Community Aircraft Noise: A Public Health Issue

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The Project-Agenda

- Overview of the issue
  - Background
  - Adult health effects
  - Child health effects
  - Comparison to Whidbey Island situation
- Summary of findings
- Recommendations for exposure control and strategies for advocacy

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The Project-Agenda

- Overview of the issue
  - Review of Coupeville noise studies
  - Definition
  - Overview of anatomy of the ear and hearing
  - Discuss adult and children health effects associated with community noise exposures
- Summary of findings
- Recommendations and Strategies for Advocacy
  - Control measures
  - Health Impact Statements (human health and the environment)
  - Advocacy/Policy

Whidbey and the OLF

A public Health Issue - Increased Chronic Exposure to Aircraft Noise

Public Health

- Public health refers to all organized measures (whether public or private) to prevent disease, promote health, and prolong life among the population as a whole. Activities aim to provide conditions in which people can be healthy
- (3) main public health functions:
  - Assess and monitor the health of communities and populations at risk
  - Development of public policy to solve health problems and priorities
  - Assure all populations have access to appropriate and cost effective care including health promotion and prevention

http://www.who.int/trade/glossary/story076/en/

Healthy People 2020

- Hearing and Other Sensory or Communication Disorders (Ear, Nose, and Throat [ENT]—Voice, Speech, and Language [VSL])
  - ENT–VSL–7 Noise-induced hearing loss in adolescents
  - ENT–VSL–8 Noise-induced hearing loss in adults

http://www.healthypeople.gov/2020/about/default.aspx

Concept: Environmental Health

"Environmental health comprises those aspects of human health, ***including quality of life***, that are determined by physical, chemical, biological, social and psychological factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially affect adversely the health of present and future generations." WHO

What is Noise?

EPA defines noise as

"unwanted or disturbing sound"

Sound becomes unwanted when it either interferes with normal activities such as sleeping, conversation, or disrupts or diminishes one's quality of life.

www.epa.gov/air/noise.html#what

How Do We Measure Noise?

- dB
  - Noise measurement (noise pitch (frequency) and loudness (intensity)) is defined in terms of a logarithmic decibel scale (dB). Specifically, the dB scale is the logarithm of the ratio of the sound pressure of the signal to a reference pressure.

- A Weighted dBA
  - Weights sound pressure levels by frequency to correspond to the sensitivity of the human ear
  - Environmental noise assessment and measurement is usually always A-weighted

Decibel Levels of Common Noise Sources

Sound Pressure Level (dBA)	Noise Source
140	Jet Engine (at 25 meters)
130	Jet Aircraft (at 100 meters)
120	Rock and Roll Concert
110	Pneumatic Chipper
100	Jointer/Planer
90	Chainsaw
80	Heavy Truck Traffic
70	Business Office
60	Conversational Speech
50	Library
40	Bedroom
30	Secluded Woods
20	Whisper

How do we Measure Noise?

- Maximum sound over a fraction of a second
  - L_{Amax}
- Average noise level over a defined time period
  - L_{Aeq}

Washington and National Noise Standards

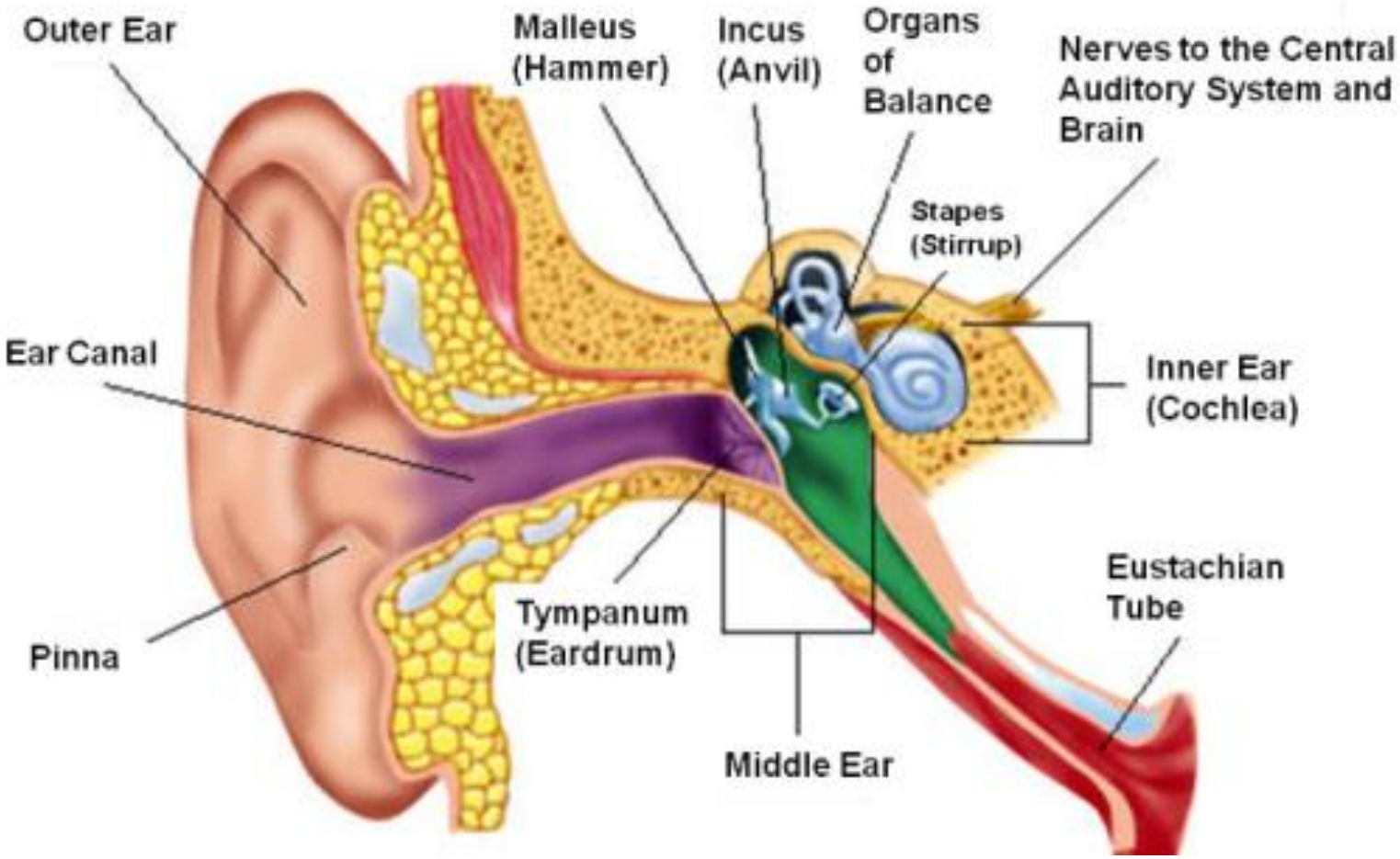
- Washington State (Chapter 70.107 RCW NOISE CONTROL/WAC 173-60)
  - Max noise in a residential setting *55dBA*
  - 10pm-7am Max noise is reduce by 10dBA = *45dBA*

https://fortress.wa.gov/ecy/publications/SummaryPages/17360.html

- EPA sets community noise standards as:
  - *70-dBA 24 hour (Leq)*
- US Noise Control Act of 1972

http://www.epa.gov/air/noise.html

Anatomy and Functions of the Ear



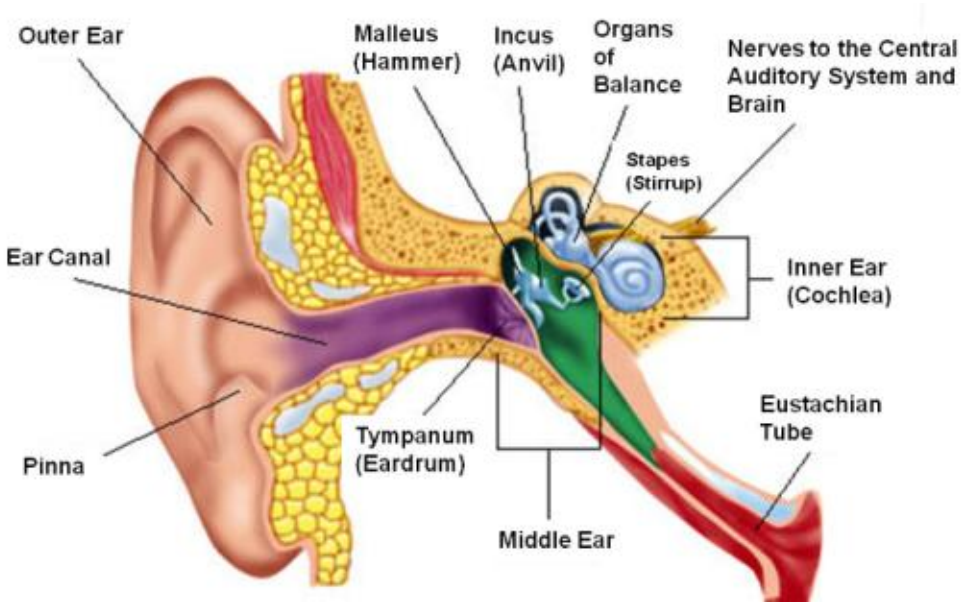
Aircraft Noise and Adult Health

- Hearing loss
- Stress hormones and health
- Immune toxicity
- Psychosocial impacts and cognition
- Cardiac implications, heart attacks and death

Noise Induced Hearing Loss (NIHL)

Types of Hearing Loss

- Conductive
- Sensorineural
- Combination



Hearing is 10x more sensitive than eye sight

One of the biggest concerns of NIHL is that it rarely causes pain

Noise is a Biological Stressor

- Excessive exposure to noise [aircraft or military aircraft noise] is a health risk and may contribute to;
  - sleep disturbances, gastrointestinal disease, migraine headaches, immune system problems cardiovascular disease, hypertension and death from myocardial infarction
- Stress creates a cascade of releasing “fight or flight hormones” which affect multiple systems in the body.

The Etiology of Commercial Aircraft Noise on Human Health

Chronic Commercial Aircraft Noise Exposure → Increased Stress Load → Chronic Psycho-physiological Stress Activation → Adverse Health Effects + Reduced Quality of Life

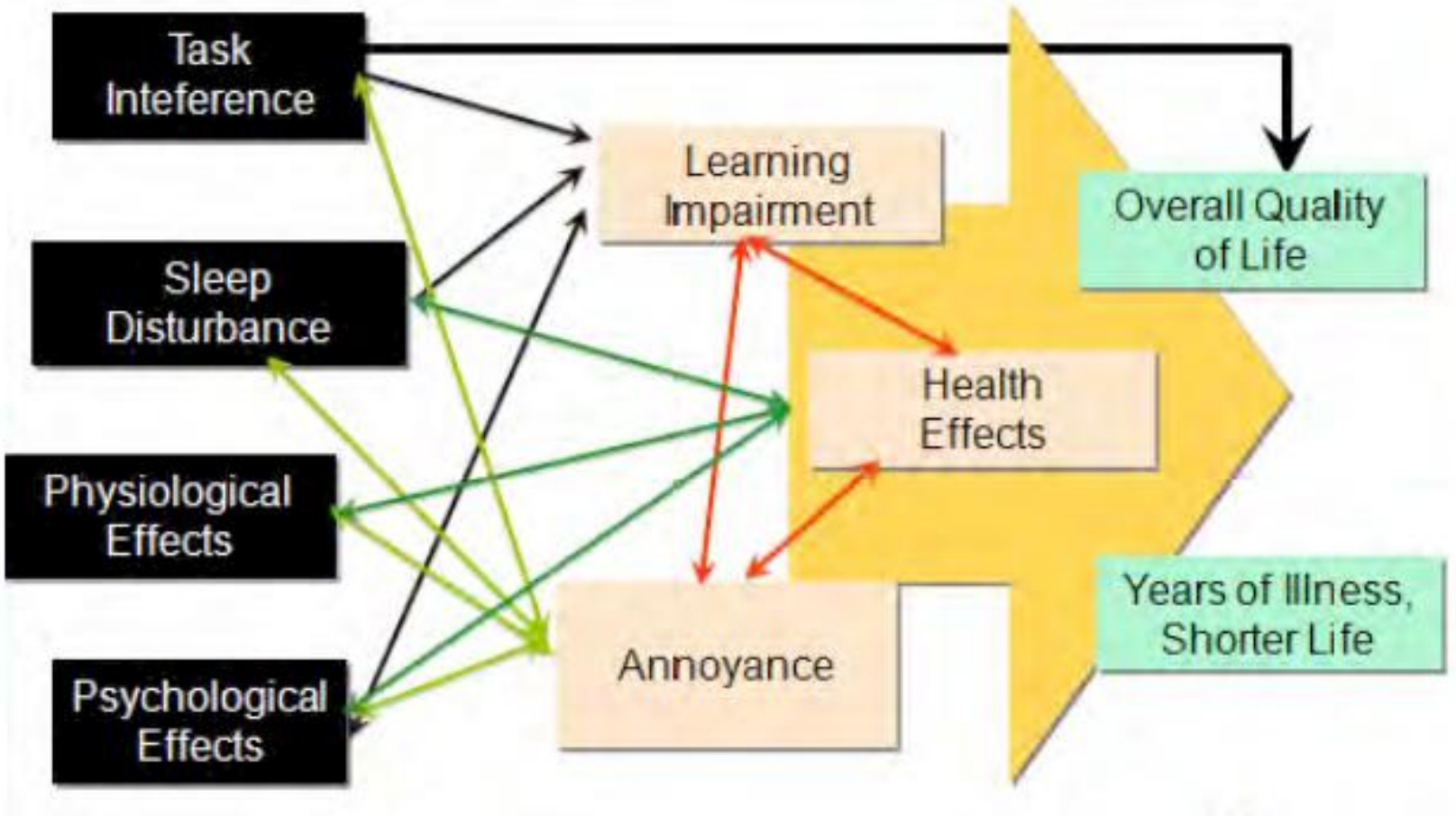
[i] Meister, E., Donatelle, R. (2000) The impact of commercial aircraft noise on human health: a neighborhood study in metropolitan minnesota. *Journal of Environmental Health.pg.9-15 Nov.2000.*

Stress Hormones, Sleep and Your Immune System

Some research shows there is a relationship between sleep loss and weakening the immune system which may lead to other health problems including heart attacks

There are also some indications that noise exposure can increase susceptibility to viral infection and toxic substances. [Further research needs to be conducted in this area but it deserves mention]

Broader Health Effects of Noise Context



Swift, H. (2010) A review of the literature related to potential health effects of aircraft noise: partner project 19 final report

Psychosocial Impacts and Cognition

- The most documented subjective response to noise is annoyance.
  - Aircraft noise interfere with activities of daily living [ADL] and is dose response related
  - The louder the aircraft noise the less an individual is able to adapt. Stansfeld, S.A., Matheson, M.P. (2003). Noise pollution: non-auditory effects on health. *British Medical Bulletin,* Vol. 68:243-257
- Environmental noise exposure effects;
  - Memory, memory recall and reduces performance. Stansfeld, S.A., Matheson, M.P. (2003). Noise pollution: non-auditory effects on health. *British Medical Bulletin,* Vol. 68:243-257.
- Studies show strong association with noise and increased accidents at work

Aircraft Noise and Health

- Physical characteristics of military low-altitude flight noise are different in terms of other aircraft noise;
  - Extremely high maximal sound levels [Lmax] and the very rapid increase in sound level during direct over-flights.
    - ↑ community annoyance and health symptoms
- Low altitude over-flight noise strongly associated with;
    - Cardiovascular disease
    - Sleep disturbances – even during quiet nights

Aircraft Noise and Health

- One study using (4) neighborhoods exposed to commercial aircraft airports and (2) as a control found;
  - All health measures were significantly worse in the exposed communities
  - This study confirmed the strong link between aircraft noise, stress load and decreased health.
  - Aircraft noise affects sense of well being as measured by a “sense of vitality”

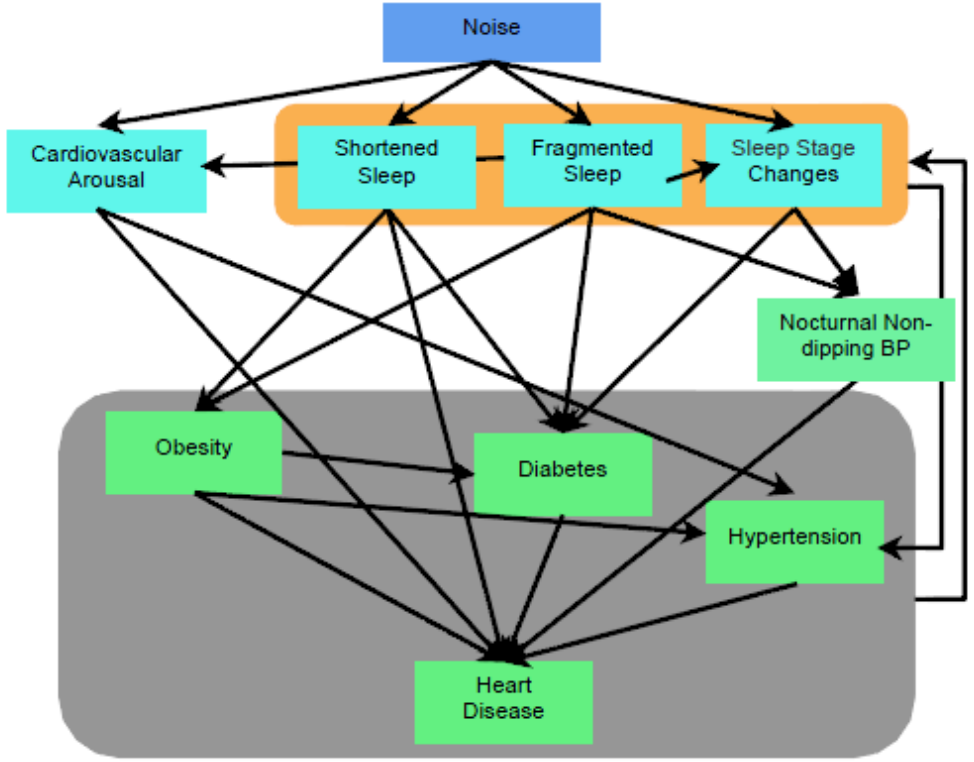
Cardiovascular Disease

- Two potential pathways to cardio vascular disease
  - sleep disruption and noise induced stress
- Cardiovascular arousal during “waking and sleep” creates short term increases blood pressure
- High blood pressure is a well-known risk factor for cardiovascular disease and particularly heart attack (myocardial infarction).
- Significant findings relate noise to blood pressure changes and especially to the development of hypertension
  - transportation noise studies [including aircraft noise] have exposed a link between noise exposure and myocardial infarction, for which noise-induced hypertension may be a pathway.

Swift, H. (2010) A review of the literature related to potential health effects of aircraft noise: partner project 19 final report

Potential Pathways for the Health Effects of Noise Through Sleep Disturbance

The Babisch meta-analysis reports an odds ratio for occurrence of myocardial infarction of 1.13 per 10 dB increase of L_{day} – meaning there is a strong statistical relationship between aircraft noise and heart attacks



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Cardiac Disease, Heart Attacks and Death

- Los Angeles Airport Study determined chronic exposure to aircraft noise raised systolic and diastolic blood pressure.
- Munich study linked chronic noise exposure to increases in systolic blood pressure when doing a cognitive task under acute noise.
- Residential exposure to aircraft noise -hospital admissions for cardiovascular diseases: multi-airport retrospective study in Boston
- Swiss National Cohort study (hospitalizations and ICD-9 codes) 65 airports/airfields shows acute and chronic noise exposure in particular aircraft noise is associated with;
  - high BP, heart attacks, ↑cardiovascular medication, cardiovascular morbidity and mortality.
  - risk of death from heart attacks was higher in individuals exposed to aircraft noise of 60 dB(A) or more when exposed to PM10

Stansfeld, S.A., Matheson, M.P. (2003). Noise pollution: non-auditory effects on health. *British Medical Bulletin,* Vol.68: 243-257. Huss, A., Spoerri, A., Egger, M., Roosli, M. (2010). Aircraft noise, air pollution, and mortality from myocardial infarction. *Epidemiology*. Vol 21:no.6. 829-836.

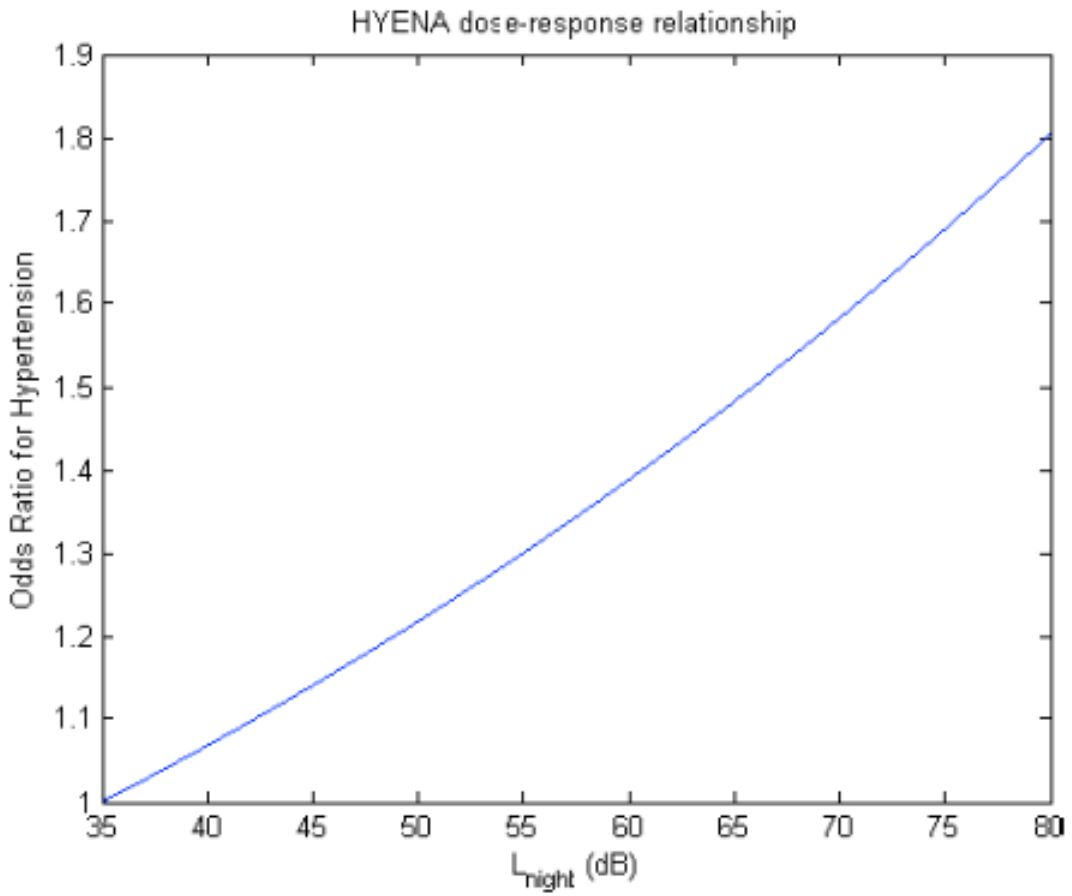
The HYENA Study: Night Time Aircraft Noise as a Risk Factor for Hypertension

a 10-dB increase leads to an elevated
odds ratio of 1.14

95% CI and 35 dB(A) is assumed to be the baseline value

Findings confirm a statistical relationship between aircraft noise and hypertension

The higher the Lnight dBA the higher the relationship of aircraft noise to high blood pressure



Jarup, L., Babisch, W., Houthuijs, D., Pershagen, G., Katsouyanni, K., Cadum, E., ... Vigna-Taglianti, F. (2008). Hypertension and exposure to noise near airports: the HYENA study. *Environmental Health Perspectives*. Volume 116

Summary of Findings

- Serious health effects of environmental noise exposure in particular aircraft noise/military aircraft at the community level.
  - Sleep disturbance and cognitive impairment to atherosclerosis, cardiac disease, myocardial infarction and even death.
  - The continued over activation of stress hormones are key factors in cardiac disease
  - Some research shows immunotoxicity but further research is needed.
- Aircraft noise [especially as a night time exposure] exacerbates the release of the hormones and impairs health.
- Aircraft noise [in particular low-altitude over-flights] is associated with cardiovascular problems and sleep disturbances even during the “quiet” nights that follow over-flights

Recommendations

- Implement control measures
  - Eliminate the exposure hazard
  - Engineering controls to reduce noise in residence
  - Reduce over-flight noise levels to and a reduce over-flights.
  - Conduct Health Impact Statement and explore avenues of research
  - Educate community on health effects of aircraft noise and personal protective equipment to protect hearing
  - Advocacy and Policy changes

Chronic Aircraft Noise Exposure and Children's Health

Vulnerability of Children

- Developmental toxicity
- Dependency on adults for safe environments
- May be more exposed due to behavior and settings
- Origin for adult onset of disease

Health Effects Studied

- Most consistent evidence
  - Learning
  - Annoyance
  - Motivation
- Less consistent evidence
  - Memory & Attention
  - Perceived stress
  - Stress hormone changes
  - Cardiovascular effects
  - Hearing loss
  - Behavioral disorders
- No studies in children
  - Sleep disturbance

Most consistent evidence

Reading Comprehension & Academic Performance

- ↑aircraft noise dose ↓ reading comprehension (most difficult questions)
- Noisy school reading comprehension < Quiet school
- ↓ failure rates on standardized tests after noise reduction

Annoyance

- Annoyance: triggers feelings of irritation, discomfort, distress, frustration, and offence
- ↑ aircraft noise dose ↑ annoyance
  - Netherlands
  - Spain
  - UK
- Annoyance in noisy schools/homes >Quiet schools/homes
  - China
  - Germany
  - UK
  - South Africa

Motivation

- Motivation impacted by aircraft noise
- Motivation of noisy school < Quiet school

Less consistent evidence

Memory and Attention

- Sustained Attention
  - 3 studies
- Memory
  - 4 studies
- Inconsistent effects, no effects, small effect size

Perceived Stress/Well-Being/Health

- 3 studies
  - Tendency toward higher quality of life in quiet group
  - No difference in perceived stress or health symptoms between noise and quiet groups

Stress Hormones

Exposure (L_{eq})	N	Adrenaline	Noradrenaline	Cortisol	Author
53, 62	217	+	+	+	Evans, 1998
56, 70	40	0	0	0	Ising, 1999
<57, >66	238			0	Stansfeld, 2001
53, 62	204	0	0	0	Haines, 2001

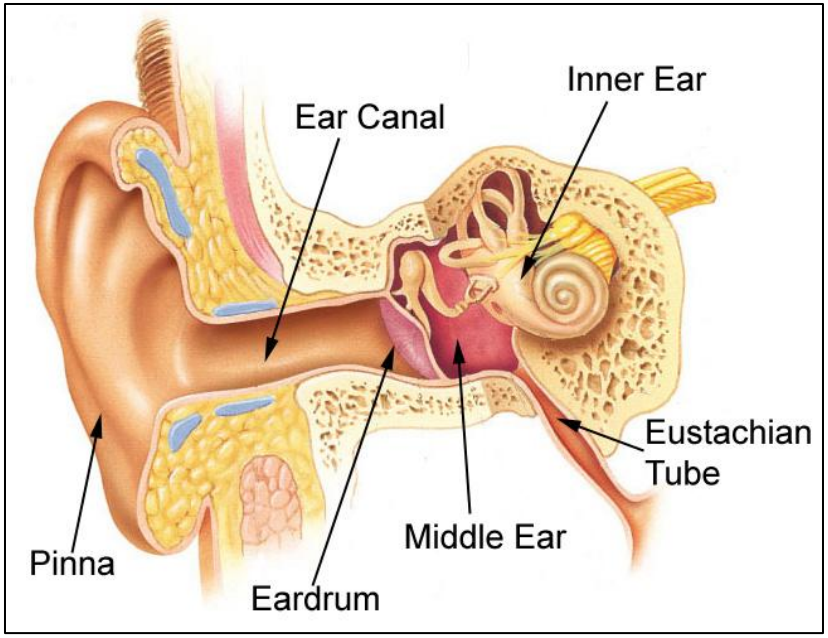
Hypertension

- Tendency toward positive association between aircraft noise exposure and children's blood pressure
- Uncertainty based on methodological differences between studies
- Future research needed

Behavioral Disorders

- No link between aircraft noise and overall health evaluation
- 2 UK studies link aircraft noise with hyperactivity

Hearing Loss



- Three studies published in 1990s
  - Two negative
  - One with mild hearing loss for students near airport
- Standards to protect hearing loss
  - Occupational settings: L_{Amax}= 115 dBA
  - Indoor and outdoor educational/residential areas: $L_{eq,\ 24\ hr}$ = 70 dBA

No field studies in children

Sleep Disturbance

- Sleep is important for learning, memory and behavior
- No recent studies identified directly addressing this question in children
- Federal Aviation Administration (FAA) has identified research on noise-induced sleep disturbance as high priority

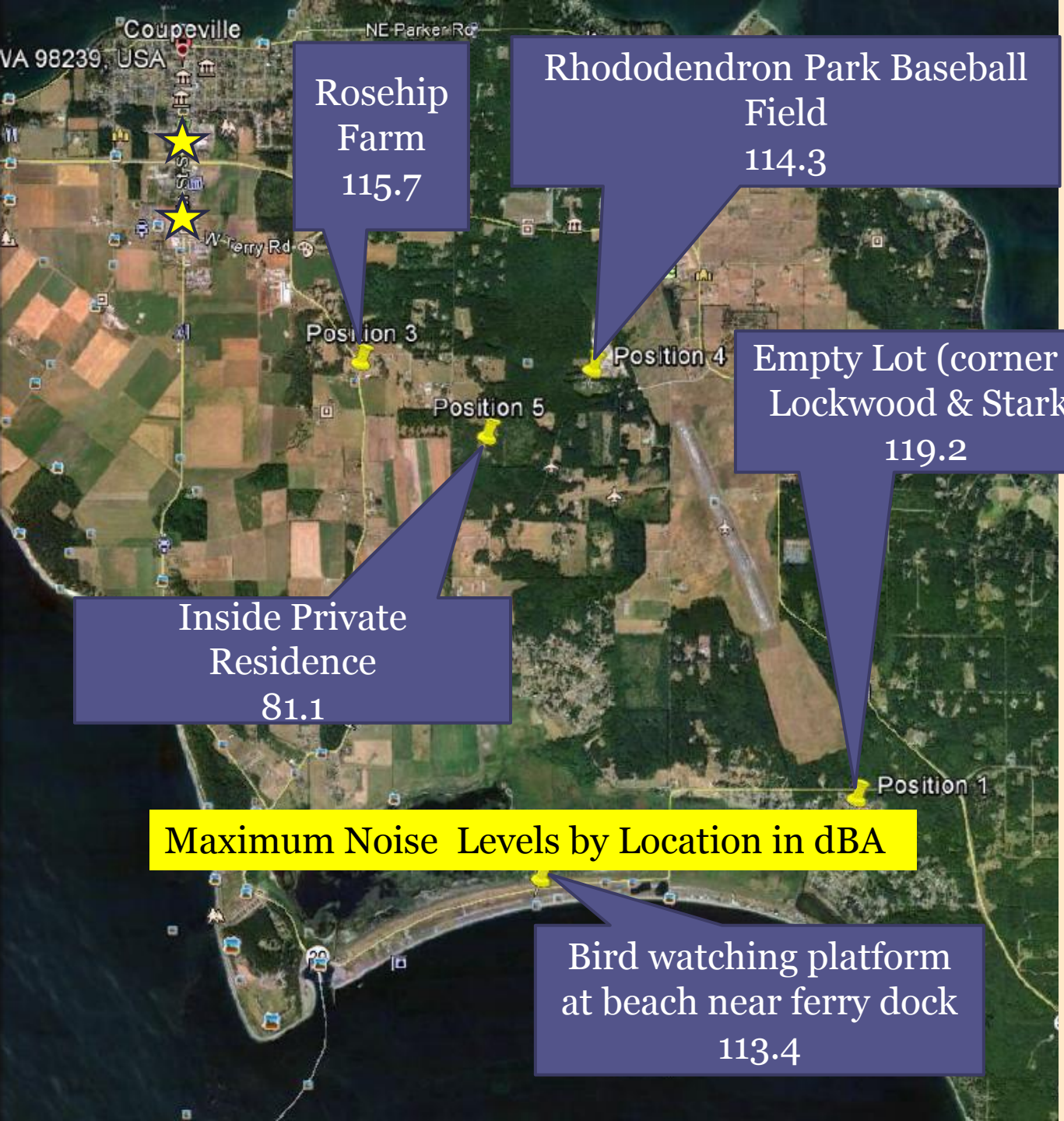
Summary Findings for Children

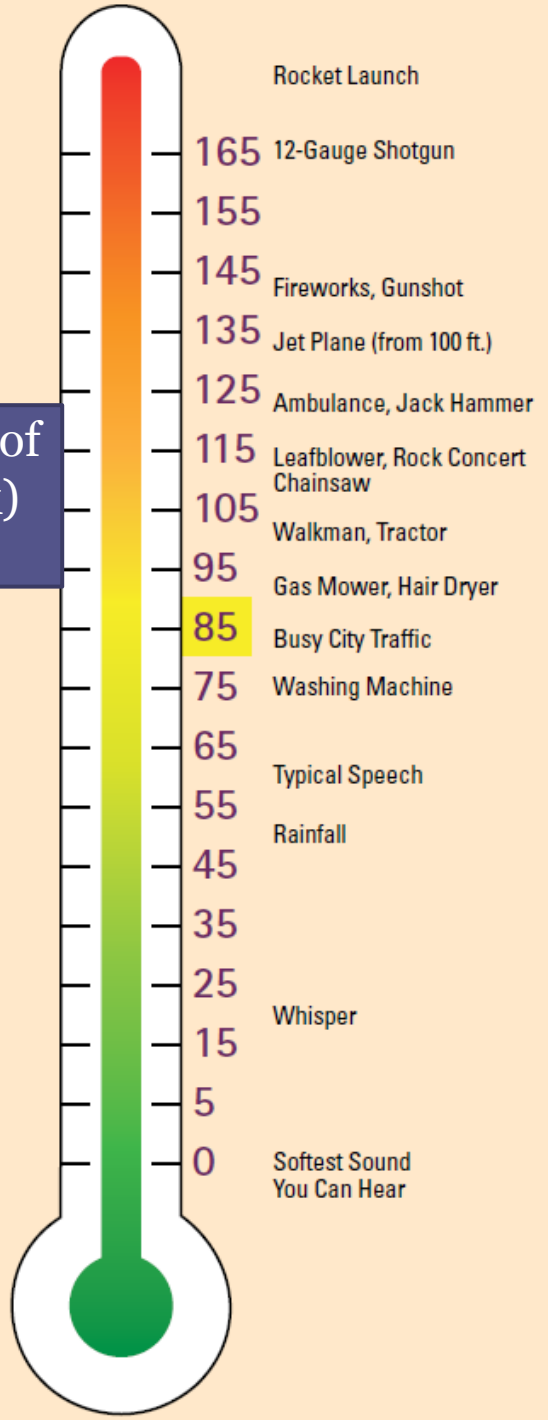
- Aircraft noise is associated w/multiple child health outcomes
  - Learning
  - Annoyance
  - Motivation

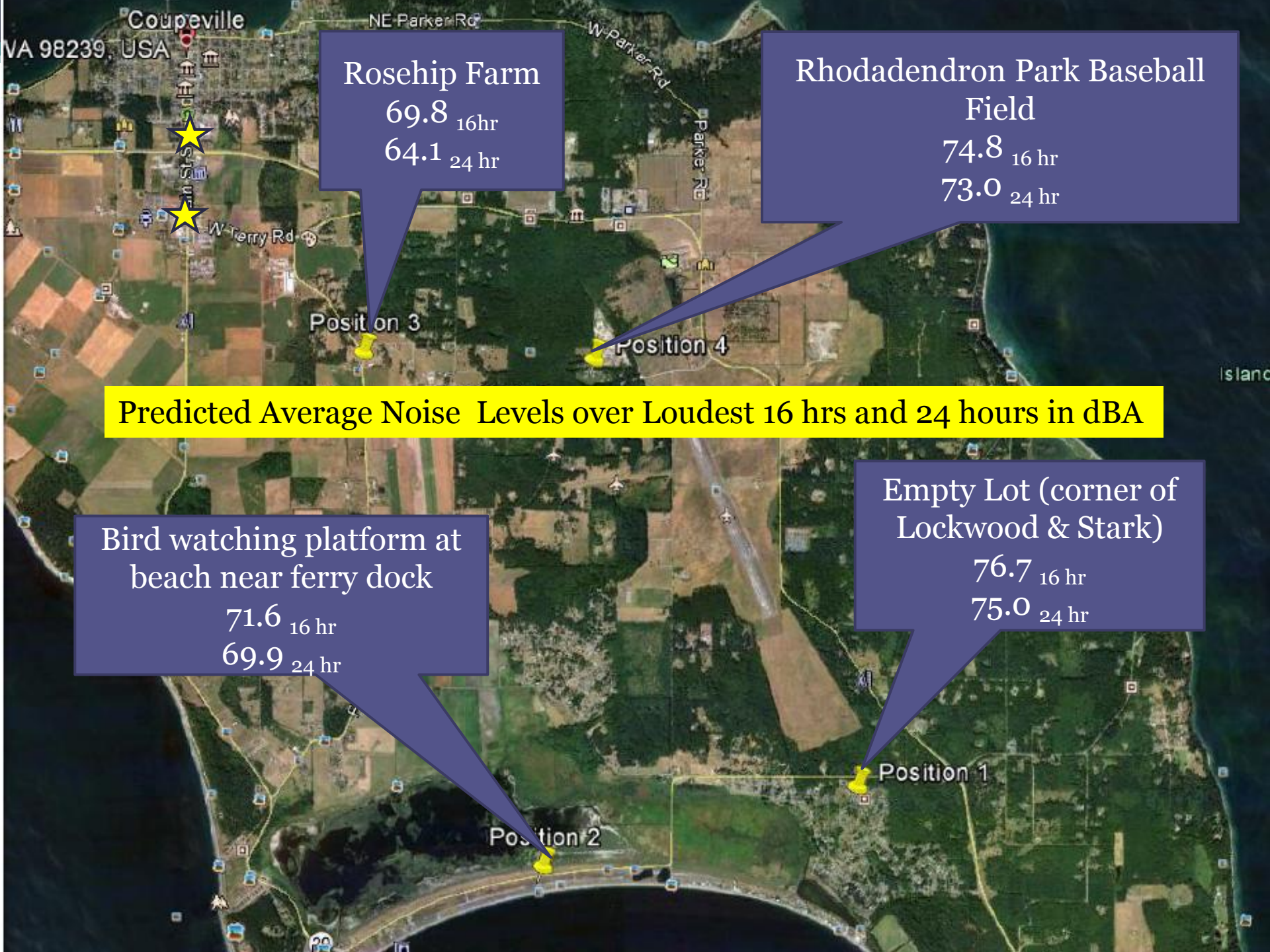
Jet Noise Levels near Coupeville, WA on Whidbey Island

JGL Acoustics Report

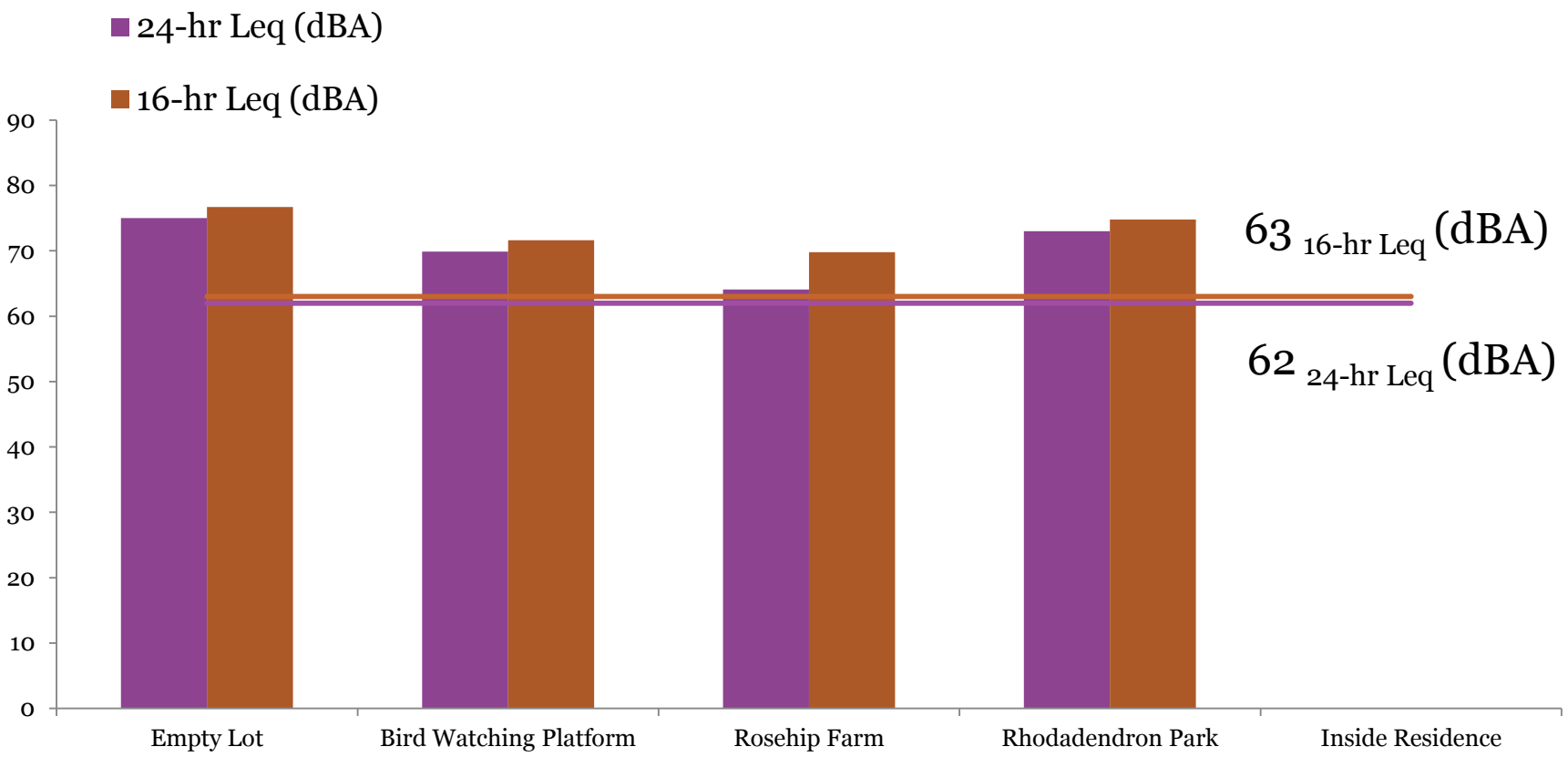
- Jet noise on May 7, 2013
  - 4 outdoor measurements during 4 jet practice sessions
  - 1 indoor measurement in private residence


Coupeville
VA 98239, USA
NE Parker Rd
N Terry Rd
Rosehip Farm 115.7
Rhododendron Park Baseball Field 114.3
Position 3
Position 4
Position 5
Empty Lot (corner of Lockwood & Stark) 119.2
Inside Private Residence 81.1
Position 1
Maximum Noise Levels by Location in dBA
Bird watching platform at beach near ferry dock 113.4


Rocket Launch
165 12-Gauge Shotgun
155
145 Fireworks, Gunshot
135 Jet Plane (from 100 ft.)
125 Ambulance, Jack Hammer
115 Leafblower, Rock Concert Chainsaw
105 Walkman, Tractor
95 Gas Mower, Hair Dryer
85 Busy City Traffic
75 Washing Machine
65 Typical Speech
55 Rainfall
45
35
25 Whisper
15
5
0 Softest Sound You Can Hear

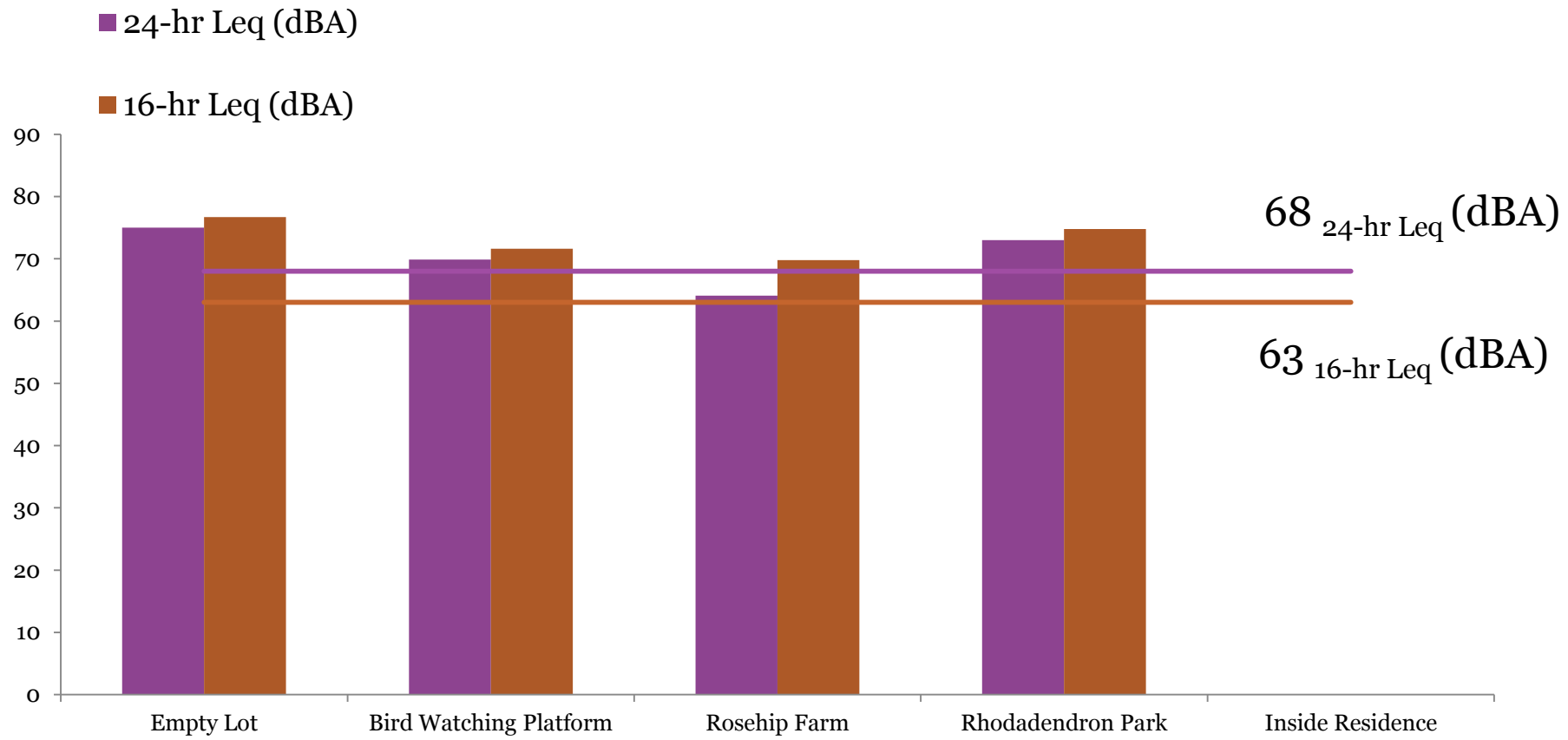

Coupeville
VA 98239, USA
NE Parker Rd
W Parker Rd
Parker Rd
Main St
W Terry Rd
Rosehip Farm
69.8 16hr
64.1 24 hr
Rhodadendron Park Baseball Field
74.8 16 hr
73.0 24 hr
Position 3
Position 4
Predicted Average Noise Levels over Loudest 16 hrs and 24 hours in dBA
Bird watching platform at beach near ferry dock
71.6 16 hr
69.9 24 hr
Empty Lot (corner of Lockwood & Stark)
76.7 16 hr
75.0 24 hr
Position 1
Position 2

Coupeville Noise Measurement Comparison w/Research Data



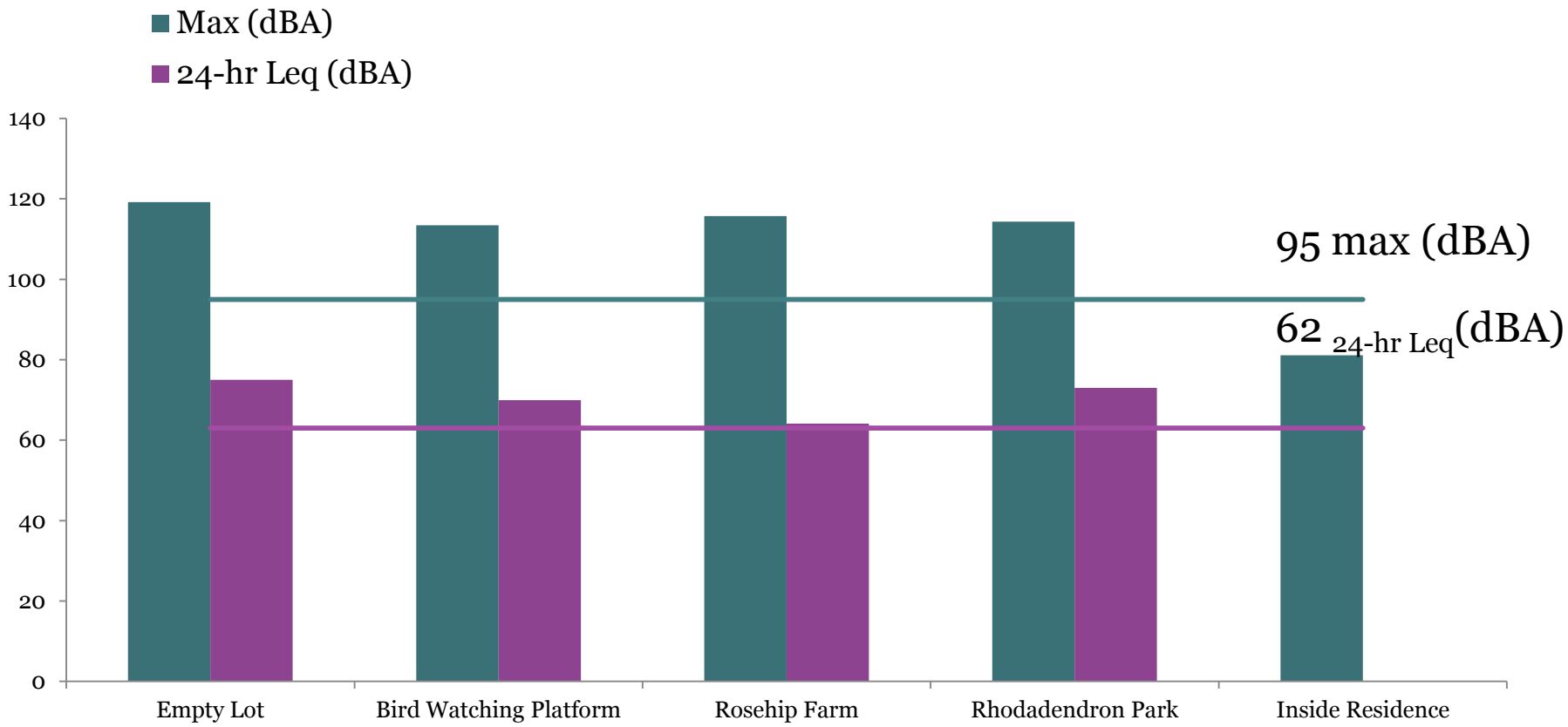
Impaired Reading Comprehension in Children

Coupeville Noise Measurement Comparison w/Research Data



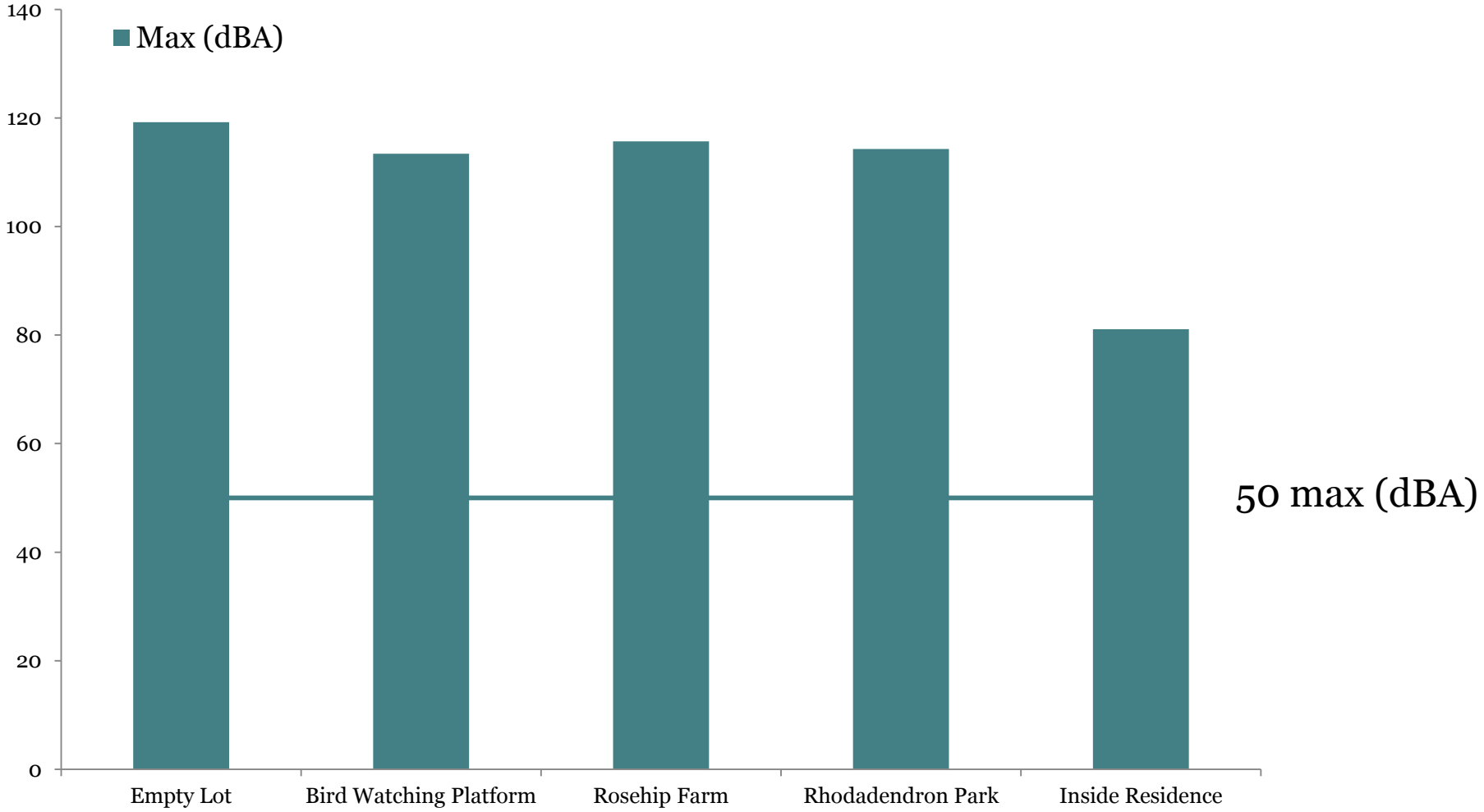
Annoyance in Children

Coupeville Noise Measurement Comparison w/Research Data



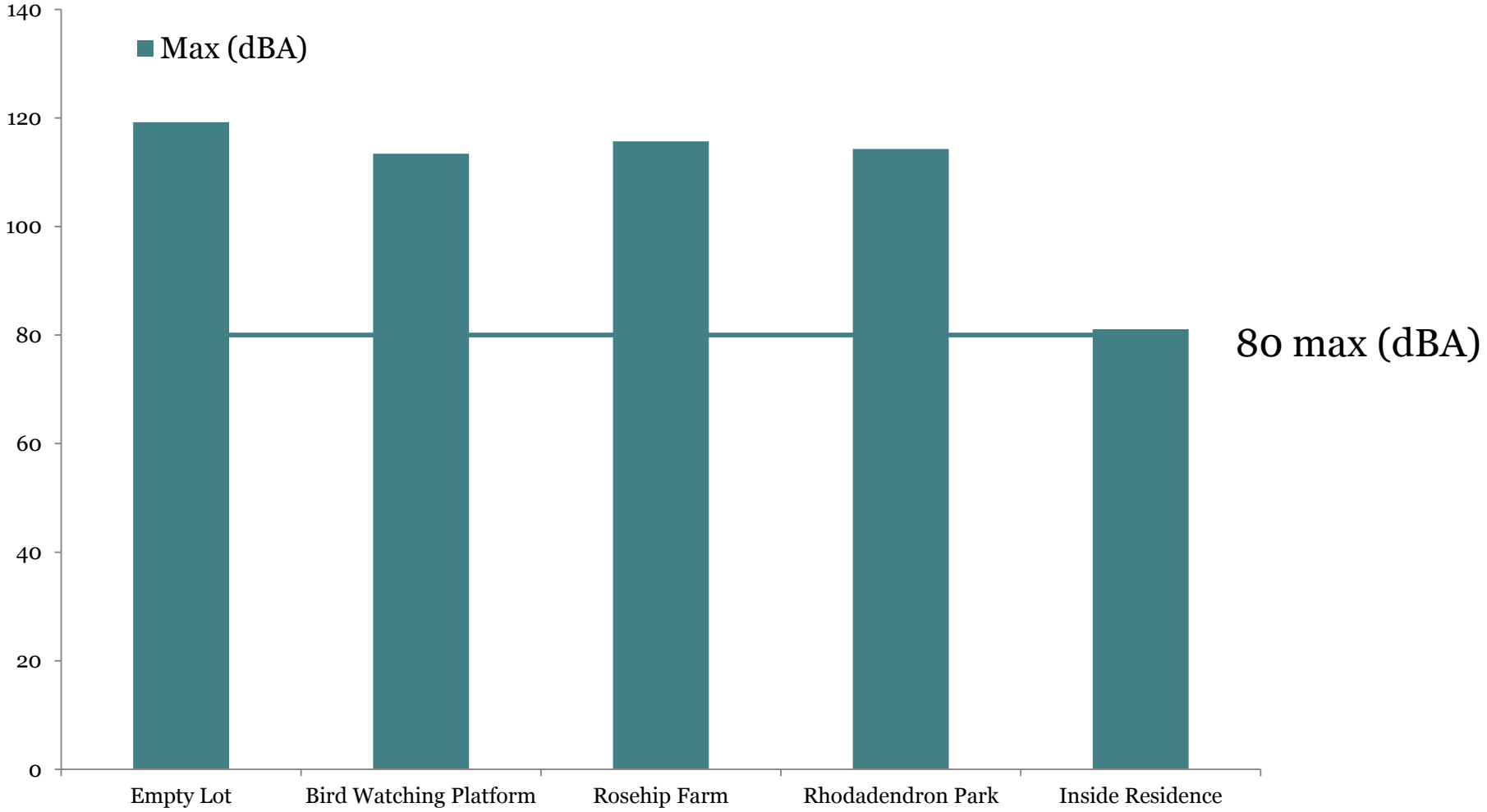
Decreased Motivation in Children

Coupeville Noise Measurement Comparison w/Reference Values



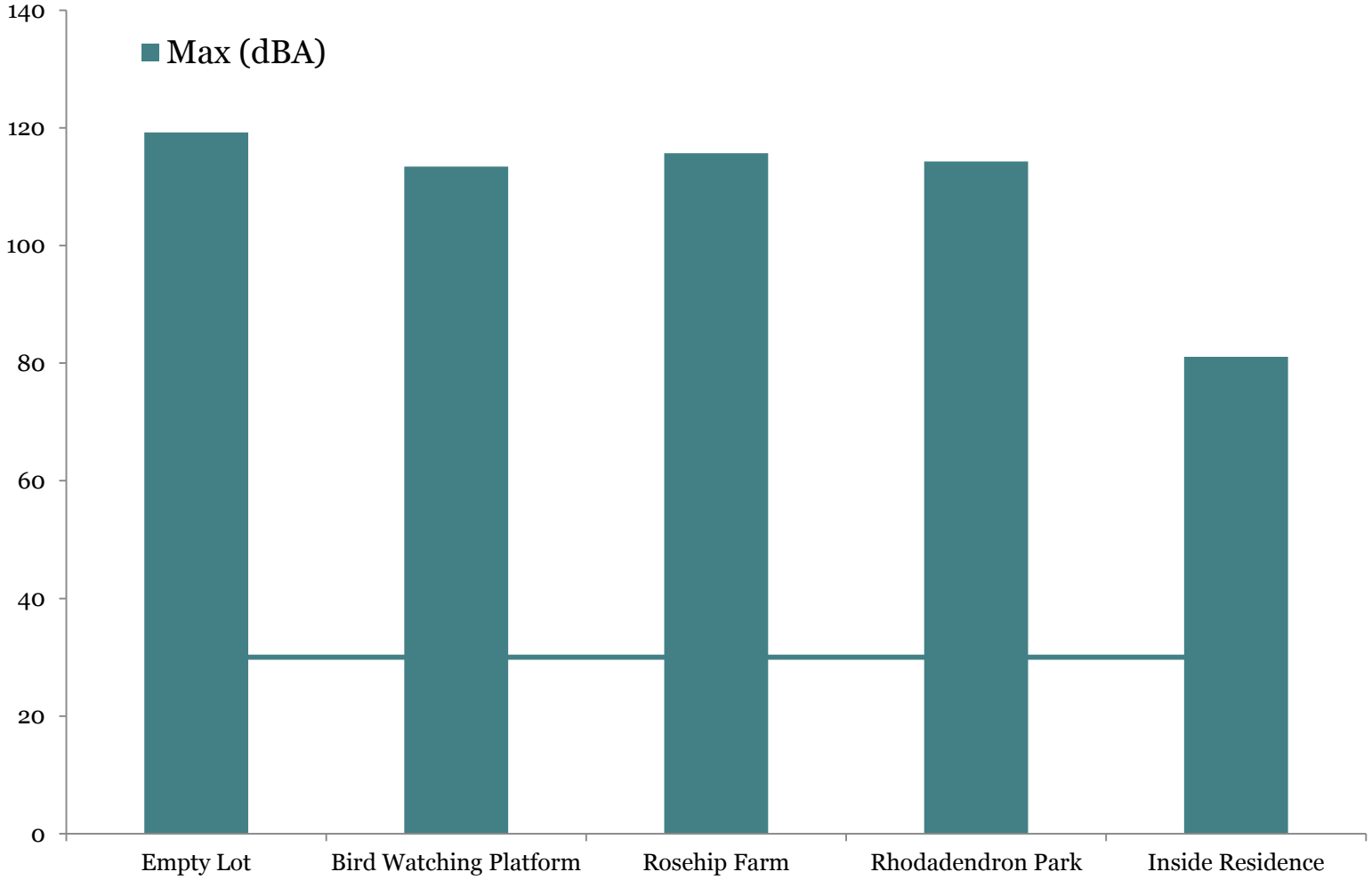
WHO Annoyance

Coupeville Noise Measurement Comparison w/Reference Values



WHO Decreased Motivation/Increased Helplessness

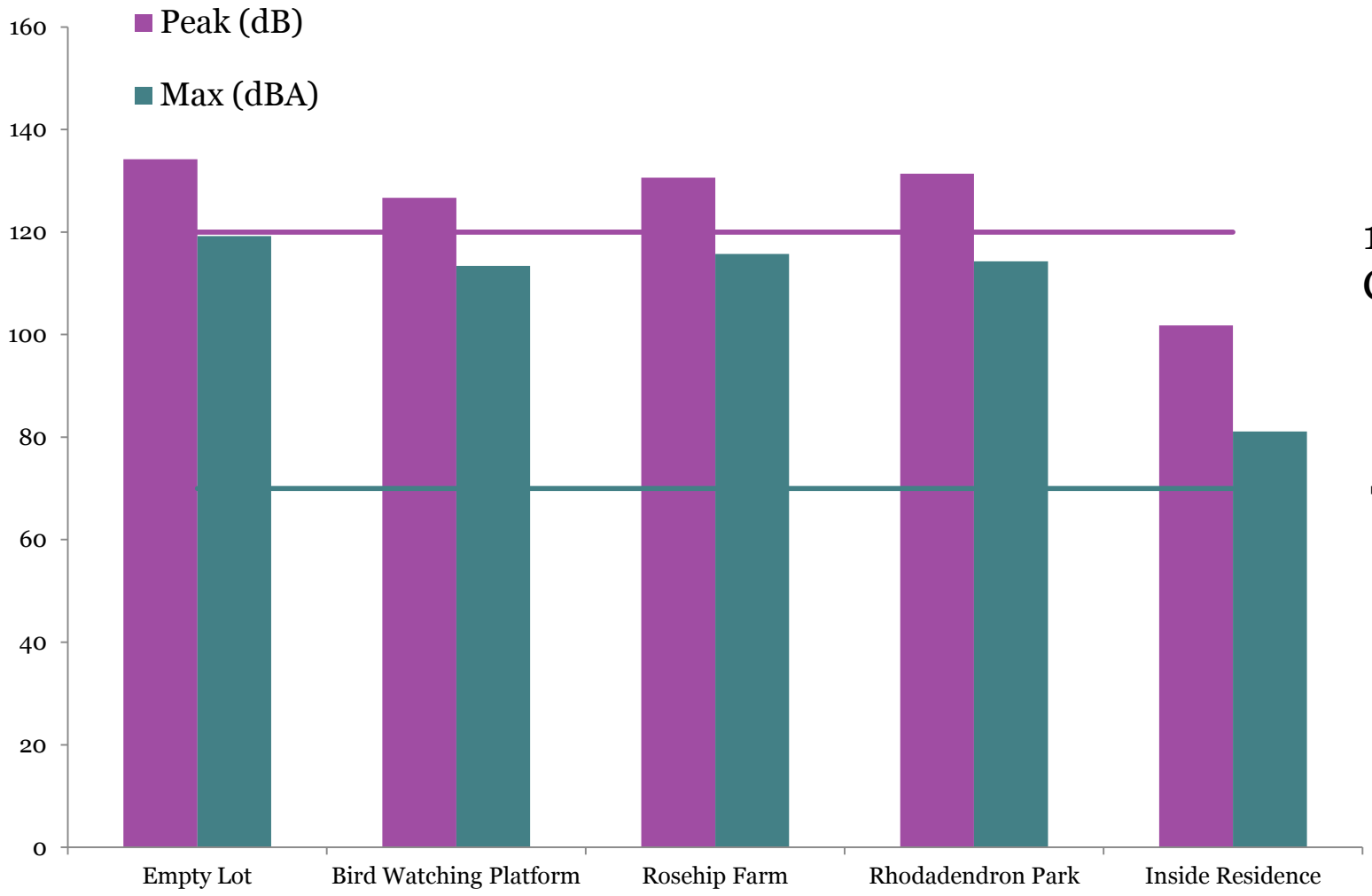
Coupeville Noise Measurement Comparison w/Reference Values



35 max (dBA)

WHO Sleep Disturbance

Coupeville Noise Measurement Comparison w/Reference Values

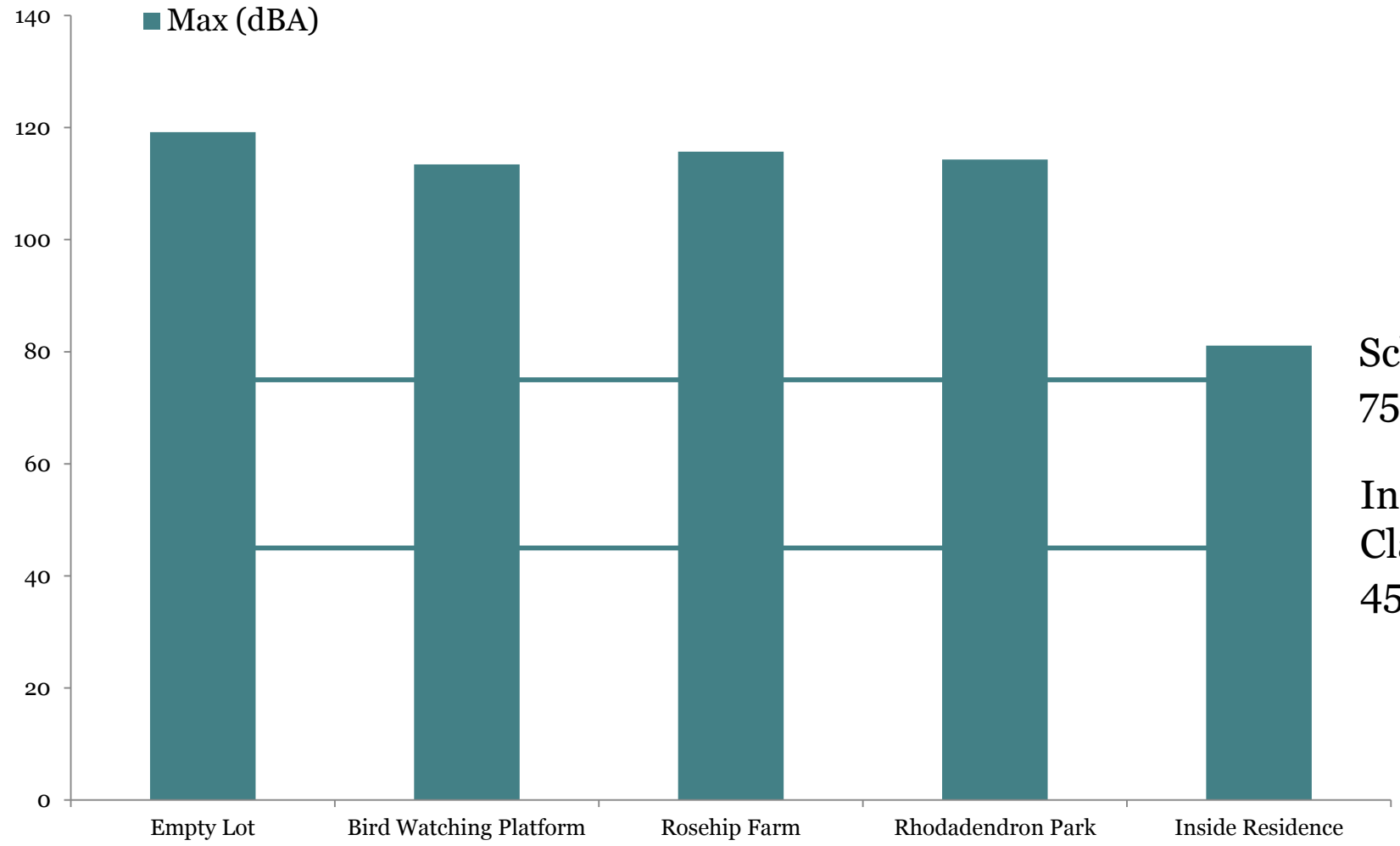


120 peak (dB) Children

70 max (dBA)

WHO/EPA Hearing Loss

Coupeville Noise Measurement Comparison w/Reference Values

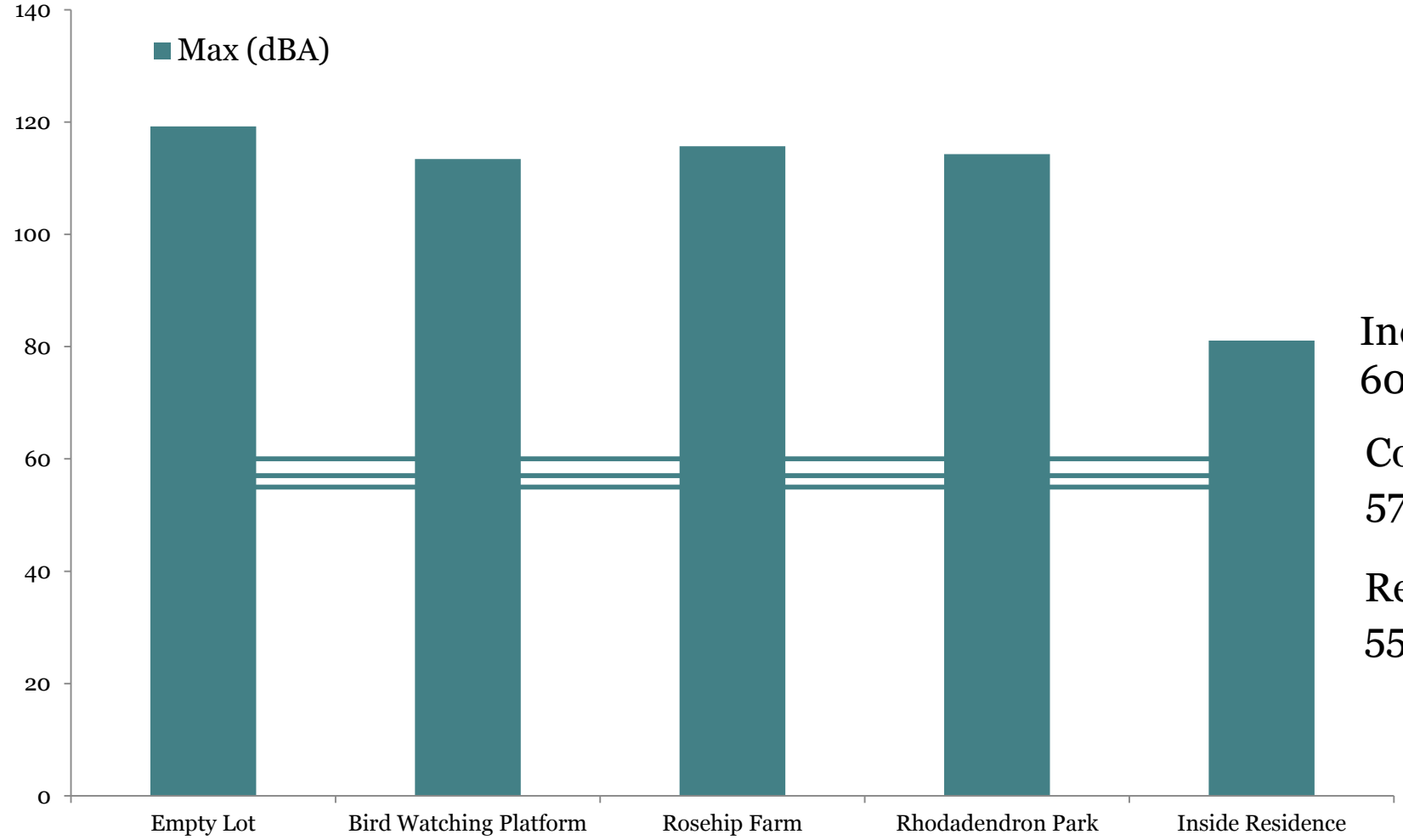


School Sites
75 max (dBA)

Inside Classroom
45 max (dBA)

Washington State DOH - Schools

Coupeville Noise Measurement Comparison w/Reference Values



Industrial
60 max (dBA)

Commercial
57 max (dBA)

Residential
55 max (dBA)

Washington State Ecology - Residential

Summary of Findings

Summary of Findings

- Scientific evidence for:
  - Adult Health Impacts
    - Sleep disturbance
    - Cognitive impairment
    - Atherosclerosis
    - Cardiac disease - myocardial infarction and even death
  - Child Health Impacts
    - Learning
    - Annoyance
    - Motivation
- Measurements exceed levels that protect human health

Recommendations

Hierarchy of Hazard Control

- Eliminate the hazard
  - Relocate touch and go training activity
- Disrupt the pathway
  - Relocate outdoor child play/study areas to quiet settings
  - Engineering controls in schools, daycares and homes to reduce indoor noise exposure
    - Acoustic insulation
  - Community design policy for new buildings
    - Prioritize low exposure (siting and building design)
- Personal protection
  - Educate: instruct child to walk away from sources of loud noises
  - Ensure that child wears child-sized hearing protection such as earplugs during touch and go training
  - Guard against additional, interior noise sources

Health Impact Assessment (HIA)

- Used to assess the potential health effects of a project or policy prior to implementation
- Focus on child health
- Health impacts (i.e. noise, jet fuel combustion products)

More Information - EPA Factsheet

Noise and Its Effects on Children

INFORMATION FOR PARENTS, TEACHERS, AND CHILDCARE PROVIDERS

Children often participate in recreational activities that can harm their hearing.

These activities include attending music concerts and sporting events, fireworks, playing with

What Is Noise?

Noise is defined as any unwanted or disagreeable sound and is often dismissed simply as a "nuisance." However, noise can become harmful when it interferes with a child's normal activities, such as sleeping or talking, or disrupts or diminishes a child's health or quality of life.

Measurement of Noise

Noise, like all sounds, is measured by the intensity and frequency of the sound waves that hit the ear. The unit used to measure the volume of sound is the decibel (dB). The greater the number of decibels, the louder the noise and the more harmful it is to your ears.

How the Ear Works

The ear is divided into three parts-

This material was supported by the Association of Occupational and Environmental Clinics (AOEC) and funded (in part) by the cooperative agreement award number 1U61TS000118-03 from the Agency for Toxic Substances and Disease Registry (ATSDR).

Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing funds to ATSDR under Inter-Agency Agreement number DW-75-92301301-0. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU publications.