NOISE BARRIER RESEARCH & ROAD MAP SESSION:
ADVANTAGES & CHALLENGES OF EARTHEN NOISE BERMS

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Presenter:
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Introduction

• Kimberly Burton, P.E., AICP CTP, LEED AP ND
  • President of Burton Planning Services
    • Planning & environmental consulting
  • Associate Professor of Practice at The Ohio State University
    • City & Regional Planning

• 20+ years of experience working in the public and private sectors
• Numerous traffic noise analyses, research studies, expert witness
• Co-published a chapter in the *Guide to Planning in Ohio* on “Noise-Compatible Land Use Planning” (2007)
Outline

• Introduction
• Earthen berm study results
• Additional advantages & challenges
• Wrap-up & questions
Introduction

- State DOTs sponsor noise barrier construction programs to mitigate noise impacts.
- Minimal research has been performed to compare earthen mounds & structural noise walls for:
  - Noise mitigation effectiveness
  - Property value effects
- 2 recent research projects in Ohio for Ohio DOT & Ohio Department of Commerce (ODC):
Earthen Berm Noise Reduction Analysis
Problem Statement

- Earthen berms cost less to construct & maintain than structural concrete and fiberglass noise walls.
- There is a limited information about comparative mitigation effectiveness of earthen berms.
- Determining the difference is essential to guiding future noise mitigation implementation strategies.
Study Area Sites

- 45 noise measurement sites
  - 35 earthen berm sites
  - 10 structural wall sites

- Readings were taken at 4 locations at each site:
  - A - top of berm or wall
  - B - rear base of berm or wall
  - C - 100 feet behind B
  - D - 100 feet behind C
Analysis Results

Effects on Noise Levels

- Level of effect from different elements varied:
  - Major Effect
    - Traffic Volumes (especially trucks)
    - Distance Offset
    - Traffic Speed
    - Functional Class (related to traffic volumes)
  - Minor Effect
    - Berm Height (strong performance by Small-Height Berms)
    - Temperature
  - No Effect
    - Vegetation, Berm Length, Wind
Analysis Results

Equivalent Height Comparisons

• 2 methods of calculating the equivalent height ratio:
  • Method 1 – Field Data; Method 2 – Snapshot Scenario Analysis
• Final Calculation
  • Average of Methods 1 & 2
  • For 1.0 foot of berm height, a structural wall would need to be 1.15 feet in height for an equivalent noise reduction.

Cost-Benefit Analysis Overview

• C-B analysis included 3 cost types: Construction, ROW & Maintenance
Analysis Results

Life Cycle Cost Comparisons

<table>
<thead>
<tr>
<th>Berm Cost, Cumulative over time</th>
<th>Wall Cost, Cumulative over Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per unit height/length</td>
<td>Test Demo - Barrier Ht:</td>
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<table>
<thead>
<tr>
<th>Year</th>
<th>Berm-ROW-Rural/Small City</th>
<th>Berm-ROW-Suburban</th>
<th>Berm-ROW-Urban</th>
<th>Berm-ROW-Other</th>
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</table>

- Construction, maintenance & ROW costs
- Rural/Small City, Suburban & Urban Locations
- 20-year projections
- Default: 10-foot high barrier, 1,000 feet long
- Year 1: wall costs 2 - 4 times more the berm
- Year 20: wall costs 3 - 5 times more than the berm
Research Approach

Cost-Benefit Analysis & Evaluation

• Part 3: Life Cycle Cost Comparisons
Analysis Results

Noise Barrier Spreadsheet Calculator

- 3 interactive tables for quick estimation of berm & wall life cycle costs.
- Calculates costs, equivalent effective heights, and equivalent costs.
- Developed for easy updates over time to remain useful into the future.
### Noise Barrier Spreadsheet Calculator

*Includes initial and ongoing costs*

#### Table 1: Berm/Wall Cost Comparison, Same Height/Length/Years

<table>
<thead>
<tr>
<th>Height (ft)</th>
<th>Length (ft)</th>
<th>Years</th>
<th>Berm Total Cost</th>
<th>Wall Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROW-Rural/Small City</td>
<td></td>
<td></td>
<td>$0</td>
<td>$0</td>
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<tr>
<td>ROW-Suburban</td>
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<td>$0</td>
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<tr>
<td>ROW-Urban</td>
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<td>$0</td>
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<tr>
<td>ROW-Other</td>
<td></td>
<td></td>
<td>$0</td>
<td>$0</td>
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</tbody>
</table>

#### Table 2: Berm to Wall Conversion Cost Comparison, Equivalent Height for Same Mitigation Results

<table>
<thead>
<tr>
<th>Height (ft)</th>
<th>Length (ft)</th>
<th>Years</th>
<th>Equivalent Wall Height</th>
<th>Berm Total Cost</th>
<th>Wall Equivalent Height Total Cost</th>
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</thead>
<tbody>
<tr>
<td>ROW-Rural/Small City</td>
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<td></td>
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<td>$0</td>
<td>$0</td>
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<tr>
<td>ROW-Suburban</td>
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<tr>
<td>ROW-Urban</td>
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<td></td>
<td>0.00</td>
<td>$0</td>
<td>$0</td>
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<tr>
<td>ROW-Other</td>
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<td></td>
<td>0.00</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

#### Table 3: Wall to Berm Conversion Cost Comparison, Equivalent Height for Same Mitigation Results

<table>
<thead>
<tr>
<th>Height (ft)</th>
<th>Length (ft)</th>
<th>Years</th>
<th>Equivalent Berm Height</th>
<th>Berm Equivalent Height Total Cost</th>
<th>Wall Total Cost</th>
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</thead>
<tbody>
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<td>$0</td>
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<tr>
<td>ROW-Suburban</td>
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<td>0.00</td>
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<tr>
<td>ROW-Urban</td>
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<td>$0</td>
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</tbody>
</table>
Analysis Results

Noise Barrier Spreadsheet Calculator

- Example:
- Rural Berm/Wall
- 10-Year Cost Estimates

### NOISE BARRIER SPREADSHEET CALCULATOR

*Includes initial and ongoing costs*

### Look-Up Table 1: Berm/Wall Cost Comparison, Same Height/Length/Years

<table>
<thead>
<tr>
<th>Enter Berm or Wall Info</th>
<th>Height (ft)</th>
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Analysis Results

Noise Barrier Spreadsheet Calculator

- Example:
  - Rural Berm/Wall
  - 10-Year Cost Estimates

<table>
<thead>
<tr>
<th>NOISE BARRIER SPREADSHEET CALCULATOR</th>
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<tbody>
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Look-Up Table 1: Berm/Wall Cost Comparison, Same Height/Length/Years

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</tr>
<tr>
<td>ROW-Rural/Small City</td>
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<tr>
<td>ROW-Suburban</td>
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<td>ROW-Other</td>
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</tbody>
</table>
Analysis Results

Noise Barrier Spreadsheet Calculator
- Example:
- Rural Berm/Wall
- **20**-Year Cost Estimates

<table>
<thead>
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Look-Up Table 1: Berm/Wall Cost Comparison, Same Height/Length/Years

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### Analysis Results

**Noise Barrier Spreadsheet Calculator**

- Example:
  - Rural & Suburban Berm/Wall
  - 20-Year Cost Estimates

#### Look-Up Table 1: Berm/Wall Cost Comparison, Same Height/Length/Years

<table>
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<th>Enter Berm or Wall Info</th>
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<td>20</td>
<td>$0</td>
<td>$0</td>
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*Includes initial and ongoing costs*
Study Conclusions

- Earthen berms are more cost effective and more effective at noise reduction than structural noise walls.
- Small-height earthen berms (5’-6’) were found to be very effective at reducing noise on both low & high-volume roadways.
- ODOT should consider prioritizing earthen mounds over structural walls for new barrier construction & old barrier replacement but opportunities will be very limited.
- Successful implementation should result in a significant annual costs savings - for construction and maintenance, compounding over time.
- Qualitative benefits should be emphasized too.
Additional Advantages & Challenges
Advantages

- **Property Values** - “Property Valuation Comparison on Noise-Mitigated Residences”
  - Study completed in 2017 for the Ohio Department of Commerce (through OSU)
  - Objective: to determine if property values are higher for residences located behind earthen berms or behind structural noise barriers – or if there is no measurable difference.
- **Hypotheses:**
  1. Property values should be higher for noise-mitigated residences than non-mitigated residences. Why? - Due to the benefit of reducing noise levels.
  2. Property values should be slightly higher for residences behind earthen mounds than for residences behind structural walls. Why? - Due to the higher aesthetic value of the natural landscaped elements of earthen berms over structural walls.
Advantages

- Property Values
  - Study Area Sites
    - 1 – Canton/I-77
    - 2 – Orange Twp/I-71
    - 3 – Grove City/I-71
    - 4 – Hilliard/I-70
    - 5 – Centerville/I-675
    - 6 – Cincinnati/I-71
Advantages

• Property Values

  • Study Conclusions
    • The hedonic method models indicated that both hypotheses could be true – or not true.
    • The more variables that were included in the model the less significant noise mitigation became & the more skewed the noise mitigation effects became from the hypotheses.
    • Simplified analysis with only 2 variables (average total value, square footage) proved both hypotheses true.

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Advantages

• Aesthetics/visual effects
  • Earthen berms provide a more natural appearance and a less confined feeling.
  • Earthen berms provide a more aesthetically-pleasing noise barrier type with grasses, bushes, trees, and flowers.
Advantages

• Environmental effects
  • Structural noise walls create a physical barrier that prevents wildlife from crossing roadway corridors; earthen berms are more accessible.
  • Vegetative covering of earthen berms can create habitat for native plant and animal species.
  • Earthen berms are able to absorb many of the air pollutants caused by vehicles.
Advantages

• Reduced construction impacts
  • Earthen berms are simple to construct –
    • No issues or risks with manufacturing and transporting materials
    • No invasive drilling or auguring
    • No special equipment, such as cranes
  • Can be built with waste materials from nearby construction projects.
Challenges

- **Ground space**
  - **Top challenge** - not enough ground space to build an earthen mound.
  - Example: 10-foot high earthen mound with a 4:1 slope needs 80 feet of ground width.
  - Current Ohio regulations do not allow for land acquisition for noise mitigation.
Challenges

- Potential conflicts with utilities, lighting, drainage, clear zones
  - Depending on the location, some design features can be in the way (same as with structural walls).
  - Can necessitate re-design, slow down the construction schedule, and increase construction costs.
Challenges

• Vegetation selection & mowing
  • There can be challenges with the vegetation on the earthen mound, such as selecting the best vegetation for un-mowable areas and coordinating mowing.
Wrap-Up
Wrap-Up

• Earthen berm study results
  • Cost, lifespan, maintenance advantages
  • Mitigation effectiveness

• Additional advantages & challenges
  • Property value advantages?
  • Aesthetic, environmental, construction advantages
  • Ground space, design, vegetation maintenance challenges
Wrap-Up

• These studies were aimed at providing accurate information on noise mitigation options to federal and state agencies and local municipalities.

• The results of these studies could result in priority and policy changes at the state level to save money and increase noise mitigation effectiveness.

• In addition, communities could change their zoning codes at the local level in order to help improve residents’ quality of life and property values along major roadways.
NOISE BARRIER RESEARCH & ROAD MAP SESSION:
ADVANTAGES & CHALLENGES OF EARTHEN NOISE BERMS

QUESTIONS?
Contact Information:
Kimberly Burton
(614) 392-2284
kburton@burtonplanning.com
www.burtonplanning.com