
Drill Rigs	84	84	74
Dump Trucks	84	79	
Excavator	85	77	
Excavator with Ram Hoe	90	90	80
Fuel Truck	84	79	
Generators	82	68	
Hoist	85	80	70
Impact Wrenches	85	85	75
Jack Hammer	85	82	72
Mortar Mixer	80	63	
Power Trowel	85	85	75
Powder Actuated Device	85	85	75
Pump (Spray On Fire Proof)	82	76	
Pump (Water)	77	76	
Rebar Bender	80	80	
Rivet Buster	85	85	75
Rock Drill	85	85	75
Saw (Chain Saw)	85	75	
Saw (Concrete Saw)	90	85	75
Saw (Masonry Bench)	85	76	
Saw (Circular & Cut off)	76	76	
Saw (Table Saw)	76	76	
Sledge Hammers	85	85	75
Street Cleaner	80	80	
Tractor Trailer	84	79	
Vibratory Plate Compactor	80	80	
Welding Machines	73	73	

2.3 Receptor Control

Receptor control (i.e., measures at sensitive receptors to reduce sound levels at these locations) will be implemented. When emission and path controls are not sufficient to prevent significant adverse noise impacts at residential locations, and when the residences do not have both double-glazed or storm windows and alternative ventilation (e.g., air conditioning), double-glazed windows and alternative ventilation systems will be provided to meet the related interior noise criterion in New York City, which is the worst-case hour L_{10} less than or equal to 45 dBA.

3 A CONSTRUCTION NOISE MITIGATION CASE STUDY

3.1 Project Description

A major mixed-use development in the Atlantic Terminal area of Brooklyn in New York City will be built by 2016. Figure 1 shows a representation of project buildings that will be developed in Brooklyn. The proposed project will occupy an approximately 22-acre area and introduce a mix of uses, with the greatest activity concentrated closest to Brooklyn's major transportation hub. The project site will contain a new arena for the New Jersey Nets, along with commercial office and retail, hotel, and residential uses. All construction is expected to be completed over a 10-year period. The construction activities will generally take place Monday through Friday, beginning at 7 AM and ending at 6:00 PM on weekdays. Occasionally, evening and night work will be required. Weekend work will also occur, with a typical workday on a Saturday starting at 7 AM and finishing by 5 PM.

Figure 1: Representation of Atlantic Yards mixed-use project buildings in Brooklyn.

Noise-sensitive receptors, including residences, school, church, and park, are located directly adjacent to the project site. Table 2 and Figure 2 shows the selected noise receptor locations, which are representative of other sensitive noise receptors in the immediate project area and are the locations where maximum project impacts from construction noise are expected.

Table 2: Noise receptor locations

Receptor Site	Location	Land Use
A	4th Avenue between Atlantic Avenue and Pacific Street	Church
B	Pacific Street between Flatbush and 4th Avenues	Residential
C	Flatbush Avenue at Pacific Street	Park
D	Flatbush Avenue at Dean Street	Residential & Retail
E	Pacific Street between Carlton and 6th Avenues	Residential & Retail
F	Vanderbilt Avenue between Pacific and Dean Streets	Residential & Retail
G	Academy Park Place between South Elliot Place and South Portland Avenue	Residential
H	Carlton Avenue between Fulton Street and Atlantic Avenue	Residential
I	Atlantic Avenue between Clermont and Carlton Avenues	Residential & School

Figure 2: Noise receptor locations in Atlantic Terminal study area.

3.2 Construction Noise Impact Criteria

The *CEQR Technical Manual* states that significant noise impacts due to construction would occur "only at sensitive receptors that would be subjected to high construction noise levels for an extensive period of time." This has been interpreted to mean that such impacts would occur only at sensitive receptors where the activity with the potential to create high noise levels would occur for approximately two years or longer. In addition, the *CEQR Technical Manual* states that impact criteria for vehicular sources, using existing noise levels as the baseline, should be used for assessing construction impacts. The criteria are as follows:

- If the existing noise levels are less than 60 decibels, A-weighted equivalent sound level for one hour (dBA $L_{eq(1)}$) and the analysis period is not a nighttime period, the threshold for a significant impact would be an increase of at least 5 dBA $L_{eq(1)}$. For the 5 dBA threshold to be valid, the resulting proposed action condition noise level with the proposed action would have to be equal to or less than 65 dBA.

- If the existing noise level is 61 dBA $L_{eq(1)}$, the maximum incremental increase would be 4 dBA, since an increase higher than this would result in a noise level higher than the 65 dBA $L_{eq(1)}$ threshold.
- If the existing noise level is equal to or greater than 62 dBA $L_{eq(1)}$, or if the analysis period is a nighttime period (defined in the CEQR criteria as being between 10:00 PM and 7:00 AM), the incremental significant impact threshold would be 3 dBA $L_{eq(1)}$.

The impact criteria contained in the *CEQR Technical Manual* were used for assessing impacts from mobile and on-site construction activities.

3.3 Construction Noise Analysis Methodology

In general, construction activities for most large-scale projects would be expected to result in increased noise levels as a result of: (1) the operation of construction equipment on-site; and (2) the movement of construction-related vehicles (i.e., worker trips, and material and equipment trips) on the surrounding roadways. The effect of each of these noise sources need to be evaluated.

Noise from the operation of construction equipment on-site at a specific receptor location near a construction site was calculated by computing the sum of the noise produced by all pieces of equipment operating at the construction site. For each piece of equipment, the noise level at a receptor site was calculated at sensitive noise using the following equation.

$$L_{eq(1)} = E.L. + 10 \log (U.F.) - 20 \log (D/50) - Shielding \qquad (1)$$

where:

$L_{eq(1)}$ is the noise level at a peak-hour time period;

E.L. is the noise emission level of the equipment at a reference distance of 50 feet;

U.F. is a usage factor that accounts for the fraction of time that the equipment is in use over the specified time period in full power;

D is the distance from the receiver to the piece of equipment; and

Shielding is the noise attenuation by structures.

Noise effects from construction activities were evaluated using the computer software, CadnaA[5]. Geographic input data used with the software included CAD drawings, which defined site work areas, adjacent building footprints and heights, street locations, and locations of sensitive receptors. For each analysis period, the geometric location and operational characteristics—including equipment usage factors for each piece of construction equipment operating at the project site, as well as noise control measures described above—were input to the software. In addition, reflections and shielding by barriers erected on the construction site, as well as shielding from both adjacent buildings and project buildings (as they are constructed), were accounted for in the model (see Figure 3).

3.4 Mitigation Measure Results

Construction noise results for the maximum predicted peak hour of activity during weekday daytime periods in 2008 at typical receptor elevations in the Atlantic Yards area are shown in Table 3. Computations were initially performed assuming typical construction equipment operation and equipment placement on-site with no consideration of mitigation measures. The maximum noise level generated by construction will be up to 89 dBA at receptor Site B, which will result in significant adverse impacts.

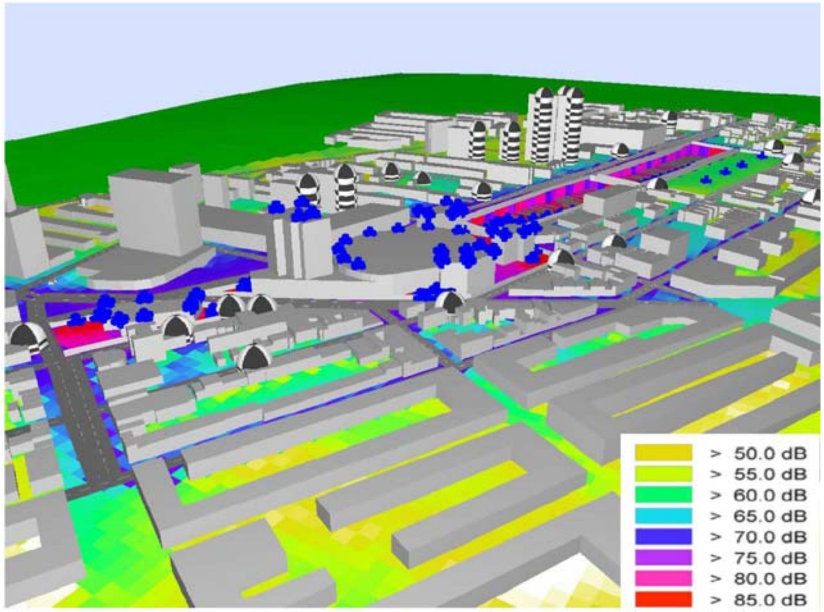

Figure 3: Construction noise computation model in 2008.

Using the mitigation measures described above, a reduction of 3 to 6 dBA can be obtained with source control techniques, 2 to 7 dBA reduction can be obtained with path control techniques for receptors on the 3rd floor or on lower levels, 3 to 9 dBA reduction can be obtained with trucks located behind noise barriers for receptors on the 3rd floor or on lower levels, and up to 2 dBA reduction can be obtained by using both path control techniques and placing trucks behind barriers for receptors on the 4th floor or on higher levels.

In general, receptor locations that have a clear line of sight to locations on the project site where construction activities will take place will tend to have higher noise levels then locations with restricted views. Noise barriers are more effective when they break the line of sight between the source and receptor. At elevated receptor locations and/or when construction operations take place at elevated locations, ground-level noise barriers may not provide any appreciable noise attenuation. Consequently, noise levels at buildings are higher at elevated receptor locations than at lower-floor locations.

With regard to residential locations where significant noise impacts were predicted to occur, surveys were performed to examine the types of windows and alternative ventilation so that an assessment could be made of the impact of noise produced by the project on interior noise levels of residences and other buildings near and adjacent to the project site, and to determine whether interior noise levels would meet the CEQR interior L_{10} noise criteria for residences of 45 dBA. At locations where the residences do not contain both double-glazed or storm-windows and/or alternative ventilation (i.e., air conditioning), the project sponsor will make receptor mitigation measures available, i.e., double-glazed windows and alternative ventilation systems will be provided.

In summary, because of the construction noise mitigation measures incorporated into the Atlantic Yards project, the magnitude of the noise levels produced by construction activities for the project will be below those typically produced by major construction projects in New York City. Without mitigation measures, construction activities will produce noise levels at nearby receptor locations generally ranging from 73 to 89 dBA. With mitigation measures, construction activities will produce noise levels at nearby receptor locations generally ranging from 64 to 77 dBA. Noise levels can decrease by a maximum of 19 dBA at certain locations.

Table 3: Predicted construction noise levels in 2008, dBA re 20μPa.

Noise Receptor	Elevation Level	Worst Period $L_{eq(1)}$	Source Controls		Path Controls		Trucks Behind Barriers		Total Decrease
			$L_{eq(1)}$	Decrease	$L_{eq(1)}$	Decrease	$L_{eq(1)}$	Decrease	
A	1st Floor	85	82	-3	76	-6	67	-9	-18
B	1st Floor	89	85	-4	78	-7	70	-8	-19
C	1st Floor	88	83	-6	79	-3	70	-9	-18
D	3rd Floor	87	82	-5	78	-4	73	-5	-14
E	3rd Floor	79	74	-5	69	-5	67	-3	-12
F	3rd Floor	78	73	-5	71	-2	64	-7	-14
G	15th Floor	81	76	-5	76	0	76	0	-5
H	15th floor	73	69	-5	68	-1	66	-2	-7
I	30th Floor	85	80	-5	78	-2	77	-1	-8

4 CONCLUSION

With construction noise mitigation plans, construction activities for large-scale projects examined above can reduce noise levels significantly at sensitive noise receptors adjacent to construction sites. Based on the noise analyses results, noise control techniques were developed to identify and develop practical mitigation measures that were incorporated into the projects to substantially reduce potential construction noise impacts. Key findings are summarized below:

- Before taking mitigation measures, a logical and realistic review of construction schedule is necessary.
- Eliminate unnecessary equipment on site.
- As early in the construction period as possible, replace diesel-powered equipment with electrical-powered equipment.
- Where feasible, use quiet equipment (for dominant noise equipment).
- Noisy equipment needs be located away from sensitive receptor locations and shielded from sensitive receptor locations.
- Delivery trucks should be located adjacent to noisy streets or behind noise barriers.
- 3 to 6 dBA reduction can be obtained with source control techniques.
- 2 to 7 dBA reduction can be obtained with path control techniques for receptors at lower elevation levels.
- 3 to 9 dBA reduction can be obtained by placing delivery trucks behind noise barriers for receptors at lower elevation levels.
- A maximum reduction of 19 dBA can be obtained with noise source and path control techniques.
- If possible schedule louder activities; to times people are less sensitive to noise intrusions.
- Limited benefits of noise reduction can be expected by using path control techniques for receptors at higher-level floors.

5 REFERENCES

[1] *New York City Environmental Quality Review (CEQR) Technical Manual*, Chapter 3R Noise, New York, 2001.

[2] New York City Noise Code, Subchapter 5, New York City Department of Environmental Protection, 2005.

[3] Citywide Construction Noise Mitigation, Chapter 28, Department of Environmental Protection of New York City, 2007

[4] Transit Noise and Vibration Impact Assessment, May 2006, Federal Transit Administration.

[5] CadnaA is the computerized software developed by DataKustik.