Michael Theriault INC
ACOUSTICS
NOISE CONTROL CONSULTING SERVICES

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Michael D. Theriault – Noise Specialist

- Electrical Engineer – University of Maine – 1986
- 24 Years Experience in Acoustics
- 22 Years Experience in Power Plant Noise Control
- President & Principal Consultant for MTAcoustics since 1998
- Expert Witness throughout the Country
- Member of Institute of Noise Control Engineering
- Member of Acoustical Society of America – Greater Boston Chapter

Michael Hankard – Noise Specialist

- Electrical Engineer – University of Maine – 1990
- 20 Years Experience in Acoustics
- 10 Years Experience in Power Plant Noise Control
- President & Principal Consultant for Hankard Environmental since 1996
- Experience with noise measurements and data analysis on dozens of projects located across the U.S.
- Member of Institute of Noise Control Engineering
- Member of Acoustical Society of America

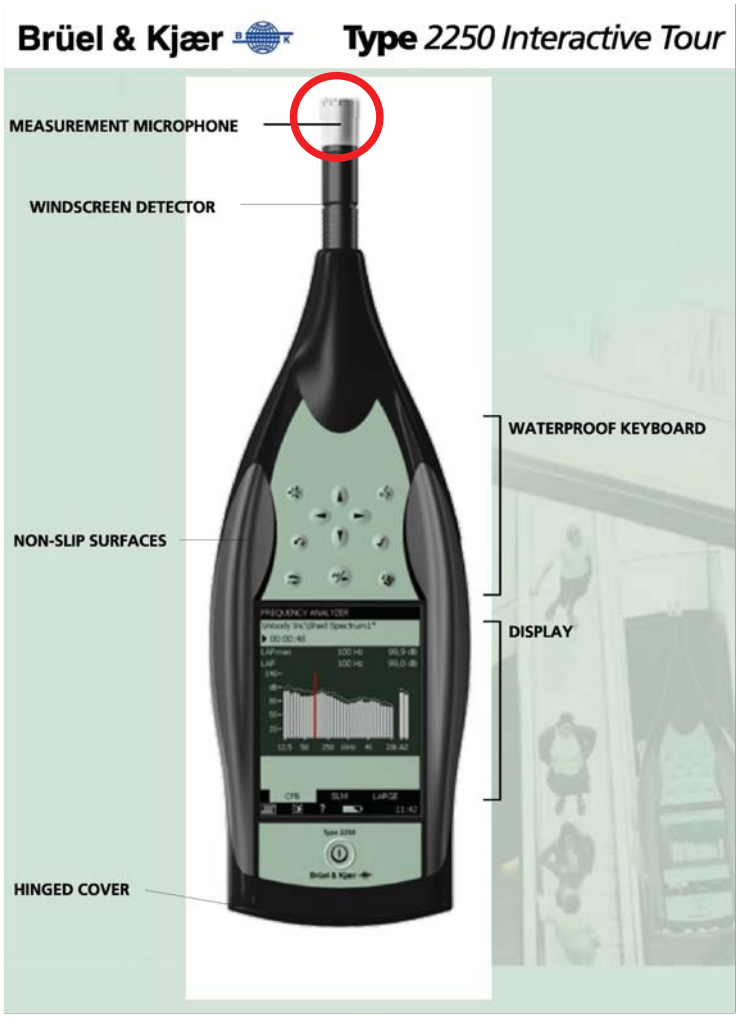
Noise Topics

- Noise Basics
- GHEC Noise Testing
- Noise from GHEC Expansion

Noise Basics

What is Noise?

How is Noise Measured?



Range of Hearing

1 to 10,000,000

Logarithms Compress Range

Range of Hearing

0 to 140 decibels (dB)

Common Sources of Noise & Subjective Human Responses		
Thresholds/ Noise Sources	**Noise Level (dBA)**	**Subjective Evaluations**
Human Threshold of Pain Carrier jet takeoff (50 ft)	140	Deafening
Siren (100 ft) Loud rock band	130	
Jet takeoff (200 ft) Auto horn (3 ft)	120	
Chain saw Noisy snowmobile	110	Very Loud
Lawn mower (3 ft) Noisy motorcycle (50 feet)	100	
Heavy truck (50 feet)	90	
Pneumatic drill (50 feet) Busy urban street, daytime	80	Loud
Normal automobile at 50 mph Vacuum cleaner (3 ft)	70	
Large air conditioning unit (20 feet) Conversation (3 feet)	60	Moderate
Quiet residential area Light auto traffic (100 ft)	50	
Library Quiet home	40	Faint
Soft whisper	30	
Slight rustling of leaves	20	Very Faint
Broadcasting Studio	10	
Threshold of Human Hearing	0	

Note that the subjective evaluations are continuous without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the noise receivers.

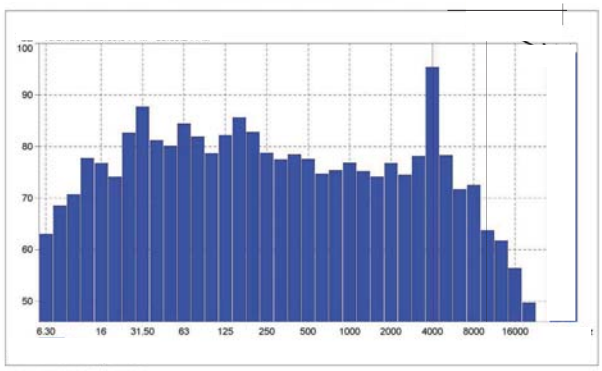
How are changes in noise levels perceived?

Sound Perception

Change in Sound Level (dB)	Change in Apparent Loudness
1	Imperceptible
3	Just barely perceptible
6	Clearly noticeable *
10	About twice (or half) as loud
20	About 4 times (or one-fourth) as loud

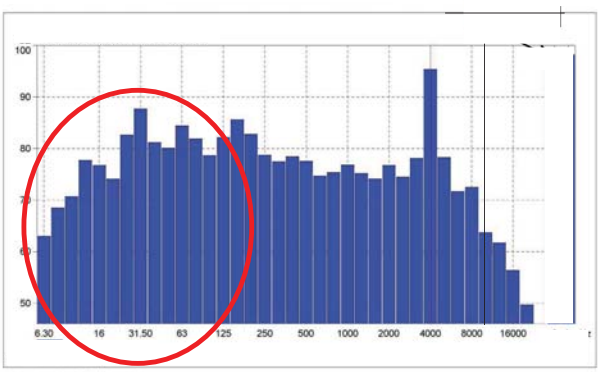
* For example, distance to the point source outdoors is halved or doubled.

Pitch or Frequency



PITCH OR FREQUENCY EXAMPLE

Michael Theriault Acoustics



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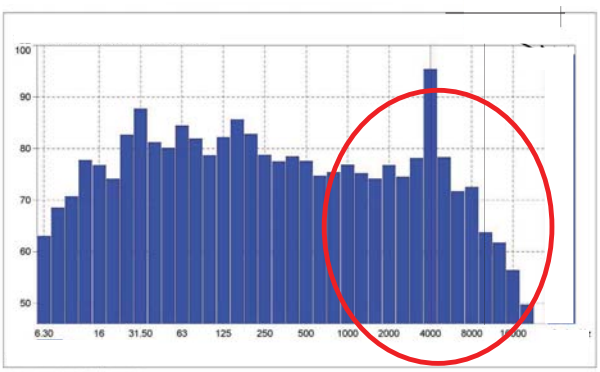

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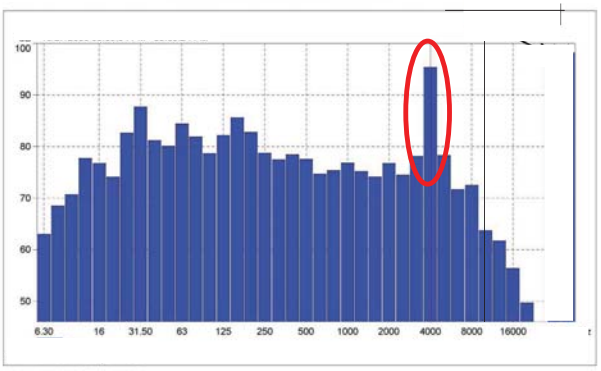


PITCH OR FREQUENCY EXAMPLE

Noise Level (dBA)

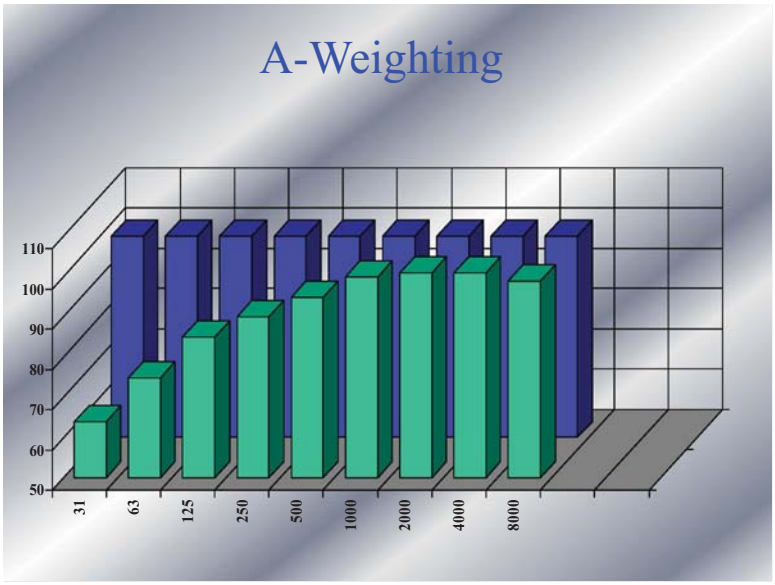
dB = decibels

dBA = decibels, A-Weighted

A-Weighting

=

Wind Chill



How do multiple noise sources add together?

40 dBA + 40 dBA = 43 dBA

Sound Perception

Change in Sound Level (dB)	Change in Apparent Loudness
1	Imperceptible
3	Just barely perceptible
6	Clearly noticeable *
10	About twice (or half) as loud
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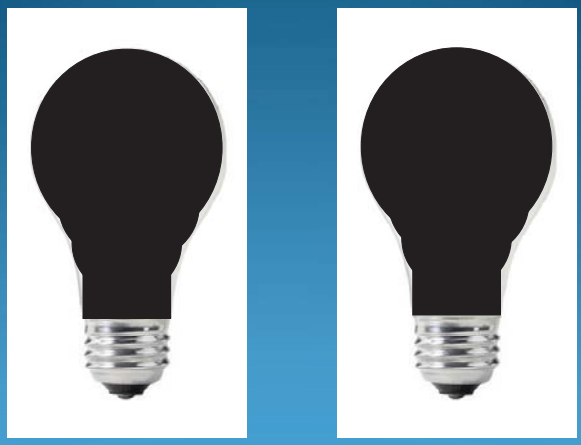
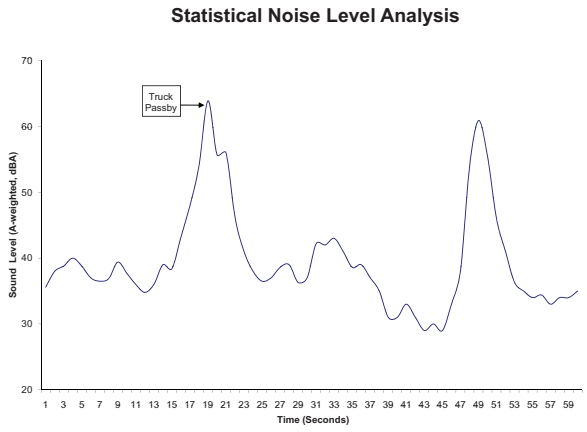
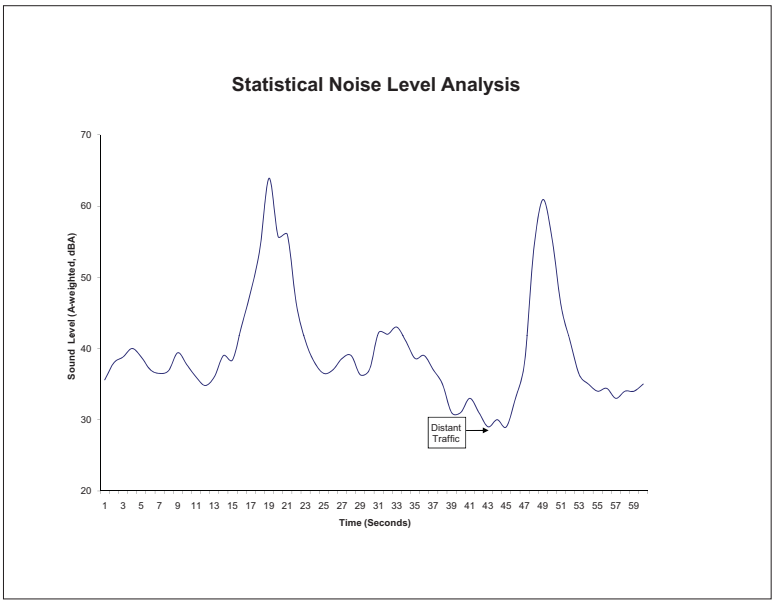
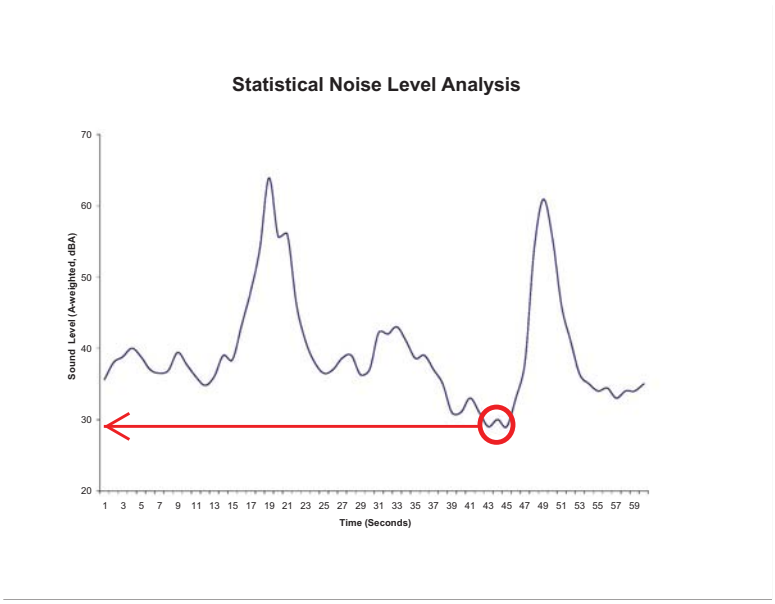
* For example, distance to the point source outdoors is halved or doubled.



How is environmental noise measured?




Statistical Noise Level Analysis
Sound Level (A-weighted, dBA)
Time (Seconds)
Distant Traffic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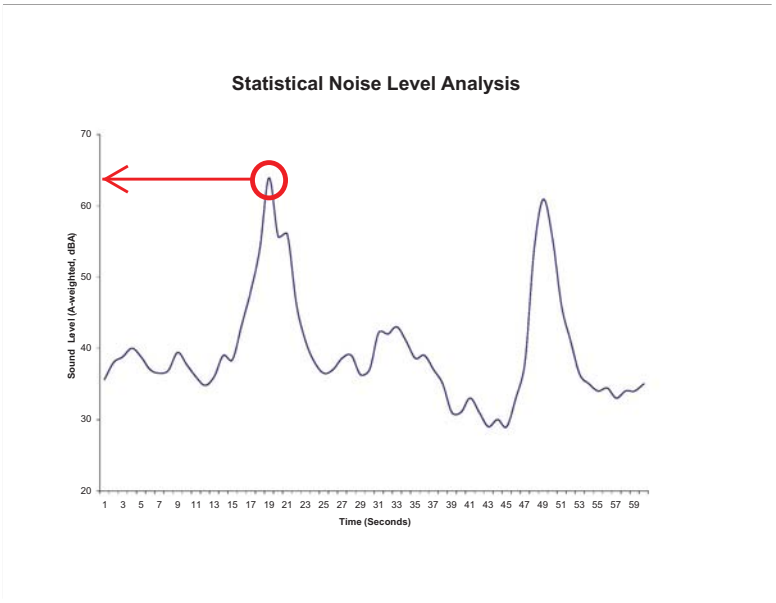
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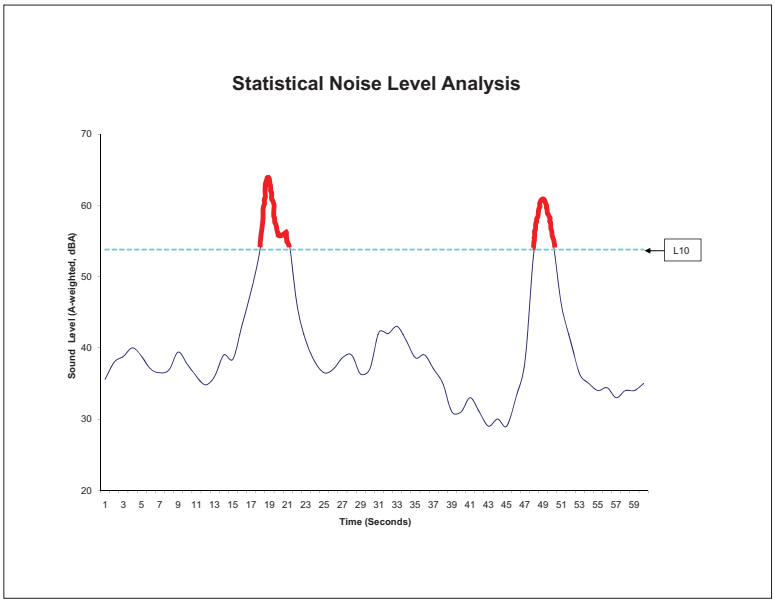
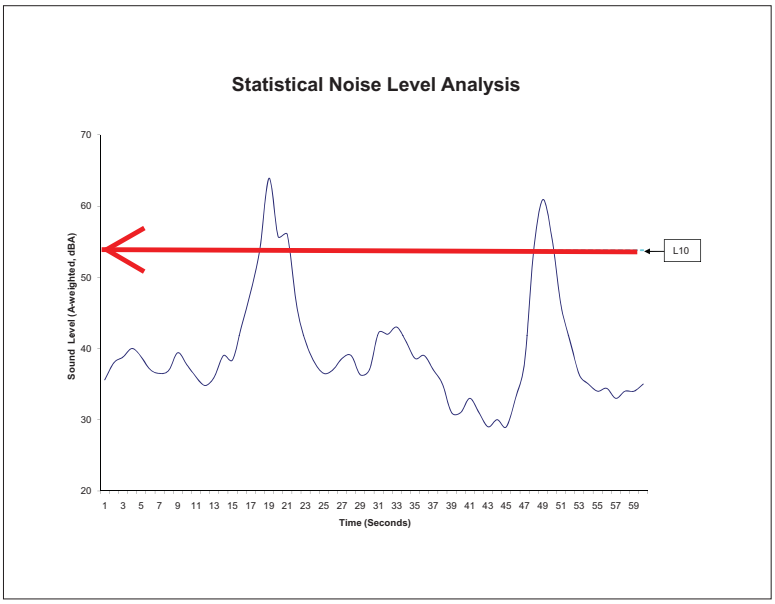

Statistical Noise Level Analysis
Sound Level (A-weighted, dBA)
Time (Seconds)
L10


Statistical Noise Level Analysis
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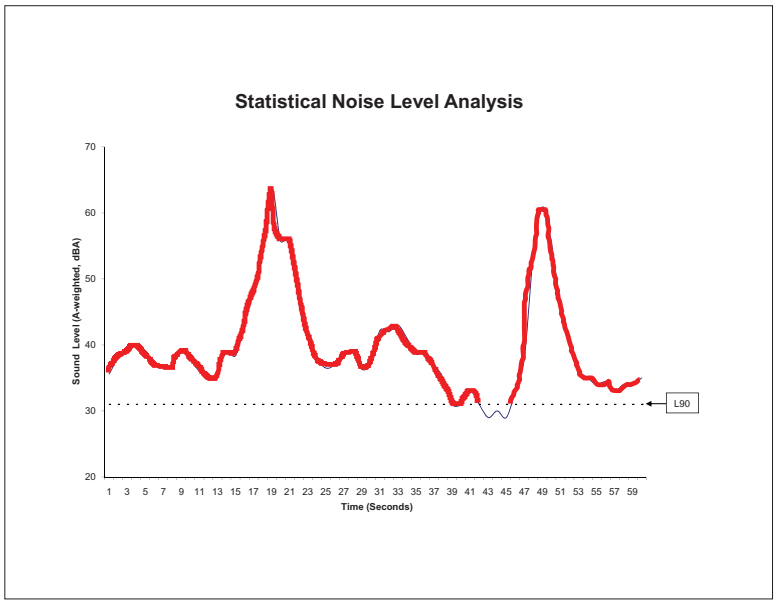
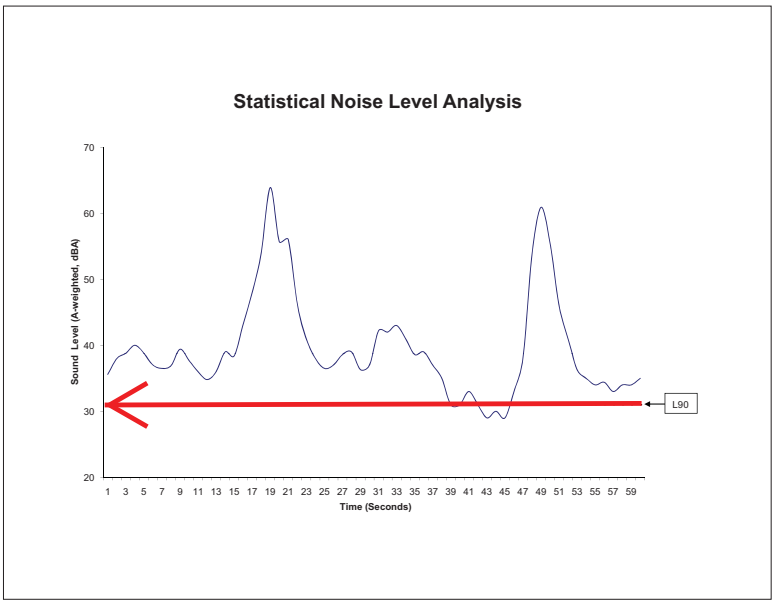

Statistical Noise Level Analysis
Sound Level (A-weighted, dBA)
Time (Seconds)
L90


Statistical Noise Level Analysis
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Time (Seconds)
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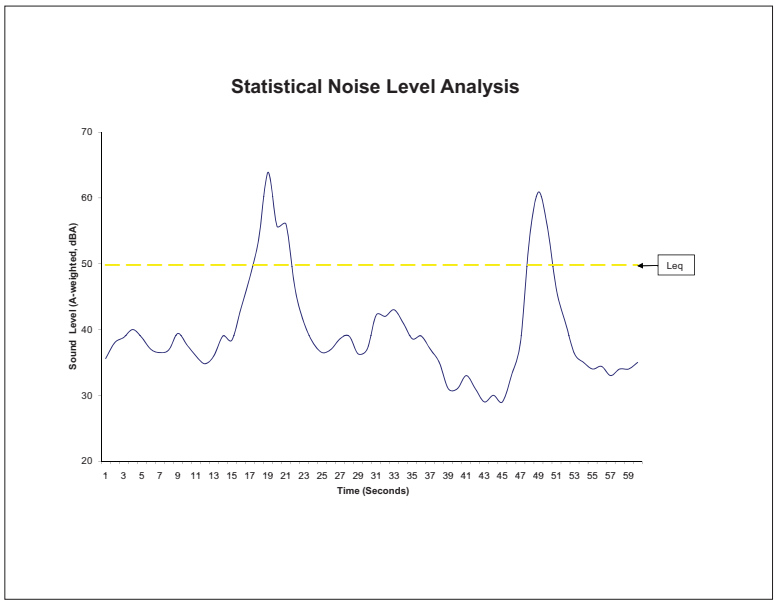
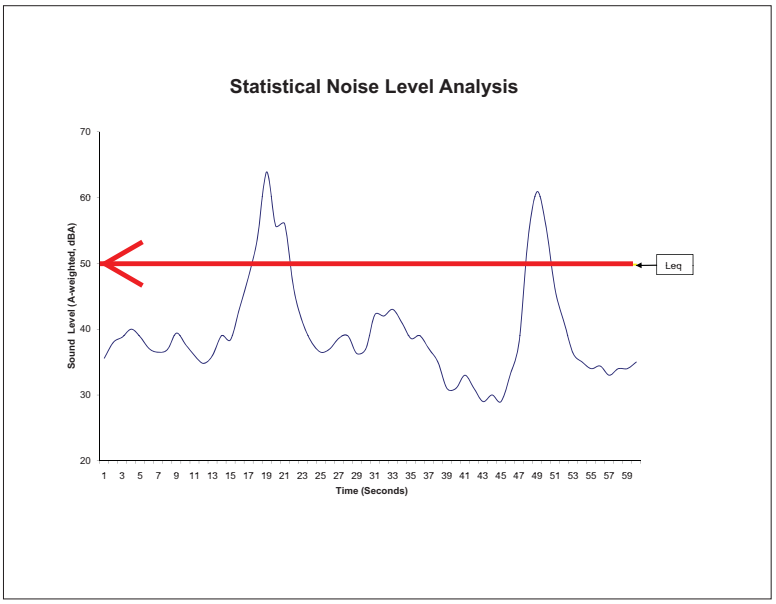

Statistical Noise Level Analysis
Sound Level (A-weighted, dBA)
Time (Seconds)
Leq



GHEC Noise Testing

Noise Regulations

Established by Washington Department of Ecology (WDE)

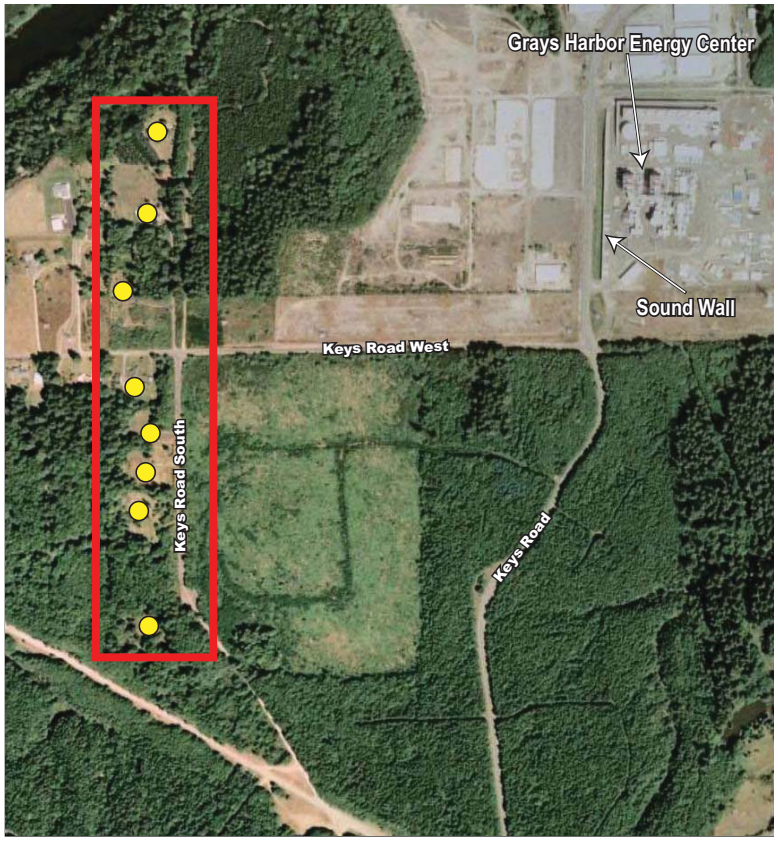
Chapter 173-60

Washington Administrative Code (WAC)

60 dBA - Day

50 dBA - Night

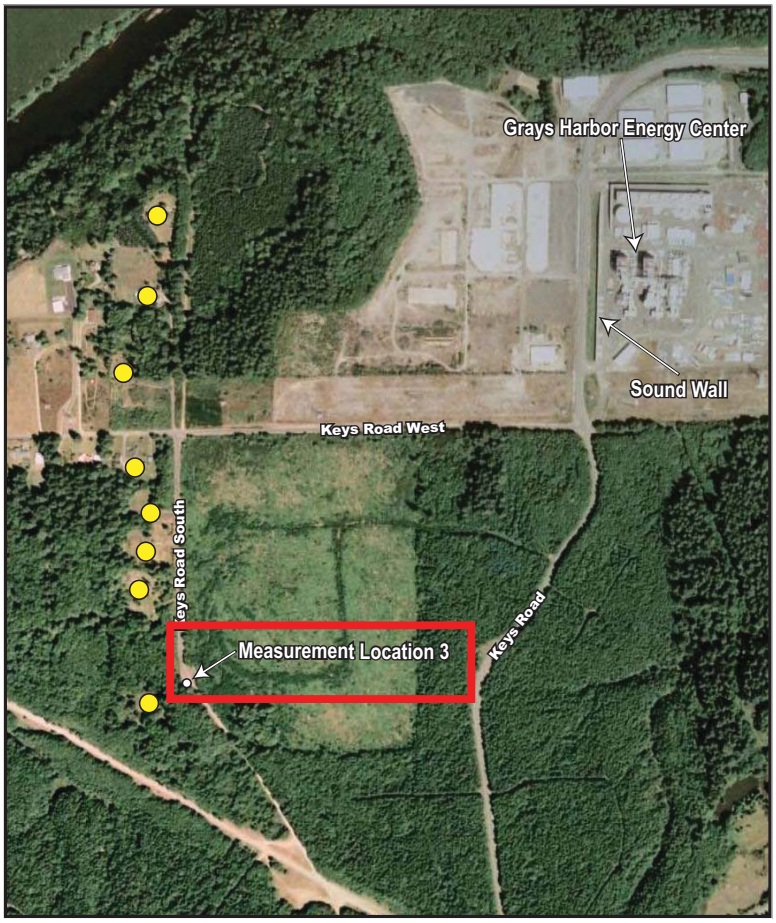
Where are the nearest residences?



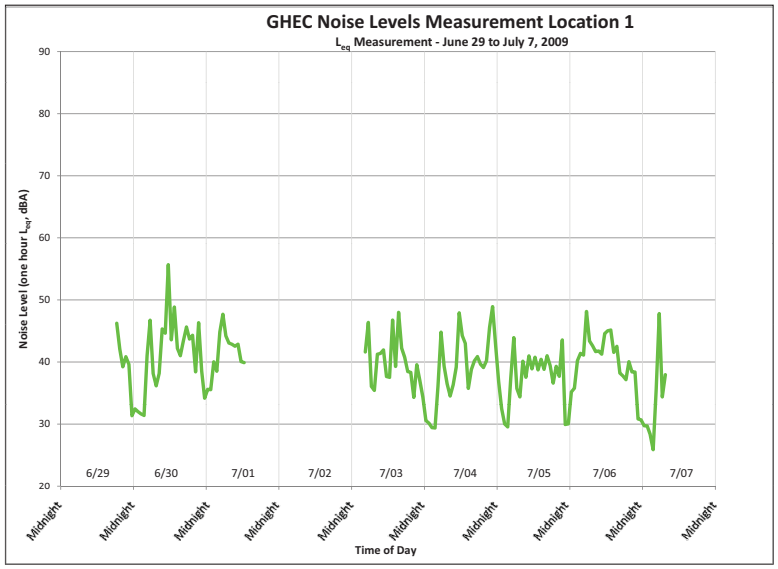
How was noise testing conducted?

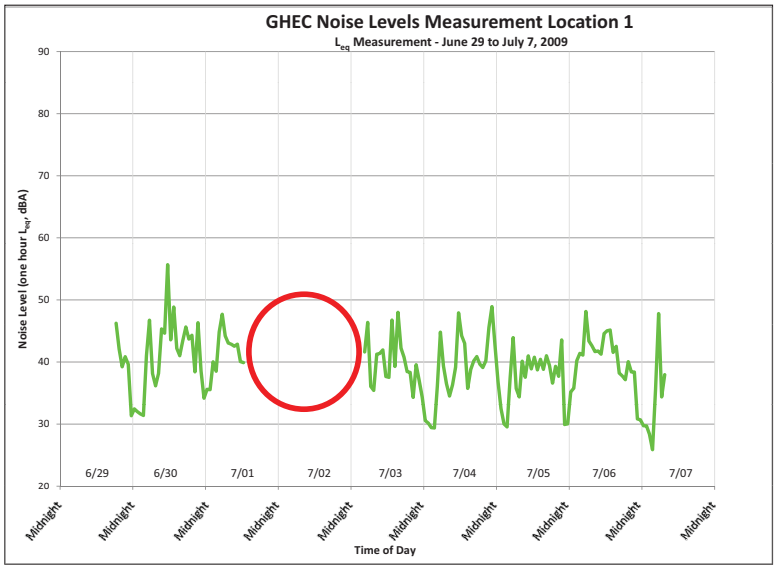
Noise Monitors Deployed

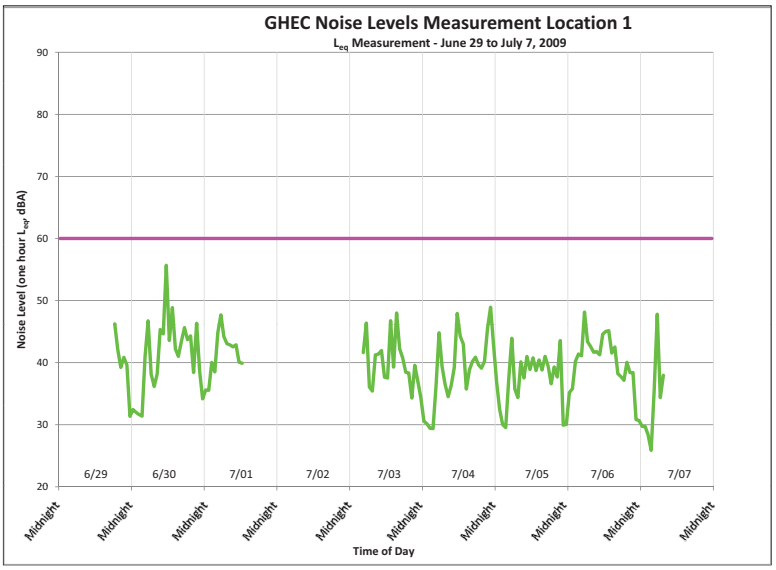
Where were noise monitors installed?



Location 1 Monitoring Results






GHEC Noise Levels Measurement Location 1
L_{eq} Measurement - June 29 to July 7, 2009
Noise Level (one hour L_{eq}, dBA)
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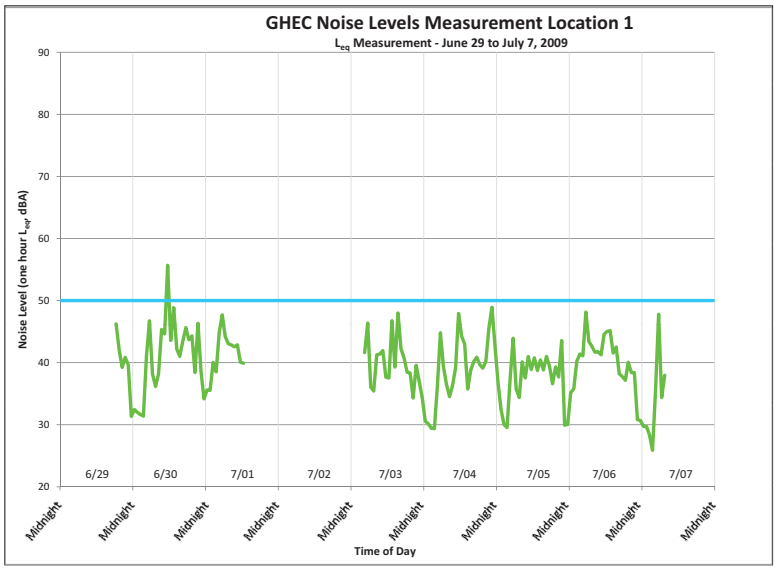
Midnight
Time of Day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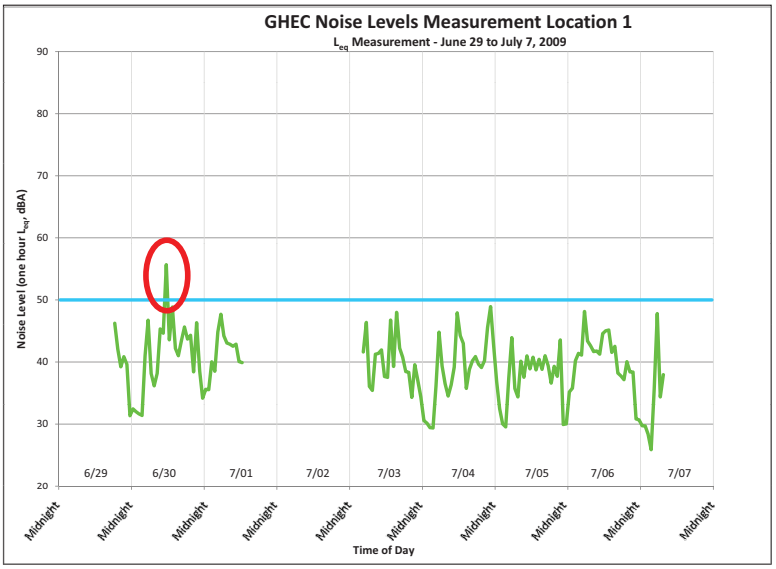
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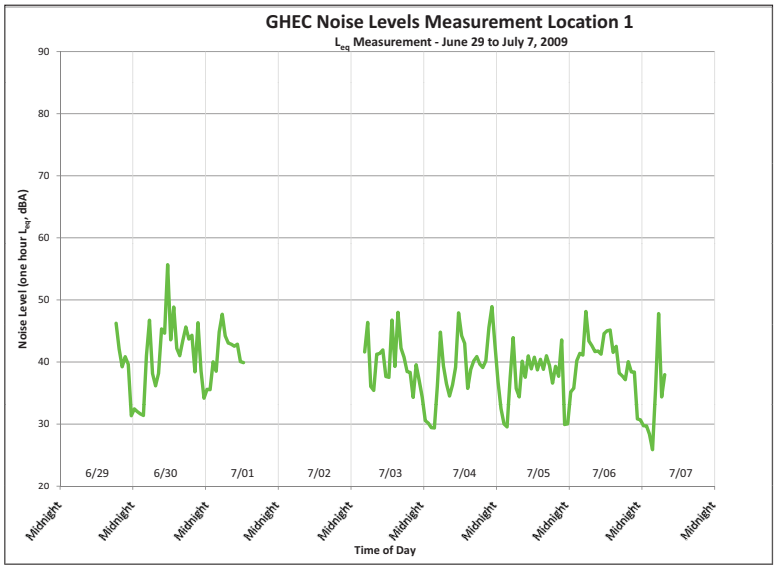
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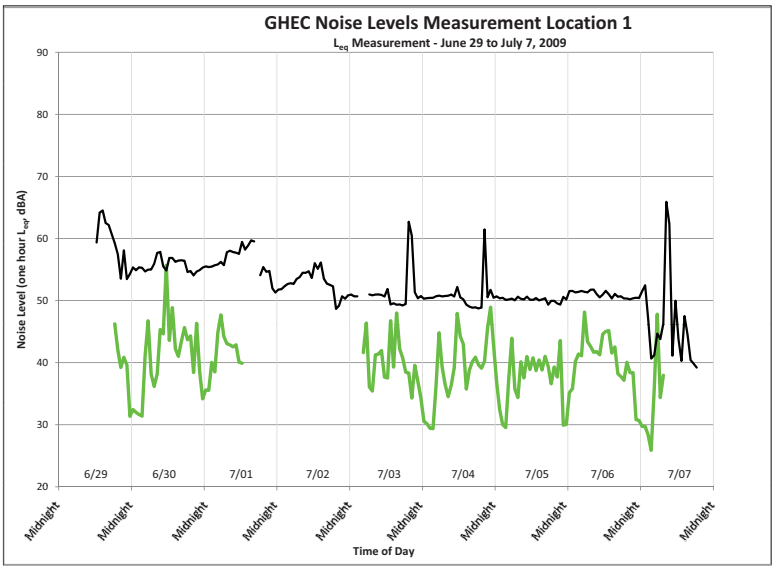
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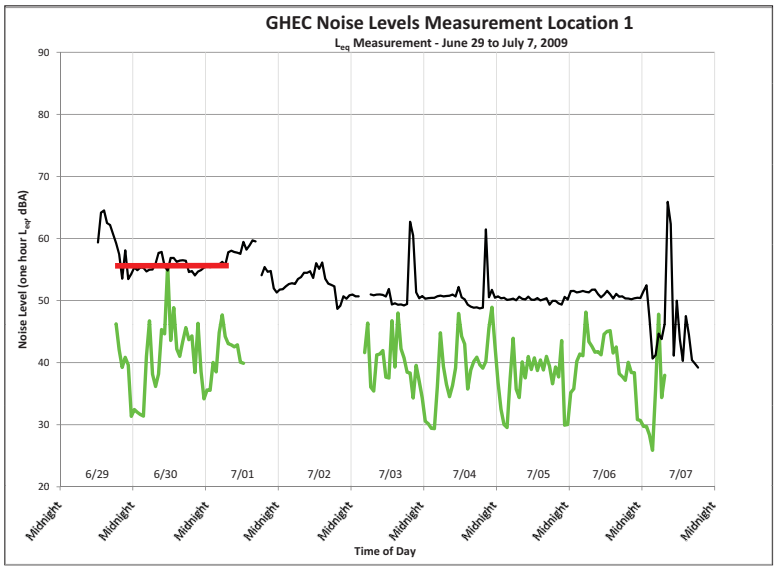
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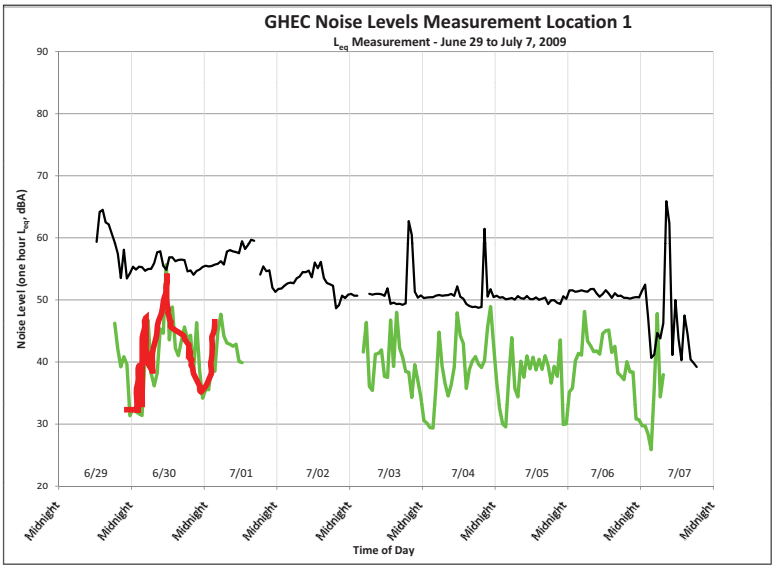
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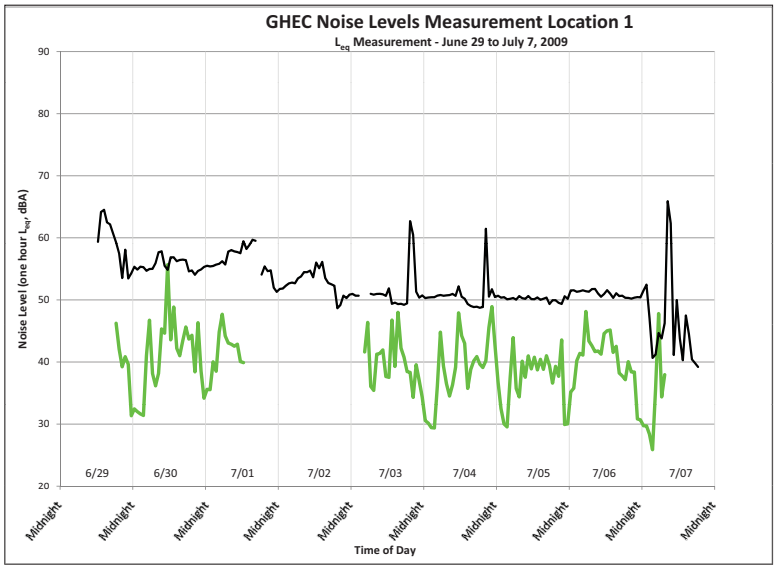
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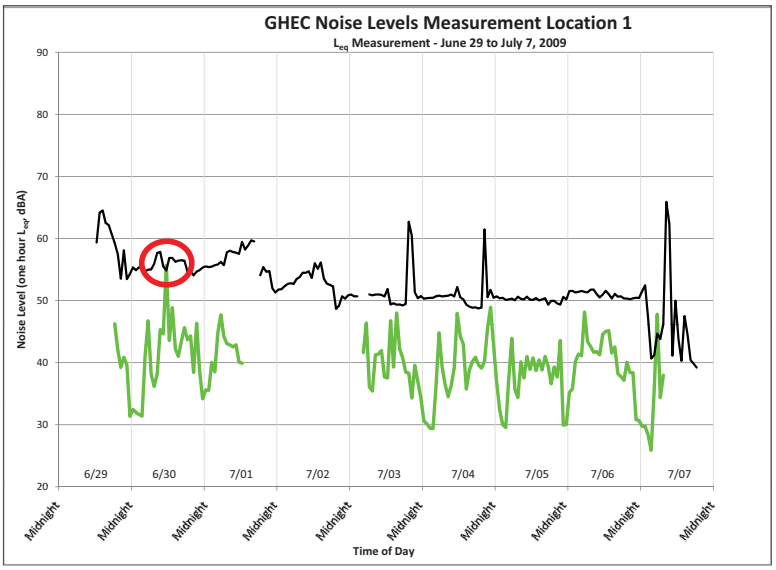
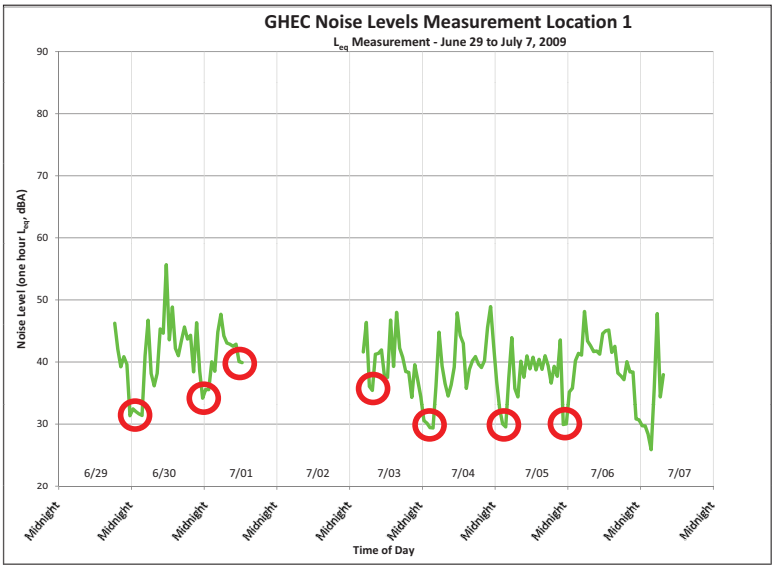
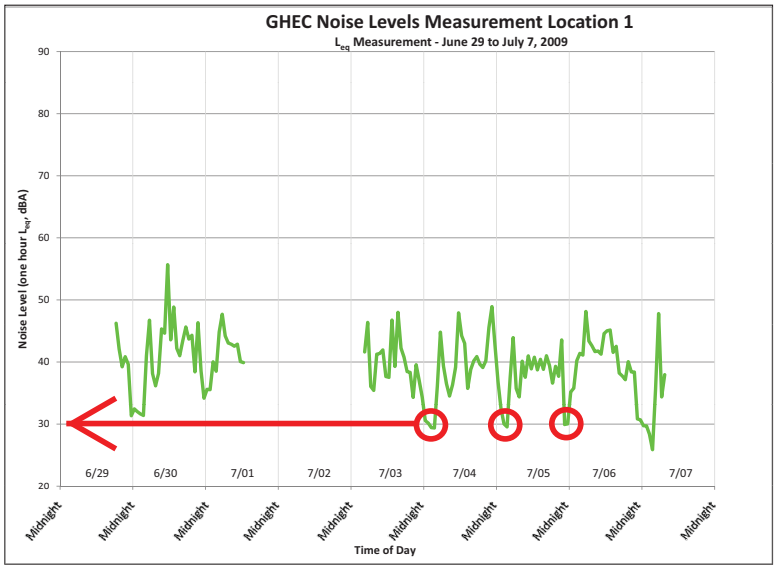
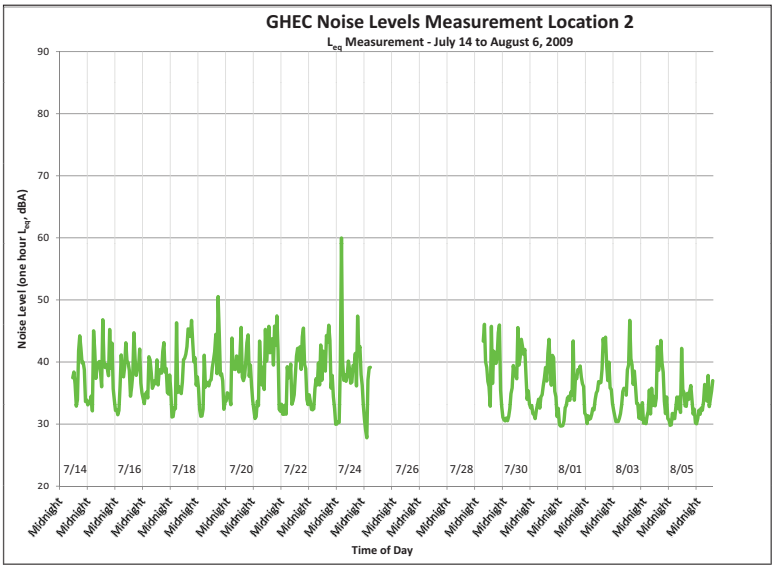


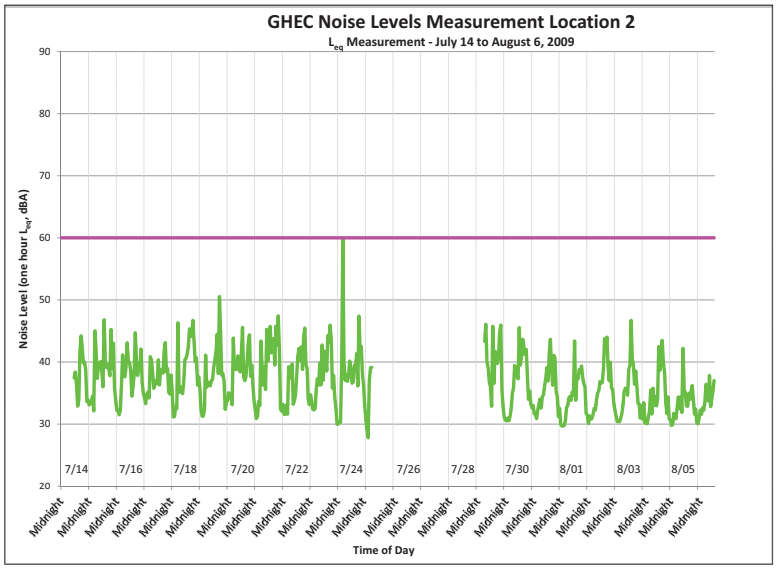
GHEC Noise Level at Location 1

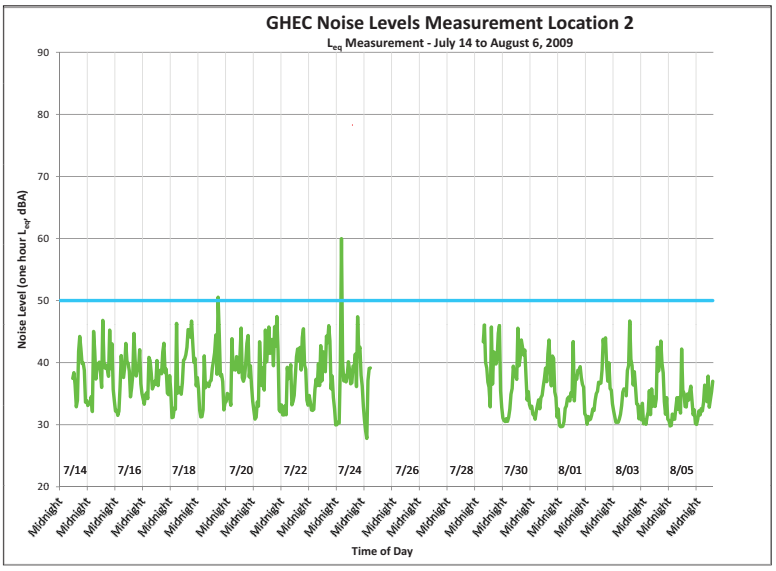




Location 2 Monitoring Results






GHEC Noise Levels Measurement Location 2
L_{eq} Measurement - July 14 to August 6, 2009
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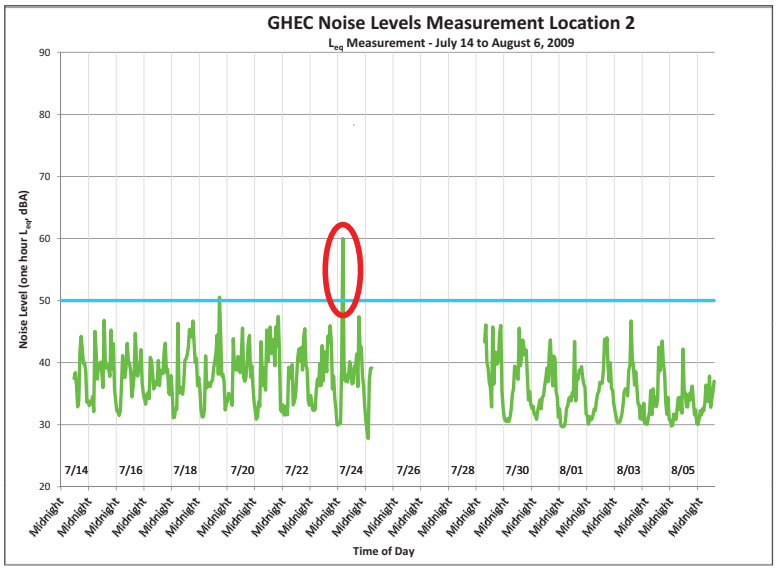
Midnight
Time of Day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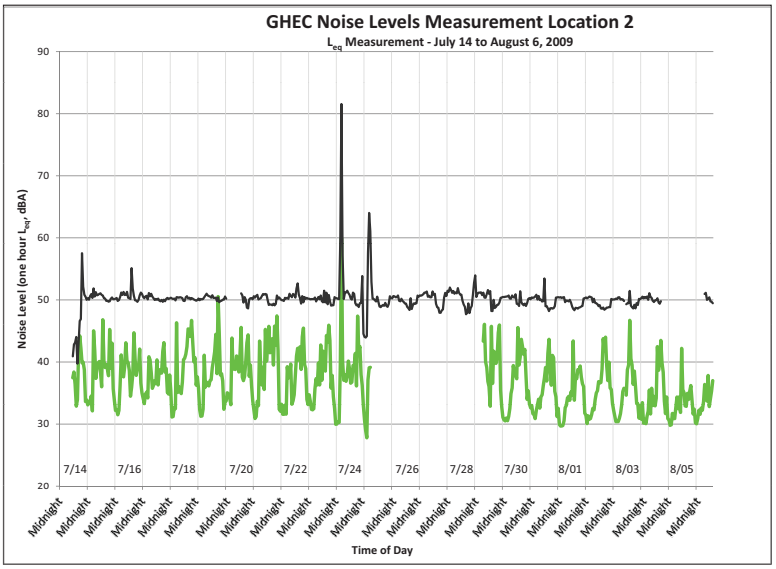
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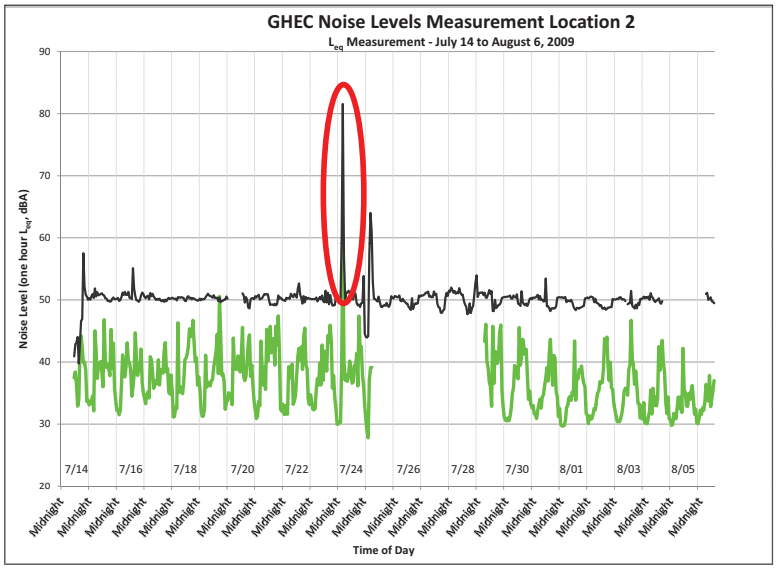
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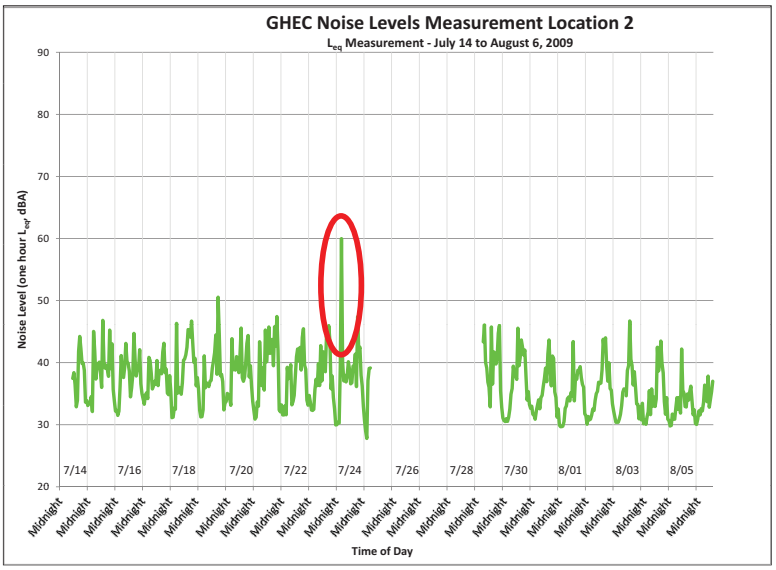
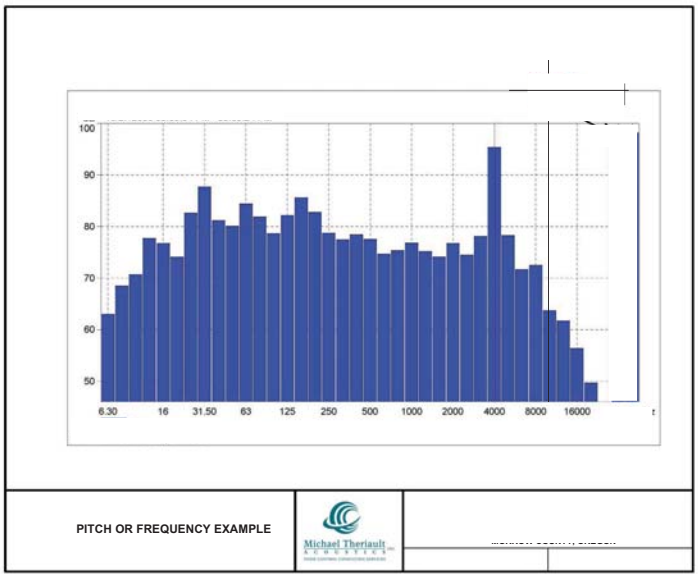
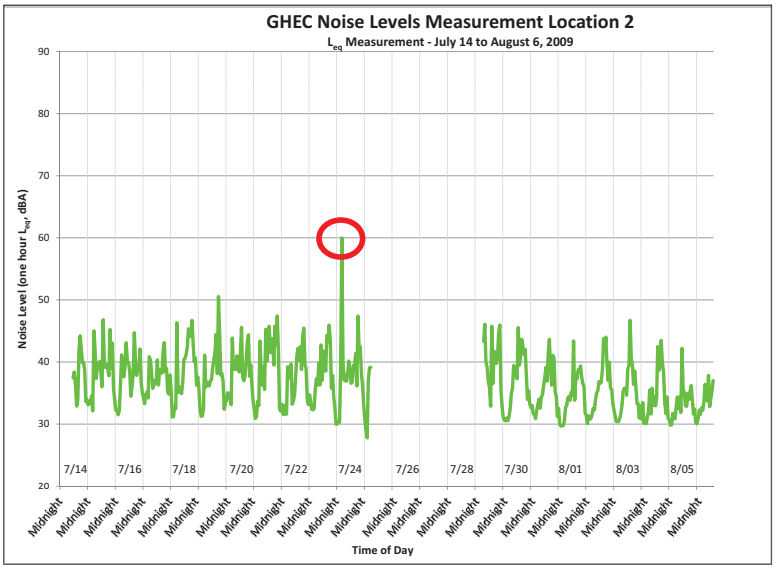
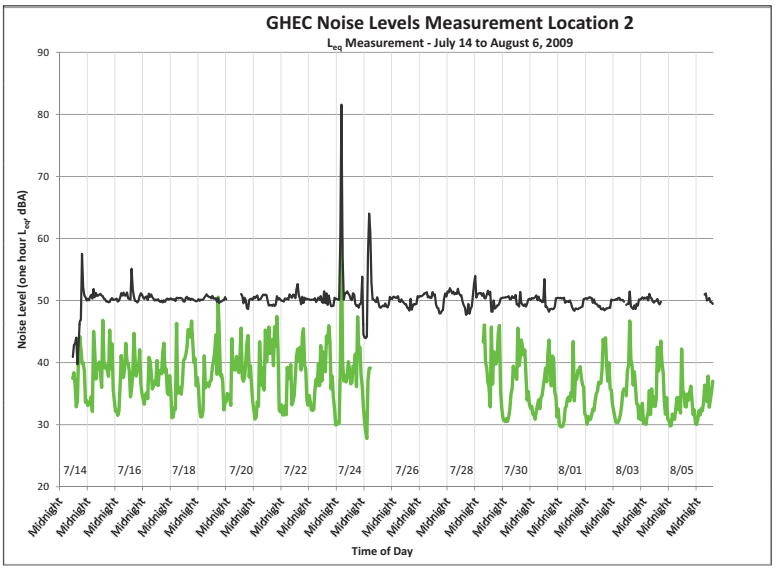
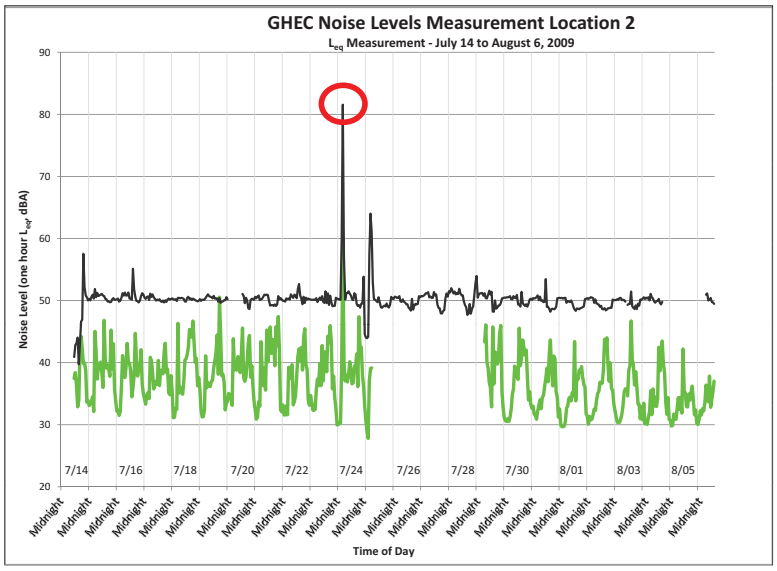


Spectral Analysis






GHEC Noise Levels Measurement Location 2
L_{eq} Measurement - July 14 to August 6, 2009
Noise Level (one hour L_{eq}, dBA)
Time of Day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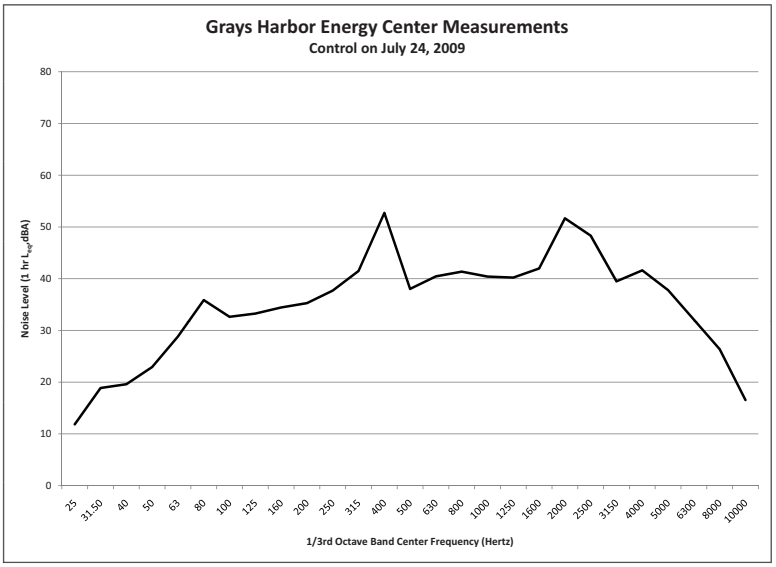
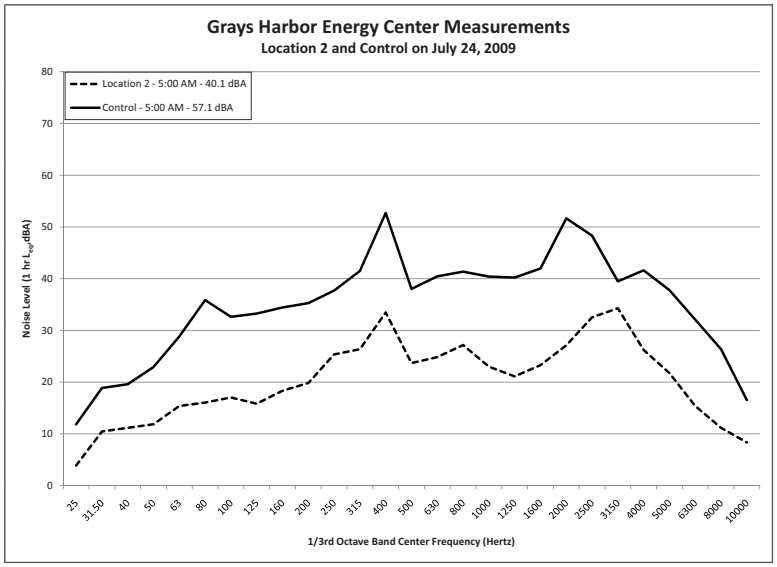

Grays Harbor Energy Center Measurements
Control on July 24, 2009
Noise Level (1 hr L_{eq}, dBA)
1/3rd Octave Band Center Frequency (Hertz)


Grays Harbor Energy Center Measurements
Location 2 and Control on July 24, 2009
Location 2 - 5:00 AM - 40.1 dBA
Control - 5:00 AM - 57.1 dBA
Noise Level (1 hr L_{eq}, dBA)
1/3rd Octave Band Center Frequency (Hertz)

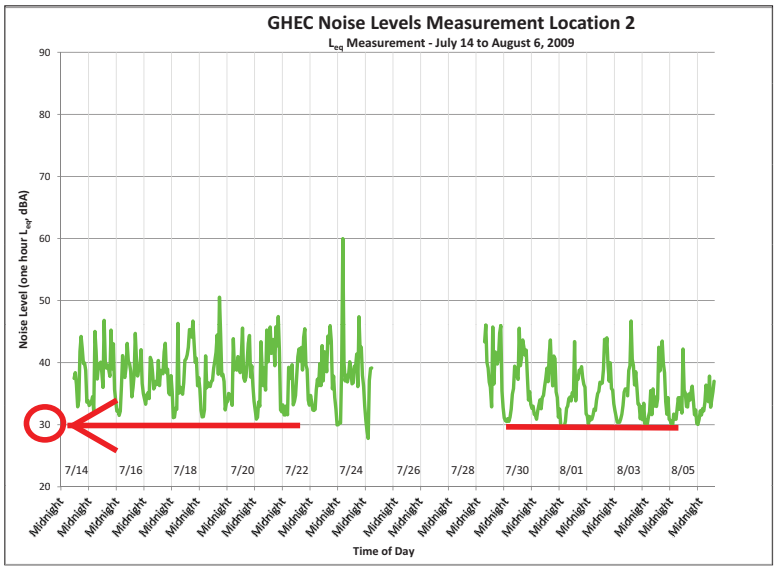
Analysis Methods

Analysis Methods

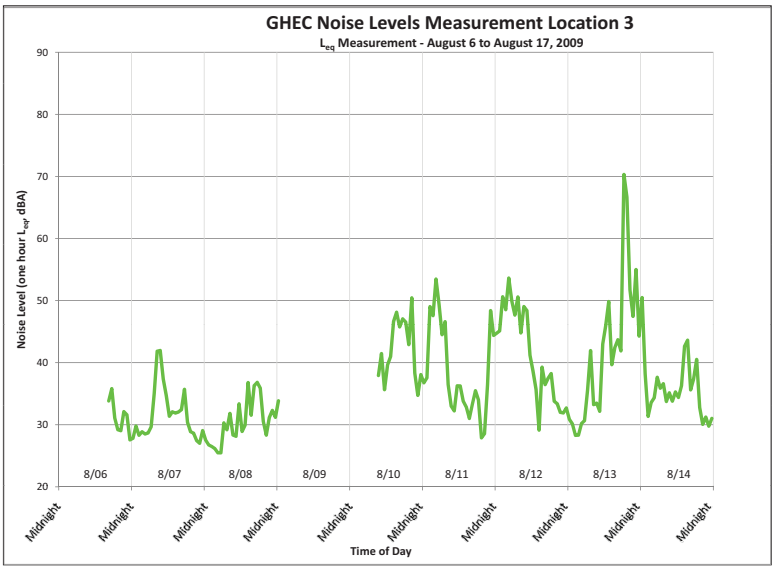
- Time Analysis
- Spectral Analysis
- Review of Operations

Upset Condition Rarely Occurs

GHEC Noise Level at Location 2



Location 3 Monitoring Results


GHEC Noise Levels Measurement Location 3
L_{eq} Measurement - August 6 to August 17, 2009
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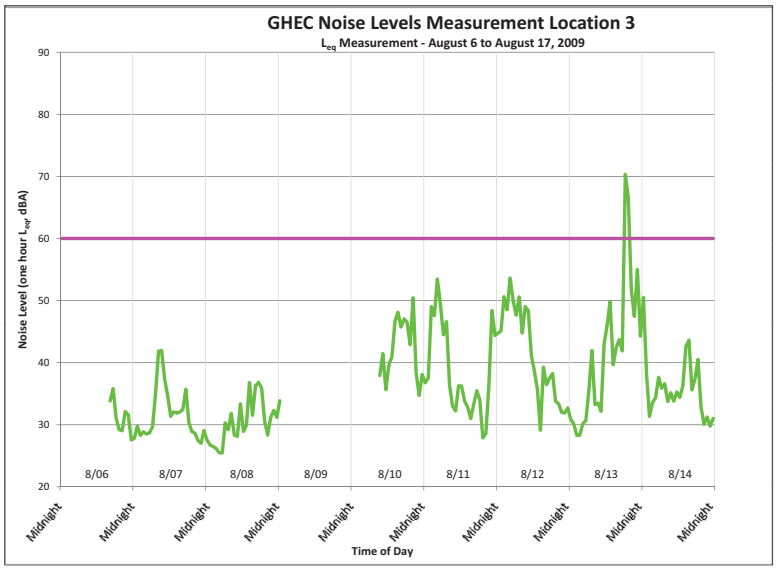
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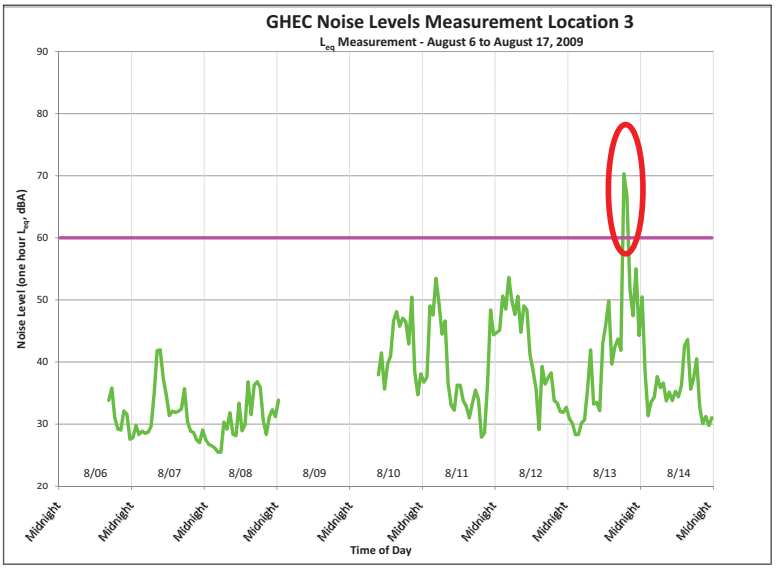
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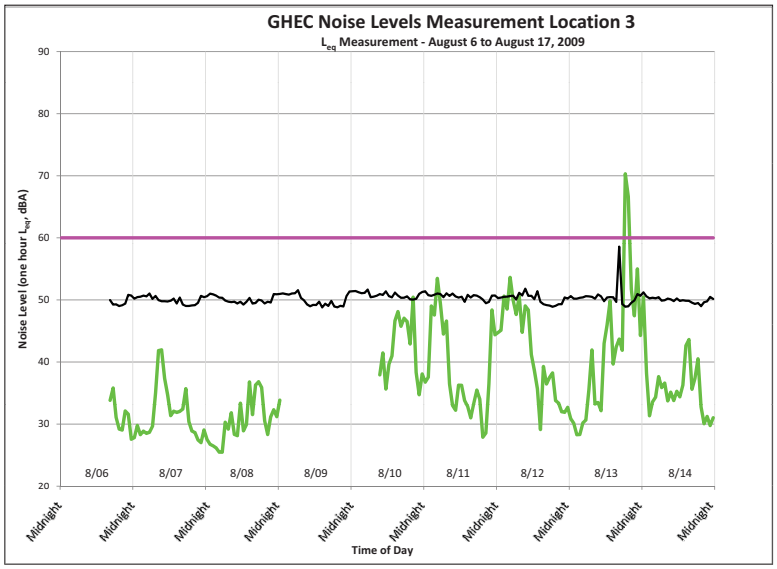
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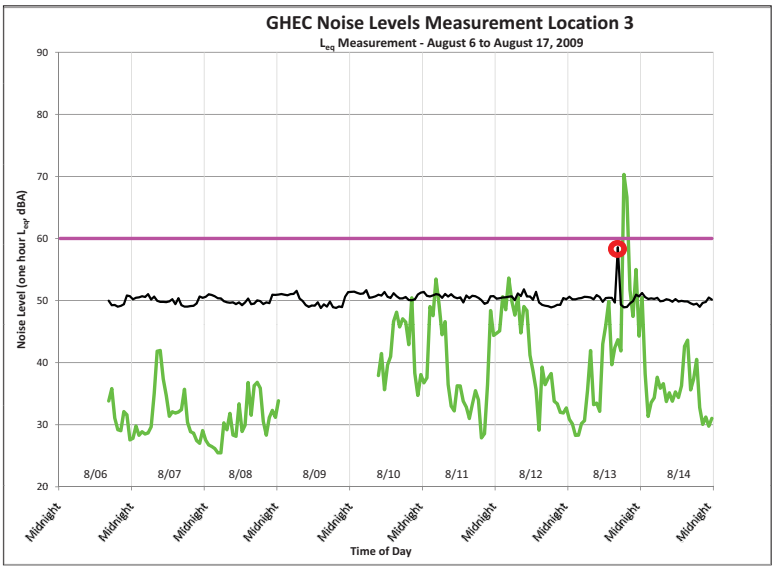
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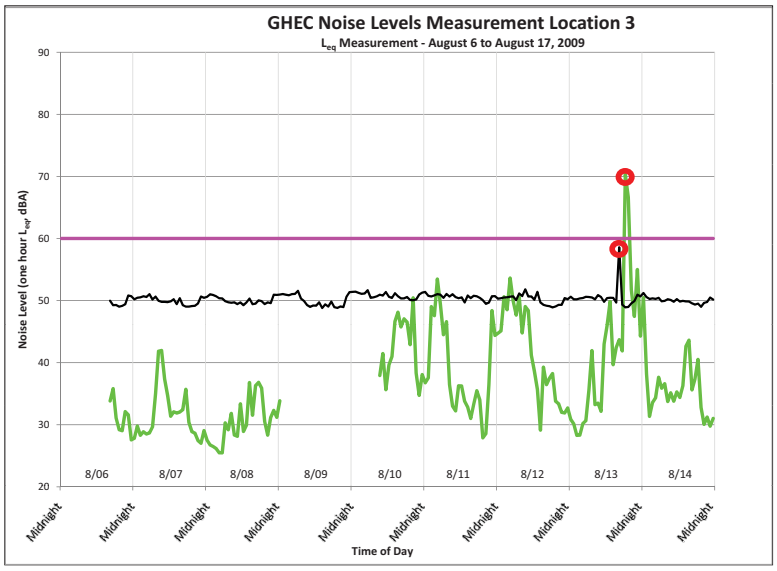
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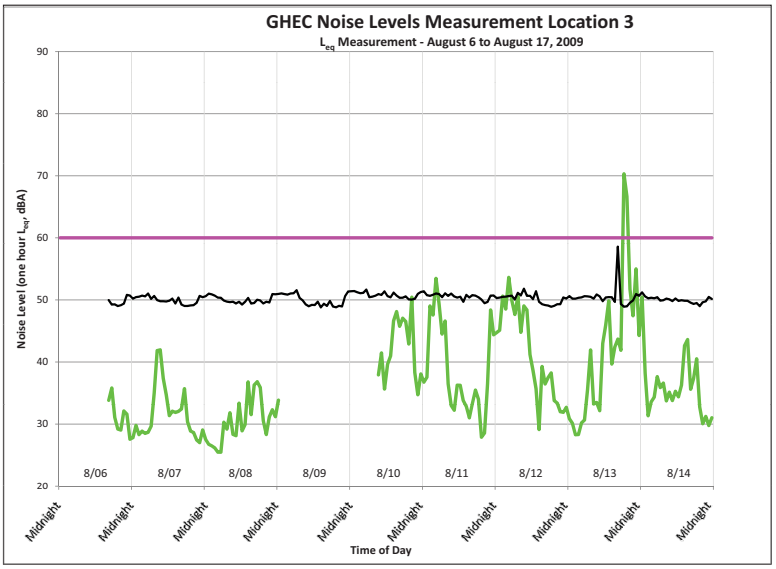
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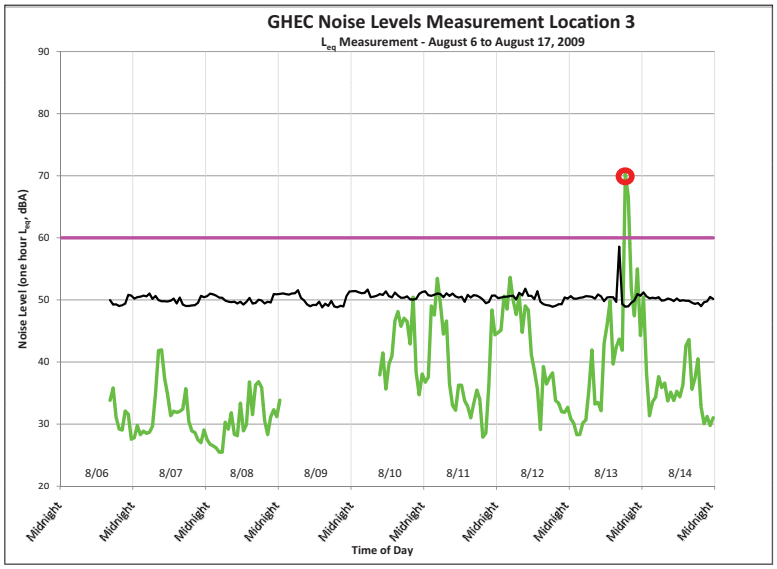
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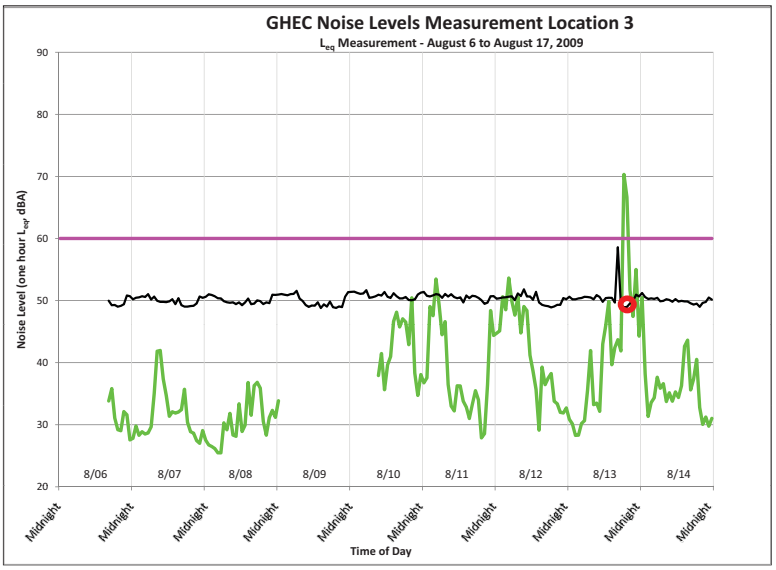
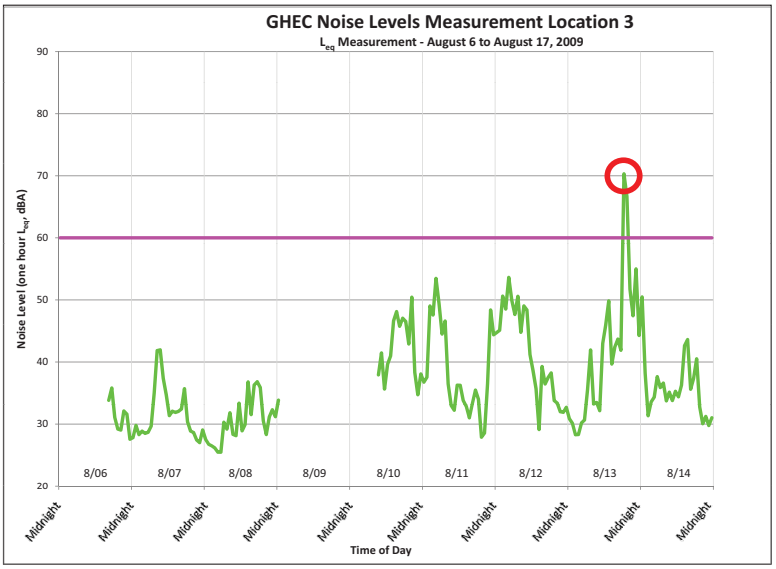
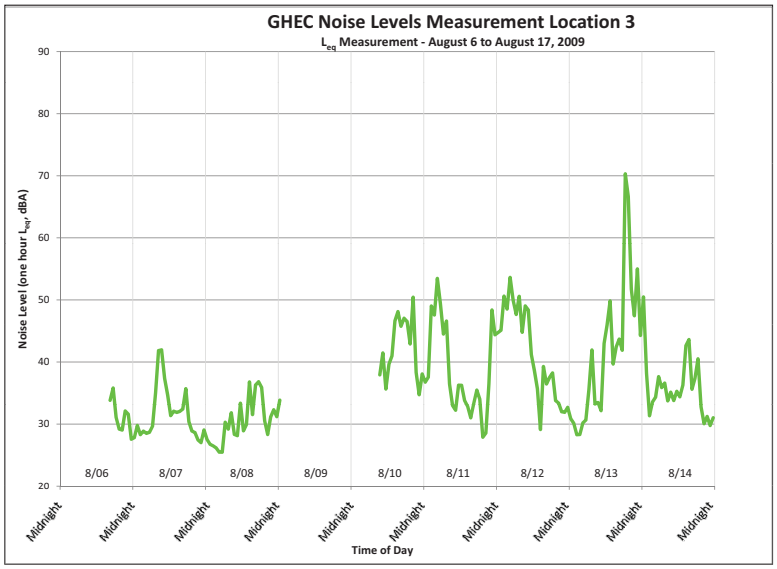
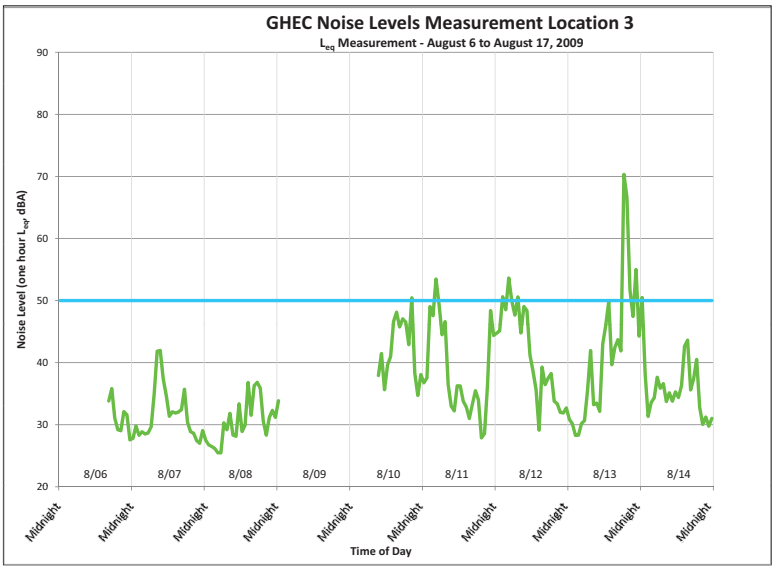


Analysis Methods

- Time Analysis
- Spectral Analysis
- Review of Operations
- Review Audio Recordings



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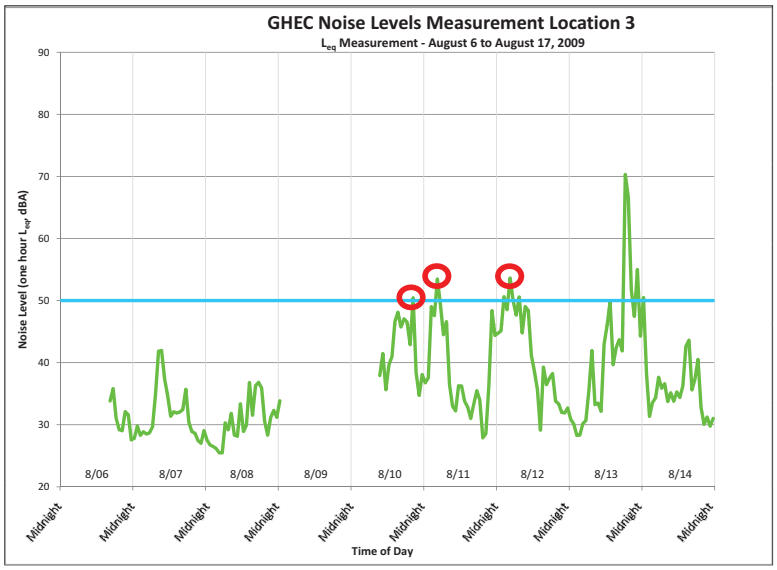
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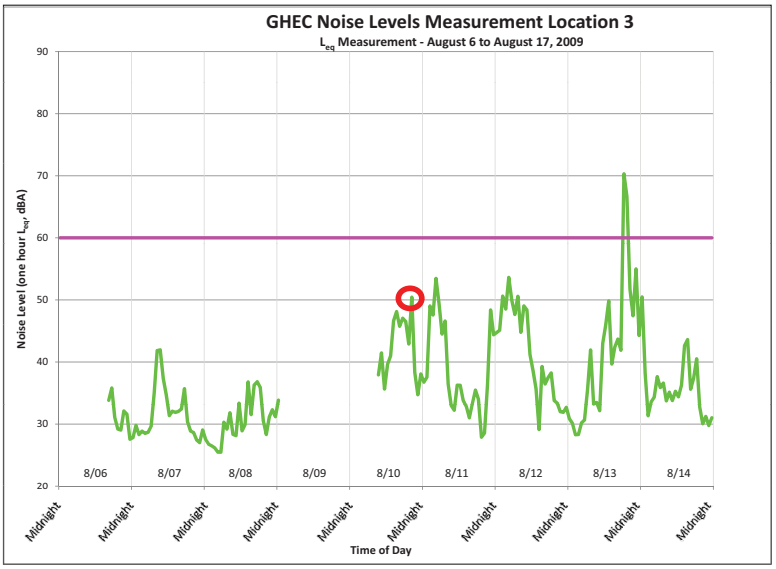
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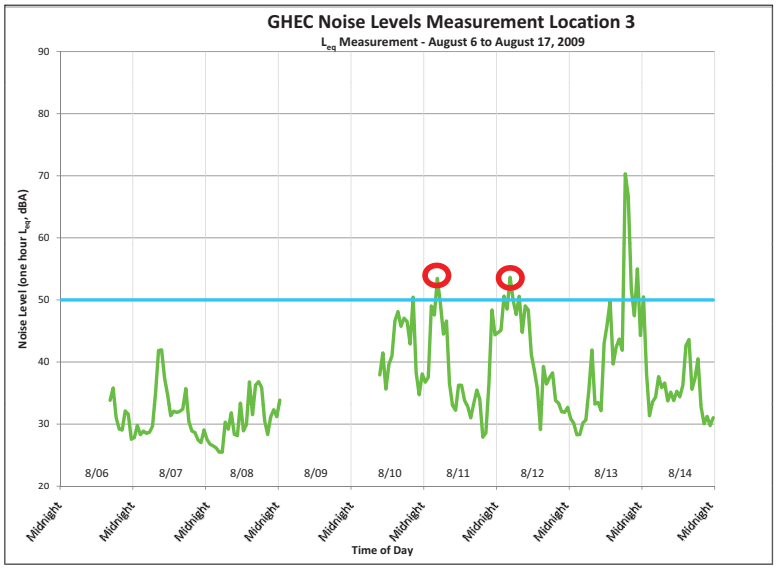
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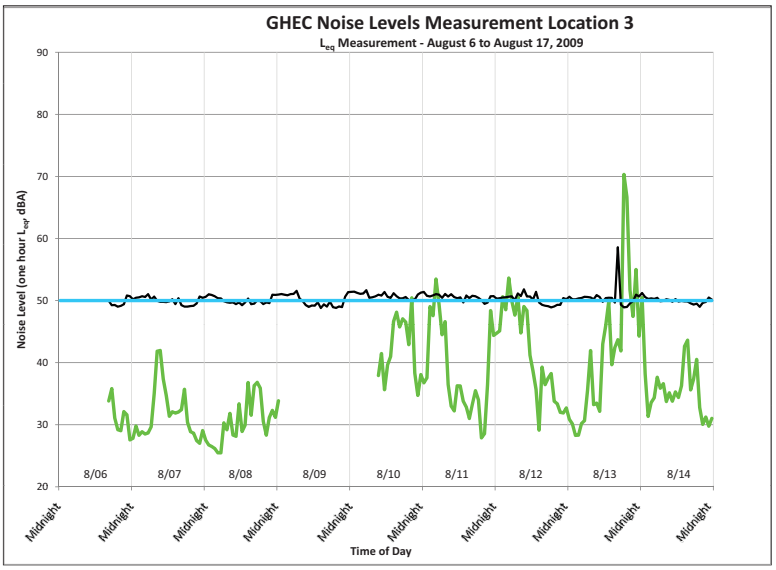
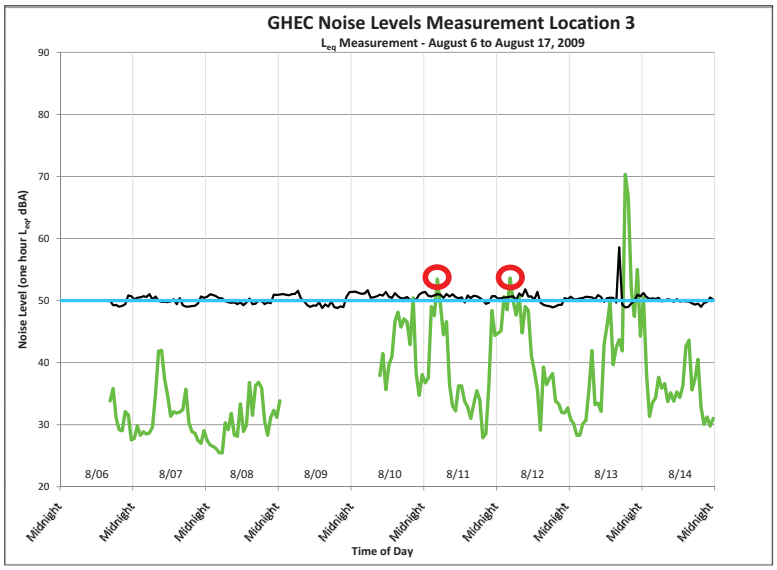
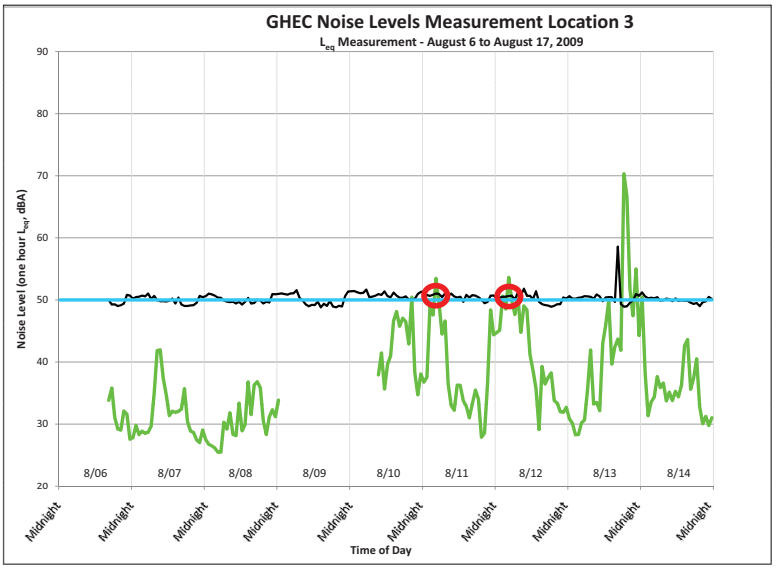
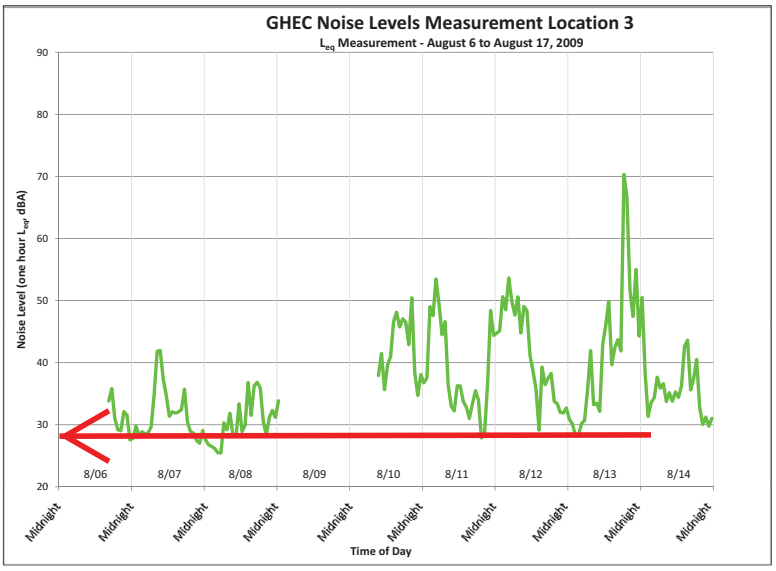






GHEC Noise Level at Location 3



Noise Testing Summary

Analysis Methods

- Time Analysis
- Spectral Analysis
- Review of Operations
- Review Audio Recordings

GHEC noise levels range from 28 to 40 dBA

GHEC Expansion Project

How much noise will the expansion make?

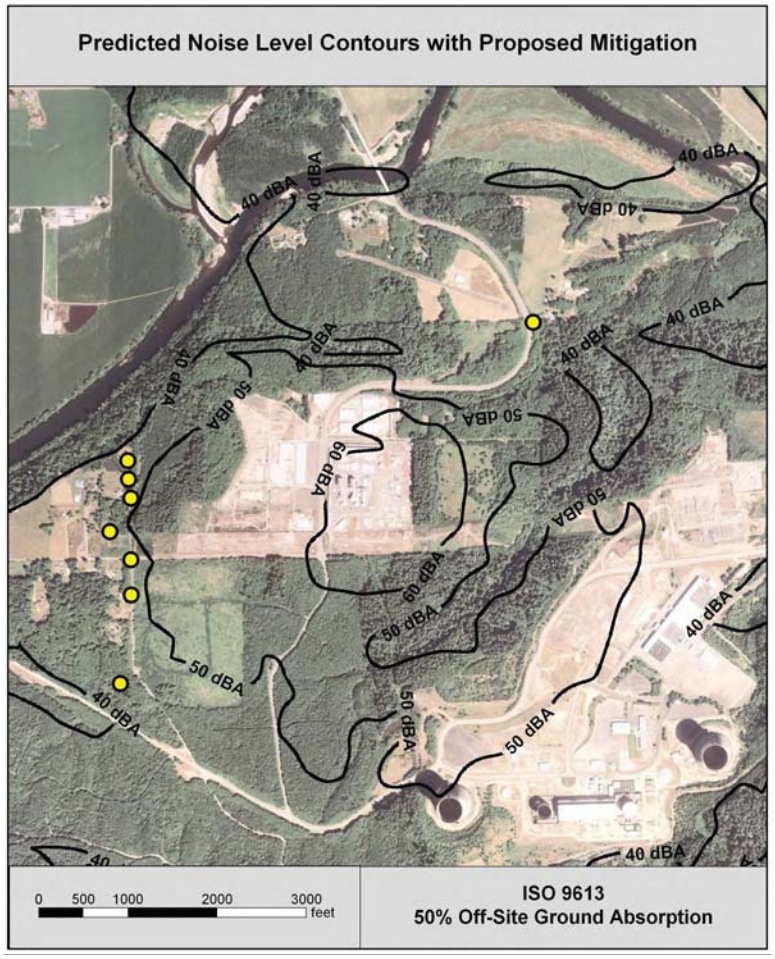
40 dBA + 40 dBA = 43 dBA

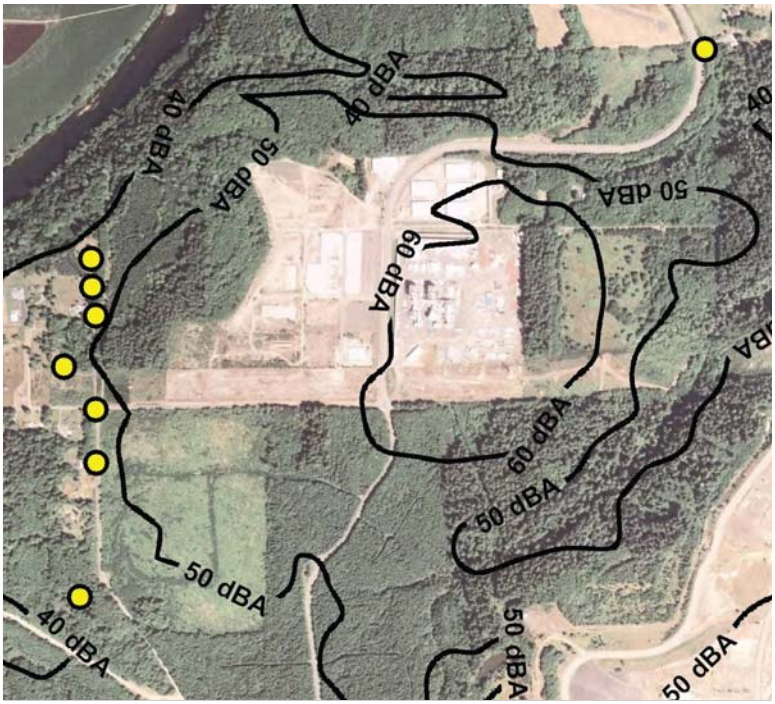
Sound Perception

Change in Sound Level (dB)	Change in Apparent Loudness
1	Imperceptible
3	Just barely perceptible
6	Clearly noticeable *
10	About twice (or half) as loud
20	About 4 times (or one-fourth) as loud

* For example, distance to the point source outdoors is halved or doubled.

Modeling Used Conservative Assumptions





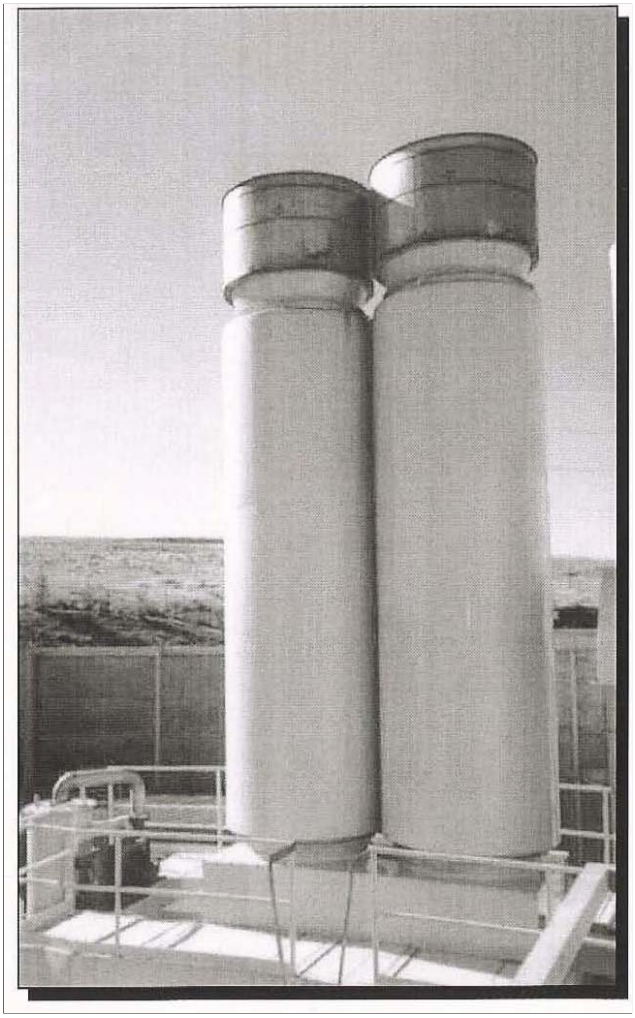
What mitigation strategies will GHEC implement?

(1) Fully Comply with State Noise Regulations

(2) Design of Unit 3 & 4 includes noise reduction features

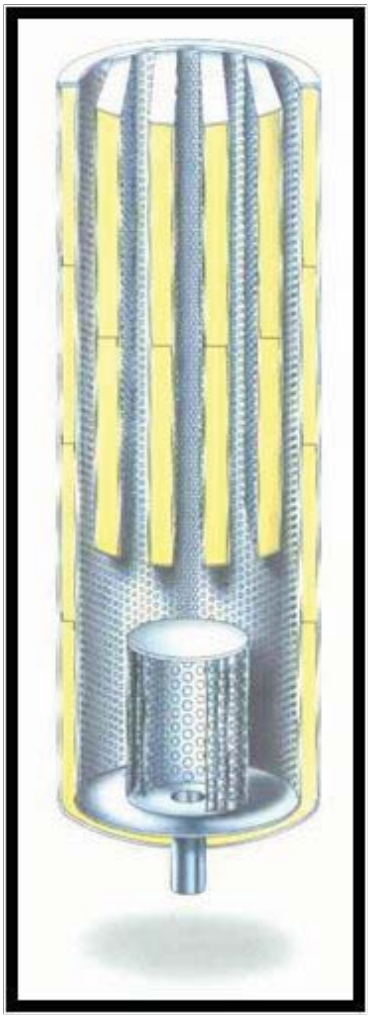
Acoustical Enclosures

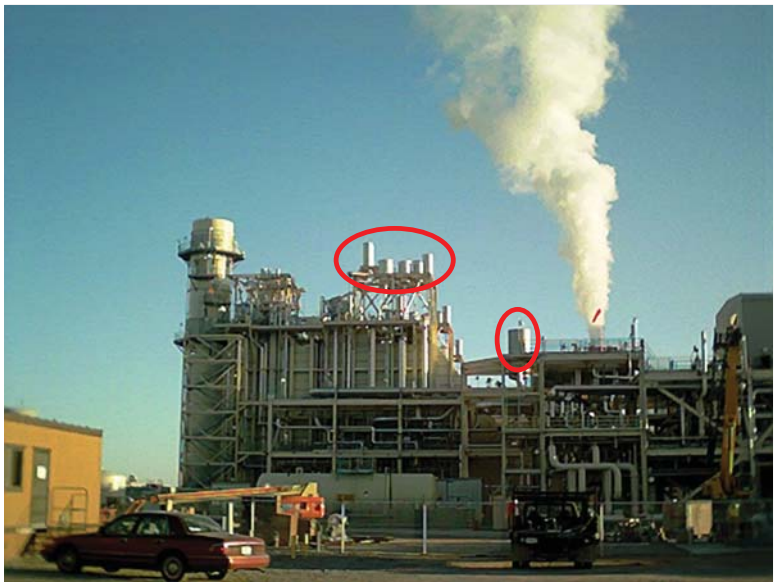
Ventilation Silencers



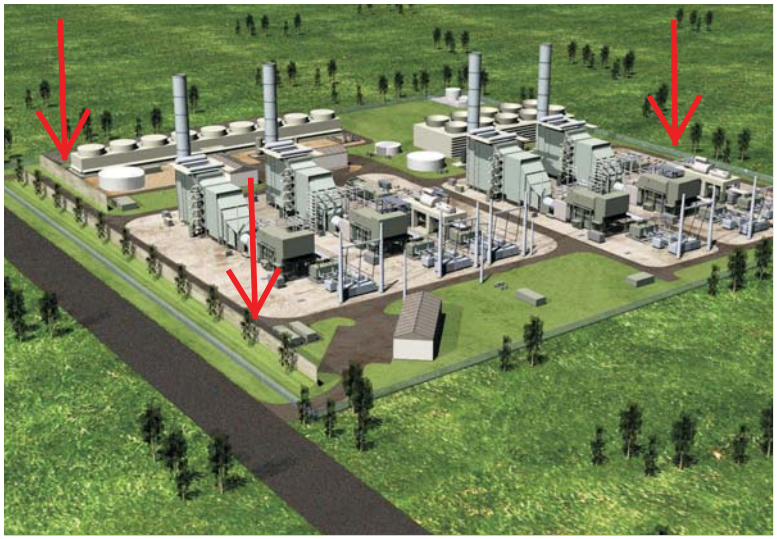
Exhaust Silencers

Steam Vent Silencers





Noise Walls

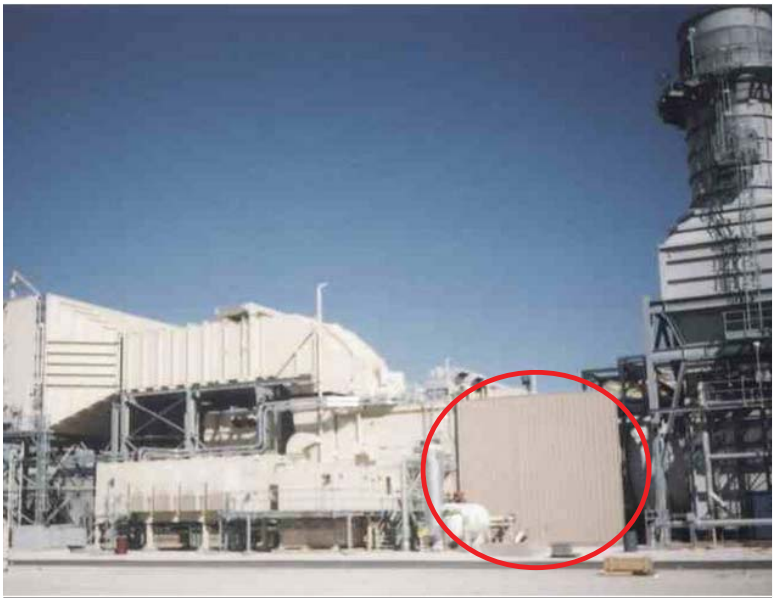


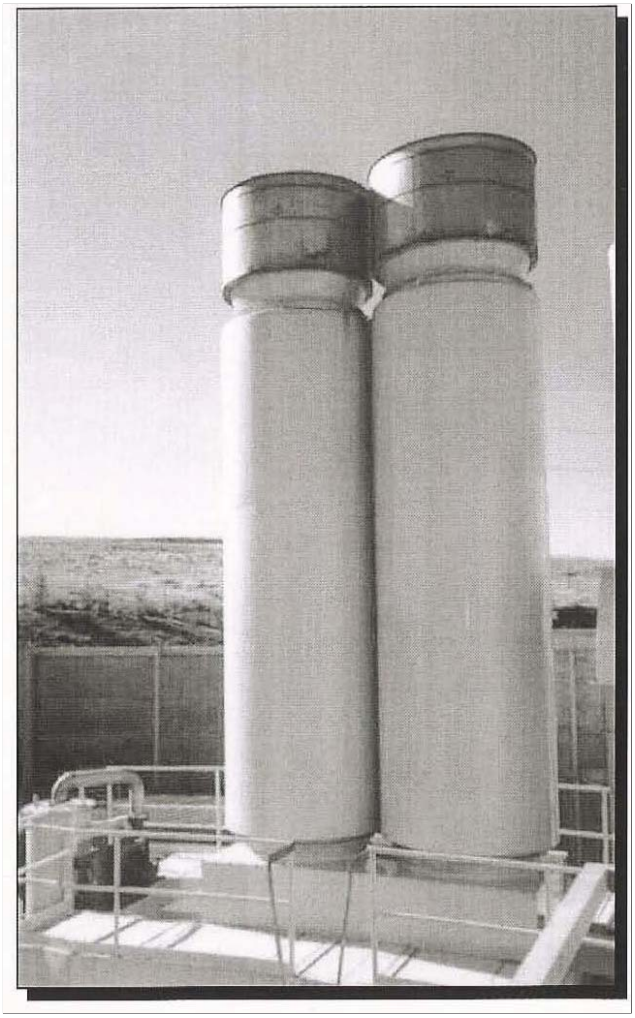
(3)
Conduct noise study of Unit 1 & 2 before constructing Unit 3 & 4

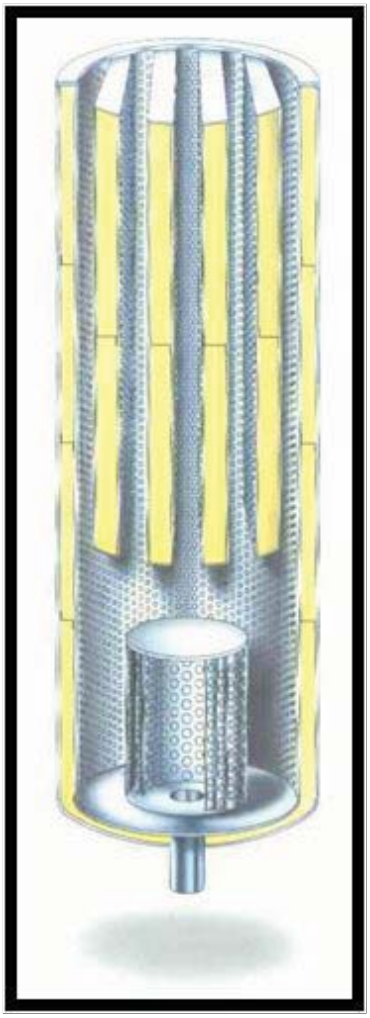
(4)
Conduct noise testing of all units

(5)
Complaint response improved

Planned Mitigation







Noise Summary

(1) Units 1 & 2 well under limits.
(2) Upset conditions are rare.
(3) Units 3 & 4 well under limits.
(4) Implement mitigation strategies.
(5) GHEC installing new controls.

Michael Theriault INC
ACOUSTICS
NOISE CONTROL CONSULTING SERVICES