# APPENDIX: NOISE

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MEMORANDUM

**TO:** Julie Geisler

**FROM:** James P. Cowan
Stephen J. Holley

**RE:** SCA Playground Noise Study

**DATE:** October 23, 1992

Introduction

Between October 1 and 14, 1992, eight New York City public schools - consisting of early childhood (PS 52R), elementary (PS 299, PS 52R, PS 57, and PS 69), intermediate (IS 7, IS 72, and IS 75), and high (Tottenville High School) - were monitored for noise emissions from playground activities. The purpose of this monitoring was to provide updated noise level values, that will accurately reflect existing school playground noise levels, for use in future environmental assessments of new school projects.

The levels currently used in environmental noise assessments are 75 dBA $L_{eq(1)}$ at the playground boundary, 73 dBA $L_{eq(1)}$ 15 feet away from the playground boundary, 70 dBA $L_{eq(1)}$ 30 feet away from the playground boundary, and a 4.5 dBA drop-off rate per doubling of distance for locations farther than 30 feet away. Additionally, $L_{10(1)}$ levels are presently assumed to be 2 dBA greater than $L_{eq(1)}$ levels.

Noise Monitoring

Three sound level meters were used for the measurements. Two of the instruments were Larson Davis Labs (LDL) Model 700 meters (serial numbers 2216 and 1362) and the third was a Bruel & Kjaer (B&K) Type 4427 noise level analyzer (serial number 1167006). All of these instruments meet ANSI Standard S1.4-1983 tolerances for Type 1 specification. The LDL instruments were mounted on tripods at heights of 5 feet above the ground and the B&K 4427 was supported with its microphone fixed at a height of approximately 4 feet above the ground. All instruments were calibrated before and after each measurement session with an LDL Model CA250 Precision Acoustic Calibrator (serial number 1894) and the appropriate microphone adapter. Windscreens were used for all measurements. The weather conditions were clear to partly cloudy with winds under 10 miles per hour and temperatures in the 45 to 55 degree Fahrenheit range. All monitoring methods conformed with industry-accepted practices for measuring sound pressure levels.

Background noise levels, without playground activity, were recorded at each location. All school playgrounds monitored, except P.S. 299 in Brooklyn, were in Staten Island because the Staten Island schools provided the lowest background noise levels of any schools in the New York City area.

The lowest possible background noise levels were desirable for this study to ensure that all readings recorded were clearly generated by the playground

sources and not by other sources (e.g., vehicles, trains, airplanes, or manufacturing sources). As long as measured levels with playground activity exceed background levels without playground activity by more than 9 dBA, the measured levels are clearly indicative of those associated with the playground activity only.

With playground activity, noise levels were recorded at the playground boundaries and, wherever practical considering traffic and other extraneous sources, at distances away from the playground boundaries simultaneously. Simultaneous readings were used to estimate a drop-off rate of noise from the playground with distance.

Table 1, below, summarizes the monitored data by listing the most relevant $L_{eq}$ and $L_{10}$ values obtained. The complete set of monitored data is listed in Attachment A. The data is divided according to the type of school, (i.e., early childhood, elementary, junior high, or high) and activity (i.e., line-up, PE class, or recess).

It was originally planned that ten schools would be monitored; however, P.S. 52R was used for both its early childhood and elementary school sources and neither I.S 61 nor I.S. 24 could be monitored with reliable results for this study's purpose because of high background noise levels. Therefore, eight school sites are listed below.

Of all the data used in the analysis, the only monitored $L_{eq}$ value that was less than 9 dBA greater than the background was the 60' recess reading at I.S. 72. This value was used only for drop-off rate analysis and the actual level due to playground noise alone, after the background noise is subtracted from the reading, is 1.7 dBA less than the recorded value (which was a composite of background and playground noise).

Analysis Methodology

New York City regulations, standards, and guidelines used for environmental noise assessments are based on hourly noise levels, specifically $L_{eq(1)}$ and $L_{10(1)}$ (where the number 1 in parentheses denotes a 1-hour value). However, each school monitored had different playground usage periods for activities such as morning lineups, physical education (PE) classes, or lunch recesses. To account for these different usage durations, noise levels during active playground use were recorded separately from the background levels and the two sets of data were combined into $L_{eq(1)}$ levels by utilizing the standard mathematical definition of the $L_{eq}$ which is:

$$L_{eq(T)} = 10 \log \left( \left[ (1/T) \int_{t_0}^{t_n} p^2(t)\,dt \right] / p_{ref}^2 \right)$$

where T is the measurement time period (1 hour in this case), p is the measured acoustic pressure, and $p_{ref}$ is the pressure at the threshold of hearing ($2 \times 10^{-5}$ $N/m^2$). All logarithmic references are to the base 10. Attachment B shows the specific use of this equation in the determination of the values quoted herein.

Table 1

MEASURED NOISE LEVELS (in dBA)

| School | Grade | Activity | Distance From Playground (ft) | Duration (min) | $L_{10}$ | $L_{eq}$ |
|---|---|---|---|---|---|---|
| **Early Childhood/Elementary Schools:** | | | | | | |
| PS 52R | K-2 | Recess | 0 | 15 | 77.5 | 74.6 |
| | K-2 | Recess | 30 | 15 | 67.5 | 65.3 |
| | 3-5 | Recess | 0 | 25 | 78.0 | 77.3 |
| PS 299 | K-5 | Line-up | 0 | 17 | 79.5 | 78.9 |
| PS 57 | K-5 | Line-up | 0 | 25 | 74.5* | 77.9* |
| | 4,5 | Recess | 0 | 20 | 72.0 | 71.8 |
| PS 69 | K-5 | Line-up | 0 | 20 | 71.5 | 68.4 |
| | 1,3 | Recess | 0 | 20 | 76.0 | 73.8 |
| | 1,3 | Recess | 20 | 20 | 70.8 | 68.2 |
| | 1,3 | Recess | 40 | 20 | 66.5 | 64.0 |
| | 2,5 | Recess | 0 | 21 | 77.0 | 73.4 |
| | 2,5 | Recess | 20 | 21 | 72.7 | 69.5 |
| | 2,5 | Recess | 40 | 21 | 68.0 | 65.0 |
| **Intermediate Schools:** | | | | | | |
| IS 7 | 6-8 | Line-up | 0 | 10 | 79.0* | 87.1* |
| | 6-8 | Line-up | 30 | 10 | 76.5 | 74.5 |
| | 8 | PE Class | 0 | 25 | 67.5 | 66.1 |
| | 8 | PE Class | 30 | 25 | 63.0 | 59.6 |
| | 7 | Recess | 0 | 30 | 78.0 | 74.8 |
| IS 72 | 6-8 | Line-up | 0 | 15 | 73.5 | 70.9 |
| | 8 | Recess | 0 | 17 | 78.0 | 76.9 |
| | 8 | Recess | 30 | 17 | 73.8 | 70.8 |
| | 8 | Recess | 60 | 17 | 66.0 | 63.4 |
| IS 75 | 6-8 | Line-up | 0 | 26 | 68.5 | 67.4 |
| | 6-8 | Line-up | 30 | 26 | 65.0 | 62.3 |
| | 8 | PE Class | 0 | 20 | 67.5 | 64.8 |
| | 8 | PE Class | 30 | 20 | 63.0 | 60.3 |
| | 8 | Recess | 0 | 15 | 69.5 | 68.2 |
| | 8 | Recess | 30 | 15 | 65.7 | 63.0 |
| **High Schools:** | | | | | | |
| Totten-ville HS | 9-12 | Line-up | 0 | 20 | 76.5 | 73.5 |
| | 9-12 | Recess | 0 | 20 | 71.5 | 69.7 |
| | 9-12 | Recess | 30 | 20 | 63.3 | 62.8 |

* High level discrete events biased these measurements. These values were not used in the analysis.

Playground usage durations for the different school types and activities were developed based on field observations and verified by school principals and other school officials of the New York City Board of Education. These playground usage durations (which were the same or longer than the observed usage durations), rather than the measured durations, were used in the analysis to derive the recommended levels. Table 2 shows these usage durations by school type.

Table 2

DURATION OF OUTDOOR PLAYGROUND ACTIVITIES*

Early Childhood/Elementary Schools (Grades K-2/3-5):

| TIME | ACTIVITY | | |
|---|---|---|---|
| 7- 8 AM | 30-Minute Line-up | | |
| 8- 9 AM | 30-Minute Line-up | or | 30-Minute PE Class |
| 9-10 AM | | | 40-Minute PE Class |
| 10-11 AM | 30-Minute Recess | or | 40-Minute PE Class |
| 11-12 PM | 40-Minute Recess | or | 40-Minute PE Class |
| 12- 1 PM | 40-Minute Recess | or | 40-Minute PE Class |
| 1- 2 PM | | | 40-Minute PE Class |
| 2- 3 PM | | | 40-Minute PE Class |

Intermediate Schools (Grades 6-8):

| TIME | ACTIVITY | | |
|---|---|---|---|
| 6- 7 AM | 15-Minute Line-up | | |
| 7- 8 AM | 30-Minute Line-up | | |
| 8- 9 AM | 30-Minute Line-up | or | 50-Minute PE Class |
| 9-10 AM | | | 50-Minute PE Class |
| 10-11 AM | 30-Minute Recess | or | 50-Minute PE Class |
| 11-12 PM | 40-Minute Recess | or | 50-Minute PE Class |
| 12- 1 PM | 40-Minute Recess | or | 50-Minute PE Class |
| 1- 2 PM | 30-Minute Recess | or | 50-Minute PE Class |
| 2- 3 PM | | | 50-Minute PE Class |

High Schools (Grades 9-12):

| TIME | ACTIVITY | | |
|---|---|---|---|
| 6- 7 AM | 15-Minute Line-up | | |
| 7- 8 AM | 30-Minute Line-up | or | 30-Minute PE Class |
| 8- 9 AM | 30-Minute Line-up | or | 50-Minute PE Class |
| 9-10 AM | | | 50-Minute PE Class |
| 10-11 AM | 45-Minute Recess | or | 50-Minute PE Class |
| 11-12 PM | 45-Minute Recess | or | 50-Minute PE Class |
| 12- 1 PM | 45-Minute Recess | or | 50-Minute PE Class |
| 1- 2 PM | | | 50-Minute PE Class |
| 2- 3 PM | | | 50-Minute PE Class |

* Worst-case assumptions include the longest duration of activity that would normally happen during each hour. Note that during some hours a 40-minute lunch recess is indicated, this may not be a continuous recess but could include two 20-minute recess periods occurring within the same hour.

All calculations performed are in terms of $L_{eq}$ values. Because $L_{10}$ values cannot be combined mathematically the way $L_{eq}$ values can be, $L_{10}$ values can only be estimated through their relationship to the $L_{eq}$ values.

Analysis Results

Table 3 shows the maximum hourly noise levels at the playground boundary for each type of school based upon the duration of outdoor playground activities shown in Table 2, above. Table 4, below, shows the maximum noise levels at the playground boundary for specific activities. There does not seem to be a clear relationship between noise levels measured and the number of students in the playground or the total number of students at any given school. The average difference between $L_{eq}$ and $L_{10}$ measured values was 2.8 dBA*.

Table 3

MAXIMUM HOURLY PLAYGROUND BOUNDARY NOISE LEVELS
FOR ENVIRONMENTAL ASSESSMENTS**

| Early Childhood Schools: (Grades K-2) | | Elementary Schools: (Grades 1-5): | |
|---|---|---|---|
| TIME | $L_{eq(1)}$ (dBA) | TIME | $L_{eq(1)}$ (dBA) |
| 7- 8 AM | 63.8 | 7- 8 AM | 63.8 |
| 8- 9 AM | 69.3 | 8- 9 AM | 69.3 |
| 9-10 AM | 62.9 | 9-10 AM | 62.9 |
| 10-11 AM | 69.3 | 10-11 AM | 69.3 |
| 11-12 PM | 71.5 | 11-12 PM | 71.4 |
| 12- 1 PM | 71.5 | 12- 1 PM | 71.4 |
| 1- 2 PM | 62.9 | 1- 2 PM | 62.9 |
| 2- 3 PM | 62.9 | 2- 3 PM | 62.9 |

* In calculating this average, all measured differences less than 1.5 dBA were not used because they were associated with readings where extraneous peak levels from such sources as sirens, trucks, buses, and children yelling into the microphones contaminated the measurements.

** Noise data from intermediate schools was used for PE class activities for all school types.

Table 3 (Continued)

MAXIMUM HOURLY PLAYGROUND BOUNDARY NOISE LEVELS FOR ENVIRONMENTAL ASSESSMENTS*

| Intermediate Schools: (Grades 6-8): | | High Schools: (Grades 9-12): | |
|---|---|---|---|
| TIME | $L_{eq(1)}$ (dBA) | TIME | $L_{eq(1)}$ (dBA) |
| 6- 7 AM | 61.5 | 6- 7 AM | 63.5 |
| 7- 8 AM | 64.9 | 7- 8 AM | 68.2 |
| 8- 9 AM | 64.9 | 8- 9 AM | 68.2 |
| 9-10 AM | 64.3 | 9-10 AM | 64.3 |
| 10-11 AM | 68.9 | 10-11 AM | 67.6 |
| 11-12 PM | 71.0 | 11-12 PM | 67.6 |
| 12- 1 PM | 71.0 | 12- 1 PM | 67.6 |
| 1- 2 PM | 68.9 | 1- 2 PM | 64.3 |
| 2- 3 PM | 64.3 | 2- 3 PM | 64.3 |

Table 4

MAXIMUM PLAYGROUND BOUNDARY NOISE LEVELS FOR SPECIFIC ACTIVITIES

| Grades | Activity | Duration (min) | $L_{eq(1)}$ (dBA) |
|---|---|---|---|
| Early Childhood Schools (Grades K-2): | | | |
| K-2 | Line-up | 30 | 63.8 |
| K-2 | Recess | 40 | 71.5 |
| K-2 | PE Class | 40 | 62.9 |
| Elementary Schools (Grades K, and 1-5): | | | |
| K-5 | Line-up | 30 | 63.8 |
| 1-5 | Recess | 40 | 71.4 |
| K-5 | PE Class | 40 | 62.9 |
| Intermediate Schools (Grades 6-8): | | | |
| 6-8 | Line-up | 30 | 64.9 |
| 6-8 | Recess | 40 | 71.0 |
| 6-8 | PE Class | 50 | 64.3 |
| High Schools (Grades 9-12): | | | |
| 9-12 | Line-up | 30 | 68.2 |
| 9-12 | Recess | 45 | 67.6 |
| 9-12 | PE Class | 50 | 64.3 |

* Noise data from intermediate schools was used for PE class activities for all school types.

Average drop-offs were 4.8 dBA at 20', 6.2 dBA at 30', 9.1 dBA at 40', and 15.2 dBA (the only reading) at 60'. Beyond 30 feet from the playground borders, drop-off rates were generally 6 dBA per doubling of distance from the noise source (in this case the playground boundary). This corresponds with generally accepted rule-of-thumb for other typical outdoor applications. However, if the new playground were to be located near any large reflective buildings, a lower drop-off rate per doubling of distance from the playground boundary could exist. In such cases, the actual drop-off rates can only be verified by field measurements, which should be performed, because of the complexity of the acoustical environment that is created by the buildings. However, if field measurements are not possible, a more conservative drop-off rate per doubling of distance from the playground boundary should be assumed (on the order of 4.5 dBA).

Recommendations

Based on the measurements and calculations derived from measurements in this study, the following values shown in Table 5, are recommended to be used as a preliminary estimate of the noise levels generated by students in a New York City school playground. Applying these levels to all operating hours for a new school would result in a conservative analysis, and are based on the maximum levels calculated for Table 4, above, to provide worst-case values.

Table 5

RECOMMENDED PLAYGROUND BOUNDARY NOISE LEVELS
FOR PRELIMINARY ENVIRONMENTAL ASSESSMENTS

| School Type | $L_{eq(1)}$ (dBA) |
|---|---|
| Early Childhood Center | 71.5 |
| Elementary School | 71.4 |
| Intermediate School | 71.0 |
| High School | 68.2 |

If, after a preliminary analysis the potential for significant project impacts exists, a more refined analysis may be warranted. For this type analysis, noise levels for playground related noise should be added on an hour by hour basis. Appropriate levels for this purpose are shown above in Table 3, by school type.

$L_{10(1)}$ levels should be estimated, whenever measured values are not available, as approximately 3.0 dBA higher than $L_{eq(1)}$ values. Unless the proposed playground is near (within 100 feet of) any large buildings, hourly noise levels can be expected to decrease by the following values at the specified distances from the playground boundary: 4.8 dBA at 20', 6.8 dBA at 30', and 9.1 dBA at 40'. The general rule of a 6 dBA drop-off per doubling of distance from the

playground boundary for all distances between 40 and 300 feet appears to be appropriate for analytical purposes. Atmospheric absorption, terrain, and meteorological conditions would affect noise levels beyond 300 feet away from the playground, and should be considered on a case-by-case basis. However, for most areas of New York City, background noise levels and building densities are high enough to make most playgrounds inaudible beyond distances of 300 feet away.

cc: Ed Applebome

SJH:wp
JPC<SCA>/scaplay2.mem

ATTACHMENT A

NOISE MEASUREMENTS WITH RESPECT TO PLAYGROUND BOUNDARY (in dBA)

Early Childhood/Elementary Schools (Grades K-2/3-5)

P.S. 52R - Dongan Hills Avenue between Mason and Nugent Avenues (10/1,2/92), 650 Students

| Grade | Activity | Time | $L_{max}$ | $L_1$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | $L_{min}$ | $L_{eq}$ |
|---|---|---|---|---|---|---|---|---|---|
| | Background | 11:45AM-12:00PM | 64.0 | 60.0 | 55.5 | 52.5 | 50.0 | 46.5 | 53.6 |
| K-2 | Recess @0' | 12:10PM-12:25PM | 90.5 | 85.0 | 77.5 | 71.0 | 62.5 | 57.5 | 74.6 |
| K-2 | Recess @30' | 12:10PM-12:25PM | 74.5 | 71.0 | 67.5 | 64.5 | 59.0 | 54.0 | 65.3 |
| 3-5 | Recess @0' | 12:35PM- 1:00PM | 97.5 | 90.0 | 78.0 | 71.0 | 58.0 | 50.0 | 77.3 |

P.S. 299 - Maple Street between Albany and Kingston Avenues (10/1/92), 600 Students

| Grade | Activity | Time | $L_{max}$ | $L_1$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | $L_{min}$ | $L_{eq}$ |
|---|---|---|---|---|---|---|---|---|---|
| | Back+Lineup | 8:18AM- 9:18AM | 101.0 | 85.0 | 75.5 | 62.0 | 56.0 | 51.5 | 73.8 |
| K-5 | Lineup @0' | 8:18AM- 8:35AM | 101.0 | 91.0 | 79.5 | 73.5 | 68.5 | 61.5 | 78.9 |

P.S. 57 - Oder Avenue between Palma Drive and Saunders Street, Lineup @ Palma Drive and Park Hill Avenue (10/6,8/92), 600 Students

| Grade | Activity | Time | $L_{max}$ | $L_1$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | $L_{min}$ | $L_{eq}$ |
|---|---|---|---|---|---|---|---|---|---|
| | Background | 9:57PM-10:20AM | 68.0 | 64.5 | 58.0 | 52.5 | 49.0 | 46.5 | 55.2 |
| K-5 | Lineup @0' | 8:20AM- 8:45AM | 105.0* | 86.0* | 74.5* | 66.5* | 61.5* | 54.0* | 77.9* |
| 4-5 | Recess @0' | 11:25AM-11:45AM | 93.0 | 84.5 | 72.0 | 66.5 | 63.0 | 56.0 | 71.8 |

P.S. 69 - Keating Place between Rockland and Saxon Avenues (10/9,13/92), 1450 Students

| Grade | Activity | Time | $L_{max}$ | $L_1$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | $L_{min}$ | $L_{eq}$ |
|---|---|---|---|---|---|---|---|---|---|
| | Background | 1:05PM- 1:15PM | 66.0 | 64.5 | 55.5 | 50.0 | 47.0 | 45.5 | 53.5 |
| K-5 | Lineup @0' | 8:20AM- 8:40AM | 85.0 | 80.0 | 71.5 | 62.5 | 58.0 | 49.0 | 68.4 |
| 1,3 | Recess @0' | 12:39PM-12:59PM | 94.0 | 83.5 | 76.0 | 70.5 | 63.0 | 54.0 | 73.8 |
| 1,3 | Recess @20' | 12:39PM-12:45PM | 78.7 | 76.3 | 70.1 | 65.9 | 58.3 | ---- | 67.6 |
| 1,3 | Recess @20' | 12:45PM-12:59PM | 80.9 | 76.5 | 71.1 | 67.3 | 63.7 | ---- | 68.4 |
| 1,3 | Recess @40' | 12:39PM-12:59PM | 75.5 | 70.0 | 66.5 | 63.0 | 59.0 | 50.5 | 64.0 |
| 2,5 | Recess @0' | 1:17PM- 1:38PM | 87.5 | 82.0 | 77.0 | 70.5 | 62.5 | 51.0 | 73.4 |
| 2,5 | Recess @20' | 1:17PM- 1:30PM | 77.5 | 76.3 | 72.7 | 68.1 | 60.9 | ---- | 69.5 |
| 2,5 | Recess @20' | 1:30PM- 1:38PM | 79.7 | 77.7 | 72.7 | 67.1 | 61.5 | ---- | 69.4 |
| 2,5 | Recess @40' | 1:17PM- 1:38PM | 75.5 | 71.5 | 68.0 | 63.5 | 57.5 | 49.0 | 65.0 |

* High level discrete events biased these measurements.

ATTACHMENT A (Continued)

NOISE MEASUREMENTS WITH RESPECT TO PLAYGROUND BOUNDARY (in dBA)

Intermediate Schools (Grades 6-8)

I.S. 7 - Irvington Street between Hylan Boulevard and Edith Avenue (10/6,9/92), 800 Students

| Grade | Activity | Time | $L_{max}$ | $L_1$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | $L_{min}$ | $L_{eq}$ |
|---|---|---|---|---|---|---|---|---|---|
| | Background | 10:50AM-11:05AM | 67.0 | 65.0 | 56.0 | 48.0 | 44.0 | 40.5 | 53.7 |
| 6-8 | Lineup @0' | 7:25AM- 7:35AM | 114.0* | 95.5* | 79.0* | 68.5* | 60.5* | 54.5* | 87.1* |
| 6-8 | Lineup @30' | 7:25AM- 7:35AM | 90.0 | 86.5 | 76.5 | 69.0 | 60.0 | 54.5 | 74.5 |
| 8 | PE Class @0' | 11:05AM-11:30AM | 92.0 | 76.0 | 67.5 | 61.0 | 55.0 | 45.5 | 66.1 |
| 8 | PE Class @30' | 11:05AM-11:30AM | 73.0 | 67.5 | 63.0 | 57.0 | 52.5 | 45.0 | 59.6 |
| 7 | Recess @0' | 9:30AM-10:00AM | 85.5 | 83.5 | 78.0 | 72.0 | 66.5 | 61.0 | 74.8 |

I.S. 72 - Travis Avenue between Ferndale Avenue and Merry Mount Street, Background @ Merry Mount Street between Travis and Saxon Avenues (10/9,13/92), 1685 Students

| Grade | Activity | Time | $L_{max}$ | $L_1$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | $L_{min}$ | $L_{eq}$ |
|---|---|---|---|---|---|---|---|---|---|
| | Background | 7:35AM- 7:55AM | 70.5 | 68.0 | 62.5 | 53.0 | 49.0 | 45.5 | 58.5 |
| 6-8 | Lineup @0' | 7:15AM- 7:30AM | 83.0 | 81.5 | 73.5 | 67.5 | 60.5 | 54.0 | 70.9 |
| 8 | Recess @0' | 11:51AM-12:08PM | 97.0 | 91.0 | 78.0 | 71.5 | 63.5 | 52.5 | 76.9 |
| 8 | Recess @30' | 11:51AM-12:00PM | 89.3 | 80.1 | 74.7 | 69.1 | 64.1 | .... | 71.8 |
| 8 | Recess @30' | 12:00PM-12:08PM | 85.7 | 79.3 | 72.7 | 65.9 | 61.5 | .... | 69.6 |
| 8 | Recess @60' | 11:51AM-12:08PM | 76.5 | 71.0 | 66.0 | 61.5 | 58.0 | 53.0 | 63.4 |

I.S 75 - Boulder Street between Woodrow Road and Castor Place (10/13,14/92), 1465 Students

| Grade | Activity | Time | $L_{max}$ | $L_1$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | $L_{min}$ | $L_{eq}$ |
|---|---|---|---|---|---|---|---|---|---|
| | Background | 10:56AM-11:08AM | 63.0 | 61.0 | 53.5 | 48.5 | 46.0 | 45.0 | 51.0 |
| 6-8 | Lineup @0' | 7:49AM- 8:15AM | 85.5 | 79.0 | 68.5 | 64.0 | 60.0 | 53.0 | 67.4 |
| 6-8 | Lineup @30' | 7:49AM- 8:15AM | 75.5 | 70.0 | 65.0 | 60.5 | 57.0 | 52.5 | 62.3 |
| 8 | PE Class @0' | 9:00AM- 9:20AM | 78.5 | 73.5 | 67.5 | 62.5 | 59.0 | 56.0 | 64.8 |
| 8 | PE Class @30' | 9:00AM- 9:20AM | 74.5 | 67.5 | 63.0 | 58.5 | 55.5 | 52.5 | 60.3 |
| 8 | Recess @0' | 11:45AM-12:00PM | 88.5 | 75.0 | 69.5 | 64.5 | 58.5 | 48.0 | 68.2 |
| 8 | Recess @30' | 11:45AM-12:00PM | 79.9 | 71.7 | 65.7 | 59.9 | 52.1 | .... | 63.0 |

* High level discrete events biased these measurements.

ATTACHMENT A (Continued)

NOISE MEASUREMENTS WITH RESPECT TO PLAYGROUND BOUNDARY (in dBA)

High Schools (Grades 9-12)

Tottenville High School - Luten Avenue between Deisius and Eylandt Streets (10/14/92), 3500 Students

| Grade | Activity | Time | $L_{max}$ | $L_1$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | $L_{min}$ | $L_{eq}$ |
|---|---|---|---|---|---|---|---|---|---|
| | Background | 8:40AM- 9:00AM | 61.5 | 60.0 | 55.5 | 50.0 | 48.0 | 47.0 | 52.5 |
| 9-12 | Lineup @0' | 7:40AM- 8:10AM | 89.5 | 81.5 | 76.5 | 71.5 | 65.0 | 60.0 | 73.5 |
| 9-12 | Recess @0' | 12:20PM-12:40PM | 92.0 | 79.5 | 71.5 | 65.5 | 62.0 | 58.5 | 69.7 |
| 9-12 | Recess @30' | 12:20PM-12:40PM | 83.9 | 73.9 | 63.3 | 57.9 | 55.5 | ---- | 62.8 |

## ATTACHMENT B

## CALCULATION OF $L_{eq(1)}$ PLAYGROUND NOISE LEVELS

The standard definition of $L_{eq}$, as quoted in the text, is:

$$L_{eq(T)} = 10 \log \{[(1/T)\int_{t_0}^{t_n} p^2(t)dt]/p_{ref}^2\}, \qquad (B.1)$$

where T is the measurement time period, p is the measured acoustic pressure, and $p_{ref}$ is the pressure associated with the threshold of hearing, $2 \times 10^{-5}$ N/m$^2$. All logarithmic references are to the base 10. If we assume that the acoustic pressure in each time period measured is constant and T is 1 hour, the total acoustic pressure part of equation (B.1) under the integral reduces to:

$$p(t) = p_1(t_1 - t_0) + p_2(t_2 - t_1) + \ldots + p_n(t_n - t_{n-1}), \qquad (B.2)$$

where n = 0,1,2,.....

Also in this case, the $L_{eq}$ takes on the standard sound pressure level (SPL) definition over each time period of interest, namely:

$$SPL = 20 \log [p(t)/p_{ref}] \qquad (B.3)$$

Solving equation (B.3) for p(t), we get:

$$p(t) = p_{ref}\ 10^{SPL/20}, \qquad (B.4)$$

as a function of time. When different constant SPLs are measured for different time periods within the total period of interest, they can be combined by converting the individual SPLs into their respective acoustic pressures (using equation (B.4)), multiplying them by their respective time contributions, combining the individual time-compensated pressure components into a total pressure value, and solving equation (B.3) with the total pressure as input.

As an example from the text, the monitored $L_{eq}$ for the K-2 lunch recess at the boundary of the P.S. 52R playground was 74.6 dBA and the background $L_{eq}$ was 53.6 dBA. Using the prescribed New York City Board of Education recess limit of 30 minutes (½-hour) for the recess duration, equation (B.4) can be solved for the playground and background pressures and analyzed as follows:

$$P_{playground} = 2 \times 10^{-5}\ 10^{74.6/20} = 0.10741,$$

$$P_{background} = 2 \times 10^{-5}\ 10^{53.6/20} = 0.00957,$$

$T = 1$, $t_1 - t_0 = \frac{1}{2}$, and $t_2 - t_1 = \frac{1}{2}$.

Then, $$P_{total}(t) = \frac{1}{2}(0.10741) + \frac{1}{2}(0.00957) = 0.05849$$

Using this pressure value in equation (B.3), the result is $L_{eq(1)} = 69.3$ dBA.

Whenever more than one playground noise level was available for a certain school type, each $L_{eq(1)}$ was calculated for each individual case and the resultant values were logarithmically averaged using a method similar to that described above.