

Tire-Pavement Noise Evaluation Using On-Board Sound Intensity (OBSI) Measurements

Douglas Barrett

**Northeast Pavement Preservation Partnership
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Noise Fundamentals

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- Noise is unwanted sound
- Sound is measured in decibels (dB)
- A-weighted decibels (dBA) correspond to human hearing



Image source: City of Vancouver, Canada

Noise Fundamentals

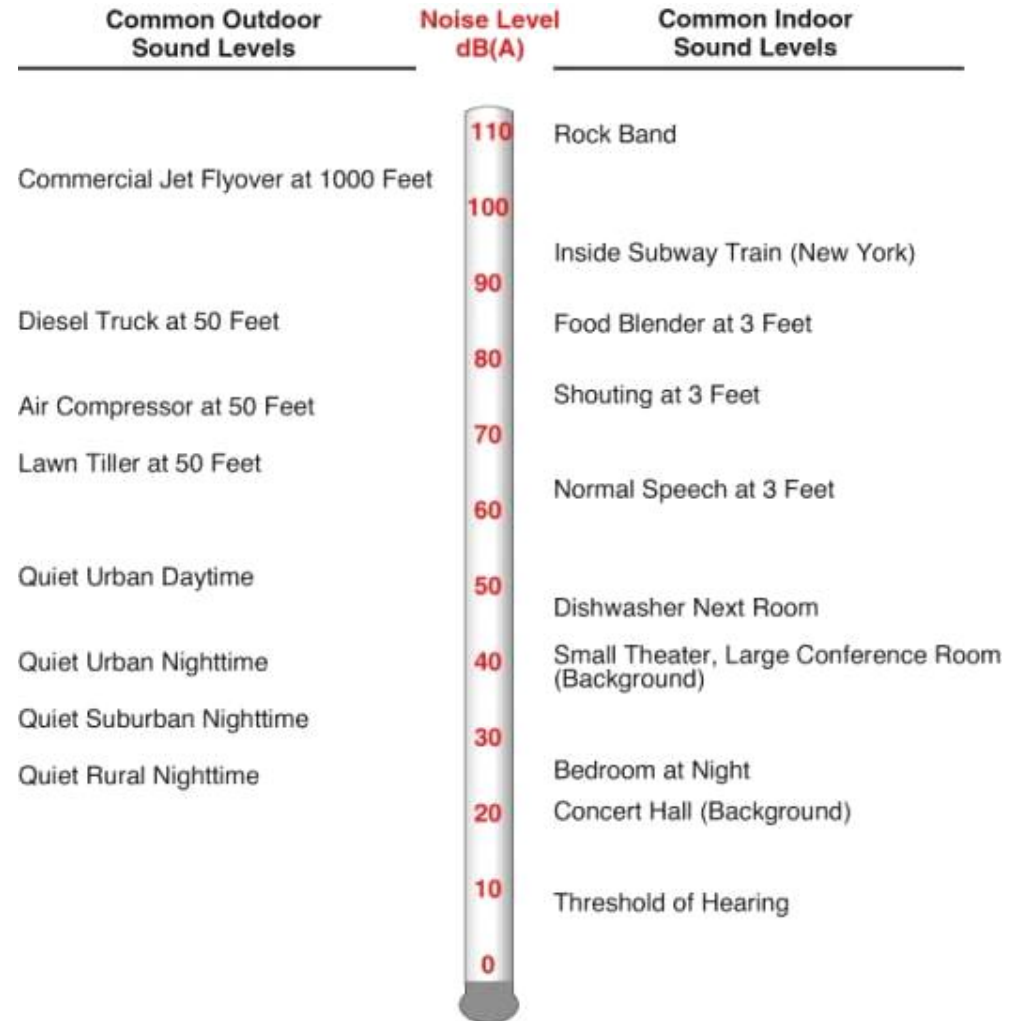
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Logarithmic scale:

- **2x sound energy = 3 dB increase**
- **10x sound energy = 10 dB increase**

but . . .

- **1-3 dB change barely perceptible**
- **6-10 dB change perceived as doubling or halving**



Noise Fundamentals

- 23 CFR 772 provides Federal Procedures for Abatement of Highway Traffic Noise
- Each State DOT must develop policy consistent with 23 CFR 772
- Who has this responsibility in your state?



Quieter pavements: another tool in the toolbox

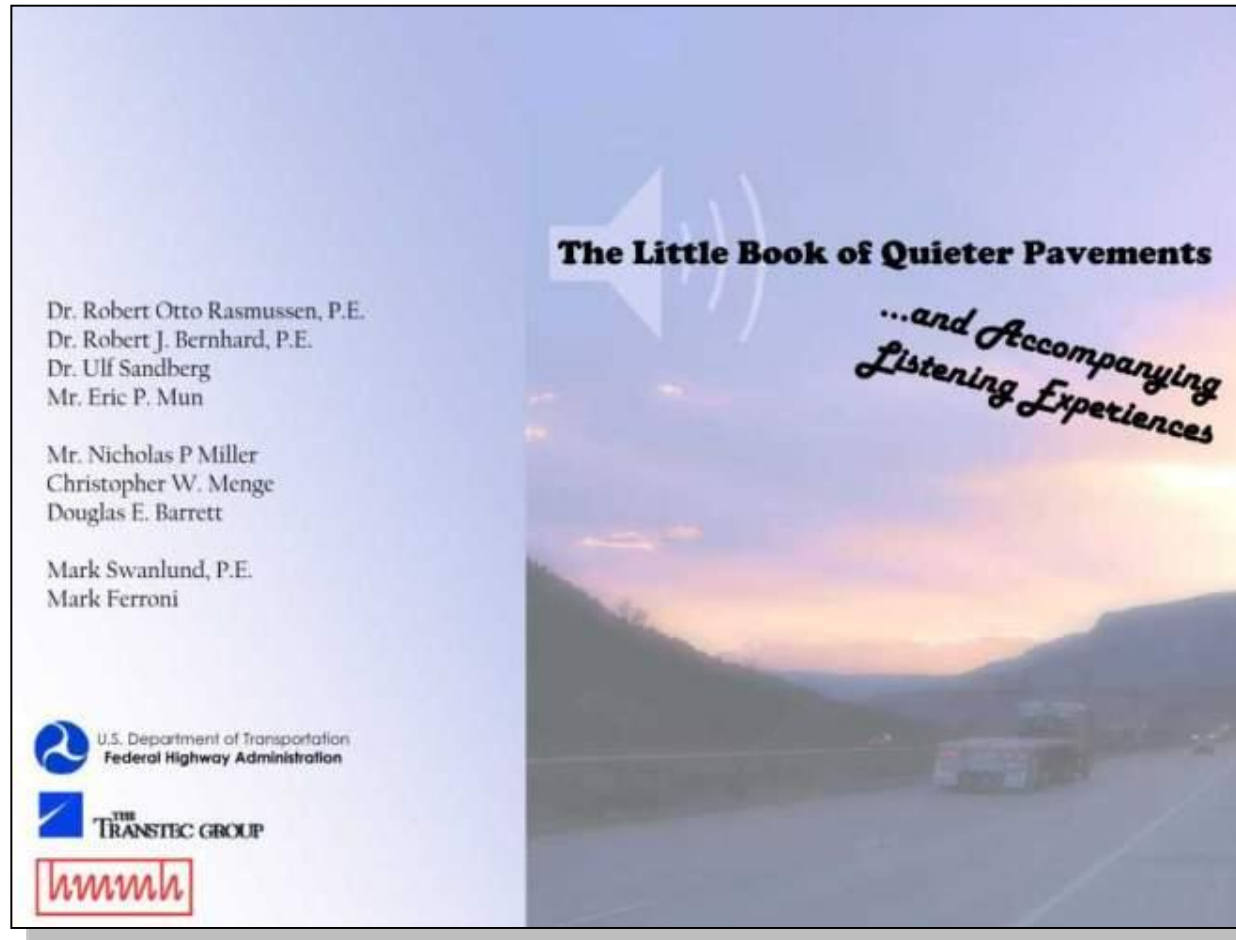
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- Noise barriers not always the best/only solution
- Quieter pavements provide another tool



FHWA's Little Book of Quieter Pavements

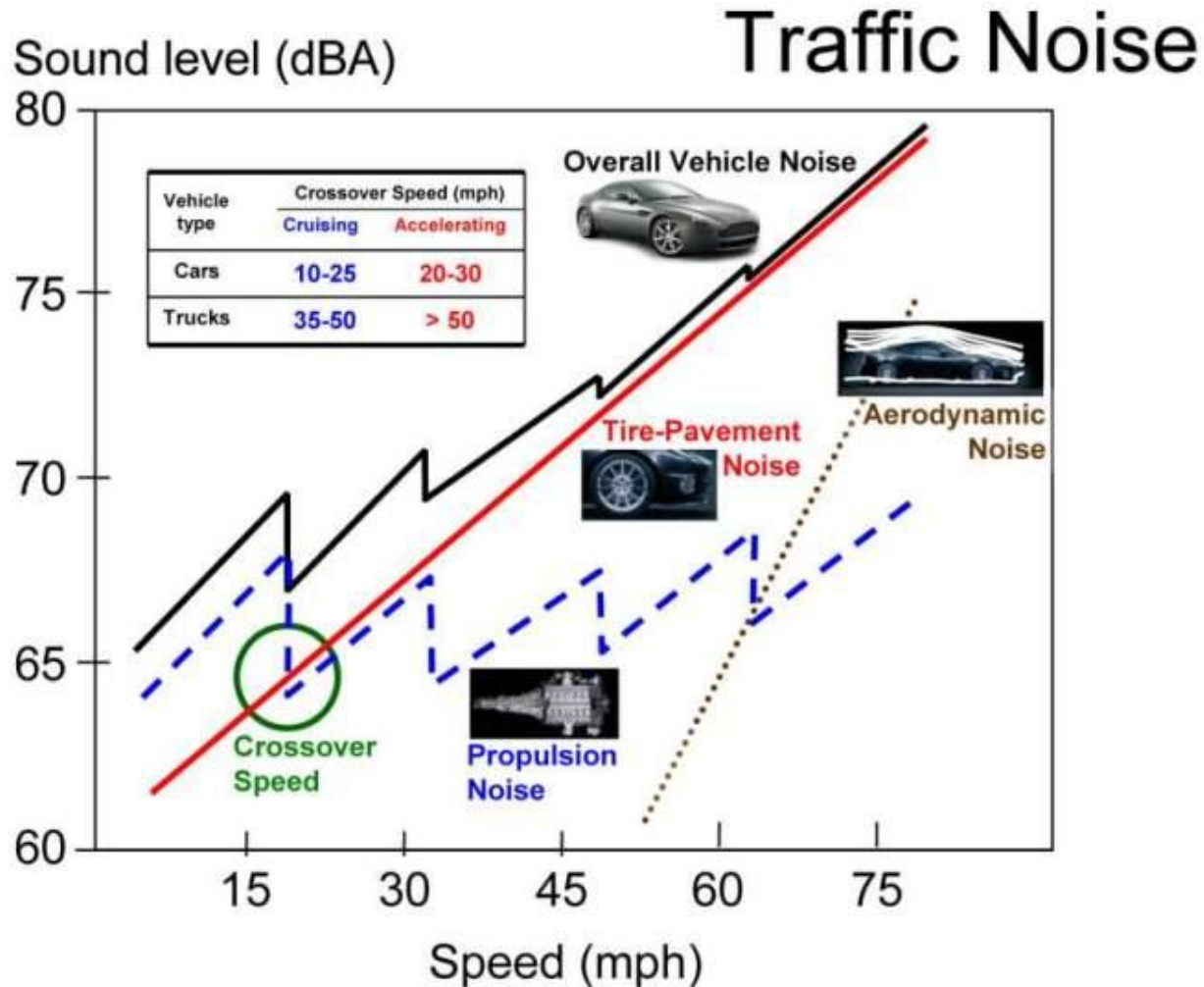
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<http://www.fhwa.dot.gov/publications/focus/08jun/03.cfm>

<http://www.hmmh.com/low-noise-pavement.html>

What is Traffic Noise?



What are the sources of tire-pavement noise?

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- **Tread impact**
- **Air pumping**
- **Stick-slip**
- **Stick-snap**



Source: FHWA Little Book of Quieter Pavements

What amplifies tire-pavement noise?

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- **Horn effect**
- **Helmholtz resonance**
- **Sidewall vibrations**
- **Pipe resonance**
- **Cavity resonance**



What pavement characteristics affect tire-pavement noise?

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- **Texture (this is the big one)**
- **High Porosity**
- **Low Stiffness (less important)**

How can tire-pavement noise be measured?

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- **Wayside Measurements**
 - Controlled Passby (CPB)
 - Statistical Isolated Passby (SIP)
 - Continuous Flow Traffic Time-Integrated Model (CTIM)



How can tire-pavement noise be measured?

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■ Source Measurements

■ Close Proximity (CPX)

- Sound *pressure* level
- ISO standard (11819-2)

■ On-Board Sound Intensity (OBSI)

- Sound *intensity* level
- AASHTO standard (TP 76-09)



On-Board Sound Intensity (OBSI) Test Rig

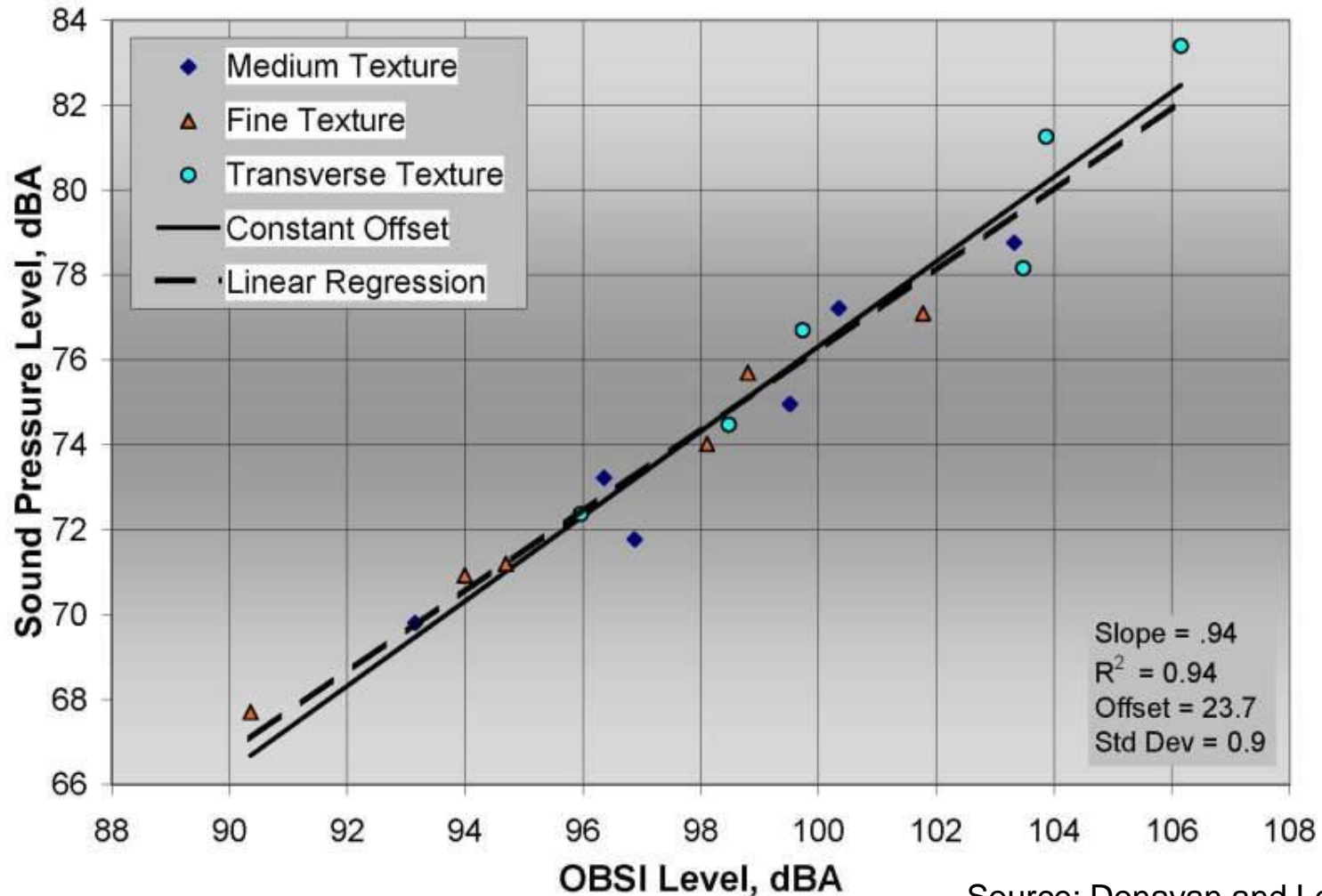
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Relationship of OBSI level to wayside noise level

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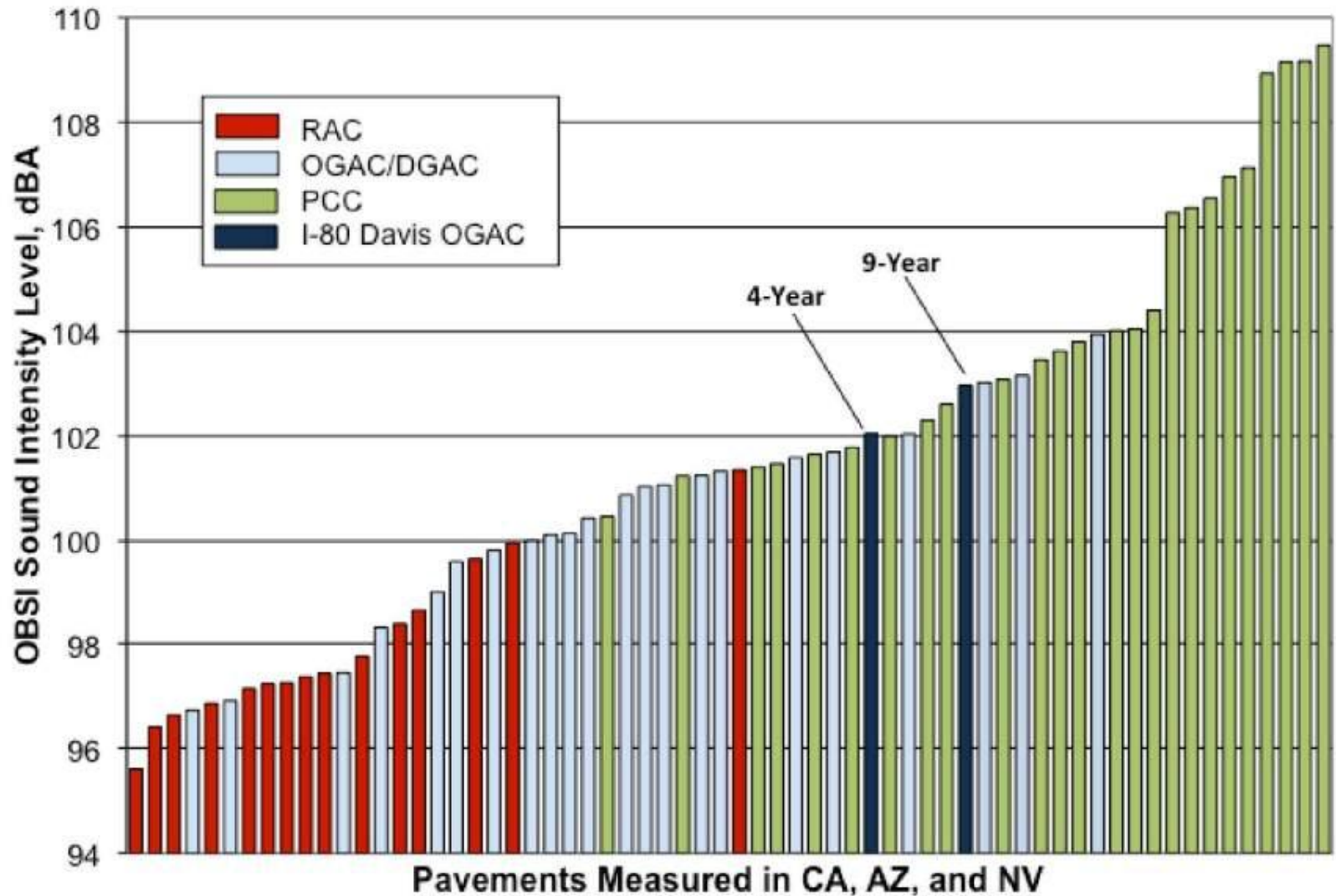
CPB vs. OBSI – Ideal Sites, Non-Porous AC



Source: Donovan and Lodico, 2008

Representative OBSI Test Results

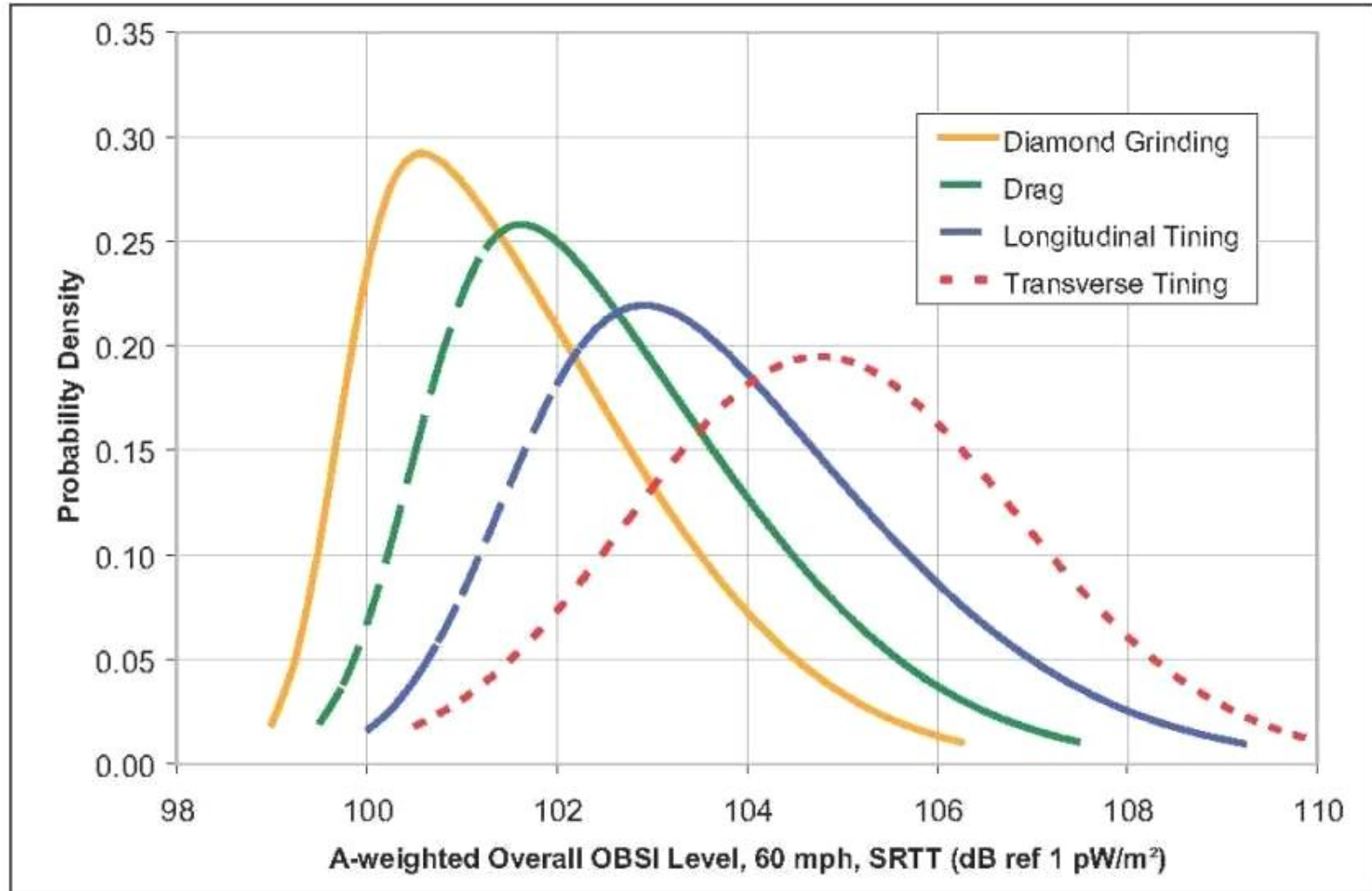
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Source: Lodico and Donovan, 2009

Normalized Distributions of OBSI Noise Levels for Conventional Concrete Pavement Types

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Source: National Concrete Pavement Technology Center Tech Brief, September, 2010

Quiet Pavement Pilot Program (QPPP) vs. Quiet Pavement Research (QPR)

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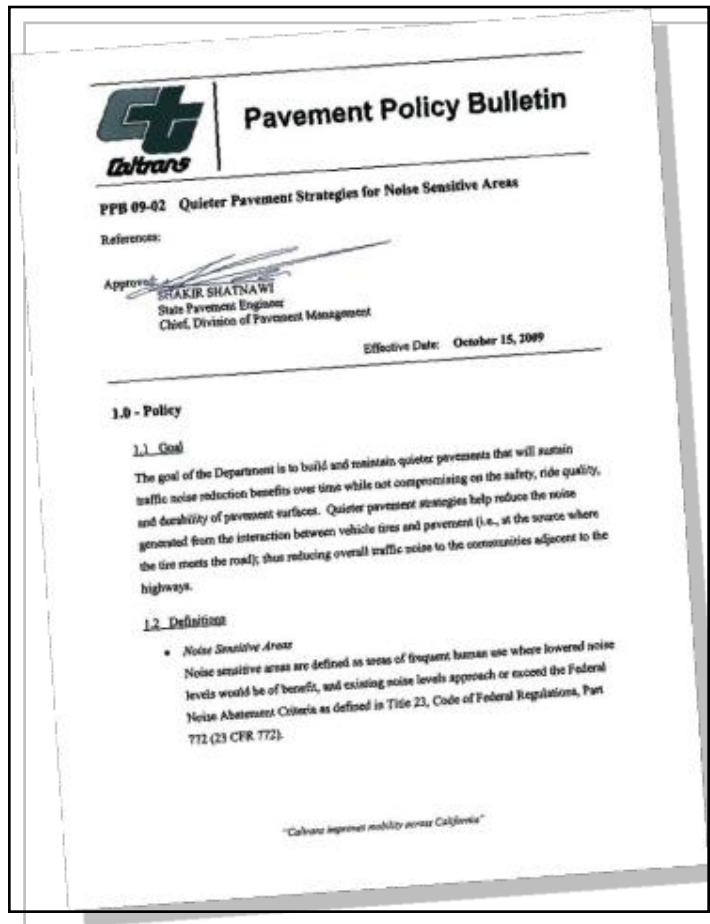


- The data gathered are the same.
- Arizona (ADOT) only state with an approved **QPPP**.
- With an approved **QPPP**, the State may make adjustments for (1) pavement type in the prediction of traffic noise levels; and (2) the use of specific pavement types or surface textures as noise abatement measures.
- State DOT(s) implementing a **QPPP** must commit to monitor noise levels and take appropriate actions if the noise reduction benefits do not last in perpetuity.
- Several states conducting **QPR**: CA, TX, MN, CO, VA, WA, FL.
- State DOT(s) conducting **QPR** do not need to make any commitment regarding the noise reduction benefits of the pavement, since no change in program policy can occur until the research is complete.

http://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/qpppmem.cfm

Caltrans Quieter Pavement Policy Bulletin (Oct. 2009)

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“The goal of this bulletin and the overall QPR Program is . . . to build quieter pavements that will maintain noise reduction benefits over time without compromising on safety, ride quality, and sustainability of pavement surfaces.”

<http://www.dot.ca.gov/hq/esc/Translab/ope/QuiterPavements.html>

Summary

- **Tire-pavement noise is the most significant contributor to overall highway traffic noise**
- **Noise barriers helpful, but have limitations**
- **Quieter pavements address tire-pavement noise at the source**
- **Both asphalt and concrete pavements can be louder or quieter**
- **OBSI provides an efficient, standardized approach for comparing noise characteristics of different pavements and also evaluating benefits over time**
- **FHWA provides two approaches for quieter pavement programs: QPPP and QPR**
- **Effective program requires cooperation between environmental and pavement management personnel**

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