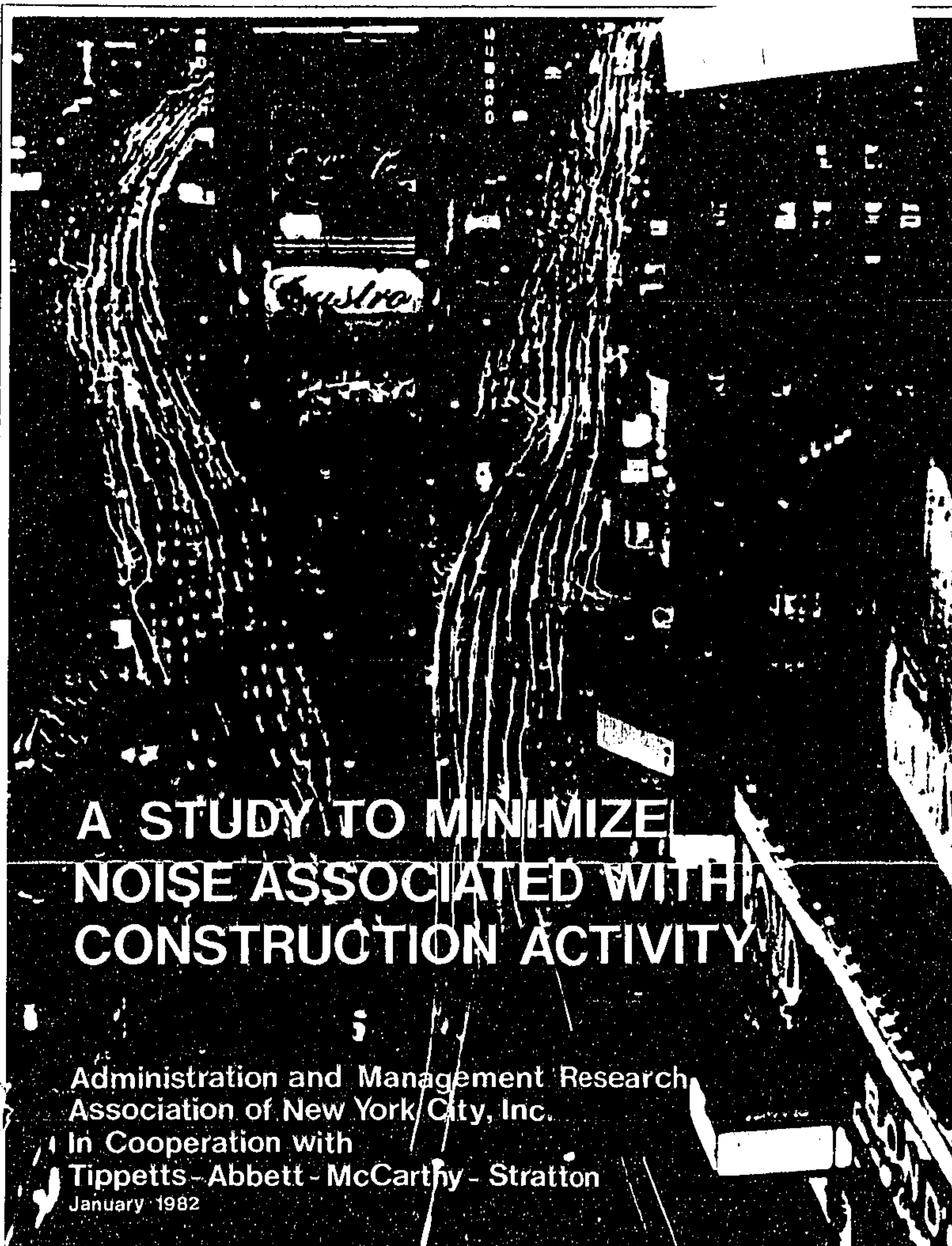

A STUDY TO MINIMIZE NOISE ASSOCIATED WITH CONSTRUCTION ACTIVITY

Administration and Management Research Association of New York City, Inc.
In Cooperation with
Tippetts - Abbett - McCarthy - Stratton
January 1982

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The preparation of this report has been financed in part through a grant from the U.S. Environmental Protection Agency, Office of Noise Abatement and Control. This document is disseminated under their sponsorship in the interest of information exchange. The United States Government assumes no liability for its contents thereof. (W-3049-NAGX).

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1.0 INTRODUCTION

The purpose of this study is to evaluate the noise associated with the construction of Broadway Plaza and identify selected methods to mitigate noise related impacts. The work program selected to achieve these aims consists of several elements:

- Determination of existing noise levels within the project area.

- Calculation of construction noise levels.

- Identification and evaluation of mitigation techniques to reduce construction noise.

2.0 EXISTING BASELINE NOISE LEVELS

To assess the potential noise impact of the project construction, the existing noise levels or baseline condition must be determined. The severity of construction noise impact is based on the extent the construction noise levels exceed the baseline conditions.

2.1 Review of Existing Noise Data

There have been two recent studies in the vicinity of Times Square that have measured the existing noise levels; the Draft Environmental Impact Statement, Proposed Times Square Hotel and the Final Environmental Impact Statement N.Y. Broadway Plaza. The noise measurement data from these studies represent the existing levels of the Times Square area from 45th Street to 49th Street. Six noise measurement sites were selected (Sites 7 through 12). The noise levels at these sites range from 75 dBA to 78 dBA (Table 1). Traffic is the predominant source of noise.

2.2 Selection of Noise Measurement Sites

As part of this study, six additional noise measurement sites were selected for monitoring (Figure 1) (Sites 1 through 6). These sites were specifically selected to consider those locations in the Times Square area that will be closest to major project construction activity and are representative of noise sensitive land uses such as legitimate theaters, movie theaters and office buildings.

TABLE 1

NOISE MEASUREMENT DATA

SITE	LOCATION	NOISE LEVEL (L_{eq})-dBA
1	Midblock of Seventh Ave, between 45th & 46th Sts.	75
2	Midblock of Seventh Ave, between 46th & 47th Sts.	79
3	Midblock of Broadway, between 44th & 45th Sts.	76
4	Midblock of Broadway, between 47th & 48th Sts.	74
5	Midblock of Broadway, between 46th & 47th Sts.	75
6	Midblock of Seventh Ave, between 48th & 49th Sts.	72
7	Midblock of Broadway, between 48th & 49th Sts.	75
8	Intersection of Broadway and 48th St.	78
9	Intersection of Broadway and 46th St.	76
10	Traffic Island: Broadway and Seventh Ave at 45th St.	77
11	Intersection of Seventh Avenue and 48th St.	75
12	Midblock of Broadway, between 45th & 46th Sts.	76

Note: Sites 1 through 6 were measured as part of this study. Site 7 through 11 were measured as part of the Broadway Plaza FEIS and Site 12 was measured as part of the Times Square Hotel DEIS.

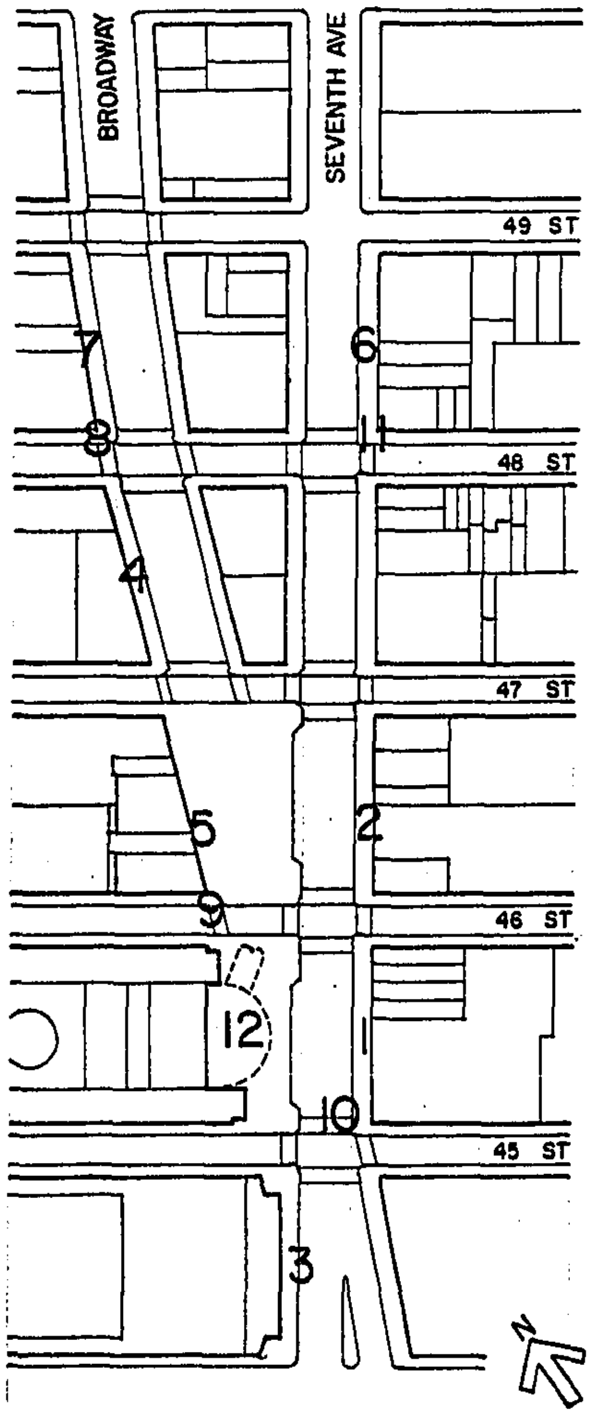


FIGURE 1. NOISE MEASUREMENT SITES

2.3 Noise Measurement

Noise levels were sampled with a ½" Bruel & Kjaer condenser microphone fitted with a windscreen. The signal from the microphone was passed to a Bruel & Kjaer Type 4426 Noise Level Analyzer where it is A-Filtered. A calibration signal of 94 dB at 1000 Hz was used before each measurement period.

Each of the six measurement sites were sampled for 30 minutes between the hours of 9:00 am and 5:00 pm on September 21, 1981. At each monitoring site the microphone was located midblock one meter from the building line to avoid building face reflection. Meteorlogical conditions during the noise survey period are listed in Appendix A.

2.4 Measured Existing Noise Levels

Measured existing noise levels within the project area range from 72 dBA to 79 dBA. The majority of the 12 sites have noise levels in the range of 74 dBA to 76 dBA which reflects a consistency in noise level throughout this area of Times Square. The major source of noise is the movement of vehicular traffic.

3.0 PROJECTION OF CONSTRUCTION NOISE LEVELS

For the purpose of this study the construction of Broadway Plaza is divided into the following five phases:

Phase I	-	Vault and Subsurface exploration
Phase II	-	Water Main Replacement
Phase III	-	Seventh Avenue Realignment and BMT Vent Modification
Phase IV	-	Traffic Diversion Plan and New BMT Vents
Phase V	-	Plaza Area Construction

The effect of the noise levels generated by these construction phases is considered for interior and exterior locations.

3.1 Existing Activities

Existing activities in the Times Square area, have been divided into exterior and interior categories as follows:

- Exterior
  Seating area in Duffy Square
  Pedestrians on line at TKTS
  Pedestrians walking through the area.

- Interior
  Theaters (Movie and legitimate)
  Restaurants
  Offices
  Retail Shops

To evaluate the potential effects of construction noise on interior uses it is necessary to know the sound level reduction (SLR) properties of the buildings exterior construction. Various building construction in this area may range from office buildings of masonry construction with 50% operable window glass area to a theatre that is all masonry construction with no glass area. In some instances, there are open, counter top, restaurants where there is no separation between the street and the eating area. We have estimated the range of sound level reduction for each of the four interior uses identified (Table 2).

Table 2

Sound Level Reduction Properties of Buildings in the Project Area

Land Use	Range of Sound Level Reduction (SLR) - dB
Theater	35 to 40
Restaurant	10 to 25
Office	20 to 30
Retail	15 to 20

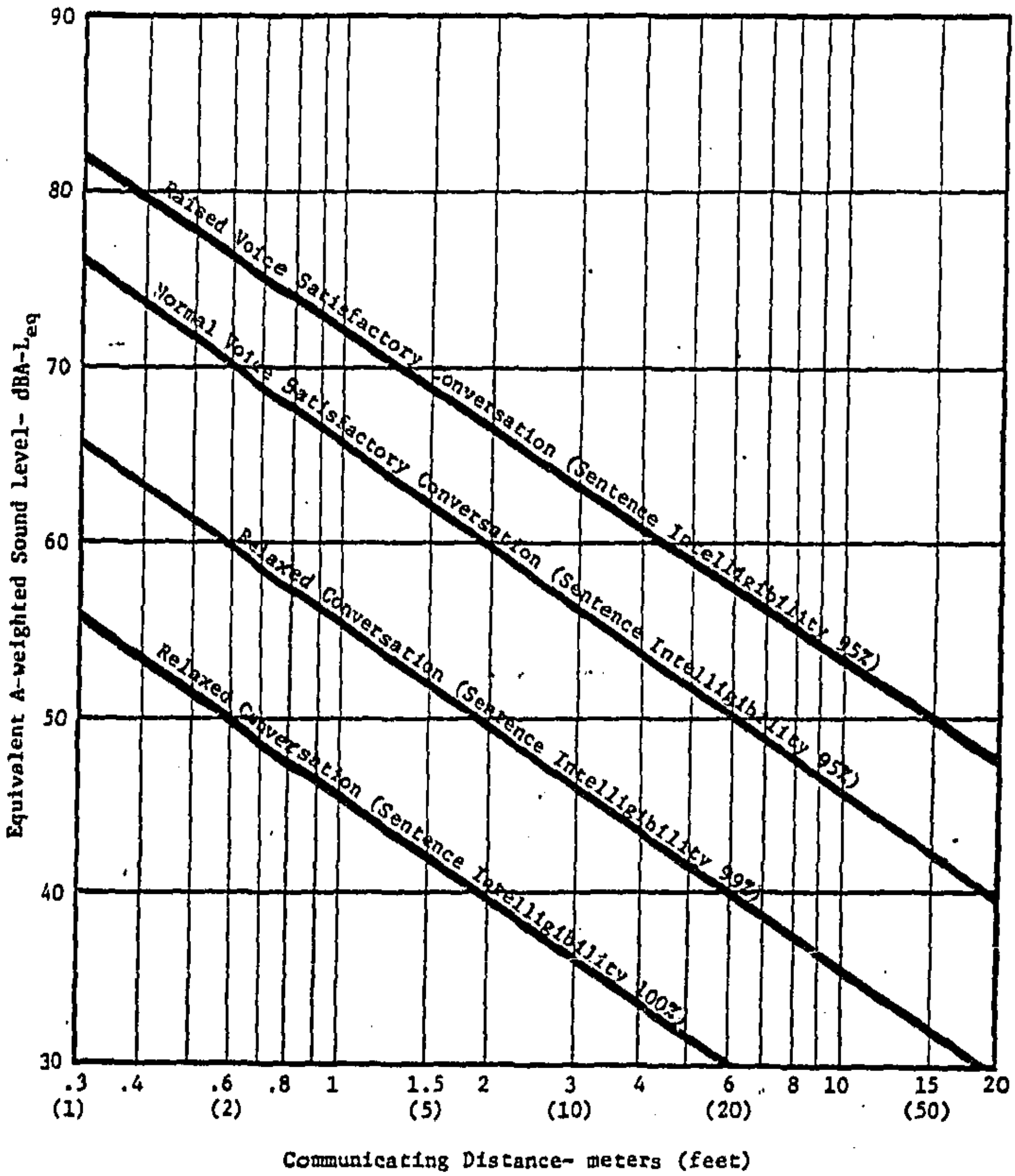
Note: 1. The SLR properties of a restaurant range from 10 dB for an open counter type restaurant to 25 dB for a fully enclosed restaurant with a masonry and glass exterior wall construction.

3.2 Criteria

The impact of construction noise can be related to physiological and psychological effects. The physiological effect is risk of hearing damage to persons in the project area. The USEPA has determined that continuous exposure to noise levels of L_{eq} = 75 dBA or greater for eight hours per day or more will experience hearing damage over a 40-year period (USEPA, 1978). This effect is particularly relevant since the existing noise levels in the Times Square area exceeds this criteria at most of the measurement sites.

The psychological effect is primarily interference with speech communication. The criteria to evaluate speech interference outdoors is shown in Figure 2 as the maximum distance outdoors over which conversation is considered to be satisfactorily intelligible (USEPA, 1974). Speech intelligibility is shown as a function of distance between speaker and listener (communicating distance) and voice effort of speaker.

The related effects of noise on interior activities is primarily speech communication. The maximum acceptable background sound level for interior uses are referred to as the Noise Criteria (NC) Curves (ASHRAE, 1970). The NC Curves are plotted as sound pressure level in each of the eight octave bands. The NC curves have been converted to A-weighted sound levels, for the purpose of this study, and are listed in Table 3 as design objectives for interior spaces with various uses.



Source: USEPA,1974

Figure 2 MAXIMUM DISTANCE OUTDOORS OVER WHICH CONVERSATION IS CONSIDERED TO BE SATISFACTORILY INTELLIGIBLE

Table 3

Recommended Noise Criteria

Interior Activity	Range of Noise Criteria-dBA
Theater	31 to 36
Restaurant	41 to 51
Office	41 to 51
Retail	46 to 56

Source: ASHRAE, 1970.

3.3 Construction Schedule

The proposed schedule for final design and construction of Broadway Plaza is shown in Figure 3. The schedule is formulated in response to the following city objectives for project completion:

- A realignment of Broadway and Seventh Avenue to traffic on the 45th - 46th Street block at the earliest possible date to provide a staging area for construction of the Time Square Hotel.
- Reconstruction of Seventh Avenue prior to closing of Broadway.
- Provision for continued sale of reduced price theater tickets to be made during construction of the Times Square Theater and Information Center Building.

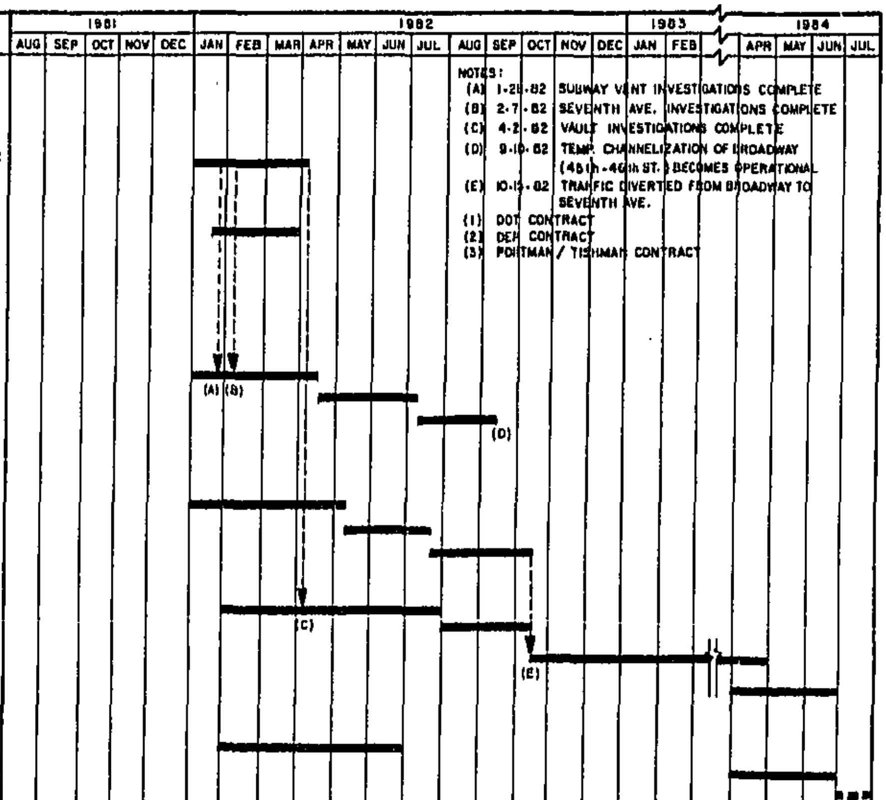
Five construction contracts are proposed to accomplish the city's objectives. The first contract is for the In-depth Vault and subsurface exploration which is required to provide details concerning existing vault and subsurface conditions for final design. The second contract is the water main replacement from Broadway to Seventh Avenue. The next contract will be for the Seventh Avenue realignment and modification of the BMT Subway ventilator located in the traffic Island between 45th and 46th Street. The fourth construction contract is for traffic diversion plan and construction of new BMT ventilators.

TAMS ENGINEERS & ARCHITECTS

BROADWAY PLAZA
PROPOSED DESIGN & CONSTRUCTION SCHEDULE

1-11-82 DRAFT
4-1-82 REVISION No 1

PHASE	PROJECT ELEMENT	Date Start	Date Complete
I	IN-DEPTH VAULT & SUBSURFACE EXPLORATION CONTRACT PERFORMANCE (1)	1-4-82	3-27-82
II	WATER MAIN REPLACEMENT CONTRACT PERFORMANCE (2)	1-15-82	3-31-82
III & IV	SEVENTH AVE. RE-ALIGNMENT, BMT VENT MODIFICATION AND REPLACEMENT BMT VENTS		
	Prepare Contract Documents		4-23-82
	Award Contract	4-26-82	7-2-82
	Contract Performance	7-5-82	9-10-82
V	TRAFFIC DIVERSION PLAN		
	Prepare Contract Documents		5-7-82
	Award Contract	5-10-82	7-21-82
	Contract Performance (1)	7-26-82	10-15-82
VI	PLAZA AREA CONSTRUCTION		
	Prepare Contract Documents	2-1-82	7-31-82
	Award Contract	8-2-82	10-15-82
	Contract Performance: 46th-47th Street (1)	10-18-82	4-30-83
	Contract Performance: 45th-46th Street (3)	4-84	7-84
VII	SEVENTH AVENUE RESURFACING		
	Prepare Contract Documents		6-30-82
	Award Contract	5-84	7-84
	Contract Performance	7-84	10-84



The final construction contract would provide for the realignment of Broadway and construction of the project plaza areas including the following major items.

- sidewalk vault alterations.
- IRT subway ventilator modifications.
- Drainage system modifications.
- Traffic control devices and signing.
- Landscaping.
- Lighting.
- Street furniture and monument relocation
- Graphics

3.4 Construction Noise Levels

Noise levels are calculated by identifying construction equipment at the site during the five construction phases in terms of:

- Number of each equipment type typically present at the site in a given phase.
- Duty cycle of each type of equipment.
- Average noise level of each equipment type during operation.

The construction site is viewed as a complex noise source in which equipment is centered at a point 50 feet (ft) from an observer. The site equivalent sound level (L_{eq}) at 50 ft. is calculated for each of the five phases of construction (Table 4). These noise levels represent the average L_{eq} for a daily workshift of 10 hours. Depending upon the specific activity, the noise levels may be higher or lower at any given time during the workshift. The calculation methodology is presented in Appendix B.

The calculated construction noise levels range from 83 dBA to 89 dBA with the maximum site L_{eq} occurring during the third phase of construction (Seventh Avenue realignment and BMT vent modification). The fifth phase of construction, plaza area construction, has a site L_{eq} of 86 dBA and will last for 40 weeks and therefore will have a greater impact than the third phase which has a duration of four weeks. The following impact analyses of construction activities is based on the calculated site L_{eq} for the fifth phase of construction. This approach assumes that all the equipment to be used have not been retrofitted with noise control equipment nor are they the newer models of equipment that have lower noise emission levels. This represents a worst case example of construction noise for this project.

Table 4

Calculated Construction Site L_{eq} Noise Level at 50 feet

Phase	Project Element	Duration	Noise Level
I	Vault and Subsurface Exploration	12 weeks	85 dBA
II	Water Main Replacement	10 weeks	83 dBA
III	Seventh Ave. Realignment and BMT Vent Modification	4 weeks	89 dBA
IV	Traffic Diversion Plan and New BMT Vents	10 weeks	86 dBA
V	Plaza Area Construction	40 weeks	86 dBA

3.5 Noise Impact

The expected noise impact of the Broadway Plaza project is due to both traffic and construction activities.

3.5.1 Traffic Noise

The diversion of traffic due to the construction of Broadway Plaza will result in reduced traffic speed through the Times Square area. The traffic noise during construction is expected to be lower than the present traffic noise.

3.5.2 Construction Noise

The expected impact due to the fifth and longest phase of construction (worst case) is assessed for both interior and exterior locations.

Exterior Land Use

Construction noise will vary as the distance between the center of the construction site and the observer is changed. The expected construction noise at locations throughout the Times Square area are shown as noise contours on Figure 4. The expected noise levels, during each phase of construction at each of the 12 measurement sites is listed in Table 5.

Interior Land Use

Interior noise levels, due to construction, are listed in Table 6 for each of the four interior uses. At a distance of 200 ft. the interior noise levels exceed the recommended noise criteria described in Section 3.2.2. The construction noise may effect Wednesday afternoon matinees of the Palace Theater located on Seventh Avenue between 46th and 47th Streets. The other legitimate theaters in the Times Square area will be exposed to lower noise levels therefore not being effected during matinee performances.

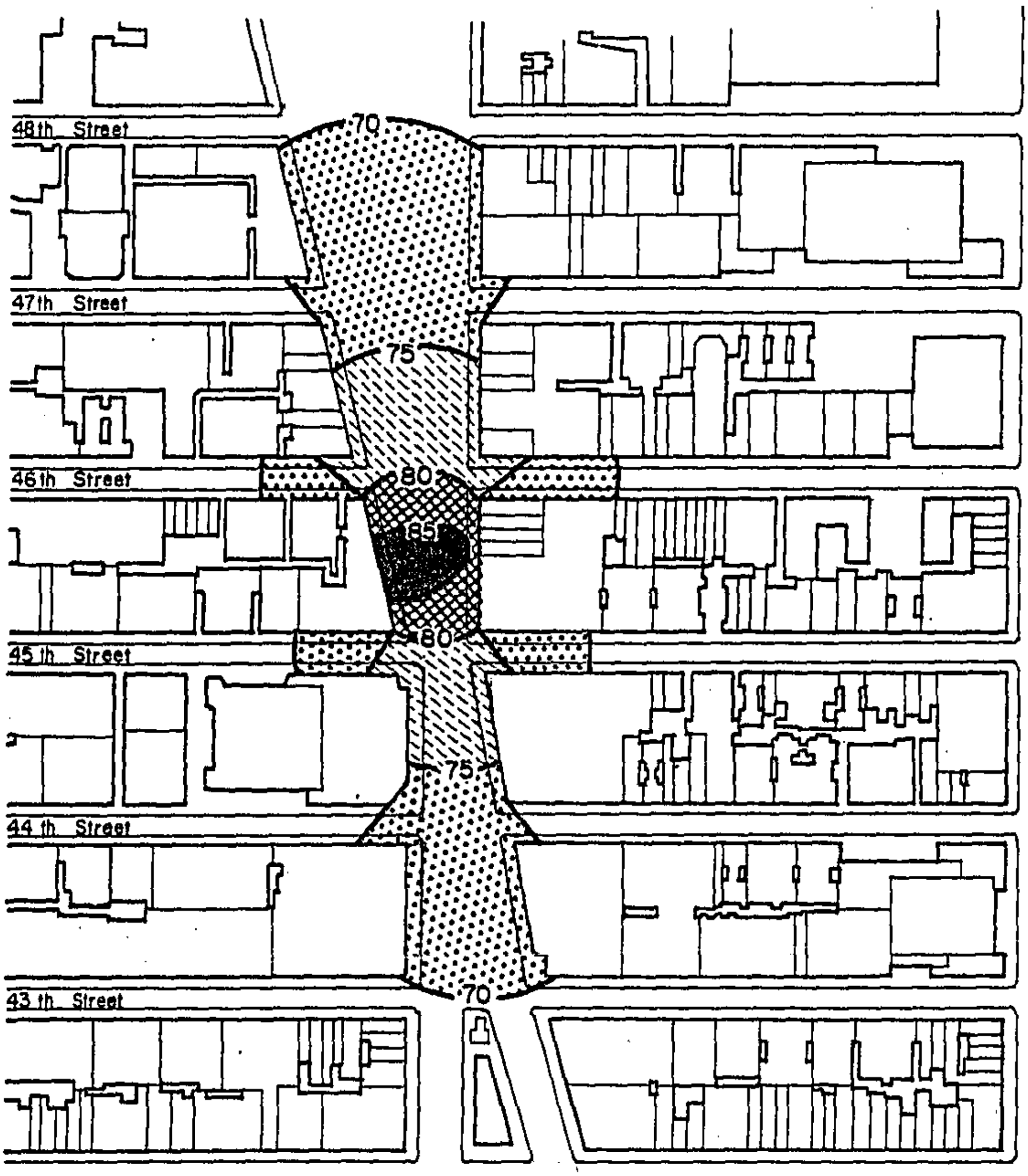


FIGURE 4 NOISE CONTOURS OF PLAZA AREA CONSTRUCTION

LEGEND:

- 70 dBA to .75 dBA.
- 75 dBA to 80 dBA
- 80 dBA to 85 dBA
- GREATER THAN 85 dBA

ADMINISTRATION AND MANAGEMENT RESEARCH ASSOCIATION OF NEW YORK CITY, INC JANUARY 1982

Table 5

Expected Noise Levels During Each Phase of Construction

	Noise Level - L_{eq} (dBA)				
Site	Phase I	Phase II	Phase III	Phase IV	Phase V
1	85	83	82	79	80
2	74	72	82	79	74
3	74	72	75	72	74
4	69	67	75	72	71
5	73	71	80	77	75
6	68	66	72	69	68
7	67	65	72	69	68
8	68	66	72	69	69
9	77	75	82	79	78
10	79	77	80	77	78
11	68	66	73	70	69
12	77	75	83	80	86

Table 6

Expected Interior Noise Levels

Land Use	Range of Interior Noise Level - dBA @ 50 ft	@ 100 ft	@ 200 ft	Recommended Noise Criteria - dBA
Theater	46-51	42-47	38-43	31-36
Restaurant	61-76	57-72	53-68	41-51
Office	56-66	52-62	48-58	41-51
Retail	66-71	62-67	58-61	46-56

4.0 MITIGATION OF CONSTRUCTION NOISE

The most commonly used construction noise control methods are: (1) barriers; (2) equipment modification; (3) equipment substitution; and (4) proper scheduling of noisy construction activities.

4.1 Barriers

A possible site noise control technique would be a plywood fence as a barrier. The placement of a barrier between the construction site and the passing pedestrians increases the distance the sound has to travel to reach the observer, and in most cases will reduce noise levels 5 db to 7 db.

However, the use of a plywood fence along Seventh Avenue and Broadway would not be effective because the fence would end at the crosstown streets. This interruption would considerably reduce the acoustical effectiveness of the barrier. Additional consideration that precludes the installation of barriers include interferrence with curbside delivery to retail stores, visual blockage of theater marquis and store signs and pedestrian safety.

A barrier could only be effectively used for phases of construction that are limited to a small area such as the subway vent modifications.

4.2 Equipment Modifications

Most of the construction equipment, assumed for this study, can be grouped into four categories: (1) trucks; (2) wheel and crawler tractors; (3) pneumatic impact tools and (4) air compressors. Equipment in two of these categories, air compressors and paving breakers, is regulated by the City of New York Noise Control Code. The operation of a paving breaker manufactured after December 31, 1975 may not exceed 90 dBA at a distance of one meter. An air compressor manufactured after December 31, 1975 may not exceed 70 dBA at a distance of one meter.

The remaining construction equipment is not regulated by the NYC Noise Control Code and therefore the modification of equipment to achieve lower operating noise levels or the use of newer and quieter equipment could be stipulated by the construction contract.

4.3 Equipment Substitution

The selection of equipment or processes to perform construction tasks based on their noise emissions is another method of reducing construction noise. A single large piece of equipment used in place of several small units may result in a lower average site noise level. One type of equipment can be selected to perform a task because of its lower noise emission and/or higher efficiency. For example, in some cases a scraper can be used instead of a loader for earth removal since scrapers have larger capacities and are usually quieter than loaders. Wheeled vehicles can be selected rather than track vehicles because of their lower noise. The noise reduction expected depends entirely on the equipment to be substituted and can only be evaluated on a case by case basis.

The use of offsite facilities for the prefabrication of materials will also reduce overall site noise. For example, it may be possible to prefabricate certain concrete sections instead of batch pouring at the project site.

4.4 Scheduling

The NYC Noise Control Code restricts the hours of construction to weekdays between 7 am and 6 pm. Scheduling of construction tasks will not decrease the total noise energy emitted during the duration of construction activity but it will reduce peak times of annoyance to people at nearby noise sensitive land use areas.

The scheduling of a break in construction or reduced construction activities is a viable mitigating measure to reduce noise levels during sensitive times of day such as Wednesday afternoon matinees. This method of noise control is expected to reduce the noise level of construction 10 db or more.

5.0 COST OF NOISE CONTROL

As an example of the cost of noise control, TAMS has researched past studies relating cost to quieting overall construction noise levels. The most effective method of noise control for this project is equipment modification, substitution, and scheduling of construction during sensitive times of the day such as Wednesday afternoon theater matinees. The extent of noise control (equipment modification and substitution) and its related cost is presented as a percentage increase in construction cost vs a noise level reduction of 3 db, 6 db, and 10 db (CERL, 1978):

Site Noise Reduction	Percentage Increase of Construction Cost
3 db	0.40%
6 db	0.72%
10 db	2.01%

An additional method of noise control is to reschedule noisy activities during sensitive times of the day. The cost of this is approximately a 2% to 4% increase in construction cost, and will provide a noise reduction of 10 db or more during Wednesday afternoons. This estimate of increased construction cost is based on past experience with similar projects.

This cost analysis is intended as an illustration of the relationship between cost and achieving construction site noise reduction. It is not a cost-benefit analysis.

The subjective perception of a reduction in noise level of 3 db, 6 db, and 10 db is:

3 db - A change in sound level of 3 db is barely perceptible by most people.

5 db - A change in sound level of 5 db is noticeable

10 db - A change in sound level of 10 db is perceived as a halving of loudness.

6.0 CONCLUSIONS

To achieve a site noise reduction of 10 db by equipment substitution and modification, the construction costs will increase $157,500.00 or 2.01% of a $7.5 million total budget. The additional cost of rescheduling noisy activities during Wednesday afternoon matinees is in the range of $150,000.00 to $300,000.00. These estimates need to be re-evaluated when a construction program is finalized.

The expected interior noise levels (during plaza area construction) with a 10 db reduction in construction noise is listed in Table 7. Theaters, restaurants, offices and retail shops within 100 ft. from the construction site just barely meet the recommended noise criteria. At distances of 100 ft. or more the expected interior noise levels are within the range of the criteria.

Table 7

Expected Interior Noise Levels with a 10 dB Reduction in Construction Noise

Land Use	Range of Interior Noise Level - dBA @ 50 ft	@ 100 ft	@ 200 ft	Recommended Noise Criteria - dBA
Theater	36-41	32-37	28-33	31-36
Restaurant	51-66	47-62	43-58	41-51
Office	46-56	42-52	38-48	41-51
Retail	56-61	52-57	48-51	46-56

APPENDIX A

NOISE NOMENCLATURE

The decibel as used herein is defined as:

Sound pressure level in decibels (dB) = $20 \log_{10} \left(\frac{P}{P_o}\right)$ where P is measured sound pressure and P_o is the reference sound pressure required for a minimum sensation of hearing. This reference sound pressure is 0.002 microbar and is equivalent to zero decibels. Essentially, decibel notation is used because it compresses the very large range of sound pressures that can be detected by humans to a workable range using logarithms.

Since the human ear perceives sounds at different frequencies in different manners, weighting networks are used to simulate the human ear. Sounds of equal intensity at low frequencies are not perceived as loud as those most commonly used in sound analysis to simulate the human ear. A-weighted values are used in Federal, State, and local noise guidelines and ordinances. Sound levels measured in decibels, on the A-weighting network are expressed in dBA.

Statistical analysis is used to describe the time-varying property of sound. Single number descriptors are used to report sound levels. This report contains the statistical A-weighted sound levels:

L_x- This is the sound level exceeded X% of the time. For example: L_{90} is the sound level exceeded 90 percent of the time during the measurement period and is often used to represent the "residual" sound level.

L_{50} is the sound level exceeded 50 percent of the time during the measurement period and is used to represent the "median" sound level.

L_{10} is the sound level exceeded 10 percent of the time during the measurement period and is often used to represent the "intrusive" sound level.

L_{eq}- This is the equivalent steady sound level which provides an equal amount of accoustic energy as the time varying sound.

The results of the noise measurement survey are listed in Table A-1. The meteorological conditions noted during the survey are listed in Table A-2.

Table A - 1

Noise Survey Data

	Noise Level - dBA					
Site	L_1	L_{10}	L_{50}	L_{90}	L_{99}	L_{eq}
1	83.0	76.8	72.3	69.0	52.3	75.0
2	87.8	79.3	73.3	68.0	65.8	78.6
3	84.8	76.3	71.5	67.8	57.0	75.6
4	83.3	75.5	69.3	66.0	53.5	74.1
5	84.0	77.3	73.3	71.5	56.3	74.9
6	80.5	74.5	69.5	66.5	64.3	71.6

Source: Survey performed by TAMS, September 21, 1981

Table A - 2

Meterological Conditions During

Noise Survey

Time	Temperature - °F	Wind Speed (mph)	Wind Direction	Humidity(%)
10 AM	62	6	NW	69
11 AM	64	5.2	NW	54
12 Noon	64	10	NW	47
1 PM	67	8	SE	47
2 PM	69	7	NW	44
3 PM	71	6	SW	41
4 PM	72	7	SW	44

APPENDIX B

CONSTRUCTION-SITE NOISE MODEL

Basic Model

The model used in this study is similar to one developed for the U.S. Environmental Protection Agency (EPA). Use of the model yields an estimation of the average sound level, L_{eq}, emitted from a construction site. The model is simple to use and reasonably accurate. With the model, one may evaluate the noise emitted from construction sites as a result of construction equipment operating at present noise levels or future quieted levels.

Required Equipment Data

To apply the model, the following data must be known:

1. Equipment Schedule - A list of the types and numbers of equipment used during each construction scenario
2. Equipment Noise Levels - Noise levels for each equipment type used are needed. The maximum A-weighted sound level produced by the equipment and the distance at which the measurements were made.
3. Usage Factors - The fraction of time the equipment is operated in its noisiest mode.

In the course of a typical work cycle, construction equipment spends part of its cycle idling or preparing to perform a task. During some part of its work cycle, the level of the noise the machine emits is higher than at any other time. Since L_{eq} is an average value representing the total sound energy emitted during the period of interest, the maximum sound level and the duration of maximum noise as a fraction of the total period must be known to determine the equivalent (energy average) sound level emitted by the machine during a total work period: for example, a typical work day. The fraction of this period that the equipment operates in its noisiest mode is designated as the Usage Factor (UF). The usage factor is considered to be the product of two component elements, an operating factor (F_1) and a utilization factor (F_2); UF = $F_1 \times F_2$. The operating factor is that portion of the typical work cycle during which the equipment emits its maximum noise. Three possible time-varying modes of equipment noise emission are possible.

Mode 1: The equipment works cyclically; for example, a backhoe or front-end loader may generate maximum sound while trenching but significantly less sound while using its loader.

Mode 2: The equipment moves throughout the site.

Mode 3: An operation is performed sporadically, possibly only once during the observation period.

The utilization factor is that portion of the work period (e.g., 8-hr. work day) that the equipment is on the site and is being used. Thus, the utilization factor considers the number of work cycles for the equipment during typical operations over the work period. The utilization factor is then multiplied by the operating factor to yield the usage factor.

Stationary equipment may not be operating, may be idling while other preparatory activities are in process, or may be operating at full load (and maximum noise level). These operations may be repeated often during a typical construction day.

Mobile equipment may be operating at maximum noise levels for a short duration; an example is a front-end loader while loading. The equipment (the loader) may travel a considerable distance to place this load. At a receiver, sound levels drop significantly as the loader leaves the scene even though the source noise level has not diminished.

Operating factors and utilization factors are best determined from measurements at a construction site where operations similar to those at the site under study are occurring. Data on usage factors for various construction sites are sparse.

Description of Model

Construction-site noise levels are estimated for each construction phase of activity. The construction-site noise is calculated by adding applicable construction equipment average noise levels and extrapolating these levels to the locations of interest. The noise from all the equipment is normalized to a common distance and then summed as:

$$L_{eq} = 10 \log \sum_{i}^{n} UF_i \times N_i \times 10^{L_{Pi}/10}$$

L_{eq} = average noise level of all equipment

UF_i = usage factor of equipment type i

N_i = number of units of equipment type i

L_{Pi} = maximum sound level of equipment type i.

The resulting sound level is then extrapolated to the site boundary or various noise-sensitive land-use areas assuming hemispherical spreading.

For large sites which cannot be treated as point sources, the average noise level for each equipment unit must be individually extrapolated to the land-use area considered, and the resulting average sound levels (L_{eq}) are then added to obtain the total value.

These procedures are even further complicated if the equipment moves appreciable distances on the site, as is the case for dump trucks or earth-moving equipment which transfer material from one location to another. If the equipment path length is comparable to the distance from the noise source to the observer, then the construction operation cannot be considered stationary. Equipment movement can be classified into several categories.

Category 1: Equipment moves from one point on a site to another. The transit time is short and the equipment spends most of its time stationary.

Category 2: Equipment moves in a simple, predictable pattern from one point on the site to another. The equipment spends the majority of its time moving.

Category 3: Equipment moves in a random or complex path, spending part of the time in motion and part of the time stationary.

The first category is dealt with by assuming that the equipment spends all of its time at different site locations. Transit time is ignored. The equipment is considered individually for each location at which it operates. The equipment usage factor is adjusted to reflect the operations at the separate locations. A separate usage factor is used for subsequent calculations for each location.

Calculations for Category 2 are somewhat more complex. Equipment is considered a point source if the distance between the source and receiver is at least three times the major dimension of the source. To apply the calculation technique presented below for Category 2 mobile operations, the distance between the source and receiver must be at least three times the length of the path over which the equipment travels. If the source moves in a complex path, then the longest straight-line distance between two points on the path is used for this criterion. Equipment operations which meet this criterion may be treated as a stationary point source at the "acoustic center" of the path. It is assumed that the equipment moves along the defined path at a relatively constant speed throughout its work cycle. With the "acoustic center" having been selected, the computation is accomplished in the same manner as for the fixed sources.

Very little noise is generated by equipment operating throughout the site in a random manner. Thus, for Category 3, mobile operations, little error is introduced by assuming that the equipment noise emanates from the approximate geometric center of the construction activity.

Table B - 1

Phase I Construction Site Noise: Vault and Subsurface Exploration

Equipment	Average Noise Level at 50 ft. - dBA	Quantity of Equipment	Usage Factor	L_{eq} during work peric
Paving breaker[1]	90	2	0.2	86
Drill	85	1	0.1	75
Backhoe	85	1	0.2	78
Air Compressor[1]	70	2	1.0	73
Pneumatic hand tool	85	2	0.3	83

L_{eq} at 50 ft during daily work period = 85 dBA

Notes: 1. Noise emission of equipment regulated by NYC Noise Control Code.

Source: CERL, 1978.

Table B - 2

Phase III Construction Site Noise:
Seventh Avenue Realignment and BMT Vent Modification

Equipment	Average Noise Level at 50ft-dBA	Quantity of Equipment	Usage Factor	L_{eq} During Work Period
Backhoe	85	1	0.2	78
Paving breaker[1]	90	1	0.1	80
Jackhammer	90	1	0.1	80
Air Compressor[1]	70	2	1.0	73
Pneumatic hand tool	85	5	0.5	87

L_{eq} at 50 ft during daily work period = 89 dBA

Note: 1. Noise emission of equipment regulated by NYC Noise Control Code.

Source: CERL, 1978

Table B - 3

Phase IV Construction Site Noise: Traffic Diversion Plan

and New BMT Vents

Equipment	Average Noise Level at 50ft-dBA	Quantity of Equipment	Usage Factor	L_{eq} During work Period
Small Steam roller	80	1	.2	73
Backhoe	85	1	.2	78
Paving breaker	90	1	0.1	80
Air compressor	70	2	1.0	73
Light compactor	91	1.	0.1	81
Excavator	85	1	0.1	81

L_{eq} at 50 ft during daily work period = 86 dBA

Note: 1. Noise emission of equipment regulated by NYC Noise Control Code

Source: CERL, 1978

Table B - 4

Phase V Construction Site Noise: Plazas Area Construction

Equipment	Average Noise Level at 50ft-dBA	Quantity of Equipment	Usage Factor	L_{eq} During work Period
Front loader	84	1	0.3	79
Repaver	89	1	0.1	79
Backhoe	85	2	0.1	78
Air compressor	70	2	1.0	73
Pneumatic hand tool	85	2	0.2	81

L_{eq} at 50 ft during daily work period = 86 dBA

Note: 1. Noise emission of equipment regulated by NYC Noise Control Code.

Source: CERL, 1978