LA-13372-MS

An Analysis of Background Noise in Selected Canyons of Los Alamos County

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13092

Edited by Hector Hinojosa, Group CIC-1

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LA-13372-MS

UC-2000
Issued: October 1997

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by

Kristin Huchton, Steven W. Koch, Rhonda Robinson

ABSTRACT

We recorded background noise levels in six canyons within Los Alamos County in order to establish a baseline for future comparisons and to discover what noises animals are exposed to. Noise level measurements were taken within each canyon, beginning at an established starting point and at one-mile intervals up to four miles. The primary source of noise above 55 dBA was vehicular traffic. One clap of thunder provided the highest recorded noise level (76 dBA). In general, the level of noise, once away from highways and parking lots, was well below 60 dBA.

1.0 Introduction

1.1 General

Since wildlife is influenced in some way when humans enter their habitats, we must examine the impact that our activities have on survival, especially on threatened or endangered species. Whenever a project is initiated, there are many changes that take place in the area, one of which is the introduction of additional noise. The effects of noise have often been studied from a human health perspective but have not been extensively studied for influences to other species. The limited studies made concerning noise disturbance and animals indicate that noise may affect the behavior of some species (Ellis et al. 1991, Awbrey and Hunsaker 1997, Delaney et al. 1997). This study provides baseline data for background noise levels in six canyons in Los Alamos County. The analysis of existing noise levels will allow for better evaluation of future project impacts.

Noise is defined as unwanted sound. Sound is a form of energy that travels as invisible pressure vibrations in various media, such as air. Sound pressure level is usually measured in decibels (dB), a logarithmic scale. Sounds that people (and birds) can hear are given more weight than sounds that cannot be heard. The so-called A-weighted response (dBA) closely imitates the response of the human ear by filtering out the lower and higher frequencies not normally heard by the human ear. Studies examining the effects of noise on birds (and people) typically use the A-weighted curve.

Environmental noise exposure is measured outdoors. The sound levels vary and depend on the generator. The following are typical examples of sound levels (dBA) generated by barking dogs (58), sports events (74), local cars (63), aircraft overhead (66), children playing (65), and birds chirping (54) (Bell et al. 1982).

1.2 Noise and Bird Species

There are several ways that noise could adversely affect birds: (1) by masking calls, (2) by initiating a flight response, or (3) by causing a physiological effect. The masking of vocalizations could impact the establishment and defense of territories and the attraction and maintenance of mates, causing a decline in successful reproduction (RECON 1997). Noise may also cause a nest to be abandoned, an interruption in the care of young, physiological stress of adults or young, premature fledging, and the loss of eggs or small chicks that are kicked from the nest by startled adults (Ellis et al. 1991).

However, numerous studies have failed to show a strong correlation between noise levels and reproductive rate (Ellis et al. 1991, Awbrey et al. 1995, Awbrey and Hunsaker 1997, Fletcher and Busnel 1978). Ellis et al. (1991) experimented with the effects of low-level jet aircraft and mid- to high-altitude sonic booms on raptors. They found that 95% of the nests that were subjected to the stimuli successfully fledged young, and 95% were reoccupied the following year. In another study involving California gnatcatchers (*Polioptila californica*), noise from aircraft poorly correlated with reproductive success or failure, and if "noise does have an effect, . . . it is overwhelmed by such factors as predation, weather, edge effects, and differences in quality of habitat" (Awbrey and Hunsaker 1997).

Noise, such as that from low-flying aircraft and sonic booms, has been shown to disturb birds, with the severity of the disturbance varying from insignificant (interrupting an activity such as preening) to a flight response. Excessive flight response may be harmful to the birds because food intake may be lowered while the expenditure of energy is increased (Ward et al. 1994). Sonic booms have also been circumstantially associated with the 99% reproductive failure of Dry Tortugas sooty terns (*Terna fuscata*) (Fletcher et al. 1978).

Another concern is whether or not the sound level is the determining factor in response behavior, Delaney et al. (1997) noted that the distance of a helicopter was a better predictor of response than was sound level. They also commented that chain saws, although not as loud or as close as helicopters, had a higher frequency of flush responses.

1.3 Noise and Threatened and Endangered Species

A few studies have concentrated upon the effects of noise on specific threatened or endangered bird species in order to improve management practices.

1.3.1 Peregrine Falcon

Ellis et al. (1991) studied the effects of low-level military aircraft and mid- to high-altitude sonic booms on the

peregrine falcon (*Falco peregrinus*). They found that noise was not a serious concern as 10 of the 12 nests that were subjected to the noise stimulus successfully fledged young. Reoccupancy was also within expected rates for a self-sustaining population.

1.3.2 Mexican Spotted Owl

Extensive research was carried out on the reaction of the Mexican spotted owl (*Strix occidentalis lucida*) during the nesting season to both helicopter overflights and chain saws (Delaney et al. 1997). It was found that flush response became more frequent as the distance to the disturbance decreased or when the sound level was raised. Interestingly, even though the chain saws were not as loud as the helicopters, owls responded from further away and with greater frequency than from helicopters. In regards to reproductive success, the findings indicated that aircraft overflights alone had a negligible effect.

1.4 Other Noise Measurements on Laboratory Land

Several sets of noise measurements have been taken in Los Alamos County.

During PHERMEX tests the background noise level was reported at 31 to 35 dBA with peaks reaching 71.1 dBA from readings taken three-quarters of a mile east of the Technical Area (TA) 49 gate and 60 dBA from readings taken 100 yards west of the Bandelier National Monument entrance (Vigil 1995) (Appendix 1). Measurements taken in White Rock during the same PHERMEX tests (Burns 1995) show a background noise ranging from 31 dBA to 51 dBA (caused by a passing car) and peak noise levels ranging from 60.9 dBA (from a high-explosive load of 10 lb of TNT) to 71.6 dBA (from a high-explosive load of 100 lb of TNT) (Appendix 2).

Sound levels were measured during an M-60 automatic rifle test (Macdonell 1984). One and two rifles were fired at four different locations while measurements were taken at five points. Background measurements ranged from 34 to 63 dBA, with measurements during firing ranging from 44 to 70 dBA (Appendix 3).

Sound level measurements were also taken within Los Alamos Canyon to analyze the possible impact of noise within potential nesting habitat (Keller and Foxx 1997). Noise levels were measured from three different transects. First, background noise was measured in three locations: a mesa top, the bottom of the canyon, and at the base of the cliff containing the potential nest site; second, the noise from a truck horn on the TA-21 mesa top was measured (Appendix 4); and third, the noise of the truck horn was measured from the north rim of the canyon, following a transect that led to the cliff on the north-facing slope containing the potential nest site, down into the canyon, and up the other side (Appendix 4).

Sound levels were also measured by Haarmann et al. (1997) in a wooded lot at TA-62 and in upper Los Alamos Canyon. They found that background noise levels in an area north of West Jemez Road and west of West Road averaged 72 dBC. Background noise levels in Los Alamos Canyon just north of this spot averaged 62 dBC. A car horn in this wooded area (113 dBC) produced

the sound levels reported in Appendix 5. These levels were measured at increasing 50-m (164-ft) points along a transect moving away from the source of the noise.

2.0 Methods

For this study, an Extech Instruments 401135 Sound Level Meter was attached to a six-foot-tall tripod. This allowed the sound level meter to be placed a minimum of six feet from any large solid surface, thereby avoiding the complications of reflected sound waves. The "low" range of the sound level meter—35 to 100 dB—was used. The response time of the sound level meter was set to "slow." The A-weighting network, which responds to sound frequencies in a manner similar to human and avian hearing, was chosen in order to allow for comparison to existing data. A windscreen covered the microphone in order to reduce wind-generated noise. Before and after each measurement was taken, the sound level meter was internally calibrated.

Measurements were taken in six canyons: Los Alamos Canyon, Water Canyon, Cañada del Buey, Mortandad Canyon, Rendija Canyon and Upper Los Alamos Canyon. In Los Alamos Canyon, Cañada del Buey, Water Canyon, and Upper Los Alamos Canyon, measurements began at the gate and were taken every mile. The odometer of the vehicle was used to measure the distance between points. In Mortandad Canyon and Rendija Canyon measurements began at the end of the pavement and were taken every mile. At each mile mark, measurements were taken for three minutes, during which time the recorder took data about every three seconds, yielding approximately 110 points of data.

The data were analyzed and plotted with the program Microsoft Excel®. The mean, maximum, and minimum were determined, and the standard deviation was calculated.

3.0 Results

3.1 General

The primary sources of noise exceeding 55 dBA were cars and trucks. Thunder provided the highest reading taken (76 dBA), but was only heard distinctly at one point. Generally, the sources of noise were environmental, such as the wind in the trees, the buzzing of bees, the calls of birds, and flowing water. Readings taken near flowing water were up to 11 dBA higher than those readings taken away from the water in the same canyon. Human-generated noise included the hum of machinery and the sounds of joggers. In general the level of noise, once away from highways and parking lots, was well beneath 60 dBA.

Since the sound level meter could only measure levels above 35 dBA, it is possible that some of the canyons were quieter than what we recorded, in particular Mortandad Canyon, Water Canyon, and Rendija Canyon.

3.2 Los Alamos Canyon

Table 1 shows the noise level at the starting point and at one-mile intervals up to the fourth mile. Figure 1 shows the approximately 110 data points taken at each one-mile mark. The average at the gate was high because the gate is adjacent to State Road 4 and cars were passing almost continuously.

Sources for noise in Los Alamos Canyon were environmental—a slight wind in the trees, the calling of birds, and a stream, which, at three miles from the gate, was approximately 25 feet away from the sound level meter and, at four miles from the gate, was less than 10 feet from the sound level meter.

3.3 Cañada del Buey

Table 2 shows the readings at the starting point and at one-mile intervals up to the third mile in Cañada del Buey. Figure 2 shows the approximately 110 data points taken at each one-mile mark. At the gate the higher levels were caused by the frequent passing of cars. Other sources of noise for Cañada del Buey were environmental and the hum of machinery at TA-54.

3.4 Water Canyon

Table 3 shows the readings at the starting point and at one-mile intervals up to the third mile in Water Canyon. Figure 3 shows the approximately 110 data points taken at each one-mile mark. Passing cars were heard periodically at the gate of Water Canyon, resulting in a higher maximum and overall mean. At the other points, noise was purely environmental.

3.5 Mortandad Canyon

Table 4 shows the measurements from Mortandad Canyon. Figure 4 shows the approximately 110 data points taken at each one-mile mark. The end of the pavement was located next to a parking lot, yielding the sound of one car pulling out and that of people walking from their cars to nearby buildings. The primary noises heard at the other points were environmental. Thunder was heard while measurements were made. One very loud clap of thunder was recorded four miles from the end of the pavement, giving the highest decibel reading taken in the study, 76 dBA.

3.6 Rendija Canyon

Rendija Canyon, Table 5, was the quietest canyon measured, and the actual levels could have been lower than the meter's lower limit of 35 dBA, which was recorded at three of the four points. There was no man-made noise audible while measurements were being taken.

Table 1: Measurements taken in Los Alamos Canyon; August 6, 1997, 8:30 to 9:30 AM.

	at gate	miles from gate			
	∅	1	2	3	4
mean (dBA)	62	39	38	44	50
maximum (dBA)	74	42	44	48	52
minimum (dBA)	45	38	38	38	49
standard deviation	6.1	1.1	1.0	1.0	0.7

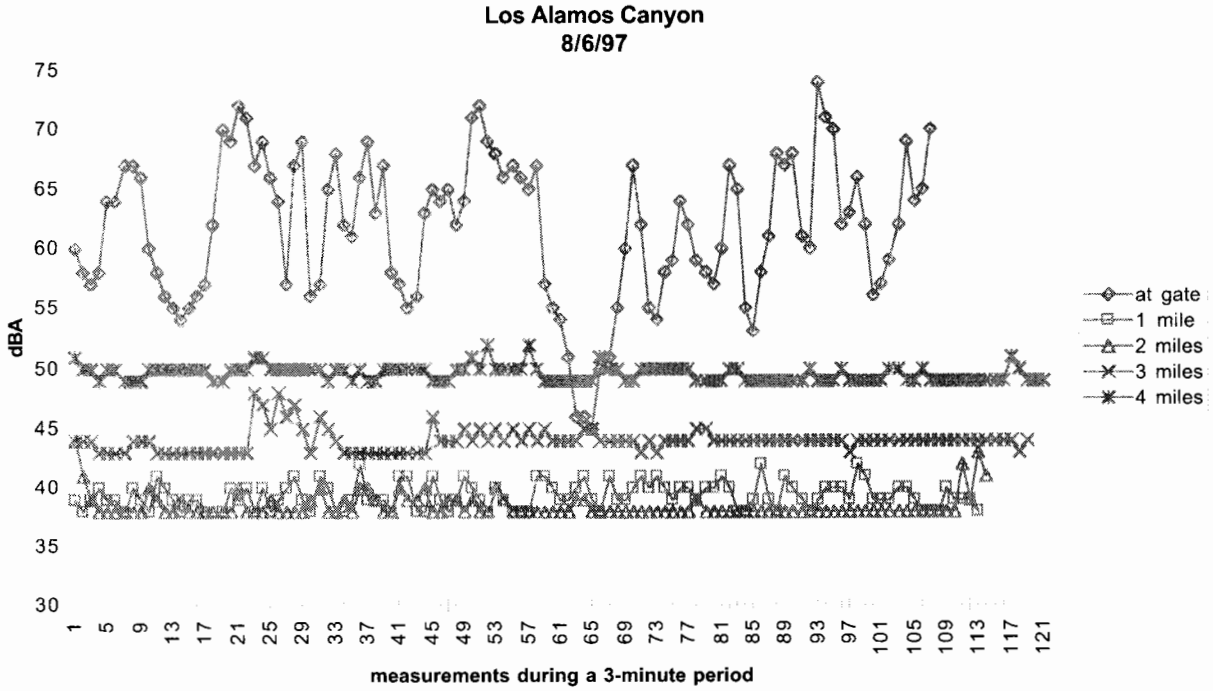

Figure 1. Sound levels recorded at each one-mile mark in Los Alamos Canyon.

Table 2: Measurements taken in Cañada del Buey; August 6, 1997, 9:55 to 10:40 AM.				
	at gate	miles from gate		
	∅	1	2	3
mean (dBA)	47	44	37	37
maximum (dBA)	63	48	39	38
minimum (dBA)	38	40	37	37
standard deviation	8.0	2.4	0.3	0.4

Table 3: Measurements taken in Water Canyon; August 20, 1997, 9:00 to 9:45 AM.				
	at gate	miles from gate		
	∅	1	2	3
mean (dBA)	40	35	37	38
maximum (dBA)	62	38	44	51
minimum (dBA)	35	35	35	35
standard deviation	7.6	0.4	2.1	4.3

Table 4: Measurements taken in Mortandad Canyon; August 25, 1997, 1:40 to 2:25 PM.					
	end of pavement	miles from end of pavement			
	∅	1	2	3	4
mean (dBA)	47	38	42	37	41
maximum (dBA)	61	445	58	51	76
minimum (dBA)	40	36	36	35	35
standard deviation	4.7	2.0	4.9	2.9	8.8

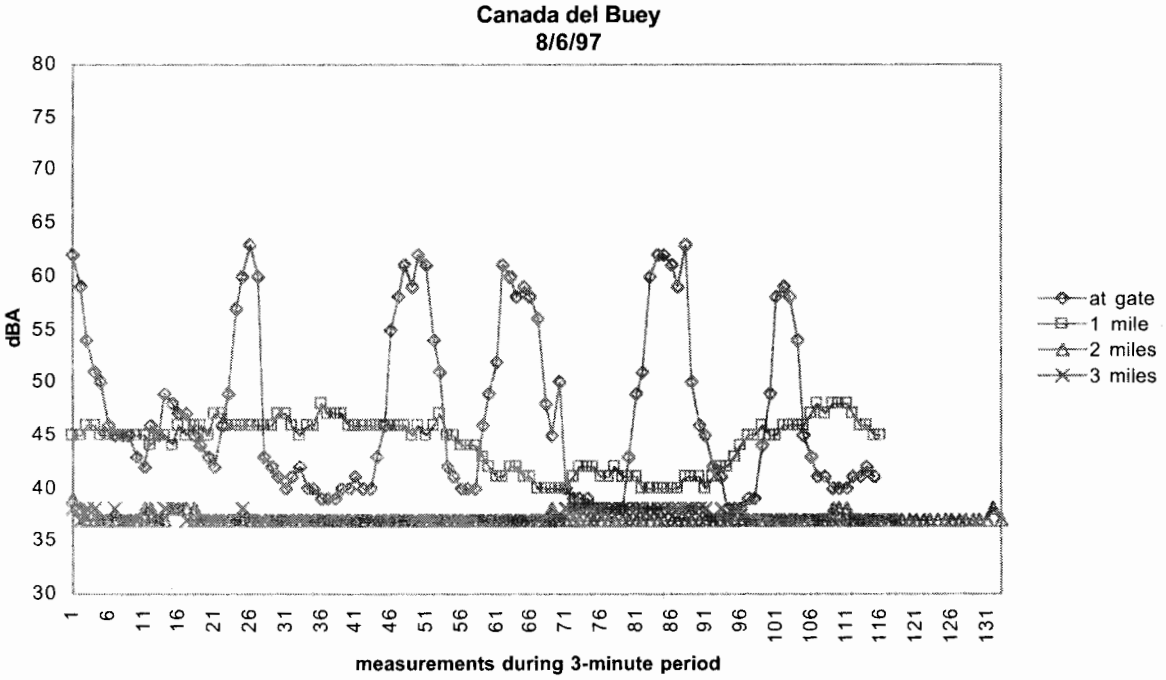

Figure 2. Sound levels recorded at each one-mile mark in Cañada del Buey.

3.7 Upper Los Alamos Canyon

Table 6 shows the measurements from Los Alamos Canyon. Figure 6 shows the approximately 110 data points taken at each one-mile mark. At the gate of Los Alamos Canyon, the noise was due to both the stream, which was approximately 20 feet away, and the approach of a car on the road into the canyon toward the end of the measurements, the car was approximately 50 feet away at the nearest while recording was taking place.

The fairly high reading at 1 mile from the gate was caused by the almost continuous passing of joggers.

3.8 Disturbances

Several disturbances occurred while sound measurements were being recorded. These are all fairly routine and included thunder (one time), cars, flowing water, and joggers (Table 7). While these sounds may not seem to be extremely loud, compared to other environmental noise they are significant.

3.8.1 Passing Cars

Passing cars caused a large increase in the readings at several of the gates, the exact magnitude of the increase depended on the distance from the cars, the speed of the passing cars, and the number of cars passing simultaneously. Table 8 shows the noise levels for passing cars in three canyons. Figure 7 shows the data points for the three-minute measurements taken at the three canyons where cars were heard. The higher maximum, and therefore higher reading of a passing car, for Los Alamos Canyon is due to the fact that there were multiple cars passing simultaneously.

The higher average is due to the fact that the cars went by almost constantly, which did not allow for the sound level to reach its minimum point. Both Cañada del Buey and Water Canyon had practically the same maximum reading, in both cases only a single car passed at any point in time and time elapsed between each pass, allowing the meter to register the natural background noise.

4.0 Discussion

In Los Alamos County, animals experience sound that varies widely—from loud, stochastic thunderclaps, continuous traffic noises, and running water. As could be expected, sound levels were higher in areas of human disturbance—near paved roads and in canyons adjacent to developments—than in areas away from human disturbances. In order to minimize the effects of increased noise levels, future developments should be placed near areas of existing disturbance, leaving those areas that are isolated from human impacts to remain free from projects that would greatly increase the ambient noise levels.

In the future, more baseline sound levels should be recorded to make certain that the data presented above are indicative of typical noise levels.

5.0 Acknowledgments

This project was funded as part of the Threatened and Endangered Species Habitat Management Plan. We would like to thank Leslie Hansen, ESH-20, for assisting in the field, Teralene

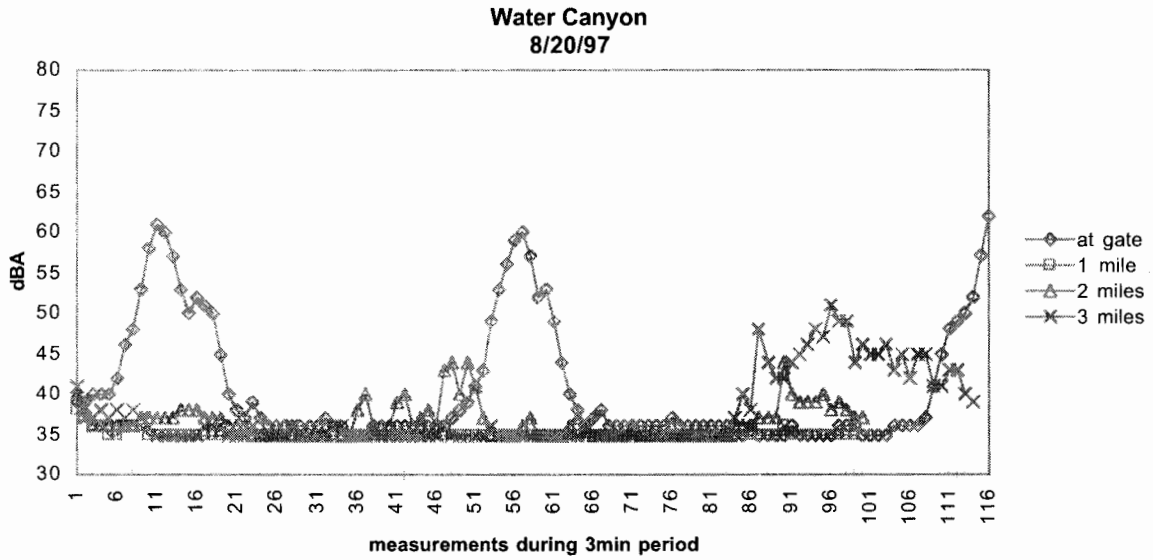

Figure 3. Sound levels recorded at each one-mile mark in Water Canyon.

APPENDIX 1

Los Alamos
NATIONAL LABORATORY
memorandum

Environment, Safety and Health Division
Industrial Hygiene and Safety Group (ESH-5)

To/MS: Michael Burns, DX-DO (P940)
From/MS: Ernesto A. Vigil, ESH-5 (K494)
Phone/Fax: 7-0858/7-1945
Symbol: ESH-5:95-11825
Date: March 17, 1995

SUBJECT: NOISE MEASUREMENTS AT STATE ROAD 4 AND BANDELIER TURN OFF AT STATE ROAD 4 DURING PHERMEX TEST ON MARCH 11, 1995

Sound level and octave band sound level measurements were made at two locations along State Road 4 during explosives tests at Phermex on Saturday, March 11, 1995.

The locations of these measurements were at 1) approximately 3/4 mile East of TA-49 gate just inside Laboratory Property and 2) approximately 100 yards west of the bandelier turn off inside Laboratory property. GPS position measurements have been made at these locations and are as follows: 35° 49.133' LAT. 106° 18.518' LONG. and 35° 47.797' LAT. 106° 16.545' LONG. for these locations, respectively.

Measurements were made using an IVIE sound level meter at each location. The two instruments were calibrated pre-shot and post-shot. The following table presents data obtained. All readings were obtained with the wind screen in place.

Location I
3/4 Mile East of TA-49 Gate

Shot #	31.5	63	125	250	500	1K	2K	4K	8K	dBA
1 (0942)	32	42	54	52	50	46	42	44	48	----
2 (0943)	<46	52	58	58	46	52	<46	---	---	66.3
3 (0944)	48	52	62	62	60	58	48	---	---	68.4
4 (0945)	---	54	56	54	54	50	48	---	---	64.4
5 (0946)	48	50	60	64	62	60	50	50	---	70.0
6 (0958)	---	62	68	64	64	58	54	48	---	71.1

Background

31.5	63	125	250	500	1K	2K	4K	8K	dBA
49	41	34	30	31	25	25	---	---	31

IVIE #677

Location II
Approximately 100 Yards West of Bandelier Entrance

Shot #	31.5	63	125	250	500	1K	2K	4K	8K	dBA
1 (942)	<50	<50	<50	<50	<50	<50	<50	<50	---	63
2 (943)	Data made invalid by Road Noise									
3 (944)	38	52	56	54	52	48	42	40	36	---
4 (945)	36	42	50	50	54	56	48	40	42	62
5 (946)	40	46	54	52	48	42	38	36	40	61
6 (958)	40	48	54	56	52	54	52	36	<36	60

Background

31.5	63	125	250	500	1K	2K	4K	8K	dBA
42	40	38	34	32	30	28	30	28	35

IVIE #436

For location number 2 the noise associated with passing traffic ranged from 60 to 64 dBA depending on whether the individual vehicle turned off to Bandelier or continued on through, respectively.

Attachment I through III are summaries of weather data obtained at the Laboratory weather station (Bandelier [2146 MSL]) located off state road 4 southeast of TA-49.

EAV:ns

Att: Graph

Cy: IHFSS Files, ESH-5 (K494)

APPENDIX 2

Los Alamos
NATIONAL LABORATORY
memorandum

DUAL-AXIS RADIOGRAPHIC HYDROTE
FACILITY (DARHT)
DX/DO

To/MS: Distribution
From/MS: M. J. Burns, DX/DO, MS P
Phone/Fax: 5-2215/7-8316
Symbol: DX/DO:DARHT-95-31
Date: March 13, 1995

SUBJECT: WHITE ROCK NOISE MEASUREMENTS DURING PHERMEX TESTS, MARCH 11, 1995

Reported here are sound level measurements made in White Rock by David Broxton (EES-1) and Carol Burns (ET) during PHERMEX explosives tests conducted Saturday, March 11, 1995.

The location of the measurement was approximately 100-150 feet east of the intersection of State Road 4 and Karen Circle in White Rock. Two GPS position measurements were made at the recording location using a Garmin GPS 40 (serial number 34011915). The first result was North 35.82033 deg., West 106.22203 deg. The second reading was North 35.82019 deg., West 106.22160 deg. (W. Hawkins reports that the GPS reading at the PHERMEX firing point during instrument implacement was North 35 deg., 49.990 min., West 106 deg., 17.682 min.)

Sound levels were recorded using a GenRad 1982 Precision Sound Level Meter and Analyzer (serial number 4420, H-5 FSS No. 170, Los Alamos property number 694063, DOE/LASL PN 347883, last calibrated Jan. 1995). Instrument settings were: Octave Filter Frequency: 250 Hz; Weighting: A; dB Range: 30-80; Detector: slow. A wind protector was fitted over the sensing element during the measurements.

To make the measurements, the general background level before the PHERMEX shot was recorded using the instrument's analog gauge. This background ranged from a low of about 38 dBA for a quiet neighborhood to a high of about 51 dBA, usually associated with a car passing on State Road 4. Radio communication was maintained with R310 and the time interval between the shot execution (provided by a countdown heard over the radio) and arrival of the blast sound was recorded (see the "Interval (sec.)" column in the table below). Finally, the peak noise level was recorded as the blast sound arrived using the instrument's digital peak hold readout. The data are presented in the table below:

White Rock Sound Measurements from PHERMEX Tests
11 March 1995

Shot Number	Approx. HE load (lbs. TNT)	Approx. shot time (MST)	Peak noise level (dBA)	Interval (sec.)
0942	10	1216	60.9	19.8
0943	25	1239	65.3	19.5
0944	50	1302	69.1	19.8
0945	50	1333	63.1	19.6
0946	100	1355	71.6	19.7
0958	150	1417	68.6	20.0