



TRANSPORTATION SYMPOSIUM

2019

Noise

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Noise in the ETDM Process

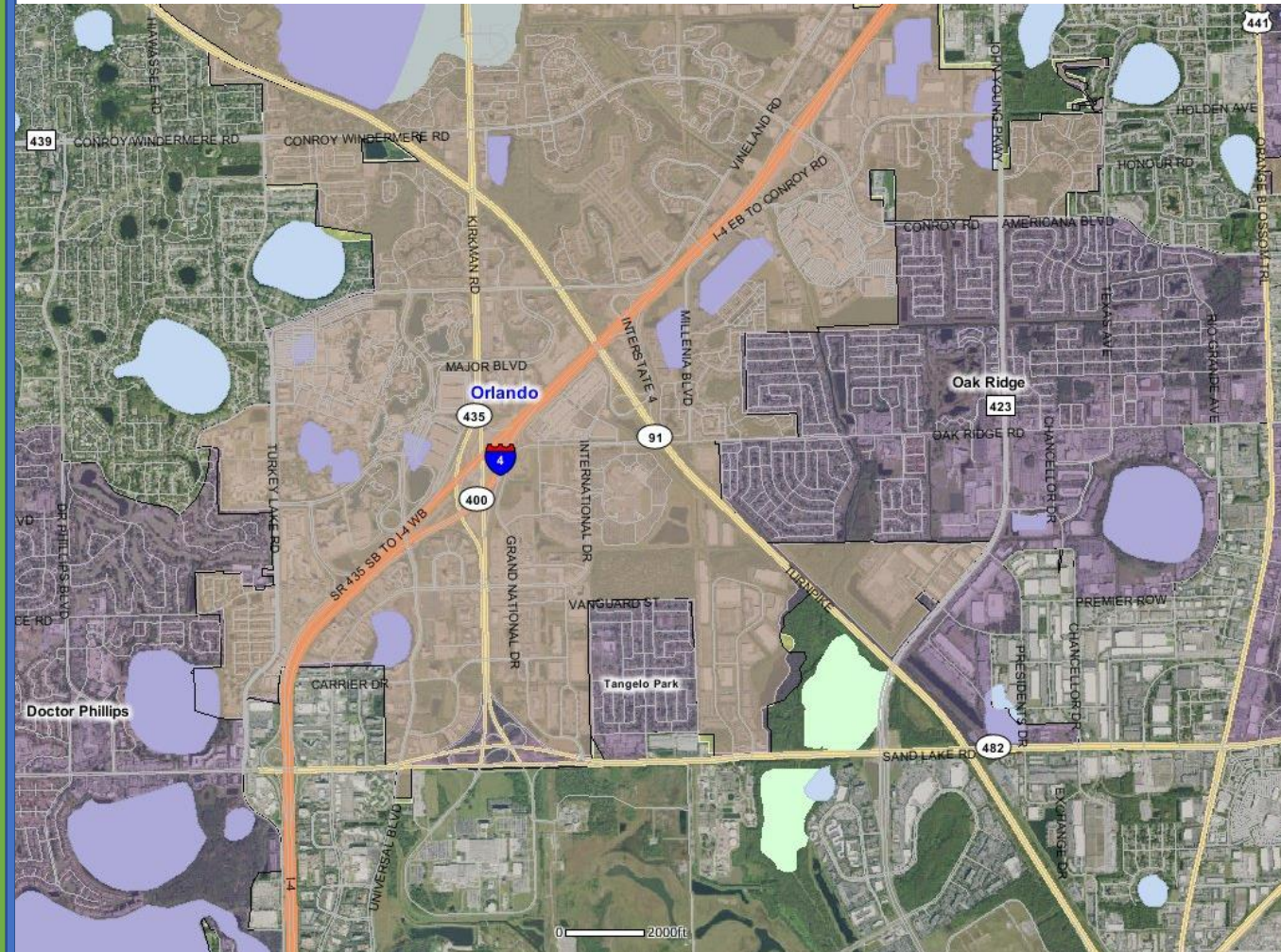
- Early identification of potential issues and impacts
- Determine if a noise study is required

etdm

Efficient Transportation Decision Making

est

Environmental Screening Tool











PD&E

- PD&E Noise Studies:
 - Fulfill requirements of 23 CFR Part 772 (and thus NEPA) and F. S. 335.17
 - 23 CFR 772 Requires the use of the FHWA **Traffic Noise Model (TNM 2.5)**
 - Are conceptual in nature
 - May include the screening of multiple (viable) alternatives
 - Evaluate existing (**current** year), future no-build (design year) and future build (design year)
 - Do NOT make commitments to construct noise barriers (only commit to further evaluation in design)
 - Provide noise contour information to local officials for land use planning



The Basic PD&E Noise Study Process (23 CFR 772)

- | | | |
|-----------------------------------|---|----------------------------|
| • Is a noise study required? |  | 23 CFR 772.7 |
| • Determine project limits |  | 23 CFR 772.5(8) |
| • What land uses are present? |  | 23 CFR 772.11(d)(1) |
| • Field review/model validation |  | 23 CFR 772.11 |
| • Predict traffic noise levels |  | 23 CFR 772.9 |
| • Evaluate abatement measures |  | 23 CFR 772.13 |
| • Documentation |  | 23 CFR 772.13(g) |
| • Information for local officials |  | 23 CFR 772.17 |

Traffic Noise Monitoring

Performed for one of two scenarios during PD&E (using noise meter)

(1) Determine existing traffic noise levels (new alignments)

(2) Validate the computer model



Traffic Noise Monitoring



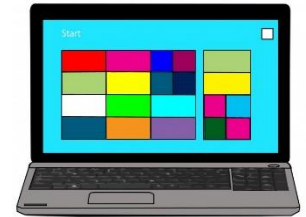
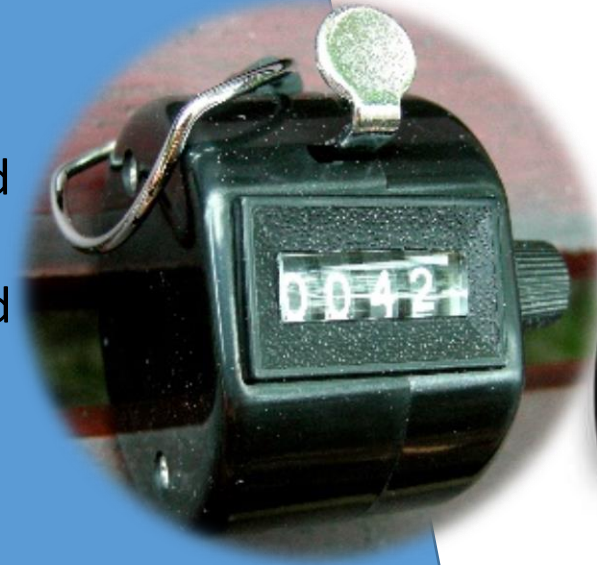
- 3 – 10 minute repetitions
- Traffic noise measurements are NOT conducted to determine traffic noise impacts and/or determine abatement feasibility and reasonableness!
- Always done during PD&E, may be done during Design, especially if it has been a long time since the PD&E was completed

TNM 2.5 Model Validation

- Total traffic counts for each vehicle type

TNM 2.5 accepts hourly traffic volumes, so you will need to multiply your observed volumes (if your measurement period was 10 minutes, those volumes are multiplied by 6)

- Average speeds for each vehicle type
- Input all necessary objects into TNM (geometry, elevations, objects, pavement, etc.)
- Measured and predicted levels should be within ± 3 dB(A)



Traffic Data for Actual Noise Study Modeling

- Traffic characteristics that yield the worst traffic noise impact for the design year shall be used for modeling (23 CFR 772.9(d))
- Level of Service “C” or Demand volumes?
 - For mainline, the traffic volumes will either be:
 - LOS C peak direction volume
 - Project traffic peak hour directional demand volume
 - Interchange ramps, use demand, even if the LOS C volumes greater

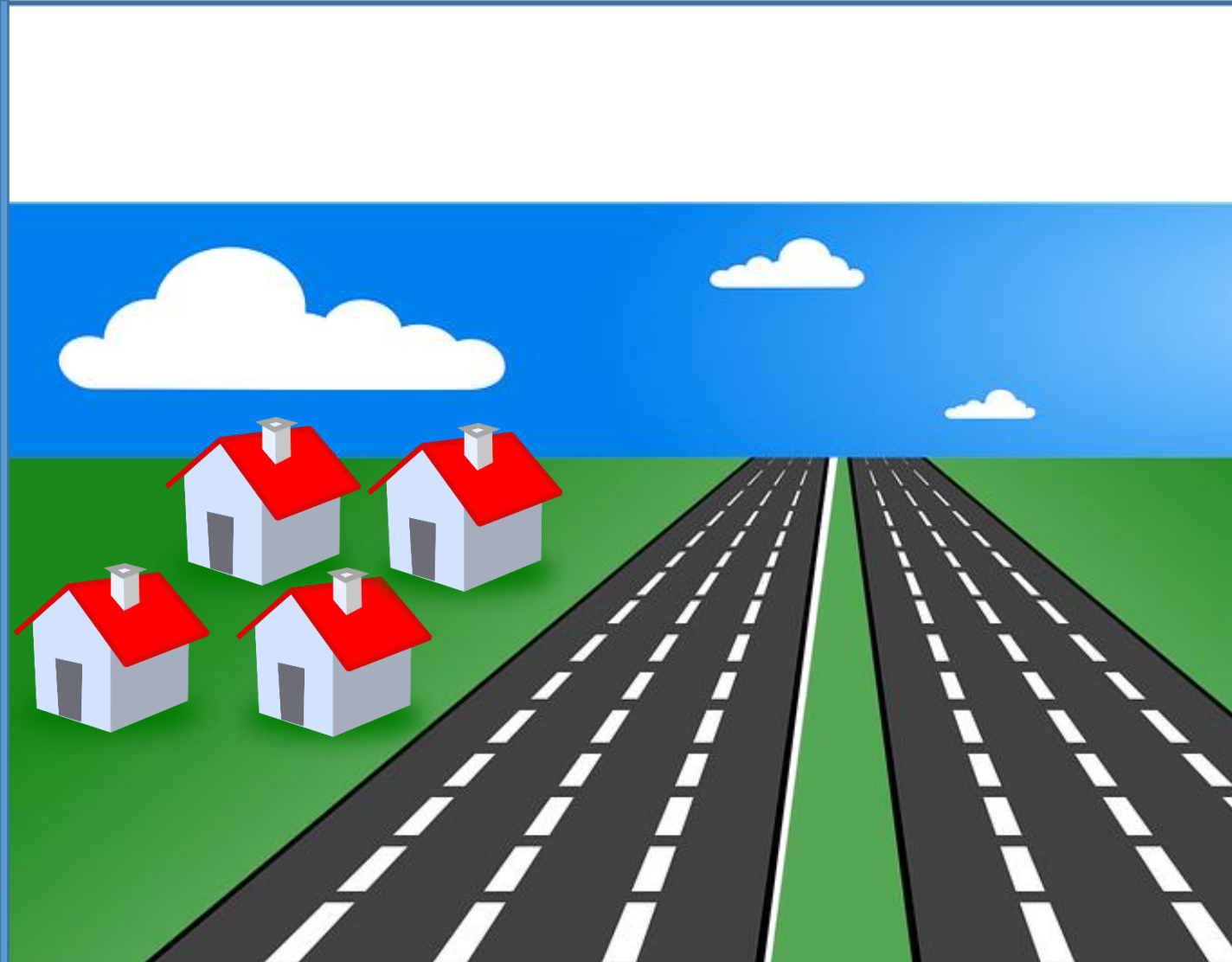
TABLE 7 Generalized **Peak Hour Directional** Volumes for Florida's Urbanized Areas¹

12/18/12

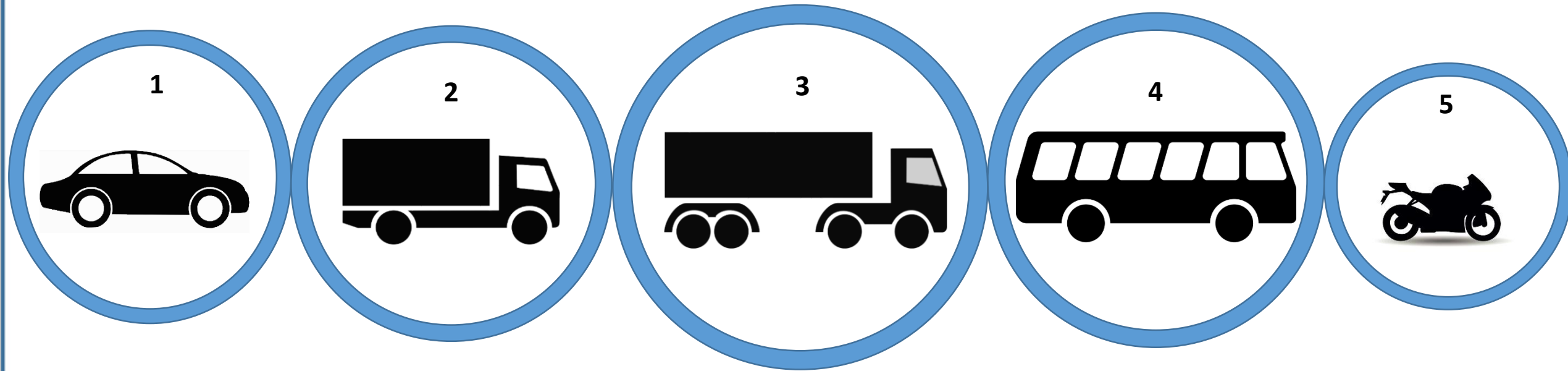
INTERRUPTED FLOW FACILITIES						UNINTERRUPTED FLOW FACILITIES				
STATE SIGNALIZED ARTERIALS						FREEWAYS				
Class I (40 mph or higher posted speed limit)						Lanes	B	C	D	E
Lanes	Median	B	C	D	E					
1	Undivided	*	830	880	**	2	2,260	3,020	3,660	3,940
2	Divided	*	1,910	2,000	**	3	3,360	4,580	5,500	6,080
3	Divided	*	2,940	3,020	**	4	4,500	6,080	7,320	8,220
4	Divided	*	3,970	4,040	**	5	5,660	7,680	9,220	10,360
						6	7,900	10,320	12,060	12,500

Receptors and Traffic

- When receptors are located on both sides of the roadway, the analyst should create two TNM files to represent worst case scenarios. The peak hour traffic will have a D-Factor (directional). You put the heaviest traffic nearest the receptors on one side.
- “Flip the traffic” for receptors on the opposite side
- Peak traffic is distributed evenly across all travel lanes, unless there is a known restriction (HOV, truck lanes, etc.)

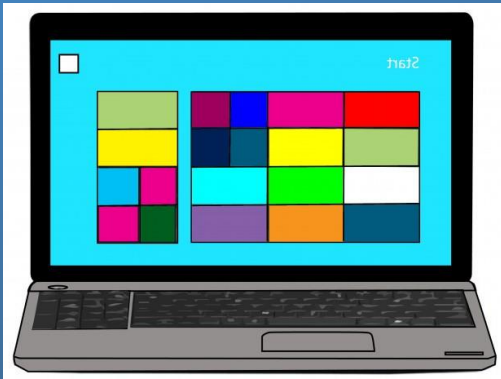


TNM 2.5 Vehicle Classifications



1. **Automobiles** - vehicles with two axles and four tires;
2. **Medium trucks** - all cargo vehicles with two axles and six tires;
3. **Heavy trucks** - all cargo vehicles with three or more axles
4. **Buses** - all vehicles designed to carry more than nine passengers; and
5. **Motorcycles** – all vehicles with two or three tires and an open-air driver/passenger seat

Prediction of Traffic Noise Levels



- TNM, Version 2.5 or newer, to predict traffic noise levels
- Existing (current year), Future No-Build (design year), Future Build (design year) conditions
- All viable alternatives under study
- Compare predicted levels to FHWA Noise Abatement Criteria (NAC)

A Traffic Noise Impact Occurs If:

- Future Build, Design Year traffic noise levels **approach**, **meet or exceed** the NAC for a given activity category
- What does **approach** mean?
 - Within 1 dB(A) of the NAC
- Future Build, Design Year traffic noise levels increase substantially (15 dB(A) or more) when compared to existing levels



Noise Abatement Criteria (NAC)

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
A	57	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	66	Exterior	Residential
C	67	66	Exterior	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	71	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	--	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	--	--	--	Undeveloped lands that are not permitted.

NAC Activity Category “A”

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
A	57	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.

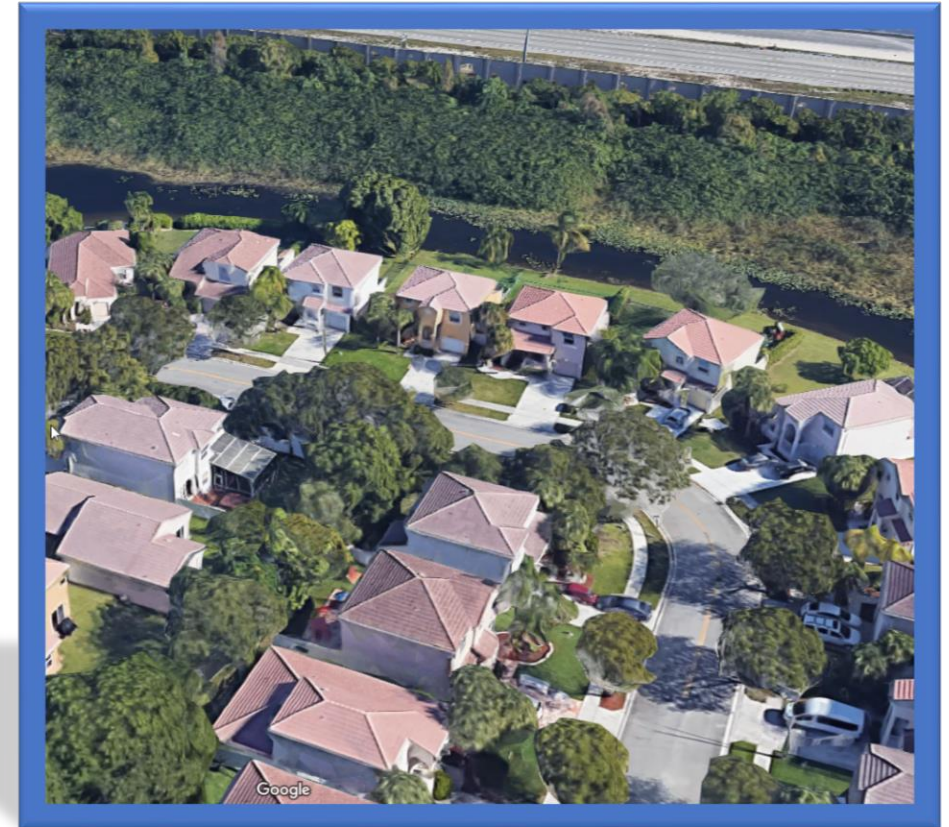
- Only used on case-by-case basis
- Justification and approval by OEM before proceeding (rarely used)
- Example: “Tomb of the Unknown Soldier”



NAC Activity Category “B”

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
B	67	66	Exterior	Residential

- Includes single family (SF) and multi-family (MF) residences
- Each dwelling unit is considered a noise sensitive site
- May be located above ground level



NAC Activity Category “C”

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
C	67	66	Exterior	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.

- Exterior only for these land uses
- “Special Land Use Methodology” to evaluate abatement reasonableness for active use areas (FL-ER-65-97). (More detail later)
- Section 4(f) sites will only apply to Federal projects



NAC Activity Category “D”

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
D	52	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.

- Interior criteria
- No exterior use areas
- Apply building reduction factor or conduct measurements



Noise Reduction Provided by a Building

Building Type	Closed Window Condition	Noise Reduction Due to Building Structure
Light Frame	Ordinary Sash	
	Closed	20
	With Storm Windows	25
Masonry	Single Glazed	25
	Double Glazed	35

Noise Reduction Provided by a Building with Open Windows

Percent of Exterior Walls Having Open Windows	Approximate Noise Reduction
1%	17 dBA
2%	14 dBA
4%	11 dBA
8%	8 dBA
16%	5 dBA
32%	2 dBA
50%	0 dBA

Source: Fundamentals and Abatement of Highway Traffic Noise. 1973 BBN, Page I-35

NAC Activity Category “E”

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
E	72	71	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.

- Must be frequent exterior human use area
- Hotel/Motel pools included in Category E
- Special Land Use Methodology
- No Balconies



NAC Activity Category “F”

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
F	--	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.

- Land uses less sensitive to traffic noise
- No abatement criteria = No analysis required



NAC Activity Category “G”

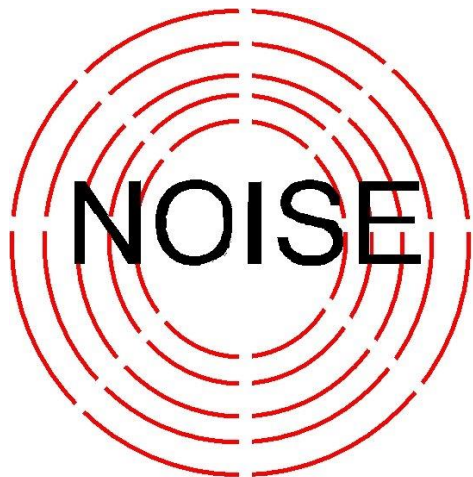
Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
G	--	--	--	Undeveloped lands that are not PERMITTED

- Permitted: A definite commitment to develop land with an approved specific design of land use activities as evidenced by the issuance of a building permit
- Date of Public Knowledge (DPK):
Date of approval of CE/FONSI/ROD



Traffic Noise Impacts

- TNM predicts sound levels to 1/10th dB(A); no rounding
- For a residence, 65.9 dB(A) is not impacted, 66.0 dB(A) is impacted
- Likewise, an increase of 14.9 dB(A) compared to existing is not “substantial”



Noise Abatement Measures

- Noise barriers: At a minimum, abatement in the form of a noise barrier shall be considered (23 CFR 772.13(1))
- Can also consider:
 - Traffic management
 - Alternative roadway alignments
 - Property acquisition for buffer zones
 - Insulation of Activity Category D uses



Feasibility and Reasonableness

Abatement measures have to be **both feasible and reasonable!**

- **Feasibility:** The combination of acoustical and engineering factors considered in the evaluation of a noise abatement measure. (23 CFR 772.5 and 772.13(d)(1))
- **Reasonableness:** The combination of social, economic and environmental factors considered in the evaluation of a noise abatement measure. (23 CFR 772.5 and 772.13(d)(2))

Feasibility

- Noise Reduction Requirements:
 - At least 5 dB(A) reduction at a minimum of two (2) impacted receptors
- Engineering Considerations:
 - Can the noise barrier be constructed as designed?
 - Topography, safety, drainage, utilities, maintenance, ROW, access requirements

Engineering considerations to keep in mind:

- Barrier height limitations:
 - Ground mounted at ROW: 22' max
 - Ground mounted at shoulder or embankment – within the clear zone: 14' max
 - On bridge/retaining wall structures: 8' max (higher – needs approval from State Structures Engineer)

Reasonableness

1. Consideration of viewpoints of benefited property owners and residents (during design)
 2. Cost effectiveness: \$42,000/benefited receptor
 3. Noise Reduction Design Goal (NRDG): At least one (1) benefited receptor must achieve a 7 dB(A) reduction
- All the above factors must be achieved to meet reasonableness requirements!

Feasibility and Reasonableness During PD&E

- Only cost and noise reduction requirements considered during PD&E
- To be advanced for consideration for the design phase, a noise barrier MUST:
 - Achieve Noise Reduction Design Goal (1 ben. rec.)
 - Benefit at least two impacted receptors (5 dB(A))
 - Cost of proposed barrier \leq \$42,000 per benefited receptor
- Other considerations can be noted, but further evaluation will occur during design

“Special Land Use” Methodology

- Determine feasibility/reasonableness of abatement at Activity Category C, D and E locations
- Use when you have “areas” of impact, rather than discrete locations
- Evaluates the amount of impacted area that may be benefited, and the amount of time people might spend in impacted and benefited area
 - Translates to a cost per person-hour per ft² of barrier

$$\begin{aligned} \text{“abatement cost factor”} &= 42\$k/\text{residence} * \text{residence} / 2.46 \text{ persons} \\ &* \text{usage}/24\text{hours} * (14\text{ft} * 100\text{ft}) = \mathbf{\$995,935 / \text{person-hr/ft}^2} \end{aligned}$$

Abatement cost is considered reasonable if the calculated “abatement cost factor” is below the “criteria abatement cost factor”

Directions: Enter the requested values in the space provided below for items 1, 2, 4, and 5, respective to the units desired. The results will be generated automatically in the table below the black line.

Item	Criteria	Input	
		English Units	SI Units
1	Enter length of proposed noise barrier (ft/m)		
2	Enter height of proposed noise barrier (ft/m)		
4	Enter the average amount of time that a person stays at the site per visit (In hours)		
5	Enter the average number of people that use this site per day that will receive at least a 5 dB(A) benefit from abatement at the site		

*** Do not input any information below this line. Results will be generated automatically in this table based on information input above.**

Item	Criteria	English Units	SI Units
1	Enter length of proposed noise barrier	0 ft	0 m
2	Enter height of proposed noise barrier	0 ft	0 m
3	Multiply item 1 by item 2	0 ft ²	0 m ²
4	Enter the average amount of time that a person stays at the site per visit	0 hours	0 hours
5	Enter the average number of people that use this site per day that will receive at least a 5 dB(A) benefit from abatement at the site	0 people	0 people
6	Multiply item 4 by item 5	0 person-hour	0 person-hour
7	Divide item 3 by item 6	#DIV/0!	m ² /person-hour
8	Multiply item 7 by \$42,000	#DIV/0!	\$/person-hour/m ²
9	Does item 8 exceed the "abatement cost factor" of: English Units = \$995,935/person-hour/ft ² or SI Units = \$92,647/person-hour/m ²	#DIV/0!	#DIV/0!
10	If item 9 is no, abatement is reasonable	#DIV/0!	#DIV/0!
11	If item 9 is yes, abatement is not reasonable	#DIV/0!	#DIV/0!

Noise Abatement Commitments During PD&E

- FDOT does NOT commit to noise barrier construction during PD&E!
- Commit to detailed reevaluation during design phase
- “Statement of Likelihood” (23 CFR 772.13(g)(3))

Public Involvement During PD&E Studies

- *Most* PD&E Studies for FDOT includes a Public Hearing or some form of public involvement
- Preliminary impact information, typically via “Noise Contours” is provided at the public workshops
- Results of detailed analysis and abatement measures recommended for further consideration provided at Public Hearing

Construction Noise and Vibration

- Identify sites that may be potentially impacted

Document in Noise
Study Report (NSR) and
environmental
document for project

Noise	Vibration
Eye Centers/Clinics Medical Centers Hospitals Geriatric Centers Sound Recording Studios TV/Radio Stations Residences Technical Laboratories Hearing Testing Centers Theaters Schools Motels/Hotels Funeral Homes Libraries Meditation Centers Churches/Shrines Parks Day Care Centers Outdoor Theaters	Eye Centers/Clinics Medical Centers Hospitals Geriatric Centers Sound Recording Studios TV/Radio Stations Residences Technical Laboratories Antiques Shops Museums Historic Buildings
Note: This list is not meant to be all inclusive or exclusive, but rather an indication of the type of sites likely to be sensitive to construction noise and/or vibration.	
Source: FDOT Noise and Vibration Task Team; August 17, 1999.	

Construction Noise and Vibration

- 23 CFR 772.19 only makes reference to construction noise, does not include vibration
- Chapter 18 includes both
- FDOT Standard Specifications for Road and Bridge Construction



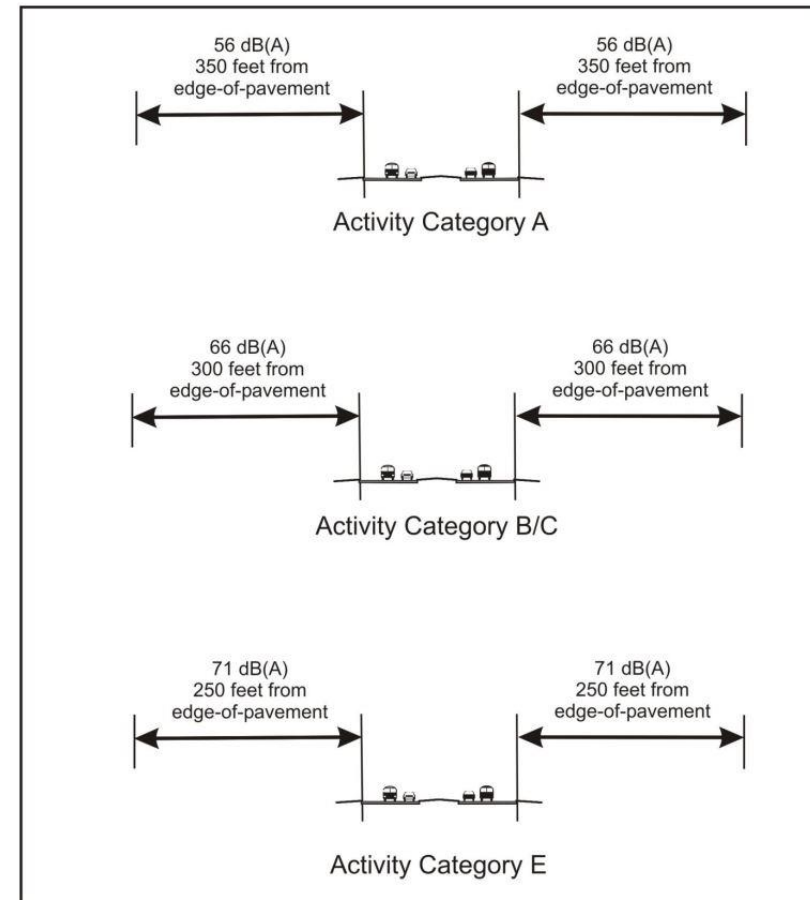
Noise Contours and Local Coordination

- PD&E NSRs shall include an estimation of the distance to impact criteria for each NAC
- After Location and Design Concept Acceptance (LDCA) or approval of State Environmental Impact Report (SEIR), noise contour info shall be provided to local government officials whose jurisdiction the project is located in for land use planning purposes.

Topic No. 650-000-001

Project Development and Environment Manual
Highway Traffic Noise

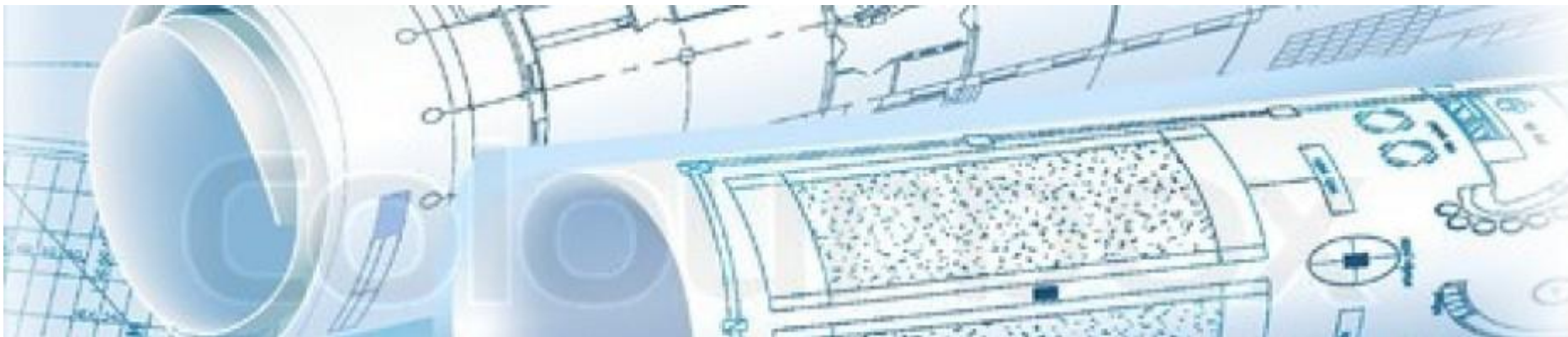
Effective: June 14, 2017



Design Phase Noise Studies

Reanalyze barriers proposed during PD&E using the current design data

- Analyze future build condition only
- Use design-level alignment detail (modeling is based on proposed roadway design and survey information)
- **Make final commitments to construct noise barriers**



Design Phase Noise Studies

- Review process:
 1. PD&E NSR Review
 2. Land Use/Field Review (possible model validation)
 3. Building Permit/DPK Review
 4. Re-evaluate noise analysis with current roadway design



Noise Barrier Design Phase Analysis:

- Predict design year traffic noise levels for adjacent community/communities using design-level details
- Re-analyze noise barrier feasibility and reasonableness based on design analysis
- If noise reduction and cost requirements are reaffirmed, proceed with engineering feasibility review

Noise Barrier Engineering Feasibility Review

- Conduct prior to noise barrier-specific public involvement
- Ensure noise barrier can be constructed as planned
- **Bottom line:** The last thing you want to do is go to the public with a noise barrier you are not 100% certain you can construct!



Noise Barrier Engineering Feasibility Review Considerations:

- Not something the Noise Analyst does themselves
- Determines if the barrier can be constructed as planned using routine materials and methods
- Usually a part of the ERC review process
- The Noise Analyst should consult with the engineers in each discipline
 - Safety
 - Access Management
 - Right of Way
 - Maintenance
 - Drainage
 - Utilities (subsurface and overhead)

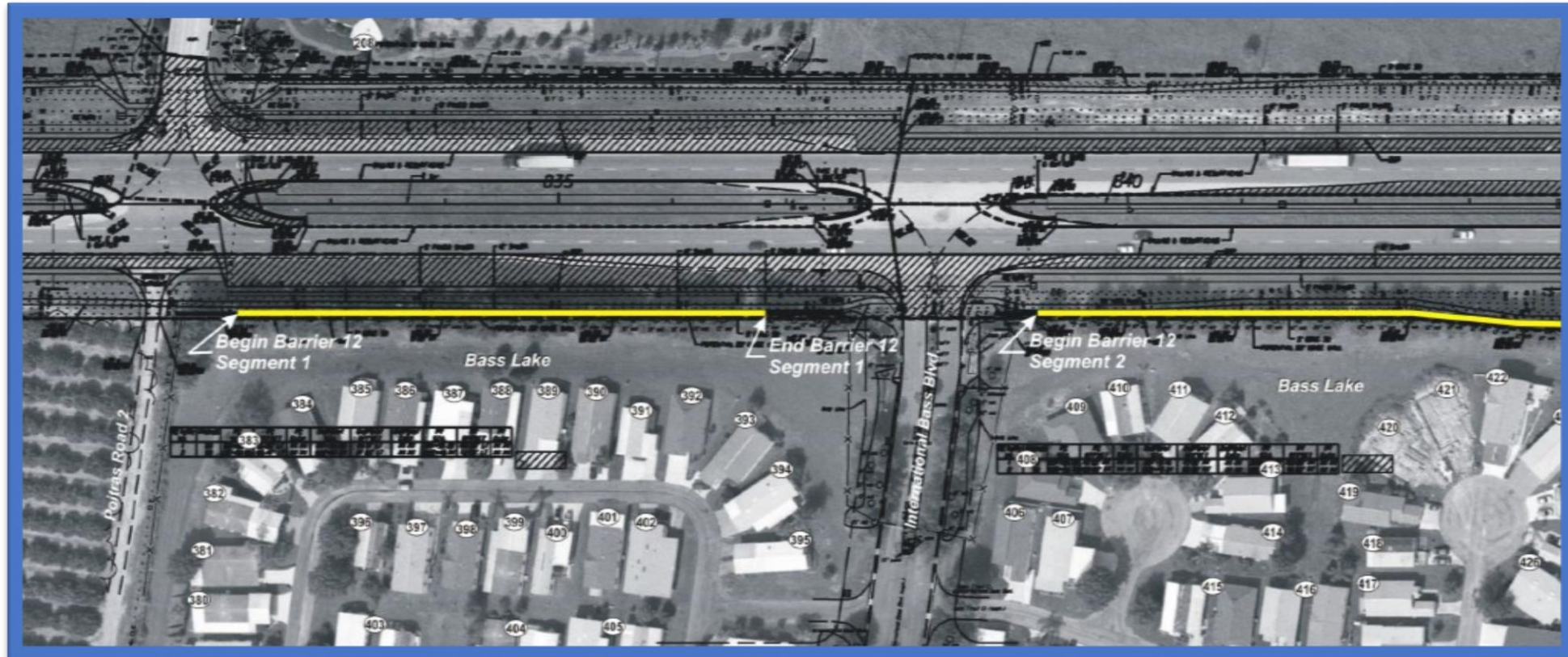
Noise Barrier Engineering Feasibility Reviews

Consideration: **Safety**

- Height limitations as previously discussed
- Crash test requirements if inside clear zone, or protected by traffic safety barrier or guardrail
- Sight distance requirements when noise barrier ends approach intersections / cross streets

Noise Barrier Engineering Feasibility Reviews

Consideration: **Safety**



Noise Barrier Engineering Feasibility Reviews

Consideration: Access

- Primarily for non-limited access facilities (arterials)
- Noise Barrier cannot block ingress/egress to properties adjacent to noise barrier
 - Can be avoided by openings in evaluated barrier for driveways, cross streets, etc.
- Same consideration applies for sidewalks and other normal routes of travel

Noise Barrier Engineering Feasibility Reviews

Consideration: Right-of-Way Factors

- Is there adequate ROW for construction and maintenance of the noise barrier?



Noise Barrier Engineering Feasibility Reviews

Consideration: Maintenance Factors

- Maintenance crews must have adequate room on both sides of barrier for maintenance personnel and equipment

Typical location is 5' inside ROW

Noise Barrier Engineering Feasibility Reviews

Consideration: Drainage Factors

- Important consideration since many drainage activities occur at/near the ROW (swales, etc.)
- This item should be reviewed in detail by the drainage engineer for the project

Noise Barrier Engineering Feasibility Reviews

Consideration: Drainage Factors



Noise Barrier Engineering Feasibility Reviews

Consideration: Drainage Factors



Noise Barrier Engineering Feasibility Reviews

Consideration: **Utility Factors**

- Most common type of conflict with noise barriers
- Includes both above and below-ground utilities
- If utility relocation costs are incurred by FDOT, they are included in noise barrier cost effectiveness

Noise Barrier Engineering Feasibility Reviews

Consideration: **Utility Factors – Overhead Utilities**



Parallel overhead utility line

Issues:

- Short term construction equipment clearances
- Long term wall clearances
- Can electric line be relocated or shut down?

Noise Barrier Engineering Feasibility Reviews

Consideration: **Utility Factors – Overhead Utilities**



Possible Solution: Low overhead equipment to drill post hole

Noise Barrier Engineering Feasibility Reviews

Consideration: Utility Factors – Overhead Utilities

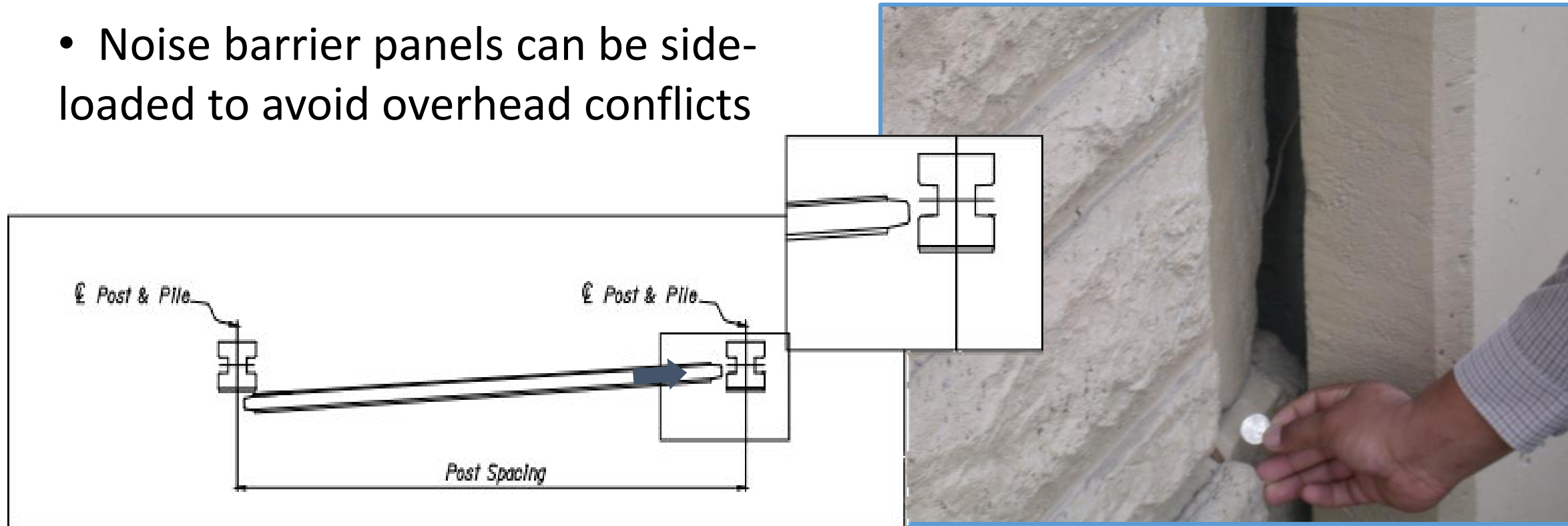
- If auger-cast post holes are not possible, a spread footing foundation can be used



Noise Barrier Engineering Feasibility Reviews

Consideration: **Utility Factors – Overhead Utilities**

- Noise barrier panels can be side-loaded to avoid overhead conflicts



Noise Barrier Engineering Feasibility Reviews

- The earlier potential conflicts are identified, the better
- Chances are, the issue has been encountered on another project
- All foreseeable issues must be resolved before proceeding with design-phase public involvement
- Resolution of some issues may result in modifications to barrier length, height

Noise Study Report Addendum

- Documents final noise abatement commitments
- Completed prior to Construction Advertisement

FINAL NOISE STUDY REPORT ADDENDUM DESIGN NOISE STUDY REPORT

SR 542
from 1st Street to Buckeye Loop Road
Polk County, Florida

Financial Project Identification (FPID) Number: 410666-2-52-01

Prepared for:



Florida Department of Transportation
District One
P.O. Box 1249
Bartow, Florida 33831-1249

May 2013

Questions?