~~Pi~~ Piscataway (1985)

- Zicinsky's Environmental Analysis report
  + Cost analysis
  + Piscataway land development sound analysis

67 pgs

- ML 000273E

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I - Preliminary Environmental Analysis

There are 3 major soil types found on the site, belonging to the Ellington, Klinesville and Reaville series.

The Ellington series (7N2U-A and 7N23-B -- see Soils Map) consist of deep, moderately well-drained soils with a dark reddish-brown silt loam surface (0 to 8"), subsoil (8 to 18") of similar material, and substratum (18 to 26") of mottled reddish-brown very fine sandy loam. Depth to bedrock is over 5 feet and to seasonal high water from 1.5 to 3 feet. Slopes range from 0 to 15 percent.

The Klinesville series (521A-B and 521U-B) consist of shallow well-drained soils typically with a dark reddish brown very shaly silt loam surface (0 to 5"), subsoil (5 to 15") of similar characteristics, and substratum (15 to 19") of weak red weathered shale fragments. Bedrock is at 19" and seasonal high water is over 6 feet.

The Reaville series (512U-A and 512U-A) consist of moderately deep, moderately or poorly drained soils with a reddish-brown shaly silt loam surface layer (0 to 9"), a mottled reddish-brown shaly silt loam subsoil (9 to 15"), and a mottled substratum (15 to 25") of dusky red very shaly silt loam. Bedrock is at 1.5 to 3.5 feet, while seasonal high water is at .5 feet. The Reaville series has a wet variant (513U-A) consisting of moderately deep poorly drained soils with a

dark reddish-brown silt loam surface (0 to 8"), a gray silty clay loam subsoil (8 to 20") and mottled reddish-brown silty clay loam (20 to 25"), and a substratum (25 to 30") of dark reddish-brown very shaly silty clay loam. Depth to bedrock is 1.5 to 3.5 feet, and to seasonal high water is .5 to 3 feet.

Although more detailed and reliable information can only be provided by test borings in the field, the preliminary soils analysis indicates that 4/5 of the site has bedrock at between 1 and 3.5 feet; and that 20 percent of the site has high water at 0 to .5 feet, with another 20 percent at .5 to 3 feet. These would appear to constitute the major potential constraints.

References:

Soil Properties and Soil Survey Interpretations, Middlesex County, USDA, SCS 1978

II - Zoning in the Route 287 Corridor

In order to assess the predominant zoning categories along the Rt 287 corridor for aproximately 8.5 miles to the north and 8.5 miles to the south of the site a zoning map was prepared compiling the current ordinances for the towns of Somerville, Bridgewater, Franklin, Piscataway, South Plainfield, Metuchen and Edison, which have frontage onto Rt 287 along this area under study (see Rt 287 Corridor: Zoning Map). It was found that of the aproximately 34 miles (both northbound and southbound) of frontage on Rt 287 covered, only 18 percent, or aproximately 6 miles, were zoned residential; and of these 18 percent, 20 percent were, in turn, atributable to the site itself. In other words, the site's frontage on 287 accounts for a full 1/5 of the total residentially zoned frontage along the entire corridor -- in its dimensions it represents a perfectly unique case. It should also be added that most of the portions zoned residential seem to correspond to older built up areas, such as those found in Metuchen, rather than vacant areas awaiting development. The remaining 82 percent of frontage are totally zoned for various commercial uses: manufacturing, warehousing, business, hotel, office, education, etc..

A strip of aproximately 2,000 feet on either side of Rt 287 was also considered. It was found that of the land contained within this strip only 1/3 was zoned residential, with the remaining zoned for the the various commercial uses.

In conclusion, it would seem that the zoning of residential land with frontage along Rt 287 within this strip occurs essentially when it is necessary to deal with pre-existing situations, housing being considered neither an appropriate use nor the "highest and best use".

III - Existing Land Use in the Route 287 Corridor

A windshield overview of existing land use in the strip of Rt 287 between Somerville and Edison was undertaken. In Somerville, on Rt 287 southbound, are located several large office complexes (Hoescht, NUI), warehousing (Courier News) and manufacturing (NJ Kenworth, Ronson, Asarcon). There follows more warehousing, some vacant land, and the huge American Cyanamid complex in Bridgewater. Approaching and entering Franklin Township, one finds hotels (Ramada Inn, Hilton) and office space (Franklin Corporate Park, Hoescht). Crossing the Raritan into Piscataway, one finds located more office space (American Standard, ATT), hotels (Sheraton Motor Inn), education (Katharine Gibbs School), warehousing and manufacturing (Foley Caterpillar, Young Drugs, Daido, Holland). After the Possumtown Rd exit are located more offices and warehousing; after the Rt 529 exit, again offices, the large Datsun complex and Brother. Into South Plainfield, after some vacant land, one finds several manufacturing concerns (Fromm Electric,Lean Line, Thin Life), and crossing into Edison, more office/warehousing (Brownell Electronic, Sterling Extruder) and the vacated Prudential Headquarters building. After some more vacant frontage, again warehousing (Holophane, Metroplex), manufacturing (Southland Containers), and the huge Revlon chemical complex, followed by some residential in the vicinity of the Rt 1 interchange.

Northbound from Edison into Metuchen one finds residential, both single family and multifamily (Durham Woods), extensive deposits of building materials, warehousing (Tingley Rubber, Silvatrium Corp), followed by some scattered residential and restaurants into S. Plainfield. Entering Piscataway one encounters more manufacturing (Ipco, Mary Kay Cosmetics, Whitestone Products) and some office.

Approaching the site, one finds Hoffman Equipment, Penske Powers, the Rutgers Industrial Center, Star Ledger, Nuodex and Beechan Labs. Crossing the Raritan into Franklin one finds located more offices, and the Marriott Hotel, followed by some vacant frontage and some residential. Further to the north, and into Bridgewater, are located other industrial/warehousing pockets, interspersed with vacant parcels and educational facilities (Bridgewater High School, Somerset County Vocational Technical School).

In summary, existing land uses in the corridor cover a large range of uses, with preponderance of office/industrial/warehousing/hotels, with some educational facilities, some vacant land, and some residential, in general either in older structures or more recent fairly low-market construction.

IV - Noise Abatement and Land Use

Noise can derive from many different sources , but it is most closely identified with various forms of transportation: airports, heliports, highways and major arterials, railroads, etc.. In the case at hand the noise generator is a major expressway, namely Route 287.

The location of different land use types vis-a-vis the location of noise generating sources has long been a subject of interest for planning officials and government authorities. Most O.E.C.D. (Organization for Economic Cooperation and Development) countries have issued regulations establishing acceptable noise standards and measures to enforce them, by land use type, while governing the relative compatibility of different land uses in the proximity of noise generators (1).

One of the strategies used by planning authorities for noise abatement is through the control of land use, i.e. to discourage the location of noise sensitive uses while, on the other hand, allowing the location of noise compatible or less sensitive uses, thus ensuring an overall land use pattern without major discontinuities due to noise related concerns. It is possible to rely on such a strategy because it is well accepted that some uses are more compatible than others to higher noise levels, depending on

(a) reliance on outdoor activities;

(b) capacity to incorporate the high costs of noise barrier construction and soundproofing of structures;

(c) intensity of human activity

The Noise Sensitivity Code (2) considers housing (both single family and multifamily) as the most noise sensitive land use, on par with hospitals, schools, nursing homes and others. The least noise sensitive uses were considered to be public right-of-way and agriculture. Commercial-retail and office buildings where considered

of intermediate noise sensitivity. This is readily understandable since the financial burden of soundproofing and erecting barriers is more easily diluted in commercial/office buildings than in residential developments; and, given the fact that these uses are active on a more restricted schedule (8 to 6) and do not rely on outdoor activities. "..Types of structures which can feasibly be located near noise sources include commercial offices, industrial buildings,and hotels since the predominant human activity in these cases is inside the building" (3).

Housing, on the other hand, is considered too noise sensitive. In France and Germany housing construction is prohibited in high noise areas, while in Canada mortgage financing is denied to dwellins in such environments.

References

(1) U.S. Environmental Protection Agency Summary of Noise Programs in the Federal Government, Washington 1971

U.S. Environmental Protection Agency An Assessment of Noise Concerns in Other Nations, Washington 1971

(2) Organization for Economic Cooperation and Development, Environment Directorate, Planning and Land Use Controls for Noise Prevention and Abatement, Paris 1977. see Appendix A and bibliography contained therein

(3) O.E.C.D. op cit, pg 24

V - Multifamily Residential Development on the Site

The site's holding capacity for housing was calculated, assuming development of multifamily garden apartment or condo block units at moderately high densities and with a 20 percent low and moderate income household component. Several alternatives were considered, using either a berm or a vertical barrier as noise abatement devices. Also, the development of 3 story structures along the deeper part of the site (the most removed from Rt 287) was considered.
A concept plan was developed which accomodates 530 units in two-storey blocks of 10 units each organized around courtyards and separated by common parking (see Housing Holding Capacity Analysis Concept Plan). The units would have an average area of 1,000 square feet, and the gross density would be around 7.5 du/acre. This alternative results from the multiple constraints operating on the site.

The constraints which the site presents do not allow for great flexibility in lay-out schemes. Thus, a 25 foot high berm along the frontage with Route 287 is required to maintain noise levels under Federal standards. This berm, in turn, requires a 100 foot base, assuming a 1:2 ratio for the earthworks. The site which, in its deepest point, is still under 600 feet, is therefore reduced by 1/5 to allow location of the barrier. The possibility of substituting this berm for a vertical barrier of equal height was abandoned, given that its foundation requirements made it unrealistic. Another constraint is the location of the retention facilities required to accomodate runoff. Although the exact dimensions of these facilities remains to be calculated, a reasonable estimate was used to allocate area for this purpose in the concept plan. Two detention ponds are envisaged -- one in the southwestern portion of the site,

abutting on the River Rd interchange, and a second between Brentwood Drive and Oakwood Way. Finally, the alternative of rising an extra story along the deepest part of the site (beyond the 325 foot setback threshold in relation to Rt 287) was also considered. Assuming a parking ratio of 1.5 places for each low and moderate income unit, and 2 places for each market unit, it seems possible to increase the overall number of units by no more than 50 -- to 580 -- given that the parking requirements become in turn a constraint. In order to retain a reasonable open space and internal circulation component, the trade-off between extra units and extra parking spaces quickly becomes a very stringent constraint. The gross density in this option would increase to 8.3 du/acre. In order to achieve this density, it was necessary to essentially denude the site of any existing wooded areas and to develop over some areas with a depth to seasonal high water table of less than one foot. The plan provides for no active or passive recreation areas on the site.

COST ESTIMATE OF BERM

REQUIRED FOR ZIRINSKY SITE - PISCATAWAY, N.J.

1/18/85

PISCATAWAY

Berm along Interstate 287 for Sound Attenuation -

Berm size - 25' High - 100' Wide at the base

Compaction - 95% Modified Density

Since the property is mostly farmland, the depth of topsoil will be in excess of 12 inches. The characteristics of topsoil make it unsuitable for constructing the berm. The topsoil is unstable because of the following:

1. High organic content.
2. High percentage of very fine particles.
3. Very sensitive to slightly high or slightly low moisture content.
4. Low structural value.

Therefore, it is reasonable to assume that the 278,000 cubic yards of fill required to construct the berm will be purchased off site and hauled to the site.

The length of the slope from toe to top of the berm is 56 feet. Since the 50% pitch of the slope could easily cause children to have serious accidents, it is reasonable to assume that a fence would be required on the project side of the berm located at the toe of the slope and running continuously along the entire length of the berm. This item is not included in the estimate and would add $60,000 to the cost.

The berm design would be required to include provisions to accomodate the high velocity water that would run off the slopes during heavy rains. The estimate does not include the costs of these drainage structures.

The added weight of the berm will require that extensive subsurface investigation and soils analysis be performed to determine if the existing soils are structurally suitable as a foundation for the berm. Failure of the subsurface soils could seriously damage the adjacent Route 287 road structure.

PISCATAWAY

Estimate for Berm

Description	Cost
Strip Topsoil and Stockpile	$56,000
Cut Key, Grade and Prepare Ground to Receive Berm	14,000
Purchase Fill	2,502,000
Place, Shape and Compact Fill	2,780,000
Erosion Control	50,000
Place Topsoil	34,000
Hydro Seed and Mulch	95,000
Plants and Trees	150,000
Restore Area Adjacent to Berm	20,000
Maintance of Landscaping until Established	10,000
Sub - Total	$5,711,000
Contingency at 5%	286,000
Bond, Permits and Fees at 5%	286,000
Engineering at 5%	286,000
Total	$6,569,000

Prepared by Hal Fishkin 1/18/85

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PISCATAWAY LAND DEVELOPMENT
SOUND LEVEL ANALYSIS

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Date: 21 January 1985

Project No: 1858A

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INTRODUCTION

A parcel of land in Piscataway, New Jersey is located on the north side of Interstate 287 and bounded by River Road on the east and Possumtown Road on the west (see Figure 1 in the Appendix). Approximately the eastern third of the property is covered by trees, while the remaining portion of the property has been used for farming. The property elevation to the east is slightly below the road elevation, while to the west the property is on the order of 8 to 10 feet above the highway elevation.

It has been proposed that this property be used for commercial purposes; e.g., an office complex. Questions have been asked about the suitability of this property for residential use.

Ostergaard Associates conducted 24 hour sound level measurements on the property, and has also utilized traffic information to calculate sound levels at various locations on the property. In addition, several different methods for reducing the sound levels in the area are discussed in this report. The report contains the methodologies used for the sound level survey, the engineering calculations, and portions of the documents referred to in the report.

SUMMARY OF RESULTS

The entire parcel of land is currently unsuitable for use for residential purposes. Extensive engineering in the form of road-side berms or barriers would be necessary to lower the sound levels on the property to an acceptable range. As a practical matter, the extent of the modifications necessary to the property are such that they may not be realistic.

The 24-hour day-night sound levels (Ldn) measured along the back of the property (see Figure 1) are approximately 65 dBA. Along the front of the property, near I-287, they are 75 dBA. This range of 65 to 75 dBA, in fact, corresponds to the Department of Housing and Urban Development (HUD) criteria for "Normally Unacceptable".

Furthermore, approximately half of the property exceeds the Department of Transportation, Federal Highway Administration, Noise Abatement Criteria of 67 dBA for the maximum hourly average sound level (Leq). This calls for abatement measures before the property can be used for, among other things, residences.

Interstate 287 is a 24 hour noise source. The New Jersey Department of Environmental Protection has state-wide noise standards that call for a maximum property line level of 50 dBA at night (10 PM to 7 AM). The nighttime average sound levels for this property range from 57 dBA at the rear of the property to 69 dBA at the side closest to Interstate 287.

In order to reduce the sound levels to values even approaching 50 dBA, an earth berm averaging 25 feet high relative to the road height and 100 feet wide would be necessary. This would occupy approximately 20 percent of the entire property. A road-side barrier would have to be slightly higher; approximately 30 feet, because a barrier is less effective than a berm at reducing noise. It is questionable whether it is

practical to build a vertical wall 30 feet high along the edge of the property.

To place the various sound levels in perspective, the day-night sound levels measured on the property range from 65 to 75 dBA. Studies we have performed in New York City, as part of evaluating sites for HUD-sponsored development, typically show average day-night sound levels of approximately 65 dBA. By comparison, then, the property in Piscataway is as much as 10 dBA louder than many areas of New York City. The 10 decibel increase is a factor of ten more in sound energy, and a doubling of the perceived loudness, as heard by an individual.

RECOMMENDATIONS

1. The property is not suitable for use as a residential area. Because of highway noise, land adjacent to a main highway is usually reserved for commercial development.

2. The engineering feasibility of constructing a berm or, in particular, a road-side barrier of the heights required to reduce the sound levels on this property should be very carefully evaluated, setting aside the question of whether the residents would want such a visible structure, or the difficulty of constructing it. The associated cost would .be distributed among the units utilizing the property.

EQUIPMENT AND STUDY PROCEDURES

Figure 1 shows the locations at which the 24-hour continuous sound measurements were made. Metrosonics db-301 time-history noise dosimeters were used. These were programmed to accumulate the sound over 4-minute intervals and store the energy-averaged (Leq) sound level for each 4-minute period. The five instruments were placed on the site on 12 December 1984 and removed the following day. In all instances the instruments operated for at least 24 hours. Each instrument was calibrated prior to its use with a Bruel & Kjaer Type 4230 sound level calibrator.

The Appendix contains a graph and table showing the results of each instrument's analysis. The graph shows how the sound levels varied over time. The corresponding table shows the same numbers, and also presents various sound level values calculated when working with community noise projects.

The 24-hour energy-average level (Leq) and the day-night average levels (Ldn) are technically "power averages" of the acoustical energy measured during the survey. The Appendix contains a number of definitions which the reader might find useful.

The day-night level (Ldn) is computed by adding 10 dBA to the nighttime (10 PM to 7 AM) levels and then energy-averaging over a 24-hour period. This takes into account the fact that people are more sensitive to noise during nighttime hours. It should be noted that all of these acoustical terms are standardized. The Ldn, for example, is used by five major Federal agencies as the single best descriptor of environmental noise.

In addition to measuring the actual sound levels, a computer model for predicting highway noise was utilized to both verify the sound level measurements and to evaluate the effects of various abatement measures. The computer program was run on

our own computer system, but is described in the Federal Highway Administration document "FHWA-RD-77-108". This is the same model that is referenced in the FHWA "Procedures for Abatement of Highway Traffic Noise", contained in the Appendix. The model is referred to as the "FHWA Highway Traffic Noise Prediction Model". I uses information about the position and number of highway lanes, the distance between the roads' edges and the observer/listener, the vehicle counts, types of vehicles (cars and trucks), the highway grade, and the propagation paths between the highway sound and the observer; "soft" or "hard" sites, barriers, or berms.

While sources such as aircraft, lawn mowers, public address systems, etc. can generate noticeable noise in a community, motor vehicle traffic is a constant and often major source of community noise. A major expressway can often be heard a mile or more away, when other surrounding sounds are not significant. Trucks, as might be expected, are individually louder than automobiles. However, there are many more automobiles than trucks present on a typical highway, so the total amount of sound from all the automobiles can sometimes exceed that of the trucks.

The sound we hear with our ears or measure with an instrument is the sum of all the sounds from all the sources. When sounds combine they add "exponentially". That is, the total energy present in each sound is combined with the other energies from other sounds. As a result, if two individual noise sources each produce a sound level of 60 dB at a listener's location, the sum of the two sounds would be 63 dBA. Ten noise sources, each producing 60 dBA by itself will, when all operating at once, produce a total sound of 70 dBA.

As we move away from a noise source the sound level decreases. The amount of the reduction depends upon the acoustical characteristics of a source. For a "point source", such as a single motor vehicle, a power tool, etc., the sound level decreases by 6 dB as we double our distance away from the noise source. If the particular point source creates 60 dBA at a distance of 50 feet, we would expect to measure 6 dB less, or 54 dB, at a distance of 100 feet.

Highways do not act in this manner, however. A highway is a "line source" because it consists of many individual point sources stretched out in a long line. Sound traveling away from a line source, ignoring other factors, decreases by 3 dB as distances double.

In fact, the sound that we hear coming from a highway depends upon several factors. These include:

1. The total number of the different types of vehicles over a given time.

2. The number of lanes in each direction and the distance between the lanes.

3. The speeds of the vehicles.

4. The height of the vehicles (trucks are taller than cars).

5. The grade, or slope, of the highway.

6. How much of the highway we can "see", from side to side.

7. The nature of the terrain over which the sound travels and the elevation of the receiver above the terrain.

8. Obstacles between the highway and the listener.

These constitute the major items, although there are others. For example, all things else being equal, the sound coming from a highway will be louder when the highway is wet then when it is dry. All of the calculations in this report have assumed a dry highway.

Most work currently being done with community noise deals not with short-term noise producing events, but rather the ever-present, more routine sounds that build up in an area due to increased population, etc. Thus, various guidelines for community noise, especially that emanating from highways, often look at the sound on an hourly or even 24 hour basis. It is for this reason that our sound measurements conducted on the actual site covered a full 24-hour period.

The map in Figure 1 shows the locations of the five measurements. The graphs and accompanying tables show the results of those measurements. The tables also show a number of calculated values based on the measured data; these includes the day-night sound level (Ldn), the 24-hour average sound level (Leq), the average of the daytime sound levels and nighttime sound levels, the minimum and maximum levels measured, and the maximum hourly average sound level and the time period in which it occurred. All of these numbers, in various combinations, are used when evaluating highway noise and its control.

Reducing the noise on the site will necessitate constructing some sort of barricade which reduces the sound energy impinging on the property. Work of this type has been done for many years (see USDOT FHWA report "Highway Noise Barrier Selection, Design, and Construction Experiences", Implementation Package 76-8). Typically, earth berms and vertical barriers (concrete panels or block, timber, metal panels, etc.) are used for this purpose.

The effectiveness of a given barrier or berm depends on its height and position relative to both the noise source and the listener. For a given height of barrier, it should be placed as close as possible to either the noise source or the observer. Of course, when siting road-side noise barriers, access, construction, and other restrictions may limit the exact placement of the berm or barrier. As a barrier or berm gets taller, its noise reduction capabilities increase. Making a barrier twice as tall, however, does not yield a doubling of the noise reduction.

The acoustics of barriers and berms is well understood. Similarly, equations which predict the sound level from motor vehicle traffic on highways, given all of the above conditions, also exist. These models were utilized as part of preparing this report; see the Equipment and Study Procedure section.

To evaluate the effectiveness of both berms and barriers (the two do not have exactly the same acoustical properties), several assumptions had to be made about the site. Because we had "close" and "distant" measurements at two points along the property (see Figure 1, the extension of Crestwood Street to the west and the underground pipeline right-of-way to the east), these sites and their geography were also chosen for points along which the barrier and berm effects could be calculated. By having actual sound measurements in these areas the reliability of the calculations is enhanced considerably.

Traffic count figures supplied to us by the New Jersey DOT were used to check the accuracy of the computer model against the calculated values. For the type of terrain and the distances involved, the calculations were within 1 dBA of the measured value over the 24 hour period. This is excellent agreement. It should be noted that 20% of the highway traffic on this portion of I-287 is from trucks. The trucks are the dominant noise sources.

The terrain in the vicinity of the pipeline right-of-way is actually slightly lower than the road surface, based on a contour map with 2 foot intervals supplied to us by Hintz/Nelessen Associates. The ground immediately adjacent to the highway is slightly lower than the highway surface. As we move north the ground level continues to drop off a total of approximately 10 feet, where the "away" sound measurement was made.

On the west side of the property, in a line extending from Interstate 287 north to Crestwood Street, the terrain initially rises very steeply; the fence along the north side of the highway is elevated above the road surface approximately 8 feet. Continuing north, the land rises approximately 3 more feet to the back of the property. The property along the eastern portion of the overall property is wooded, while the western area is open; it has been used fairly recently for

farming. It should be noted that at this time of year the trees have essentially no effect upon the propagation of sound, as they are not covered with leaves.

Our first calculations involved determining the effect of a berm placed along the southern edge of the property, adjacent to Interstate 287. We chose three distances back from the highway, in each of the two evaluation areas. The distances chosen were 75 feet, 325 feet (approximately the center of the property), and 550 feet, representing the northern boundary of the property. These distances are measured from the highway surface.

Using the computer model, we mathematically "built" a series of berms of different heights along the southern edge of the property. We placed them as close as possible to the highway, to maximize their noise reduction effects. We then calculated the reduced sound levels at three different elevations above the local ground level; 6, 15, and 25 feet, representing the ground, second, and third floor windows of hypothetical structures on the property. A 6 foot elevation also represents the sound someone would hear standing out-of-doors.

The calculations showed that the berm had to be on the the order of 25 feet tall, relative to the local road elevation, in order to be effective. The design goal of 50 dBA, to meet the State of New Jersey nighttime noise limits, was used. This also represents a noise reduction of slightly less than 10 dBA along the northern edge of the property. A noise reduction of 10 dBA represents a halving of the perceived loudness, and is often used as a desirable figure when implementing community noise control measures.

In order to maintain a berm slope of 1 foot of elevation for every 2 feet in horizontal direction, a berm 25 feet high must be a total of 100 feet wide. Since this exceeded the 75 foot distance we initially assumed for our calculations, the

calculations were repeated for distances of 180, 325, and 550 feet from the road, with the centerline of the berm 80 feet from the road.

The results of these calculations are summarized in Tables 1 and 2. These tables show various distances from the road, floor elevations above grade, and resulting sound levels for various berm heights. For the property in the vicinity of the pipeline right-of-way, a berm 25 feet tall, relative to the road elevation, would result in a calculated sound level of 51 dBA at the second floor of a structure 180 feet from the highway, 53 dBA at a distance of 325 feet on the third floor, and 50 dBA at a distance of 550 feet, measured at the third floor. Although some of these numbers exceed the desired 50 dBA limit, it was felt that making the berm any taller to achieve further noise reduction would not be practical. It should be noted that with the berm being 100 feet wide it would take approximately 20 percent of the total available property, rendering it unsuitable for construction of housing, parking lots, recreational facilities, etc.

Table 3 shows a similar calculation for the western edge of the property. Here, because the ground rises as it moves away from the highway surface, the houses would be at a higher elevation relative to the highway, and thus receive less shielding for a given height of berm. As a result, the berm height relative to the road surface must be 30 feet high to give comparable second story sound levels at a distance of 180 feet and third story sound levels at 325 and 550 feet, respectively. However, because the existing ground is above the highway surface, the actual added berm height over existing ground elevation would be approximately 22 feet. On the eastern edge, because the ground is lower than the highway elevation, the actual berm height would be 27 feet relative to the local surface. For design purposes, a nominal height of 25 feet has been chosen.

The effects of a vertical barrier were also considered. A barrier has the potential advantage of taking substantially less of the available property. On the other hand, the acoustics of a barrier vs berm are such that the barrier must be taller than a berm to achieve the same amount of noise reduction; for a given height, a barrier is approximately 3 dBA less effective than a berm.

Table 4 shows the results of barrier calculations made in a manner similar to those described above for the berms. A barrier 35 feet tall, 40 feet from the highway, results in a second floor sound level at 75 feet from the highway of 54 dBA, a second story sound level of 52 dBA at 180 feet, and a third story sound level of 51 dBA at a distance of 325 feet.

Again, these levels do not meet the desired level of 50 dBA, but constructing a barrier of this height constitutes a substantial engineering undertaking. It should be noted that the overall length of the berm or barrier will be on the order of 5,000 feet. A vertical barrier 30 feet high by 5,000 feet long will be subjected to immense wind loads. Barriers of this height also will probably not give the calculated amount of sound reduction; the mathematics in the computer model are being "pushed" to extremes. In general, barriers of this size are not built for noise control purposes. However, to achieve anything approaching a suitable land use, it would be necessary here.

Without providing a substantial berm or barrier along the southern edge of the property, next to Interstate 287, the existing property, in our opinion, is not suitable for residential use. With measured day-night sound levels ranging between 65 and 75 dBA, HUD considers the property to be "Normally Unacceptable" for residential use. Architectural methods would be necessary to reduce the interior sound levels an additional 5 dBA along the northern half of the property, and an additional 10 dBA along the southern half of the

property. It should be noted that none of these measures, however, would reduce the exterior sound levels below what are presently there.

Using FHWA guidelines, the southern half of the property also falls into the range where noise control measures in the form of barriers and/or berms would be called for. The FHWA Highway Noise Standards consider at least half of the property to be unsuited for "recreation areas, play grounds, active sports areas, parks, residences" and other uses that could be expected in this area if developed for residential use.

Finally, the added cost to the overall project from building a berm or barrier should be considered. Due to the complexities of either of these structures, a realistic estimate of the cost should be worked out by someone knowledgeable in soil excavation and compacting techniques, foundation design, etc. Cost figures are available for smaller size berms and barriers, but nothing in the size range of the berms and barriers required here is available. Furthermore, the local terrain and local soil conditions can strongly affect the design details of the berm or barrier, and this information is not available to us.

The aforementioned "Highway Noise Barrier...Construction Experiences" document provides design details and costs for a number of berms and barriers around the country. At this time the document is approximately 10 years old, so the cost figures would have to be scaled by at least a factor of 2. However, because none of the berms or barriers in this document are of the size that would be required for this property, the cost figures would need further upward adjustment.

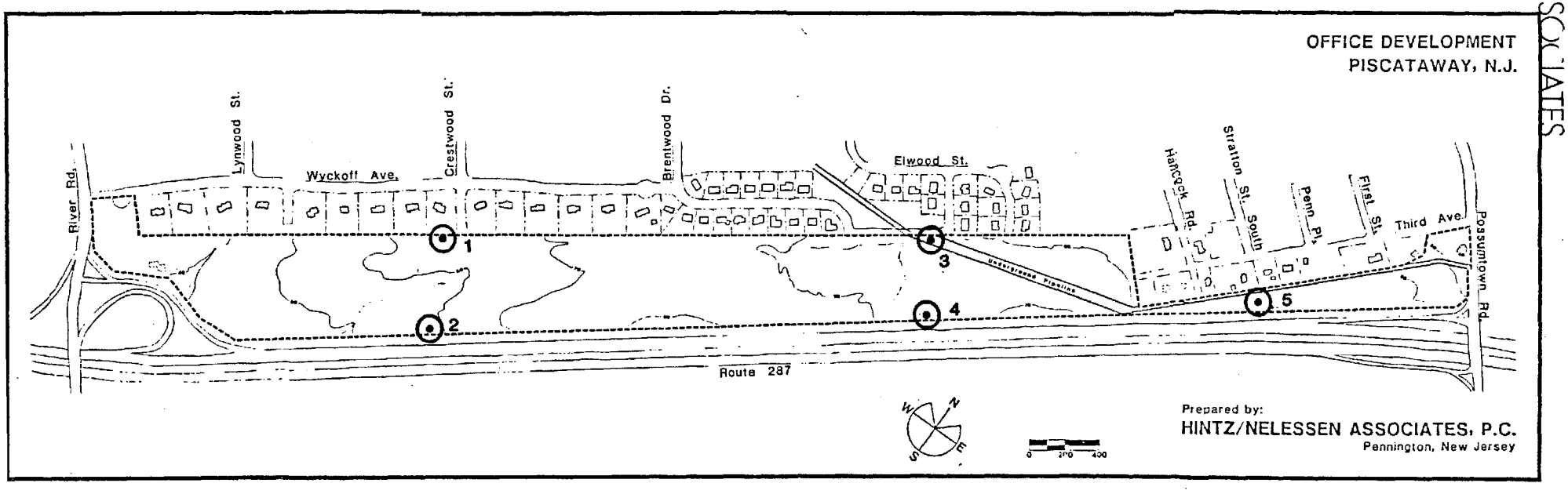
A suggested approach for estimating the cost of the berm or barrier, in today's dollars, would be to first estimate the cost of the berm, as it is a considerably simpler design than a 30 or 35 foot high vertical barrier. An estimate of the

barrier cost could then be developed using the ratio of the barrier to berm costs contained in the "Highway Noise Barrier...Construction Experiences" document.

We have done this for timber, concrete, and metal walls, all with respect to earth berms. Using the low and high cost ranges, on a square foot basis, for these four types of noise barriers, it is estimated that a timber wall costs 1.7 - 2 times the cost of an earth berm, a concrete panel or block wall costs 2.3 - 3 times the cost of the berm, and a metal panel wall costs approximately 2.7 times that of an earth berm. It should be noted that the beginning paragraph of the "cost" section of the document states that "noise barriers normally cannot be constructed inexpensively, especially if constructed as a separate project within a limited right-of-way, which frequently happens after the highway has been opened to traffic".

APPENDIX

Sound Measurement Locations



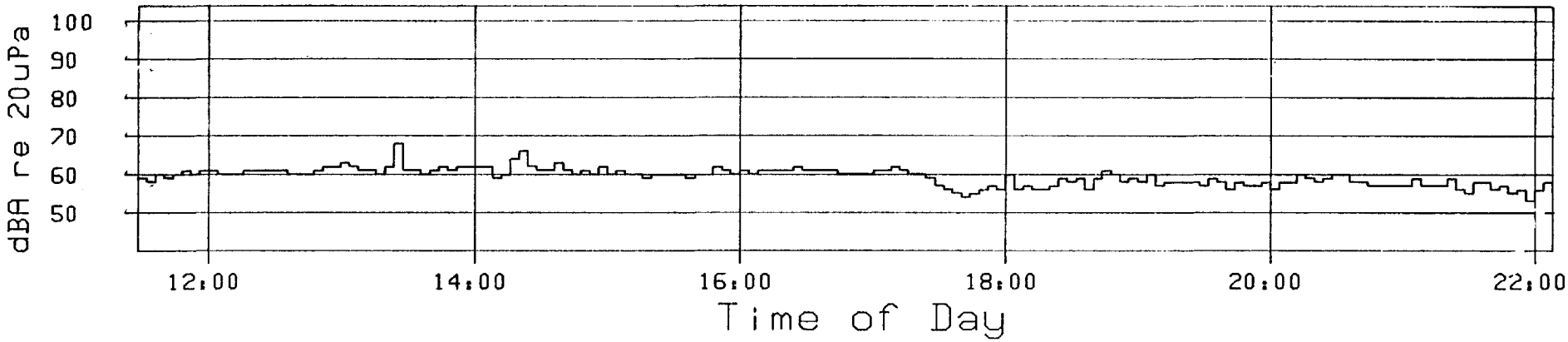
Prepared by Ostergaard Associates

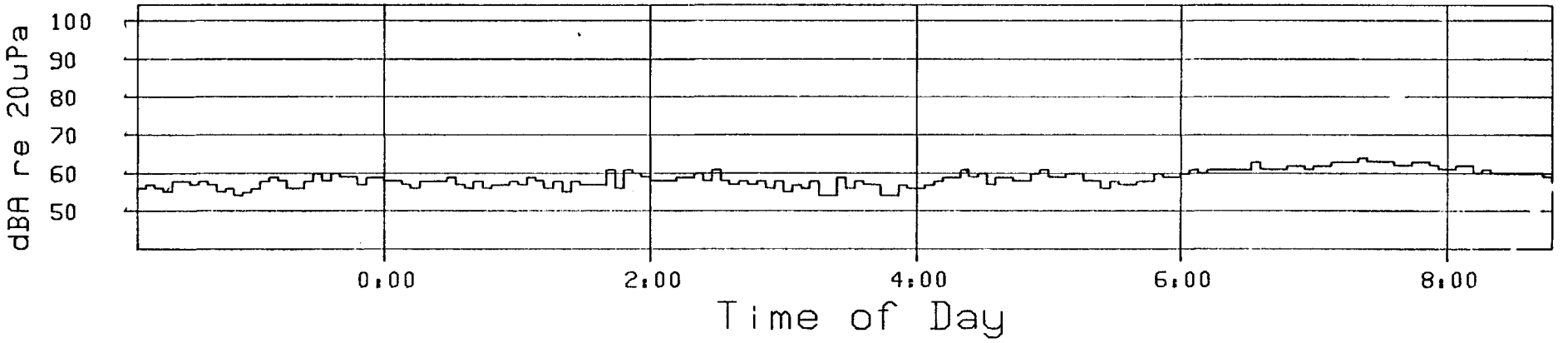
Figure 1

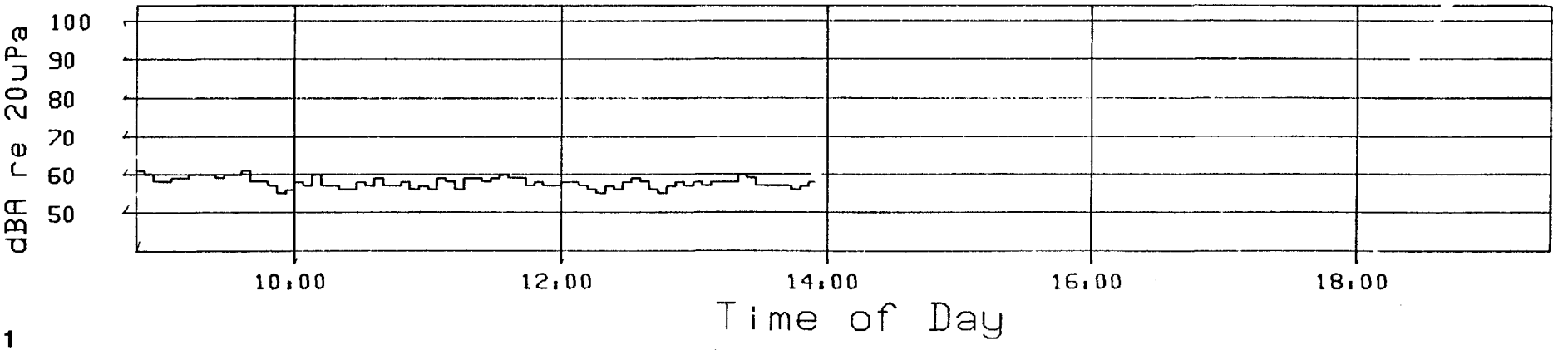
A-Weighted Sound Level vs. Time

Dosimeter:1764 G, Crestwood, far property line
Sample period: 4 min
Exchange rate: 3 dB

Project No. 1858A
Date: 12-DEC-84
Time: 11:28







#1

Project number:1858A
Client: Lawrence Zirinsky
Dosimeter: 1764 G
R.O.W. by red barn

Measured 4 minute dBA Leq values:

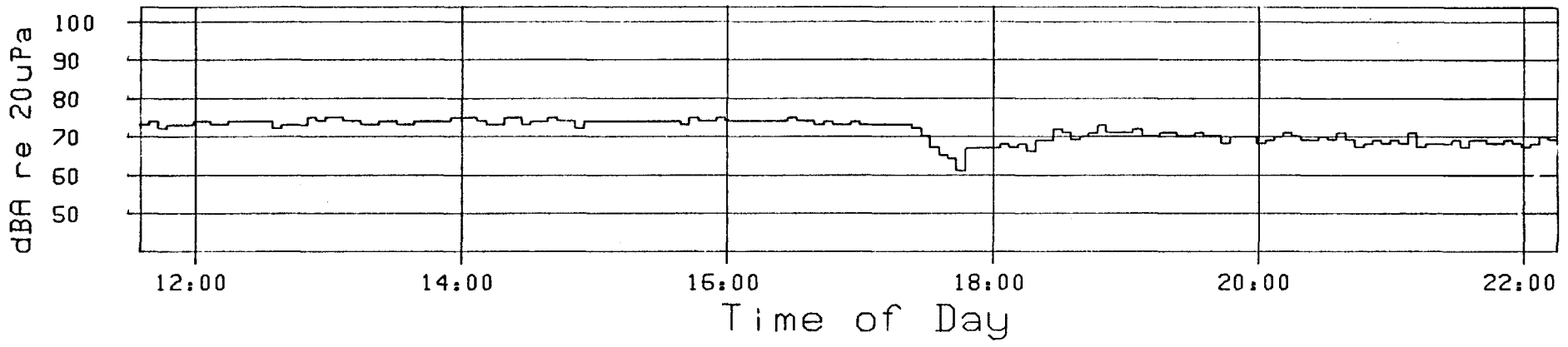
Time: min hours	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	Leq
1100								67	59	58	60	59	60	61	60	
1200	61	61	60	60	60	61	61	61	61	61	60	60	60	61	62	61
1300	62	63	62	61	61	60	62	68	61	61	60	61	62	61	62	62
1400	62	62	62	59	60	64	66	62	61	61	63	61	60	61	60	62
1500	62	60	61	60	60	59	60	60	60	60	59	60	60	62	61	60
1600	60	61	60	61	61	61	61	62	61	61	61	61	60	60	60	61
1700	60	61	61	62	61	60	60	59	57	56	55	54	55	56	57	59
1800	56	60	56	57	56	56	57	59	58	59	56	59	61	60	58	58
1900	59	58	60	57	58	58	58	58	57	59	58	56	58	57	57	58
2000	58	56	58	58	60	59	58	59	60	60	58	58	57	57	57	58
2100	57	57	59	57	57	57	59	56	55	58	58	56	57	55	56	57
2200	53	56	58	56	57	56	55	58	58	57	58	57	55	56	54	57
2300	55	56	58	59	58	56	56	58	60	58	60	59	59	57	59	58
000	59	58	58	57	56	58	58	58	59	57	56	58	56	57	57	58
100	58	57	59	58	56	58	55	58	57	57	57	61	56	61	60	58
200	59	58	58	58	59	59	60	58	61	58	57	58	57	58	56	58
300	58	55	57	56	58	54	54	59	56	58	57	57	54	54	57	57
400	56	56	57	58	59	59	61	59	60	57	59	59	58	58	60	59
500	61	59	59	60	60	58	58	56	58	57	57	58	58	60	59	59
600	59	60	61	60	61	61	61	61	61	63	61	61	61	62	62	61
700	61	62	62	63	63	63	64	63	63	63	62	62	63	63	62	63
800	61	61	62	62	60	61	60	60	60	60	60	60	59	61	60	61
900	58	58	59	59	60	60	60	59	60	60	61	58	58	57	55	59
1000	56	58	57	60	57	57	56	56	58	57	59	57	57	58	56	57
1100	57	56	59	58	56	59	59									60

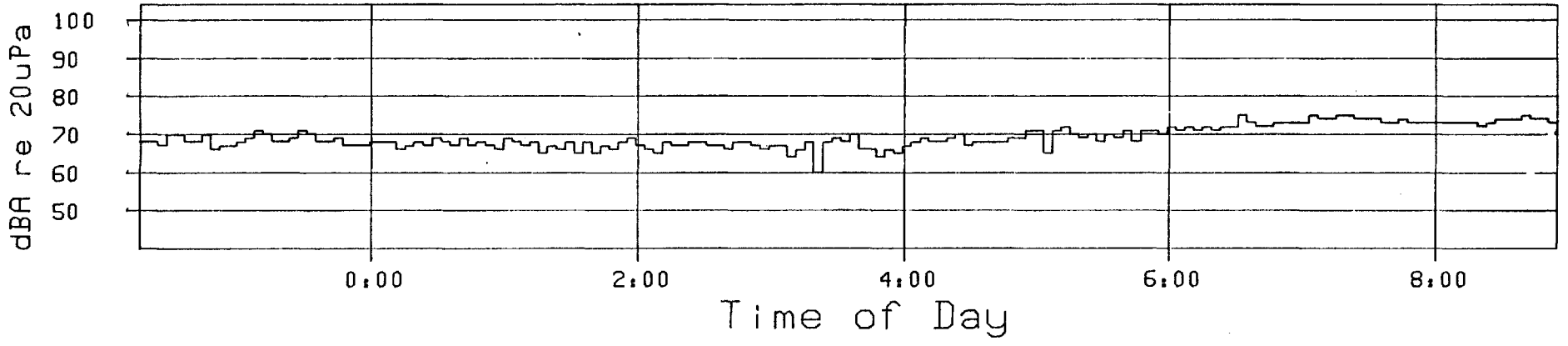
Ldn = 65 dBA, Leq(24) = 60 dBA
Daytime Leq = 60 dBA based on 15.00 hours of data.
Nighttime Leq = 58 dBA based on 9.00 hours of data.
Minimum value: 53 dBA, Maximum value: 68 dBA
Maximum hourly Leq = 63 dBA from 1328 to 1428

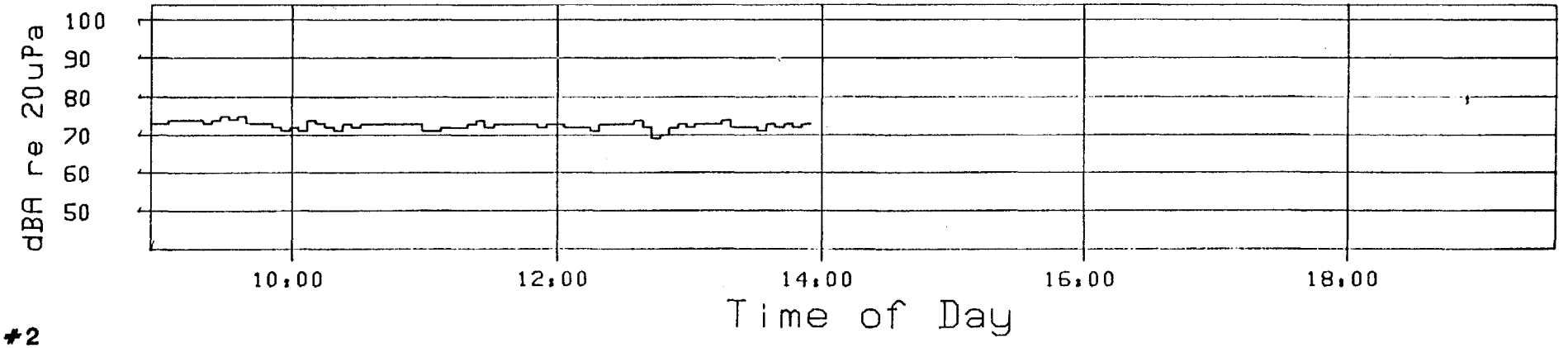
ighted Sound Level vs. Time

Dosimeter:9323 D, Crestwood, interstate fence line
Sample period: 4 min
Exchange rate: 3 dB

Project No. 1858A
Date: 12-DEC-84
Time: 11:35







#2

Project number:1858A
Client: Lawrence Zirinsky
Dosimeter: 9323 D
Interstate fence @ exit 5 sign

Measured 4 minute dBA Leq values:

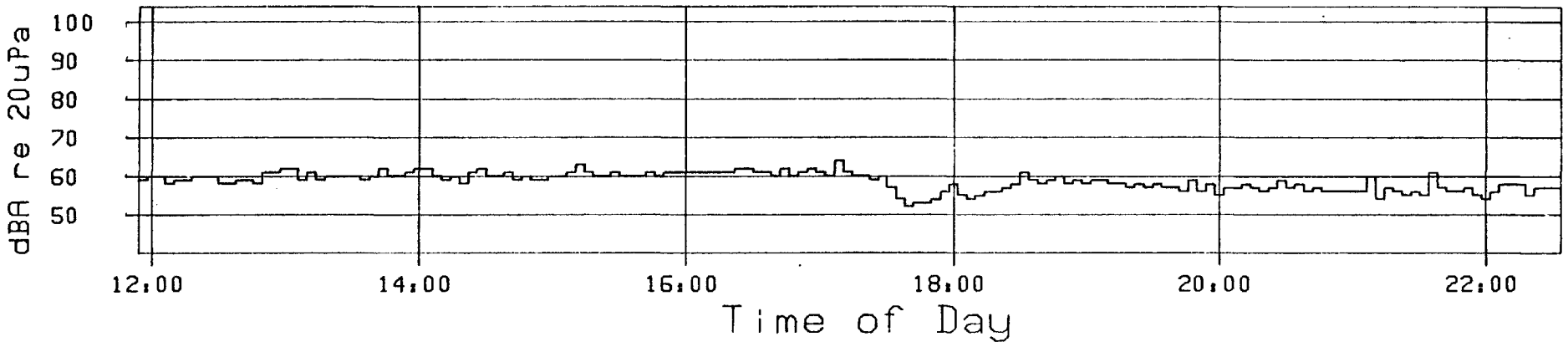
Time: hours	min : 3	:7	:11	:15	:19	:23	:27	:31	:35	:39	:43	:47	:51	:55	:59	Leq
1100									75	73	74	72	73	73	73	
1200	74	74	73	73	74	74	74	74	74	72	73	73	73	75	74	74
1300	75	75	74	74	73	73	74	74	73	73	74	74	74	74	75	74
1400	75	75	74	73	73	75	75	73	74	74	75	74	74	72	74	74
1500	74	74	74	74	74	74	74	74	74	74	73	75	74	74	75	74
1600	74	74	74	74	74	74	74	75	74	74	73	74	73	73	74	74
1700	73	73	73	73	73	73	72	70	67	65	64	61	67	67	67	71
1800	67	68	67	68	66	69	69	72	71	69	70	71	73	71	71	70
1900	71	72	70	70	71	71	70	70	71	70	70	68	70	70	70	70
2000	68	69	70	71	70	69	69	70	69	71	69	67	68	69	68	69
2100	69	68	71	67	68	68	68	69	67	69	69	68	68	69	68	69
2200	67	68	70	69	68	68	67	70	70	68	68	70	66	67	67	68
2300	68	69	71	70	68	68	69	71	70	68	68	69	67	67	67	69
000	68	68	68	66	67	68	67	69	68	67	69	67	68	67	66	68
100	69	68	67	68	65	67	66	68	65	68	65	67	66	68	69	67
200	67	66	65	68	67	67	68	68	67	67	66	68	68	67	66	67
300	67	67	64	66	68	60	68	69	68	70	66	66	64	66	65	67
400	67	68	69	68	68	69	70	67	68	68	68	68	69	69	71	69
500	71	65	71	72	70	69	70	68	70	69	71	68	71	71	70	70
600	72	71	72	71	72	71	72	72	75	73	72	72	73	73	73	72
700	73	75	74	74	75	75	74	74	74	73	73	74	73	73	73	74
800	73	73	73	73	73	72	73	74	74	74	75	74	74	73	73	73
900	73	74	74	74	74	73	74	75	74	75	73	73	73	72	71	74
1000	72	71	74	73	72	71	73	72	73	73	73	73	73	73	73	73
1100	71	71	72	72	72	73	74	72								73

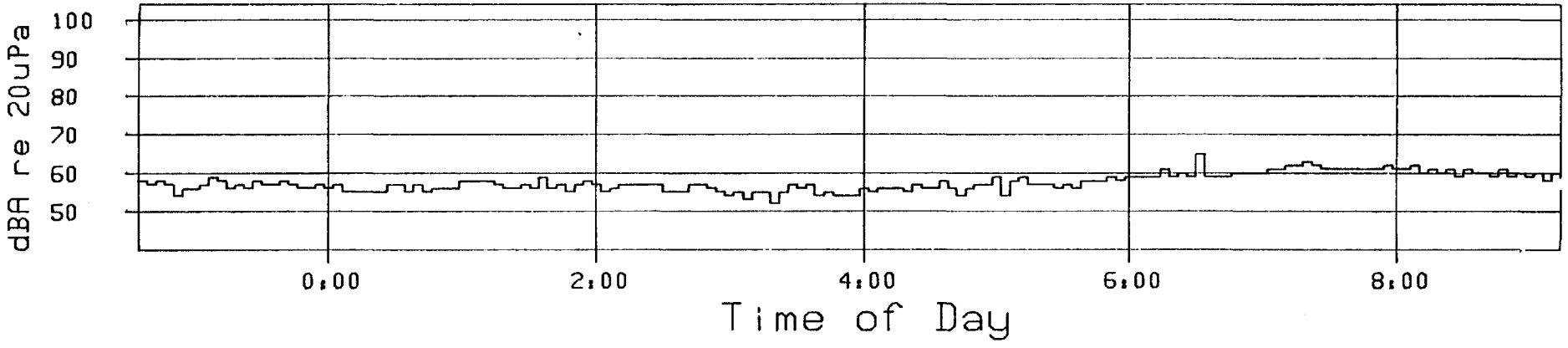
Ldn = 76 dBA, Leq(24) = 72 dBA
Daytime Leq = 73 dBA based on 15.00 hours of data.
Nighttime Leq = 69 dBA based on 9.00 hours of data.
Minimum value: 60 dBA, Maximum value: 75 dBA
Maximum hourly Leq = 74 dBA from 1447 to 1547

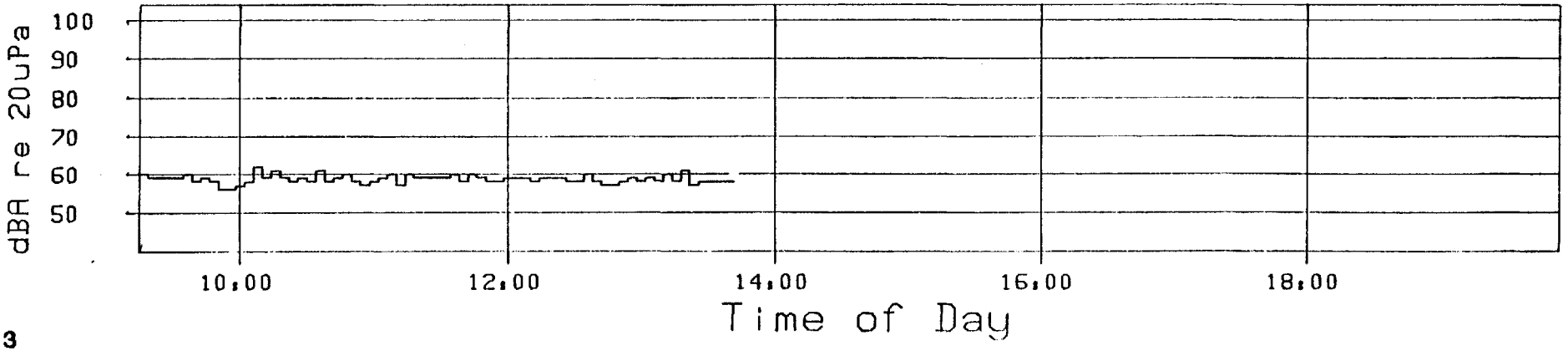
A-Weighted Sound Level vs. Time

Dosimeter:9322 C, Pipeline ROW, access road
Sample period: 4 min
Exchange rate: 3 dB

Project No. 1858A
Date: 12-DEC-84
Time: 11:54







#3

Project number:1858A
Client: Lawrence Zirinsky
Dosimeter: 9322 C
25 yd in from street

Measured 4 minute dBA Leq values:

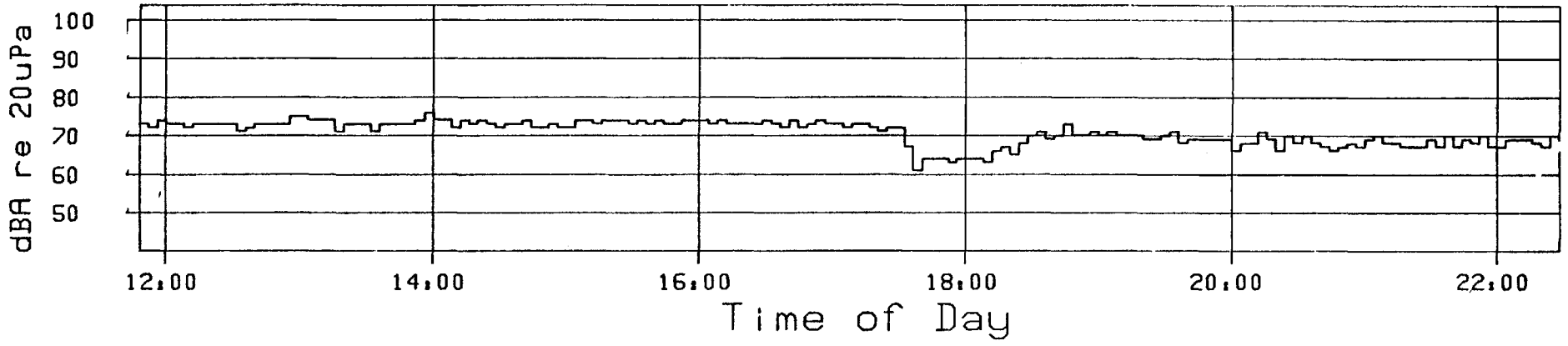
Time: hours	min : 2	: 6	:10	:14	:18	:22	:26	:30	:34	:38	:42	:46	:50	:54	:58	Leq
1100														69	59	
1200	60	60	58	59	59	60	60	60	58	58	59	59	58	61	61	59
1300	62	62	59	61	59	60	60	60	60	59	60	62	60	60	61	60
1400	62	62	60	59	60	58	61	62	60	60	61	59	60	59	59	60
1500	60	60	61	63	61	60	60	61	60	60	60	61	60	61	61	61
1600	61	61	61	61	61	61	62	62	61	61	60	62	60	61	62	61
1700	61	60	64	61	60	60	59	60	57	54	52	53	53	54	56	59
1800	58	55	54	55	56	56	57	58	61	59	58	59	60	58	59	58
1900	58	59	59	58	58	57	58	57	58	57	57	56	59	56	58	58
2000	55	57	57	58	57	56	57	59	57	58	56	57	56	56	56	57
2100	56	56	60	54	57	56	55	56	55	61	57	56	56	57	55	57
2200	54	56	58	58	58	55	57	57	57	58	57	58	57	54	56	57
2300	56	57	59	58	56	57	56	58	57	57	58	57	56	56	57	57
000	56	57	55	55	55	55	55	57	57	55	57	55	56	56	56	56
100	58	58	58	58	57	56	56	57	56	59	56	57	55	57	58	57
200	57	55	56	57	57	57	57	57	55	55	55	57	57	56	55	56
300	54	55	53	55	55	52	55	57	56	57	54	55	54	54	54	55
400	56	55	56	56	56	55	57	56	56	58	56	54	56	57	57	56
500	59	54	58	59	57	57	57	56	57	56	58	58	58	59	58	58
600	59	59	59	59	61	59	60	59	65	59	59	59	60	60	60	60
700	60	61	61	62	62	63	62	61	61	61	61	61	61	61	62	61
800	61	61	62	60	61	60	61	59	61	60	60	59	61	59	60	60
900	59	60	58	60	60	59	59	59	59	60	58	59	58	56	56	59
1000	57	58	62	59	61	59	58	59	58	61	58	59	60	58	57	59
1100	58	59	60	57	60	59	59	59	59	60	58	60	59			61

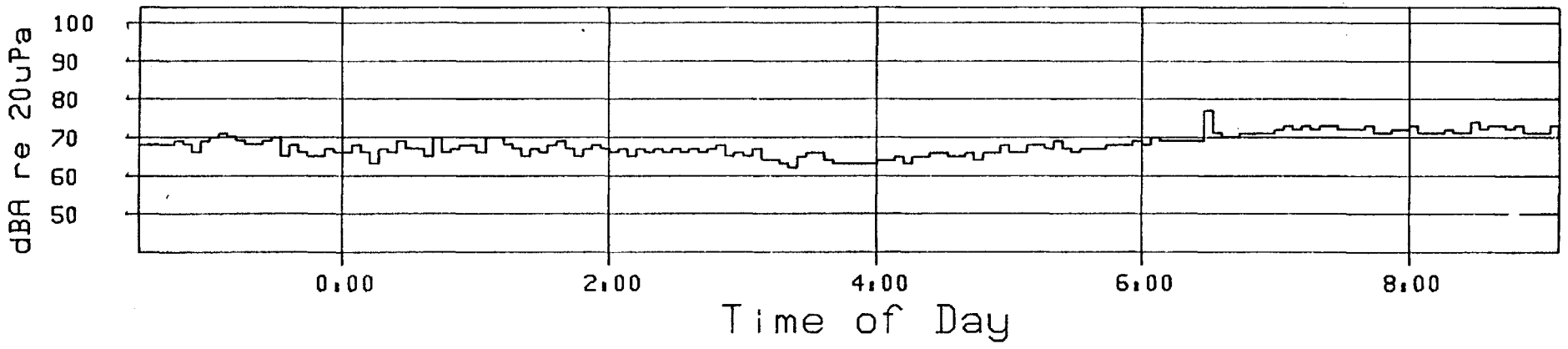
Ldn = 64 dBA, Leq(24) = 59 dBA
Daytime Leq = 60 dBA based on 15.00 hours of data.
Nighttime Leq = 57 dBA based on 9.00 hours of data.
Minimum value: 52 dBA, Maximum value: 69 dBA
Maximum hourly Leq = 62 dBA from 714 to 814

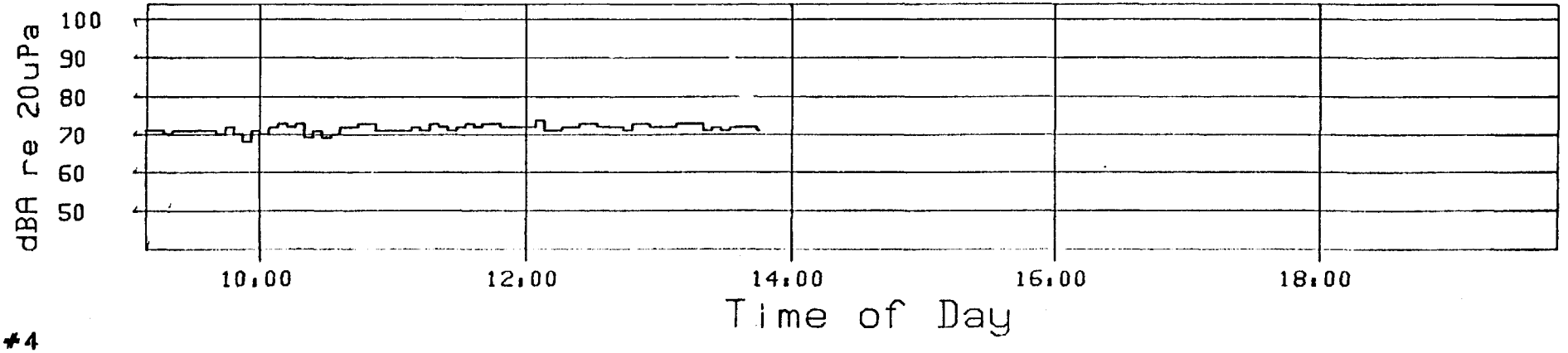
A-Weighted Sound Level vs. Time

Dosimeter:9324 E, Pipeline ROW, interstate fence
Sample period: 4 min
Exchange rate: 3 dB

Project No. 1858A
Date: 12-DEC-84
Time: 11:48







#4

Project number:1858A
Client: Lawrence Zirinsky
Dosimeter: 9324 E
10 ft. from culvert ditch

Measured 4 minute dBA Leq values:

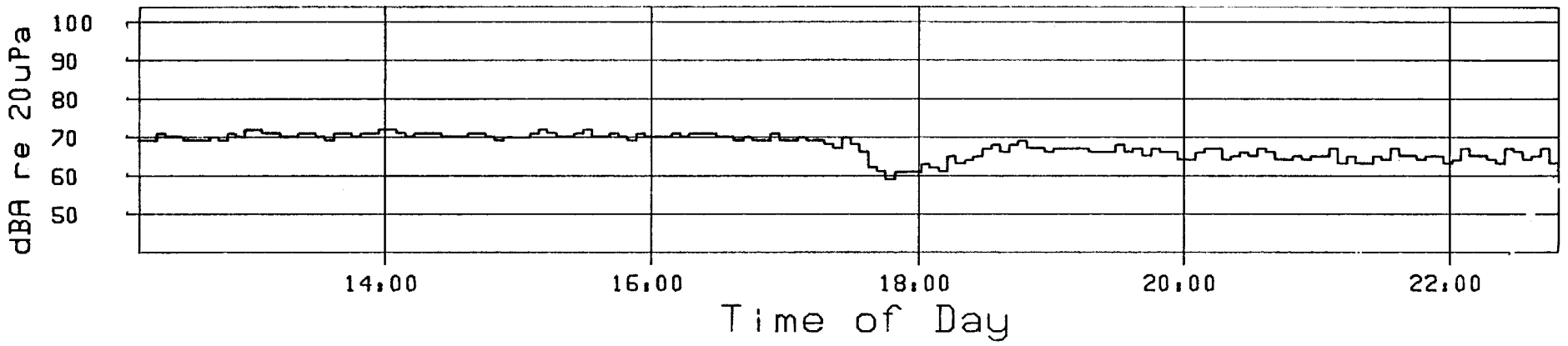
Time: min hours	:0	:4	:8	:12	:16	:20	:24	:28	:32	:36	:40	:44	:48	:52	:56	Leq
1100													76	73	72	
1200	74	73	73	72	73	73	73	73	73	71	72	73	73	73	73	73
1300	75	75	74	74	74	71	73	73	73	71	73	73	73	73	74	73
1400	76	74	74	72	74	73	74	73	72	73	73	74	72	72	73	73
1500	72	72	74	74	73	74	74	74	73	74	73	74	73	73	74	73
1600	74	74	73	74	73	73	73	73	74	73	72	74	72	73	74	73
1700	73	73	72	73	73	72	71	72	72	67	61	64	64	64	63	71
1800	64	64	64	63	66	67	65	68	70	71	69	70	73	70	70	69
1900	71	70	71	70	70	70	69	69	70	71	68	69	69	69	69	70
2000	69	66	68	68	71	69	66	70	68	70	68	67	66	67	68	68
2100	67	69	70	68	68	67	67	67	69	67	70	67	69	68	70	68
2200	67	67	69	69	69	68	67	70	68	68	68	68	69	68	66	68
2300	69	70	71	70	69	68	68	69	70	65	68	66	65	65	67	68
000	66	66	68	66	63	67	66	69	67	67	65	70	66	67	68	67
100	68	66	70	70	68	67	65	67	66	68	69	67	65	67	68	68
200	67	66	67	65	67	66	67	66	67	66	67	66	67	68	65	67
300	66	65	67	64	64	63	62	65	66	66	64	63	63	63	63	65
400	63	64	64	65	63	65	65	66	66	65	65	66	64	66	66	65
500	68	66	66	68	68	67	69	67	66	67	67	67	68	68	68	67
600	69	68	70	69	69	69	69	69	77	71	70	70	71	71	71	71
700	71	72	73	72	73	72	73	73	72	72	72	73	71	71	72	72
800	72	73	71	71	71	72	71	71	74	72	73	73	72	73	71	72
900	71	71	73	71	71	70	71	71	71	71	71	70	72	70	68	71
1000	71	70	72	73	72	73	69	71	69	70	72	72	73	73	71	72
1100	71	71	71	72	71	73	72	71	72	73	72	73				72

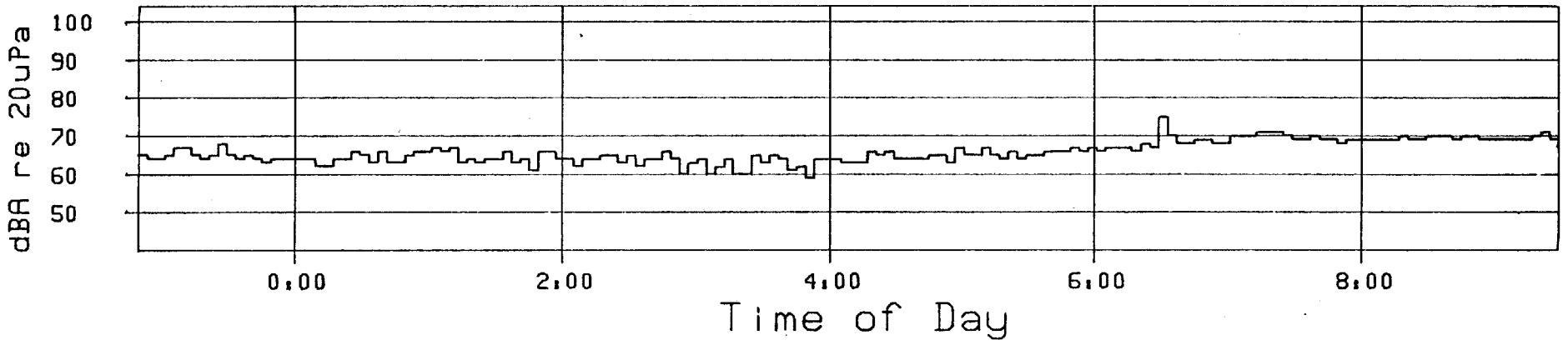
Ldn = 75 dBA, Leq(24) = 71 dBA
Daytime Leq = 72 dBA based on 15.00 hours of data.
Nighttime Leq = 68 dBA based on 9.00 hours of data.
Minimum value: 61 dBA, Maximum value: 77 dBA
Maximum hourly Leq = 74 dBA from 1508 to 1608

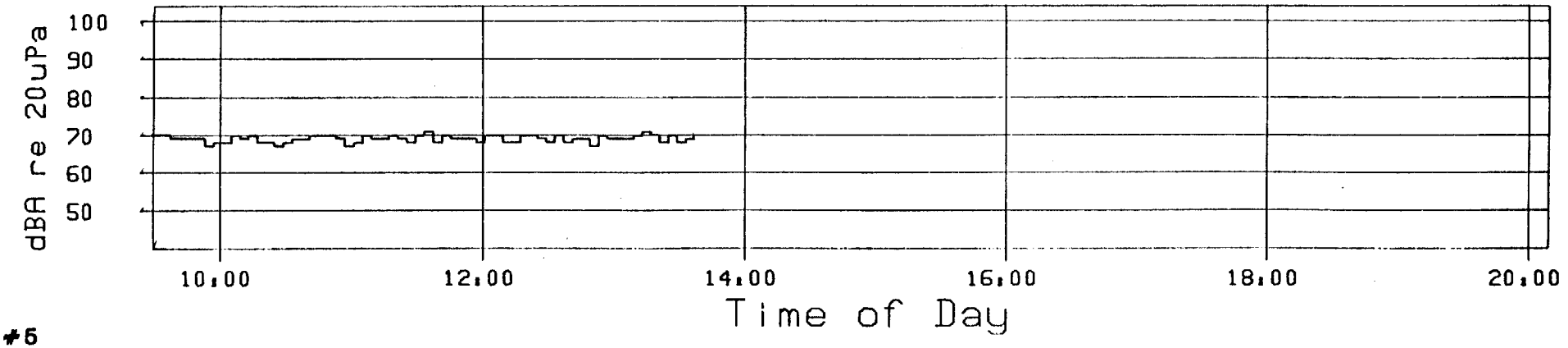
A-Weighted Sound Level vs. Time

Dosimeter:9320 A, #17 Third Ave., in strip
Sample period: 4 min
Exchange rate: 3 dB

Project No. 1858A
Date: 12-DEC-84
Time: 12:09







#5

Project number:1858A
Client: Lawrence Zirinsky
Dosimeter: 9320 A
Wooded triangular section

Measured 4 minute dBA Leq values:

Time: min hours	:1	:5	:9	:13	:17	:21	:25	:29	:33	:37	:41	:45	:49	:53	:57	Leq
1200			75	69	69	71	70	70	69	69	69	70	69	71	70	
1300	72	72	71	71	70	70	71	71	70	69	71	71	70	71	71	71
1400	72	72	71	70	71	71	71	70	70	70	71	71	70	69	70	71
1500	70	70	71	72	71	70	70	71	72	70	70	71	70	69	71	71
1600	70	70	70	71	70	71	71	71	70	70	69	70	69	69	71	70
1700	69	69	70	69	69	68	67	70	68	66	62	61	59	61	61	67
1800	61	63	62	61	65	63	64	65	67	68	66	68	69	67	67	66
1900	66	67	67	67	67	66	66	66	68	66	67	65	67	66	66	67
2000	64	64	66	67	67	64	65	66	65	67	66	64	64	65	64	65
2100	65	65	67	63	65	63	63	65	64	67	65	65	64	65	65	65
2200	63	64	67	65	65	64	63	67	66	64	65	67	63	65	64	65
2300	64	65	67	67	65	64	65	68	65	64	65	64	63	64	64	65
000	64	64	64	62	62	64	64	66	65	63	66	63	63	65	66	64
100	66	67	66	67	63	64	63	64	64	66	63	64	61	66	66	65
200	64	64	62	64	64	65	65	63	65	62	64	64	66	64	60	64
300	63	64	60	62	64	60	60	65	63	65	64	61	62	59	64	63
400	64	64	63	63	63	66	65	66	64	64	64	64	65	65	63	64
500	67	65	65	67	65	64	66	64	65	65	66	66	66	67	66	66
600	67	66	67	67	67	66	68	67	75	70	68	68	69	69	68	69
700	68	70	70	70	71	71	71	70	69	69	70	69	69	68	69	70
800	69	69	69	69	69	70	69	69	70	70	70	69	70	70	69	69
900	69	69	69	69	69	70	71	69	70	70	69	69	69	69	67	69
1000	68	68	70	69	70	68	68	67	68	69	69	70	70	70	69	69
1100	67	68	70	69	69	70	69	68	70	71	68	70	69	69	69	69
1200	68	70														70

Ldn = 73 dBA, Leq(24) = 68 dBA
Daytime Leq = 69 dBA based on 15.00 hours of data.
Nighttime Leq = 66 dBA based on 9.00 hours of data.
Minimum value: 59 dBA, Maximum value: 75 dBA
Maximum hourly Leq = 71 dBA from 1325 to 1425

TABLE 1

Roadside Berm Effects

A-weighted Sound Levels at Listener Location
(Near measurement locations #3 and #4, east side)

Berm Height (ft.)	Elevation (floor)	Road-to-Listener Distance (ft.) 75	325	550
0	1	67	60	57
10	3	L.O.S.	--	--
	2	--	--	--
	1	--	--	54
15	3	--	55	52
	2	60	54	52
20	3	61	53	50
	2	55	51	49
25	3	--	50	--
	2	52	--	--
30	3	54	48	--
	2	50	--	--

Berm centerline 40' from road edge
L.O.S. = Line of sight; no reduction

TABLE 2

Roadside Berm Effects

A-weighted Sound Levels at Listener Location
(Near measurement locations #3 and #4, east side)

Berm Height (ft.)	Elevation (floor)	Road-to-Listener Distance (ft.) 180	325	550
25	3	--	53	50
	2	51	--	--

Berm centerline 80' from road edge.

TABLE 3

Roadside Berm Effects

A-weighted Sound Levels at Listener Location
(Near measurement locations #1 and #2, west side)

Berm Height (ft.)	Elevation (floor)	Road-to-Listener Distance (ft.) 180	325	550
20	3	61	--	--
	2	58	--	--
25	3	58	--	--
	2	55	--	--
30	3	--	52	49
	2	52	--	--

Berm centerline 80' from road edge.

TABLE 4

Roadside Barrier Effects

A-weighted Sound Levels at Listener Location
(Near measurement locations #1 and #2, west side)

Berm Height (ft.)	Elevation (floor)	Road-to-Listener Distance (ft.) 75	180	325
30	3	--	--	53
	2	56	54	--
35	3	--	--	51
	2	54	52	--

Barrier located 40' from road edge.

DEPARTMENT OF TRANSPORTATION, FEDERAL HIGHWAY ADMINISTRATION PROCEDURES FOR ABATEMENT OF HIGHWAY TRAFFIC NOISE

(Title 23, Code of Federal Regulations, Chapter I, Subchapter J, Part 772, 38 FR 15953, June 19, 1973; as amended at 39 FR 6696, February 22, 1974; Part 772 revised at 41 FR 16936, April 23, 1976, effective May 24, 1976; amended at 43 FR 45838, October 4, 1978; amended at 44 FR 30682, May 29, 1979; revised at 47 FR 29654, July 8, 1982)

Title 23—Highways

CHAPTER I—FEDERAL HIGHWAY ADMINISTRATION, DEPARTMENT OF TRANSPORTATION

SUBCHAPTER J—RIGHT-OF-WAY AND ENVIRONMENT

PART 722—PROCEDURES FOR ABATEMENT OF HIGHWAY TRAFFIC NOISE AND CONSTRUCTION NOISE

Sec.

Authority: 23 U.S.C. 109(h), 109(i); 42 U.S.C. 4331, 4332; 49 CFR 1.48(b).

§ 772.1 Purpose.

To provide procedures for noise studies and noise abatement measures to help protect the public health and welfare, to supply noise abatement criteria, and to establish requirements for information to be given to local officials for use in the planning and design of highways approved pursuant to title 23, United States Code (U.S.C.).

§ 772.3 Noise standards.

The highway traffic noise prediction requirements, noise analyses, noise abatement criteria, and requirements for informing local officials in this regulation constitute the noise standards mandated by 23 U.S.C. 109(i). All highway projects which are developed in conformance with this regulation shall be deemed to be in conformance with the Federal Highway Administration (FHWA) noise standards.

§ 772.5 Definitions.

(a) *Design year*—the future year used to estimate the probable traffic volume for which a highway is designed. A time, 10 to 20 years, from the start of construction is usually used.

(b) *Existing noise levels*—the noise, resulting from the natural and mechanical sources and human activity, considered to be usually present in a particular area.

(c) L_{10}—the sound level that is exceeded 10 percent of the time (the 90th percentile) for the period under consideration.

(d) $L_{10}(h)$—the hourly value of L_{10}.

(e) *Leq*—the equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same time period.

(f) *Leq*(h)—the hourly value of Leq.

(g) *Traffic noise impacts*—impacts which occur when the predicted traffic noise levels approach or exceed the noise abatement criteria (Table 1), or when the predicted traffic noise levels substantially exceed the existing noise levels.

(h) *Type I projects*—a proposed Federal or Federal-aid highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizonal or vertical alignment or increases the number of through-traffic lanes.

(i) *Type II projects*—a proposed Federal or Federal-aid highway project for noise abatement on an existing highway.

§ 772.7 Applicability.

(a) *Type I projects.* This regulation applies to all Type I projects unless it is specifically indicated that a section applies only to Type II projects.

(b) *Type II projects.* The development and implementation of Type II projects are not mandatory requirements of 23 U.S.C. 109(i) and are, therefore, not required by this regulation. When Type II projects are proposed for Federal-aid highway participation at the option of the highway agency, the provisions of §§ 772.9(c), 772.13, and 772.19 of this regulation shall apply.

§ 772.9 Analysis of traffic noise impacts and abatement measures.

(a) The highway agency shall determine and analyze expected traffic noise impacts and alternative noise abatement measures to mitigate these impacts, giving weight to the benefits and cost of abatement, and to the overall social, economic and environmental effects.

(b) The traffic noise analysis shall include the following for each alternative under detailed study:

(1) Identification of existing activities, developed lands, and undeveloped lands for which development is planned, designed and programmed, which may be affected by noise from the highway;

(2) Prediction of traffic noise levels;
(3) Determination of existing noise levels;
(4) Determination of traffic noise impacts; and
(5) Examination and evaluation of alternative noise abatement measures for reducing or eliminating the noise impacts.

(c) Highway agencies proposing to use Federal-aid highway funds for Type II projects shall perform a noise analysis of sufficient scope to provide information needed to make the determination required by § 772.13(a) of this chapter.

§ 772.11 Noise abatement.

(a) In determining and abating traffic noise impacts, primary consideration is to be given to exterior areas. Abatement will usually be necessary only where frequent human use occurs and a lowered noise level would be of benefit.

(b) In those situations where there are no exterior activities to be affected by the traffic noise, or where the exterior activities are far from or physically shielded from the roadway in a manner that prevents an impact on exterior activities, the interior criterion shall be used as the basis of determining noise impacts.

(c) If a noise impact is identified, the abatement measures listed in § 772.13(c) of this chapter must be considered.

(d) When noise abatement measures are being considered, every reasonable effort shall be made to obtain substantial noise reductions.

(e) Before adoption of a final environmental impact statement or finding of no significant impact, the highway agency shall identify:
(1) noise abatement measures which are reasonable and feasible and which are likely to be incorporated in the project, and
(2) noise impacts for which no apparent solution is available.

(f) The views of the impacted residents will be a major consideration in reaching a decision on the reasonableness of abatement measures to be provided.

(g) The plans and specifications will not be approved by FHWA unless those noise abatement measures which are reasonable and feasible are incorporated into the plans and specifications to reduce or eliminate the noise impact on existing activities, developed lands, or undeveloped lands for which development is planned, designed, and programmed.

§ 772.13 Federal participation.

(a) Federal funds may be used for noise abatement measures where:
(1) A traffic noise impact has been identified,
(2) The noise abatement measures will reduce the traffic noise impact, and
(3) The overall noise abatement benefits are determined to outweigh the overall adverse social, economic, and environmental effects and the costs of the noise abatement measures.

(b) For Type II projects, noise abatement measures will not normally be approved for those activities and land uses which come into existence after May 14, 1976. However, noise abatement measures may be approved for activities and land uses which come into existence after May 14, 1976, provided local authorities have taken measures to exercise land use control over the remaining undeveloped lands adjacent to highways in the local jurisdiction to prevent further development of incompatible activities.

(c) The noise abatement measures listed below may be incorporated in Type I and Type II projects to reduce traffic noise impacts. The costs of such measures may be included in Federal-aid participating project costs with the Federal share being the same as that for the system on which the project is located, except that Interstate construction funds may only participate in Type I projects.

(1) Traffic management measures (e.g., traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive land designations).

(2) Alteration of horizontal and vertical alignments.

(3) Acquisition of property rights (either in fee or lesser interest) for construction of noise barriers.

(4) Construction of noise barriers (including landscaping for esthetic purposes) whether within or outside the highway right-of-way. Interstate construction funds may not participate in landscaping.

(5) Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development which would be adversely impacted by traffic noise. This measure may be included in Type I projects only.

(6) Noise insulation of public use or nonprofit institutional structures.

(d) There may be situations where (1) severe traffic noise impacts exist or are expected, and (2) the abatement measures listed above are physically infeasible or economically unreasonable. In these instances, noise abatement measures other than those listed in § 772.13(c) of this chapter may be proposed for Types I and II projects by the highway agency and approved by the Regional Federal Highway Administrator on a case-by-case basis when the conditions of § 772.13(a) of this chapter have been met.

§ 772.15 Information for local officials.

In an effort to prevent future traffic noise impacts on currently undeveloped lands, highway agencies shall inform local officials within whose jurisdiction the highway project is located of the following:

(a) The best estimation of future noise levels (for various distances from the highway improvement) for both developed and undeveloped lands or properties in the immediate vicinity of the project,

(b) Information that may be useful to local communities to protect future land development from becoming incompatible with anticipated highway noise levels, and

(c) Eligibility for Federal-aid participation for Type II projects as described in § 772.13(b) of this chapter.

§ 772.17 Traffic noise prediction.

(a) Any traffic noise prediction method is approved for use in any noise analysis required by this regulation if it generally meets the following two conditions:
(1) The methodology is consistent with the methodology in the FHWA Highway Traffic Noise Prediction Model (Report No. FHWA-RD-77-108).*
(2) The prediction method uses noise emission levels obtained from one of the following:
(i) National Reference Energy Mean Emission Levels as a Function of Speed (Appendix A).
(ii) Determination of reference energy mean emission levels in Sound Procedures for Measuring Highway Noise: Final Report, DP-45-1R.*

(b) In predicting noise levels and assessing noise impacts, traffic characteristics which will yield the worst hourly traffic noise impact on a regular basis for the design year shall be used.

* These documents are available for inspection and copying as prescribed in 49 CFR Part 7, Appendix D.

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§ 772.19 Construction noise.

The following general steps are to be performed for all Types I and II projects:

(a) Identify land uses or activities which may be affected by noise from construction of the project. The identification is to be performed during the project development studies.

(b) Determine the measures which are needed in the plans and specifications to minimize or eliminate adverse construction noise impacts to the community. This determination shall include a weighing of the benefits achieved and the overall adverse social, economic and environmental effects and the costs of the abatement measures.

(c) Incorporate the needed abatement measures in the plans and specifications.

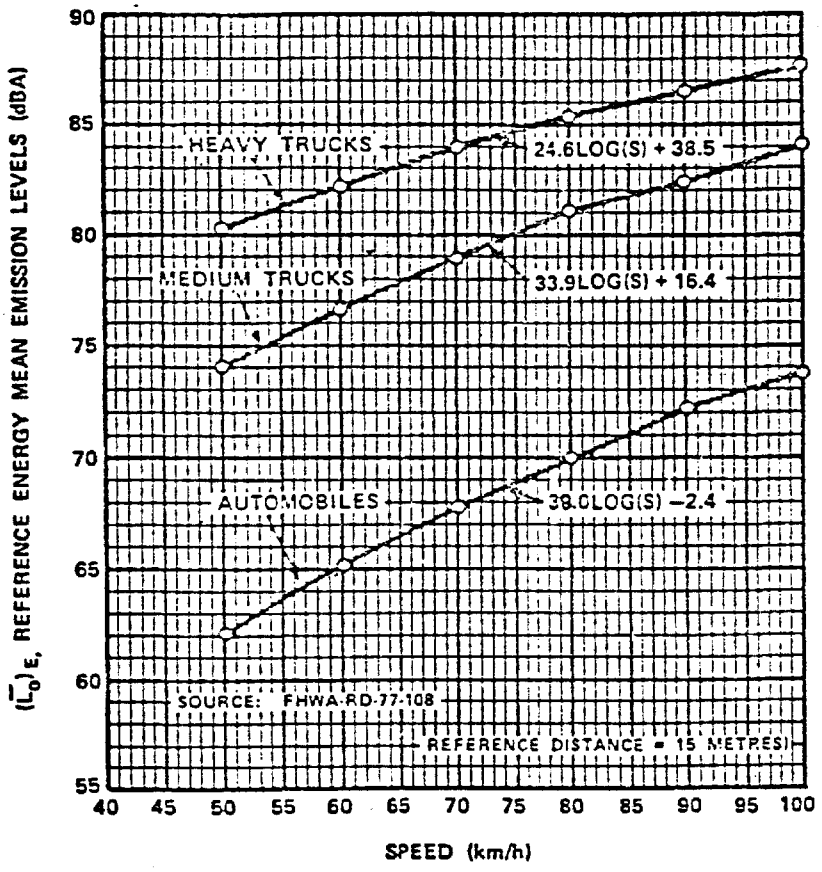
TABLE 1.—Noise Abatement Criteria

[Hourly A-Weighted Sound Level—decibels (dBA)[1]]

Activity Category	Leq(h)	L_{10}(h)	Description of activity category
A	57 (Exterior)	60 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (Exterior)	70 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	75 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D			Undeveloped lands.
E	52 (Interior)	55 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

[1] Either L_{10}(h) or Leq(h) (but not both) may be used on a project.

Appendix: A



LEGEND:

1. AUTOMOBILES: ALL VEHICLES WITH TWO AXLES AND FOUR WHEELS.
2. MEDIUM TRUCKS: ALL VEHICLES WITH TWO AXLES AND SIX WHEELS.
3. HEAVY TRUCKS: ALL VEHICLES WITH THREE OR MORE AXLES.

National Reference Energy Mean Emission Levels as a Function of Speed

Thursday
July 12, 1979

Federal Register

Part V

Department of Housing and Urban Development

Office of the Secretary

Environmental Criteria and Standards

HOUSING AND URBAN DEVELOPMENT

24 CFR Part 51

[Docket No. R-79-595]

Environmental Criteria and Standards

AGENCY: Department of Housing and Urban Development.

ACTION: Final rule.

SUMMARY: This final rule adds a new Part 51, Environmental Criteria and Standards to Title 24 of the CFR. The rule sets forth Subparts A and B covering General Provisions and Noise Abatement and Control respectively.

EFFECTIVE DATE: August 13, 1979.

FOR FURTHER INFORMATION CONTACT: James F. Miller or Gretchen Van Hyning, Office of Environmental Quality, Room 7266, U.S. Department of Housing and Urban Development, 451 7th Street, SW., Washington, 20410 D.C. (202) 755-8909 (this is not a toll-free number).

SUPPLEMENTAL INFORMATION: A Notice of Proposed Rulemaking was published on December 27, 1978 (43 FR 60396) indicating that HUD proposed to add a new Part 51, Environmental Criteria and Standards, to Title 24 of the CFR. The proposed rule would include Subpart A, General Provisions, and Subpart B, Noise Abatement and Control. The Notice invited public comment until January 26, 1979.

Subpart B establishes Departmental standards, requirements, and guidelines on noise abatement and control, replacing and revising the noise policies, standards and procedures previously set forth in HUD Circular 1390.2, which is cancelled when this final rule becomes effective.

Subpart B converts the existing noise policy to regulation format and makes revision and improvements intended to make the policy more flexible and consistent with other Federal agencies' noise programs. Revisions to the current policy (1) bring into conformity, through the use of the day-night average sound level, separate standards and measurements for aircraft and non-aircraft noise; (2) afford Field Offices more flexibility in implementing the policy thus reducing the number of cases having to come into the Region and Headquarters Offices; (3) remove the dual exterior and interior standards, hence, if exterior noise levels are found to be acceptable, the interior noise will be considered acceptable using normal building techniques; and (4) allow easy use of already existing data, particularly from FHWA and DOD. The standards apply primarily to HUD support for new residential construction in certain noise zones—as does the existing policy.

Overall, the comments indicated strong support for the revisions to the noise policy, particularly the use of the day-night average sound level descriptor and the acceptability thresholds used by the Department. The one topic which generated substantial discussion and a divergence of opinion was the methodology for describing "loud implusive sounds."

The following discussion summarizes the significant comments and the changes that were made in the final rule.

1. *Use of the Day-Night Average Sound Level (DNL) to Describe Noise.*—Of the 18 responses, 15 commented on the proposed noise descriptor. Only two of these expressed reservations (one Federal agency and one industry group) about use of the day-night average sound level; these two comments were directed to use of a nighttime penalty in DNL. Both parties recommended substituting a computer based model which itself, among other things, incorporates a nighttime penalty. The same agency has also issued advisory materials containing noise metrics which include the nighttime correction.

The proposed methodology for describing noise has been widely used to relate individual and community reaction to aircraft and road traffic noise, to predict the likelihood and the severity of interference with speech and sleep, and to correlate hearing loss with noise exposure. The simple concept of average sound level must be somewhat refined to account for the fact, documented by most community response and public opinion surveys, that the same noise level is considered more disturbing or annoying during the nighttime than during daytime. Not only do the requirements for undisturbed sleep and relaxation make a lower nighttime noise level desirable, but the exterior background noise level in most communities drops during the night by 10 dB or more and reduced activity inside homes contributes to a general lowering of interior noise levels. Consequently, intrusive noises are more disturbing during the night. To assess nighttime noise events in a way that accounts for their increased potential for causing disturbances a weighting factor of 10 dB is applied to all nighttime noises; i.e., nighttime noises are treated as if they were 10 dB noiser than they actually are. The need for a nighttime correction has also received international concensus through the International Organization for Standardization (ISO).

In view of the acceptance and support for the DNL descriptor, HUD is publishing the final rule using the DNL with the nighttime correction for application of the standards.

2. *Proposed Standards.*—Most responses indicated the appropriateness of the general goals and levels proposed by HUD. Two responses however indicated concern that noise transmitted within multifamily dwellings was not addressed. This problem is however covered in Section 51.101(a)(10); the relevant reference to the Minimum Property Standards for Multifamily Housing is Section 404 on Acoustic Control.

Several comments related to conversion of existing data to DNL. The conversion factors have been clarified in the final rule and the conversion indicates the measures "are approximately equal to" rather than the same. In the final rule one descriptor for aircraft noise was added—(Community Noise Equivalent Level, used in California) and one was deleted (Composite Noise Rating). The Composite Noise Rating methodology was developed in the early 1960's and is subject to error and is used only infrequently and therefore it has been dropped from the final rule (see Section 51.106).

Conversion of highway levels (Section 51.106) to DNL is discussed in the National Cooperative Highway Research Program Report No. 173 on "Highway Noise Generation and Control," published by the Transportation Research Board in 1976.

3. *Analysis of Loud Impulsive Sounds.*—Five responses were directed to the methodology for calculating "loud impulsive sounds." The method for characterizing noise from explosions or sonic booms proposed by HUD in Section 103(b) is consistent with the interim procedures of the Department of Defense. HUD recognizes that the subject is currently undergoing technical debate, but no alternative has emerged upon which the technical community has agreed. This method is likely to be applied mostly in rare instances where sites are proposed in the vicinity of artillery firing ranges or other similar activities. In view of the current debate the final rule has been amended, in the text and in the Appendix, to emphasize that this methodology is to be used on an *interim basis.* When a final procedure is adopted by all the concerned Federal agencies, HUD's rule will be changed to incorporate the agreed upon methodology.

4. *Noise Attenuation.*—It was recommended by one reviewer that noise attenuation be expressed in terms of total sound attenuation rather than the requirement for attenuation measures in addition to the attenuation provided by housing as commonly constructed in the area. The results are essentially the same and both approaches have been considered. It was determined that the suggested approach by the reviewer may overstate the requirements while HUD's policy is to state minimum requirements to provide adequate protection at minimum cost. The final rule was changed to indicate that the additional noise attenuation measures are minimum requirements.

5. *Other Comments.*—Several reviewers provided editorial and technical corrections which have been included in the final rule. Some comments were not relevant to the specific rule, while other suggested that the Department prepare documents setting forth the rationale for the HUD standards and provide guidance to local governments. This work is underway, and a revised "Noise Assessment Guidelines" document should be available by the time the rule becomes effective. A technical background report on the policy is also in preparation and will be available at a later date. Two reviewers also suggested that HUD develop a procedure for notifying purchasers of existing properties if noise levels exceed those of the established regulation. HUD does consider noise as a marketability factor in Section 51.101(a)(4) in determining the amount of insurance or other assistance that may be given but does not propose to include a specific additional notification procedure in the appraisal process.

Some reviewers suggested that HUD take a major role in Federal efforts to control noise. HUD is cooperating with the EPA, DOT and DOD in interagency noise programs; these other agencies have responsibility for controlling noise at the source. HUD's regulations are necessarily limited to programs administered by the Department; however, the standards and guidance material should assist local governmental agencies and others in formulating policies to achieve quieter urban environments.

OTHER INFORMATION: A Finding of Inapplicability with regard to Environmental Impact has been prepared in accordance with HUD's environmental procedures. Copies of the statement and findings are available for inspection and copying in the Office of the Rules Docket Clerk, Room 5218, Department of Housing and Urban Development, 451 7th Street, S.W., Washington, D.C. 20410.

Accordingly, Title 24 of the CFR is amended by adding a new Part 51 to read as follows:

PART 51—ENVIRONMENTAL CRITERIA AND STANDARDS

Subpart A—General Provisions

Sec.
51.1 Purpose.
51.2 Authority.
51.3 Responsibilities.
51.4 Program coverage.
51.5 Coordination with environmental clearance requirements.
51.6 [Reserved]

Subpart B—Noise Abatement and Control

51.100 Purpose and authority.
51.101 General policy.
51.102 Responsibilities.
51.103 Criteria and standards.
51.104 Special requirements.
51.105 Exceptions.
51.106 Implementation.

Appendix

Authority: Sec. 7(d), Department of HUD Act (42 U.S.C. 3535(d)).

Subpart A—General Provisions

§ 51.1 Purpose.

The Department of Housing and Urban Development is providing program Assistant Secretaries and administrators and field offices with environmental standards, criteria and guidelines for determining project acceptability and necessary mitigating measures to insure that activities assisted by the Department achieve the goal of a suitable living environment.

§ 51.2 Authority.

This Part implements the Department's responsibilities under the following statutes:

(a) The National Housing Act of 1934 (Pub. L. 73–479) which was enacted "to encourage improvements in housing standards and conditions, to provide a system of mutual mortgage insurance, and for other purposes," thus providing the basis for HUD's Minimum Property Standards (MPS) which have evolved as required by legislation over the past 44 years.

(b) The Housing Act of 1949 (Pub. L. 81–171) which sets forth the national goal of "a decent home and a suitable living environment for every American family," affirmed by the Housing and Urban Development Act of 1968 (Pub. L. 90–448).

(c) The Department of Housing and Urban Development Act of 1965 (Pub. L. 89–174) which provides that the Secretary may make such rules and regulations as may be necessary to carry out functions, powers, and duties, and sets forth, as a matter of national purpose, the sound development of the Nation's communities and metropolitan areas.

(d) The National Environmental Policy Act of 1969 (Pub. L. 91–190) which directs Federal agencies to develop procedures to carry out the purposes of the Act.

(e) Intergovernmental Cooperation Act of 1968 (Pub. L. 90–577) which, under Title IV, directs that Federal programs and projects serve the objectives of appropriate land use for housing, commercial, industrial, governmental, institutional, and other purposes to achieve sound and orderly development of all areas, both urban and rural.

§ 51.3 Responsibilities.

(a) *Assistant Secretary for Community Planning and Development.* The Assistant Secretary for Community Planning and Development shall be responsible for administering environmental regulations, and shall provide oversight, interpretation and guidance, and shall update the regulations as required. The Assistant Secretary shall also maintain liaison with other Federal agencies on matters of environmental policy implementation.

(b) *Assistant Secretary for Policy Development and Research.* The Assistant Secretary for Policy Development and Research shall undertake research and demonstration studies necessary for the technical development of environmental standards, criteria, and implementing techniques as a basis for the development and implementation of environmental regulations. The Assistant Secretary shall also maintain liaison with Federal agencies on related technical matters.

(c) *Other Assistant Secretaries, Administrators, and the General Counsel.* Other Assistant Secretaries, Administrators, and the General Counsel shall:

(1) Incorporate adopted environmental regulations by reference into program regulations, guidance documents, and administrative forms and procedures;

(2) Evaluate the effects of, and compliance with Departmental environmental regulations policy and report significant issues and problems to the Assistant Secretary for Community Planning and Development; and

(3) Identify program areas under their jurisdiction in which additional

environmental regulations are needed, and refer them to the Assistant Secretary for Community Planning and Development.

(d) *Regional Administrators, Area Office Managers and Service Office Supervisors.* Regional Administrators, Area Office Managers and Service Office Supervisors shall assure that adopted environmental regulations are implemented in relation to program decisions and recommendations. They shall also monitor projects to assure that mitigation measures are implemented.

§ 51.4 Program coverage.

Environmental standards shall apply to all HUD actions except where special provisions and exemptions are contained in each Subpart.

§ 51.5 Coordination with environmental clearance requirements.

Environmental standards shall be implemented prior to commitment in the decision-making process and, where environmental clearances are required, the decision points shall be identical. Compliance with HUD environmental standards shall be addressed in the environmental clearance process.

§ 51.6 [Reserved]

Subpart B—Noise Abatement and Control

§ 51.100 Purpose and authority.

(a) *Purpose.* The Department of Housing and Urban Development finds that noise is a major source of environmental pollution which represents a threat to the serenity and quality of life in population centers and that noise exposure may be a cause of adverse physiological and psychological effects as well as economic losses.

It is the purpose of this Subpart to:

(1) Call attention to the threat of noise pollution;

(2) Encourage the control of noise at its source in cooperation with other Federal departments and agencies;

(3) Encourage land use patterns for housing and other noise sensitive urban needs that will provide a suitable separation between them and major noise sources;

(4) Generally prohibit HUD support for new construction of noise sensitive uses on sites having unacceptable noise exposure;

(5) Provide policy on the use of structural and other noise attenuation measures where needed; and

(6) Provide policy to guide implementation of various HUD programs.

(b) *Authority.* Specific authorities for noise abatement and control are contained in:

(1) The Noise Control Act of 1972 (Pub. L. 92–574) which directs Federal agencies to administer their programs in ways which reduce noise pollution.

(2) The Quiet Communities Act of 1978 (Pub. L. 95–609) which amended Pub. L. 92–574.

(3) The General Services Administration, Federal Management Circular 75–2: *Compatible Land Uses at Federal Airfields* prescribes the Executive Branch's general policy with respect to achieving compatible land uses on either public or privately owned property at or in the vicinity of Federal airfields.

(4) Section 1113 of the Housing and Urban Development Act of 1965 (Pub. L. 89–117) directs the Secretary "* * * to determine feasible methods of reducing the economic loss and hardships suffered by homeowners as a result of the depreciation in the value of their properties following the construction of airports in the vicinity of their homes, including a study of feasible methods of insulating such homes from the noise of aircraft."

§ 51.101 General policy.

(a) It is HUD's general policy to provide minimum national standards applicable to HUD programs to protect citizens against excessive noise in their communities and places of residence.

(1) *Comprehensive planning assistance.* HUD requires that grantees give adequate consideration to noise exposures and sources of noise as an integral part of the urban environment in HUD assisted comprehensive planning, as follows:

(i) Particular emphasis shall be placed on the importance of compatible land use planning in relation to airports, highways and other sources of high noise.

(ii) Applicants shall take into consideration HUD environmental standards impacting the use of land as required in 24 CFR Part 600.

(iii) Environmental studies, including noise assessments, are allowable costs.

(2) *Community Development Block Grants.* Recipients of community development block grants under the Housing and Community Development Act of 1974 (Pub. L. 93–383), as amended by the Housing and Community Development Act of 1977 (Pub. L. 95–128), must take into consideration the noise criteria and standards in the environmental review process and consider ameliorative actions when noise sensitive land development is proposed in noise exposed areas. Grant recipients shall address deviations from the standards in their environmental reviews as required in 24 CFR Part 58.

Where CDBG activities are planned in a noisy area, and HUD assistance is contemplated later for housing and/or other noise sensitive activities, the CDBG grantee risks denial of the HUD assistance unless the HUD standards are met. Environmental studies, including noise assessments, are allowable costs.

(3) *HUD support for new construction.* HUD assistance for the construction of new noise sensitive uses is prohibited generally for projects with Unacceptable noise exposures and is discouraged for projects with Normally Unacceptable noise exposure. (Standards of acceptability are contained in § 51.103(c).) This policy applies to all HUD programs providing assistance; subsidy or insurance for housing, college housing, mobile home parks, nursing homes, hospitals, and all programs providing assistance or insurance for land development, new communities, redevelopment or any other provision of facilities and services which are directed to making land available for housing or noise sensitive development. The policy does not apply to research demonstration projects which do not result in new construction or reconstruction, flood insurance, interstate land sales registration, or any action or emergency assistance under disaster assistance programs which are provided to save lives, protect property, protect public health and safety, remove debris and wreckage, or assistance provided that has the effect of restoring facilities substantially as they existed prior to the disaster.

(4) *HUD support for existing construction.* Noise exposure by itself will not result in the denial of HUD support for the resale and purchase of otherwise acceptable existing buildings. However, environmental noise is a marketability factor which HUD will consider in determining the amount of insurance or other assistance that may be given.

(5) *HUD support of modernization and rehabilitation.* For modernization projects located in all noise exposed areas, HUD shall encourage noise attenuation features in alterations. For major or substantial rehabilitation projects in the Normally Unacceptable and Unacceptable noise zones, HUD actively shall seek to have project sponsors incorporate noise attenuation features, given the extent and nature of the rehabilitation being undertaken and the level or exterior noise exposure. In

Unacceptable noise zones, HUD shall strongly encourage conversion of noise-exposed sites to land uses compatible with the high noise levels.

(6) *Research, guidance and publications.* HUD shall maintain a continuing program designed to provide new knowledge of noise abatement and control to public and private bodies, to develop improved methods for anticipating noise encroachment, to develop noise abatement measures through land use and building construction practices, and to foster better understanding of the consequences of noise. It shall be HUD's policy to issue guidance documents periodically to assist HUD personnel in assigning an acceptability category to projects in accordance with noise exposure standards, in evaluating noise attenuation measures, and in advising local agencies about noise abatement strategies. The guidance documents shall be updated periodically in accordance with advances in the state-of-the-art.

(7) *Construction equipment, building equipment and appliances.* HUD shall encourage the use of quieter construction equipment and methods in population centers, the use of quieter equipment and appliances in buildings, and the use of appropriate noise abatement techniques in the design of residential structures with potential noise problems.

(8) *Exterior noise goals.* It is a HUD goal that exterior noise levels do not exceed a day-night average sound level of 55 decibels. This level is recommended by the Environmental Protection Agency as a goal for outdoors in residential areas. The levels recommended by EPA are not standards and do not take into account cost or feasibility. For the purposes of this regulation and to meet other program objectives, sites with a day-night average sound level of 65 and below are acceptable and are allowable (see Standards in § 51.103(c)).

(9) *Interior noise goals.* It is a HUD goal that the interior auditory environment shall not exceed a day-night average sound level of 45 decibels. Attenuation measures to meet these interior goals shall be employed where feasible. Emphasis shall be given to noise sensitive interior spaces such as bedrooms. Minimum attenuation requirements are prescribed in § 51.104(a).

(10) *Acoustical privacy in multifamily buildings.* HUD shall require the use of building design and acoustical treatment to afford acoustical privacy in multifamily buildings pursuant to requirements of the Minimum Property Standards.

§ 51.102 Responsibilities.

(a) *Authority to approve projects.* (1) Decisions on proposed projects with acceptable noise exposures shall be delegated to the program personnel within field offices, including projects where increased noise levels are considered acceptable because of non-acoustic benefits under § 51.105(a). Field office program personnel may also approve projects in normally unacceptable noise exposed areas where adequate sound attenuation is provided and where the project does not require an Environmental Impact Statement under § 51.104(b).

(2) Other approvals in normally unacceptable noise exposed areas require the concurrence of the Regional Administrator.

(3) Requests for approvals of projects or portions of projects with unacceptable noise exposures shall be referred through the Regional Office to the Assistant Secretary for Community Planning and Development for approval pursuant to § 51.104(b).

(4) In cases where the Regional Administrator determines that an important precedent or issue is involved, such cases shall be referred with recommendations to the Assistant Secretary for Community Planning and Development.

(b) *Surveillance of noise problem areas.* Appropriate field staff shall maintain surveillance of potential noise problem areas and advise local officials, developers, and planning groups of the unacceptability of sites because of noise exposure at the earliest possible time in the decision process. Every attempt shall be made to insure that applicants' site choices are consistent with the policy and standards contained herein.

(c) *Notice to applicants.* At the earliest possible stage, HUD program administrators shall:

(1) Determine the suitability of the acoustical environment of proposed projects;

(2) Notify applicants of any adverse or questionable situations; and

(3) Assure that prospective applicants are apprised of the standards contained herein so that future site choices will be consistent with these standards.

(d) *Technical assistance.* Technical assistance in the measurement, estimation, interpretation, or prediction of noise exposure is available from the Office of Community Planning and Development and the Office of Policy Development and Research. Field office questions shall be forwarded through the Regional Office to the Assistant Secretary for Community Planning and Development or his designee.

(e) *Interdepartmental coordination.* Regional Administrators shall foster appropriate coordination between field offices and other departments and agencies, particularly the Environmental Protection Agency, the Department of Transportation, Department of Defense representatives, and the Veterans Administration. HUD staff shall utilize the acceptability standards in commenting on the prospective impacts of transportation facilities and other noise generators in the Environmental Impact Statement review process.

§ 51.103 Criteria and standards.

These standards apply to all programs as indicated in § 51.101.

(a) *Measure of external noise environments.* The magnitude of the external noise environment at a site is determined by the value of the day-night average sound level produced as the result of the accumulation of noise from all sources contributing to the external noise environment at the site. Day-night average sound level, abbreviated as DNL and symbolized as L_{dn}, is the 24-hour average sound level, in decibels, obtained after addition of 10 decibels to sound levels in the night from 10 p.m. to 7 a.m. Mathematical expressions for average sound level and day-night average sound level are stated in the Appendix.

(b) *Loud impulsive sounds.* On an interim basis, when loud impulsive sounds, such as explosions or sonic booms, are experienced at a site, the day-night average sound level produced by the loud impulsive sounds alone shall have 8 decibels added to it in assessing the acceptability of the site (see Appendix). Alternatively, the C-weighted day-night average sound level (L_{Cdn}) may be used without the 8 decibel addition, as indicated in Section 51.106(a)(3).

Methods for assessing the contribution of loud impulsive sounds to day-night average sound level at a site and mathematical expressions for determining whether a sound is classed as "loud impulsive" are provided in the Appendix.

(c) *Exterior standards.* The degree of acceptability of the noise environment at a site is determined by the sound levels external to buildings or other facilities containing noise sensitive uses. The standards shall usually apply at a location 2 meters (6.5 feet) from the building housing noise sensitive activities in the direction of the predominant noise source. Where the

ding location is undetermined, the standards shall apply 2 meters (6.5 feet) from the building setback line nearest to the predominant noise source. The standards shall also apply at other locations where it is determined that quiet outdoor space is required in an area ancillary to the principal use on the site.

The noise environment inside a building is considered acceptable if (a) the noise environment external to the building complies with these standards, and (b) the building is constructed in a manner common to the area or, if of uncommon construction, has at least the equivalent noise attenuation characteristics.

Site Acceptability Standards

	Day-night average sound level (in decibels)	Special approvals and requirements
Acceptable	Not exceeding 65 dB(1)	None
Normally Unacceptable	Above 65 dB but not exceeding 75 dB	Special Approvals (2) Environmental Review (3) Attenuation (4)
Unacceptable	Above 75 dB	Special Approvals (2) Environmental Review (3) Attenuation (5)

Notes.—(1) Acceptable threshold may be shifted to 70 dB in special circumstances pursuant to Section 51.105(a).
(2) See Section 51.104(b) for requirements.
(3) See Section 51.104(b) for requirements.
(4) 5 dB additional attenuation required for sites above 65 dB but not exceeding 70 dB and 10 dB additional attenuation required for sites above 70 dB but not exceeding 75 dB. (See Section 51.104(a).)
(5) Attenuation measures to be submitted to the Assistant Secretary for CPD for approval on a case-by-case basis.

§ 51.104 Special requirements.

(a) *Noise attenuation.* Noise attenuation measures are those required in addition to attenuation provided by buildings as commonly constructed in area, and requiring open windows ventilation. Measures that reduce external noise at a site shall be used wherever practicable in preference to the incorporation of additional noise attenuation in buildings. Building designs and construction techniques that provide more noise attenuation than typical construction may be employed also to meet the noise attenuation requirements.

(1) *Normally Unacceptable noise zone.* Approvals in this zone require a minimum of 5 decibels additional sound attenuation for buildings having noise-sensitive uses if the day-night average sound level is greater than 65 decibels but does not exceed 70 decibels, or a minimum of 10 decibels of additional sound attenuation if the day-night average sound level is greater than 70 decibels but does not exceed 75 decibels.

(2) *Unacceptable noise zone.* Noise attenuation measures require the approval of the Assistant Secretary for Community Planning and Development. (See § 51.104(b)(2).)

(b) *Special Approvals and Environmental Review Requirements.* Environmental clearances shall be conducted pursuant to the requirements HUD's Departmental Policies, Responsibilities and Procedures for Protection and Enhancement of Environmental Quality (38 FR 19182 as amended) or other environmental regulations which may be issued by the Department. The Special Clearance and Environmental Impact Statement (EIS) threshold requirements are hereby modified for all projects proposed in the Normally Unacceptable and Unacceptable noise exposure zones as follows:

(1) *Normally Unacceptable noise zone.* (i) All projects located in the Normally Unacceptable Noise Zone require a Special Environmental Clearance except an EIS is required for a proposed project located in a largely undeveloped area, or where the HUD action is likely to encourage the establishment of incompatible land use in this noise zone.

(ii) When an EIS is required, the concurrence of the Regional Administrator is also required before a project can be approved. For the purposes of this paragraph, an area will be considered as largely undeveloped unless the area within a 2-mile radius of the project boundary is more than 50 percent developed for urban uses and infrastructure (particularly water and sewers) is available and has capacity to serve the project.

(iii) All other projects in the Normally Unacceptable zone require a Special Environmental Clearance, except where an EIS is required for other reasons pursuant to HUD environmental policies.

(2) *Unacceptable noise zone.* An EIS is required prior to the approval of projects with unacceptable noise exposure. Projects in or partially in an Unacceptable Noise Zone shall be submitted through the Regional Administrator to the Assistant Secretary for Community Planning and Development for approval. The Assistant Secretary may waive the EIS requirement in cases where noise is the only environmental issue and no outdoor sensitive activity will take place on the site. In such cases, a Special Environmental Clearance is required.

§ 51.105 Exceptions.

(a) *Flexibility for non-acoustic benefits.* Where it is determined that program objectives cannot be achieved on sites meeting the acceptability standard of 65 decibels, the Acceptable Zone may be shifted to L_{dn} 70 on a case-by-case basis if all the following conditions are satisfied:

(1) The project does not require an Environmental Impact Statement under provisions of section 104(b)(1) and noise is the only environmental issue.

(2) The project has received a Special Environmental Clearance and has received the concurrence of the Environmental Clearance Officer.

(3) The project meets other program goals to provide housing in proximity to employment, public facilities and transportation.

(4) The project is in conformance with local goals and maintains the character of the neighborhood.

(5) The project sponsor has set forth, reasons, acceptable to HUD, as to why the noise attenuation measures that would normally be required for new construction in the L_{dn} 65 to L_{dn} 70 zone cannot be met.

(6) Other sites which are not exposed to noise above L_{dn} 65 and which meet program objectives are generally not available.

The above factors shall be documented and made part of the project file.

§ 51.106 Implementation.

(a) *Use of available data.* HUD field staff shall make maximum use of noise data prepared by others when such data are determined to be current and adequately projected into the future and are in terms of the following:

(1) *Sites in the vicinity of airports.* The noise environment around airports is described sometimes in terms of Noise Exposure Forecasts, abbreviated as NEF or, in the State of California, as

Community Noise Equivalent Level, abbreviated as CNEL. The noise environment for sites in the vicinity of airports for which day-night average sound level data are not available may be evaluated from NEF or CNEL analyses using the following conversions to DNL:

DNL≃NEF+35
DNL≃CNEL

(2) *Sites in the vicinity of highways.* Highway projects receiving Federal aid are subject to noise analyses under the procedures of the Federal Highway Administration.

Where such analyses are available they may be used to assess sites subject to the requirements of this standard. The Federal Highway Administration employs two alternate sound level descriptors: (a) The A-weighted sound level not exceeded more than 10 percent of the time for the highway design hour traffic flow, symbolized as L_{10}; or (b) the equivalent sound level for the design hour, symbolized as L_{eq}. The day-night average sound level may be estimated from the design hour L_{10} or L_{eq} values by the following relationships, provided heavy trucks do not exceed 10 percent of the total traffic flow in vehicles per 24 hours and the traffic flow between 10 p.m. and 7 a.m. does not exceed 15 percent of the average daily traffic flow in vehicles per 24 hours:

DNL≃L_{10} (design hour)—3 decibels
DNL≃L_{eq} (design hour) decibels

Where the auto/truck mix and time of day relationships as stated in this Section do not exist, the HUD Noise Assessment Guidelines or other noise analysis shall be used.

(3) *Sites in the vicinity of installations producing loud impulsive sounds.* Certain Department of Defense installations produce loud impulsive sounds from artillery firing and bombing practice ranges. Noise analyses for these facilities sometimes encompass sites that may be subject to the requirements of this standard. Where such analyses are available they may be used on an interim basis to establish the acceptability of sites under this standard.

The Department of Defense uses day-night average sound level based on C-weighted sound level, symbolized L_{Cdn}, for the analysis of loud impulsive sounds. Where such analyses are provided, the 6 decibel addition specified in 51.103(b), is not required, and the same numerical values of day-night average sound level used on an interim basis to determine site suitability for non-impulsive sounds apply to the L_{Cdn}.

(4) *Use of areawide acoustical data.* HUD encourages the preparation and use of areawide acoustical information, such as noise contours for airports. Where such new or revised contours become available for airports (civil or military) and military installations they shall first be referred to the Regional Office (Environmental Clearance Officer) for review, evaluation and decision on appropriateness for use by HUD. The Regional Office shall submit revised contours to the Assistant Secretary of Community Planning and Development for review, evaluation and decision whenever the area affected is changed by 20 percent or more, or whenever it is determined that the new contours will have a significant effect on HUD programs, or whenever the contours are not provided in a methodology acceptable under § 51.106(a)(1) or in other cases where the Regional Office determines that Headquarters review is warranted. For other areawide acoustical data, review is required only where existing areawide data are being utilized and where such data have been changed to reflect changes in the measurement methodology or underlying noise source assumptions. Requests for determination on usage of new or revised areawide data shall include the following:

(i) Maps showing old, if applicable, and new noise contours, along with brief description of data source and methodology.

(ii) Impact on existing and prospective urbanized areas and on development activity.

(iii) Impact on HUD-assisted projects currently in processing.

(iv) Impact on future HUD program activity. Where a field office has determined that immediate approval of new areawide data is necessary and warranted in limited geographic areas, the request for approval should state the circumstances warranting such approval. Actions on proposed projects shall not be undertaken while new areawide noise data are being considered for HUD use except where the proposed location is affected in the same manner under both the old and new noise data.

(b) *Site assessments.* Compliance with the standards contained in § 51.103(c) shall, where necessary, be determined using noise assessment guidelines, handbooks, technical documents and procedures issued by the Department.

(c) *Variations in site noise levels.* In many instances the noise environment will vary across a site, with portions of the site being in an Acceptable noise environment and other portions in a Normally Unacceptable noise environment. The standards in § 51.103(c) shall apply to the portions of a building or buildings used for residential purposes and for ancillary noise sensitive open spaces.

(d) *Noise measurements.* Where noise assessments result in a finding that the site is borderline or questionable, or is controversial, noise measurements may be performed. Where it is determined that noise measurements are required, such measurements will be conducted in accordance with methods and measurement criteria established by the Department. Locations for noise measurements will depend on the location of noise sensitive uses that are nearest to the predominant noise source (see § 51.103(c)).

(e) *Projections of noise exposure.* In addition to assessing existing exposure, future conditions should be projected. To the extent possible, noise exposure shall be projected to be representative of conditions that are expected to exist at a time at least 10 years beyond the date of the project or action under review.

(f) *Reduction of site noise by use of berms and/or barriers.* If it is determined by adequate analysis that a berm and/or barrier will reduce noise at a housing site, and if the barrier is existing or there are assurances that it will be in place prior to occupancy, the environmental noise analysis for the site may reflect the benefits afforded by the berm and/or barrier.

In the environmental review process under § 51.104(b), the location height and design of the berm and/or barrier shall be evaluated to determine its effectiveness, and impact on design and aesthetic quality, circulation and other environmental factors.

Appendix—definition of acoustical quantities

1. *Sound Level.* The quantity in decibels measured with an instrument satisfying requirements of American National Standard Specification for Type 1 Sound Level Meters S1.4–1971. Fast time-averaging and A-frequency weighting are to be used, unless others are specified. The sound level meter with the A-weighting is progressively less sensitive to sounds of frequency below 1,000 hertz (cycles per second), somewhat as is the ear. With fast time averaging the sound level meter responds particularly to recent sounds almost as quickly as does the ear in judging the loudness of a sound.

2. *Average Sound Level.* Average sound level, in decibels, is the level of the mean-square A-weighted sound pressure during the stated time period, with reference to the square of the standard reference sound pressure of 20 micropascals.

Day-night average sound level, abbreviated as DNL and symbolized mathematically as L_{dn} is defined as:

$$L_{dn} = 10 \log_{10}\left[\frac{1}{86400}\left(\int_{0000}^{0700} 10^{[L_A(t)+10]/10}\,dt + \int_{0700}^{2200} 10^{L_A(t)/10}\,dt + \int_{2200}^{2400} 10^{[L_A(t)+10]/10}\,dt\right)\right]$$

Time t is in seconds, so the limits shown in hours and minutes are actually interpreted in seconds. $L_A(t)$ is the time varying value of A-weighted sound level, the quantity in decibels measured by an instrument satisfying requirements of American National Standard Specification for Type 1 Sound Level Meters S1.4–1971.

3. *Loud Impulsive Sounds.* When loud impulsive sounds such as sonic booms or explosions are anticipated contributors to the noise environment at a site, the contribution to day-night average sound level produced by the loud impulsive sounds shall have 8 decibels added to it in assessing the acceptability of a site.

A loud impulsive sound is defined for the purpose of this regulation as one for which:

(i) The sound is definable as a discrete event wherein the sound level increases to a maximum and then decreases in a total time interval of approximately one second or less to the ambient background level that exists without the sound; and

(ii) The maximum sound level (obtained with slow averaging time and A-weighting of a Type 1 sound level meter whose characteristics comply with ANSI S1.4–1971) exceeds the sound level prior to the onset of the event by at least 6 decibels; and

(iii) The maximum sound level obtained with fast averaging time of a sound level meter exceeds the maximum value obtained with slow averaging time by at least 4 decibels.

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Patricia Roberts Harris,

Secretary of Housing and Urban Development.

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NEW JERSEY STATE
DEPARTMENT OF ENVIRONMENTAL PROTECTION
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7:29-1.1 DEFINITIONS

Commercial Operation: Any facility or property used for the purchase or utilization of goods, services, or land or its facilities, including but not limited to:

(a) Commercial Dining Establishments

(b) Non-commercial Vehicle Operations

(c) Retail Services

(d) Wholesale Services

(e) Banks and Office Buildings

(f) Recreation and Entertainment

(g) Community Services

(h) Public Services

(i) Other Commercial Services

Commercial Motor Vehicle Operation: Any facility or property used primarily for the dispatching, garaging, servicing, maintaining, selling, or leasing of any truck registered at a gross weight in excess of 6,000 pounds, omnibus, tractor, trailer, semitrailer, pole-trailer, or any vehicle registered in this State engaged in interstate commerce which is now or hereafter subject to regulation and license by the Interstate Commerce Commission and/or the Bureau of Motor Carrier Safety of the Federal Highway Administration.

Continuous Airborne Sound: Sound that is measured by slow response setting of sound level meter.

Decibel: A unit for measuring the volume of a sound, equal to the logarithm of the ratio of the sound pressure of the sound, to the sound pressure of a standard sound (.0002 microbars): abbreviated "dB".

dBA: The measured sound level expressed in dB when using the "A" weighted network of a sound level meter.

Emergency Energy Release Device: Emergency safety devices expressly used to release excess energy which do not have regularly scheduled operation. Process control devices are not to be considered emergency devices.

Frequency: The number of oscillations per second; expressed in hertz (abbreviation Hz).

Impulsive Sound: Either a single pressure peak or a single burst (multiple pressure peaks) for a duration less than one second.

Impulsive Sound Level: The maximum instantaneous sound pressure level measured by an impulse sound level meter meeting IEC - Publication 179 or the latest revision thereof.

Industrial Operation: Any facility or property used for the following:

(a) Storage, Warehouse or Distribution, provided that said operation shall not be construed to be an industrial operation when it is part of a commercial motor vehicle operation as defined herein.

(b) Property used for the production and fabrication of durable and nondurable manmade goods.

(c) Activities carried out on the property.

IEC: International Electrotechnic Commission

Octave Band Sound Pressure Level: Sound pressure level measured in standard octave bands with sound level meter and octave band analyser that meet ANSI S 1.4 & S 1.11 or the latest revision thereof.

Person: Any individual, public or private corporation, political subdivision, governmental agency, department or bureau of the State, municipality, industry, co-partnership, association.

Residential Property: Property used for human habitation, including but not limited to the following:

(a) Commercial Living Accomodations, commercial property used for human habitation.

(b) Recreational and entertainment property used for human habitation.

(c) Community service property used for human habitation.

Sound Level: The measured level of a sound, expressed in dB re 0.0002 microbar, obtained using a sound level meter. Sound levels include all factors inherent in measuring with a sound level meter including microphone frequency response, amplifier characteristics, meter damping, observer effects, and weighting networks.

Sound Pressure Level: The sound pressure level, in decibels, of a sound is 20 times the logarithm to the base 10 of the ratio of the pressure of the sound to the reference sound pressure. Sound pressure level is measured with a sound level meter meeting ANSI - S 1.4 or the latest revision thereof.

Stationary Emergency Signaling Device: Any device, excluding those attached to motor vehicles, used to alert persons engaged in emergency operations. These include but are not limited to fire fighters, first aid squad members and law enforcement officers, whether paid or volunteer.

(a) Upon effective date of this code, no person shall cause, suffer, allow or permit sound from any industrial or commercial operation which when measured at any residential property line is in excess of any of the following:

1 From 7:00 A.M. to 10:00 P.M.

i Continuous airborne sound which has sound level in excess of 65 dBA, or

ii Continuous airborne sound which has an octave band sound pressure level in decibels which exceeds the values listed below in one or more octave bands.

Octave Band Center Frequency (Hz)	Octave Band Sound Pressure Level (dB)
31.5	96
63	82
125	74
250	67
500	63
1000	60
2000	57
4000	55
8000	53

or,

iii impulsive sound in air which has an impulsive sound level in excess of 80 decibels.

2 From 10:00 P.M. to 7:00 A.M.

i Continuous airborne sound which has a sound level in excess of 55 dBA, or

ii Continuous airborne sound which has an octave band sound pressure level in decibels which exceeds the values listed below in one or more octave bands:

Octave Band Center Frequency (Hz)	Octave Band Sound Pressure Level (dB)
31.5	89
63	75
125	65

500	53
1000	50
2000	47
4000	45
8000	43

or,

iii Impulsive sound in air which has an impulsive sound level in excess of 80 decibels.

3 No person shall cause, suffer, allow or permit sound from any industrial or commercial operation, which when measured at the property line of any other commercial operation is in excess of any of the following:

i Continuous airborne sound which has a sound level in excess of 65 dBA, or

ii Continuous airborne sound which has an octave band sound pressure level in decibels which exceeds the values listed below in one or more octave bands.

Octave Band Center Frequency (Hz)	Octave Band Sound Pressure Level (dB)
31.5	96
63	82
125	74
250	67
500	63
1000	60
2000	57
4000	55
8000	53

or,

iii Impulsive sound in air which has an impulsive sound level in excess of 80 decibels.

4 Starting January 1, 1976, Section 2 shall be superseded by the following:

i From 10:00 P.M. to 7:00 A.M.

(1) Continuous airborne sound which has a sound level in excess of 50 dBA, or

(2) Continuous airborne sound which has an octave band sound

values listed below in one or more octave bands.

Octave Band Center Frequency (Hz)	Octave Band Sound Pressure Level (dB)
31.5	86
63	71
125	61
250	53
500	48
1000	45
2000	42
4000	40
8000	38

or,

(3) Impulsive sound in air which has an impulsive sound level in excess of 80 decibels.

7:29-1.3 Stationary Emergency Signaling Devices

Upon the effective date of this code:

i Testing of only the electromechanical functioning of a stationary emergency signaling device shall occur at the same time each day that a test is performed, but not before 8:00 A.M. or after 8:00 P.M. Any such testing shall only use the minimum cycle test time. In no case shall such test time exceed 10 seconds.

ii Testing of the complete emergency signaling system including the electromechanical functioning of the signaling device and the personnel response to the signal shall not occur more than once in each calendar month. Such testing shall not occur before 8:00 A.M. or after 8:00 P.M. The 10 second time limit on the electromechanical functioning of the signaling device shall not apply to such system testing.

(1) Stationary emergency signaling devices shall be used only for testing in compliance with applicable provisions of these regulations and for emergency purposes where personnel

and equipment are mobilized.

7:29-1.4 Exceptions

The operational performance standards established in this chapter shall not apply to any of the following noise sources:

1 Agriculture

2 Bells, chimes or carillons while being used in conjunction with religious services

3 Commercial motor vehicle operations

4 Emergency energy release devices

5 Emergency work to provide electricity, water, or other public utilities when public health or safety are involved

6 Motor vehicle race tracks

7 National Warning System (NAWAS) - Systems used to warn the community of attack or imminent public danger such as flooding or explosion. These systems are controlled by the N.J. Civil Defense & Disaster Control Agency.

8 Noise of aircraft flight operations

9 Public celebrations

10 Public roadways

11 Surface carriers engaged in commerce by railroad

12 The unamplified human voice

13 Use of explosive devices - These are regulated by the N.J. Department of Labor & Industry under the 1960 Explosive Act (R.S. 21:1A-1-27).

7:29-1.5 Performance Test Principle

For the purposes of measuring sound in accordance with the applicable provisions of these regulations, test equipment methods and procedures shall conform to standards as published by the Department or its approved equivalent.

GLOSSARY

Defined below are terms which have been used in this report. Each term is followed where appropriate, by the abbreviated designation of the term and/or the units. The terms have been defined as technically correct but not in strict technical terminology. They are defined for comprehension by the user of this report.

Metric units are used with the english units in brackets.

Full technical definitions can be found by refering to ANSI Standard S1.1 on terminology or to ASTM Designation: C 634 on definitions.

Absorption - (see Sound absorption)

Addition (decibel) - (see Decibel addition)

Air-borne sound - Sound which reaches the receiver (listener) by traveling mainly through the air.

Ambient noise - The all-encompassing noise associated with a given environment. This is usually a composite of sounds from many sources, near and far. No particular sound is dominant.

American National Standards Institute (ANSI) - A standards setting body which involves a large number of technical and professional societies. The Acoustical Society of America is responsible for the acoustical activity.

Average - The "energy" average of a series of discrete levels obtained by taking the sum of the anti-logs of one-tenth of the levels, dividing by the number of discrete levels and taking 10 times the logarithm of the result. This average is used for sound levels, sound pressure levels and sound power levels.

A-weighted sound level (dBA) - The sound level which is measured using the A-weighting network of a sound level meter or other acoustical instrument. It can also be computed from octave or 1/3-octave band sound pressure levels that have been adjusted for A-weighting.

A-weighting - A frequency network which reduces the importance of low frequencies in a manner similar to the human hearing mechanism. The network is standardized and is contained in sound level meters and other acoustical instruments.

Background noise - Noise from all sources other than the particular sound that is of interest (e.g., the sound other than that being measured, the sound other than the speech being listened to, etc.).

Day-night sound level (L_{dn}, dB) - The equivalent sound level calculated for a 24-hour period with a 10 decibel penalty during nighttime hours. This penalty is to account for the increased sensitivity of people to sound during nighttime hours (2100 hrs to 0700 hrs).

Decibel (dB) - The label used for levels in acoustics. It is 10 times the logarithm of the ratio of the acoustical properties which are being described. The properties must be proportional to power.

Decibel addition - The total of a series of discrete levels obtained by taking the sum of the anti-logs of one-tenth of the levels and taking 10 times the logarithm of the result. This sum is used for sound levels, sound pressure levels and sound power levels.

Energy average - (see Average)

Equivalent sound level (L_{eq}, dB) - The sound level which describes the energy contained in a fluctuating sound level over a certain period of time. Any time frame may be considered e.g., one minute, one hour, or one day.

Frequency (f, Hz) - The time rate of repetition of a period phenomena, such as a sound wave. The unit of frequency is the hertz (Hz), which corresponds to one cycle per second. The frequency is the reciprocal of the period.

Integration time (sec) - The time over which a sound being measured is integrated. For a standard sound measuring instruments two times have been agreed upon: fast and slow. The fast integration time is about 0.25 second, and the slow integration time is about 1.0 second.

Loudness (sones) - A subjective attribute of sound. A doubling or halving of loudness represents a change of about 10 decibels. The loudness depends on the sound pressure level of the sound and the frequency content.

Noise - Unwanted sound. This term is loosely used for sound. A sound can be noise at times and not at others.

Noise reduction (NR, dB) - The arithmetic difference in decibels between the levels measured on either side of a noise control device. This could be a muffler in a duct system, a barrier, or a wall separating two spaces.

rms (root-mean-square) - The square root of the time-weighted average of the squared value of a time-varying phenomena. It is the "effective" value of the physical quantity. The most commonly known example is ordinary electrical power where the rms value of voltage is about 115 volts whereas the actual voltage varies as a sine wave over one cycle from plus 160 volts to minus 160 volts. Sound pressure levels are measured using rms quantities.

Slow - (see Integration time)

Sound absorption - The ability of a material such as glass fiber, mineral ceiling board, or people to absorb sound which is incident upon it.

Sound level (dB) - A sound pressure level which is measured using a standard weighting network contained in sound measuring instruments.

Sound level meter - A device built according to national (ANSI) or international (IEC) standards which is used to measure sound. The sound level meter generally contains one or more weighting networks which are designated A, B, C, and flat. The lettering of the weighting networks denotes, respectively, decreasing de-emphasis of the low frequency sounds.

Speed of sound (c, m(ft)/sec) - The rate at which a sound wave travels in a medium. In air the speed of sound is 344 m/sec (1120 ft/sec) and is a function of the temperature of the air. In steel the speed is 5029 m/sec (16 000 ft/sec) and in water is 1433 m/sec (4700 ft/sec).

Wave length (lambda, m[ft]) - For a sound consisting of a pure tone the distance traveled by the sound wave over one cycle. The wave length is the speed of sound divided by the frequency.