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Dickey-Lincoln School Lakes Project Environmental Impact Statement: Appendix H: Noise Impact Assessment

Stone & Webster Engineering Corporation

New England Division

United States Army Engineer Division

ENVIRONMENTAL IMPACT STATEMENT

DICKEY-LINCOLN SCHOOL LAKES

APPENDIX H

NOISE IMPACT ASSESSMENT

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
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NOISE IMPACT ASSESSMENT
DICKEY-LINCOLN SCHOOL LAKES
ARMY CORPS OF ENGINEERS

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1.0 INTRODUCTION

The noise impact assessment of the Dickey-Lincoln School Project consisted of establishing the ambient sound levels in the vicinity of the two dam sites, predicting the off-site noise levels expected from the construction and operation of the project, assessing the potential impact of noise on residents in the surrounding area, and evaluating noise control options to eliminate potential adverse noise impacts. The field survey to measure the ambient sound levels was conducted on December 13-16, 1976, using continuous automatic-monitoring equipment and manual hand-held equipment. The sound levels for construction and operation of the project were predicted based on information supplied by the Army Corps of Engineers and by Stone & Webster Engineering Corporation (S&W) personnel. The impact assessment was accomplished using the guidelines developed by the U. S. Environmental Protection Agency (EPA)[1] as requisite to protect public health and welfare.

2.0 SURVEY METHODOLOGY

2.1 Ambient Survey

U.S.G.S.[2,3] maps were reviewed prior to the survey to determine the different noise sensitive land areas and to tentatively select representative measurement locations in these areas. The specific measurement locations were chosen during the field surveys and all were accessible from public roads, so that continued access to each location was possible throughout the survey.

The areas of concern consisted of the villages of Allagash and St. Francis, the widely spaced residences along Route 161, the active and inactive timberland and the few permanent residences located away from Route 161. The villages typically consisted of several general stores, a couple of churches, a local school, and a residential area. Many of the residences along Route 161 between the villages of St. Francis and Allagash and all of the homes west of the Allagash River including those in the village of Dickey will have to be relocated due to construction of the project.

Thirteen measurement locations were selected as representative of the different noise sensitive areas within the project area. Measurement locations 4, 5, 12, & 13 represent the villages; 3, 6, 7, 8, & 11 are near single residences; 9 & 10 are along uninhabited stretches of roadway; and 1 & 2 are in the timberland. The thirteen measurement locations are shown on Figure 1 and are listed below:

Location 1 - Post 551, 552, Allagash
2 miles frcm Michaud Tote Road

Location 2 - Michaud Tote Road, Allagash
3.5 miles from Route 161

Location 3 - Maine Forest Service, Allagash
30 ft from Route 161

Location 4 - West end of Allagash Bridge, Allagash
20 ft from Route 161

Location 5 - Town Building, Allagash
20 ft from Route 161

Location 6 - Unused log road, Allagash
30 ft from Route 161

Location 7 - Gardiner House, Allagash
20 ft from Route 161

Location 8 - Army Corps of Engineers trailer, Allagash
600 ft from Route 161

Location 9 - Road between Allagash and St. Francis
20 ft from Route 161

Location 10 - Rankin Rapids Picnic Grounds, St. Francis
20 ft from Route 161

Location 11 - Lincoln School, St. Francis
20 ft from Route 161

Location 12 - St. Charles Church, St. Francis
20 ft from Route 161

Location 13 - St. Paul's Church, St. Francis
20 ft from Route 161

2.2 Sound Level Measurements

The measured ambient sound level data consisted of continuous, automatically-recorded statistical measurements and manually recorded 5 to 15 minute daytime statistical measurements. Both types of measurements provided percentile sound levels for evaluating the residual, average, intrusive, and equivalent sound levels for the measurement period. Continuous automatic monitoring allowed data acquisition over longer time periods than could be obtained with hand-held measurements and showed the diurnal variation in ambient sound levels. The manually recorded data included a record of the identifiable noise sources which was used with the statistical sound levels to provide a complete description of the ambient noise for the measurement location. The record of noise sources was used in evaluating the sound level data from the continuous monitor. The diurnal data from the continuous monitor were used to estimate the nighttime sound levels at those locations where only daytime manually recorded measurements were made.

2.3 Set-up and Measurement Procedure

The following procedures were followed at all measurement locations. Upon arrival at a location, the wind speed and direction were measured with a hand-held pitot tube wind-speed indicator and a compass, the temperature was recorded, and the sky conditions observed. Meteorological data were obtained for reference only and not used to apply corrections to the sound level data. The sound level measurement system was then set up by locating a microphone with a windscreen on a tripod approximately 5 ft in height and 12 ft or more away from any vertical sound reflecting surface. A cable connected the microphone to the sound level meter or monitor. The measurement system was calibrated at the beginning of each measurement. Care was taken by the field personnel to be as unobtrusive as possible and to avoid non-typical ambient conditions.

2.4 Manual Statistical Measurements

The hand-held statistical measurements followed a generally accepted method for approximating the statistical distribution of A-weighted sound levels. A detailed description of the equipment used is given in Exhibit 1. The microphone was connected by a 30 ft cable to the sound level meter located inside a vehicle. A stopwatch was used to time the measurements. With the sound level meter set on "slow response", the A-weighted sound level was read and recorded every 5 seconds. The sound levels were grouped into "windows", each 2 dB wide. If the 10 lowest readings were within three contiguous "windows", the measurement data were considered acceptable. If not, one or two additional 5 minute samples were taken to provide accurate data. While the samples were being collected, identifiable noise sources were observed and recorded.

2.5 Automatic Statistical Measurements

The continuous automatic monitoring system employed a community noise analyzer which is basically a sound level meter with a memory, a digital processor, and a LED numerical display. It is a completely self-contained instrument used to monitor noise and to calculate a variety of percentile levels as well as the equivalent sound level over selectable time periods (see Exhibit 1). The setup for instrumentation followed the standard procedures described above. The microphone was connected by a 70 ft cable to the monitor which was located inside a heated building or warm vehicle. Two sequential time periods were selected for the monitor; typically, six hour periods for the nighttime measurements and three hour periods for the daytime measurements. The start time for the first monitoring period was set so that personnel could leave the measurement location before monitoring started. After the monitoring periods were complete, personnel returned to the location and the accumulated statistical data were read directly off the monitor and recorded on data sheets.

2.6 Measurement Description

The continuous automatic monitoring system was used to obtain diurnal statistical sound level data at four locations typical of all residential areas within the project area. Measurements were made over 24 hour periods at Locations 3 and 8. Nighttime monitoring was conducted at Location 7, and daytime monitoring at Location 12. In addition, for a direct comparison with the automatically recorded data, two sets of hand-held measurements were made at Locations 3, 8, and 12. Hand-held measurements were not made at Location 7 since Location 6 was very close and could be used for comparison. At the remaining nine measurement locations, only hand-held measurements were made. Three sets of measurements were made at each of Locations 4, 5, 6, 9, 10, 11, and 13 at different times of the day to provide a variety of measurements typical of each location. Only one set of hand-held measurements was made at each of Locations 1 and 2, representing the timberland, since these measurements were made to determine the residual sound levels away from all man-made intruding noise sources.

3.0 AMBIENT SOUND LEVELS

A summary of the recorded statistical ambient sound level data is presented in Exhibit 2 along with measurement locations, time, date, observed noise sources, and meteorological conditions. The statistical sound level descriptions selected to describe the ambient sound levels include residual, average, intrusive, equivalent, and day-night equivalent sound levels. The minimum and maximum readings are also presented to show the range of sound levels measured. The residual sound levels are represented by the L_{90} percentile level, which is the sound level exceeded 90 percent of the time. The average and intrusive sound levels are represented by the L_{50} and L_{10} percentile levels, respectively. The equivalent sound level (L_{eq}) is the constant level that, for a given time period, conveys the same sound energy as the actual time varying A-weighted sound. The day-night equivalent sound level (L_{dn}) is the 24-hour A-weighted equivalent sound level with a 10 dB penalty applied to the nighttime levels from 10:00 P.M. to 7:00 A.M.

For the automatic monitoring system, percentile sound levels and L_{eq}'s were computed by the instrument and were read directly from the display in the field. For the hand-held measurement system, the data were recorded in the form of histograms from which percentile levels could be calculated. The L_{eq}'s for the hand-held data were calculated by taking the energy average of all sound levels recorded during the measurement period. One L_{dn} was calculated from the L_{eq}'s for each location. Sample calculations are presented in Part 1 of Exhibit 3.

The overall project area can be described as a natural area remote from any major industrial activity with low density residential areas in the villages and sparsely located residences along the main road. The only identifiable noise sources contributing to the L_{90} and L_{50} sound levels in the entire area were directly related to wind and water noise. In the villages, the average sound levels were also affected by human activity such as children at play and people talking, and by dogs barking. The L_{10}, L_{eq}, and L_{dn} sound levels were dominated by traffic noise in all but the timberland areas.

The L_{90} sound levels throughout the project area were in the range of 25 to 35 dBA. The L_{50} sound levels in the timberland, along uninhabited stretches of road, and near single residences were 30 to 40 dBA, and in the villages, 35 to 45 dBA. The L_{10} and L_{eq} sound levels were 55 to 65 dBA at 20 ft from Route 161, but dropped to 35 to 40 dBA at 600 ft from Route 161. The only noticeable difference between the daytime and nighttime sound levels was a 5 dB decrease from the daytime to the nighttime L_{50} sound levels along Route 161. The L_{dn}'s near all residences were estimated to be 65 dB, ranging from 60 to 70 dB at all measurement locations along Route 161.

A noticeable difference in character between the winter and summer ambient noise sources is anticipated in the project area. Insect noise and increased outdoor human activities are expected to increase the summer residual and average sound levels. Truck traffic during the summer is expected to be significantly reduced from that during the winter which will cause the summer maximum sound levels to be perhaps 10 to 15 dBA lower than the winter maximum sound levels. An increase in car traffic during the summer daytime with the reduced truck traffic is expected to keep the L_{10} percentile levels approximately the same as those measured during the winter. However, the change in traffic patterns could cause a reduction of approximately 10 dB in the equivalent sound levels to an average of 55 dB for the summer daytime. Since little or no nighttime traffic is expected during the summer, the summer nighttime equivalent sound levels should be more than 10 dB lower than the daytime levels. Therefore, the estimated summer L_{dn}'s would average 55 dB near all residences. The yearly average L_{dn}'s are assumed to be 60 dB near all residences for purposes of noise impact assessment.

4.0 CONSTRUCTION NOISE PREDICTIONS

Construction sound levels were predicted for earth moving and power house construction activities at both the Dickey and Lincoln School Dam sites. The predicted sound levels are based on the schedule of construction activities, the equipment list for each activity, and the usage factor and sound level for each piece of equipment. The results of the calculations are presented as L_{dn} contours, plotted in 5 dB increments. Construction sound levels at both dam sites were dominated by noise from pile driving and trucking activities.

Construction sound levels were predicted by first determining the time periods where the types and number of individual pieces of heavy equipment expected to be working on the dam site remained constant. This information was obtained from the project document entitled "Allocation of Labor Forces, March 1976" provided by the Army Corps of Engineers, and from S&W estimates of equipment schedules. The equipment usage factor is the estimated percentage of time that the equipment is working at the dam site at its normal condition. It is assumed that the equipment sound levels would meet the future sound level requirements of the General Services Administration (GSA)[4] for construction equipment on federal job sites. Typical octave band spectra for each type of equipment were used with the GSA equipment sound levels to obtain octave band sound pressure levels for each type of equipment.

The octave band data, usage factors, and number of pieces of each type of equipment expected to be working on the dam site were used to compute the most probable octave band sound pressure level spectrum for each phase of construction. These sound pressure level spectra were converted to sound power level spectra, centered at the power house, which were then logarithmically time-averaged over the duration of all major phases of construction to obtain the equivalent sound power level for all construction. The equivalent sound power level was then extrapolated from the center of construction assuming hemispherical divergence and atmospheric absorption at standard conditions. The L_{dn}'s were calculated from the L_{eq}'s by applying corrections based on the normal working schedule for each site. L_{dn}'s for the Dickey Dam site were based on a normal working schedule of 20 hours per day, six days per week. At the Lincoln School Dam site, the normal working schedule used was eight hours per day, five days per week. A sample of the calculation used to predict off-site construction sound levels is presented in Part 2 of Exhibit 3.

The effects of topography, vegetation, and meteorological conditions on sound propagation, which in most cases reduce far field sound levels, were not included in this calculation. Typically, the barrier effect of hills will reduce the sound levels behind the hill by 5 to 20 dB depending on the relative distances of the noise source and reciever to the barrier and the size of the barrier. Noise traveling directly through dense wood could be reduced by approximately 2 dB per 100 ft of woods. The effects of meteorological conditions on sound propagation can decrease sound levels at large distances upwind from the source by 10 to 20 dB. However, these decreases are usually of an intermittent nature and cannot be relied on for noise reduction.

4.1 Dickey Dam Site

Figure 2 shows the construction noise L_{dn} contours from the Dickey Dam site, superimposed on a map of the area. The predicted L_{dn} from construction activities at the nearest neighbor, 5,600 ft from the power house in Allagash village, is 53 dB. The L_{dn} is 55 dB at 4,800 ft from the power house, 50 dB at 7,500 ft, 45 dB at 11,500 ft, and 40 dB at 18,000 ft.

4.2 Lincoln School Dam Site

The construction noise L_{dn} contours from the Lincoln School Dam site are shown on Figure 3. At the nearest neighbor, 2,700 ft northeast of the power house, the predicted L_{dn} from construction activities is 46 dB. The L_{dn} is 55 dB at 1,100 ft, 50 dB at 2,000 ft, 45 dB at 3,150 ft, and 40 dB at 4,700 ft.

5.0 OPERATIONAL NOISE PREDICTIONS

Operational sound levels were predicted for power generation at the Dickey and Lincoln School Dam sites and pumped storage at the Dickey Dam site. The predicted sound levels were based on noise from the outdoor transformers, and indoor machinery and ventilation systems for each power house. The results of the calculations were presented as L_{dn} contours plotted in 5 dB increments. Operational sound levels at both dam sites were dominated by noise from the main transformers and the ventilation systems.

Operational sound levels were calculated for each major noise source. Noise from the transformers was based on the type and size of transformers specified by the Army Corps of Engineers for each dam site. It was assumed that the dominant noise source in the power house was the turbine generators. Sound levels for the turbine-generators were taken from a published report on hydro-electric plants.[5] Sound levels for the ventilation systems were based on standard ventilation equipment for power plant turbine buildings.

Equivalent sound power levels for generation at the Dickey and Lincoln School Dam sites and pumped storage at the Dickey Dam site were calculated as a composite of the major sources for each mode of operation, centered at the power house. The equivalent sound power levels were then extrapolated off-site, assuming hemispherical divergence and atmospheric absorption at standard conditions. The L_{dn}'s presented are yearly average L_{dn}'s and were calculated from the L_{eq}'s by applying corrections based on the annual operation schedule for each site. L_{dn}'s for the Dickey Dam site were based on a yearly average of 24 hr of generation per week during the weekday daytime hours and 42 hr of pumped storage per week equally split between nighttime and weekend daytime hours. At the Lincoln School Dam site, the annual capacity factor of 42 percent was used in calculating the L_{dn}'s, assuming that the capacity factor is applied equally to both daytime and nighttime operation. A sample of the calculation used to predict off-site operational sound levels is presented in Part 3 of Exhibit 3.

The effects of topography, vegetation, and meteorological conditions on sound propagation, which in most cases reduce far-field sound levels, were not included in this calculation. These effects were previously discussed in Section 4.0, Construction Noise Predictions.

5.1 Dickey Dam Site

Figure 4 shows the operational noise L_{dn} contours from the Dickey Dam site, superimposed on a map of the area. The predicted L_{dn} from operation at the nearest neighbor, 5,600 ft from the power house in Allagash village, is 41 dB. The L_{dn} is 55 dB at 1,400 ft from the power house, 50 dB at 2,500 ft, 45 dB at 3,800 ft, and 40 dB at 6,300 ft.

5.2 Lincoln School Dam Site

The operational noise L_{dn} contours from the Lincoln School Dam site are shown on Figure 5. At the nearest neighbor, 2,700 ft northeast of the power house, the predicted L_{dn} from operation is 43 dB. The L_{dn} is 55 dB at 900 ft, 50 dB at 1,400 ft, 45 dB at 2,400 ft, and 40 dB at 4,000 ft.

6.0 NOISE IMPACT ASSESSMENT

The guidelines outlined in the EPA's "Levels Document"(1) have been selected to assess the noise impact resulting from construction and operation of this project. The "Levels Document" identifies an outdoor L_{dn} of 55 dB and an indoor L_{dn} of 45 dB in residential areas as "the maximum levels below which no effects on public health and welfare occur due to interference with speech or other activity."(6) The "Levels Document" also provides a method for assessing the reaction or annoyance of a community to a new noise source based on the intruding and the existing L_{dn}'s.

The L_{dn}'s that are to be compared to the outdoor criteria of 55 dB are those levels shown on the construction and operational noise contours (Figures 2 through 5). The indoor L_{dn}'s are predicted by subtracting from the outdoor sound levels the attenuation resulting from sound traveling through the exterior shell of a house. Typical attenuation values are found in Table B-4 of the "Levels Document." An attenuation of 17 dB will be used for all cases in this project and is representative of a house in a northern climate with windows open.

The method for assessing community reaction to an intruding noise requires the normalization of the intruding noise to take into account the seasonal character of the intruding noise, the existing ambient outdoor noise environment, the previous exposure and community attitudes to the source, and the pure tone or implusive character of the intruding noise. This procedure is outlined in detail in Appendix D of the "Levels Document." The difference between the normalized L_{dn} of the intruding noise and the existing

L_{dn}'s provides the expected community reaction as indicated in Table 1.

7.0 CONSTRUCTION NOISE IMPACT ASSESSMENT

7.1 Dickey Dam Site

The predicted construction noise L_{dn} contours, presented on Figure 2, show that all existing and potential residential areas should experience outdoor construction L_{dn}'s of less than 55 dB. The L_{dn} at the nearest neighbor to the Dickey Dam and at Allagash School is 53 dB. Since the predicted construction L_{dn}'s are below the EPA's recommended L_{dn} of 55 dB, no effects to public health and welfare are expected to occur due to interference with speech or other outdoor activity.

Using the average 17 dB attenuation for sound traveling through the shell of a house in a northern climate with the windows open, the estimated indoor L_{dn} from construction activity is 36 dB (53-17 = 36) or less for all residential areas and well below the EPA recommended indoor L_{dn} of 45 dB. Accordingly, no effects on normal indoor activities such as listening to radio or television, conversation, sleeping, reading, or relaxing are expected to occur. Likewise, no interference with indoor activities is expected at Allagash School.

As previously indicated, the EPA's "Levels Document" also provides a method for assessing the community reaction to a new intruding noise by comparing the normalized L_{dn} of the intruding noise with the existing ambient L_{dn}. The normalization correction factor for the construction activity at the Dickey Dam site has been estimated in Exhibit 4 at +15 dB. The normalized construction noise L_{dn} contours are shown on Figure 2, and the levels are indicated by the bracketed [ ] numbers. With the average ambient L_{dn} of 60 dB in all residential areas, the expected reaction of the people in Allagash village, the nearest neighbors to the site, is "widespread complaints" to "threats of legal action." The expected reaction of the community located between the construction noise L_{dn} 50 [65] dB and 40 [55] dB contours will range from "widespread complaints" to "no reaction, although noise is generally noticeable."

7.2 Lincoln School Dam Site

The predicted construction noise L_{dn} contours are shown on Figure 3. The construction L_{dn} at the nearest neighbor to the Lincoln School Dam is 46 dB. Since this level is significantly below the

EPA's recommended outdoor L_{dn} of 55 dB, no effects to public health and welfare due to interference with speech or other outdoor activity are expected to occur at any existing residences.

Using the average 17 dB attenuation for sound traveling through the shell of a house in a northern climate with the windows open, the estimated indoor L_{dn} from construction activity is 29 dB (46-17 = 29) or less for all existing residential areas and well below the EPA's recommended indoor L_{dn} of 45 dB. Accordingly, no interference with normal indoor activities is expected to occur.

Using the EPA's community reaction assessment method, the normalization correction factor for the construction activity at the Lincoln School Dam site has been estimated in Exhibit 4 at +15 dB. The normalized construction noise L_{dn} contours are shown on Figure 3, and the levels are indicated by the bracketed [ ] numbers. With the average ambient L_{dn} of 60 dB in all residential areas, the expected reaction of the nearest neighbors to the Linclon School Dam site is "sporadic complaints." No adverse reaction is expected to the construction noise beyond the 40 [55] dB contour.

8.0 OPERATIONAL NOISE IMPACT ASSESSMENT

8.1 <u>Dickey Dam Site</u>

The predicted operational noise L_{dn} contours, presented on Figure 4, show that all existing and potential residential areas should experience outdoor operational L_{dn}'s of less than 55 dB. The L_{dn} at the nearest neighbor to the Dickey Dam and at the Allagash School is 41 dB. Since the predicted operational L_{dn}'s are below the EPA's recommended L_{dn} of 55 dB, no effects to public health and welfare are expected to occur due to interference with speech or other outdoor activity.

Using the average 17 dB attenuation for sound traveling through the shell of a house in a northern climate with the windows open, the estimated indoor L_{dn} from operational activity is 24 dB (41-17 = 24) or less for all residential areas and well below the EPA's recommended indoor L_{dn} of 45 dB. Accordingly, no effects on normal indoor activities such as listening to radio or television, conversation, sleeping, reading, or relaxing are expected to occur.

Using the EPA's community reaction assessment method, the normalization correction factor for the operational noise from the Dickey Dam site has been estimated in Exhibit 4 at +15 dB. The normalized operational noise L_{dn} contours are shown on Figure 4, and the levels are indicated by the bracketed [ ] numbers. With the average ambient L_{dn} of 60 dB in all residential areas, no adverse reaction is expected to operational noise at any existing residences, althougn the noise will generally be noticeable in Allagash village.

8.2 Lincoln School Dam Site

The predicted operational noise L_{dn} contours are shown on Figure 5. The operational L_{dn} at the nearest neighbor to the Lincoln School Dam is 43 dB. Since this level is significantly below the EPA's recommended outdoor L_{dn} of 55 dB, no interference with speech or other outdoor activity would be expected at any existing or potential residences beyond the 55 dB L_{dn} contour.

Using the average 17 dB attenuation for sound traveling through the shell of a house in a northern climate with the windows open, the estimated indoor L_{dn} from operational activity is 26 dB (43-17 = 26) or less for all existing residential areas and is well below the EPA's recommended indoor L_{dn} of 45 dB. Accordingly, no interference with normal indoor activities is expected to occur.

Using the EPA's community reaction assessment method, the normalization correction factor for the operational activity at the Lincoln School Dam site has been estimated in Exhibit 4 at +15 dB. The normalized operational noise L_{dn} contours are shown on Figure 5, and the levels are indicated by the bracketed [ ] numbers. With the average ambient L_{dn} of 60 dB in all residential areas, the expected reaction of the nearest neighbors to operational noise is "sporadic complaints" to "no reaction." No adverse reaction is expected beyond the 40 [55] dB contour.

9.0 SUMMARY

The overall project area can be described as a very quiet natural area remote from any major industrial activity, but subject to high traffic noise levels along the main road. Noise sensitive areas consist of low density residential areas in the villages and widely spaced residences along the main road. The estimated yearly average L_{dn} for all noise sensitive areas is 60 dB due to the close proximity of traffic to all residences. The yearly average L_{dn} decreases to 40 dB at 600 ft from the main road, and to 30 dB in the timberland areas.

Construction sound levels were predicted for earth moving and power house construction activities and presented as L_{dn} contours.

At the Dickey Dam site, the predicted L_{dn} from construction activities at the nearest neighbor is 53 dB. The predicted construction L_{dn} at the nearest neighbor to the Lincoln School Dam is 46 dB.

Operational sound levels were predicted for normal operation at the Dickey and Lincoln School Dam sites and presented as L_{dn} contours. The L_{dn} from operation at the Dickey Dam at the nearest neighbor is 41 dB. From the Lincolon School Dam, the operational L_{dn} at the nearest neighbor is 43 dB.

The guidelines outlined in the EPA's "Levels Document" were used to assess the noise impact resulting from construction and operation of the project. The "Levels Document" identifies an outdoor L_{dn} of 55 dB and an indoor L_{dn} of 45 dB as "the maximum levels below which no effects on public health and welfare occur due to interference with speech or other activity." The "Levels Document" also provides a method for assessing "community reaction" to a new noise source based on the difference between the normalized intruding L_{dn} and the existing ambient L_{dn}.

Sound levels from construction and from operation of the Dickey Dam are not expected to affect the public health and welfare of any existing residents. However, a community reaction of "several threats of legal action" to "widespread complaints" due to construction noise is expected at the nearest neighbors. No adverse reaction is expected to operational noise at any existing residences.

At the Lincoln School Dam site, no effects to the public health and welfare are expected from the construction or operational sound levels. Community reaction to the construction and operational sound levels at the nearest residences to the Lincoln School Dam are expected to be "sporadic complaints."

10.0 MITIGATION MEASURES

10.1 Construction Noise

The predicted construction sound levels from the Dickey and Lincoln School Dams are acceptable at all existing residences according to the guidelines from the EPA's "Levels Document." However, a significant adverse reaction to the construction noise is expected in the existing residential community near the Dickey Dam site, as well as a minor reaction near the Lincoln School Dam site. Since the area has no prior experience with industrial noise sources, the impulsive characteristics of construction noise will be particlarly disturbing. In order to limit the adverse community reaction to the construction noise, the following noise control measures will be considered. Construction equipment used on the project should have the lowest available sound levels. Whenever possible, the noisier construction activities should be limited to daytime hours to minimize interference with sleep. Also, new residences should not be established inside the 55 dB construction noise contour during construction.

10.2 Operational Noise

Sound levels from operation at the Dickey and Lincoln School Dam sites are acceptable at all existing residences according to the guidelines from the EPA's "Levels Document." In addition, at the Dickey Dam site, no adverse reaction is expected to operational noise. Therefore, no noise control measures should be necessary for the Dickey Dam site as long as housing for operating personnel is not established with the 55 dB operational noise contour.

At the Lincoln School Dam site, the worst community reaction expected at any residence would be "sporadic complaints." Since no excess attenuation due to topography, vegetation, or meteorological conditions was taken into account, the actual sound levels from operation may not cause an adverse reaction at any existing residence. Therefore, noise control measures may not be necessary as long as residences are not relocated within the 40 dB operational noise contour. If, however, an adverse community reaction did occur to the operational noise, standard parallel baffle silencers could be added to the air intakes and exhausts of the ventilation system to eliminate the reaction.

11.0 REFERENCES

1. "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety." 550/9-74-004. U.S. Environmental Protection Agency. March, 1974.

2. U.S.G.S. map for Allagash, ME., N4700-W6900/15, 1930.

3. U.S.G.S. map for St. Francis, ME., N4700-W6845/15, 1930.

4. "Construction Noise: Specification, Control, Measurement, and Mitigation." AD/A-101 629. Army Construction Engineering Research Laboratory. April, 1975.

5. "Noise Reduction Theory Applied to a Large Power Plant," John Parmakian, Journal of the Power Division, Proceedings of the American Society of Civil Engineers, May, 1962.

6. U.S. EPA, op. cit., p. 22.

TABLE 1

COMMUNITY REACTION CRITERIA*

Difference Between Normalized Intruding and Ambient Noise in dB L_{dn}	Expected Community Reaction
-10 to -5	No reaction, noise unnoticeable - No reaction, although noise is generally noticeable
-5 to 0	No reaction, although noise is generally noticeable - Sporadic complaints
0 to +5	Sporadic complaints - Widespread complaints or single threat of legal action
+5 to +10	Widespread complaints or single threat of legal action - Several threats of legal action or strong appeals to local officials to stop noise
+10 to +20	Several threats of legal action or strong appeals to local officials to stop noise - Vigorous action

NOTE:

*Based on Reference 1, Figure D-7.

EXHIBIT 2: AMBIENT SOUND LEVEL DATA

LOCATION	DATE 12/76	TIME EST	SOUND LEVEL DATA								OBSERVED NOISE SOURCES	METEOROLOGY			
			MEASURED						CALCULATED			WIND		TEMP	SKY
			L_{90}	L_{50}	L_{10}	L_{min}	L_{max}	L_{eq}	L_{eq}	L_{dn}		MPH	DIR	°F	
In the Timberland:															
Location 1	16	1030	18	21	25	17	31	-	22	28	High jet flyover, truck	0-5	W	0	Cldy
Location 2	15	1500	35	35	37	35	37	-	36	42	Waterflow in river at 100 ft	0-5	VAR	30	Cldy
Along Uninhabited Roadway:															
Location 9	15	1010	33	36	40	33	43	-	37		No observed noise sources	0-5	W	30	Cldy
	15	1600	27	34	53	27	65	-	52	66	1 truck, 3 cars (road slushy)	0-5	N	24	Cldy
	16	1240	23	29	59	23	81	-	64		3 trucks, 3 cars	0-5	SW	6	Cldy
Location 10	14	1600	23	23	23	23	25	-	23		No observed noise sources	0	-	0	Cldy
	15	1345	33	39	59	33	71	-	56	61	1 car, 1 truck (road slushy)	5-10	N	32	Cldy
	16	1140	33	39	53	31	73	-	58		3 cars, 2 trucks	0-5	W	0	Cldy
Near Single Residences:															
Location 3	15	0900/1200	34	42	58	26	82	58	-		Unattended monitor				
	15	1200/1500	33	41	59	24	84	59	-	65	Unattended monitor				
	15	1800/2400	35	37	50	20	81	51	-		Unattended monitor				
	15	1530	33	45	63	31	77	-	62		Grader, plow truck, several cars (road slushy)	0-5	N	26	Cldy
Location 6	14	1305	25	30	51	23	80	-	63		3 cars, 1 truck	0	-	0	Cldy
	15	0955	35	39	56	33	65	-	52	66	5 cars (road slushy)	0-10	SW	32	Cldy
	16	1350	29	33	53	29	75	-	60		2 trucks	0-5	NW	8	Cldy
Location 7	14	1800/2400	22	23	50	21	84	54	-		Unattended monitor				
	15	0000/0600	23	25	38	22	86	55	-	61	Unattended monitor				
Location 8	13-14	1900/0300	21	25	34	20	59	33	-		Unattended monitor				
	14	0300/0900	22	30	40	21	67	41	-		Unattended monitor				
	14	1200/1400	22	25	37	20	63	39	-		Unattended monitor				
	14	1400/1600	21	25	37	20	61	37	-	46	Unattended monitor				
	13	1540	41	43	48	39	51	-	45		1 car and 1 truck on Route 161	0	-	0	Clear
	14	1145	23	23	27	23	33	-	25		1 car on Route 161	0	-	0	Clear

EXHIBIT 2: AMBIENT SOUND LEVEL DATA

LOCATION	DATE 12/76	TIME EST	SOUND LEVEL DATA: MEASURED L_{90}	L_{50}	L_{10}	L_{min}	L_{max}	L_{eq}	CALCULATED L_{eq}	L_{dn}	OBSERVED NOISE SOURCES	METEOROLOGY: WIND MPH	WIND DIR	TEMP °F	SKY
Location 11	15	1325	26	39	58	25	67	-	55		5 cars, 1 truck (road slushy)	5-10	W	34	Cldy
	16	0930	31	41	60	31	81	-	64	67	4 trucks, 2 cars	0-5	W	-10	Cldy
	16	1420	31	37	52	29	75	-	58		1 car, 1 truck, 1 pickup stopping up road	5-10	NW	10	Cldy
In the Villages:															
Location 4	15	1435	51	52	65	49	81	-	66		2 cars, 4 trucks (road slushy), truck idling at 300 ft	5-10	N	30	Cldy
	16	0955	35	45	63	33	77	-	63	69	8 cars, 6 trucks, car starting and leaving at 50 ft	0-5	W	-8	Cldy
	16	1340	31	35	44	31	49	-	39		2 men working quietly at 50 ft	0-5	NW	6	Cldy
Location 5	15	0850	41	49	64	39	73	-	60		Jet overhead, 1 car (road slushy)	0-10	SW	28	Cldy
	15	1410	35	42	57	35	67	-	54	62	3 cars, 1 truck (road slushy), people talking, truck in background	5-10	N	30	Cldy
	16	1255	31	31	32	31	35	-	31		1 door slam	0-5	SW	6	Cldy
Location 12	16	0900/1200	29	40	56	23	86	61	-		Unattended monitor				
	16	1200/1500	34	42	57	24	88	62	-	72	Unattended monitor				
	14	1540	36	39	63	33	86	-	71		3 cars, 2 trucks, children playing at 100 ft	0	-	0	Cldy
	15	1305	31	39	55	31	69	-	54		4 cars (road slushy), barking dog, people at store 200 ft	2-5	SE	38	Cldy
Location 13	16	0920	33	37	52	31	73	-	59		4 cars	0	-	-8	Clear
	16	1115	31	37	56	31	75	-	61	67	3 pickups, 2 cars	0-5	W	0	Cldy
	16	1435	33	39	61	31	79	-	63		3 trucks, 2 cars, barking dogs in distance	5-10	NW	10	Cldy

EXHIBIT 1

AMBIENT SURVEY INSTRUMENTATION

Manual Hand-Held Instrumentation

B&K Precision Sound Level Meter, Type 2209, Serial No. 434032

B&K Octave Band Filter Set, Type 1613, Serial No. 432941

B&K Condenser Microphone Type 4145, Serial No. 435832

B&K Random Incidence Corrector, Type UA 0055

B&K Pistonphone Calibrator, Type 4220, Serial No. 439897

B&K Windscreen, Type UA 0207

Automatic Continuous Monitoring Instrumentation

GEN RAD Community Noise Analyzer, Model 1945, Serial No. 232

GEN RAD One-inch Ceramic Microphone, Model 1971-9601, Serial No. 46902

GEN RAD Weatherproof Microphone System, Model 1945-9730

GEN RAD Sound Level Calibrator, Model 1562-A, Serial No. 19060

EXHIBIT 3

SAMPLE CALCULATIONS

PART 1 Calculation of Equivalent Sound Levels and Day-Night Equivalent Sound Levels

PART 2 Construction Noise Prediction

PART 3 Operational Noise Prediction

PART 1 Calculation of Equivalent Sound Levels and Day-Night Equivalent Sound Levels

The equivalent sound level (L_{eq}) is the constant sound level that, in a given situation and time period, conveys the same sound energy as the actual time-varying A-weighted sound. To compute an L_{eq} from manually recorded data, the relative pressure level $10^{x/10}$ of each sound level reading is summed and the total is divided by the total number of readings. The resulting pressure level is then converted back to a sound level. Thus,

$$L_{eq} = 10 \log_{10} \left\{ \frac{\sum_{1}^{n} 10^{\frac{x}{10}}}{n} \right\} dB,$$

where x is an individual sound level reading in dBA and n is the number of readings in the measurement period.

The day-night equivalent sound level (L_{dn}) is defined as the equivalent sound level during a 24-hour period with a 10 dB weighting applied to the equivalent sound level during the nighttime hours of 10:00 P.M. to 7:00 A.M. Thus,

$$L_{dn} \quad 10 \log_{10} \left\{ \frac{1}{24} \left[15(10^{\frac{L_d}{10}}) + 9\ (10^{\frac{L_n+10}{10}}) \right] \right\} dB,$$

where L_d is the L_{eq} for the daytime (0700-2200 hours) and L_n is the L_{eq} for the nighttime (2200-0700 hours).

PART 2 Construction Noise Prediction

The predicted construction sound levels are based on the schedule of construction activities, the equipment list for each activity, and the usage factor and sound pressure levels at 50 feet for each type of equipment. Initially, the sound pressure levels for each type of equipment in a given phase of construction were increased by the value of $10 \log_{10}(nu)$ to adjust for the number of pieces (n) of each type of equipment and the usage factor (u) assigned to that equipment to obtain the most probable number of pieces of equipment operating during that phase of construction. The totaled sound pressure levels from each type of equipment were then logarithmically combined to obtain the most probable octave band sound pressure levels for each phase. These sound pressure levels were then converted to the sound power levels for an acoustically equivalent point source centered at the powerhouse for each construction phase. The most probable average octave band sound power levels over the entire construction project were computed by logarithmically time-averaging the individual sound power levels from each phase of construction.

The most probable average octave band sound power levels were extrapolated off-site to obtain the sound pressure levels at various distances assuming hemispherical divergence and atmospheric absorption at standard conditions (20° Centigrade, 70 percent relative humidity). The calculated sound pressure levels were A-weighted, and the overall sound level at each distance was computed. The overall A-weighted sound levels are assumed to be the equivalent sound levels (L_{eq}) for all construction activities.

Daytime and nighttime construction L_{eq}'s were calculated by averaging the L_{eq} for those hours of construction activity in the daytime and nighttime periods with an L_{eq} of 0 dB for those hours without construction activity, based on the normal working schedule for each site. The working schedule (hours per day and days per week) was assumed to be the same throughout the construction period, thus yielding the yearly average L_{eq} values. The yearly average L_{dn}'s were then calculated from the daytime and nighttime L_{eq}'s as described in Part 1 of this exhibit. The results of these calculations are presented as L_{dn} contours plotted in 5 dB increments.

PART 3 Operational Noise Prediction

The predicted operational sound levels were based on noise from the outdoor transformers, indoor machinery and ventilation systems for each powerhouse. Initially, the contribution from each operational noise source at each site was calcuated at the nearest neighbor. The sound levels from each source were compared to determine the dominant noise sources and the impact of each source was then combined to determine the overall impact and the necessity of noise control. The effective sound power levels from each site were then calculated for use in determining the locations of the L_{dn} contours.

The sound level and the pressure spectrum levels for each transformer were determined at the nearest neighbor using the Schultz-Ringlee(1) technique, an assumed frequency spectrum based on a summary of field data and theory, and the atmospheric absorption over the distance to the nearest neighbor. The Schultz-Ringlee calculation was based on the NEMA rating of the transformers which was estimated from the capacity, the basic insulation levels and the expected type of cooling. Since the transformers at each site are located along the wall of the powerhouse facing the nearest neighbor, the transformer sound levels were increased by 3 dB to account for reflections from the wall.

Sound levels at the nearest neighbors from machinery inside each powerhouse were based on the reverberant sound pressure levels expected inside the powerhouse and the transmission loss of the walls and roof. The reverberant levels were estimated by adjusting the levels published in a report on noise in hydroelectric plants[2] for the difference in the capacity of the turbine-generators in the report and those proposed for each site. The sound pressure levels immediately outside the powerhouse were calculated by subtracting the noise reduction coefficients from the inside reverberant sound pressure levels. The noise reduction coefficents were equal to the transmission loss coefficients for the type of building materials of the walls and roof plus 6 dB. The effective sound power levels for the powerhouse noise were calculated by adding the area factor to the outdoor sound pressure levels. The area factor is equal to $10 \log_{10}(A) - 10$ (dB), where A is the radiating area of the powerhouse. The effective sound power levels were then extrapolated to the nearest neighbor assuming hemispherical divergence and atmospheric absorption at standard conditions (20^{o} Centigrade, 70 percent relative humidity).

Sound levels for the ventilation systems for the powerhouse were based on standard ventilation fans for power plant turbine buildings. The intake fans were assumed to be a vane axial type operating at 1,750 rpm with an air flow of 62,500 cfm, 12 or 16 blades, and 5 in. pressure drop water gage. The exhaust fans were assumed to be a propeller type operating at 580 rpm with an air flow of 41,000 cfm, 5 of 6 blades, and 1/8 in. pressure drop water gage. The ventilation system was sized on the basis of an estimated air change once every 10 minutes and the approximate volume of air in each powerhouse. Since the majority of open space in the powerhouse was in the turbine-generator bays above the deck level, the volume of air was estimated as the volume of that open space. From the required air flow, the number of fans for the ventilation systems was computed. The sound power levels of each type of fan were calculated using the Graham[3] technique and adjusted for the number of each type of fan. The adjusted sound power levels from the intake and exhaust fans were then combined to obtain the sound power levels from the total ventilation system. These sound power levels were extrapolated to the nearest neighbor assuming hemispherical divergence and atmospheric absorption at standard conditions.

The total operational sound pressure levels at the nearest neighbor were calculated by combining the sound pressure levels from all of the operational sources. These sound pressure levels were converted back to the effective operational sound power levels, centered at the powerhouse using hemispherical divergence and standard atmospheric absorption. The effective sound power levels were then used to calculate the operational sound pressure levels at various distances to determine the location of each operational noise contour. These sound pressure levels were corrected to A-weighted sound levels, and are assumed to be the equivalent sound levels (L_{eq}). Separate L_{eq} calculations were performed for generation and pumped storage operating conditions.

Daytime and nighttime operational L_{eq}'s were calculated by averaging the L_{eq}'s for each operating condition over the length of time per day that the facility would be operating in that condition. The operating schedule for each site was based on the annual capacity factor or proposed weekly schedule of operation on a yearly average. The yearly average L_{dn}'s were then calculated from the daytime and nighttime L_{eq}'s as described in PART 1 of this exhibit. The results of these calculations are presented as L_{dn} contours plotted in 5 dB increments.

REFERENCES:

(1) "Some Characteristics of Audible Noise of Power Transformers and Their Relationship to Audibility Criteria and Noise Ordinances," M. W. Schultz, Jr., and R. J. Ringler, Power Apparatus and Systems, June, 1960.

(2) "Noise Reduction Theory Applied to a Large Power Plant," John Parmakian, Journal of the Power Division, Proceedings of the American Society of Civil Engineers, May. 1962.

(3) "How to Estimate Fan Noise," I. B. Graham, Sound and Vibration, May, 1972.

EXHIBIT 4

NORMALIZATION CORRECTIONS FOR COMMUNITY REACTION ANALYSIS

Normalization corrections are applied to an intruding noise to take into account the seasonal character of the intruding noise, the existing ambient outdoor noise environment, the previous exposure and community attitudes to the source, and the pure tone or impulsive character of the intruding noise. The correction factors are from Table D-7 of the EPA's "Levels Document."(1)

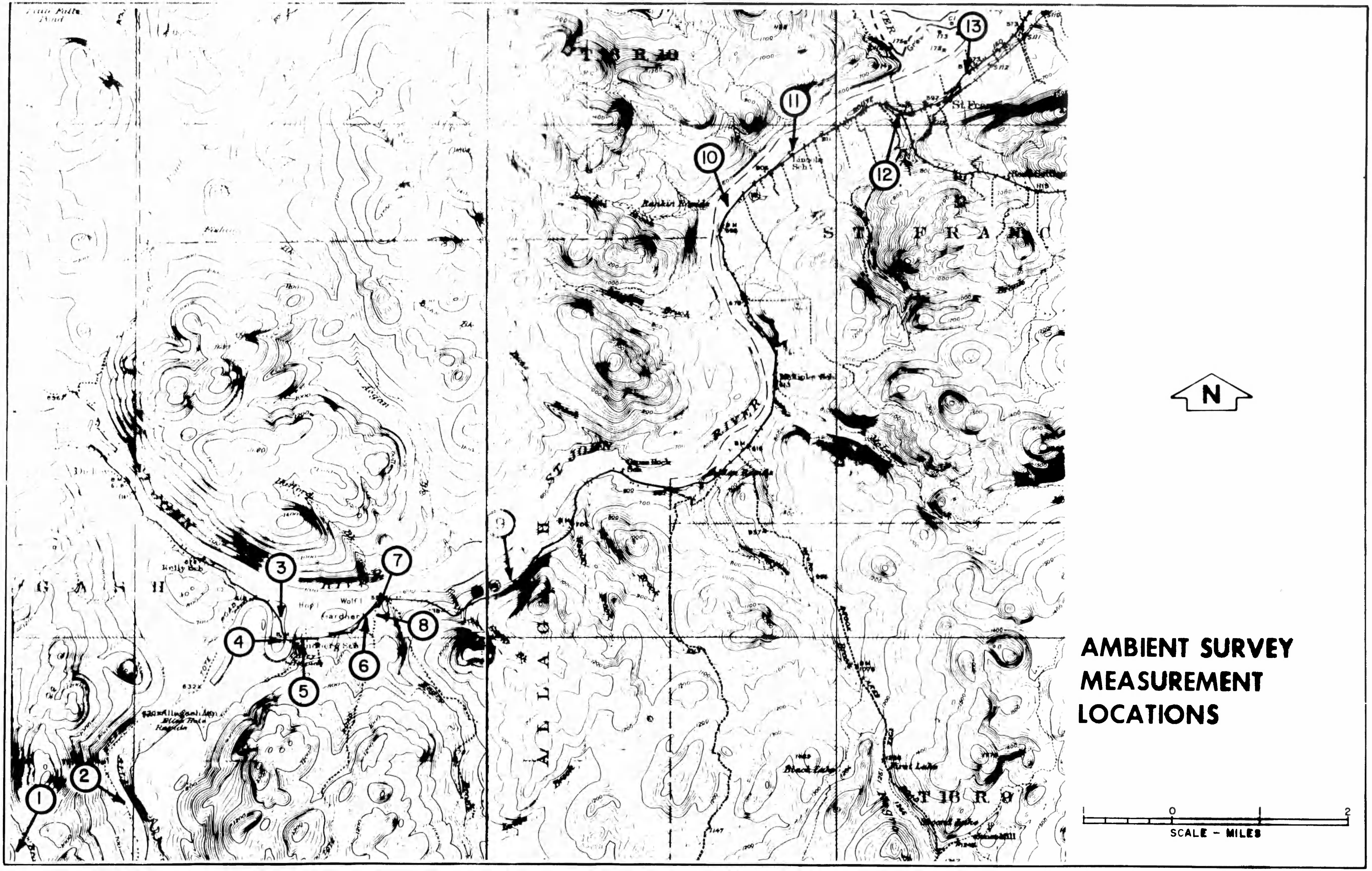
The normalization correction factors applied to the construction L_{dn}'s are as follows. The seasonal correction is 0 dB, since construction will be a "year-round operation."(2) The existing noise environment is classified as a "normal suburban community (not located near industrial activity),"(2) which is a +5 dB correction. The log truck activity in the area excludes use of the "rural community"(2) classification, since that classification specifies that the community is "remote from large cities and from industrial activity and trucking."(2) Since the community has had "no prior experience with the intruding noise,"(2) a correction of +5 dB is used. The construction noise is expected to be of an "impulsive character"(2) which is a +5 dB correction. The total normalization correction factor for the construction L_{dn} is +15 dB.

The normalization correction factors applied to the operational L_{dn}'s are listed below. The corrections to the operational L_{dn} for the existing noise environment and the previous exposure of the community to the intruding noise are the same as for construction noise, or +5 dB each. The seasonal correction is also the same, 0 dB, since the facilities will operate "year-round."(2) The primary operational noise sources are the ventilation fans and the transformers, both of which produce pure tones. Therefore, a +5 dB "pure tone"(2) correction is used. The total normalization correction factor for the operational L_{dn} is +15 dB.

REFERENCES:

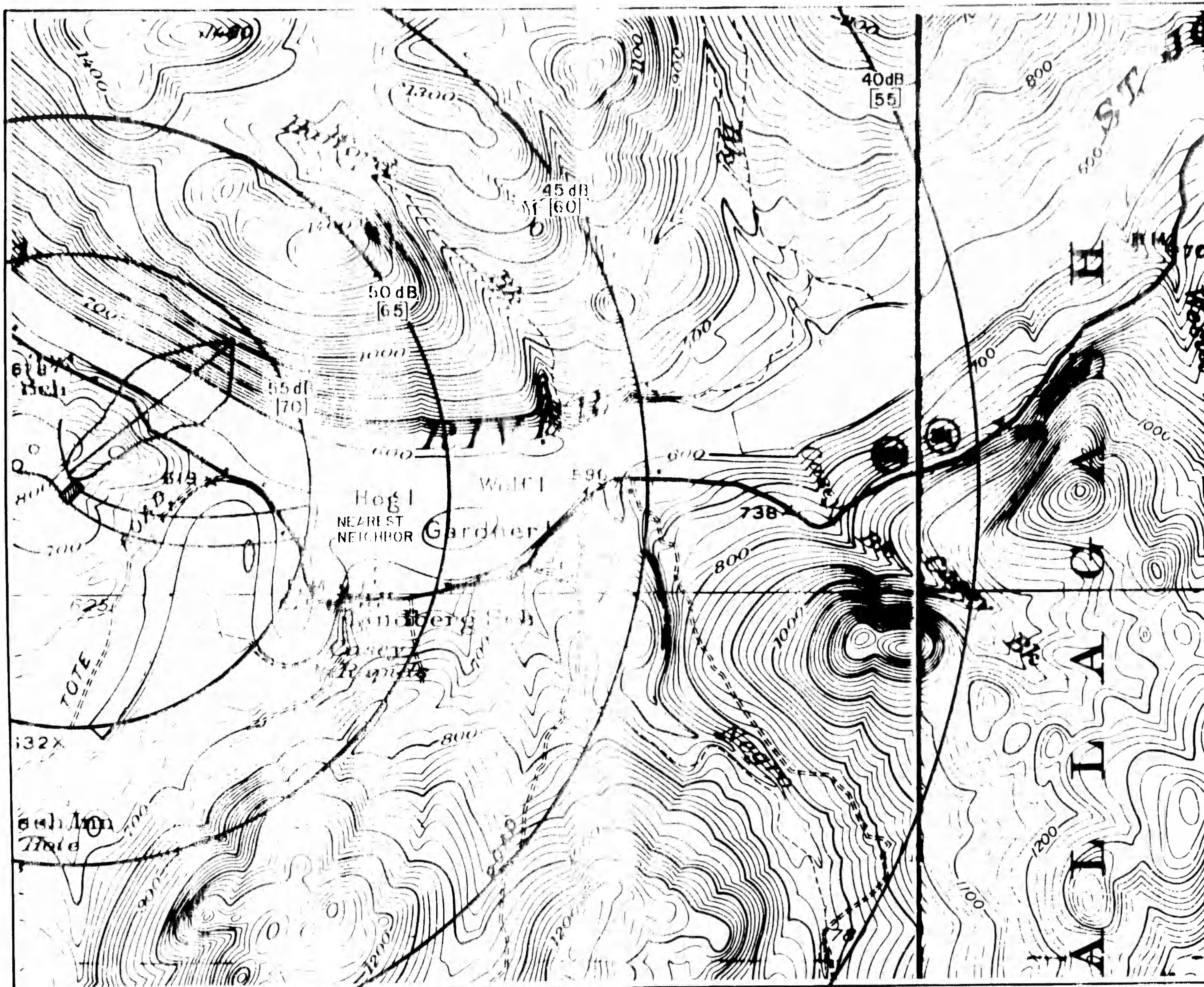
(1) "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety." 550/9-74-004. U.S. Environmental Protection Agency. March, 1974.

(2) U.S. EPA. Op. Cit., Table D-7, p. D-18.



AMBIENT SURVEY MEASUREMENT LOCATIONS

FIGURE 1



LEGEND

55dB - PREDICTED Ldn FROM CONSTRUCTION

[70] NORMALIZED Ldn FOR COMMUNITY REACTION

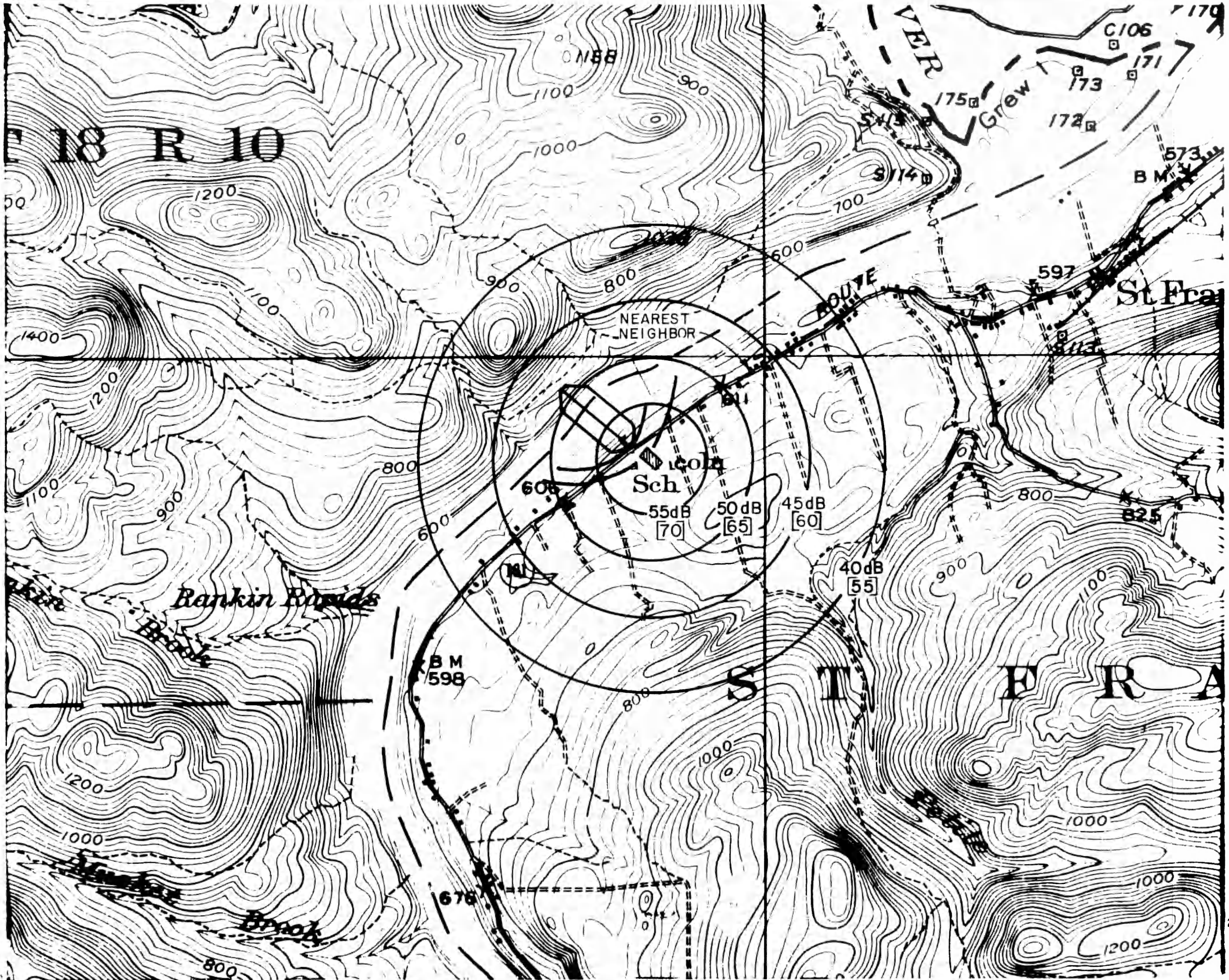
N

DICKEY DAM CONSTRUCTION NOISE Ldn CONTOURS

2000 0 2000 4000

SCALE - FEET

FIGURE 2



LEGEND

55dB - PREDICTED Ldn FROM CONSTRUCTION

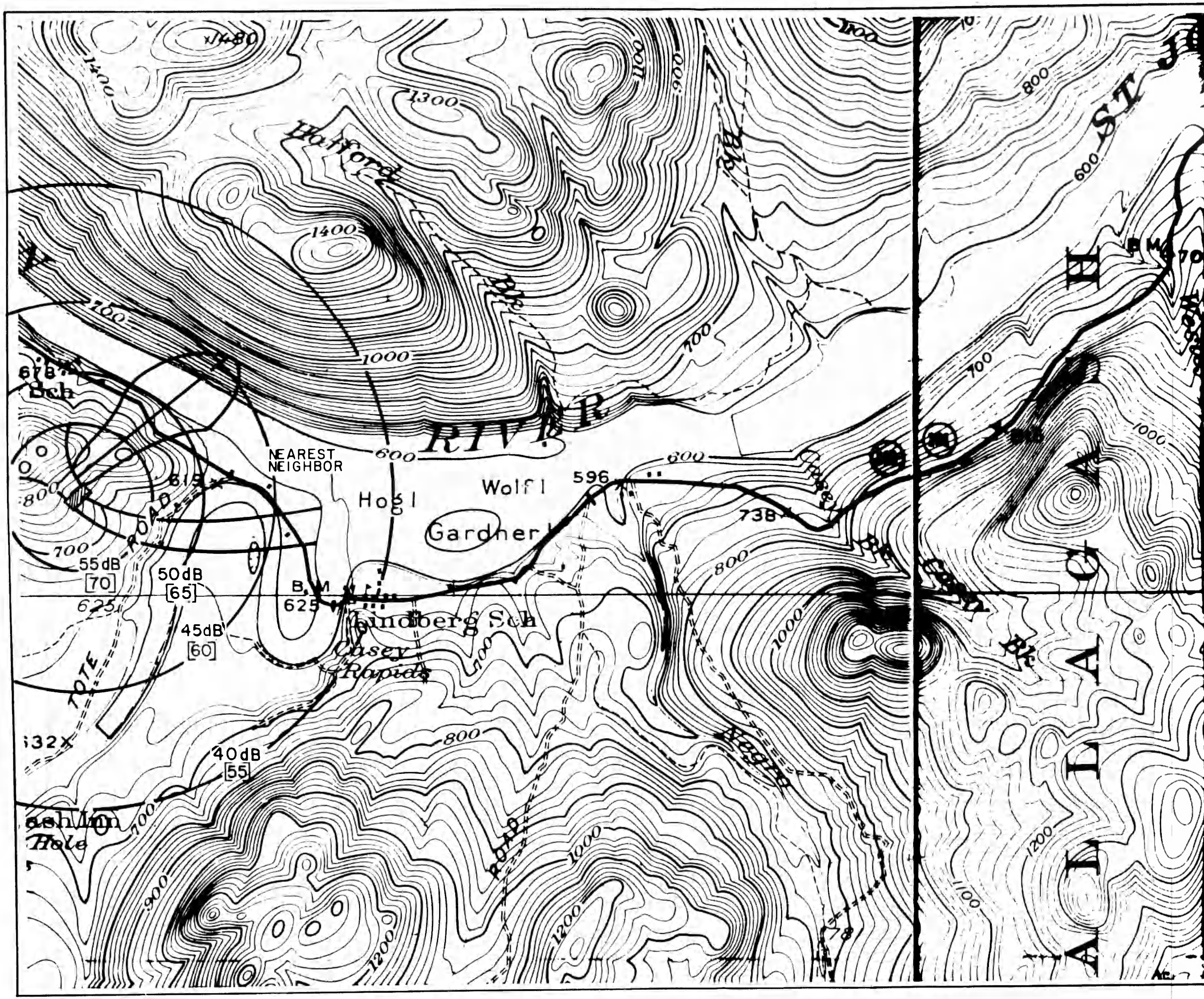
[70] - NORMALIZED Ldn FOR COMMUNITY REACTION

N

LINCOLN SCHOOL DAM CONSTRUCTION NOISE Ldn CONTOURS

2000 0 2000 4000
SCALE - FEET

FIGURE 3



LEGEND

55dB - PREDICTED Ldn FROM OPERATION

[70] - NORMALIZED Ldn FOR COMMUNITY REACTION

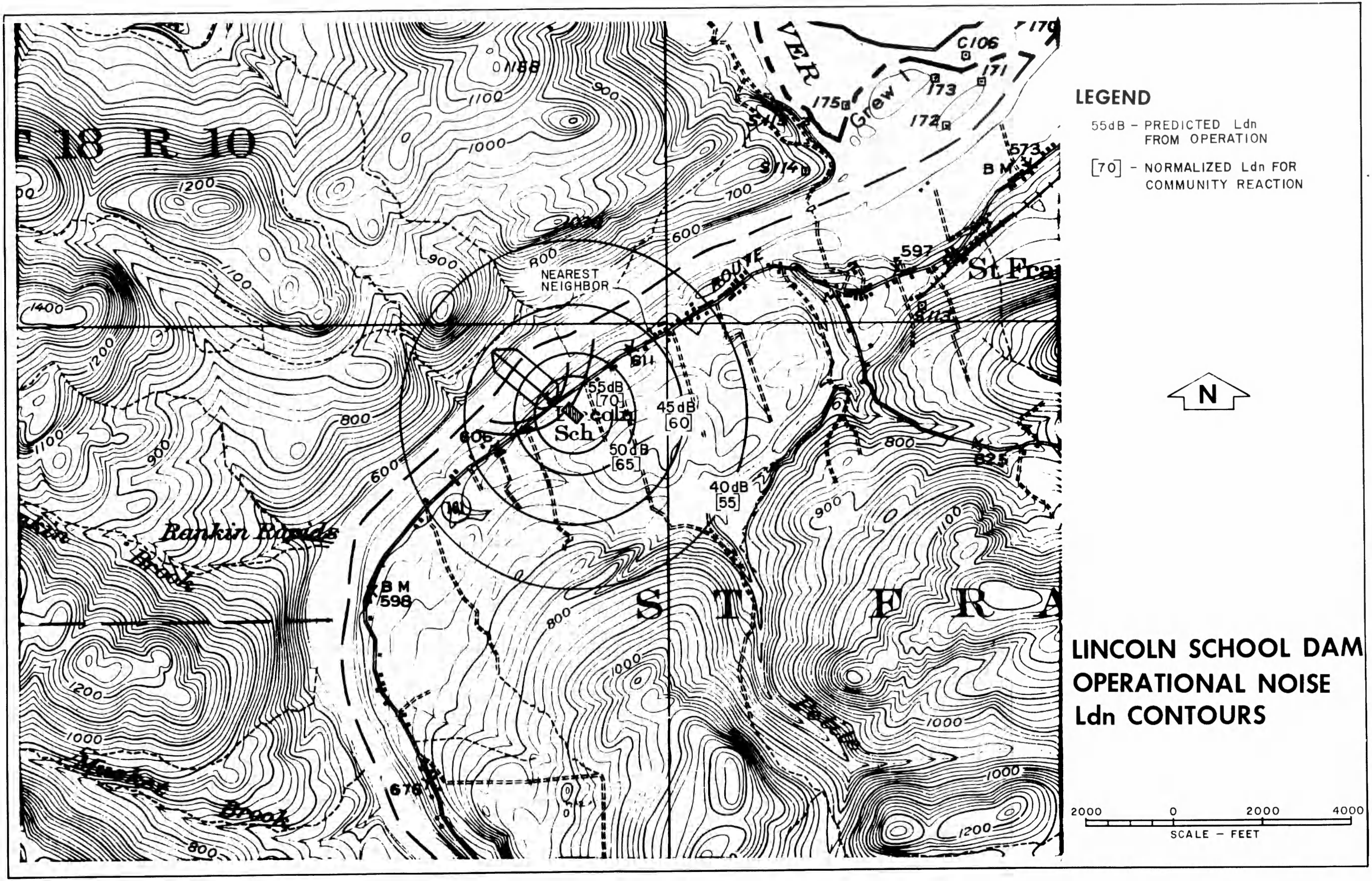
N

DICKEY DAM OPERATIONAL NOISE Ldn CONTOURS

2000 0 2000 4000

SCALE - FEET

FIGURE 4



LINCOLN SCHOOL DAM OPERATIONAL NOISE Ldn CONTOURS

FIGURE 5

[redacted]

[redacted] 113611
TK U.S. Army. Corps of Eng.
1425
D5 Environmental impact
U52323 statement,....
App.H