HARRIS MILLER MILLER & HANSON INC.
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Rick Ernenwein
National Park Service
Denver Service Center
12795 West Alameda Parkway
Denver, CO 80225

Subject: Summary of Noise Monitoring Results - Zion, Rocky Mountain National Parks

Reference: HMMH Project No. 295270.02

hmmh

Dear Rick:

We are enclosing the summarized results of Dick Hingson's use of LOWNOMS in Zion and Rocky Mountain National Parks in August and September of 1995. We have provided the summaries in a format as close as we could get to LOWNOMS standard results using a spread sheet program.

Though more work and thought needs to be devoted to interpretation of measurements, as we have discussed, I believe that it is likely we will end up focusing on the following measures:

For Intruding Sounds:

Percent of Time Audible - This metric tells simply how much of the time an attentive listener could have heard the intruding sounds. Though results vary from site to site, dose-response work to-date indicates that when aircraft are audible no more than 20% to 30% of the time, few visitors (about one-fourth or fewer) would report moderate to extreme annoyance. Also, when aircraft are audible no more than 5% to 10% of the time, few visitors (about one-fourth or fewer) would report moderate to extreme interference with natural quiet.

Sound Level Difference (Intruding Leq minus Background Leq) This metric indicates the amount that the intruding sound exceeds the background sound, in terms of both level and duration. Results vary from site to site, but if intruding aircraft Leq is within about 5 dB of the background Leq, the number of visitors reporting moderate to extreme annoyance should be kept to less than one-fourth of all visitors. Also, reports of moderate to extreme interference with natural quiet similarly should generally be limited to less than one-fourth of visitors if the intruding aircraft Leq is no more than equal to or less than the background Leq.

For Background Sounds:

Percent of Time Audible - This is the amount of time no intruding sounds are audible to an attentive listener.

Leq and L50 - These describe the sound levels of the background. The L50 is the median level - the level that the background sound exceeds half the time when only

the background is audible, and that the background sound is less than for half the time. Leq relates directly to the sound energy of the background sounds. When Leq is close to L50 (about 1dB to 3 dB greater than L50), the background sound does not vary much over time. When background Leq is more than about 3 dB larger than the background L50, then the background sound levels have some occasional higher levels.

(Quantifying any of these observations very specifically would require considerable effort, and may or may not be valuable, considering the variability of sound levels from place to place, the variability of visitor sensitivity to sound intrusions, and the intended use for this type of information.)

We include a two page memorandum for each park that describes the summary results, single page quantitative summaries for each measurement sample (nominally one hour long, each), a map of each park showing the measurement site locations, and two copies of the LOWNOMS manual.

I hope this information suits your needs. Please give me a call if you wish to discuss this information further, or have additional questions.

Sincerely,

HARRIS MILLER MILLER & HANSON INC.

Nicholas P. Miller
President

Attachments (2 measurement packages, two manuals)

HARRIS MILLER MILLER & HANSON INC.
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MEMORANDUM

To: Rick Ernenwein
National Park Service
Denver Service Center
12795 West Alameda Parkway
Denver, CO 80225

From: Nicholas P. Miller

Date: August 27, 1998

Subject: Noise Monitoring Results - Zion National Park

Reference: HMMH Job No. 295270.02

hmmh

The attached pages (Sound Source Observations) summarize the results of the noise monitoring conducted by Dick Hingson in Zion National Park during the period from 16 August 1995 through 12 September 1995. This monitoring was done during initial testing of the LOWNOMS system, which is described in detail in the enclosed manual. During these measurements, though the sound monitoring system worked continuously, some of the ancillary devices, namely the source identification "button box" and the wind monitor were not always functioning properly. In cases where the button box was not functioning, Dick tracked the sources by keeping a hand-written log. We have for these cases entered his logs into a format that could be analyzed with spread-sheet computations. For consistency of format, we used these spread sheet computations to analyze all the data he collected. The following paragraphs describe the information presented on the pages.

Site Locations

Measurements were made at the ten sites which are shown on the enclosed map. Dates and times of measurements are given, as is the approximate elevation of the site.

Site No.

1. WATCHMAN (7 samples)
2. EAST CANYON, PETRGLYPH (4 samples)
3. MAIN CANYON, SCOUT (4 samples)
4. MAIN CANYON, EMERALD (3 samples)
5. TABERNACLE DOME (2 samples)
6. KOLOB, TIMBER CREEK (3 samples)
   KOLOB, TERRACE (3 samples)
7. MAIN CANYON, RIVER FLAT (2 samples)
8. MAIN CANYON, THRONE (2 samples)
9. MAIN CANYON, WEEPING ROCK (2 samples)
10. COAL PITS (1 sample)

Intruding Sources

This table identifies the intruding sources and the percent of the measurement period (normally one hour) that each was audible. It also gives the "equivalent sound level" or Leq of each intruding source during the measurement period. Leq is a measure of the total sound

energy produced by each source during the measurement and indicates which sources are relatively the loudest and/or the longest. For example, at Watchman, 8/25/95, start at 2:54 PM, commercial jets are the loudest intruding source, even though they are not heard as much of the time as are motor vehicles; hence commercial jets produced a higher Leq. Overall, intruding sources were heard 78% of the time during this measurement sample.

Background Sources

This table gives the equivalent levels produced by the background sources during the times each was audible. In general, background sounds are not likely to be highly variable during a measurement period (normally one hour), and this lack of variation is indicated when the Leq (all sources), the L50 (all sources), and the L90 (all sources) are within a few decibels of each other. L50 is the level which the background sources exceed for half of the time; L90 is the level which the background sources exceed for 90% of the time. For the Watchman sample, all background sources are about equally loud.

In both the Intruding and Background Sources tables, "Not Ascertained" means that the operator did not identify the specific type of intruding or background source.

Source Audibility Summary

This table gives the amount of time each of three basic categories of sound were audible - background only, intruding (other than aircraft), and aircraft. For the Watchman example, there were no intruding sounds audible for 22% of the hour.

A-weighted Sound Level vs Time

This plot shows the measured second-by-second A-weighted sound levels, and identifies the source of the levels withdark horizontal lines or points at various levels, keyed to the list of levels to the left of the plot. For example, when Dick heard motor vehicles as the intruding source, a dark line is shown at the "90" level. Commercial jets are identified by dark lines (or points) at the "85" level.

This plot can be related to the other information. For the Watchman 2:54pm sample, motor vehicles (dark line at 90) clearly could be heard much of the time (47% of the time). Commercial jets were occasionally heard (dark lines at 85) - for 25% of the time - and three can easily be seen to affect the sound levels at about 37 minutes, 45 minutes, and 52 minutes into the sample period. It is primarily these three overflights that produce the Leq of 36 dB. For the brief period at about 50 minutes, when no motor vehicles, no aircraft, no wind sources are audible (only "other" - dark line at 70), the level drops to about 28 dBA, as confirmed by the Background Sources table for (6) Other.

ZION NATIONAL PARK
Sound Source Observations

WATCHMAN Elevation 4126 Feet
8/25/95
02:54 PM -- 03:57 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	4%	14
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	2%	12
(3) Commercial Jet	25%	36
(4) Motor Vehicles	47%	27
(6) Other	0%	--
Total	78%	36

Aircraft Leq minus Background Leq = 6 dB

Background Sources

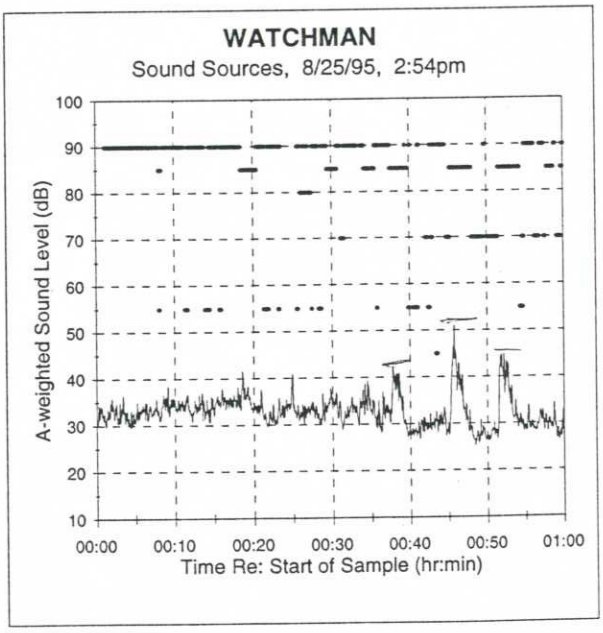
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	31
(1) Wildlife	31
(2) Water	--
(3) Wind	32
(4) Human	--
(6) Other	28
Leq (all sources)	30
L50 (all sources)	29
L90 (all sources)	27

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	22%
Intruding (Other)	51%
Intruding (Aircraft)	27%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

WATCHMAN Elevation 4126 Feet
8/25/95
04:47 PM -- 05:49 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	9%	16
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	15%	29
(4) Motor Vehicles	59%	27
(6) Other	0%	--
Total	82%	31

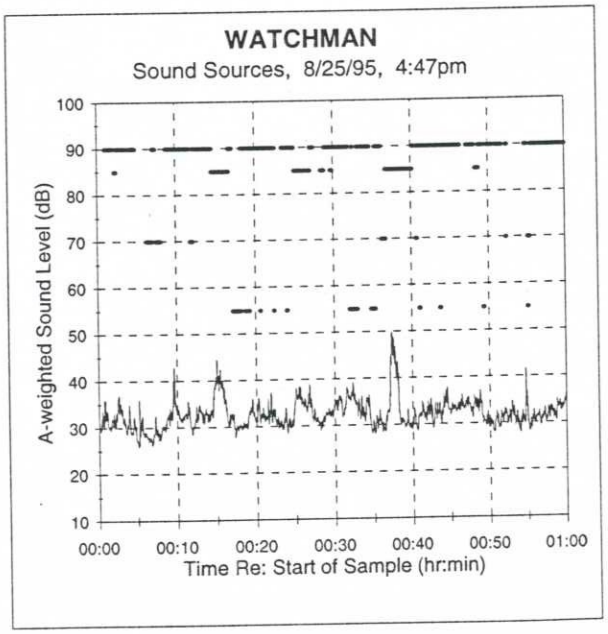
Aircraft Leq minus Background Leq = -2 dB

Background Sources

Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	31
(1) Wildlife	--
(2) Water	--
(3) Wind	32
(4) Human	30
(6) Other	29
Leq (all sources)	31
L50 (all sources)	30
L90 (all sources)	28

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	18%
Intruding (Other)	67%
Intruding (Aircraft)	15%
Total	100%



Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife

[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, WATCHMAN Elevation 4000 Feet
8/28/95
10:35 AM -- 11:36 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	4%	14
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	10%	29
(4) Motor Vehicles	48%	27
(6) Other	2%	--
Total	64%	31

Aircraft Leq minus Background Leq = -1 dB

Background Sources

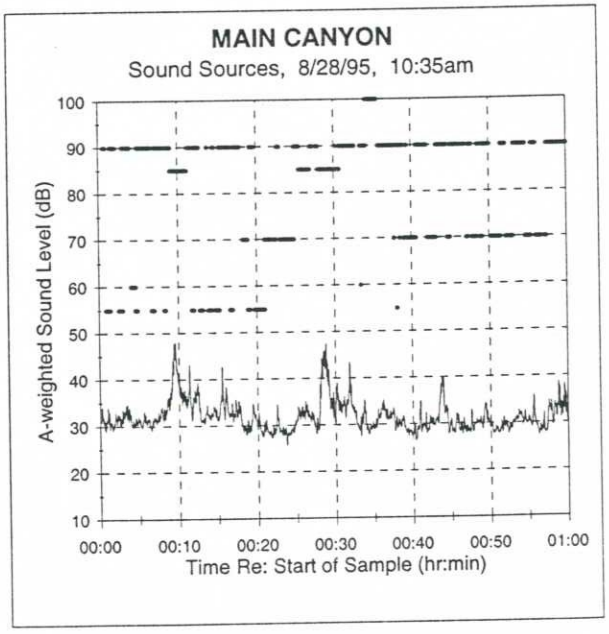
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	30
(1) Wildlife	--
(2) Water	--
(3) Wind	32
(4) Human	31
(6) Other	29
Leq (all sources)	30
L50 (all sources)	30
L90 (all sources)	28

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	36%
Intruding (Other)	54%
Intruding (Aircraft)	10%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, WATCHMAN Elevation 4000 Feet
8/28/95
12:19 PM -- 01:20 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	2%	15
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	7%	30
(3) Commercial Jet	17%	34
(4) Motor Vehicles	27%	23
(6) Other	1%	2
Total	53%	36

Aircraft Leq minus Background Leq = 5 dB

Background Sources

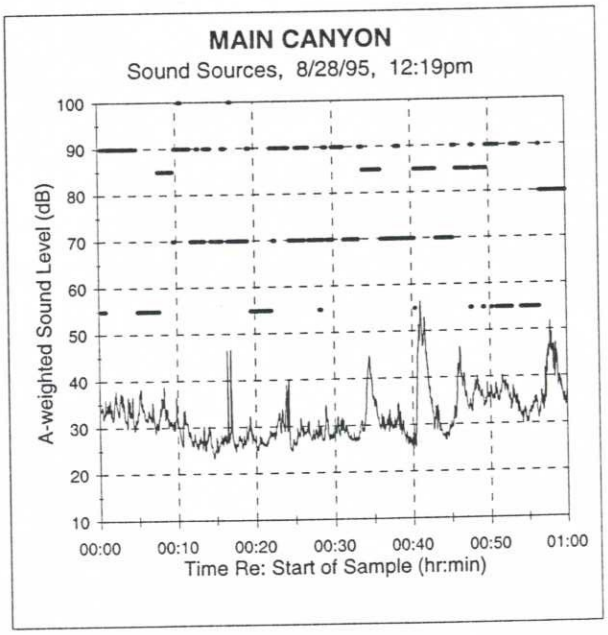
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	31
(1) Wildlife	--
(2) Water	--
(3) Wind	33
(4) Human	--
(6) Other	28
Leq (all sources)	31
L50 (all sources)	28
L90 (all sources)	26

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	47%
Intruding (Other)	30%
Intruding (Aircraft)	23%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, WATCHMAN Elevation 4000 Feet
9/2/95
09:09 AM -- 10:09 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	9%	28
(3) Commercial Jet	15%	29
(4) Motor Vehicles	67%	--
(6) Other	0%	--
Total	90%	32

Aircraft Leq minus Background Leq = -5 dB

Background Sources

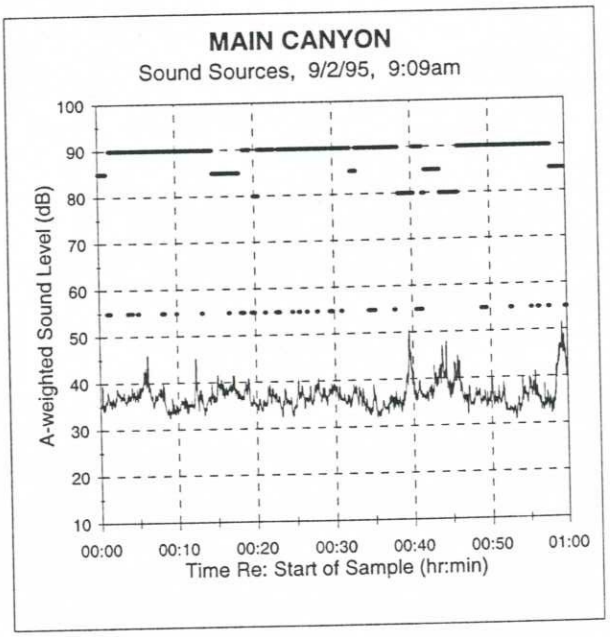
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	--
(2) Water	--
(3) Wind	37
(4) Human	--
(6) Other	--
Leq (all sources)	37
L50 (all sources)	36
L90 (all sources)	34

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	10%
Intruding (Other)	67%
Intruding (Aircraft)	23%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, WATCHMAN Elevation 4000 Feet
9/2/95
10:30 AM -- 11:30 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	3%	1
(3) Commercial Jet	21%	26
(4) Motor Vehicles	70%	22
(6) Other	0%	--
Total	94%	27

Aircraft Leq minus Background Leq = -7 dB

Background Sources

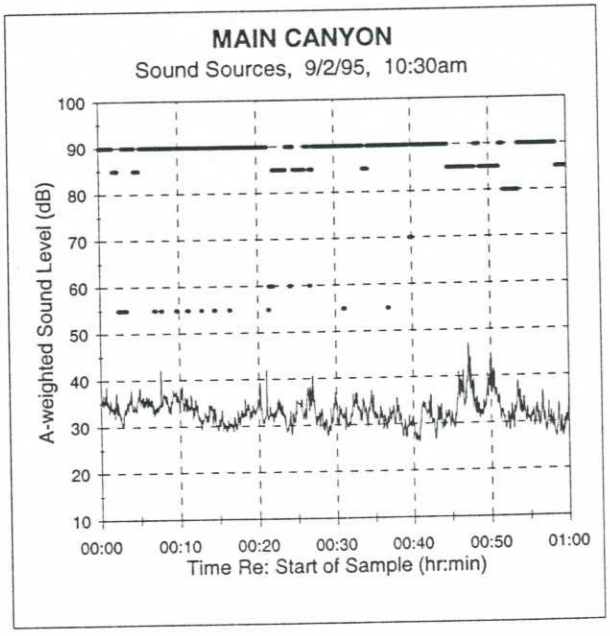
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	--
(2) Water	--
(3) Wind	33
(4) Human	32
(6) Other	30
Leq (all sources)	33
L50 (all sources)	32
L90 (all sources)	30

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	6%
Intruding (Other)	70%
Intruding (Aircraft)	24%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, WATCHMAN Elevation 4000 Feet
9/2/95
12:49 PM -- 01:49 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	21%	29
(4) Motor Vehicles	79%	32
(6) Other	0%	--
Total	100%	33

Aircraft Leq minus Background Leq = 29 dB

Background Sources

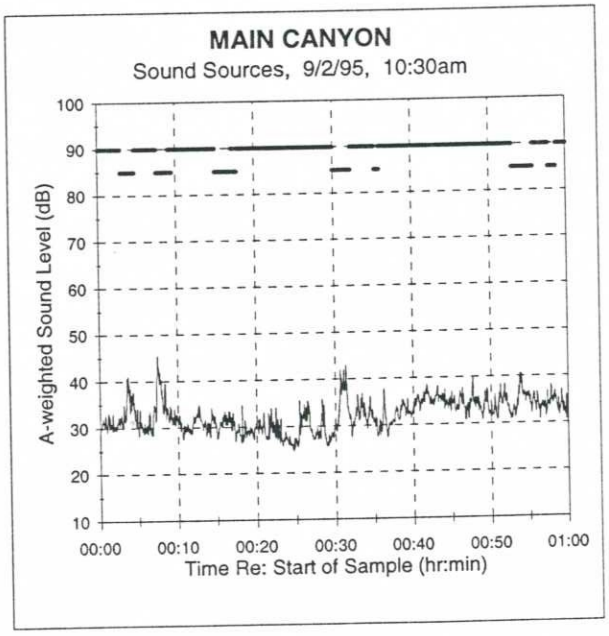
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	--
(2) Water	--
(3) Wind	--
(4) Human	--
(6) Other	--
Leq (all sources)	--
L50 (all sources)	--
L90 (all sources)	--

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	0%
Intruding (Other)	79%
Intruding (Aircraft)	21%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

EAST CANYON, PETROGLYPH Elevation 5450 Feet
8/30/95
03:07 PM -- 04:08 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	7%	18
(3) Commercial Jet	3%	19
(4) Motor Vehicles	14%	--
(6) Other	0%	--
Total	24%	22

Aircraft Leq minus Background Leq = -12 dB

Background Sources

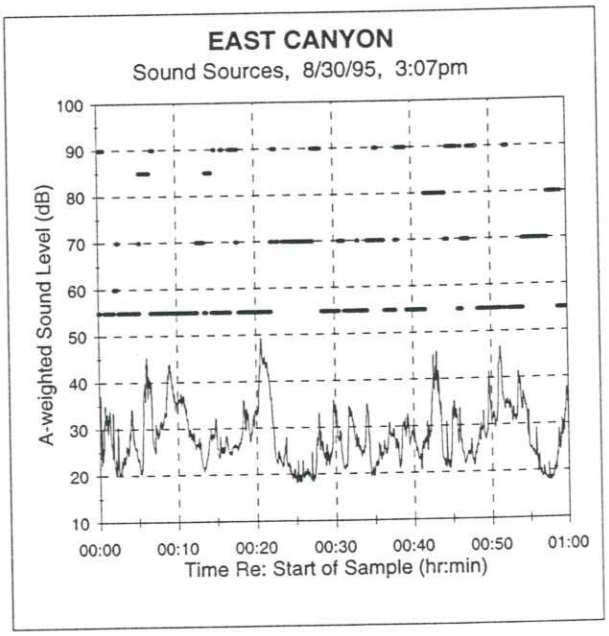
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	--
(2) Water	--
(3) Wind	35
(4) Human	24
(6) Other	25
Leq (all sources)	34
L50 (all sources)	27
L90 (all sources)	21

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	76%
Intruding (Other)	14%
Intruding (Aircraft)	10%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

EAST CANYON, PETROGLYPH Elevation 5450 Feet
8/30/95
04:26 PM -- 05:26 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	0%	--
(4) Motor Vehicles	13%	--
(6) Other	0%	--
Total	13%	--

Aircraft Leq minus Background Leq = --

Background Sources

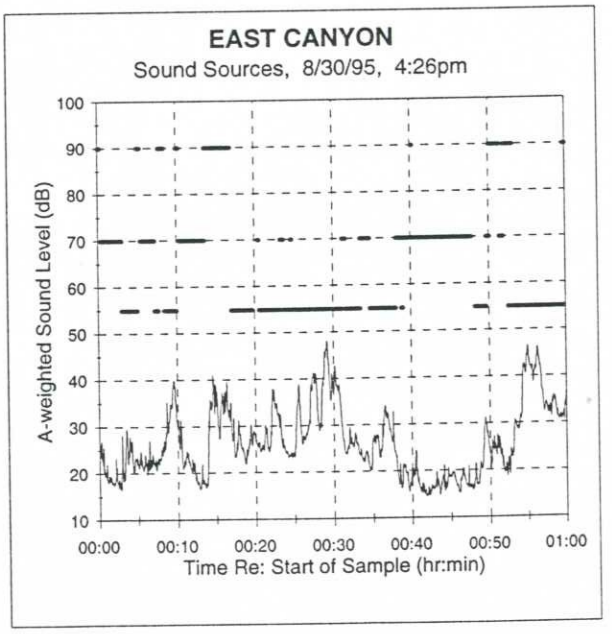
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	--
(2) Water	--
(3) Wind	36
(4) Human	--
(6) Other	21
Leq (all sources)	34
L50 (all sources)	25
L90 (all sources)	17

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	87%
Intruding (Other)	13%
Intruding (Aircraft)	0%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

EAST CANYON, PETROGLYPH Elevation 5450 Feet
8/31/95
09:53 AM -- 10:53 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	2%	--
(2) Scenic Aircraft	7%	29
(3) Commercial Jet	22%	30
(4) Motor Vehicles	7%	--
(6) Other	0%	--
Total	38%	32

Aircraft Leq minus Background Leq = 9 dB

Background Sources

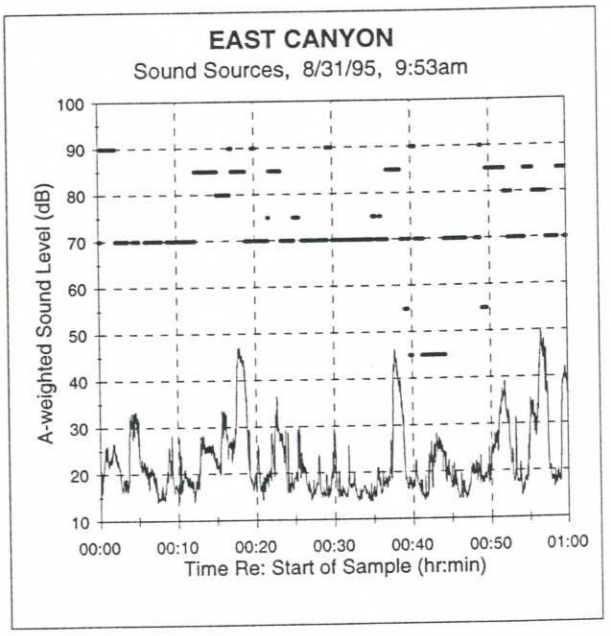
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	23
(2) Water	--
(3) Wind	18
(4) Human	--
(6) Other	23
Leq (all sources)	23
L50 (all sources)	18
L90 (all sources)	15

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	62%
Intruding (Other)	7%
Intruding (Aircraft)	31%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

EAST CANYON, PETROGLYPH Elevation 5450 Feet
8/31/95
11:06 AM -- 12:06 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	12%	19
(4) Motor Vehicles	9%	6
(6) Other	0%	--
Total	21%	19

Aircraft Leq minus Background Leq = 0 dB

Background Sources

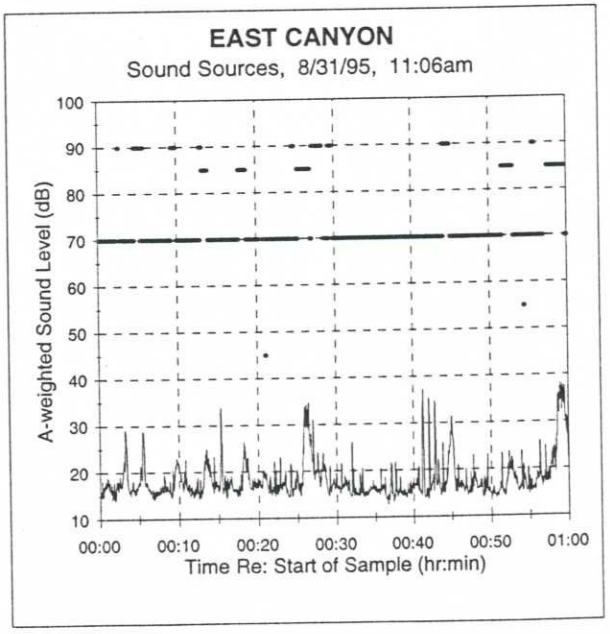
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	18
(2) Water	--
(3) Wind	17
(4) Human	--
(6) Other	19
Leq (all sources)	19
L50 (all sources)	16
L90 (all sources)	15

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	79%
Intruding (Other)	9%
Intruding (Aircraft)	12%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, SCOUT Elevation 5500 Feet
9/1/95
12:20 PM -- 01:21 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	5%	26
(3) Commercial Jet	26%	29
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	31%	31

Aircraft Leq minus Background Leq = 9 dB

Background Sources

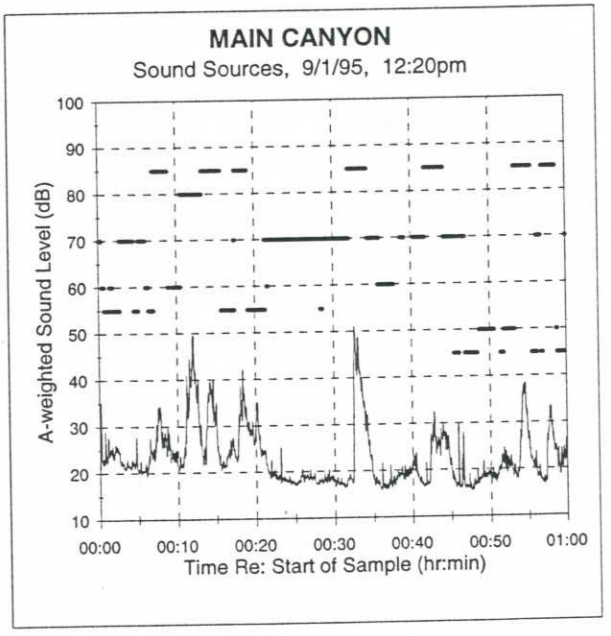
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	20
(2) Water	20
(3) Wind	26
(4) Human	21
(6) Other	20
Leq (all sources)	22
L50 (all sources)	20
L90 (all sources)	17

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	69%
Intruding (Other)	0%
Intruding (Aircraft)	31%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, SCOUT Elevation 5500 Feet
9/1/95
01:45 PM -- 02:45 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	23%	36
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	23%	36

Aircraft Leq minus Background Leq = 6 dB

Background Sources

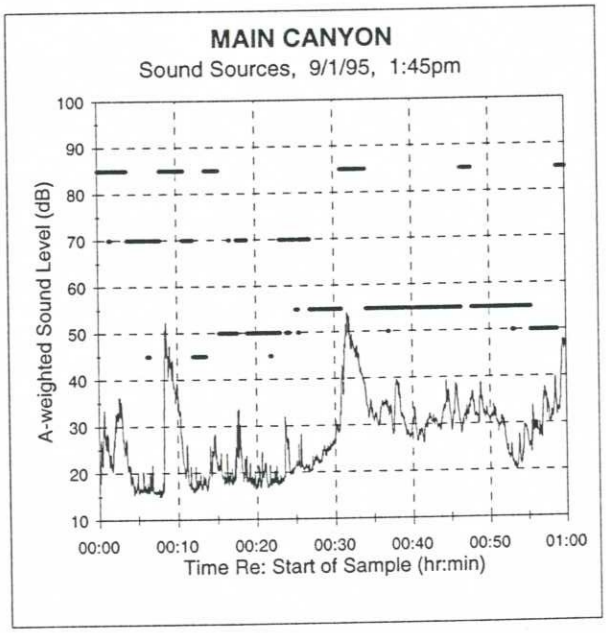
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	17
(2) Water	29
(3) Wind	32
(4) Human	--
(6) Other	21
Leq (all sources)	30
L50 (all sources)	26
L90 (all sources)	17

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	77%
Intruding (Other)	0%
Intruding (Aircraft)	23%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, SCOUT Elevation 5500 Feet
9/7/95
09:32 AM -- 10:32 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	13%	28
(3) Commercial Jet	18%	26
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	31%	30

Aircraft Leq minus Background Leq = 11 dB

Background Sources

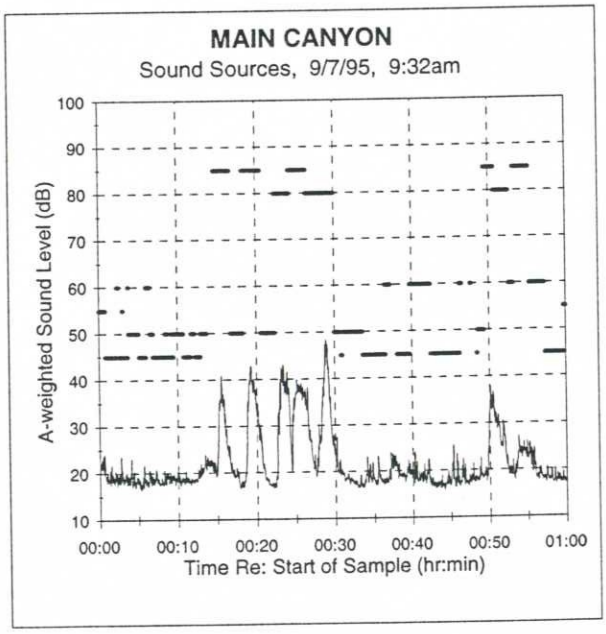
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	18
(2) Water	19
(3) Wind	20
(4) Human	19
(6) Other	--
Leq (all sources)	19
L50 (all sources)	19
L90 (all sources)	17

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	69%
Intruding (Other)	0%
Intruding (Aircraft)	31%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, SCOUT Elevation 5500 Feet
9/7/95
10:50 AM -- 11:50 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	6%	23
(3) Commercial Jet	25%	32
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	30%	33

Aircraft Leq minus Background Leq = 9 dB

Background Sources

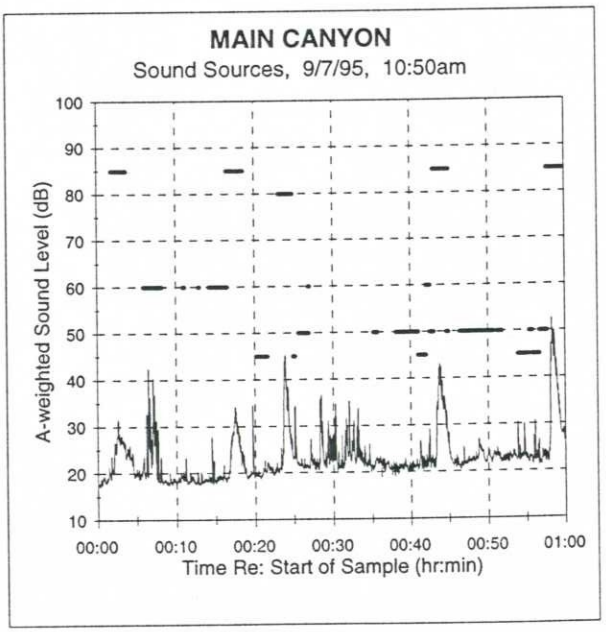
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	23
(2) Water	22
(3) Wind	--
(4) Human	26
(6) Other	--
Leq (all sources)	24
L50 (all sources)	22
L90 (all sources)	19

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	70%
Intruding (Other)	0%
Intruding (Aircraft)	30%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, EMERALD Elevation 4650 Feet
9/11/95
03:31 PM -- 04:32 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	3%	21
(3) Commercial Jet	12%	22
(4) Motor Vehicles	5%	--
(6) Other	0%	--
Total	19%	25

Aircraft Leq minus Background Leq = -16 dB

Background Sources

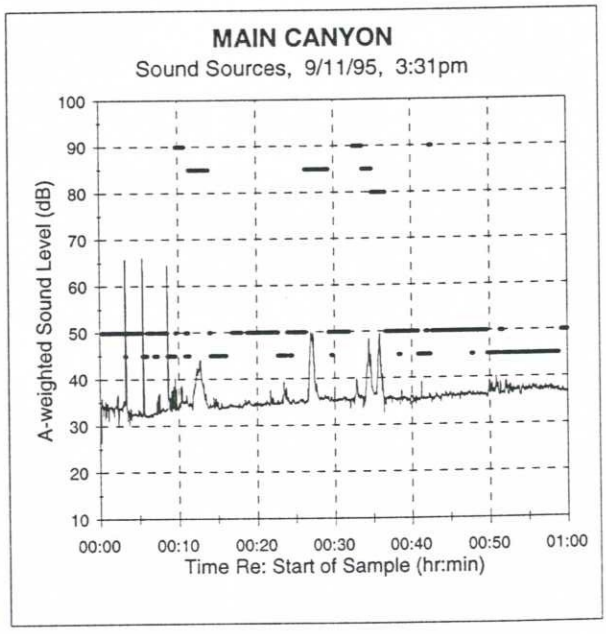
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	44
(2) Water	35
(3) Wind	--
(4) Human	--
(6) Other	--
Leq (all sources)	41
L50 (all sources)	36
L90 (all sources)	33

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	81%
Intruding (Other)	5%
Intruding (Aircraft)	15%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, EMERALD Elevation 4650 Feet
9/11/95
04:56 PM -- 05:56 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	3%	--
(3) Commercial Jet	10%	33
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	13%	33

Aircraft Leq minus Background Leq = -2 dB

Background Sources

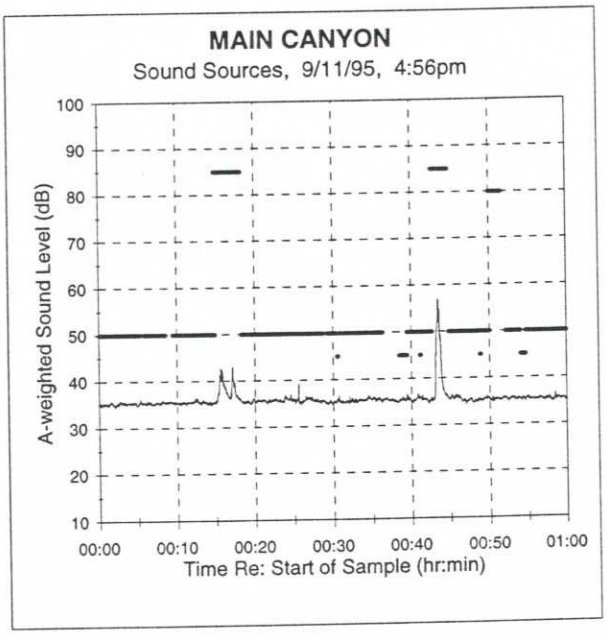
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	35
(2) Water	35
(3) Wind	--
(4) Human	--
(6) Other	--
Leq (all sources)	35
L50 (all sources)	35
L90 (all sources)	35

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	87%
Intruding (Other)	0%
Intruding (Aircraft)	13%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, EMERALD Elevation 4650 Feet
9/11/95
06:18 PM -- 07:18 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	16%	26
(4) Motor Vehicles	4%	3
(6) Other	0%	--
Total	20%	26

Aircraft Leq minus Background Leq = -10 dB

Background Sources

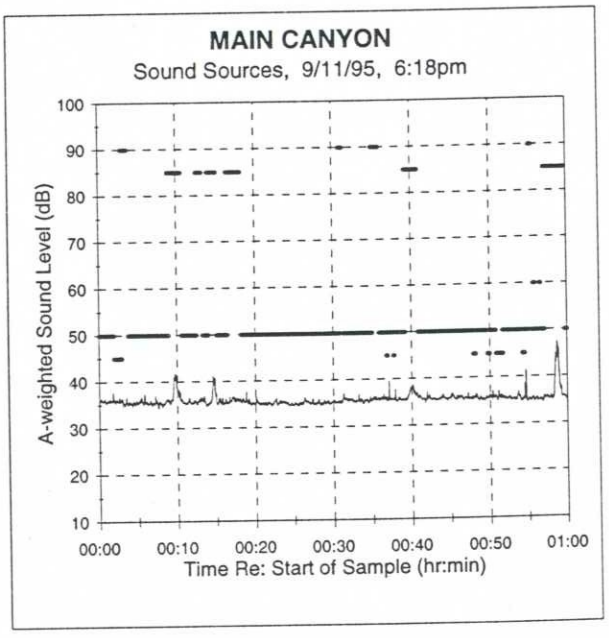
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	36
(2) Water	36
(3) Wind	--
(4) Human	35
(6) Other	--
Leq (all sources)	36
L50 (all sources)	35
L90 (all sources)	35

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	80%
Intruding (Other)	4%
Intruding (Aircraft)	16%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

TABERNACLE DOME Elevation 5150 Feet
8/26/95
10:40 AM -- 11:48 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	4%	4
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	6%	22
(3) Commercial Jet	18%	34
(4) Motor Vehicles	3%	6
(6) Other	0%	--
Total	31%	35

Aircraft Leq minus Background Leq = 11 dB

Background Sources

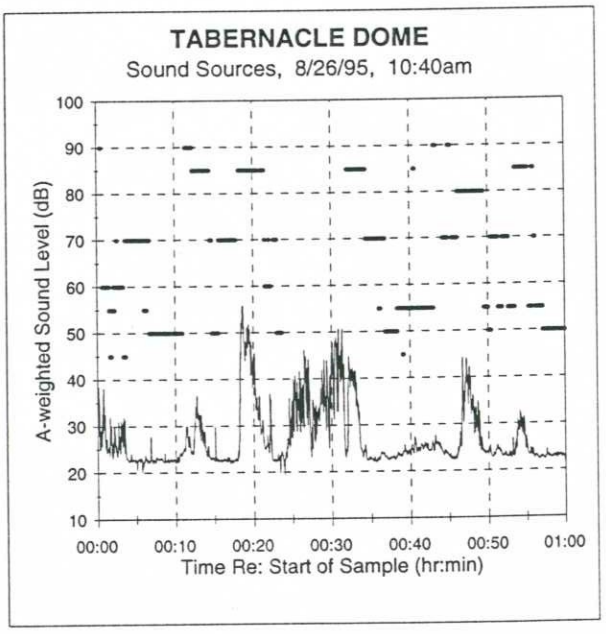
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	25
(1) Wildlife	28
(2) Water	23
(3) Wind	24
(4) Human	29
(6) Other	23
Leq (all sources)	24
L50 (all sources)	23
L90 (all sources)	23

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	69%
Intruding (Other)	7%
Intruding (Aircraft)	24%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

TABERNACLE DOME Elevation 5150 Feet
8/26/95
12:08 PM -- 01:12 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	2%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	8%	36
(3) Commercial Jet	10%	27
(4) Motor Vehicles	5%	-6
(6) Other	0%	--
Total	25%	37

Aircraft Leq minus Background Leq = 8 dB

Background Sources

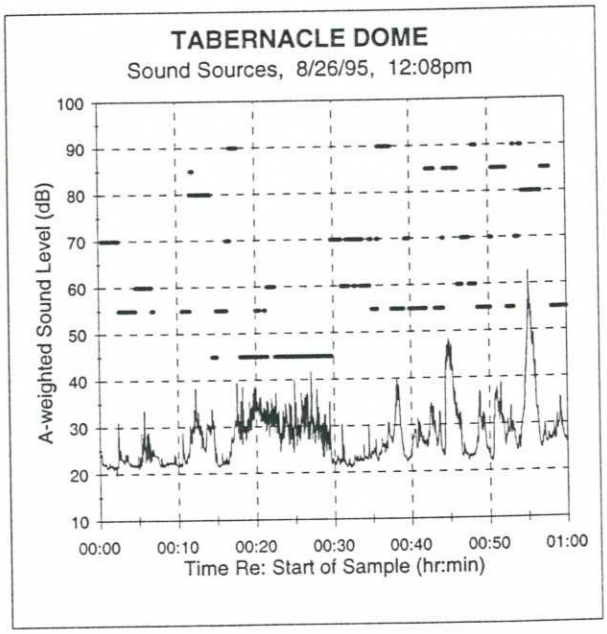
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	25
(1) Wildlife	31
(2) Water	--
(3) Wind	29
(4) Human	27
(6) Other	23
Leq (all sources)	29
L50 (all sources)	25
L90 (all sources)	22

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	75%
Intruding (Other)	7%
Intruding (Aircraft)	18%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

KOLOB, TIMBER CK Elevation 6300 Feet
8/27/95
05:02 PM -- 06:03 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	1%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	5%	--
(3) Commercial Jet	7%	21
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	12%	21

Aircraft Leq minus Background Leq = -12 dB

Background Sources

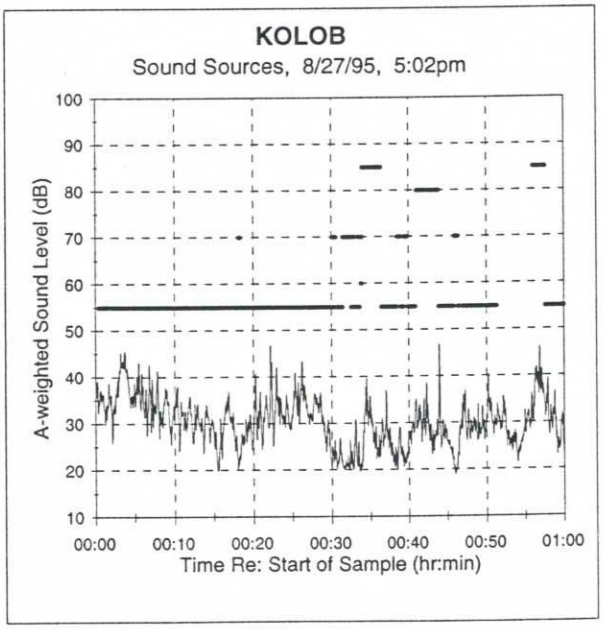
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	29
(1) Wildlife	--
(2) Water	--
(3) Wind	34
(4) Human	21
(6) Other	23
Leq (all sources)	33
L50 (all sources)	30
L90 (all sources)	23

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	88%
Intruding (Other)	1%
Intruding (Aircraft)	11%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

KOLOB, TIMBER CK Elevation 6300 Feet
8/27/95
06:48 PM -- 07:50 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	3%	-3
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	7%	18
(3) Commercial Jet	9%	35
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	20%	36

Aircraft Leq minus Background Leq = 13 dB

Background Sources

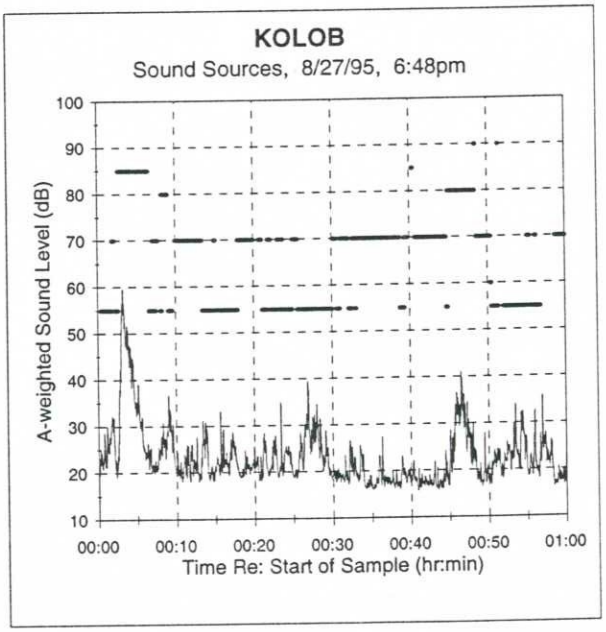
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	21
(1) Wildlife	--
(2) Water	--
(3) Wind	26
(4) Human	19
(6) Other	20
Leq (all sources)	23
L50 (all sources)	21
L90 (all sources)	17

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	80%
Intruding (Other)	4%
Intruding (Aircraft)	16%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

KOLOB, TIMBER CK Elevation 6300 Feet
9/10/95
06:45 PM -- 07:45 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	5%	15
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	5%	15

Aircraft Leq minus Background Leq = -11 dB

Background Sources

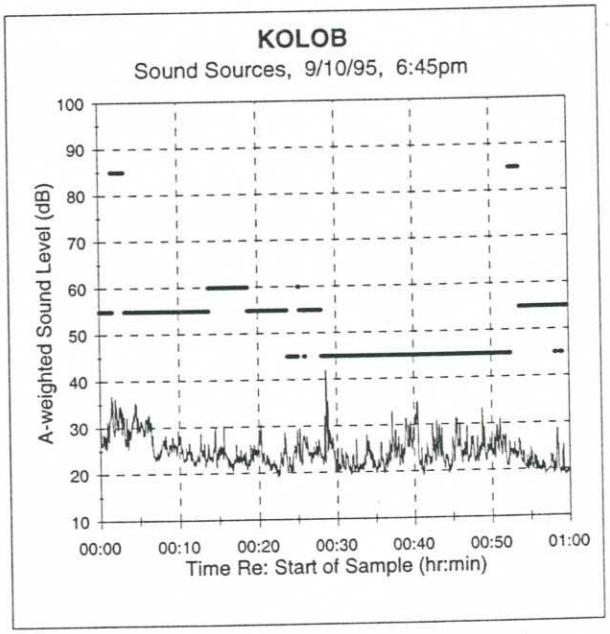
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	25
(2) Water	--
(3) Wind	26
(4) Human	24
(6) Other	--
Leq (all sources)	26
L50 (all sources)	24
L90 (all sources)	21

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	95%
Intruding (Other)	0%
Intruding (Aircraft)	5%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

KOLOB TERRACE Elevation 5450 Feet
9/6/95
10:17 AM -- 11:17 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	6%	18
(3) Commercial Jet	46%	39
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	52%	39

Aircraft Leq minus Background Leq = 16 dB

Background Sources

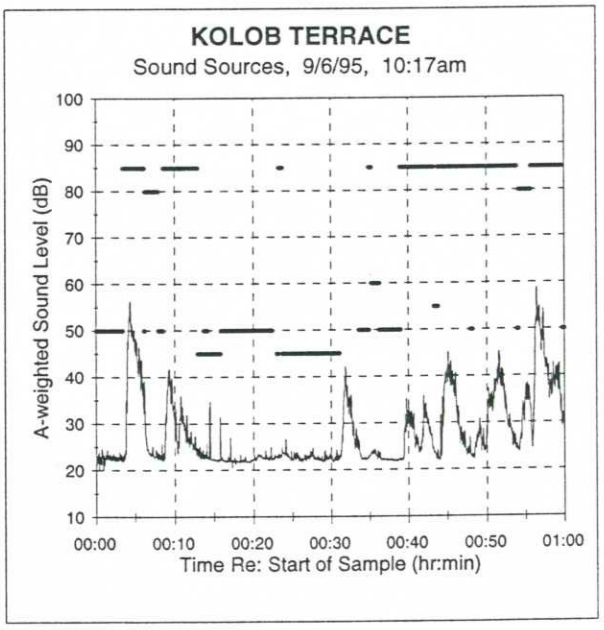
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	23
(2) Water	23
(3) Wind	23
(4) Human	23
(6) Other	--
Leq (all sources)	23
L50 (all sources)	23
L90 (all sources)	22

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	48%
Intruding (Other)	0%
Intruding (Aircraft)	52%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

KOLOB TERRACE Elevation 5450 Feet
9/6/95
11:33 AM -- 12:33 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	4%	20
(3) Commercial Jet	34%	27
(4) Motor Vehicles	0%	--
(6) Other	0%	--
Total	38%	28

Aircraft Leq minus Background Leq = 7 dB

Background Sources

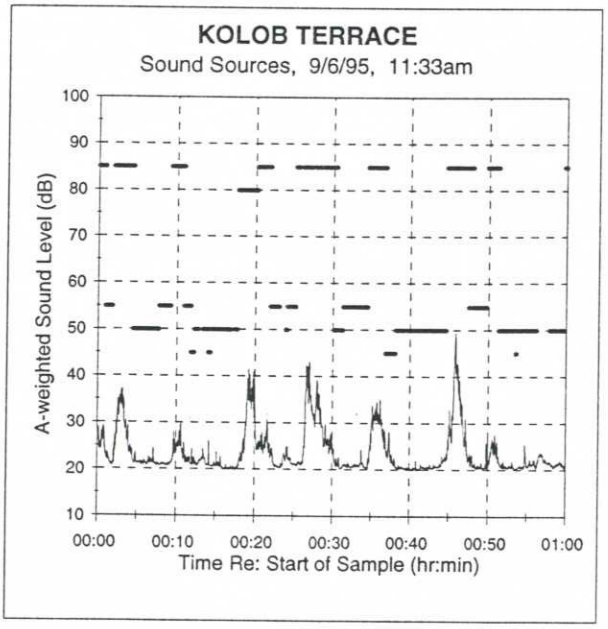
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	23
(2) Water	21
(3) Wind	21
(4) Human	--
(6) Other	--
Leq (all sources)	21
L50 (all sources)	21
L90 (all sources)	20

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	62%
Intruding (Other)	0%
Intruding (Aircraft)	38%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
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ZION NATIONAL PARK
Sound Source Observations

KOLOB TERRACE, (W/THUNDERSTORM) Elevation 5450 Feet
9/6/95
01:10 PM -- 02:11 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	3%	13
(4) Motor Vehicles	2%	--
(6) Other	0%	--
Total	4%	13

Aircraft Leq minus Background Leq = -22 dB

Background Sources

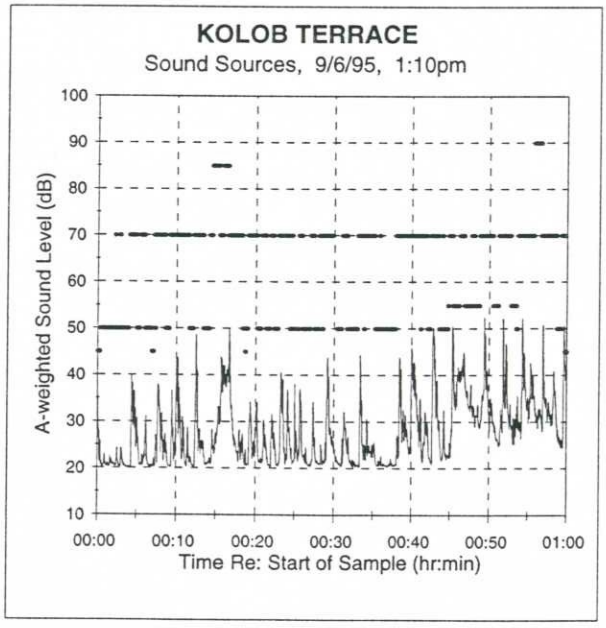
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	37
(2) Water	24
(3) Wind	37
(4) Human	--
(6) Other	37
Leq (all sources)	35
L50 (all sources)	25
L90 (all sources)	21

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	96%
Intruding (Other)	2%
Intruding (Aircraft)	3%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, RIVER FLAT Elevation 4300 Feet
8/26/95
07:39 PM -- 08:40 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	3%	18
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	0%	--
(4) Motor Vehicles	65%	34
(6) Other	0%	--
Total	68%	34

Aircraft Leq minus Background Leq = --

Background Sources

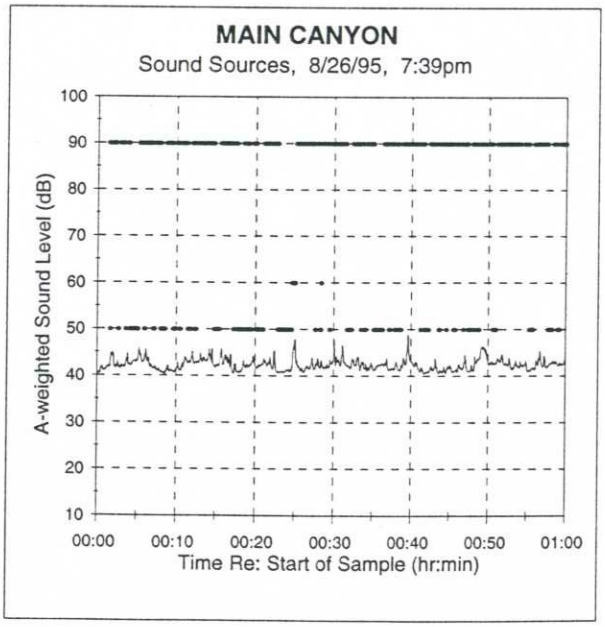
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	42
(1) Wildlife	--
(2) Water	42
(3) Wind	--
(4) Human	45
(6) Other	--
Leq (all sources)	42
L50 (all sources)	42
L90 (all sources)	41

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	32%
Intruding (Other)	68%
Intruding (Aircraft)	0%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, RIVER FLAT Elevation 4300 Feet
9/5/95
10:48 AM -- 11:48 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	3%	26
(4) Motor Vehicles	66%	37
(6) Other	0%	--
Total	69%	38

Aircraft Leq minus Background Leq = -17 dB

Background Sources

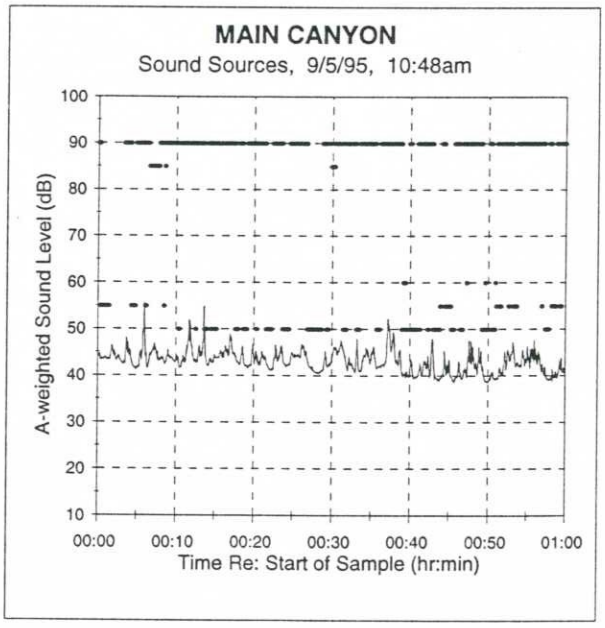
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	--
(2) Water	42
(3) Wind	43
(4) Human	40
(6) Other	--
Leq (all sources)	43
L50 (all sources)	42
L90 (all sources)	39

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	31%
Intruding (Other)	66%
Intruding (Aircraft)	3%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, THRONE Elevation 4350 Feet
9/5/95
03:04 PM -- 04:04 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	7%	--
(3) Commercial Jet	0%	--
(4) Motor Vehicles	69%	--
(6) Other	0%	--
Total	76%	--

Aircraft Leq minus Background Leq = --

Background Sources

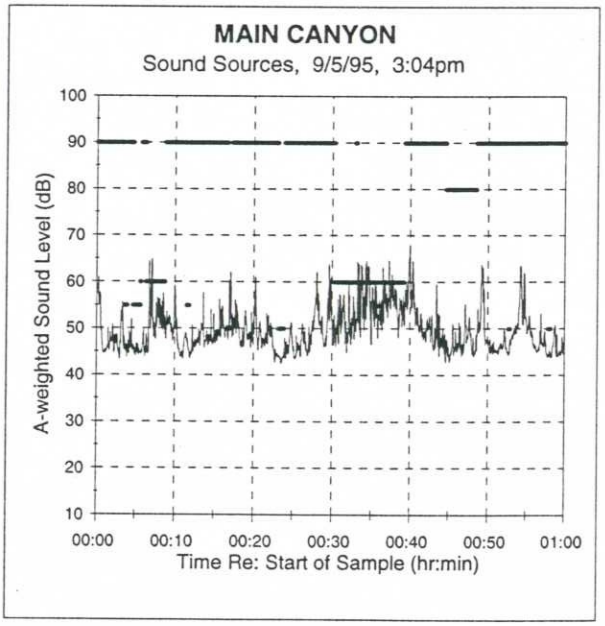
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	--
(2) Water	51
(3) Wind	48
(4) Human	56
(6) Other	--
Leq (all sources)	55
L50 (all sources)	52
L90 (all sources)	45

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	24%
Intruding (Other)	69%
Intruding (Aircraft)	7%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, THRONE Elevation 4350 Feet
9/5/95
04:14 PM -- 05:14 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	0%	--
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	3%	16
(4) Motor Vehicles	85%	51
(6) Other	0%	--
Total	88%	51

Aircraft Leq minus Background Leq = -32 dB

Background Sources

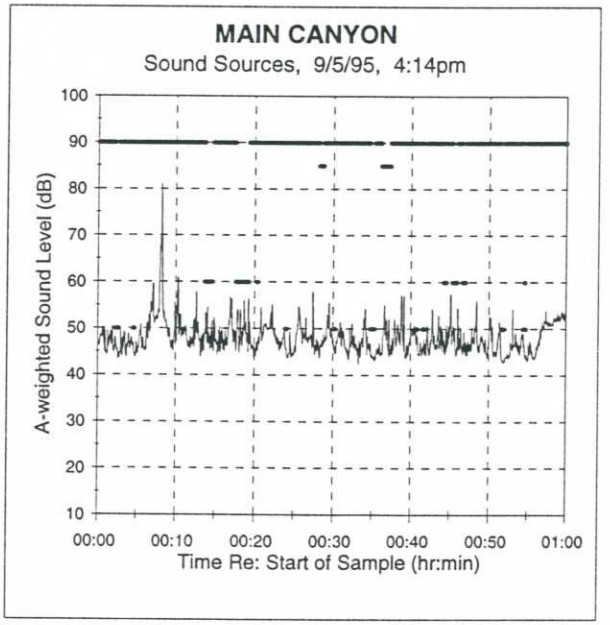
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	--
(1) Wildlife	--
(2) Water	46
(3) Wind	--
(4) Human	49
(6) Other	--
Leq (all sources)	48
L50 (all sources)	47
L90 (all sources)	44

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	12%
Intruding (Other)	85%
Intruding (Aircraft)	3%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, WEEPING RK Elevation 5200 Feet
8/29/95
09:51 AM -- 10:52 AM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	9%	13
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	2%	3
(3) Commercial Jet	16%	30
(4) Motor Vehicles	11%	10
(6) Other	6%	--
Total	44%	30

Aircraft Leq minus Background Leq = 6 dB

Background Sources

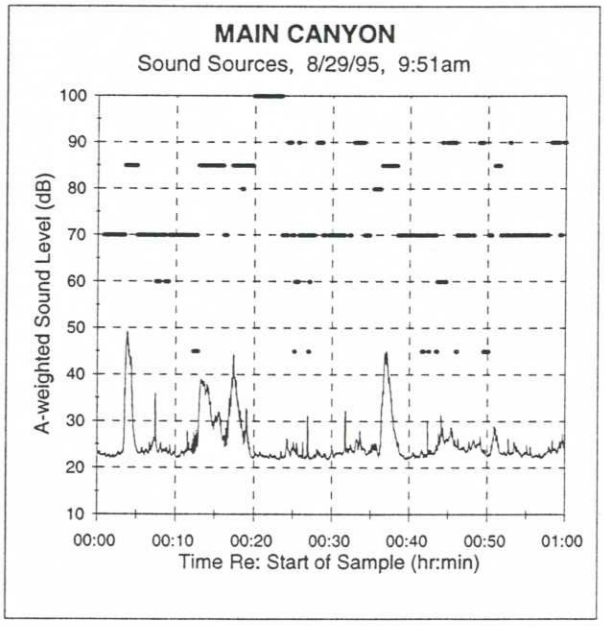
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	24
(1) Wildlife	24
(2) Water	--
(3) Wind	--
(4) Human	25
(6) Other	23
Leq (all sources)	24
L50 (all sources)	23
L90 (all sources)	22

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	56%
Intruding (Other)	26%
Intruding (Aircraft)	18%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

MAIN CANYON, WEEPING RK Elevation 5200 Feet
8/29/95
11:38 AM -- 12:39 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	10%	26
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	3%	13
(4) Motor Vehicles	20%	14
(6) Other	6%	15
Total	39%	27

Aircraft Leq minus Background Leq = -10 dB

Background Sources

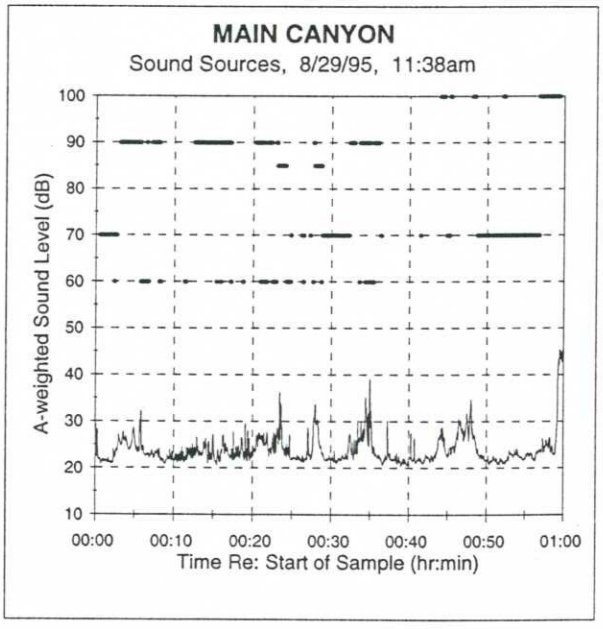
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	23
(1) Wildlife	--
(2) Water	--
(3) Wind	--
(4) Human	27
(6) Other	22
Leq (all sources)	23
L50 (all sources)	22
L90 (all sources)	21

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	61%
Intruding (Other)	36%
Intruding (Aircraft)	3%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
Observer: Dick Hingson
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ZION NATIONAL PARK
Sound Source Observations

COALPITS Elevation 4126 Feet
8/25/95
07:59 PM -- 09:01 PM

Intruding Sources

Intruding Source [3]	Percent of Time Audible	Leq over Measurement Session (decibels) [1]
(0) Not Acertained	1%	24
(1) Military Aircraft	0%	--
(2) Scenic Aircraft	0%	--
(3) Commercial Jet	4%	35
(4) Motor Vehicles	85%	41
(6) Other	0%	--
Total	91%	42

Aircraft Leq minus Background Leq = 8 dB

Background Sources

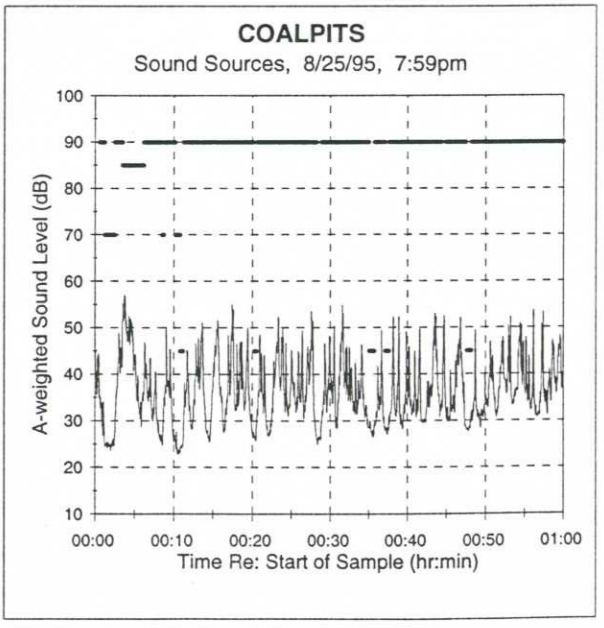
Intruding Sources	Leq during Time Audible (decibels) [2]
(0) Not Acertained	27
(1) Wildlife	27
(2) Water	--
(3) Wind	--
(4) Human	--
(6) Other	25
Leq (all sources)	27
L50 (all sources)	26
L90 (all sources)	24

Source Audibility Summary

Sound Source	Percent of Time Audible
Background Only	9%
Intruding (Other)	87%
Intruding (Aircraft)	4%
Total	100%

Intruding:
100 - Other
90 - Motor Veh
85 - Comm Jets
80 - Scenic Prop
75 - Mil Jet

Background:
70 - Other
60 - Human
55 - Wind
50 - Water
45 - Wildlife



[1] Measurement Period Normally One Hour (background noise contribution removed).
[2] Leq for Period When Only Background is Audible (windscreen-Induced noise contribution removed).
[3] Numbers in Parentheses are Button Numbers on LOWNOMS Source Logging Module.
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MEMORANDUM

To: Rick Ernenwein / Darla Sidles
National Park Service
Denver Service Center / Zion NP

From: Nicholas P. Miller / Richard D. Horonjeff

Date: November 30, 1998

Subject: Zion NP Measurements, Task Order No. 2
Sound Monitoring Results - October 1998 Field Work

Reference: HMMH Job No. 295860.02

1. Introduction

This memorandum presents the sound measurement data collected at selected sites in Zion National Park, October 15 through 23, 1998. The following sections discuss first the specific measurements that were made, where they were made, and the types of data collected. Next, Section 3 discusses a method for quantifying the natural ambient, and uses the measurement data to illustrate the approach.[1] Section 4 then shows how the relationship between the natural ambient and intruding human-produced sounds may be quantified and presented, again using the measurement data to illustrate the relationships. Attachment 1 presents the complete set of data sheets that provide, for each one hour measurement period, the reduced sound level data. Attachment 2 provides descriptions of the data provided in Attachment 1.

2. Measurements Made

2.1 Sites

Sound measurements were made for sample periods of one hour, using the NPS LOWNOMS - a self-contained, battery powered sound and wind monitoring system that permits detailed sound level, wind speed and direction, and sound source identification data to be collected in the field. Measurements were made at five different sites during one or two different one-hour periods, as shown in Table 1.

[1] In this discussion, "ambient", "background", and "natural ambient" are all used synonymously to mean the sound environment that exists when no human-produced sounds are audible to an attentive listener.

Table 1. Measurement Locations, Times of Measurement

Site Number	Measurement	Description	Date	Start Time
1	a	Coal Pits	15-Oct-98	9:02a
	b		23-Oct-98	9:22a
2	a	Tabernacle Dome	15-Oct-98	12:19p
	b		16-Oct-98	2:44p
3	a	Watchman	15-Oct-98	4:16p
	b		22-Oct-98	9:49a
4	a	Angles Landing	16-Oct-98	9:52a
	b		23-Oct-98	2:16p
5	a	East Mesa	19-Oct-98	12:41p

Note: Sites have been numbered differently from original data so that site numbers remain the same for a given site, regardless of which day it is measured. Also note that Table 1 gives the correct start times for the measurements, while the data sheets sometimes incorrectly identify am or pm.

2.2 Procedures

LOWNOMS was used to collect all data. Attachment 2 describes the specific measures it produces automatically. In general, the operator, after setting up the instrument, orienting it properly (so that wind direction data are correct), and acoustically calibrating the system, identifies each audible sound as it is heard, using a specific hierarchy. The operator listens and presses the appropriate button on the "button box" to identify when various sources of sound are heard. Any human-produced sound is considered "intruding" and takes precedence in identification over any natural "background" sound; aircraft sounds take precedence in identification over other human-produced sounds. LOWNOMS keeps and stores a running second-by-second log file containing one second A-weighted sound level, button pushed, wind speed and wind direction. The system also counts the number of samples until one hour's worth (3600 one-second samples) are stored. A final calibration confirms correct operation of the system. After collecting the data, it may be reduced to produce a seven page report for each hour sampled, as contained in Attachment 1 for the nine one-hour measurements made. (For measurements on and after 19 October, the wind monitor mal-functioned, and the two pages of wind data are not available.)

2.3 Data Types

Several types of data are produced by the measurement procedures. The data produced are slightly different for the human-produced intruding sounds and for the natural background sounds. All sound levels are measured in A-weighed decibels.

3.1 Intruding Sounds

3.1.1 Leq, Equivalent Level. This is a measure of the sound energy produced by a given intruding source ring the measurement (one-hour) period. It is a type of average that "spreads" the sound energy over the ne measured, but always increases if more events occur, even if some of the events are very quiet. In other ords, it is not an arithmetic average that can be lowered by many quiet events. Leq for a given time period vays increases with each intruding event that occurs.

3.1.2 Percent of Time Audible. This is simply a measure of the percent of the hour that a given ruding source was heard by the operator. If the percents of time for all intruding sources are added together d subtracted from 100, the percent of time only natural sounds were audible may be determined.

3.1.3 Sound Spectra. All sounds contain many frequencies, and human hearing uses these frequencies identify the type of source producing the sound. Hence, it is possible to hear or "detect" a fairly quiet craft even though leaves rustling in the wind may create a higher A-weighted sound level. Because the most urate estimates of intruding sound audibility may be made only when frequency data for both the intruding ind and the background sound are available, tape recordings (that record frequency information) were made ring the measurements. These tapes are stored for future analysis, as needed.

3.2 Background Sounds

3.2.1 Leq, Equivalent Level. This is a measure of what the sound energy of the natural environment would ve been during the measurement period, had no intruding sounds occurred. In other words, it is one means quantifying the natural ambient sound environment. If the natural ambient sound environment were npletely constant in sound level, this sound level would equal this measured Leq.

3.2.2 Cumulative Distribution. Except near rapids or a waterfall, the natural ambient does not provide a stant sound level, and one way to depict this variability for the measurement period is with a plot that shows at percent of time each sound level is exceeded during the measurement. The fourth page of reduced data each measurement documented in Attachment 1 presents such a distribution plot. This plot is very useful lepicting the variability of the natural background sounds. The more the plot is horizontal, the more stant is the background sound environment.

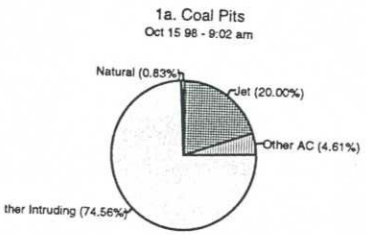
3.2.3 Sound Spectra. As with intruding sounds, tape recordings were made so that the frequency content background sounds may be determined.

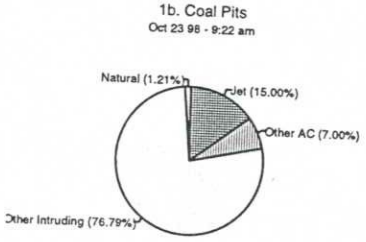
Quantifying the Natural Ambient Sounds

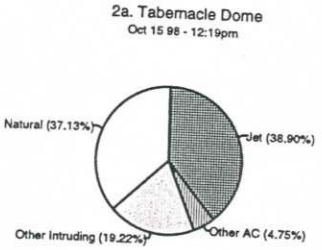
pages of Attachment 1 provide considerable data that quantify the natural ambient or background sounds occurred during the measurements. However, in order to better understand these data, summary data parisons are provided.

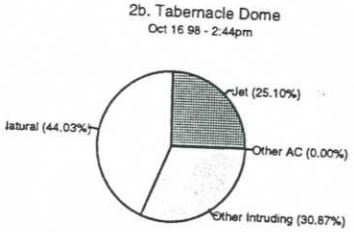
3.1 Percent of Time Only the Natural Ambient is Audible

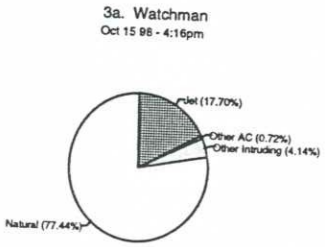
The following pie charts depict the percent of each one-hour measurement when jets, other aircraft, other intruding (human-produced) sounds, or only natural sounds were audible to the operator. It should be noted that measurements at sites where the natural background is heard less than about 10 percent of the time, as for the Coal Pits measurements, are not likely to provide a reliable measure of background sound levels. These pie charts provide a general sense of the distribution of sounds at the sites during the different measurement periods. Section 4 provides an additional method for comparing the intrusions and the natural ambient from measurement to measurement and from site to site.

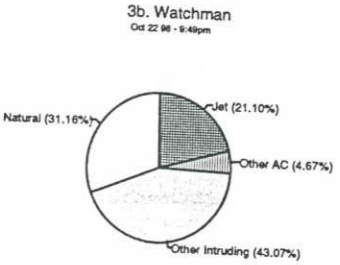


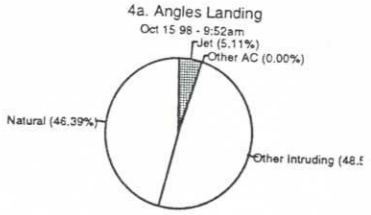


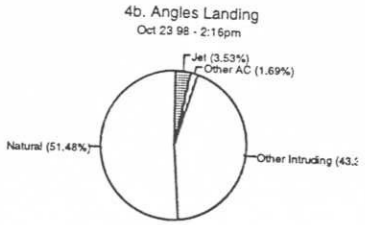


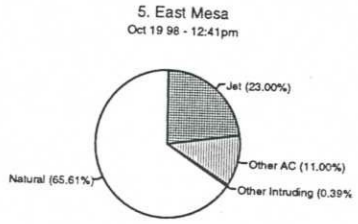










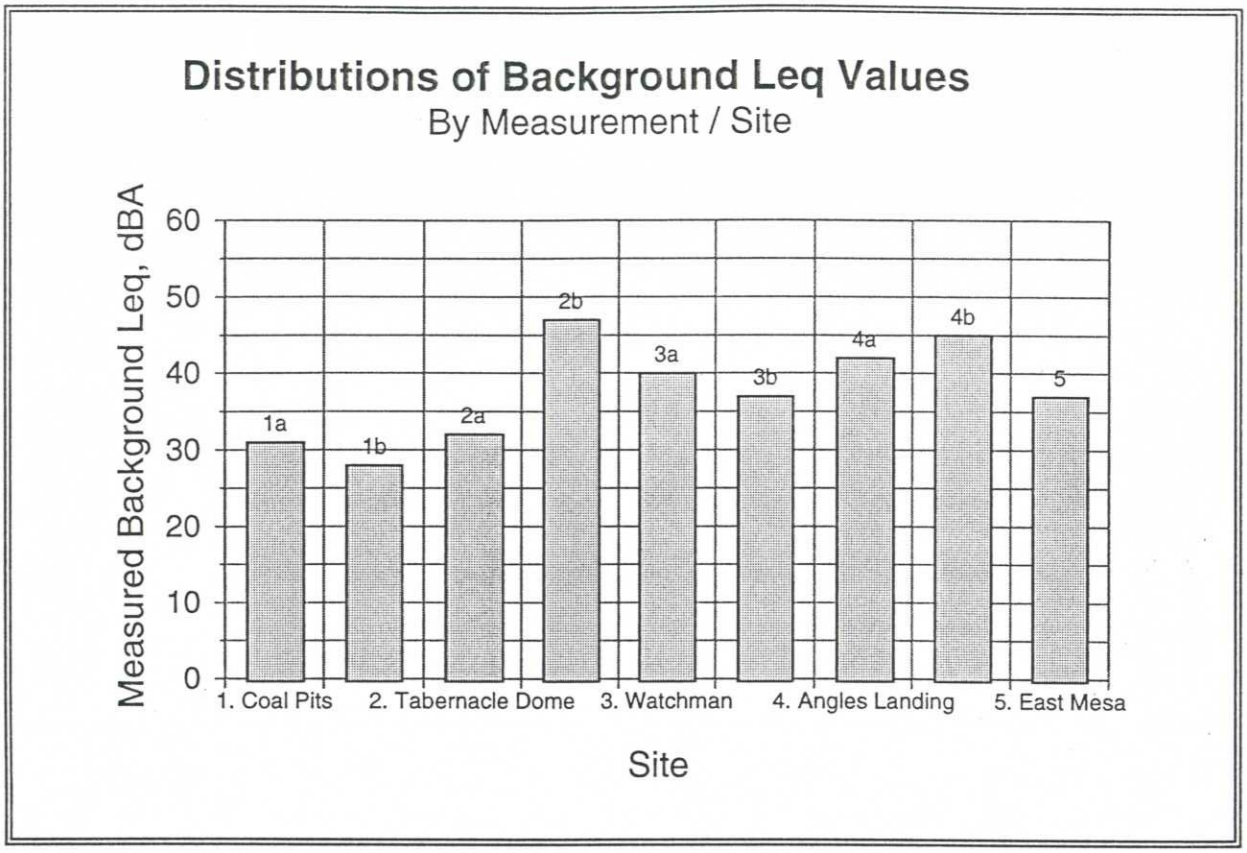


.2 Distribution of Natural Ambient Levels

he natural ambient sound levels vary second to second, minute to minute, day to day and season to season. epicting the ambient in different ways may help in understanding, and ultimately characterizing natural nbient conditions at sites and across a park.

.2.1 Ambient Leq

rst, ambient or background Leq quantifies total natural ambient sound energy during each of the one-hour easurement periods. The figure below shows the distribution of measured one-hour background Leq values ' measurement for each of the sites. The measured values vary considerably from site-to-site and from one easurement to another at a given site. This variation is to be expected, and to quantify the natural ambient any site with accuracy requires several repeat visits during the time period of interest (e.g, during the months July and August). Repeat measurements, done randomly in time, and sufficient in number, will determine e average or median level, and the confidence limits associated with that level. (Recall that the background vels for site 1, Coal Pits, cannot be considered to be an accurate representation of the natural background vels because they could be measured (heard) during only about 1 percent of each hour measured.)



3.2.2 Cumulative Distribution of Ambient Sounds

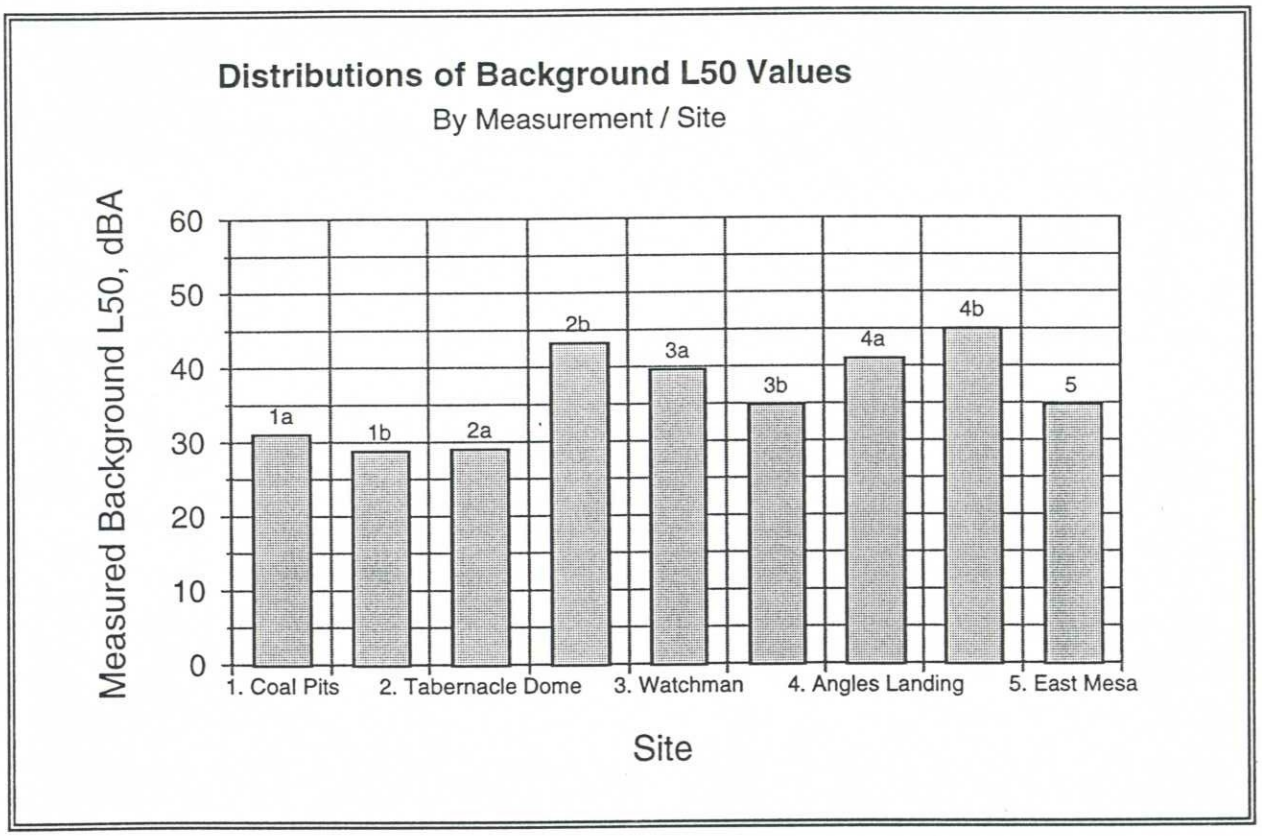
Examination of the cumulative distributions helps in understanding the variability of the ambient levels. The fourth page of each set of measurement results (Attachment 1) provides these cumulative distributions of measured background sound levels. The more horizontal is this plot, the more constant in sound level are the background, ambient levels. (Ignore the distributions for Site 1.) The greater the slope, the more variable the levels. For example, the Site 2 measurements at Tabernacle Dome show that ambient levels were considerably higher during the second measurement than during the first. "Wind in foliage" is the dominant contributor to the background levels (see the Adj Wind column), and, in fact, the wind speeds were higher during the second measurement (see page 6 of each data report, Attachment 1).

One of the important uses of these cumulative distributions is that they indicate the variability of the "masking" provided by the natural ambient. Research sponsored by NPS, the Air Force and the FAA shows that visitor reactions to aircraft overflight sound depends upon the levels of the non-aircraft sound; the louder these sounds, the less the adverse effect of aircraft overflights. These non-aircraft sounds cover up or "mask" the sound of aircraft. Thus, quantifying the natural ambient for a site or an area of a park is necessary, not only to determine the baseline natural conditions, but to aid in determining possible impacts of new intruding aircraft overflight sounds (or of other types of intruding sounds). The cumulative distributions tell what levels

may be expected.

3.2.3 Ambient L_{50}

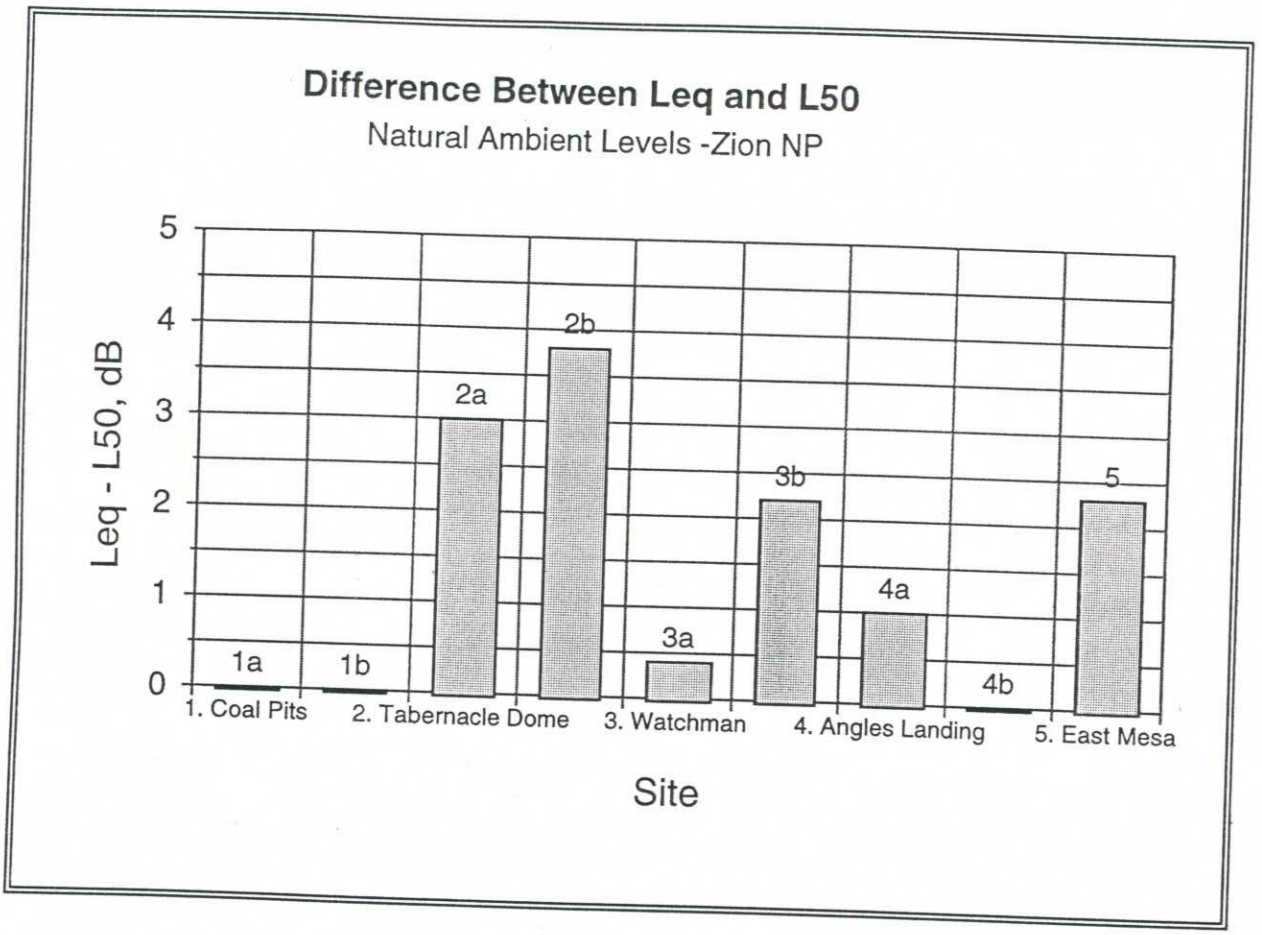
The ambient L_{50} is the level that the ambient sound levels exceed half the time. It may be thought of as the median masking level; half the time the natural ambient will provide more masking of intruding sounds, while half the time it will provide less masking than the L_{50}. The figure below presents the values of ambient L_{50} measured during each site measurement.



3.3 Quantifying the Ambient

In deciding how to best characterize the ambient, it should be remembered that, in terms of protecting the natural conditions, it is the masking effect of the ambient that is important. The cumulative distributions show graphically how much of the time the ambient provides more, or less, masking (intrusions are harder or easier to hear). If the ambient is to be simply characterized, it should be with a metric that fairly, and in an unbiased way quantifies the masking capability of the natural sounds. Leq, L_{50} and L_{90} have been considered. L_{90} represents the lowest, and infrequent level of masking provided, L_{50} is the median level provided, and Leq quantifies sound energy, rather than masking ability. When the ambient cumulative distribution shows little

variation from lowest levels to highest, then these measures vary little, one to the next. However, when the cumulative distribution is steeply sloped or increases greatly at the higher levels due to occasional loud events, then Leq can be strongly affected (increased) while L_{50} and L_{90} remain unchanged. The following plot shows the difference between Leq and L_{50} for the measurements made in Zion National Park.



Most notable is the difference between measurements 3a and 3b. While levels were higher during the 3a measurements, for most of the time (about 90 percent of the time) the 3a levels were about 5 dB higher than the 3b measurements, see the respective cumulative distributions and the L_{50} values. Leq, on the other hand, was about 3 dB higher during the 3a measurements. Thus Leq under-represents the change in the masking ability of the ambient from one measurement to the other, because Leq is strongly affected by the loudest sounds during the 3b measurements. It seems clear that L_{50} more reasonably represents the change in the ambient sound masking ability.

4. Comparing the Natural Ambient with Human-Produced Sounds

How can sites be quantitatively judged in terms of adverse effects of intrusions upon visitors? The NPS, Air Force and FAA research all show that two measures of sound intrusion correlate with visitor reactions to aircraft overflight sound: 1) the percent of the visitor's time on-site when aircraft can be heard (termed here

percent of time audible'); 2) the difference in the aircraft produced Leq and the background Leq (specifically, ircraft Leq minus background Leq, termed here "sound level difference").[2] Both of these are measures of the ntrusion of the aircraft sound, and depend not only upon the level, duration, frequency content, etc. of the ircraft sound, but also upon the level, variability, frequency content, etc., of the background sound.

he research has developed different relationships (dose-response relationships) between each of the measures nd the visitor reactions to the aircraft. Because the percent of time audible and the relative sound level are ncorrelated, that is, have no predictable relationship to each other, they may each be thought of as quantifying different aspect of aircraft sound intrusions. Percent of time audible tells how much of the time a visitor ould hear aircraft, while the sound level difference relates to how loud the aircraft are in relation to the nbient.

sing the different dose-response relationships based on these two measures of the "dose" of sound, and on sitor judgements of both the annoyance caused by the aircraft sound and the interference with natural quiet used by the aircraft sound, it is possible to develop some generalized acceptability guidelines for intrusion.[3] or example, by choosing values of both percent of time audible and of sound level difference that would limit less than ¼ the fraction of visitors likely to report annoyance at a moderately noise sensitive site, an cceptability region" on the following figure is determined.[4] Sites that have values of both percent of time dible and relative sound level in this region could be considered acceptable from the visitor's perspective.[5] / similarly using other dose-response curves developed for other sites and for the question of whether or not craft sound interfered with visitor's enjoyment of the natural quiet (a more sensitive criterion), other areas such a plot can be developed.

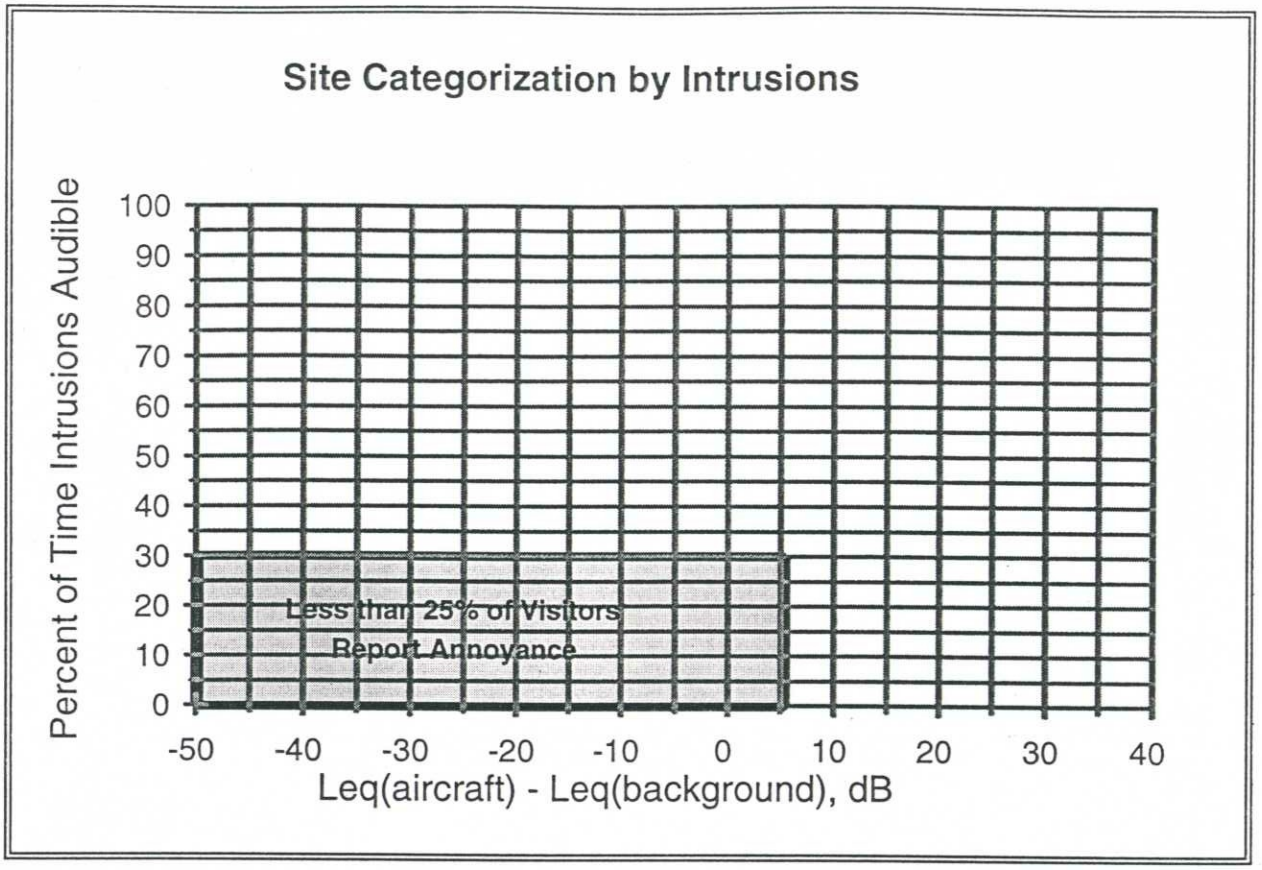
---

2 The specific way in which these measures are computed is still a matter of discussion. However, what we wish to convey here is a general concept of how these two types of measures may be used together to understand the relationship of intruding and natural sounds at a site. The precise values of these measures are less important here.

3 Recognizing the sensitivity of establishing such guidelines, we wish to emphasize that it is a concept we want to communicate here, not specific values for the guidelines.

4 It should be noted that this region is derived from average "short hike" dose-response data reported in the NPS Report to Congress and in NPOA Report No. 93-6, "Dose-Response Relationships Derived from Data Collected at Grand Canyon, Haleakala and Hawaii Volcanoes National Parks." The region also agrees with the dose-response data developed at Bryce Canyon, as reported in FAA-AEE-98-01, "Development of Noise Dose / Visitor Response Relationships for the National Parks Overflight Rule: Bryce Canyon National Park Study."

5 We note that visitor based reactions are but one of several types of information NPS management will use in determining the "acceptability" of human-produced sound intrusions at a given site or for a given area of a park.



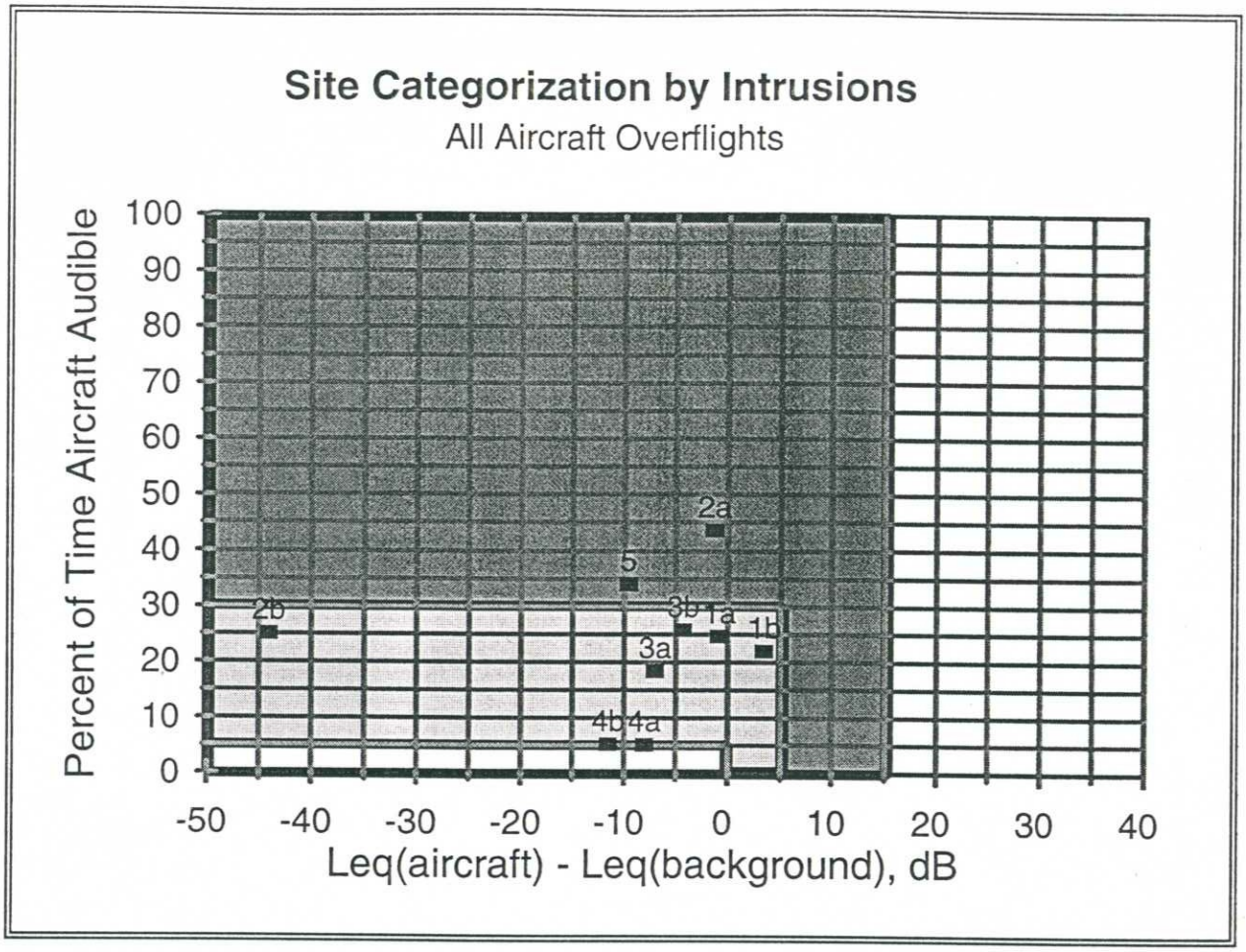
The following plot shows three different areas, ranging from very sensitive locations where protection of the natural ambient conditions (protection of natural quiet) is a primary concern, to the area derived above, to relatively insensitive areas with many visitors and much visitor activity. The figure also shows where all the measurement results from Zion National Park plot for these two measures.

The "protection of natural quiet" area is very small, extending from 0% to 5% of the time aircraft are audible, and up to Leq(aircraft) minus Leq(background), that is sound level difference, equals 0 dB. The "limitation of annoyance" area, discussed above, extends to 30% of the time aircraft are audible and to aircraft Leq greater than background Leq by 5 dB. Finally, the least sensitive region, which might be termed "limiting annoyance at busy overlooks" extends to 100% of the time audible and to aircraft Leq 15 dB greater than background Leq.[6] When aircraft Leq is more than 15 dB greater than background Leq, all guidelines are exceeded.[7]

---

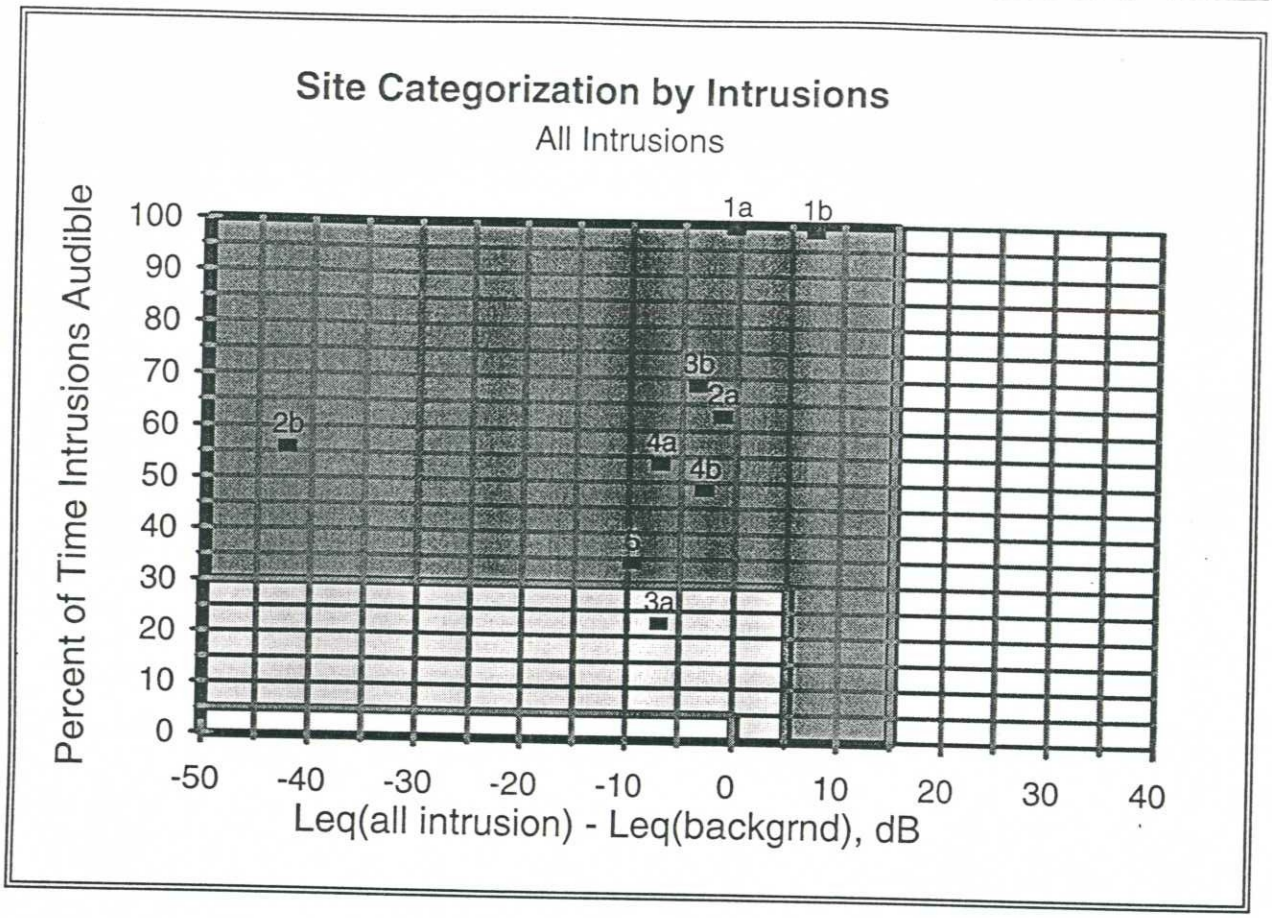
[6] The values used to define the three areas were first reported in HMMH Report 290940.16, "Fieldbook for Assessment of Aircraft Overflights," January 1996.

[7] The guidelines for sound intrusions shown in this figure were derived from the dose-response data collected at sites overflown primarily by propeller and helicopter tour aircraft. Applicability of this specific analysis to sites affected by other aircraft types or by other types of intruding sounds is untested.



If large numbers of measurements at a specific site are plotted on such a figure, a distribution will develop, with mean or median and confidence limits. Hence, the average acceptability of a site relative to these or similarly developed guidelines may be determined.

A final plot of the measured data is provided on the next page to emphasize the degree to which non-aircraft sound intrusions can also affect a site. This figure plots the measured results, but the intruding sounds are not only those produced by aircraft, but by all human-produced sources identified. Comparing the distribution of measured site values in these two last figures shows how sites change when all intrusions are considered. It should be noted that visitor responses to these other types of intrusions (particularly to road traffic noise) are unknown so that acceptability cannot be judged.



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This presentation and analysis of measured Zion data provides a starting point for characterizing the baseline ambient sound environment. Orderly collection of sufficient samples of sound level data, using the methods of this initial data collection, can provide a statistically reliable characterization of not only the ambient sound environment, but can also serve to quantify the intruding sound environment present for different areas of the park.

ATTACHMENT 1

Data Sheets for 5 Sites, Nine Measurements

1a

Site Description:

Park Name: zion national park

Site Name: coal pits

Site Number: 02

Elevation: 0

Operator: r horonjeff

Start Date: 10/15/98 Start Time: 9:02:10 pm

Stop Date: 10/15/98 Stop Time: 9:21:33 am

Type Data Collected:

Sound Level: Yes

Source Identification: Yes

Wind Speed/Direction: Yes

Equipment:

Acoustic Calibrator type B$K 4221 S/N: 183935

Sound Level Meter type LD-820 S/N: 123

Microphone type B$K 4179 S/N: 865133

Preamplifier type B$K 2660 S/N: 885020

Wind Sensor type 1172N S/N: 341

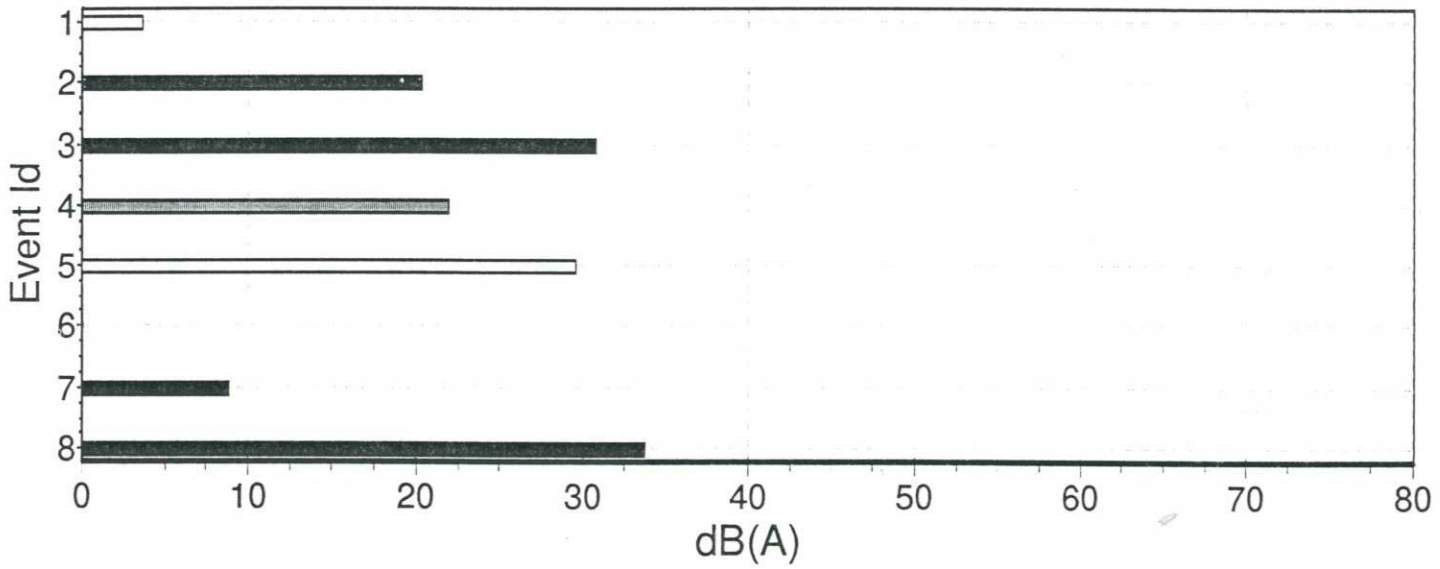
File: G:\PROJECTS\295860.NPS\2_ZI_GLA\ZION\MEASMNTS\REALTIME\0902r288.98

Spike Removal: Yes

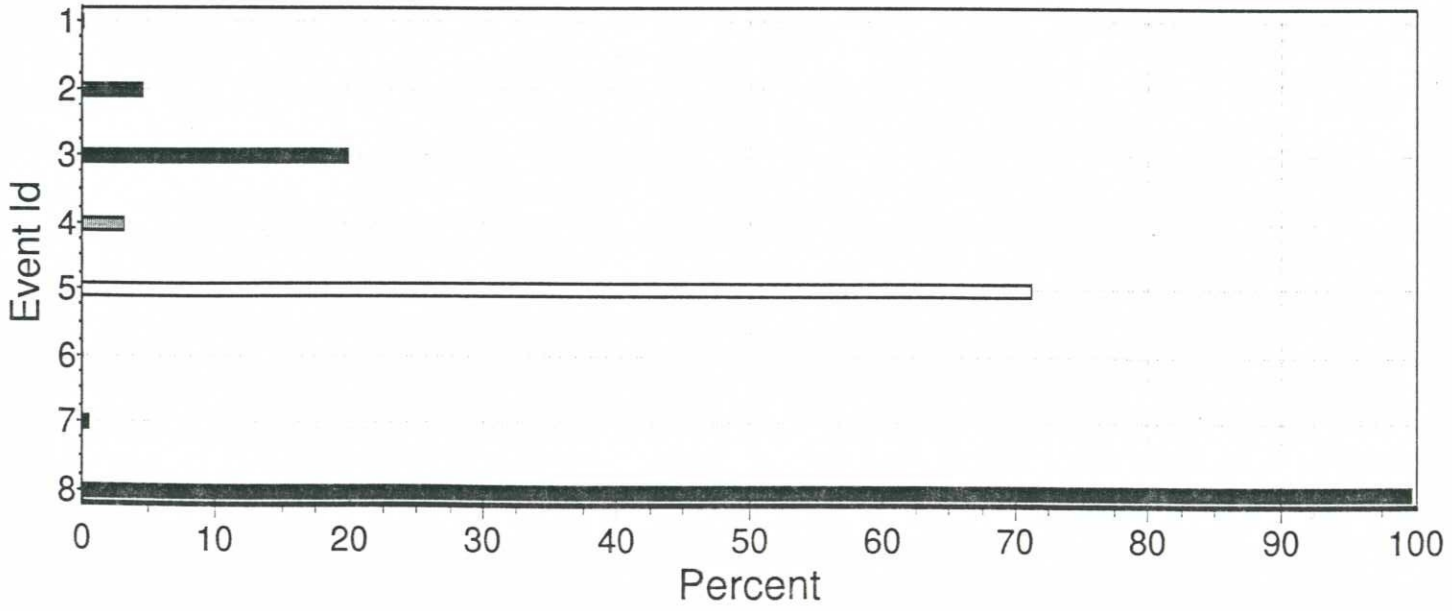
Intruding Sound Level

Id	Description	Leq,1hr	%Audible	Events	Good Num	Bad Num	Spike Num	Adj Bckg
1	other	3.70	0.17	1	6	0	0	-10.00
2	scenic aircraft	20.00	4.61	7	166	0	0	17.00
3	commercial jet	31.00	20.00	9	719	0	0	30.00
4	tour buses/lodge trams	22.00	3.19	4	115	0	0	21.00
5	other motor vehicles	30.00	71.20	22	2564	0	0	0.00
6								
7	Intruding	8.90	0.58	3	21	0	0	0.00
8	Total:	34.00	99.70	46	3591	0	0	30.00

Leq 1 hour

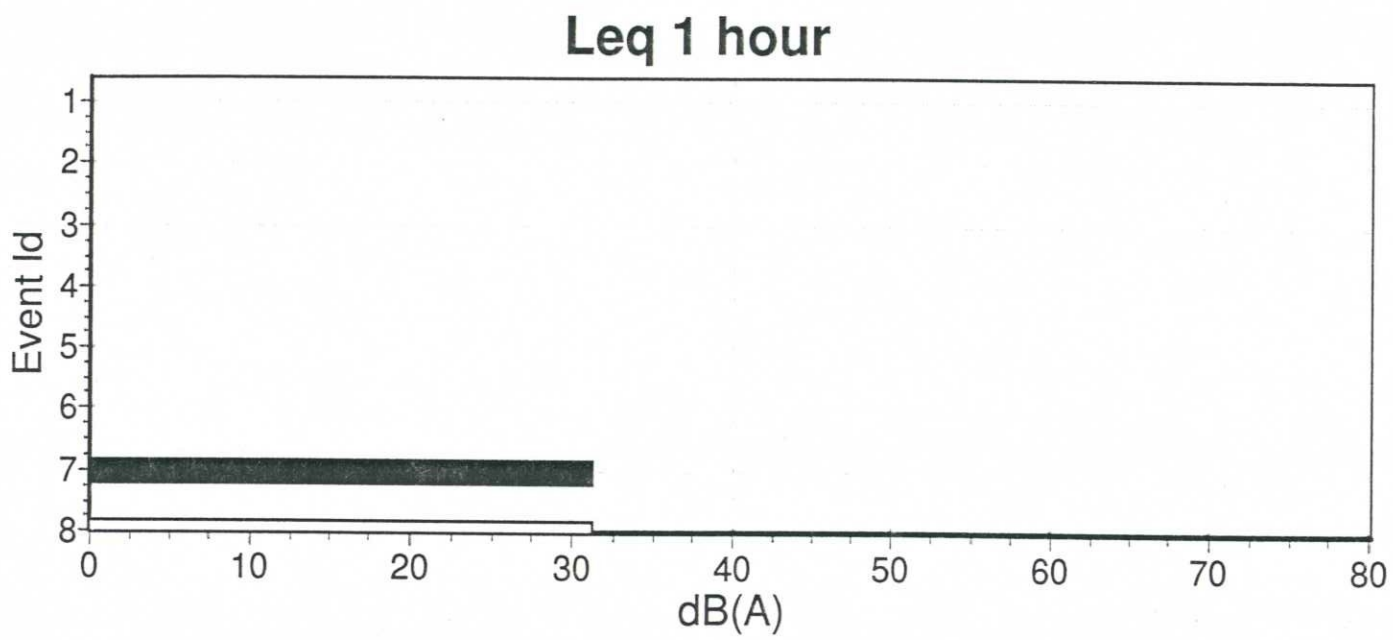


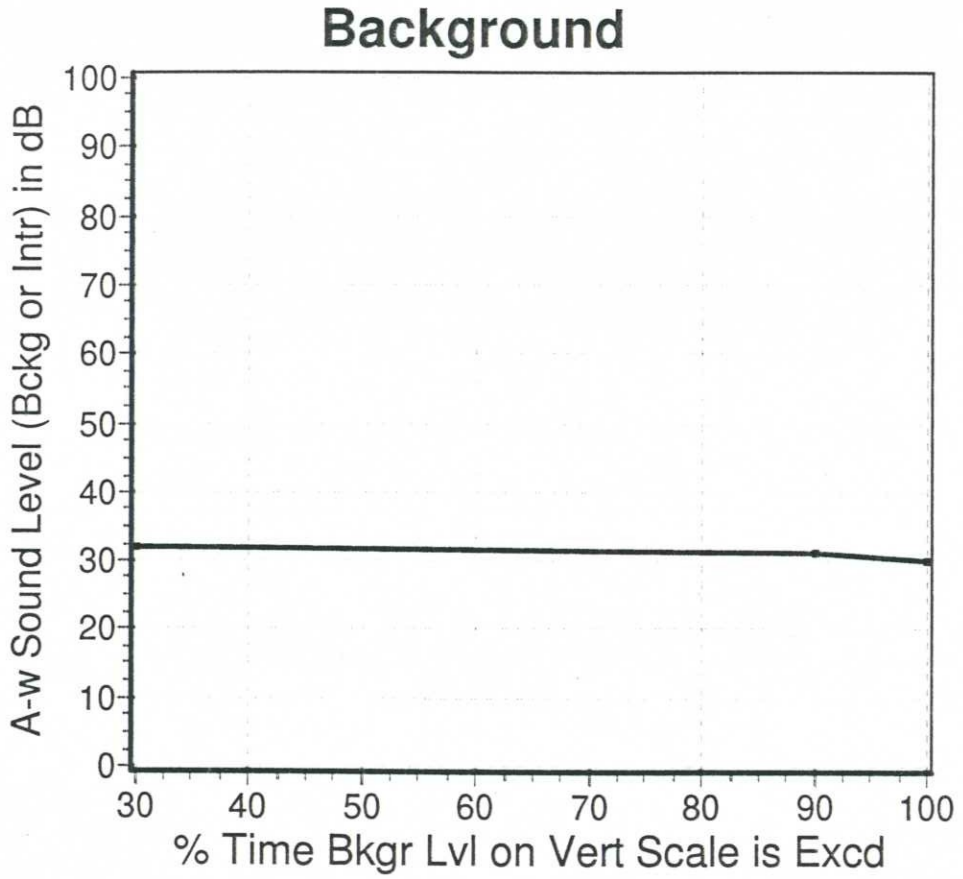
% Time Audible

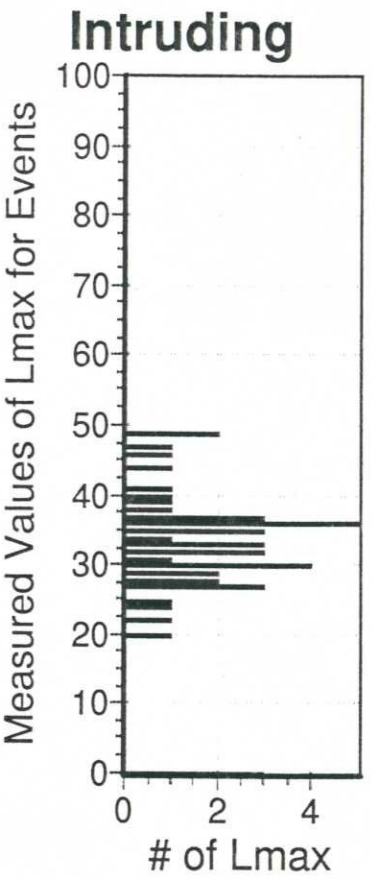


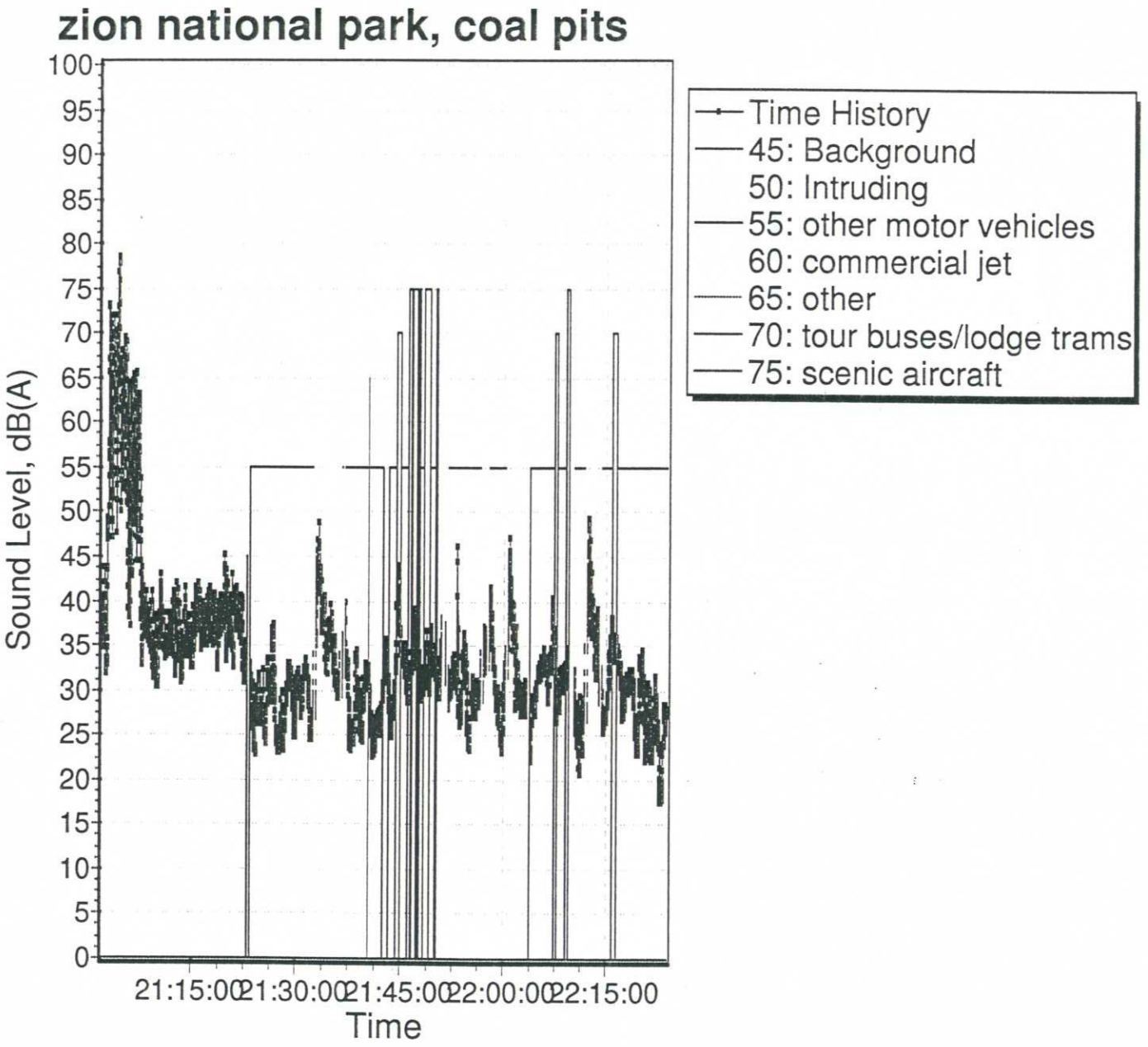
Background Sound Level

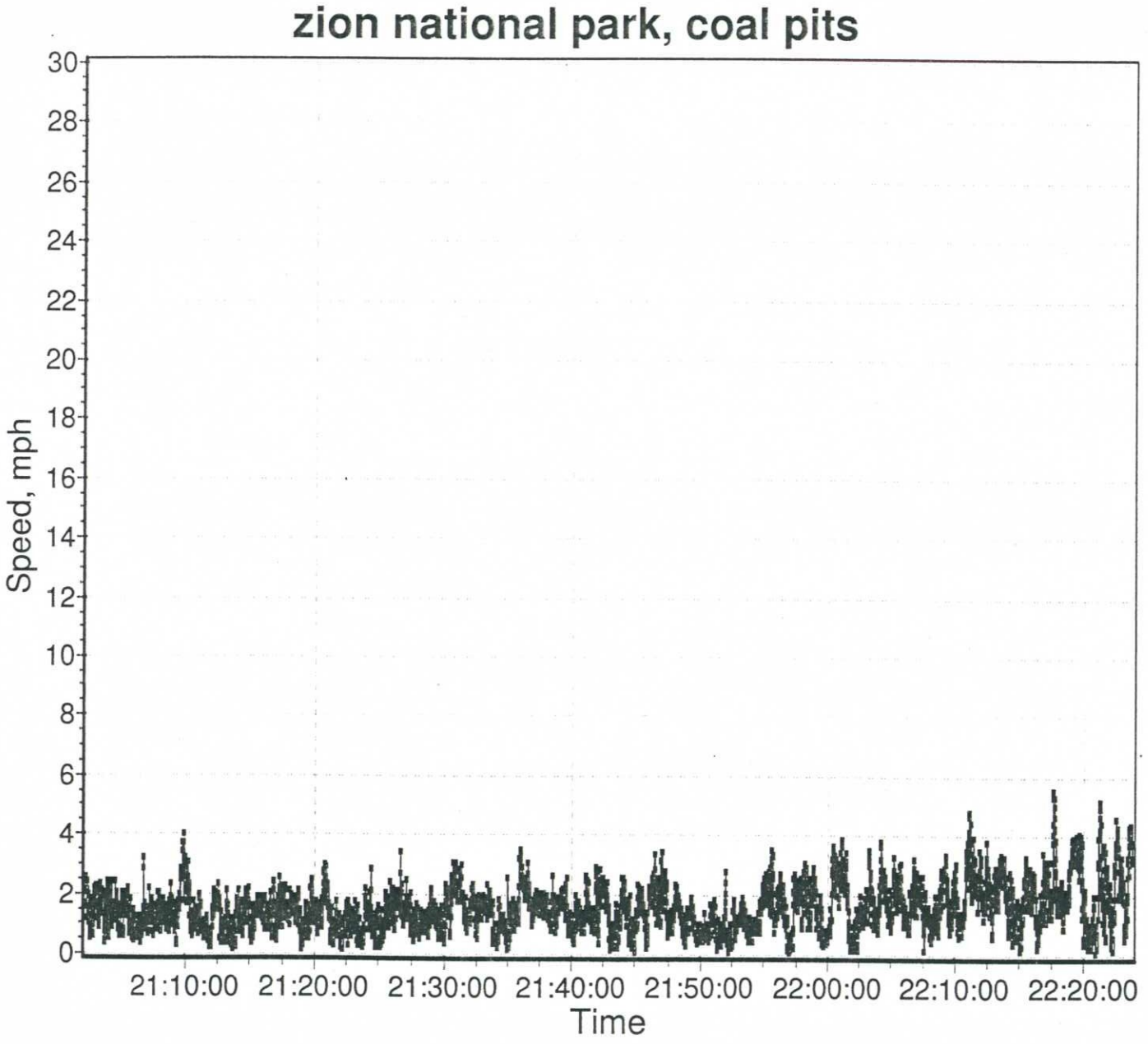
Id	Description	Leq,1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind
1								
2								
3								
4								
5								
6								
7	Background	31.00	31.00	1	10	0	0	31.00
8	Total:	31.00		1	10	0	0	31.00

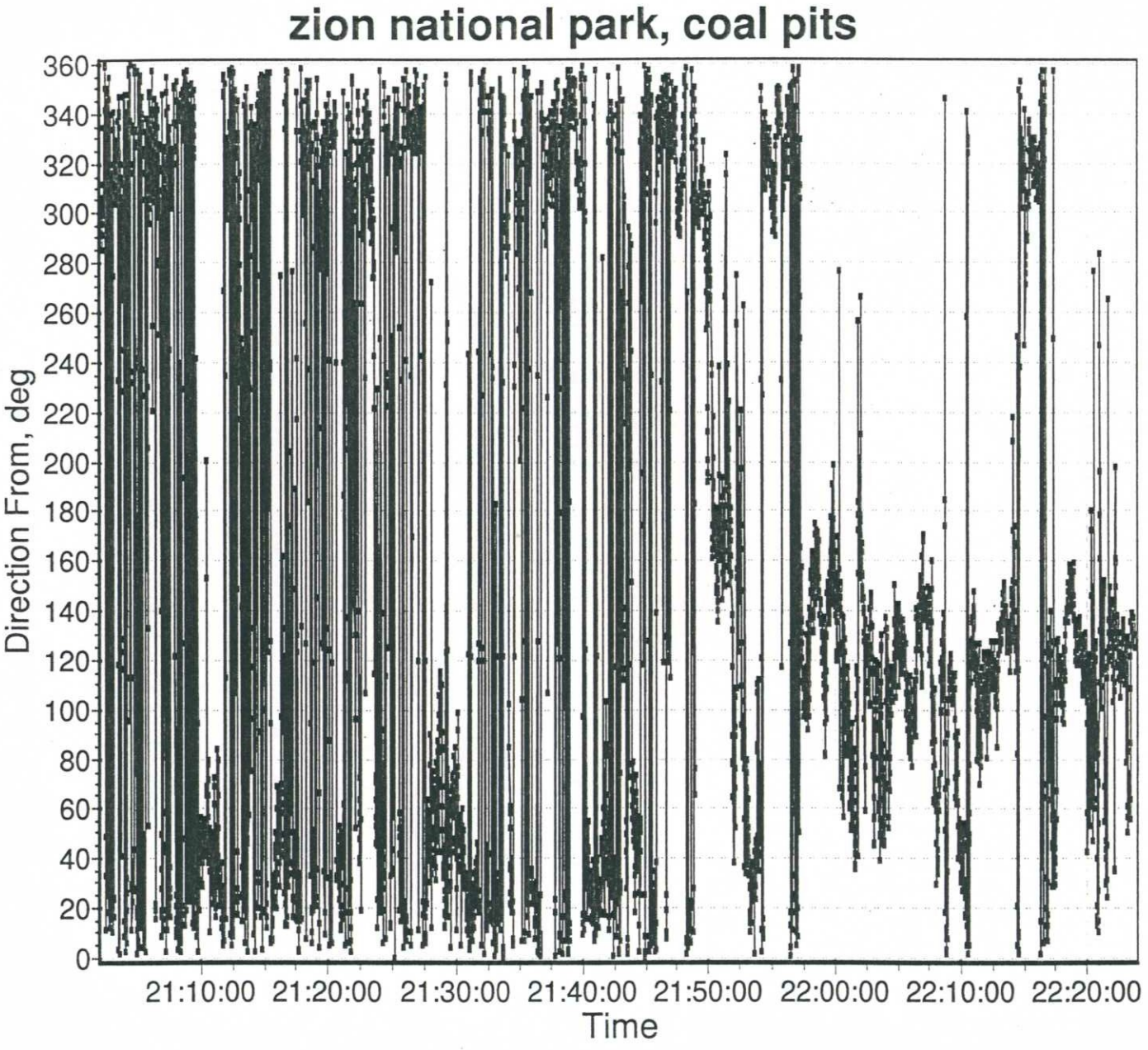



Background
A-w Sound Level (Bckg or Intr) in dB
100
90
80
70
60
50
40
30
20
10
0
30
40
50
60
70
80
90
100
% Time Bkgr Lvl on Vert Scale is Excd


Intruding
Measured Values of Lmax for Events
100
90
80
70
60
50
40
30
20
10
0
0
2
4
# of Lmax


zion national park, coal pits
Sound Level, dB(A)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
21:15:00
21:30:00
21:45:00
22:00:00
22:15:00
Time
Time History
45: Background
50: Intruding
55: other motor vehicles
60: commercial jet
65: other
70: tour buses/lodge trams
75: scenic aircraft


zion national park, coal pits
Speed, mph
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
21:10:00
21:20:00
21:30:00
21:40:00
21:50:00
22:00:00
22:10:00
22:20:00
Time


zion national park, coal pits
Direction From, deg
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
21:10:00
21:20:00
21:30:00
21:40:00
21:50:00
22:00:00
22:10:00
22:20:00
Time

Site Description:

Park Name: zion national park

Site Name: coal pits

Site Number: 01

Elevation: 0

Operator: d sidles

Start Date: 10/23/98 Start Time: 9:22:45 pm

Stop Date: 10/23/98 Stop Time: 9:01:06 am

Type Data Collected:

Sound Level: Yes

Source Identification: Yes

Wind Speed/Direction: No

Equipment:

Acoustic Calibrator type B$K 4221 S/N: 183935

Sound Level Meter type LD-820 S/N: 123

Microphone type B$K 4179 S/N: 865133

Preamplifier type B$K 2660 S/N: 885020

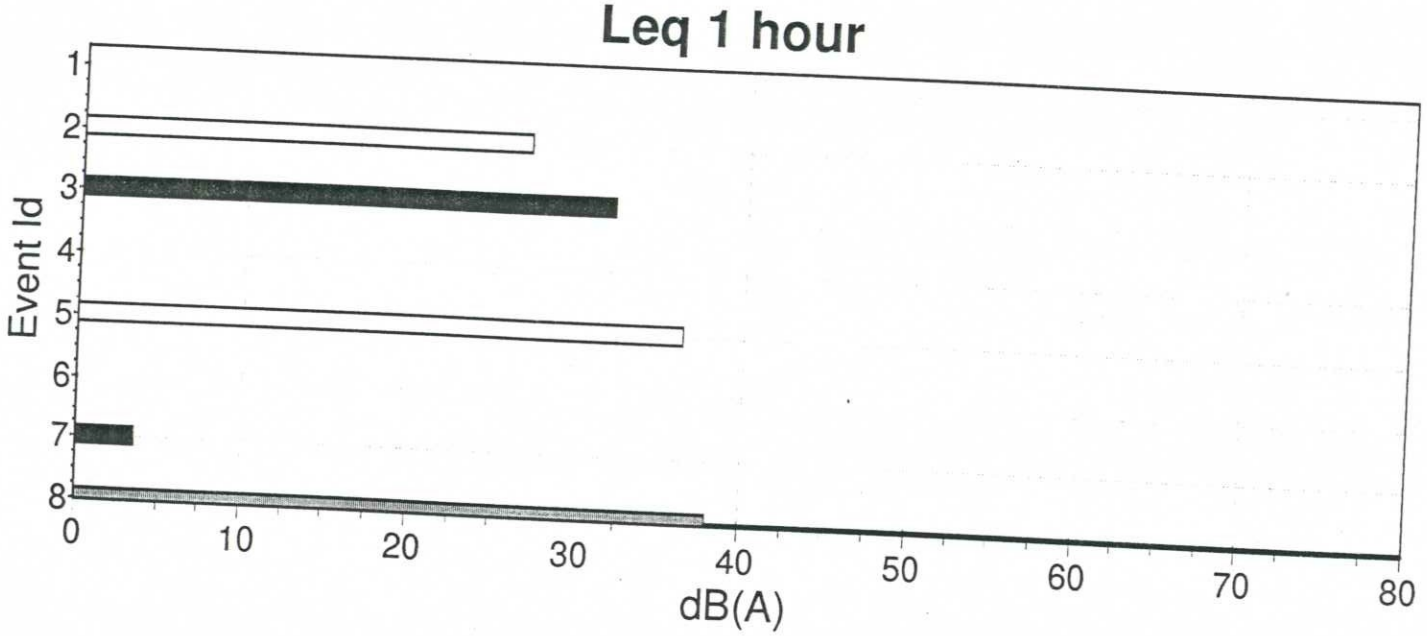
Wind Sensor type 1172N S/N: 341

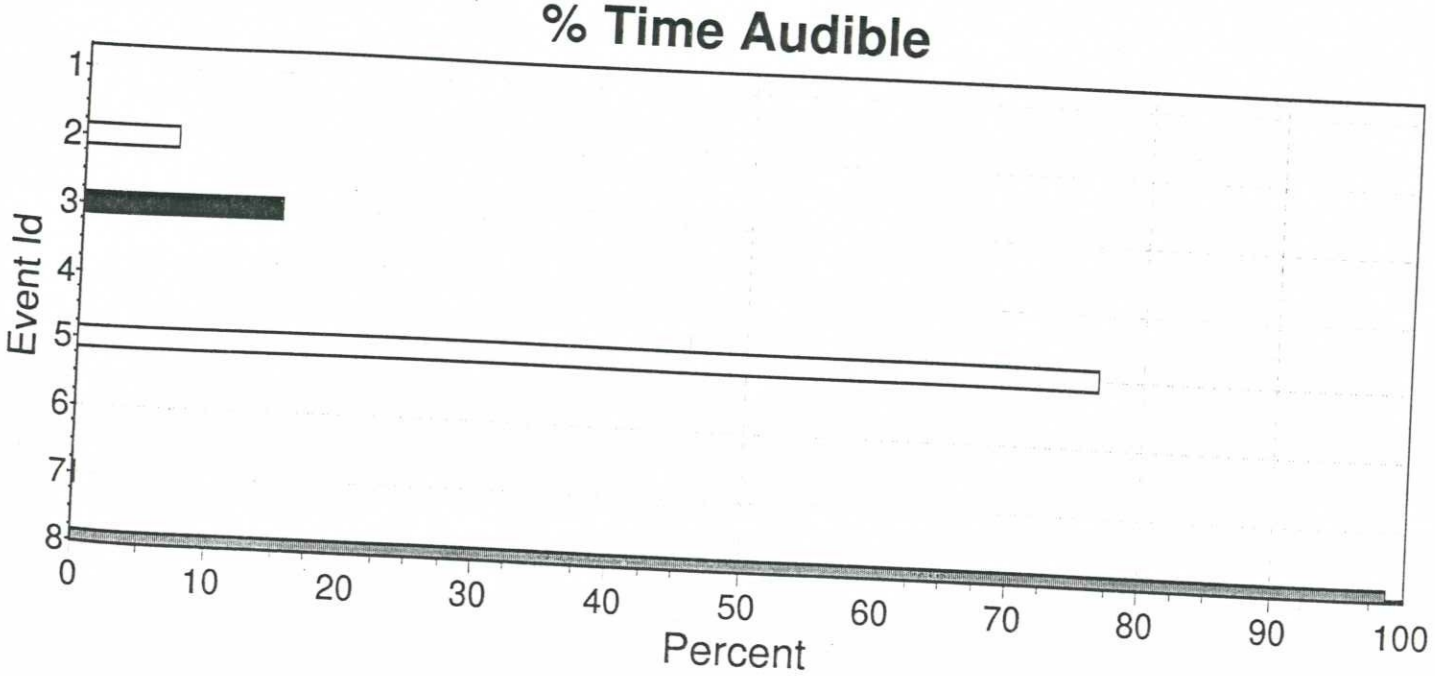
File: G:\PROJECTS\295860.NPS\2_ZI_GLA\ZION\MEASMNTS\REALTIME\0922r296.98

Spike Removal: Yes

Intruding Sound Level

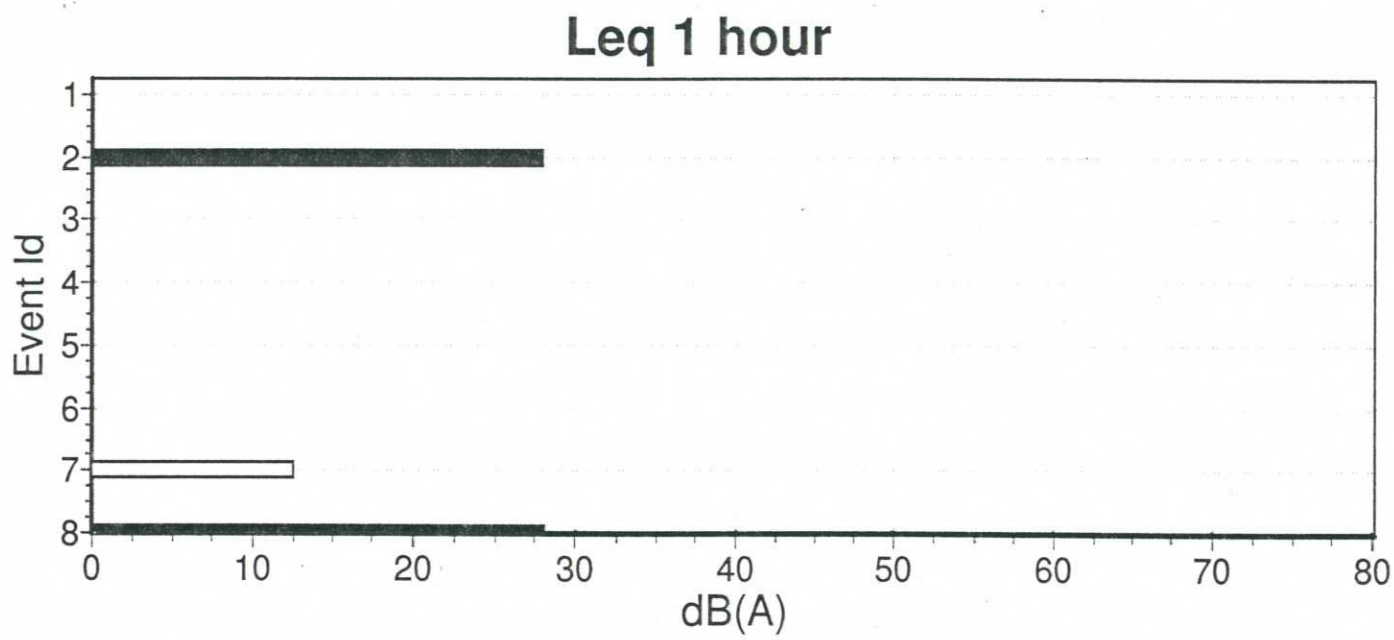
Id	Description	Leq,1hr	%Audible	Events	Good Num	Bad Num	Spike Num	Adj Bckg
1								
2	scenic aircraft	27.00	7.00	5	252	0	0	26.00
3	commercial jet	32.00	15.00	8	540	0	0	30.00
4								
5	other motor vehicles	36.00	76.60	14	2757	0	0	33.00
6								
7	Intruding	3.60	0.19	4	7	0	0	0.30
8	Total:	38.00	98.80	31	3556	0	0	35.00

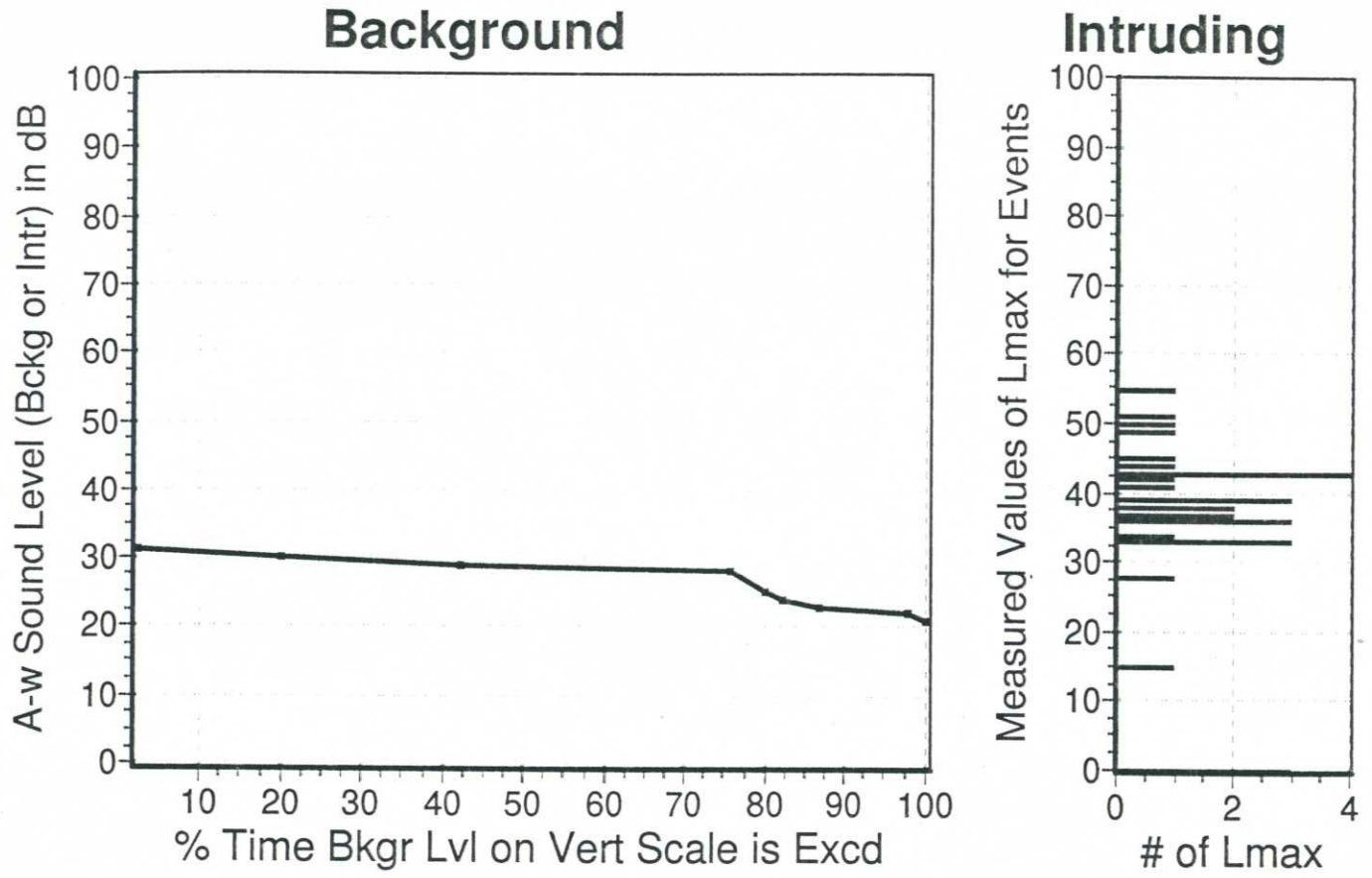


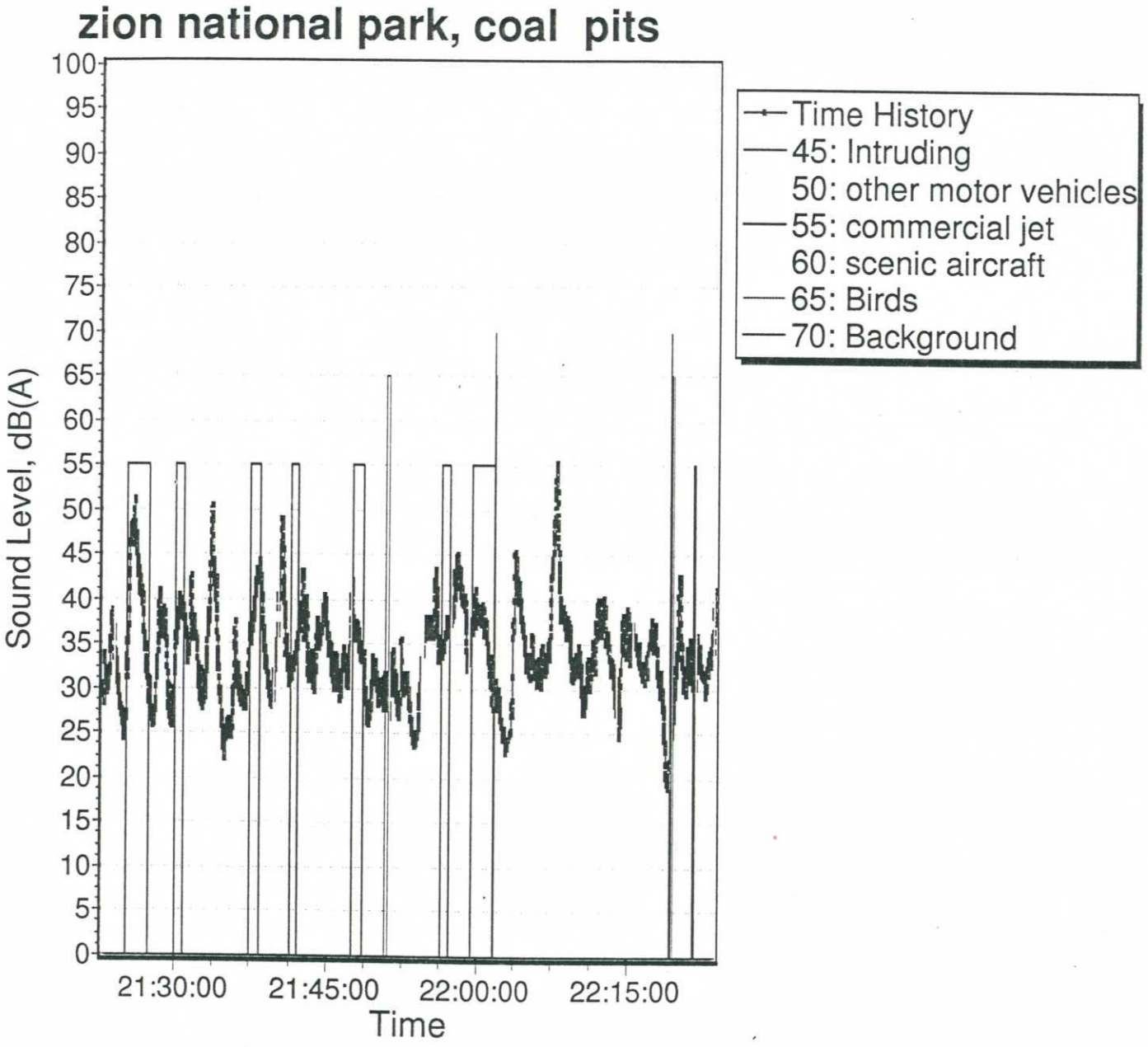


Background Sound Level

Id	Description	Leq,1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind
1								
2	Birds	28.00	28.00	3	43	0	0	28.00
3								
4								
5								
6								
7	Background	13.00	26.00	2	2	0	0	13.00
8	Total:	28.00		5	45	0	0	28.00




Background
A-w Sound Level (Bckg or Intr) in dB
100
90
80
70
60
50
40
30
20
10
0
10 20 30 40 50 60 70 80 90 100
% Time Bkgr Lvl on Vert Scale is Excd
Intruding
Measured Values of Lmax for Events
100
90
80
70
60
50
40
30
20
10
0
0 2 4
# of Lmax


zion national park, coal pits
Sound Level, dB(A)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
21:30:00
21:45:00
22:00:00
22:15:00
Time
Time History
45: Intruding
50: other motor vehicles
55: commercial jet
60: scenic aircraft
65: Birds
70: Background

2a

Site Description:

Park Name: zion national park

Site Name: tabernacle dome

Site Number: 03

Elevation: 0

Operator: d sidles

Start Date: 10/15/98 Start Time: 12:19:25 pm

Stop Date: 10/15/98 Stop Time: ~~1:30:31 am~~

Type Data Collected:

Sound Level: Yes

Source Identification: Yes

Wind Speed/Direction: Yes

Equipment:

Acoustic Calibrator type B$K 4221 S/N: 183935

Sound Level Meter type LD-820 S/N: 123

Microphone type B$K 4179 S/N: 865133

Preamplifier type B$K 2660 S/N: 885020

Wind Sensor type 1172N S/N: 341

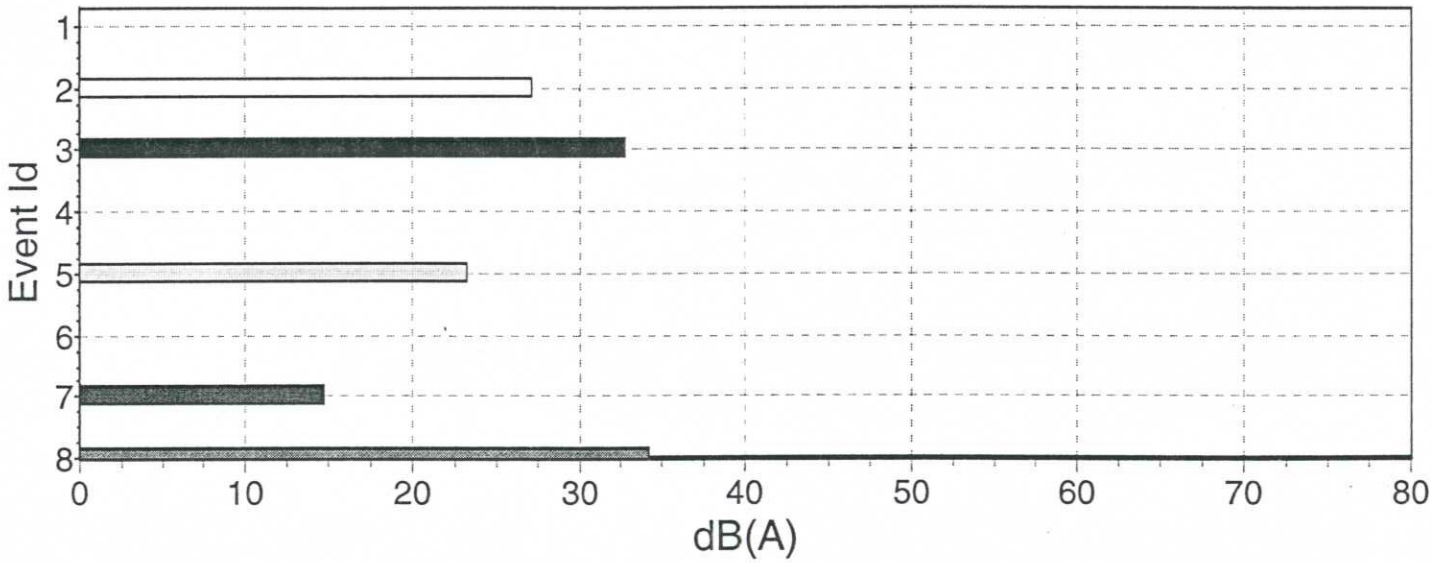
File: G:\PROJECTS\295860.NPS\2_ZI_GLA\ZION\MEASMNTS\REALTIME\1219r288.98

Spike Removal: Yes

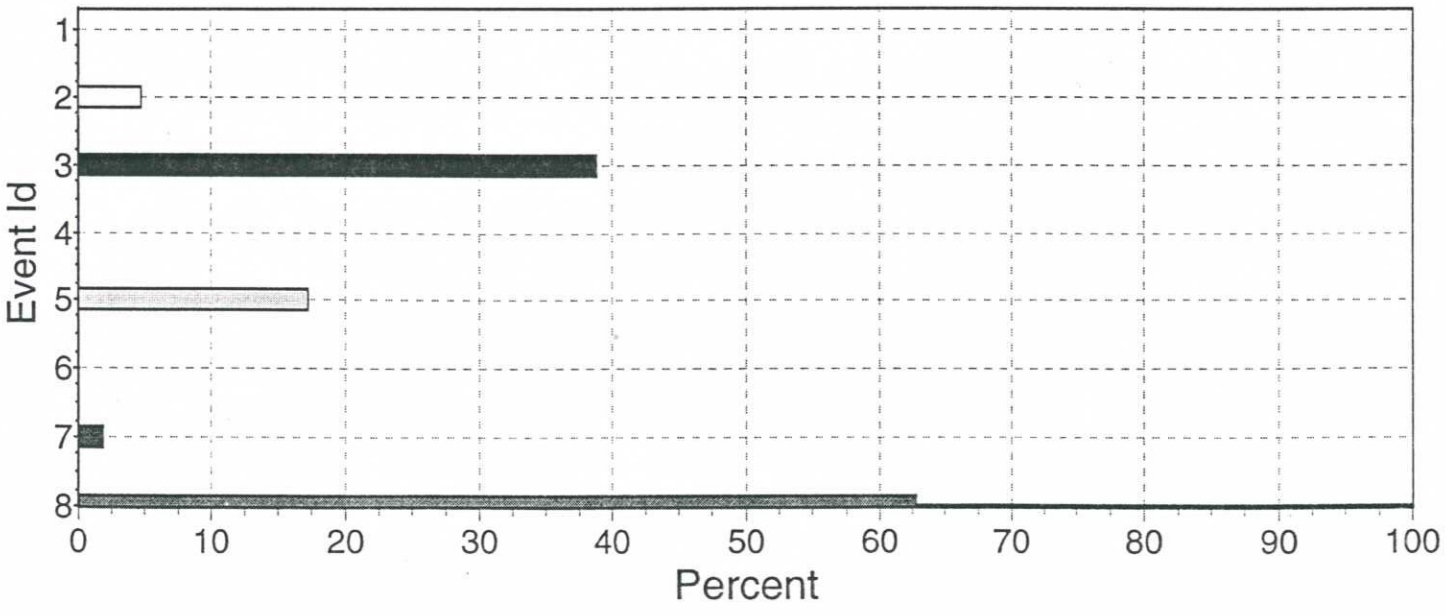
Intruding Sound Level

Id	Description	Leq,1hr	%Audible	Events	Good Num	Bad Num	Spike Num	Adj Bckg
1								
2	scenic aircraft	27.00	4.75	1	171	0	0	26.00
3	commercial jet	33.00	38.90	21	1400	0	0	29.00
4								
5	other motor vehicles	23.00	17.30	16	622	0	0	0.00
6								
7	Intruding	15.00	1.92	30	69	0	0	8.50
8	Total:	34.00	62.80	68	2262	0	0	31.00

Leq 1 hour

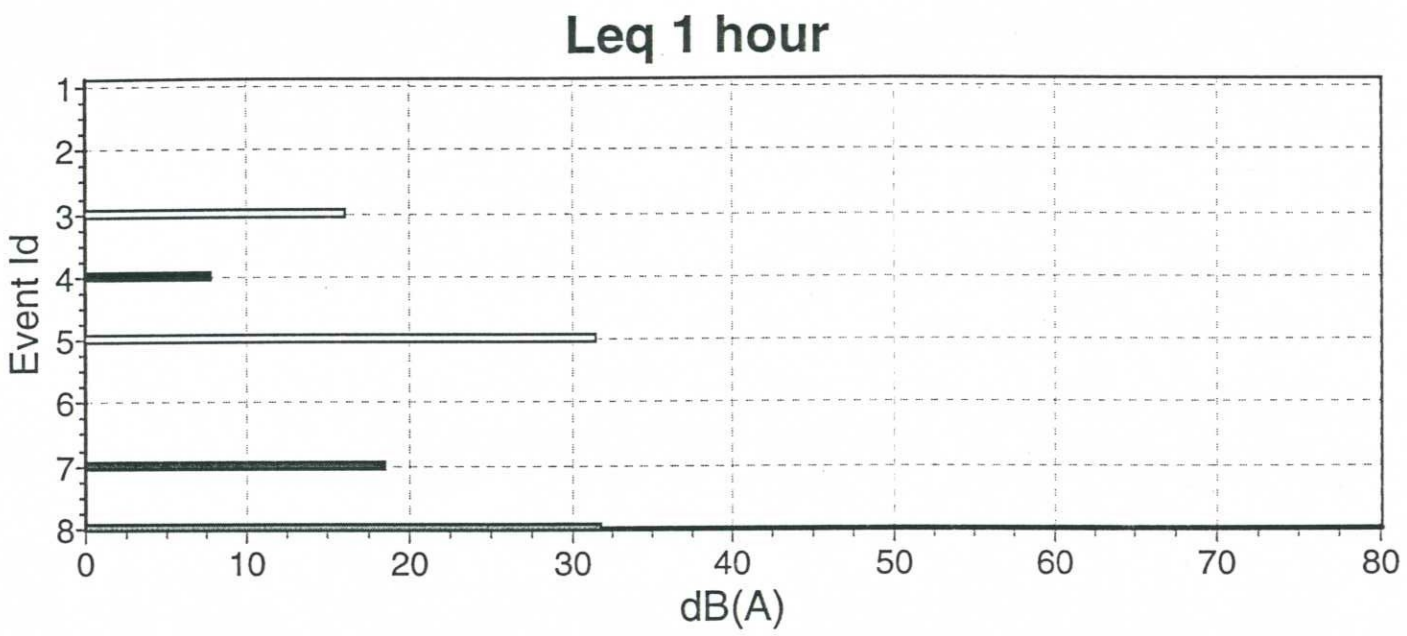


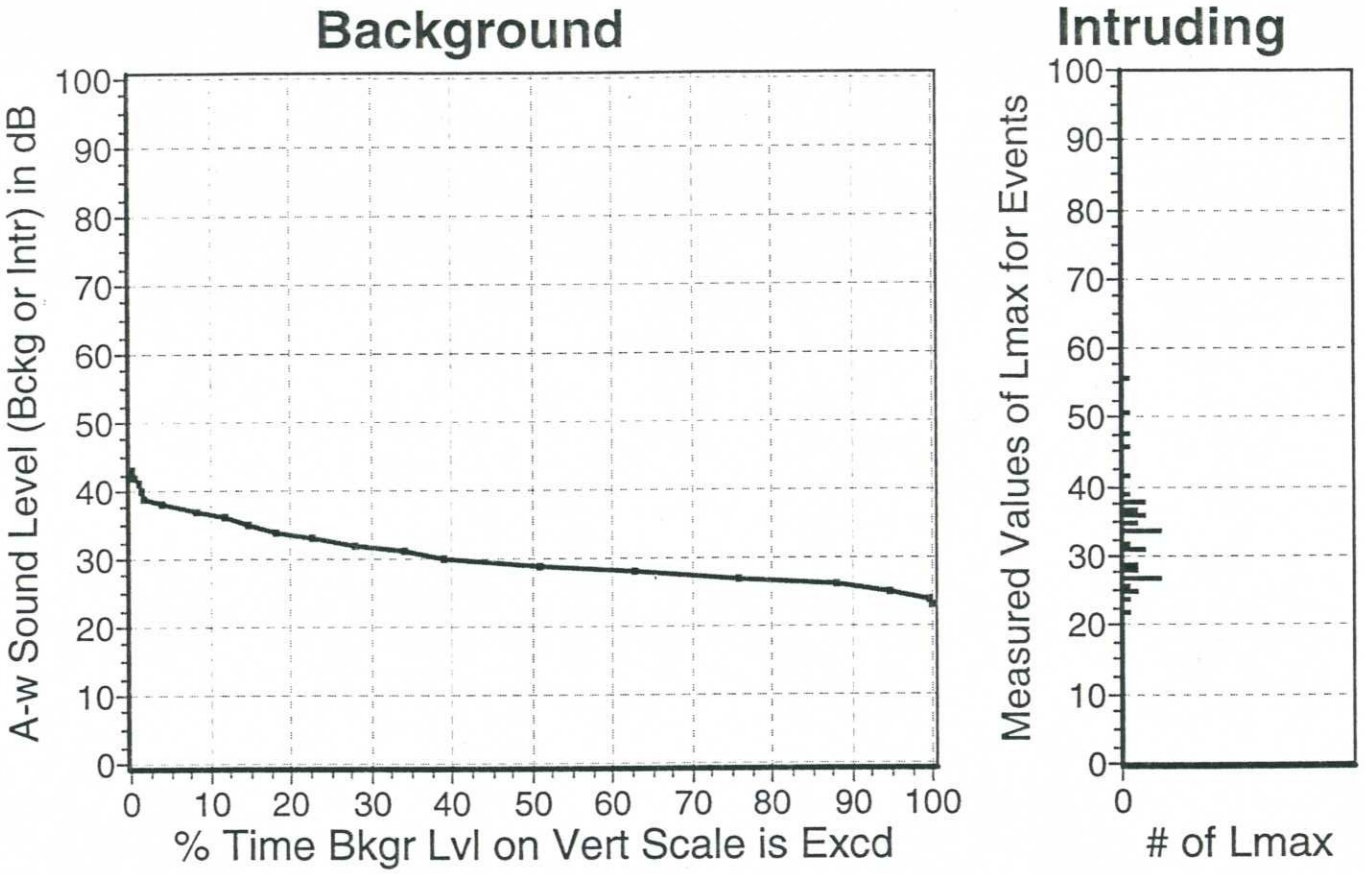
% Time Audible



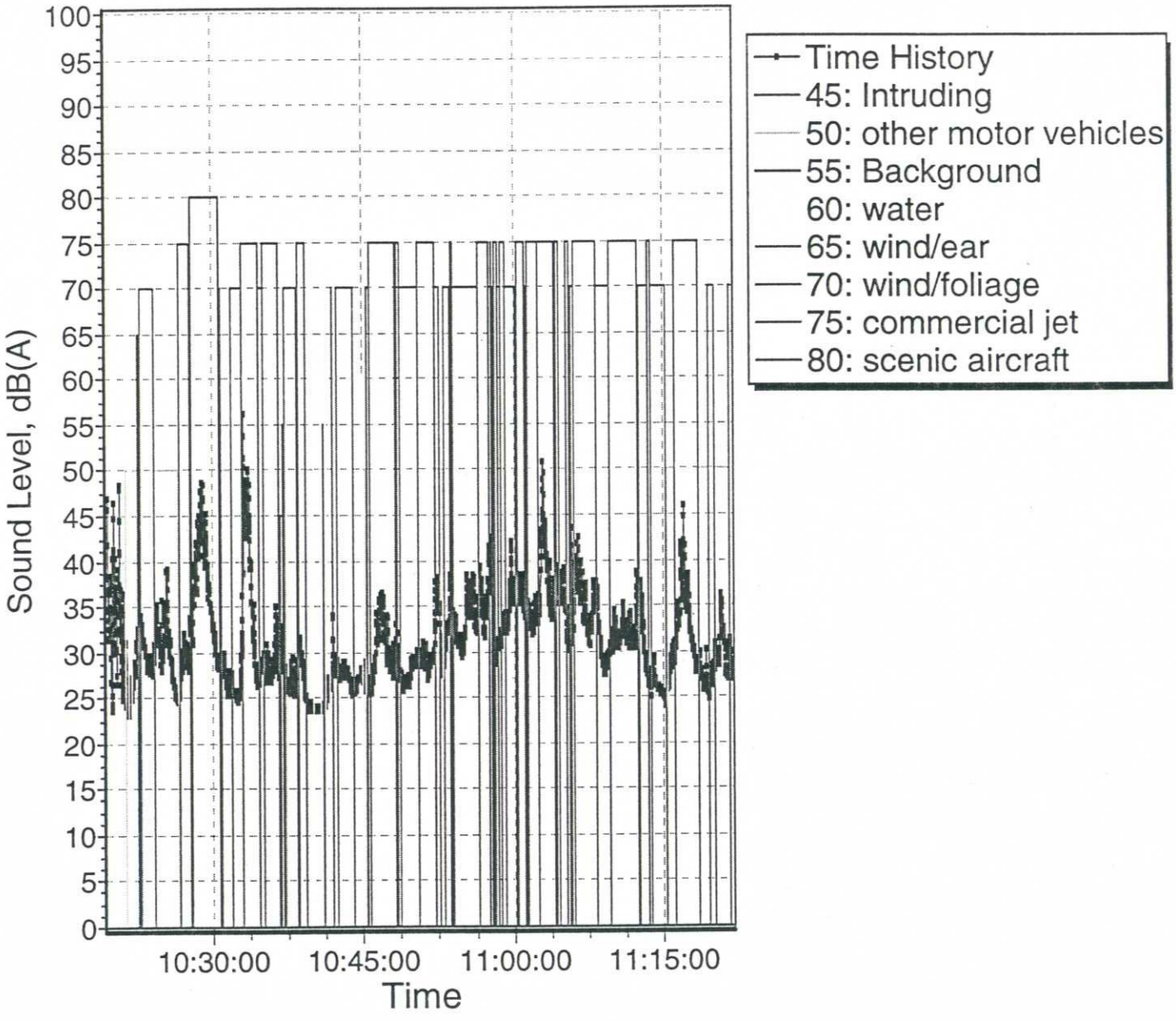
Background Sound Level

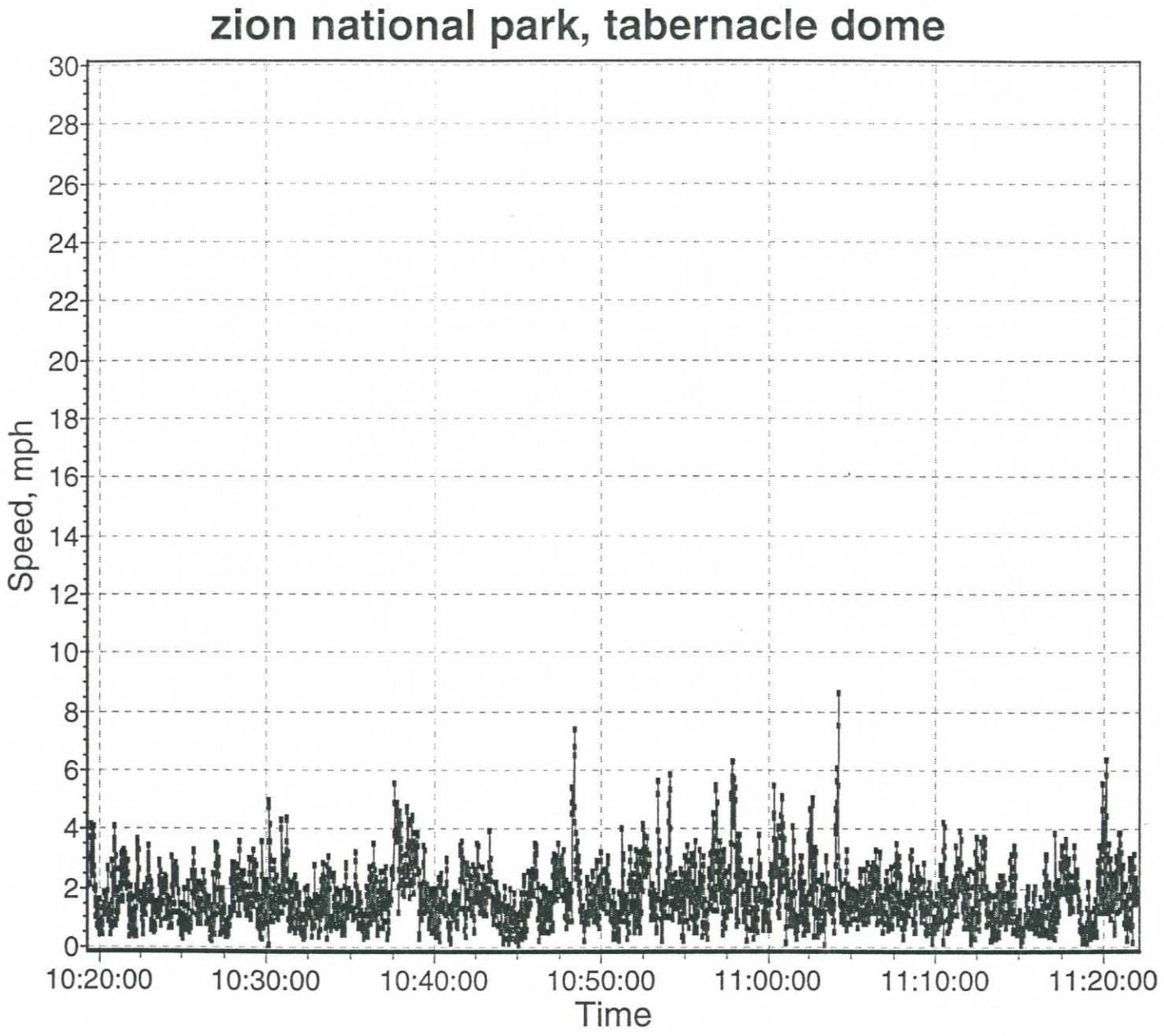
Id	Description	Leq,1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind
1								
2								
3	water	16.00	26.00	4	149	0	0	16.00
4	wind/ear	7.90	31.00	1	6	0	0	7.80
5	wind/foliage	31.00	32.00	26	1126	0	0	31.00
6								
7	Background	19.00	32.00	31	58	0	0	19.00
8	Total:	32.00		62	1339	0	0	32.00

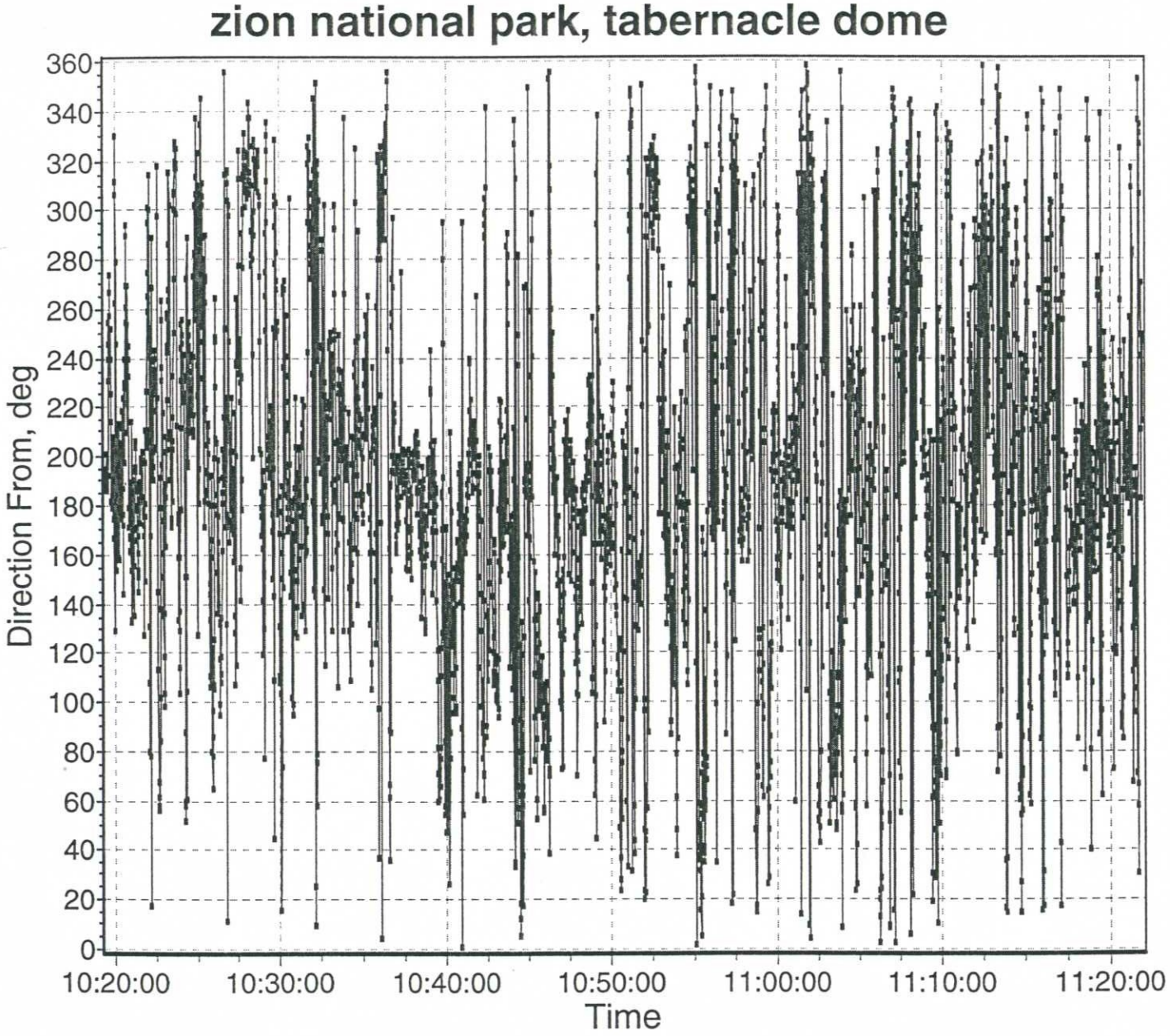



Background
A-w Sound Level (Bckg or Intr) in dB
100
90
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
% Time Bkgr Lvl on Vert Scale is Excd
Intruding
Measured Values of Lmax for Events
100
90
80
70
60
50
40
30
20
10
0
0
# of Lmax

zion national park, tabernacle dome




zion national park, tabernacle dome
Speed, mph
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
10:20:00
10:30:00
10:40:00
10:50:00
11:00:00
11:10:00
11:20:00
Time


zion national park, tabernacle dome
Direction From, deg
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
10:20:00
10:30:00
10:40:00
10:50:00
11:00:00
11:10:00
11:20:00
Time

Site Description:

Park Name: zion national park

Site Name: tabernacle dome

Site Number: 03

Elevation: 0

Operator: r horonjeff

Start Date: 10/16/98 Start Time: 2:44:17 am

Stop Date: 10/16/98 Stop Time: 8:48:35 am

Type Data Collected:

Sound Level: Yes

Source Identification: Yes

Wind Speed/Direction: Yes

Equipment:

Acoustic Calibrator type B$K 4221 S/N: 183935

Sound Level Meter type LD-820 S/N: 123

Microphone type B$K 4179 S/N: 865133

Preamplifier type B$K 2660 S/N: 885020

Wind Sensor type 1172N S/N: 341

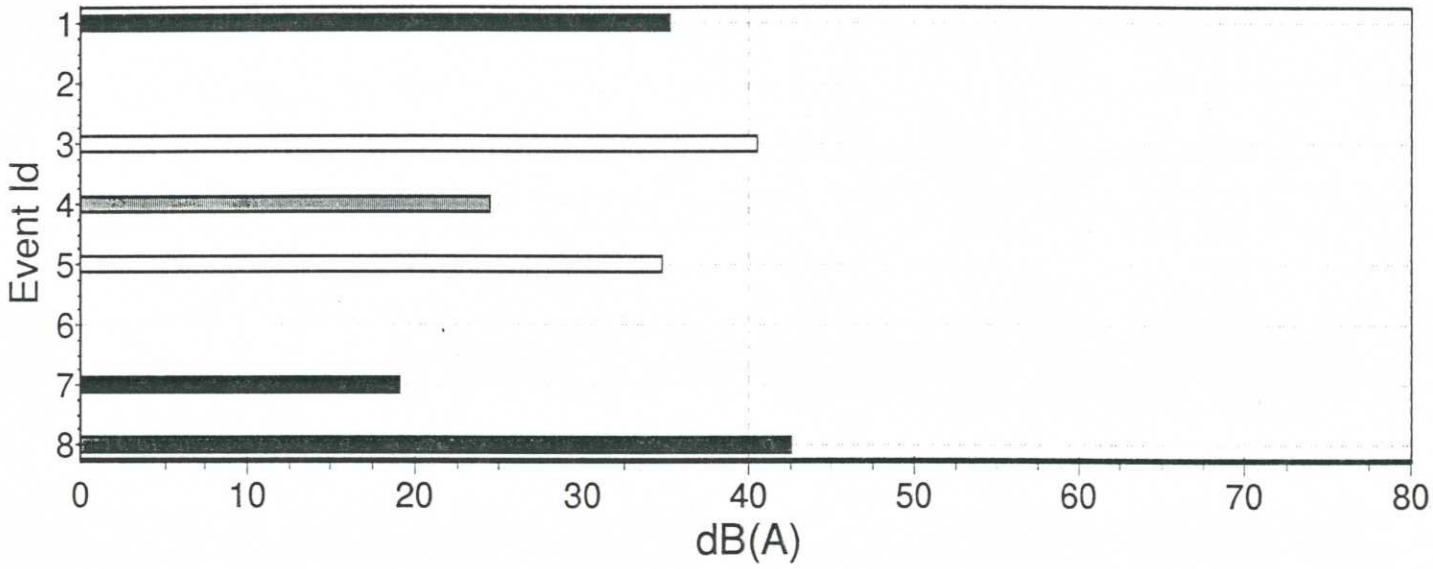
File: G:\PROJECTS\295860.NPS\2_ZI_GLA\ZION\MEASMNTS\REALTIME\1444r289.98

Spike Removal: Yes

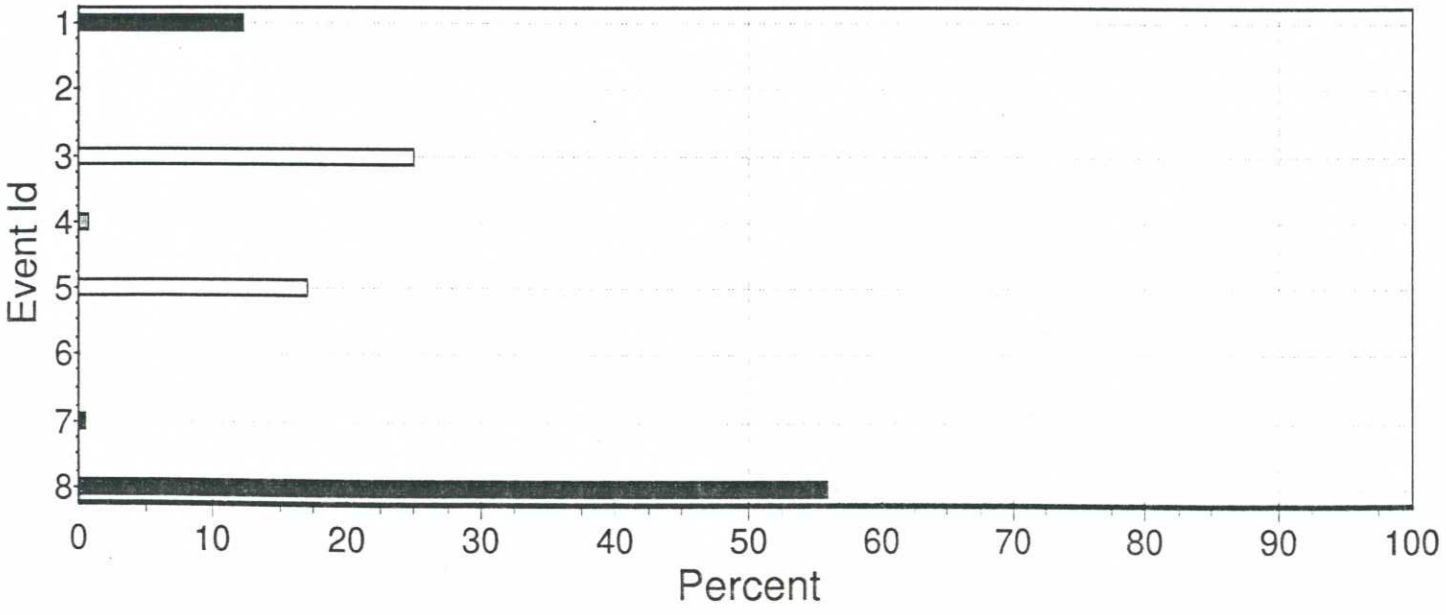
Intruding Sound Level

Id	Description	Leq,1hr	%Audible	Events	Good Num	Bad Num	Spike Num	Adj Bckg
1	other	35.00	12.40	3	352	0	0	0.00
2								
3	commercial jet	41.00	25.10	9	712	0	0	0.00
4	tour buses/lodge trams	25.00	0.77	1	22	0	0	0.00
5	other motor vehicles	35.00	17.10	13	487	0	0	0.00
6								
7	Intruding	19.00	0.60	12	17	0	0	0.00
8	Total:	43.00	56.00	38	1590	0	0	7.00

Leq 1 hour



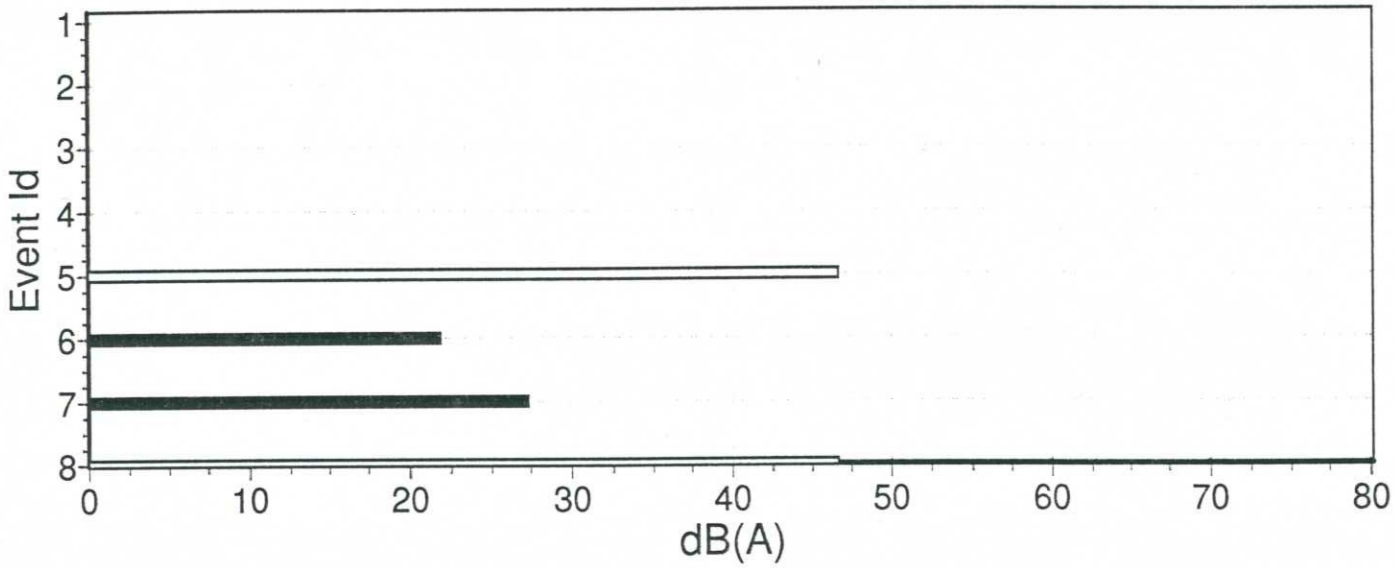
% Time Audible

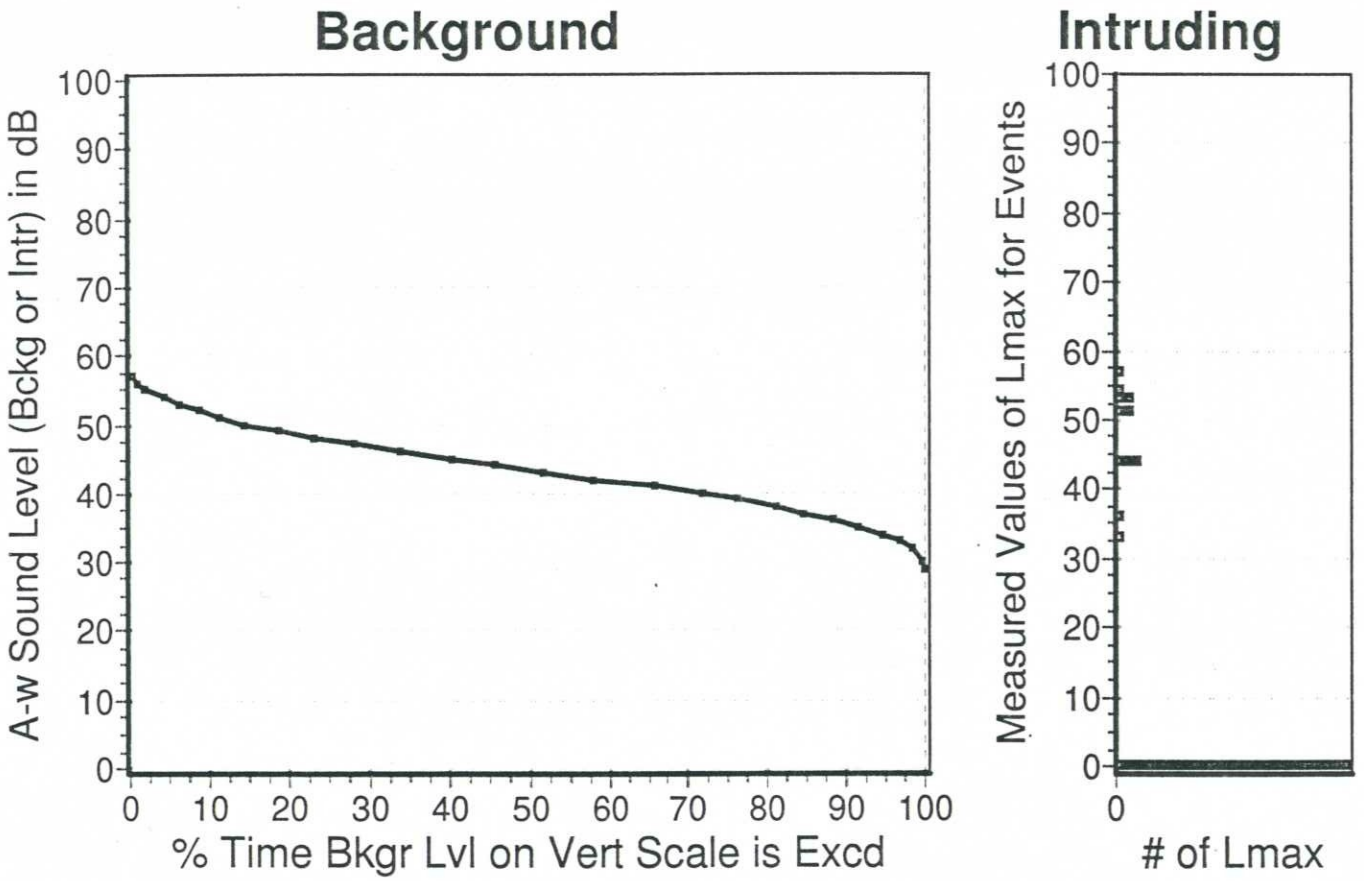


Background Sound Level

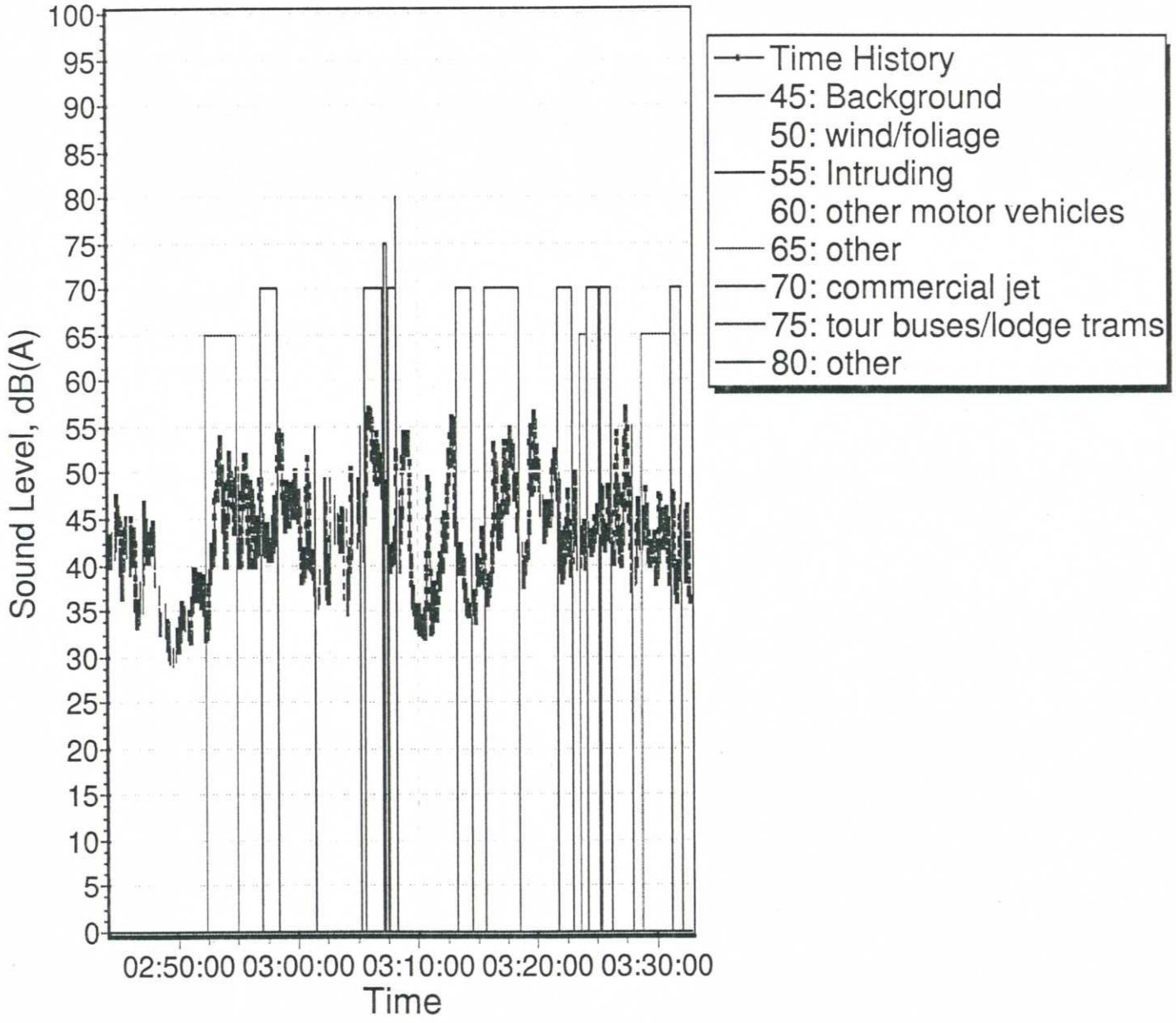
Id	Description	Leq,1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind
1								
2								
3								
4								
5	wind/foliage	47.00	47.00	15	1235	0	0	47.00
6	other	22.00	50.00	1	2	0	0	22.00
7	Background	27.00	47.00	12	14	0	0	27.00
8	Total:	47.00		28	1251	0	0	47.00

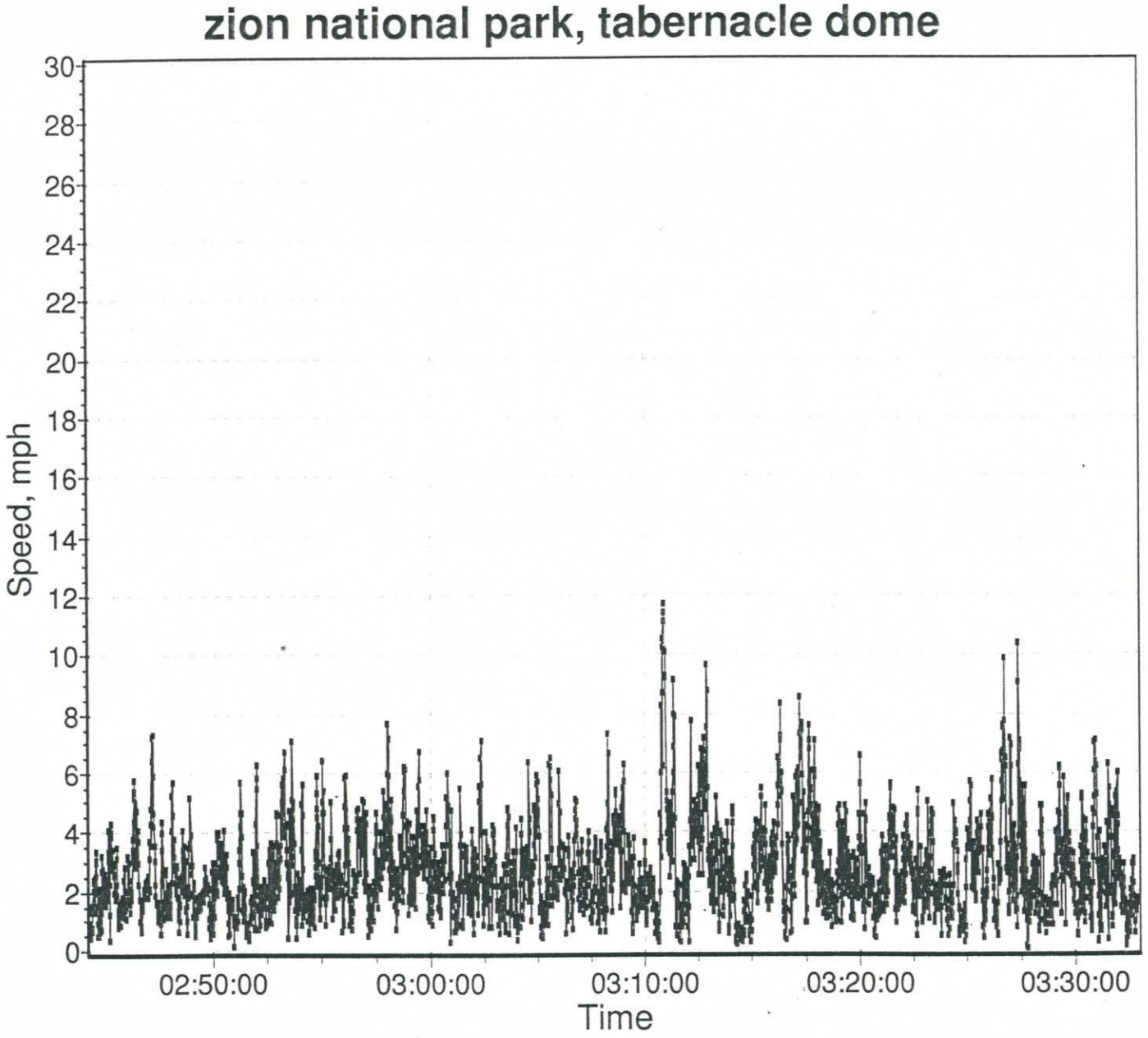
Leq 1 hour

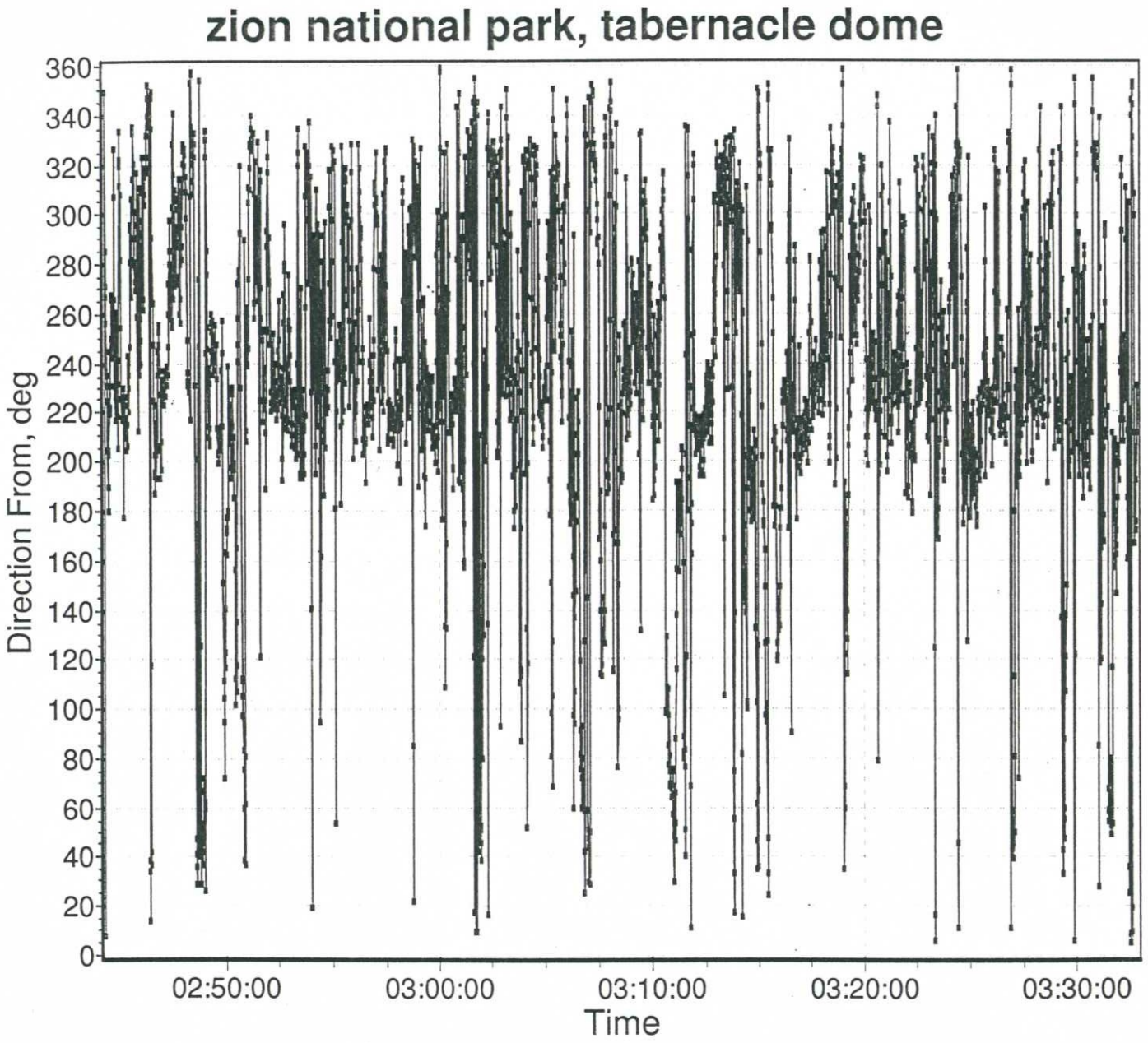



Background
A-w Sound Level (Bckg or Intr) in dB
100
90
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
% Time Bkgr Lvl on Vert Scale is Excd
Intruding
Measured Values of Lmax for Events
100
90
80
70
60
50
40
30
20
10
0
0
# of Lmax

zion national park, tabernacle dome




zion national park, tabernacle dome
Speed, mph
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
02:50:00
03:00:00
03:10:00
03:20:00
03:30:00
Time


zion national park, tabernacle dome
Direction From, deg
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
02:50:00
03:00:00
03:10:00
03:20:00
03:30:00
Time

3a

Site Description:

Park Name: zion national park

Site Name: watchman

Site Number: 04

Elevation: 0

Operator: d sidles

Start Date: 10/15/98 Start Time: 4:16:09 pm

Stop Date: 10/15/98 Stop Time: 9:03:19 am

Type Data Collected:

Sound Level: Yes

Source Identification: Yes

Wind Speed/Direction: Yes

Equipment:

Acoustic Calibrator type B$K 4221 S/N: 183935

Sound Level Meter type LD-820 S/N: 123

Microphone type B$K 4179 S/N: 865133

Preamplifier type B$K 2660 S/N: 885020

Wind Sensor type 1172N S/N: 341

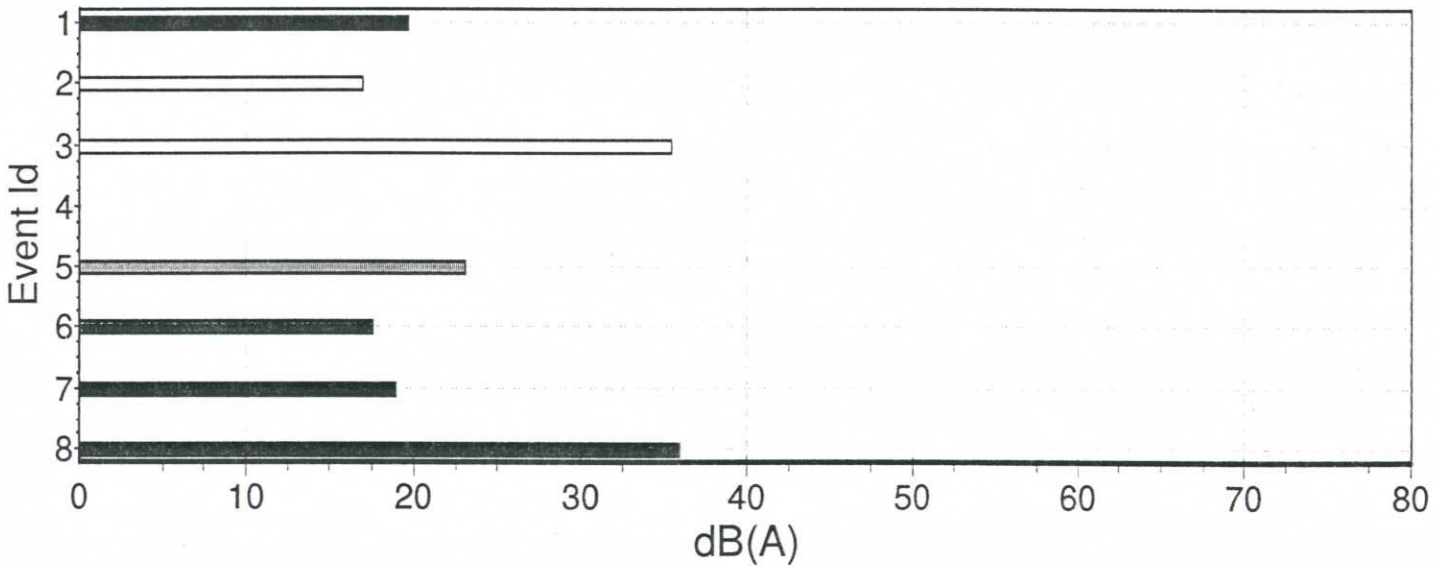
File: G:\PROJECTS\295860.NPS\2_ZI_GLA\ZION\MEASMNTS\REALTIME\1616r288.98

Spike Removal: Yes

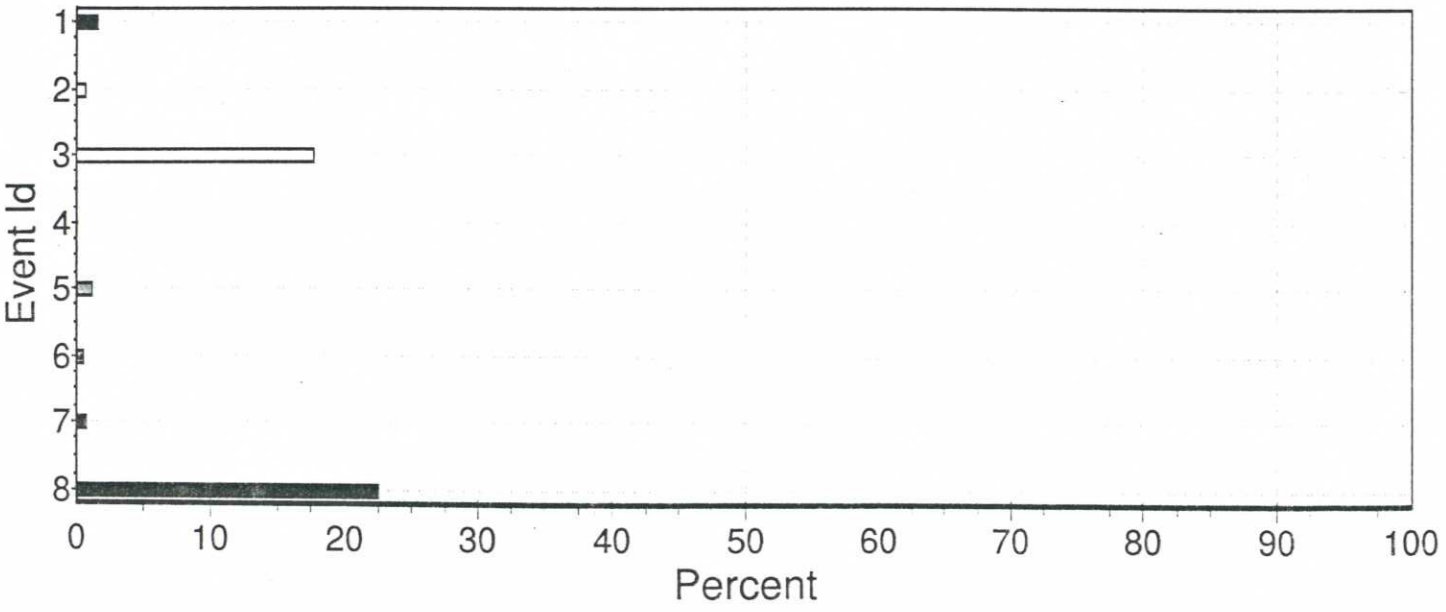
Intruding Sound Level

Id	Description	Leq,1hr	%Audible	Events	Good Num	Bad Num	Spike Num	Adj Bckg
1	other	20.00	1.61	1	58	0	0	0.00
2	scenic aircraft	17.00	0.72	1	26	0	0	0.00
3	commercial jet	35.00	17.70	6	639	0	0	33.00
4								
5	other motor vehicles	23.00	1.19	2	43	0	0	18.00
6	human	18.00	0.56	2	20	0	0	0.00
7	Intruding	19.00	0.78	11	28	0	0	8.70
8	Total:	36.00	22.60	23	814	0	0	33.00

Leq 1 hour



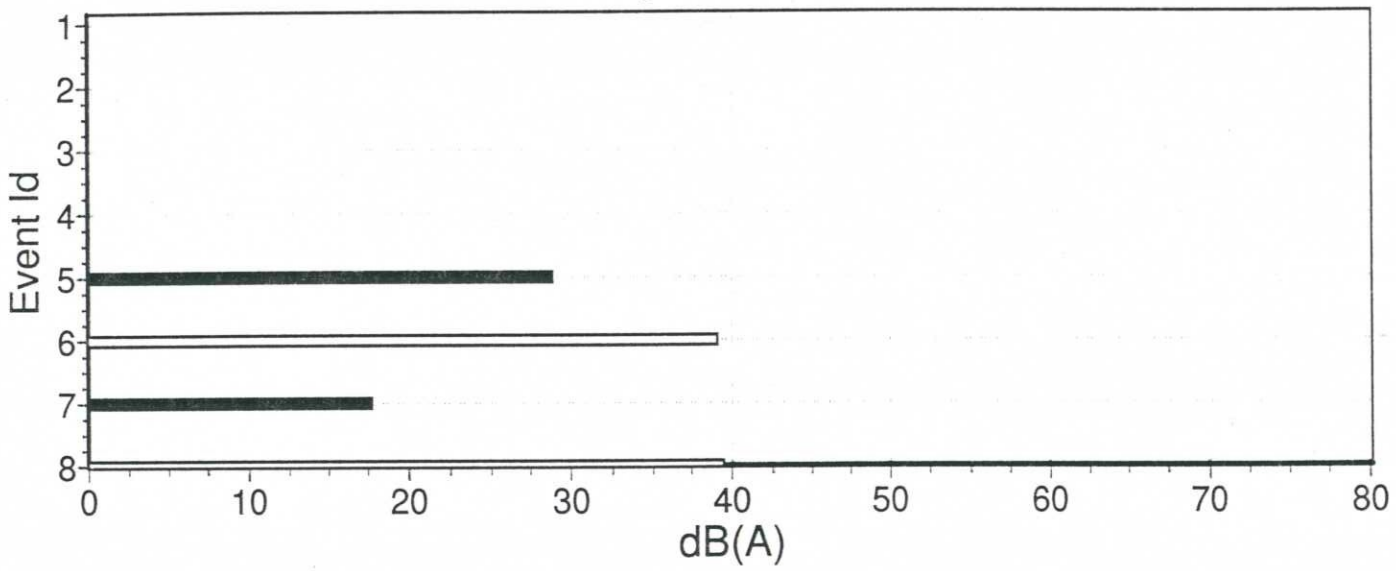
% Time Audible

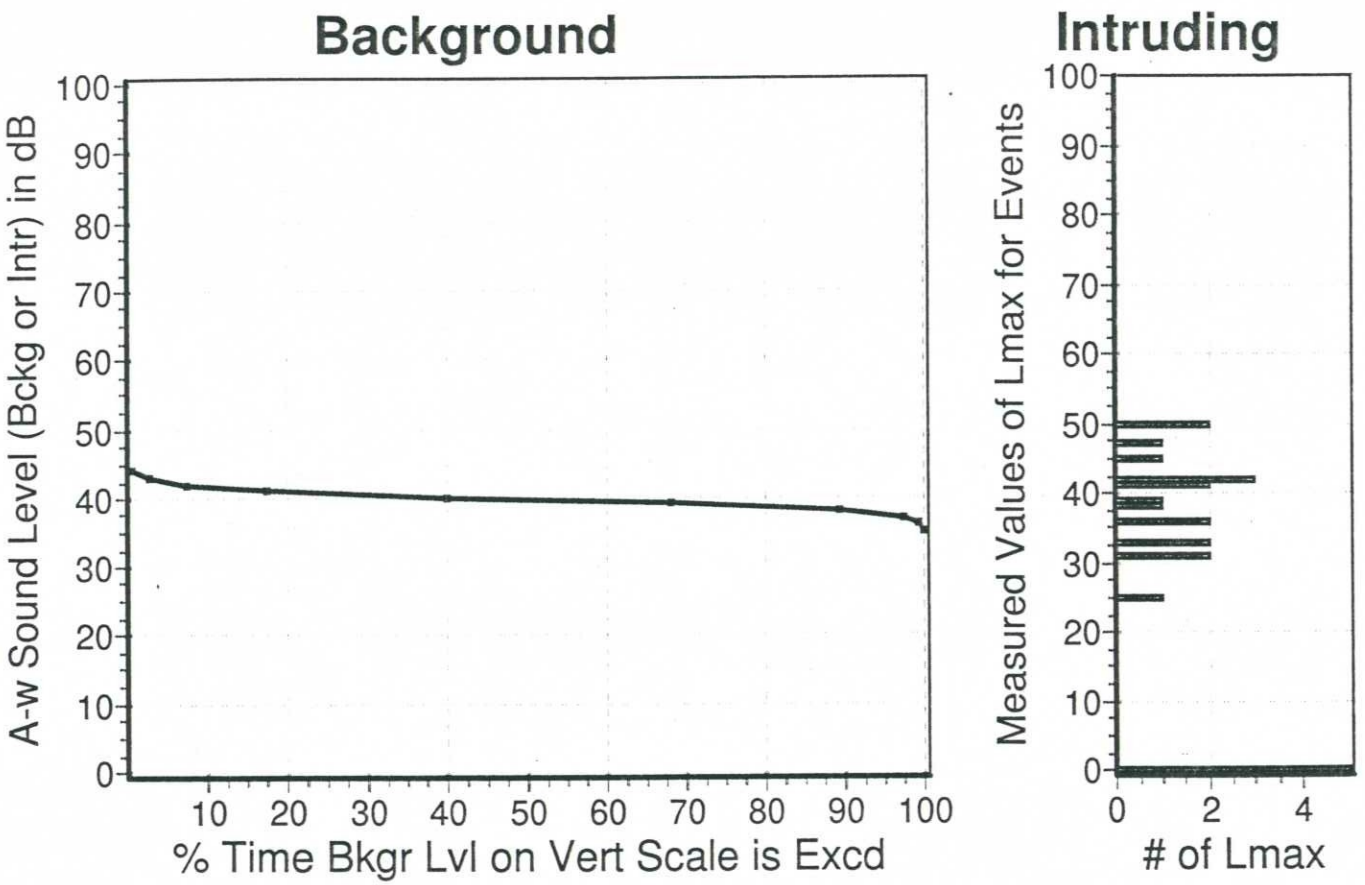


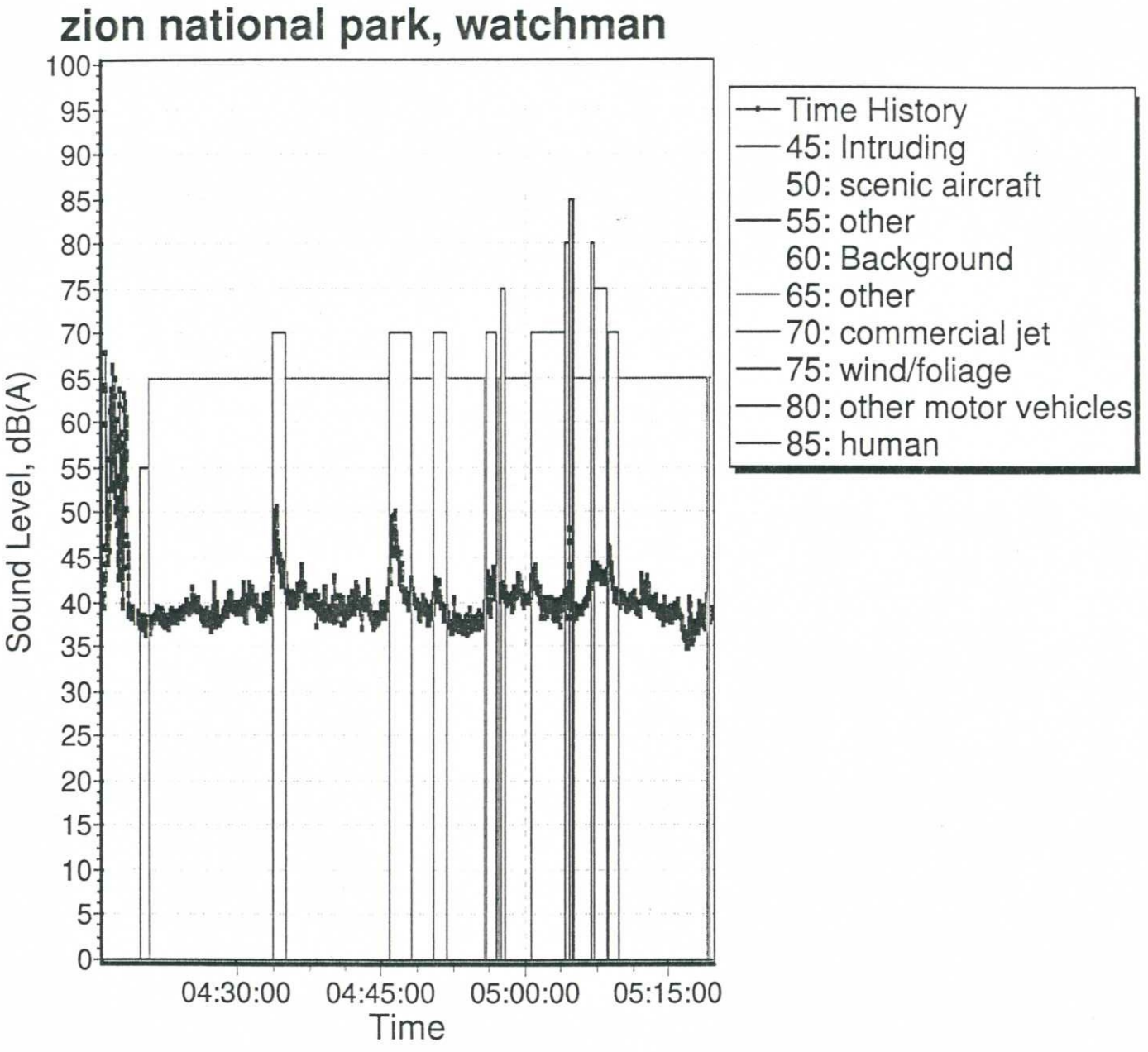
Background Sound Level

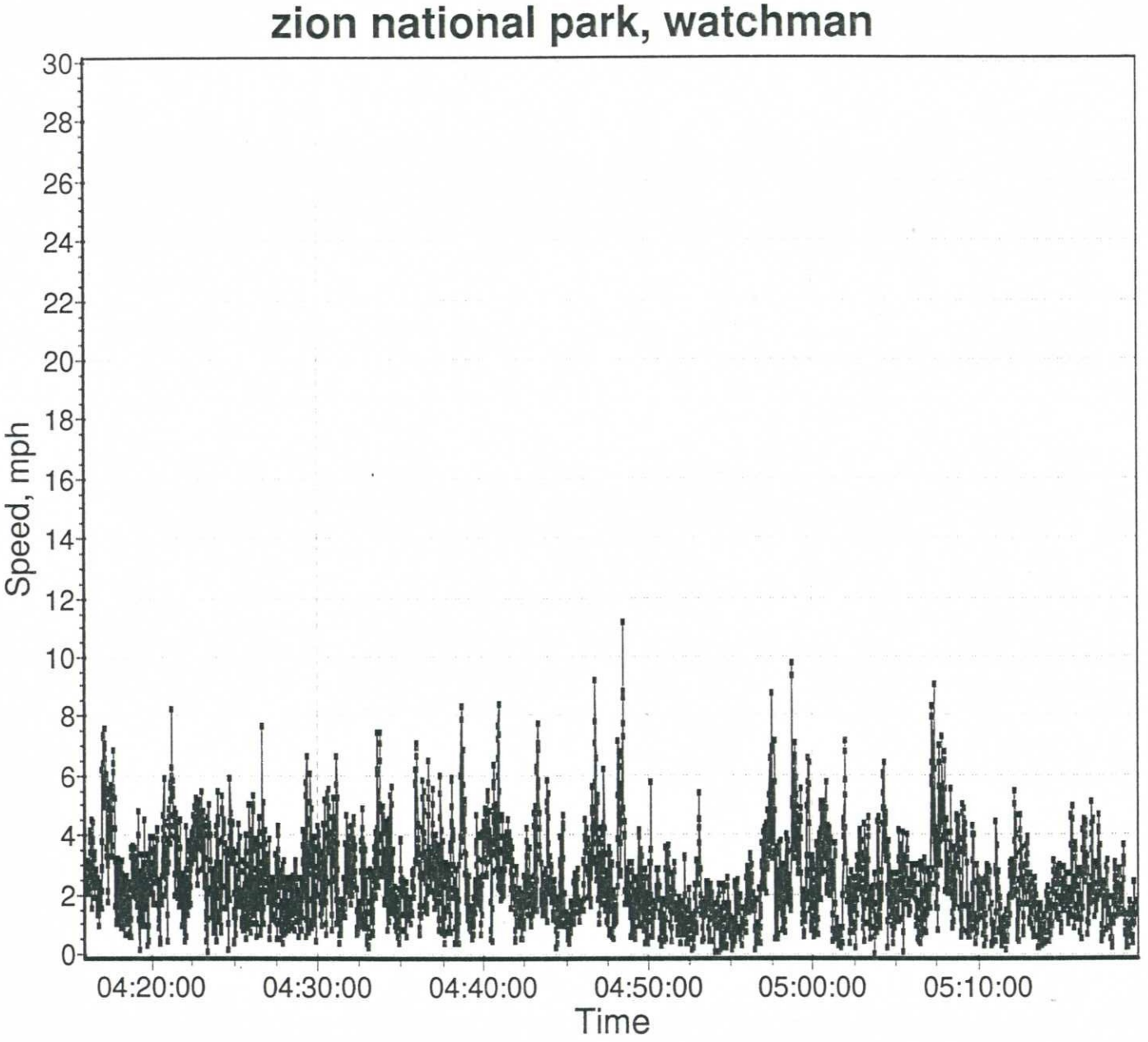
Id	Description	Leq,1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind
1								
2								
3								
4								
5	wind/foliage	29.00	43.00	2	119	0	0	29.00
6	other	39.00	39.00	9	2654	0	0	39.00
7	Background	18.00	41.00	9	14	0	0	18.00
8	Total:	40.00		20	2787	0	0	40.00

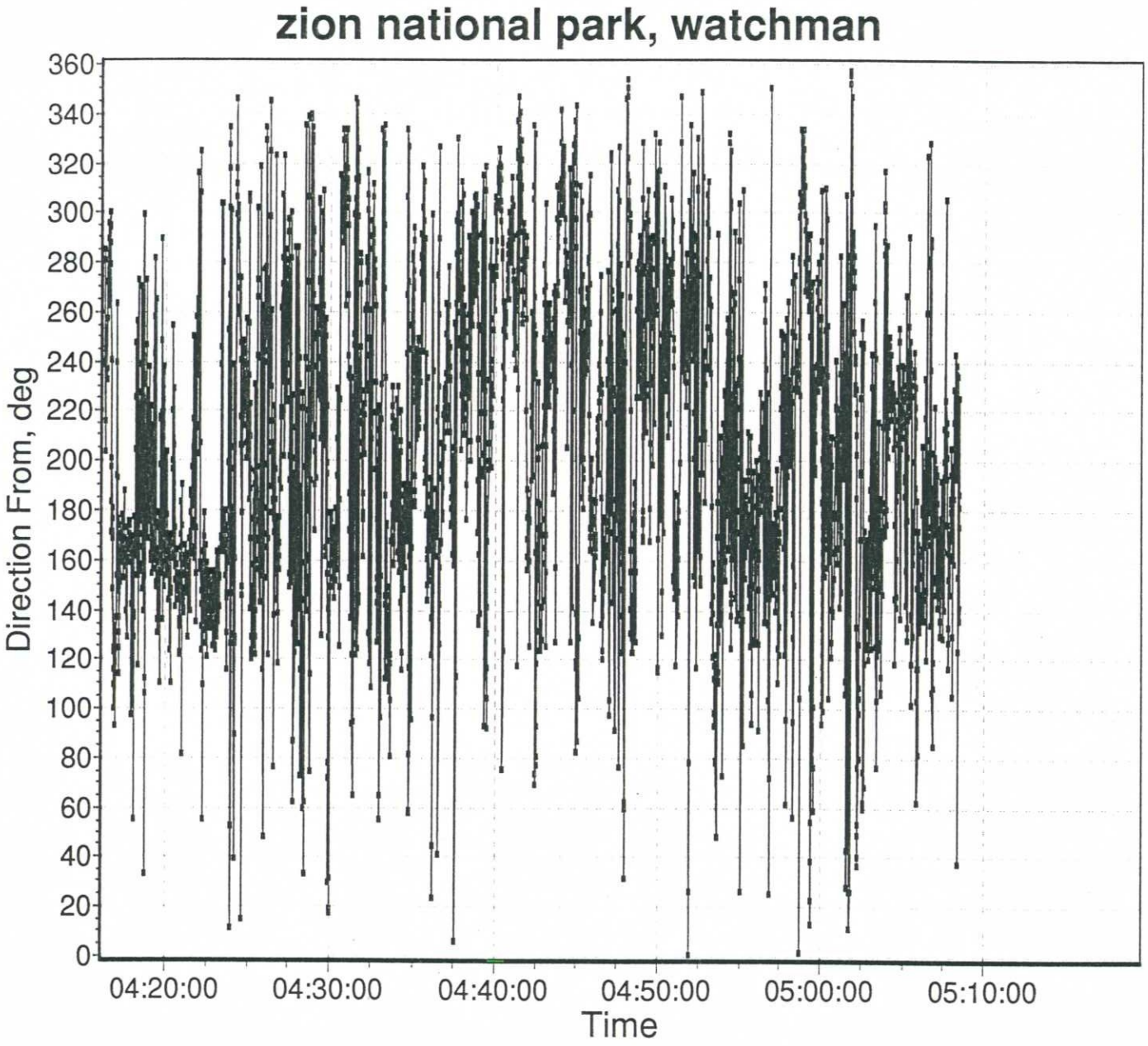
Leq 1 hour




Background
A-w Sound Level (Bckg or Intr) in dB
100
90
80
70
60
50
40
30
20
10
0
10 20 30 40 50 60 70 80 90 100
% Time Bkgr Lvl on Vert Scale is Excd
Intruding
Measured Values of Lmax for Events
100
90
80
70
60
50
40
30
20
10
0
0 2 4
# of Lmax


zion national park, watchman
Sound Level, dB(A)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
04:30:00
04:45:00
05:00:00
05:15:00
Time
Time History
45: Intruding
50: scenic aircraft
55: other
60: Background
65: other
70: commercial jet
75: wind/foliage
80: other motor vehicles
85: human


zion national park, watchman
Speed, mph
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
04:20:00
04:30:00
04:40:00
04:50:00
05:00:00
05:10:00
Time


zion national park, watchman
Direction From, deg
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
04:20:00
04:30:00
04:40:00
04:50:00
05:00:00
05:10:00
Time

Site Description:

Park Name: zion national park

Site Name: watchman

Site Number: 03

Elevation: 0

Operator: d sidles

Start Date: 10/22/98 Start Time: 9:49:38 pm

Stop Date: 10/22/98 Stop Time: 9:03:29 am

Type Data Collected:

Sound Level: Yes

Source Identification: Yes

Wind Speed/Direction: No

Equipment:

Acoustic Calibrator type B$K 4221 S/N: 183935

Sound Level Meter type LD-820 S/N: 123

Microphone type B$K 4179 S/N: 865133

Preamplifier type B$K 2660 S/N: 885020

Wind Sensor type 1172N S/N: 341

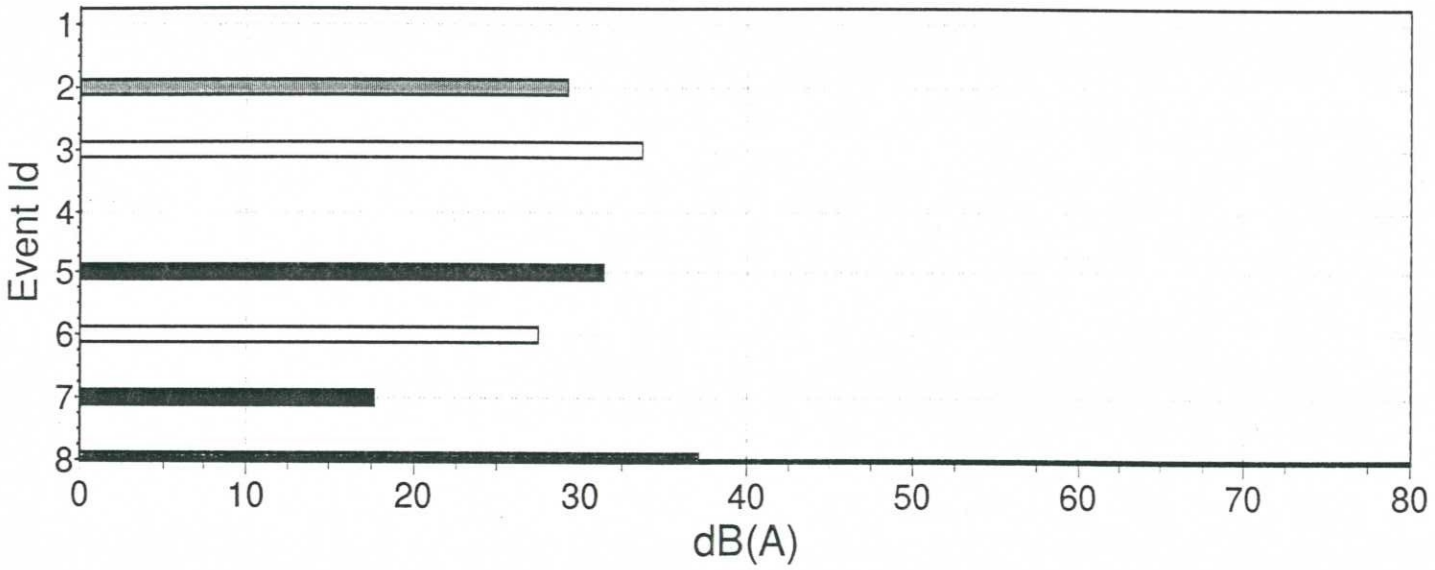
File: G:\PROJECTS\295860.NPS\2_ZI_GLA\ZION\MEASMNTS\REALTIME\0949r295.98

Spike Removal: Yes

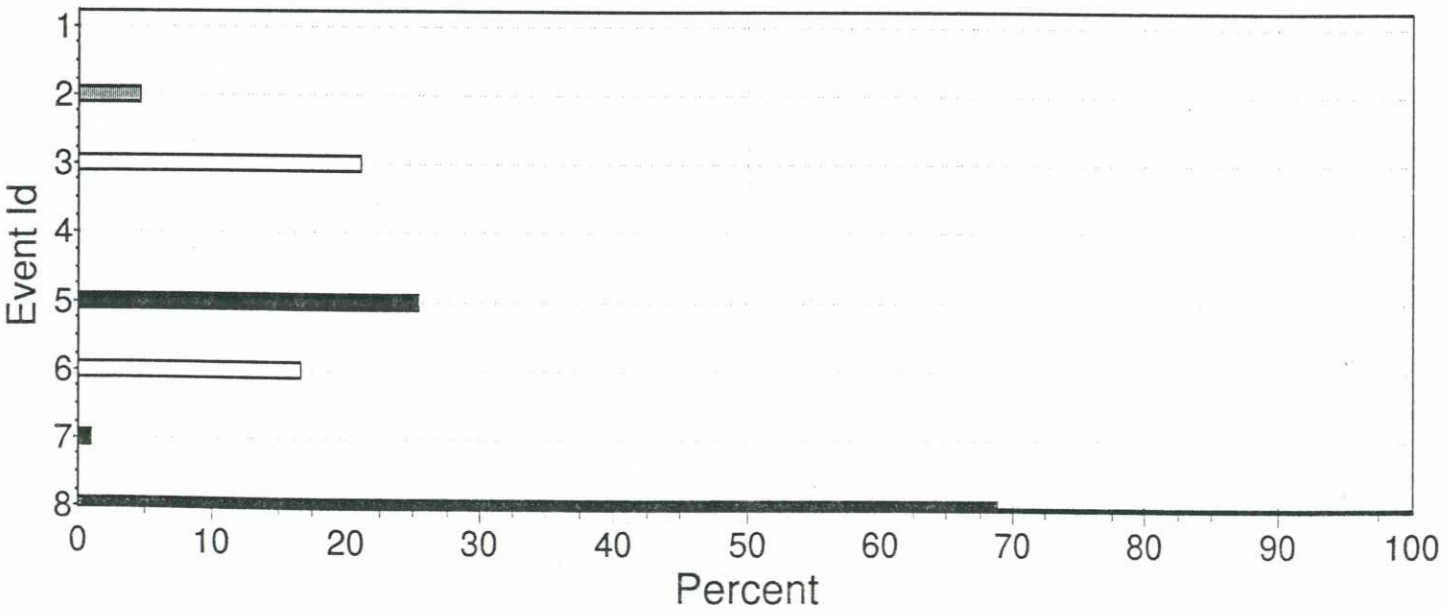
Intruding Sound Level

Id	Description	Leq,1hr	%Audible	Events	Good Num	Bad Num	Spike Num	Adj Bckg
1								
2	scenic aircraft	29.00	4.67	2	168	0	0	28.00
3	commercial jet	34.00	21.10	14	761	0	0	31.00
4								
5	other motor vehicles	31.00	25.40	21	914	0	0	25.00
6	human	27.00	16.70	26	601	0	0	0.00
7	Intruding	18.00	0.97	27	35	0	0	12.00
8	Total:	37.00	68.80	90	2479	0	0	34.00

Leq 1 hour

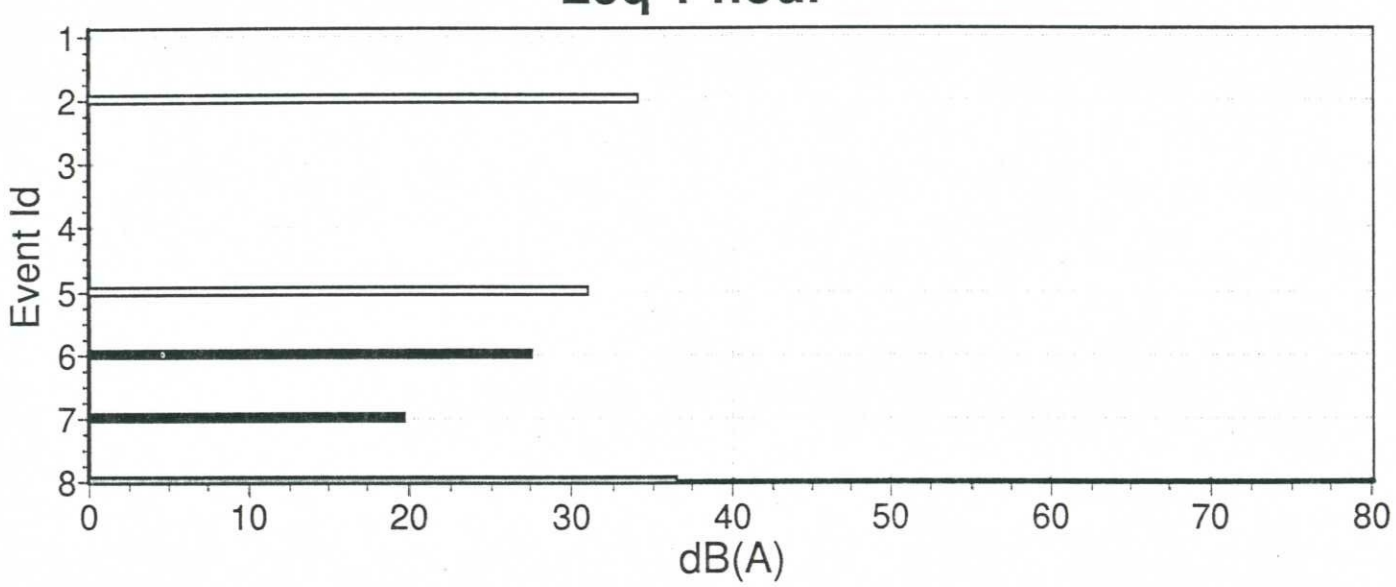


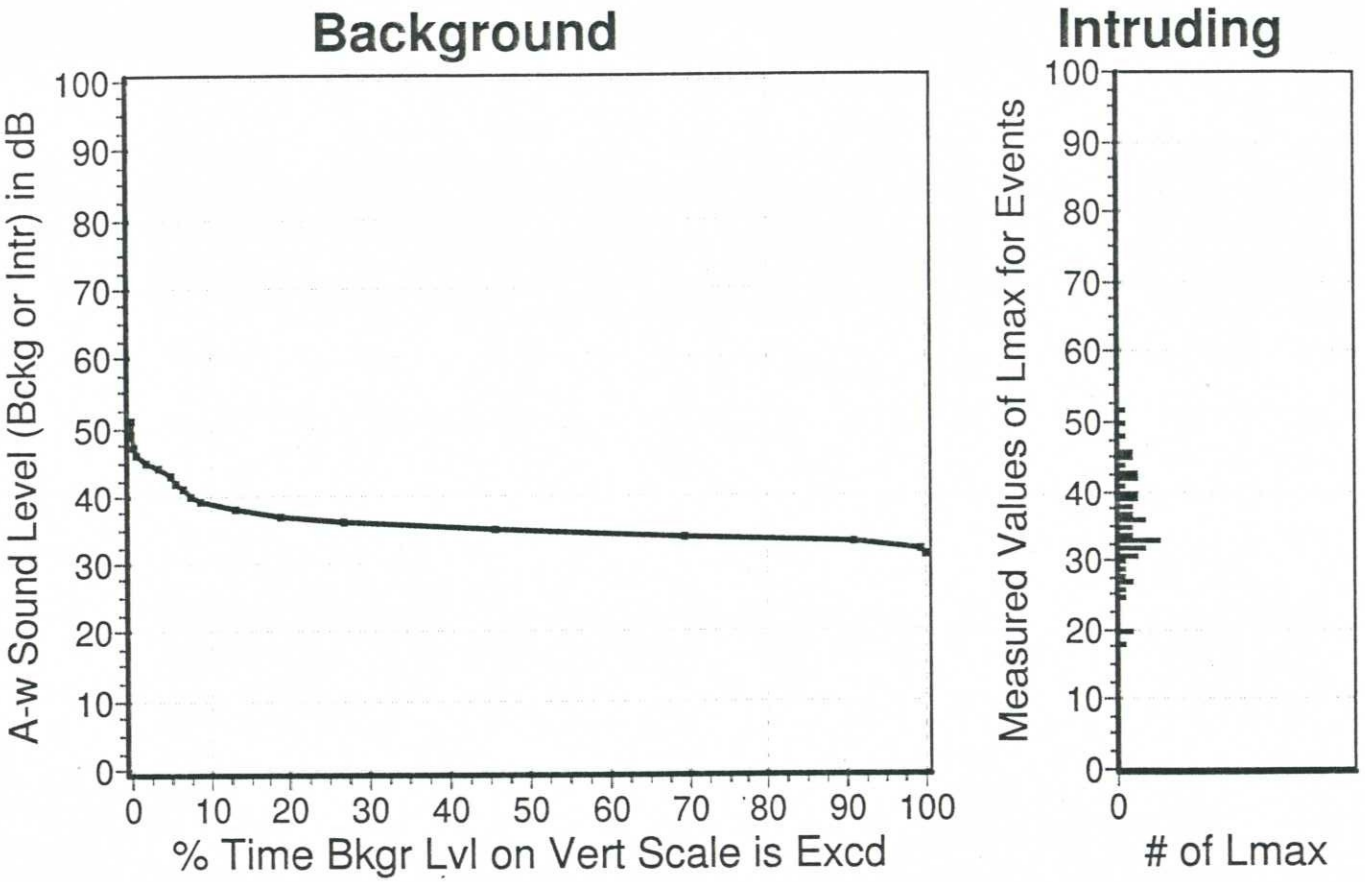
% Time Audible

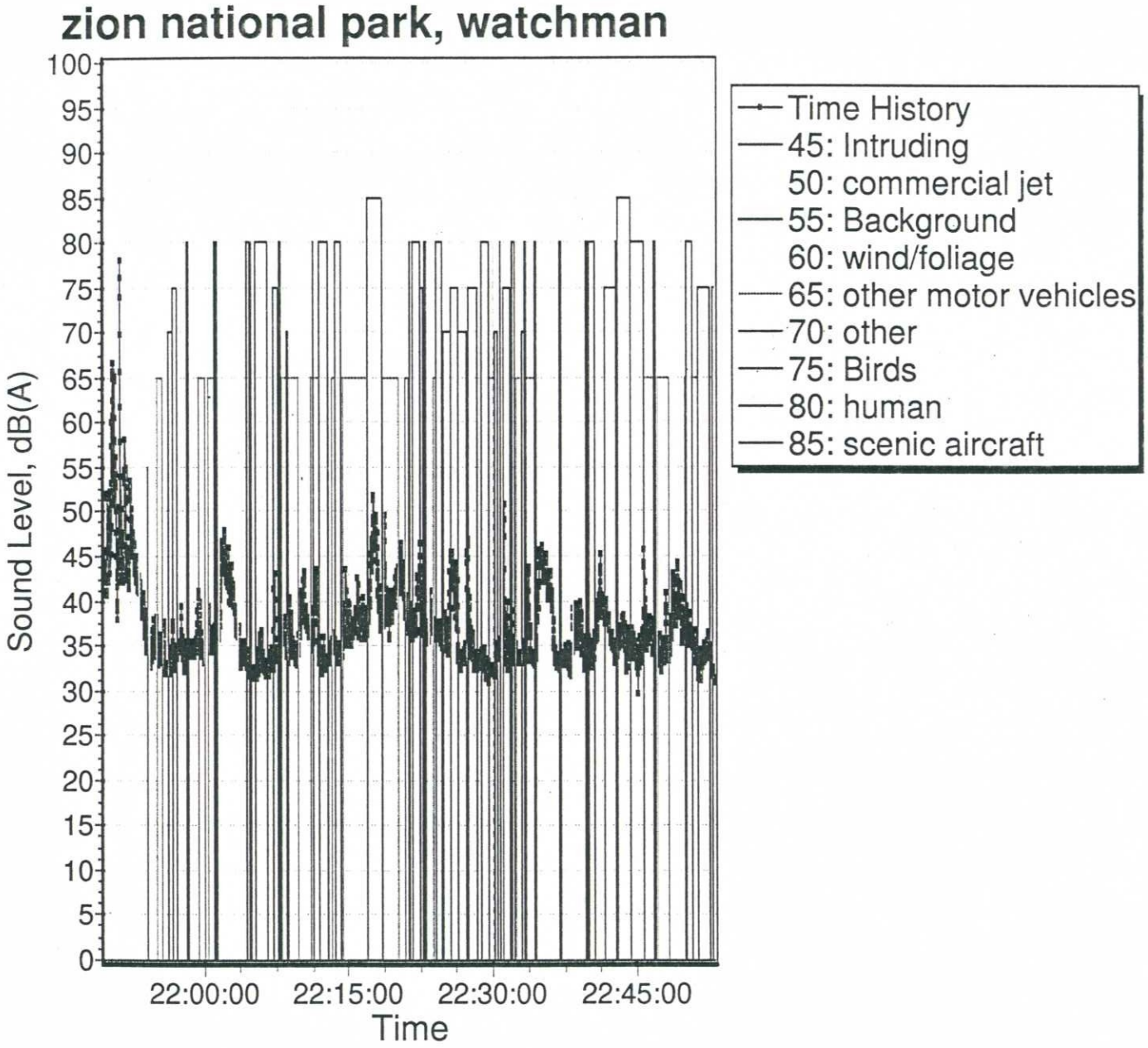


Background Sound Level

Id	Description	Leq,1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind
1								
2	Birds	34.00	39.00	9	392	0	0	34.00
3								
4								
5	wind/foliage	31.00	34.00	19	527	0	0	31.00
6	other	28.00	36.00	7	175	0	0	28.00
7	Background	20.00	36.00	23	28	0	0	20.00
8	Total:	37.00		58	1122	0	0	37.00




Background
A-w Sound Level (Bckg or Intr) in dB
100
90
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
% Time Bkgr Lvl on Vert Scale is Excd
Intruding
Measured Values of Lmax for Events
100
90
80
70
60
50
40
30
20
10
0
0
# of Lmax


zion national park, watchman
Sound Level, dB(A)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
22:00:00
22:15:00
22:30:00
22:45:00
Time
Time History
45: Intruding
50: commercial jet
55: Background
60: wind/foliage
65: other motor vehicles
70: other
75: Birds
80: human
85: scenic aircraft

4a

Site Description:

Park Name: zion national park

Site Name: angles landing

Site Number: 01

Elevation: 0

Operator: r horonjeff

Start Date: 10/16/98 Start Time: 9:52:12 pm

Stop Date: 10/16/98 Stop Time: 9:00:13 am

Type Data Collected:

Sound Level: Yes

Source Identification: Yes

Wind Speed/Direction: Yes

Equipment:

Acoustic Calibrator type B$K 4221 S/N: 183935

Sound Level Meter type LD-820 S/N: 123

Microphone type B$K 4179 S/N: 865133

Preamplifier type B$K 2660 S/N: 885020

Wind Sensor type 1172N S/N: 341

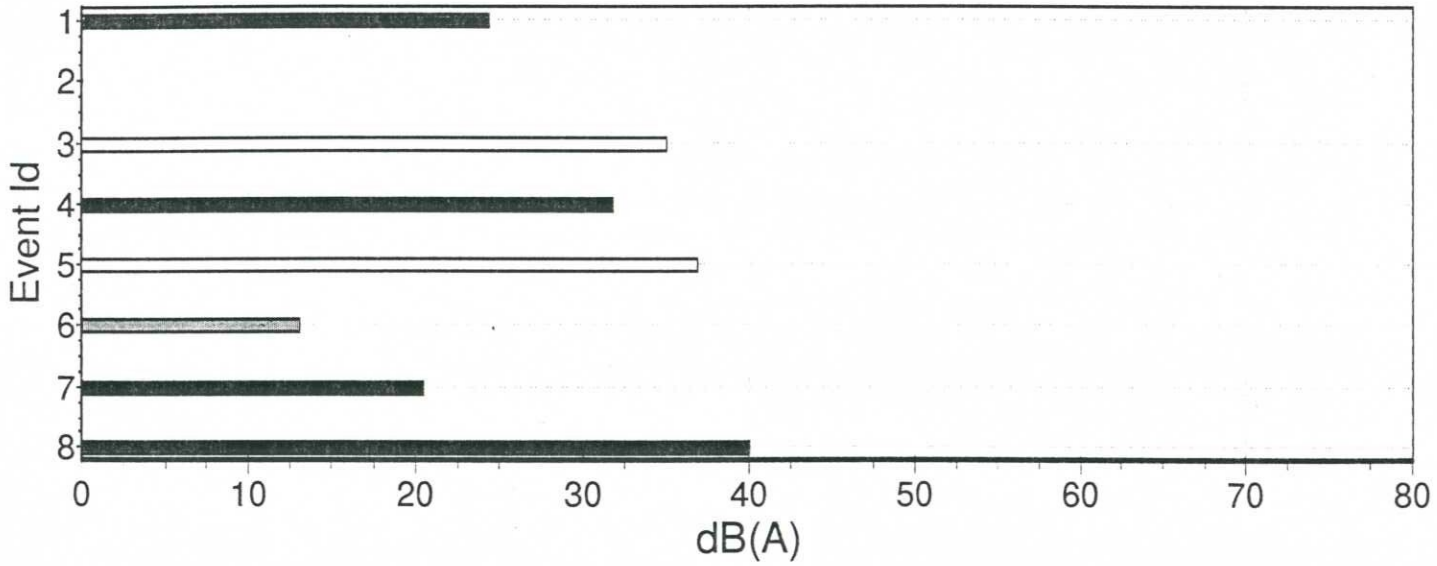
File: G:\PROJECTS\295860.NPS\2_ZI_GLA\ZION\MEASMNTS\REALTIME\0952r289.98

Spike Removal: Yes

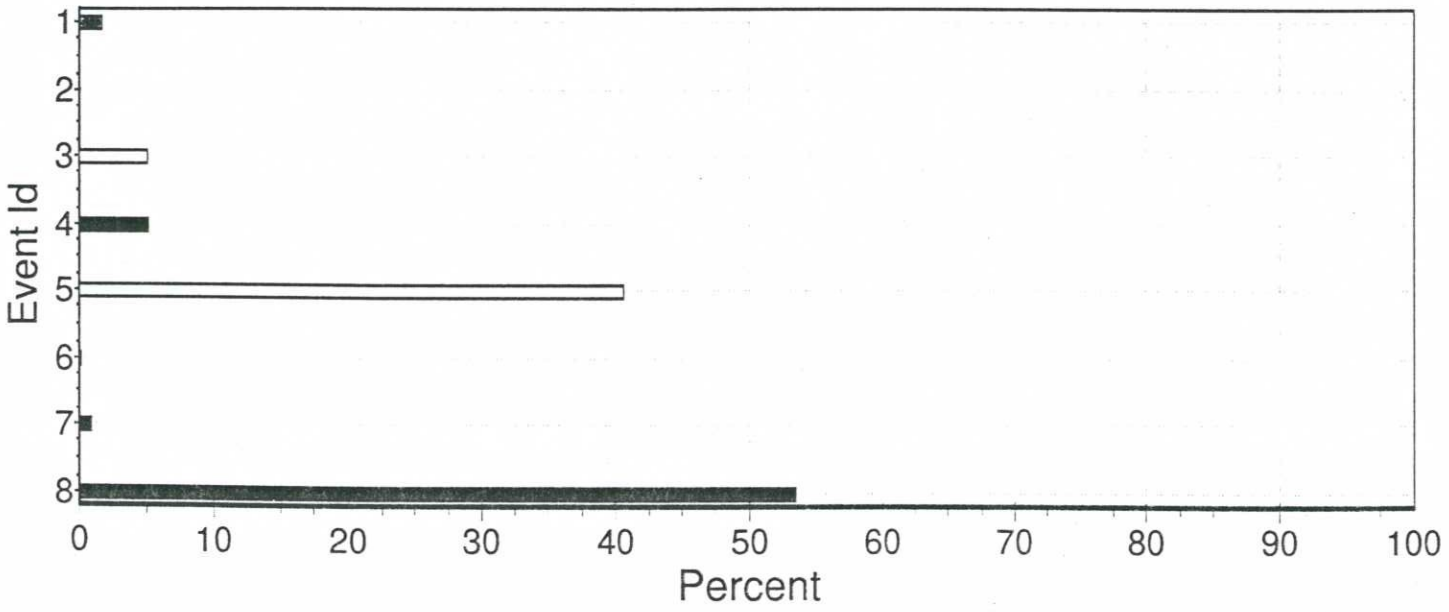
Intruding Sound Level

Id	Description	Leq,1hr	%Audible	Events	Good Num	Bad Num	Spike Num	Adj Bckg
1	other	24.00	1.67	1	60	0	0	20.00
2								
3	commercial jet	35.00	5.11	3	184	0	0	34.00
4	tour buses/lodge trams	32.00	5.14	7	185	0	0	28.00
5	other motor vehicles	37.00	40.60	33	1462	0	0	0.00
6	human	13.00	0.17	1	6	0	0	0.00
7	Intruding	21.00	0.92	22	33	0	0	0.00
8	Total:	40.00	53.60	67	1930	0	0	35.00

Leq 1 hour



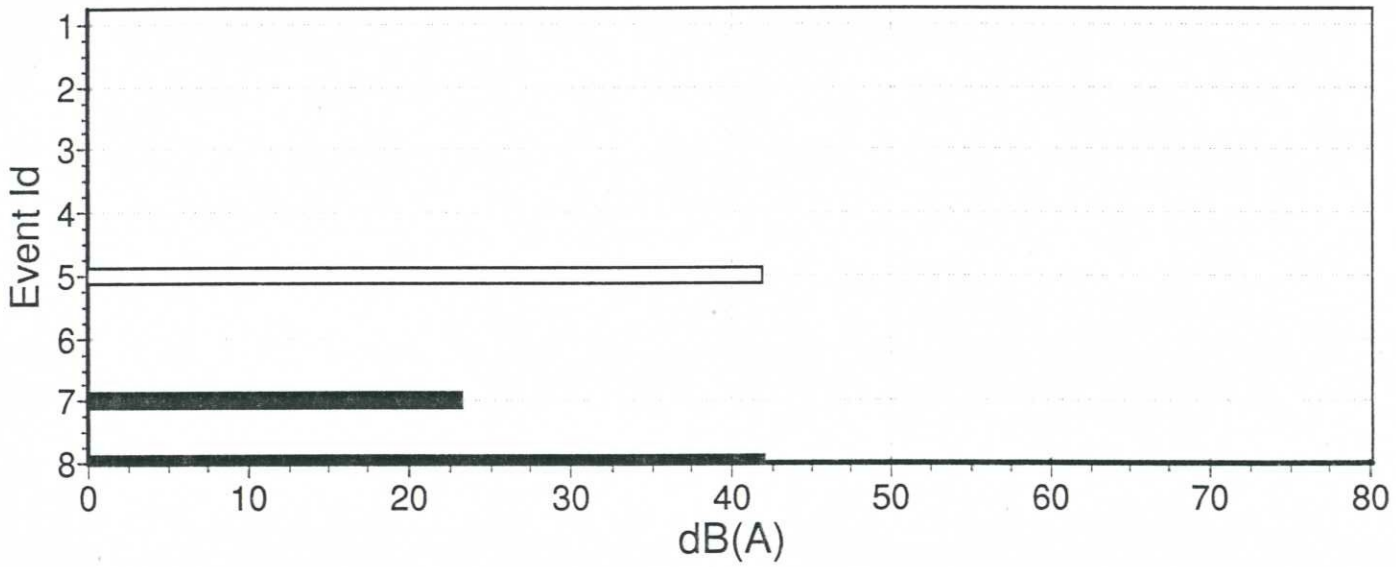
% Time Audible

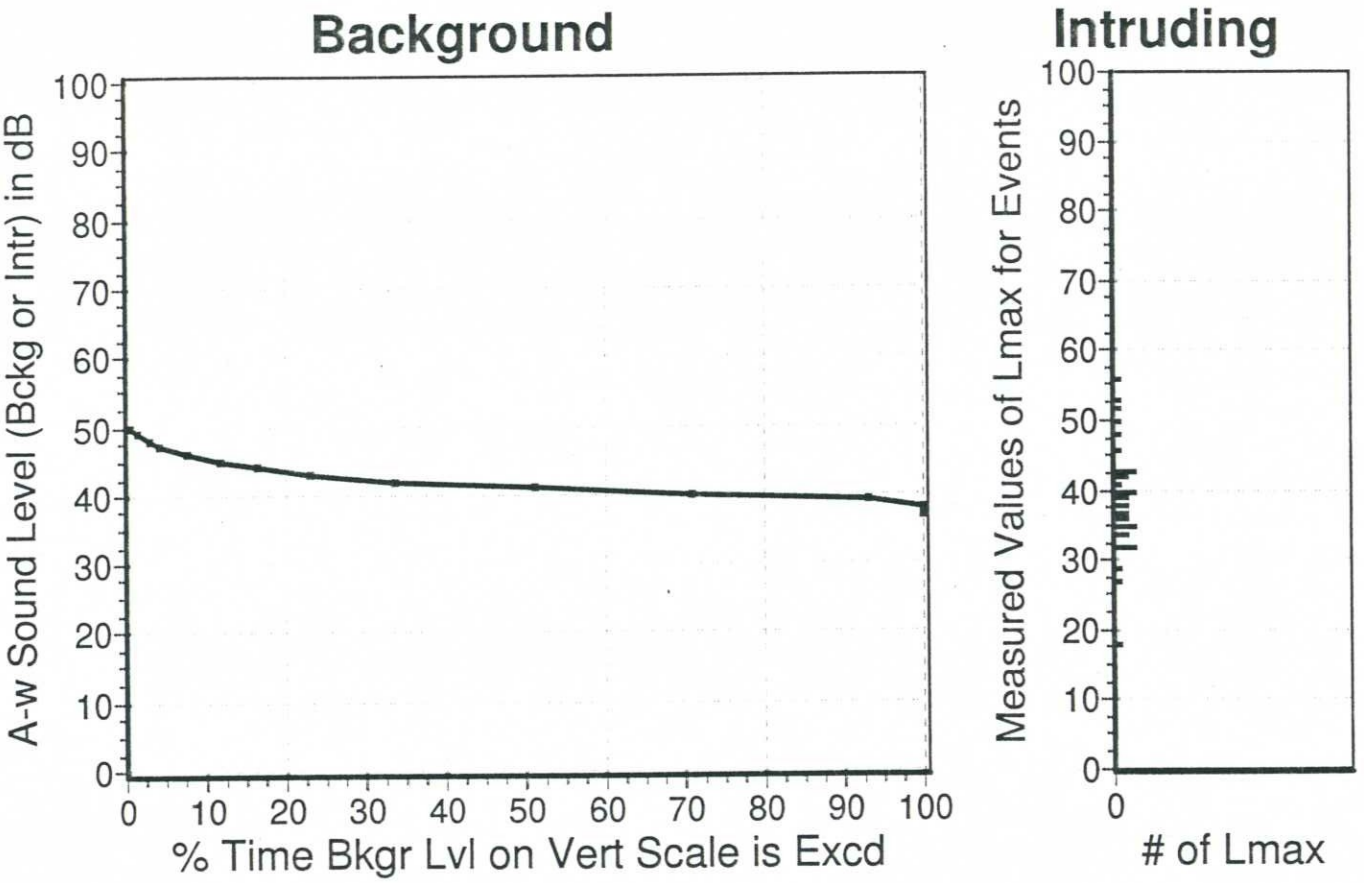


Background Sound Level

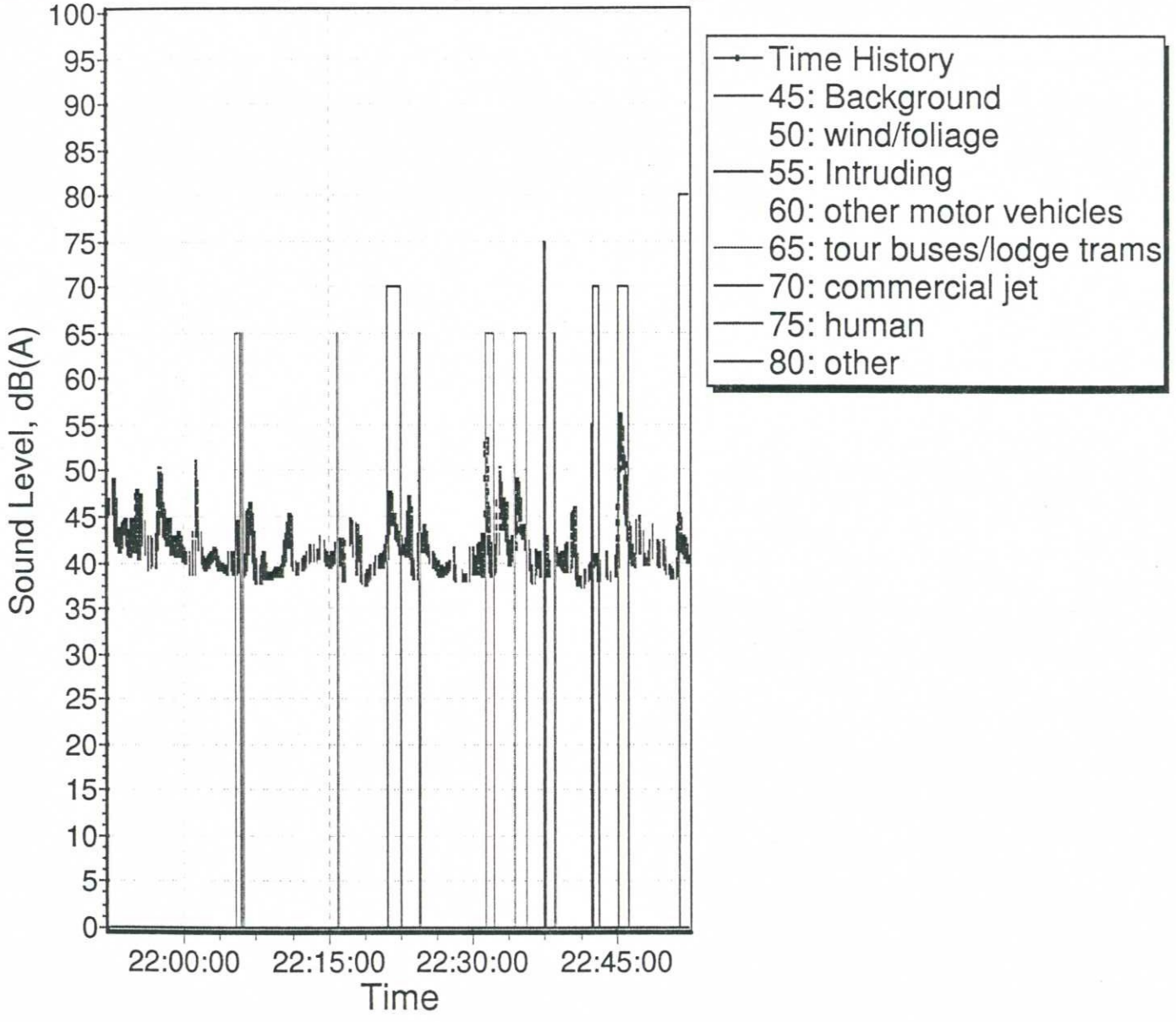
Id	Description	Leq,1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind
1								
2								
3								
4								
5	wind/foliage	42.00	42.00	29	1644	0	0	42.00
6								
7	Background	23.00	41.00	25	27	0	0	23.00
8	Total:	42.00		54	1671	0	0	42.00

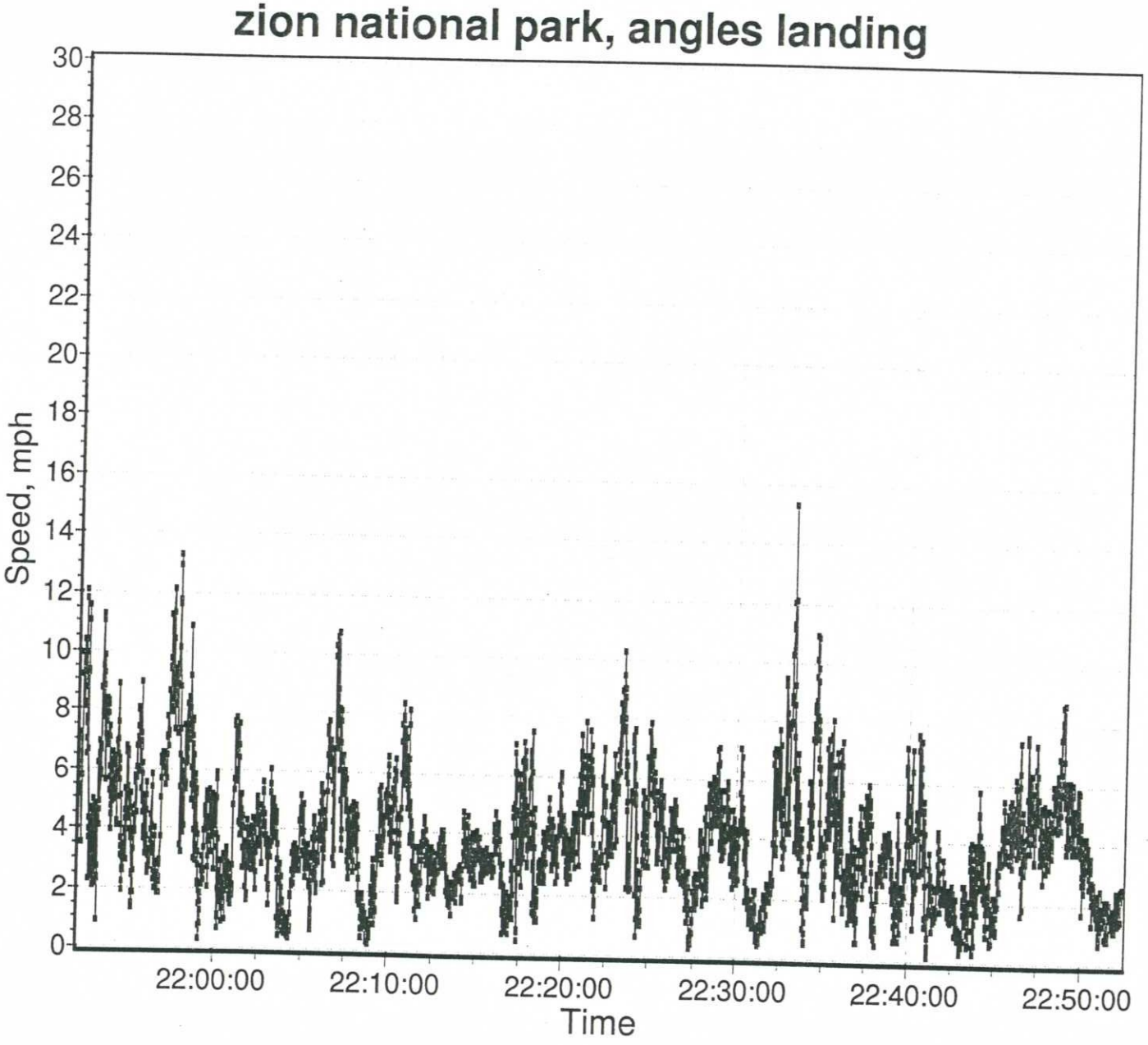
Leq 1 hour

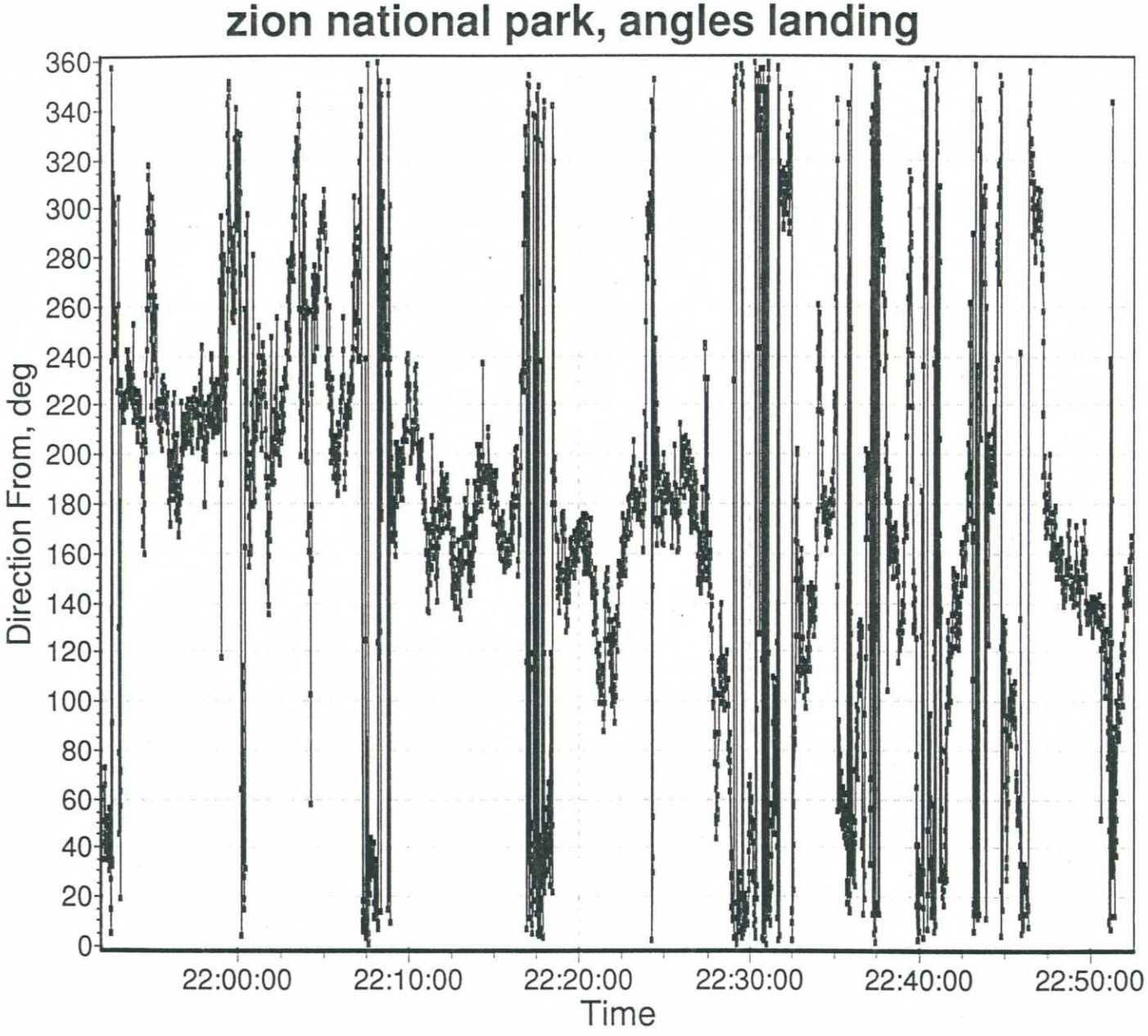



Background
A-w Sound Level (Bckg or Intr) in dB
100
90
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
% Time Bkgr Lvl on Vert Scale is Excd
Intruding
Measured Values of Lmax for Events
100
90
80
70
60
50
40
30
20
10
0
0
# of Lmax

zion national park, angles landing




zion national park, angles landing
Speed, mph
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
22:00:00
22:10:00
22:20:00
22:30:00
22:40:00
22:50:00
Time


zion national park, angles landing
Direction From, deg
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
22:00:00
22:10:00
22:20:00
22:30:00
22:40:00
22:50:00
Time

Site Description:

Park Name: zion national park

Site Name: angel's landing

Site Number: 04

Elevation: 0

Operator: d sidles

Start Date: 10/23/98 Start Time: 2:16:09 am

Stop Date: 10/23/98 Stop Time: 9:05:50 am

Type Data Collected:

Sound Level: Yes

Source Identification: Yes

Wind Speed/Direction: No

Equipment:

Acoustic Calibrator type B$K 4221 S/N: 183935

Sound Level Meter type LD-820 S/N: 123

Microphone type B$K 4179 S/N: 865133

Preamplifier type B$K 2660 S/N: 885020

Wind Sensor type 1172N S/N: 341

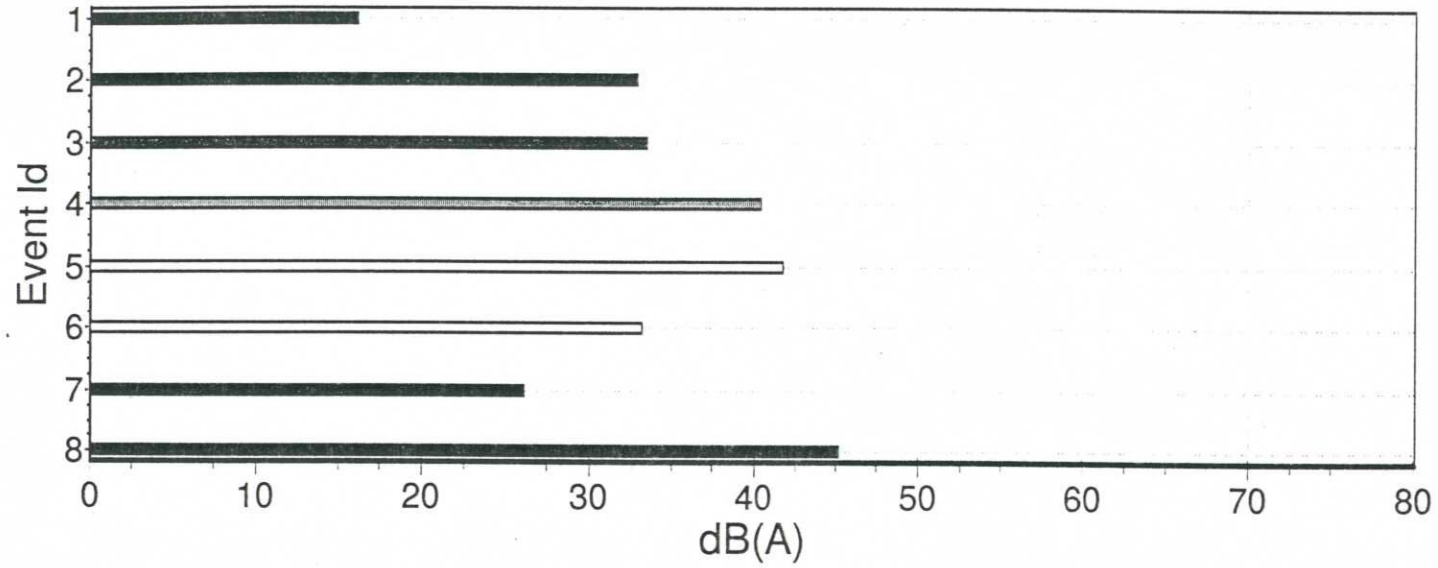
File: G:\PROJECTS\295860.NPS\2_ZI_GLA\ZION\MEASMNTS\REALTIME\1416r296.98

Spike Removal: Yes

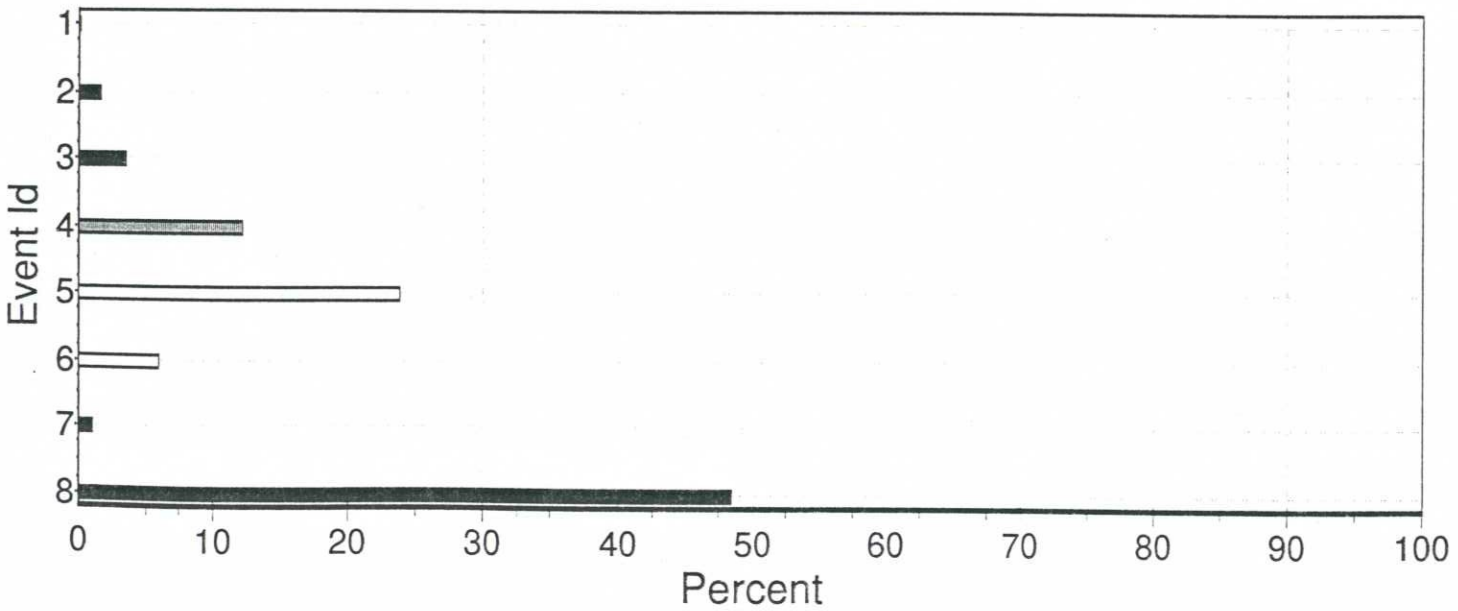
Intruding Sound Level

Id	Description	Leq,1hr	%Audible	Events	Good Num	Bad Num	Spike Num	Adj Bckg
1	other	16.00	0.14	1	5	0	0	6.60
2	scenic aircraft	33.00	1.69	2	61	0	0	31.00
3	commercial jet	33.00	3.53	3	127	0	0	30.00
4	tour buses/lodge trams	40.00	12.20	15	440	0	0	38.00
5	other motor vehicles	42.00	23.90	29	859	0	0	39.00
6	human	33.00	6.00	11	216	0	0	14.00
7	Intruding	26.00	1.06	32	38	0	0	19.00
8	Total:	45.00	48.50	93	1746	0	0	42.00

Leq 1 hour

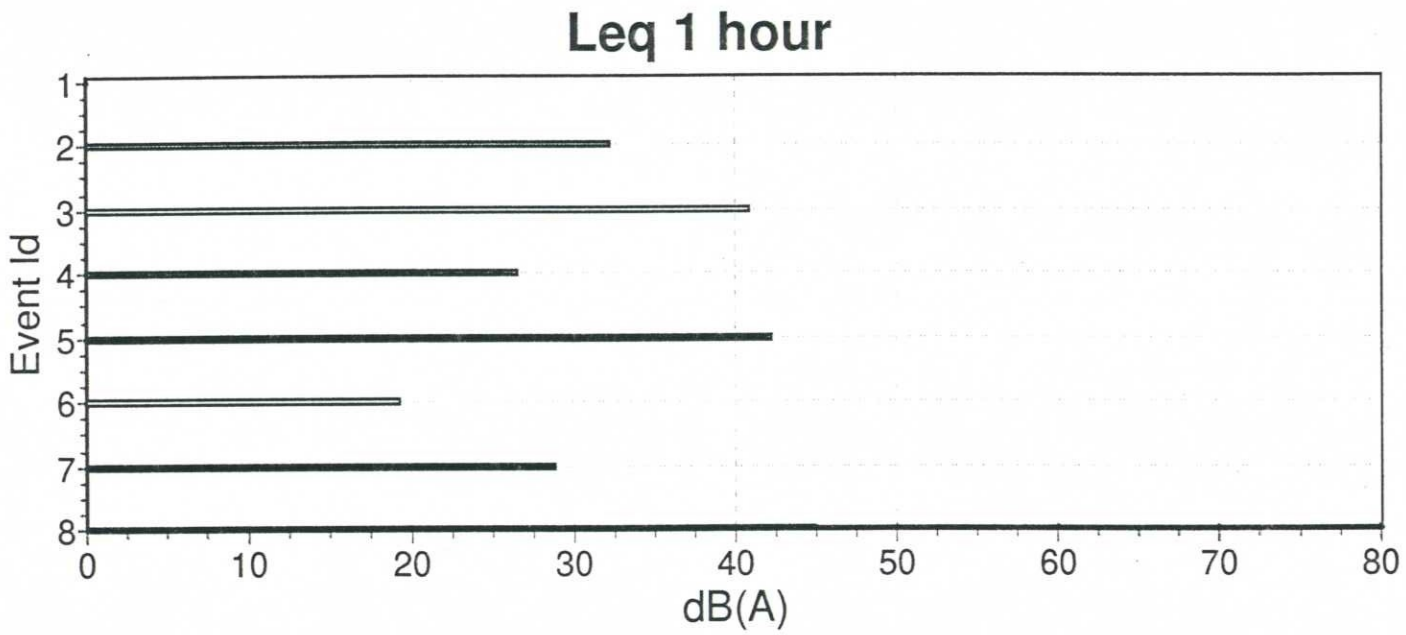


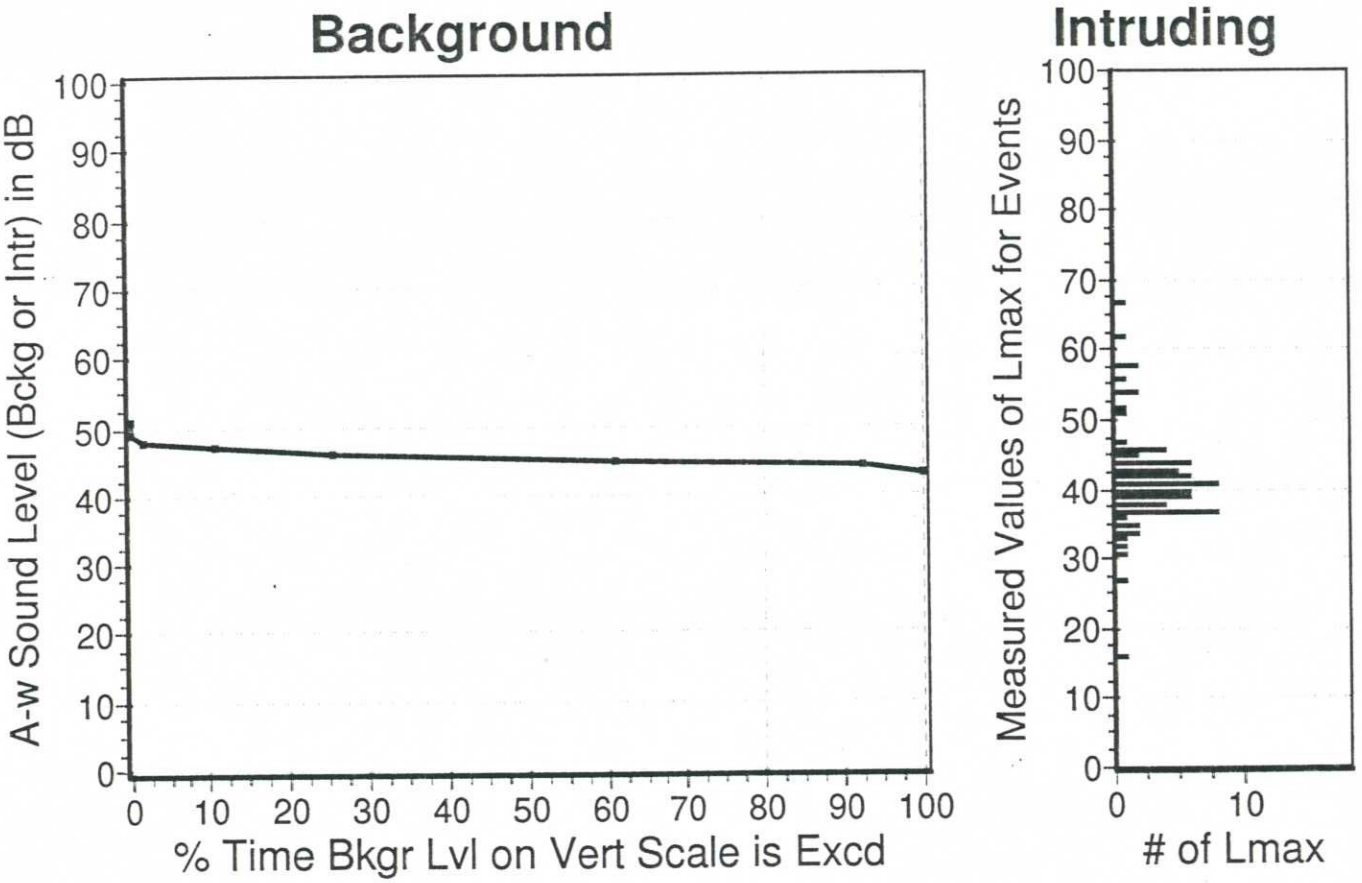
% Time Audible



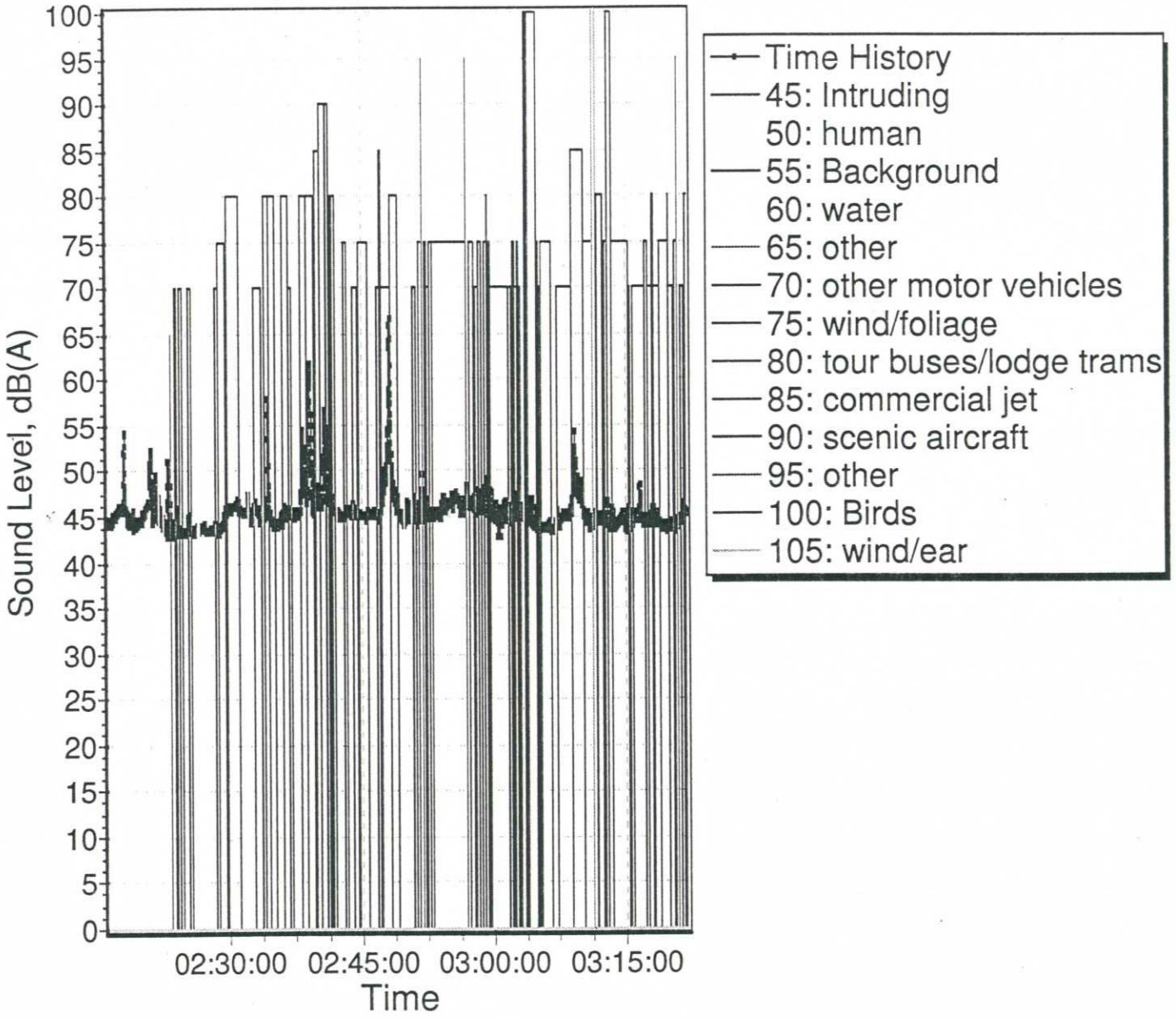
Background Sound Level

Id	Description	Leq,1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind
1								
2	Birds	32.00	45.00	3	101	0	0	32.00
3	water	41.00	45.00	22	767	0	0	41.00
4	wind/ear	27.00	45.00	1	26	0	0	27.00
5	wind/foliage	42.00	45.00	24	913	0	0	42.00
6	other	19.00	47.00	3	3	0	0	19.00
7	Background	29.00	45.00	32	45	0	0	29.00
8	Total:	45.00		85	1855	0	0	45.00




Background
A-w Sound Level (Bckg or Intr) in dB
100
90
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
% Time Bkgr Lvl on Vert Scale is Excd
Intruding
Measured Values of Lmax for Events
100
90
80
70
60
50
40
30
20
10
0
0 10
# of Lmax

zion national park, angel's landing



5

Site Description:

Park Name: zion national park

Site Name: east mesa

Site Number: 04

Elevation: 0

Operator: d sidles

Start Date: 10/19/98 Start Time: 12:41:35 pm

Stop Date: 10/19/98 Stop Time: 1:41 pm ~~1:30:22 am~~

Type Data Collected:

Sound Level: Yes

Source Identification: Yes

Wind Speed/Direction: No

Equipment:

Acoustic Calibrator type B$K 4221 S/N: 183935

Sound Level Meter type LD-820 S/N: 123

Microphone type B$K 4179 S/N: 865133

Preamplifier type B$K 2660 S/N: 885020

Wind Sensor type 1172N S/N: 341

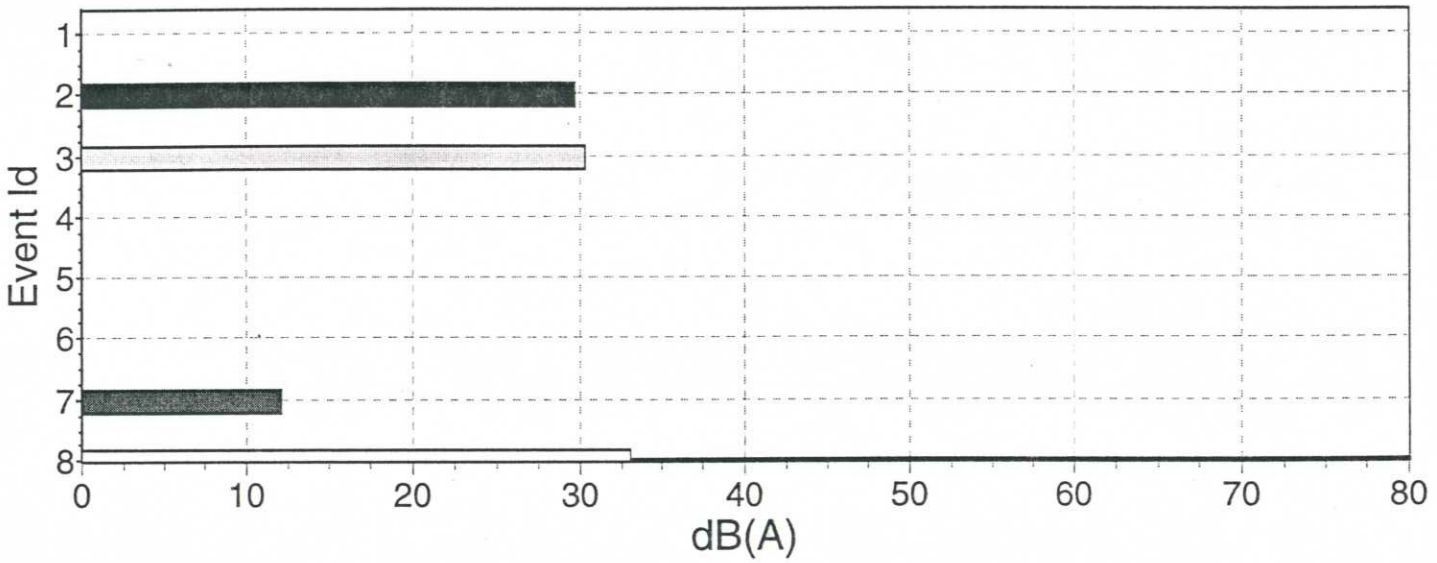
File: G:\PROJECTS\295860.NPS\2_ZI_GLA\ZION\MEASMNTS\REALTIME\1241r292.98

Spike Removal: Yes

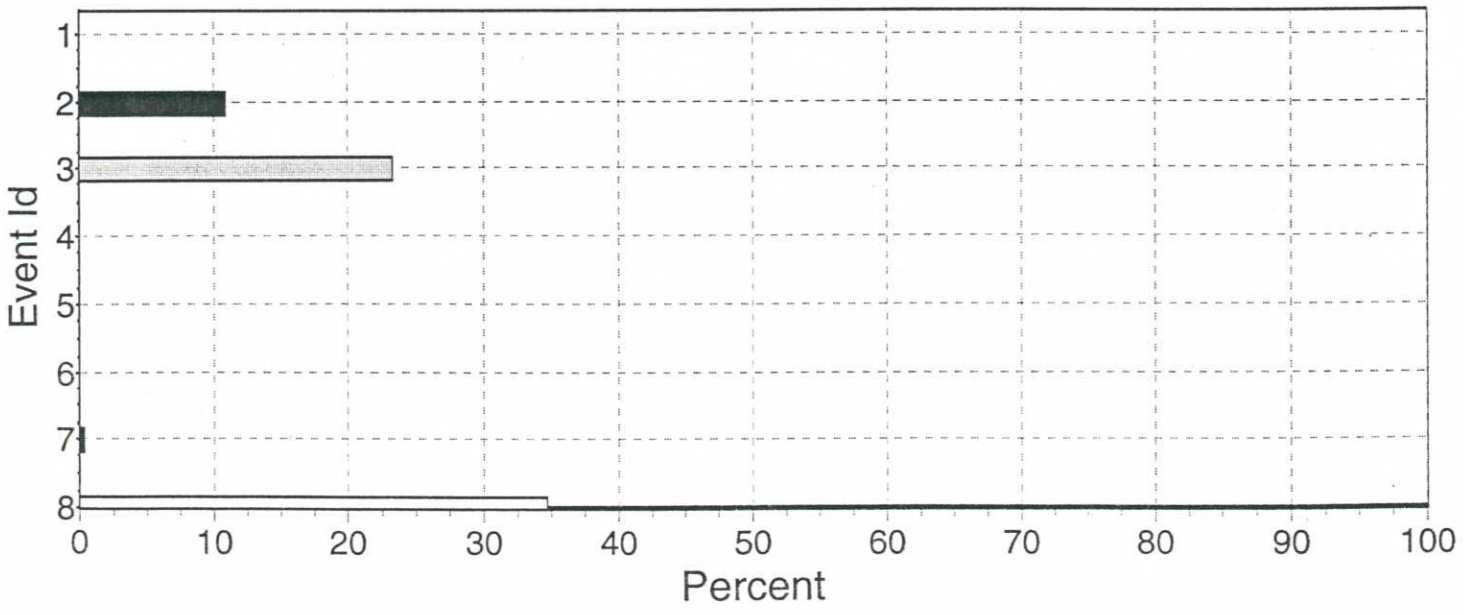
Intruding Sound Level

Id	Description	Leq,1hr	%Audible	Events	Good Num	Bad Num	Spike Num	Adj Bckg
1								
2	scenic aircraft	30.00	11.00	2	396	0	0	26.00
3	commercial jet	30.00	23.30	9	840	0	0	22.00
4								
5								
6								
7	Intruding	12.00	0.39	10	14	0	0	0.00
8	Total:	33.00	34.70	21	1250	0	0	28.00

Leq 1 hour

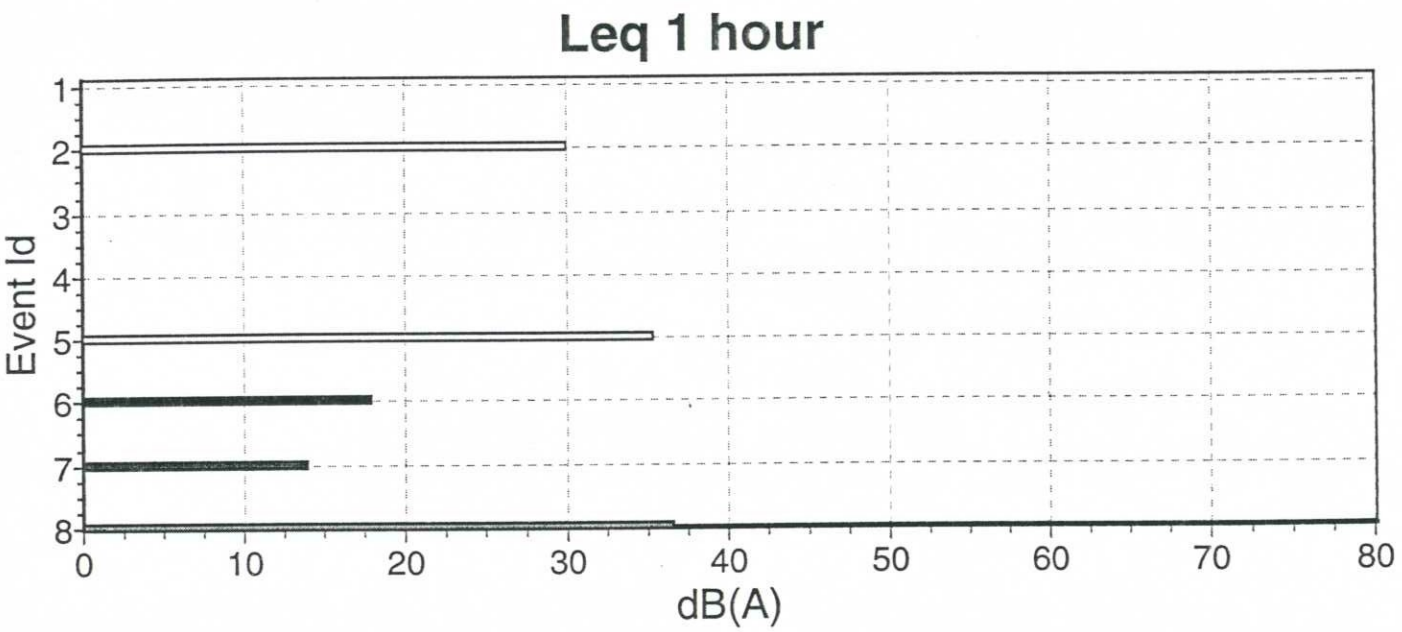


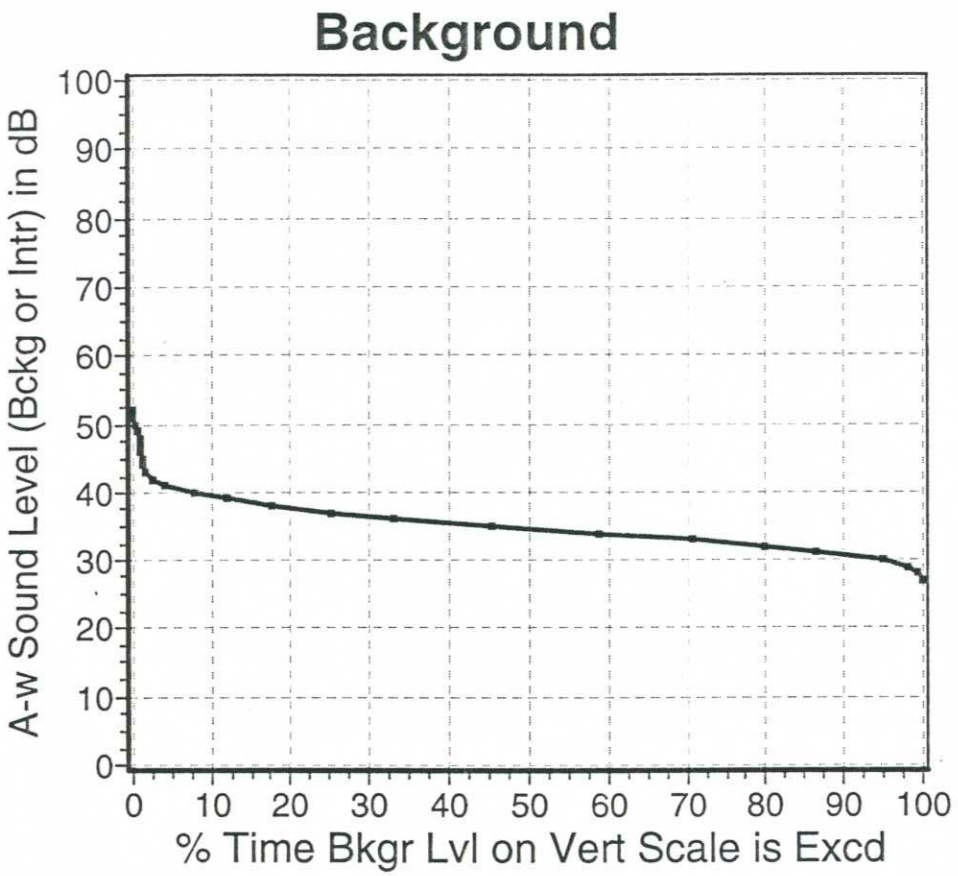
% Time Audible

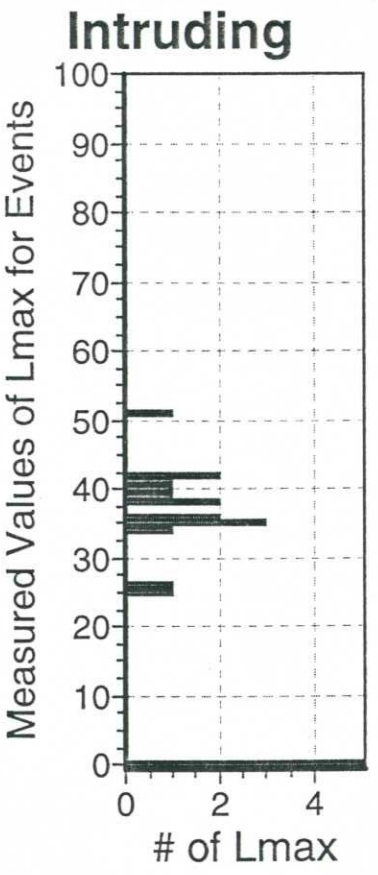


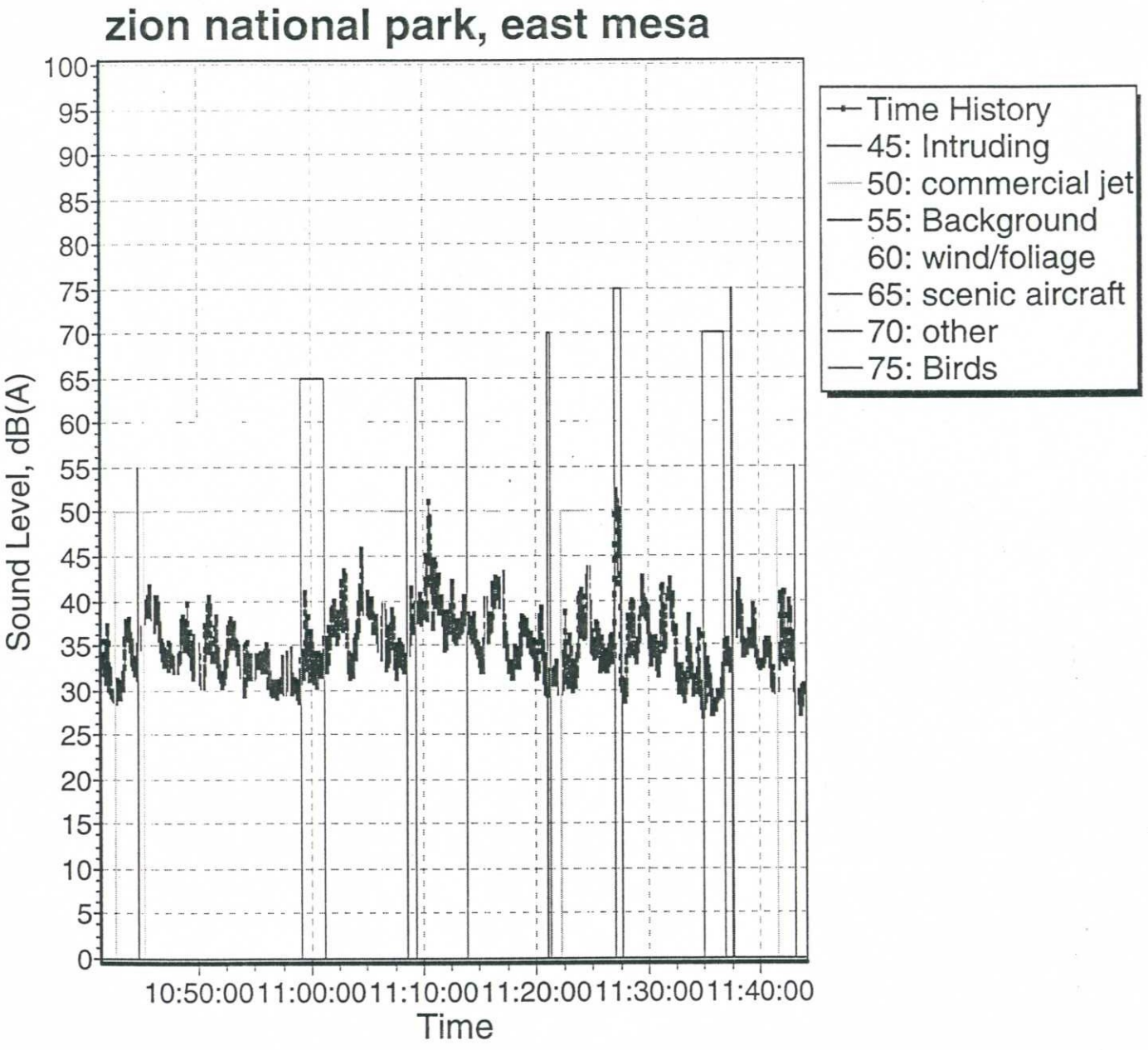
Background Sound Level

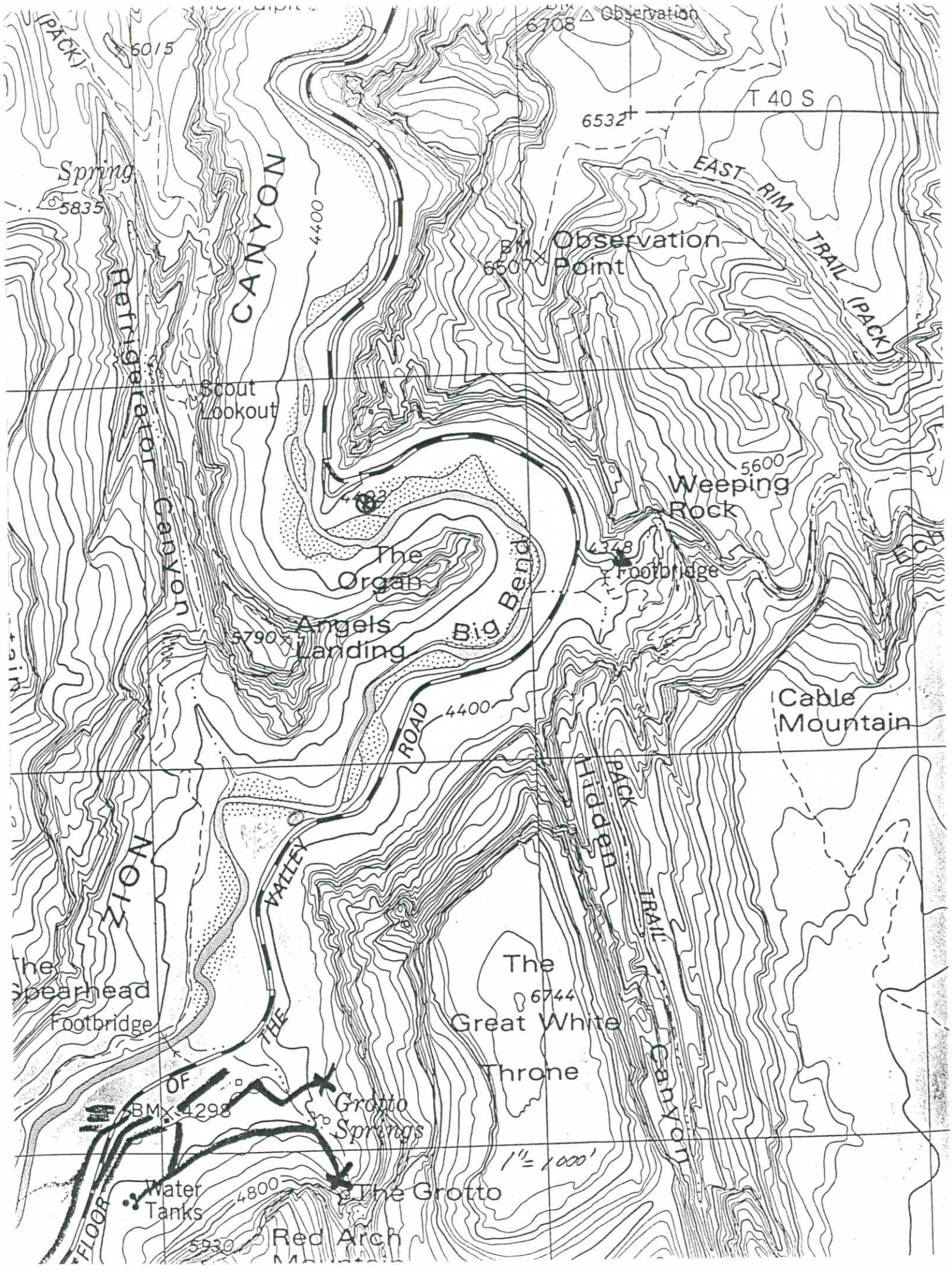
Id	Description	Leq,1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind
1								
2	Birds	30.00	47.00	2	45	0	0	30.00
3								
4								
5	wind/foliage	35.00	36.00	17	2158	0	0	35.00
6	other	18.00	30.00	2	133	0	0	18.00
7	Background	14.00	36.00	12	15	0	0	14.00
8	Total:	37.00		33	2351	0	0	37.00

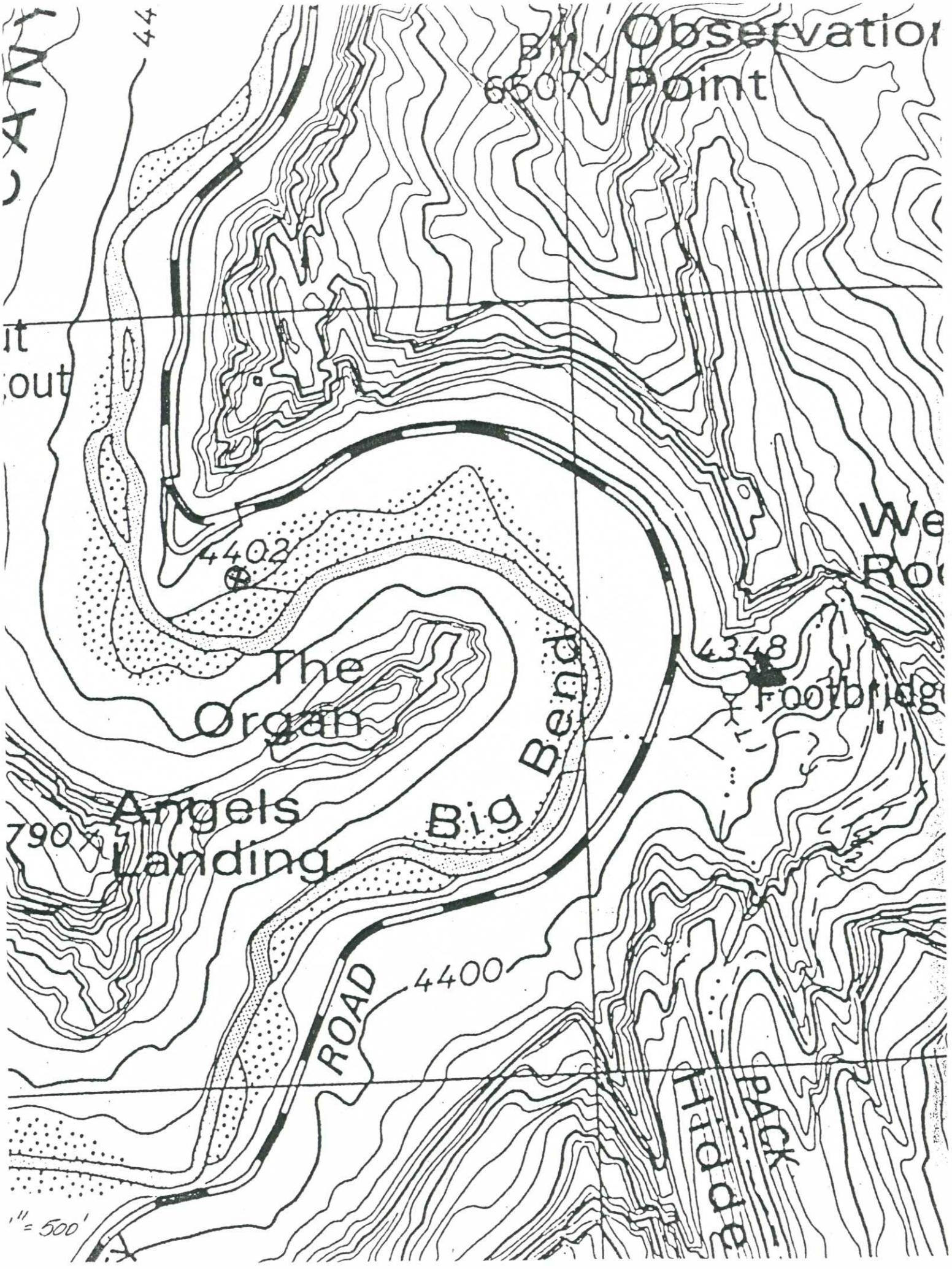


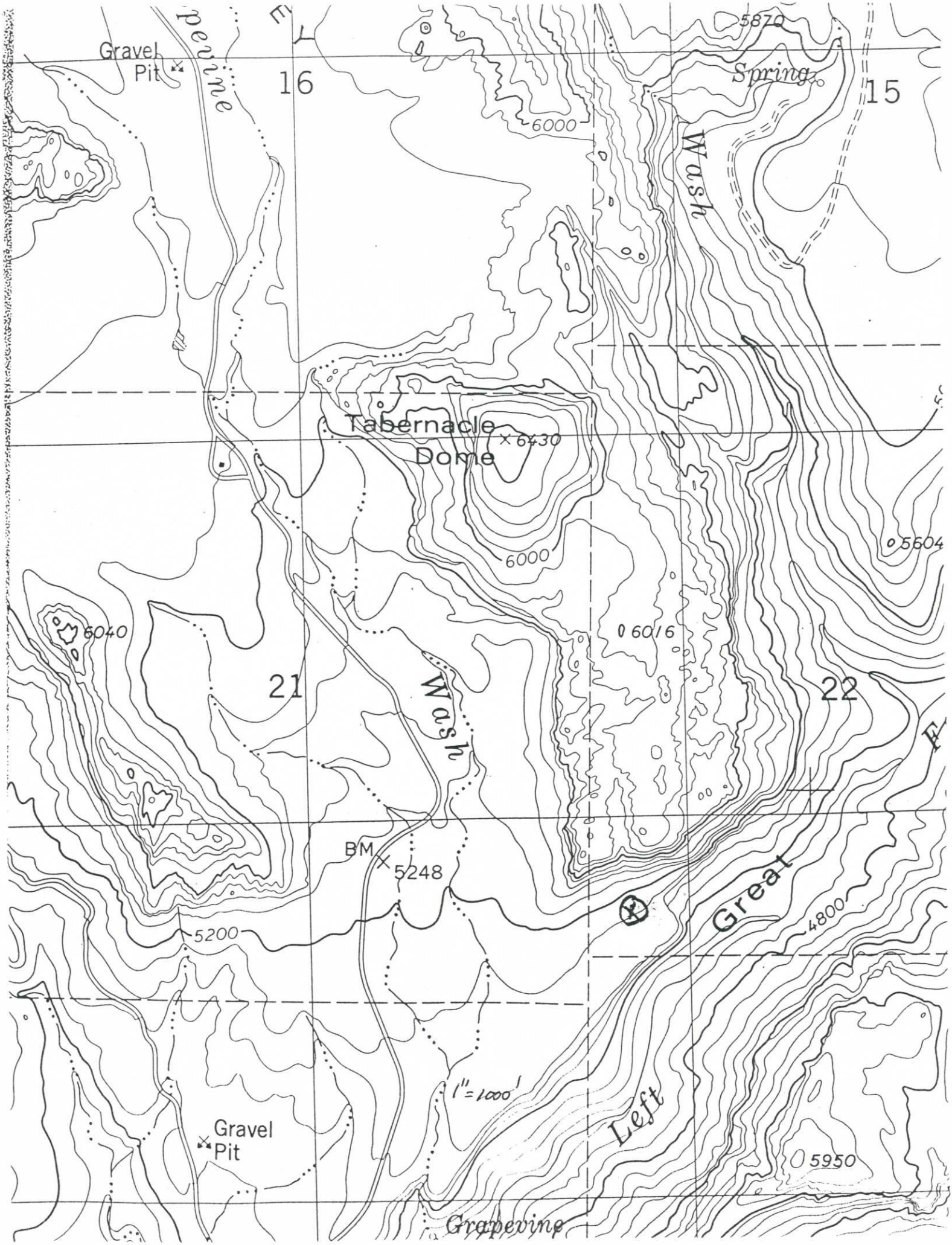

Background
A-w Sound Level (Bckg or Intr) in dB
100
90
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
% Time Bkgr Lvl on Vert Scale is Excd

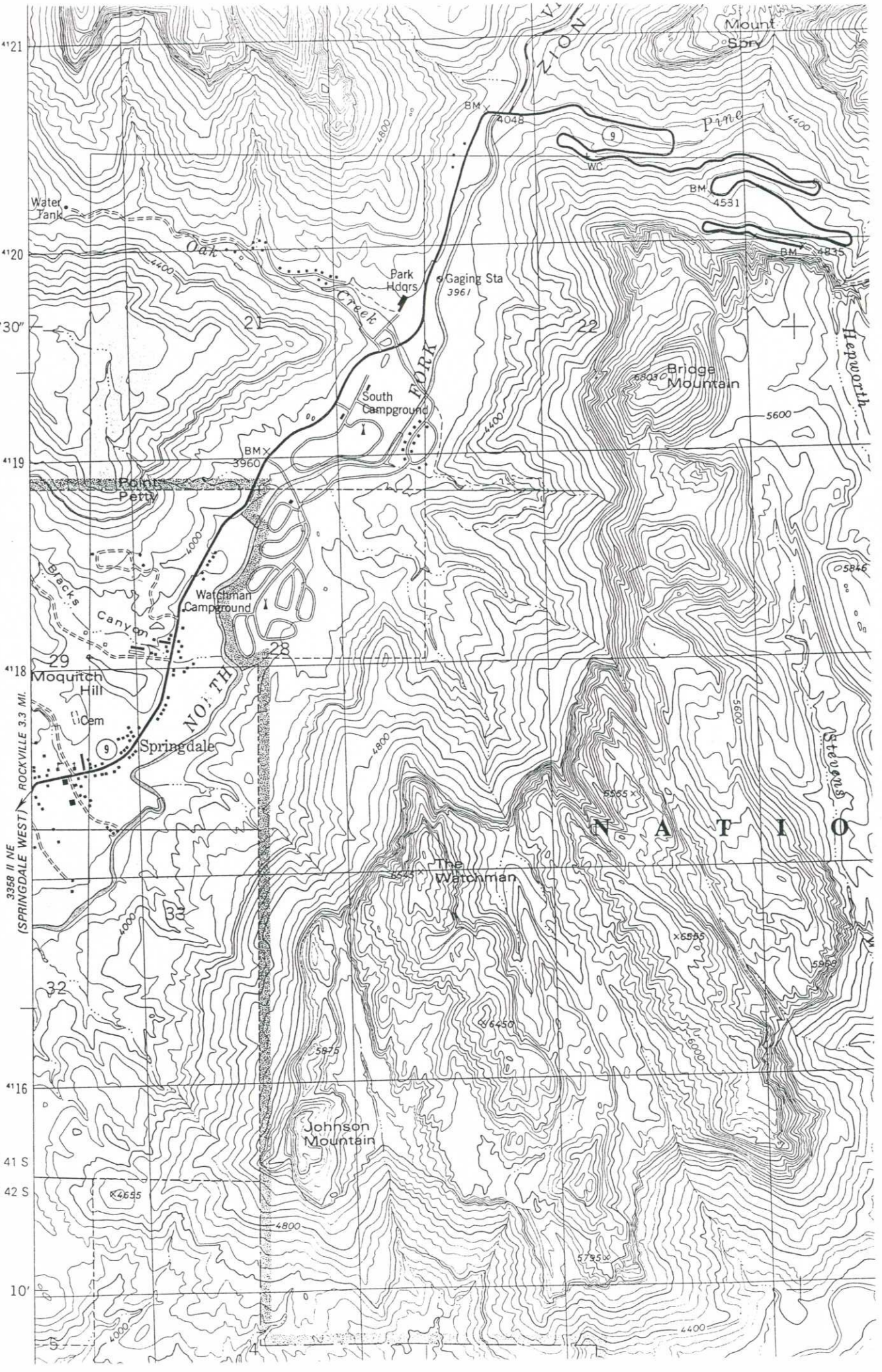

Intruding
Measured Values of Lmax for Events
100
90
80
70
60
50
40
30
20
10
0
0 2 4
# of Lmax

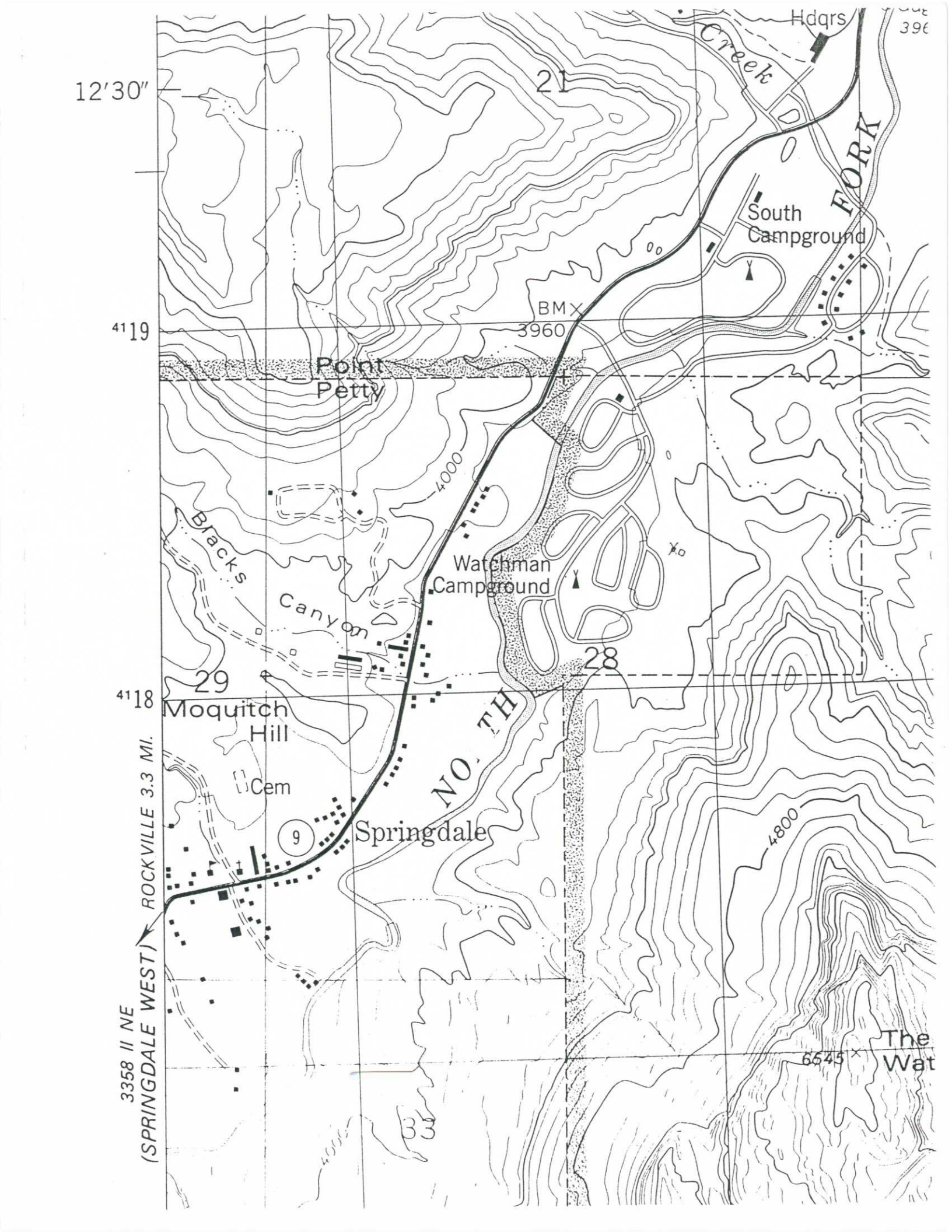

zion national park, east mesa
Sound Level, dB(A)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
10:50:00
11:00:00
11:10:00
11:20:00
11:30:00
11:40:00
Time
Time History
45: Intruding
50: commercial jet
55: Background
60: wind/foliage
65: scenic aircraft
70: other
75: Birds


(PACK)
6015
Spring
5835
CANYON
4400
Refrigerator Canyon
Scout Lookout
6708
Observation
T 40 S
6532
EAST RIM TRAIL (PACK)
BM
6507
Observation Point
5600
Weeping Rock
4348
Footbridge
The Organ
Angels Landing
5790
Big Bend
ROAD
4400
Cable Mountain
Hidden
PACK
TRAIL
ZION
VALLEY
The Spearhead
Footbridge
THE
OF
BM
4298
Grotto Springs
The
6744
Great White
Throne
Canyon
1" = 1000'
Water Tanks
4800
The Grotto
FLOOR
5930
Red Arch


Observation
Point
6507
4402
The
Organ
Angels
Landing
Big Bend
4348
Footbridge
ROAD
4400
PACK
1" = 500'


Gravel Pit
16
15
Spring
5870
6000
Wash
Tabernacle Dome
6430
5604
6040
6016
21
22
Wash
BM
5248
5200
4800
Great
Left
1"=1000'
Gravel Pit
5950
Grapevine


Mount Spry
Pine
BM 4048
BM 4531
BM 4835
WC
Water Tank
Oak
Creek
Park Hdqrs
Gaging Sta
3961
FORK
South Campground
Bridge Mountain
Hepworth
BM 3960
Point Petty
Bracks Canyon
Watchman Campground
NORTH
29
28
22
21
32
Moquitch Hill
Cem
Springdale
ROCKVILLE 3.3 MI.
3358 II NE
(SPRINGDALE WEST)
The Watchman
Johnson Mountain
Stevens
NATIO
4120
12'30"
4119
4118
4116
T 41 S
T 42 S
10'
5
4


12'30"
4119
4118
21
28
29
33
Hdqrs
Creek
FORK
South
Campground
BMX
3960
Point
Petty
4000
Watchman
Campground
Canyon
Moquitch
Hill
Cem
9
Springdale
NO. TH
4800
6545
The
Wat
3358 II NE
(SPRINGDALE WEST)
ROCKVILLE 3.3 MI.

ATTACHMENT 2

Description of LOWNOMS Produced Metrics

1. Description of Metrics

This section describes the metrics reported by the LOWNOMS™ system. The following information describes the information provided in Attachment 1 for the Zion measurements.

1.1 Intruding Sound Level Metrics

Table 1 gives the column headings in the Intruding Sound Level table output, see Attachment 1. The following paragraphs describe the information in each of the associated columns.

Table 1. Intruding Sound Level Metrics

ID	Description	Leq, 1hr	% Audible	Events	Good Num	Bad Num	Spike Num	Adj Bknd

ID

This number, 1 through 8, corresponds to each of the six intruding or "I" buttons on the button box, or to the description given in the next column.

Description

For ID's 1 through 6, these are the descriptions for each intruding sound button used during data acquisition. ID 7, Unidentified Intruding, is any sample collected while only the "I" button has been pressed and no specific intruding source has been identified (pressed). ID 8 is the total for the given column.

Leq, 1hr

This is the "equivalent sound level" in dB during the one hour of measurement that is produced by the identified intruding sound source. It is calculated by summing the sound energy of all the one second samples identified for that source, and averaging the result over the hour (3600 seconds). If a sound source is heard for only a few seconds, the **Leq, 1 hr** can be very small and even less than zero. Small or negative values of **Leq, 1hr** mean the source was quiet and / or not heard very much of the time. **Leq, 1hr** is not adjusted for background sound levels, see **Adj Bknd** below.

% Audible

This is the percent of the hour that the specific sound source was identified. It is **Good Num** for that source divided by the Total **Good Num** (Intruding Sound Level) plus the Total **Good Num** (Background Sound Level). Also, note the relationship of **% Audible** to **Leq, 1hr**

Events

This is the number of continuous periods when the specific sound source was identified. It is a count of the number of times the specific button was pressed and no other button was pressed.

Good Num

The number of "good" 1 second samples for each ID. Samples are "bad" when there is no identification at all, as occurs when no buttons are pushed, or when the wind speed exceeds 15 MPH. Bad samples are omitted from all calculations.

Bad Num

The number of samples when no buttons were pushed or when the wind speed exceeded 15 MPH.

Spike Num

The number of one second samples during which "spikes" were identified. A spike is initially identified if one sample exceeds the previous sample by more than 10 dB. This sample is averaged with the previous one to yield a criterion level for judging following samples. A spike is deemed to last until a following sample is less than this criterion level. However, if five or more of the following samples all exceed the criterion level, the event is judged not a spike, but an event. This approach is intended to permit the user to remove very short, fast rise-time events, such as occasional bird calls or car door slams.

Adj Bknd

This is the **Leq, 1hr** in dB with the background sound energy removed. It is intended to account for the fact that when an intruding sound source is measured, the non-intruding sound (or background sound) also occurs and is measured. The background Leq is first computed for an event by extracting from the 10 minutes preceding and following each event, all background samples. The total number of such background samples must equal or exceed 3 minutes of data. Otherwise, the search proceeds by adding one second at a time before and after the 10 minute ranges until 3 minutes total of background sound levels are found or the end of the measurement period is reached. The equivalent level of the background sample is computed. This value of background sound energy is then assumed to exist for each second during the event, and subtracted, on an energy basis, from the event samples. The quieter intruding sources will be more affected by this adjustment than will be the louder sources.

1.2 Background Sound Level Metrics

Table 2 gives the column headings in the Background Sound Level table output, see Attachment 1. The following paragraphs describe the information in each of the associated columns.

Table 2. Background Sound Level Metrics

ID	Description	Leq, 1hr	Equivalent	Events	Good Num	Bad Num	Spike Num	Adj Wind

ID

This number, 1 through 8, corresponds to each of the six background or "B" buttons on the button box, or to the description given in the next column.

Description

For ID's 1 through 6, these are the descriptions for each background sound button used during data acquisition. ID 7, Unidentified Background, is any sample collected while only the "B" button has been pressed and no specific background source has been identified (pressed). ID 8 is the total for the given column. No total is given for the **Equivalent** column.

Leq, 1hr

This is the "equivalent sound level" of the identified source in dB during the portion of the one hour measurement period when no intruding sounds were audible. It is calculated by summing the sound energy of all the one second samples identified for that source, and averaging the result over the total number of good background sound samples. It is designed to approximate the contribution of the specific background source to the entire hour, if no intruding sounds were heard.

Equivalent

This is what the **Leq, 1hr** in dB would be if only the specific background sound source were heard for the entire hour. This metric is intended to quantify what the background sound level would be if the specific source were heard as measured, but as if it were continuous for the entire hour.

Events

This is the number of continuous periods when the specific background sound source was identified. It is a count of the number of times the specific button was pressed and no other button was pressed.

Good Num

The number of "good" 1 second samples for each ID. Samples are "bad" when there is no identification at all, as occurs when no buttons are pushed, or when the wind speed exceeds 15 MPH. Bad samples are omitted from all calculations.

Bad Num

The number of samples when no buttons were pushed or when the wind speed exceeded 15 MPH.

Spike Num

The number of one second samples during which "spikes" were identified. A spike is initially identified if one sample exceeds the previous sample by more than 10 dB. This sample is

averaged with the previous one to yield a criterion level for judging following samples. A spike is deemed to last until a following sample is less than this criterion level. However, if five or more of the following samples all exceed the criterion level, the event is judged not a spike, but an event. This approach is intended to permit the user to remove very short, fast rise-time events, such as occasional bird calls or car door slams.

Adj Wind

Wind creates sound levels at the microphone through turbulence. The microphone / windscreen system was calibrated[1] and the following equation is used to compute the approximate A-weighted sound level produced by wind blowing past the system:

$$L_{wind} = 2.46S + 3.9 \text{ dB}(A)$$

Where *S* is the five second average wind speed. This equation is applied to wind speed data collected during each background sound level, and the resultant wind produced sound energy is subtracted from the measured background sound energy. The result for each background sound is given as **Adj Wind** which is an adjustment of **Leq, 1hr**, in dB.

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1 See Anderson, G.S. *et al*, "Dose-Response Relationships Derived from Data collected at Grand Canyon, Haleakala and Hawaii Volcanoes National Parks," Appendix A, NPOA Report No. 93-6, October 1993.