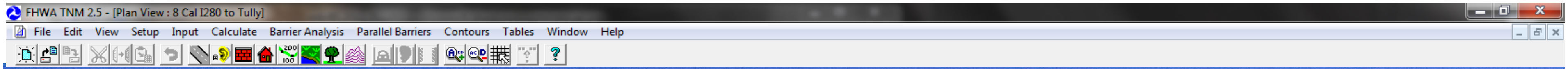

Using OBSI to Interpret TNM Predictions

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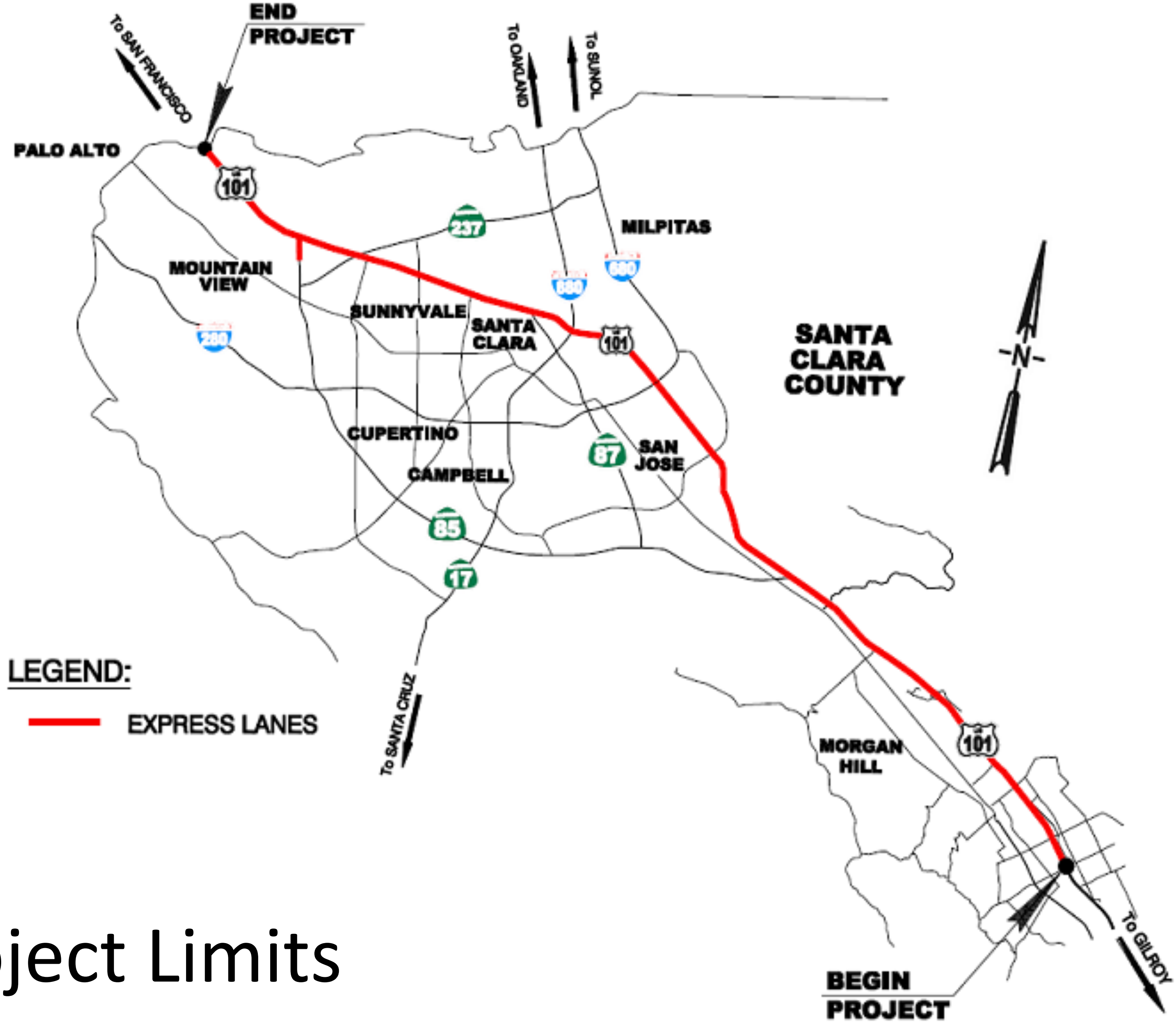
ADC40, Asheville, NC, July 24, 2012

Outline

- Overview of US 101 Project
- 23CFR772 Field Measurements
- TNM Modeling Procedure
- OBSI Measurements
- Normalization of TNM Predictions using OBSI
- Conclusions and Suggestions



Project Limits

US 101 Express Lanes Project

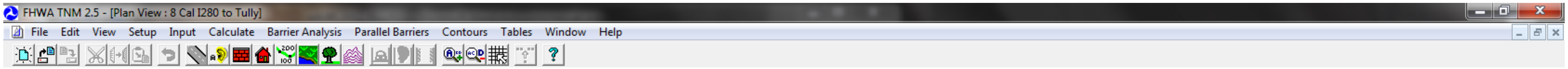
- US 101 in Santa Clara County, CA
  - 36.55 miles of Interstate 101
  - Existing 3 mainline lanes + 1 HOV lane in each direction (NB & SB)
  - Converting existing (2) HOV lanes to (2) HOT (express) lanes and adding 2 additional HOT lanes
  - 4-10% trucks, depending on segment
  - Type 1 Project

23CFR772 Procedure

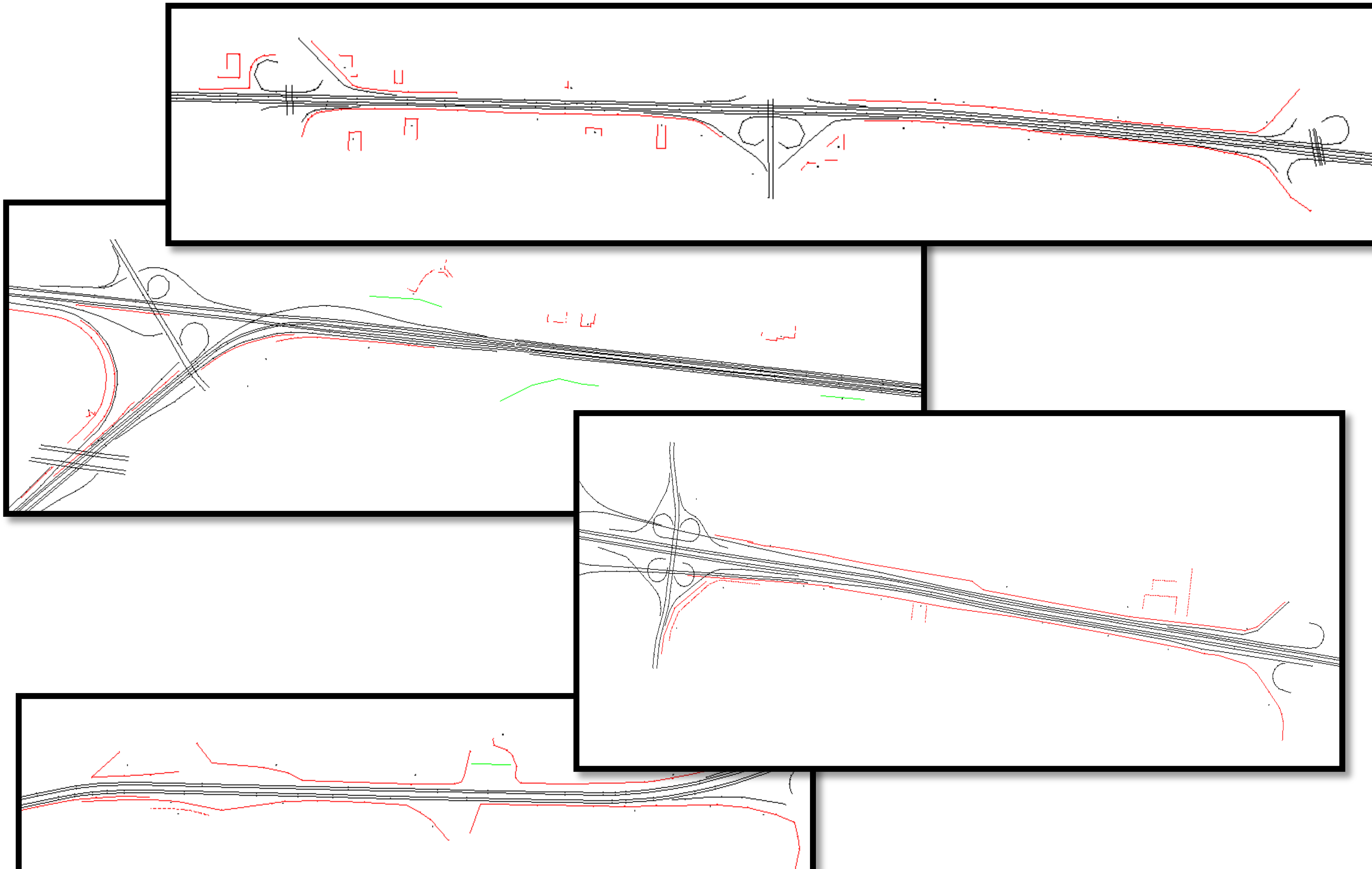
- Identify Land Uses
- Make Field Measurements
  - 167 Measurement Locations + Additional Modeled Locations
- Model Traffic Noise Levels in TNM
- Identify Impacts and Consider Abatement

Modeling Procedure for Calibration

- Travel lanes, terrain, and building locations based on digital geometric plans
- Barriers and receptor locations based on GIS coordinates recorded in the field
- Traffic conditions were documented in real time corresponded to each field noise measurement



Example TNM Models (15 total)



Calibration of TNM Model

- TNM does not account for pavement, atypical vehicles, transparent shielding, reflections, or meteorological conditions (K-factors)

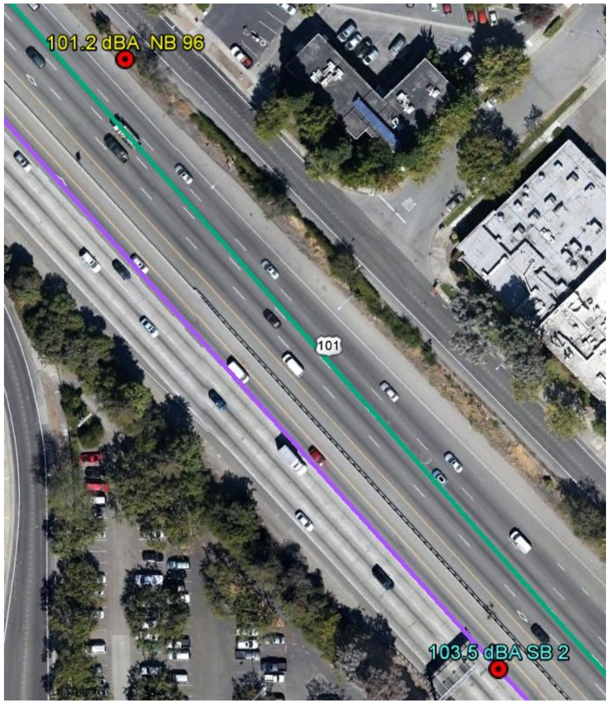
- At highway speeds, tire/pavement noise dominates noise produced by light vehicles and trucks (REMELs)

- OBSI data used to gain an understanding of the contribution of pavement to noise levels produced
  - OBSI levels found to correlate well with wayside (NCHRP 1-44)

OBSI Measurements

- Following AASHTO TP76 Procedure
- Survey method used for outside lane of each direction of travel
- Total of 88 OBSI sections
- OBSI levels ranged from 98 to 106 dBA, depending on pavement

(Show Google Earth Results)



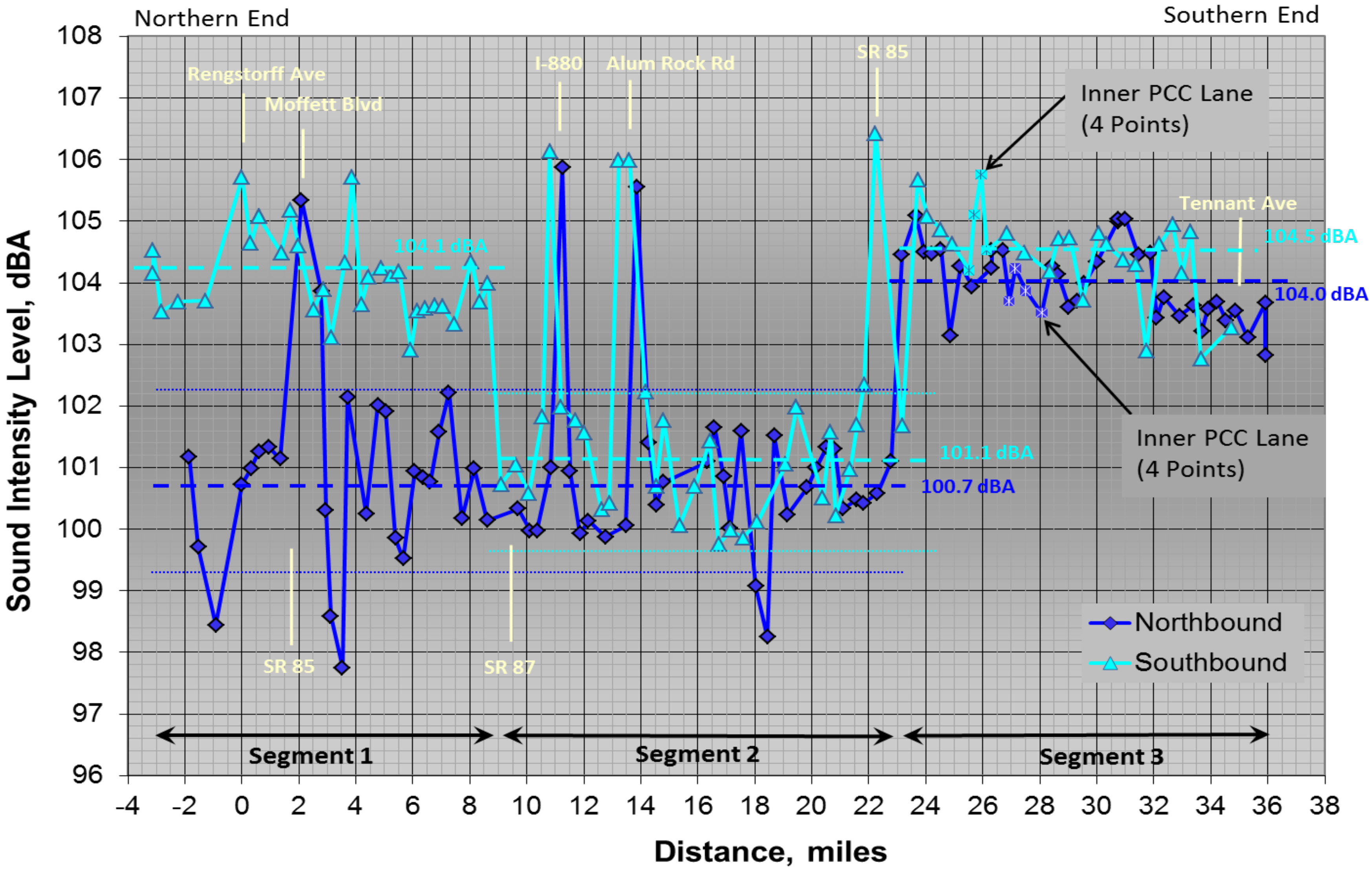
Segment 1: NB Various AC, SB PCC

Segment 2a: Various AC
Segment 2b: Porous AC

Pavement changes from AC to PCC at over & under passes

Segment 3: AC Outer Lanes, PCC Inner Lanes

OBSI Results



OBSI Normalization

- Results of NCHRP 10-76
  - TNM Average OBSI Level = 102.5 dBA
  - Wayside levels change by ~0.8 dB for every 1 dB OBSI change
  - Use of experimental version of TNM by Volpe to account for pavements within TNM (need FHWA authorization to use within a project)

$$\textit{Normalization Value} = (OBSI_{Meas.} - 102.5) * 0.8$$

General Results of Normalization

- Average difference between measured and modeled levels reduced with normalization

Average Difference = Abs (Meas. – Mod)		
Non-normalized TNM predictions	Normalized for Near Lane OBSI	Normalized for Average of both direction OBSI
1.52 dB	1.31 dB	1.21 dB

- Only 57% of all data points improved (why?)

Simple Statistics

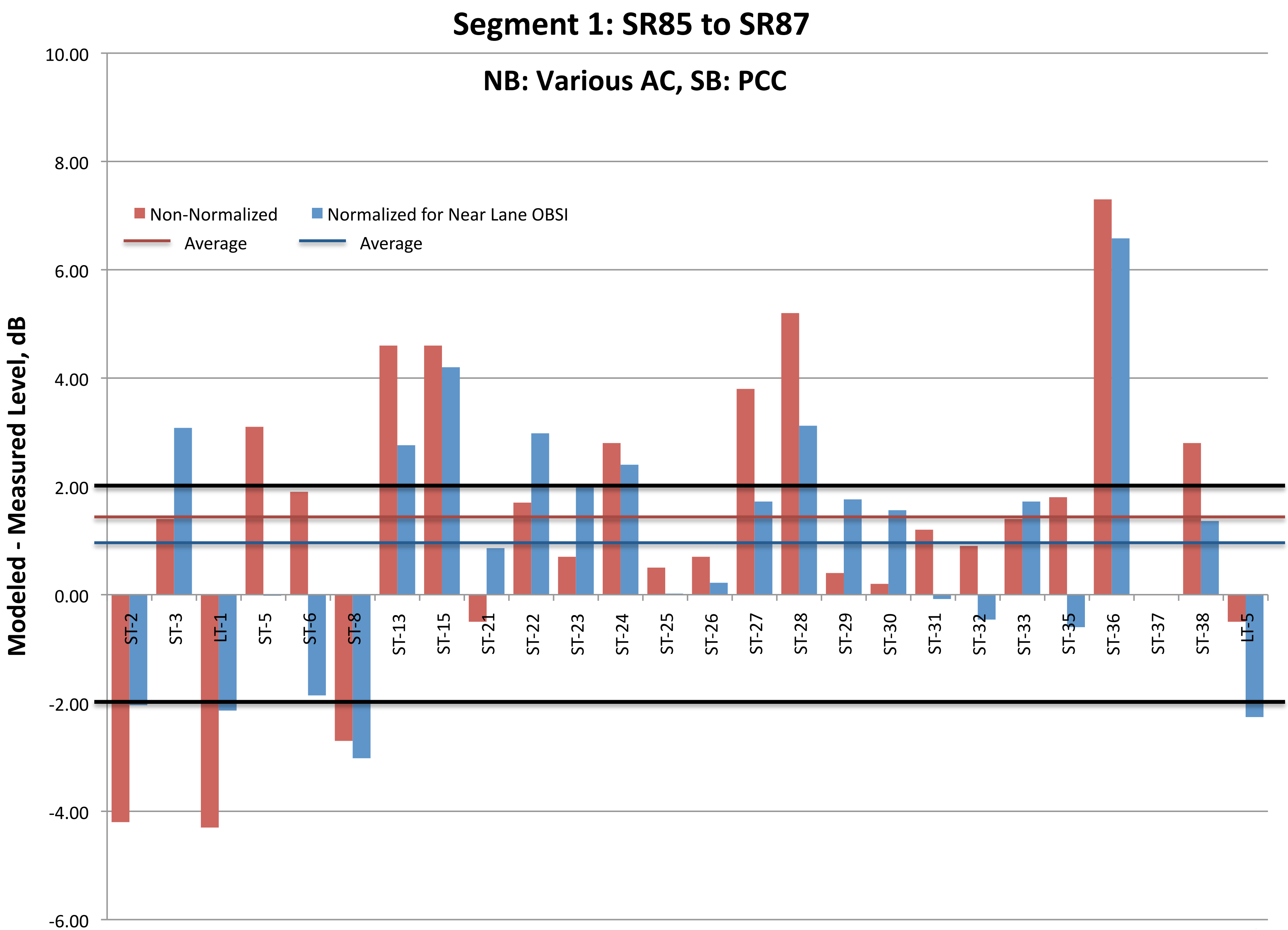
Criteria	No. Improved	Total Number	% Improved
Total	90	157	57%
Model Higher	71	107	66%
Model Lower	19	50	38%
Prediction within 2dB of Measured	34	87	39%
Prediction NOT within 2dB of Meas.	56	70	80%
No Shielding	5	8	63%
Setback	16	38	42%
Adjacent to US 101	48	77	62%
Homogeneous Pavement, Near Lane	77	112	69%
Homogeneous Pave. Both Directions	69	101	69%
Homogeneous Pavement and Predictions NOT within 2dB of Meas.	52	55	95%

Example: Pred. within 2 dB of Meas.

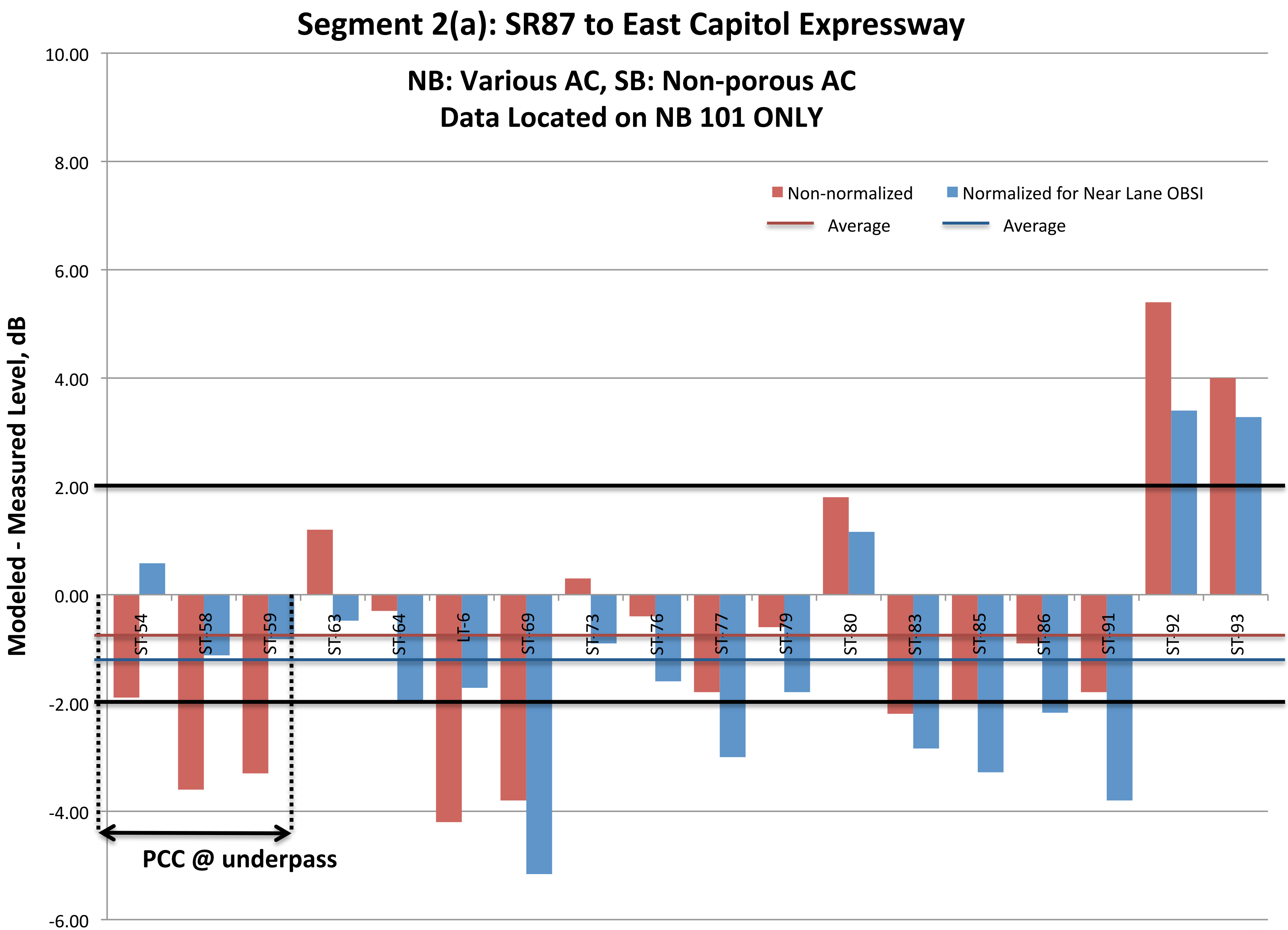
Site	Measured L_{eq}, dBA	Predicted Level, dBA			(Predicted – Measured), dB		
		Non-normalized TNM Prediction	Normalized (Near Lane)	Normalized (Average)	Non-normalized	Normalized (Near Lane)	Normalized (Average)
ST-21	64.5	64	65.4	64.5	-0.50	0.86	-0.06
ST-23	61.7	62.4	63.7	62.1	0.70	1.98	0.30
ST-25	63.9	64.4	63.9	64.8	0.50	0.02	0.94
ST-26	64.8	65.5	65.0	65.9	0.70	0.22	1.14

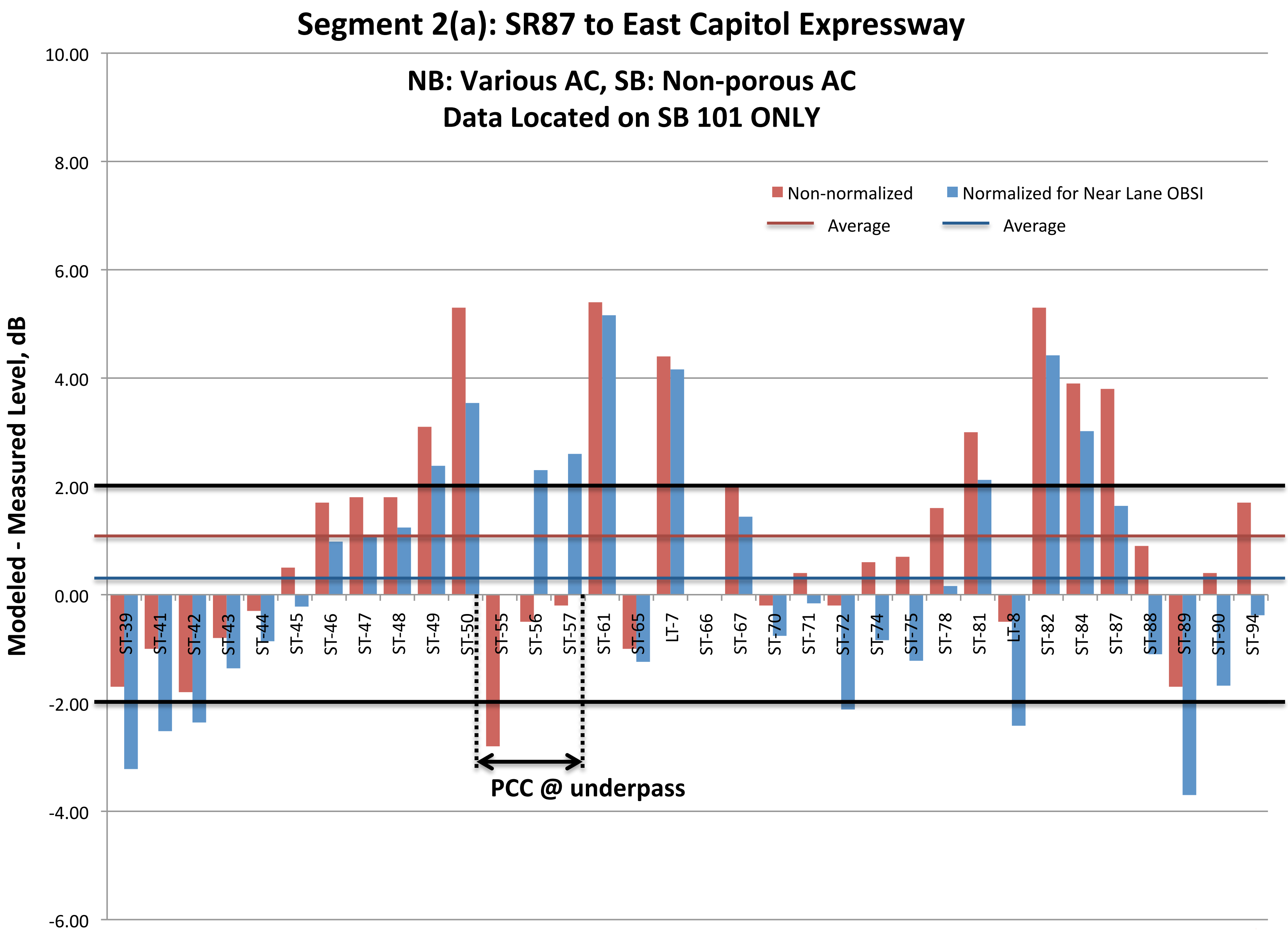
•Typically not adjusted under 23CFR772 to take into account slight variations caused by meteorological conditions, etc

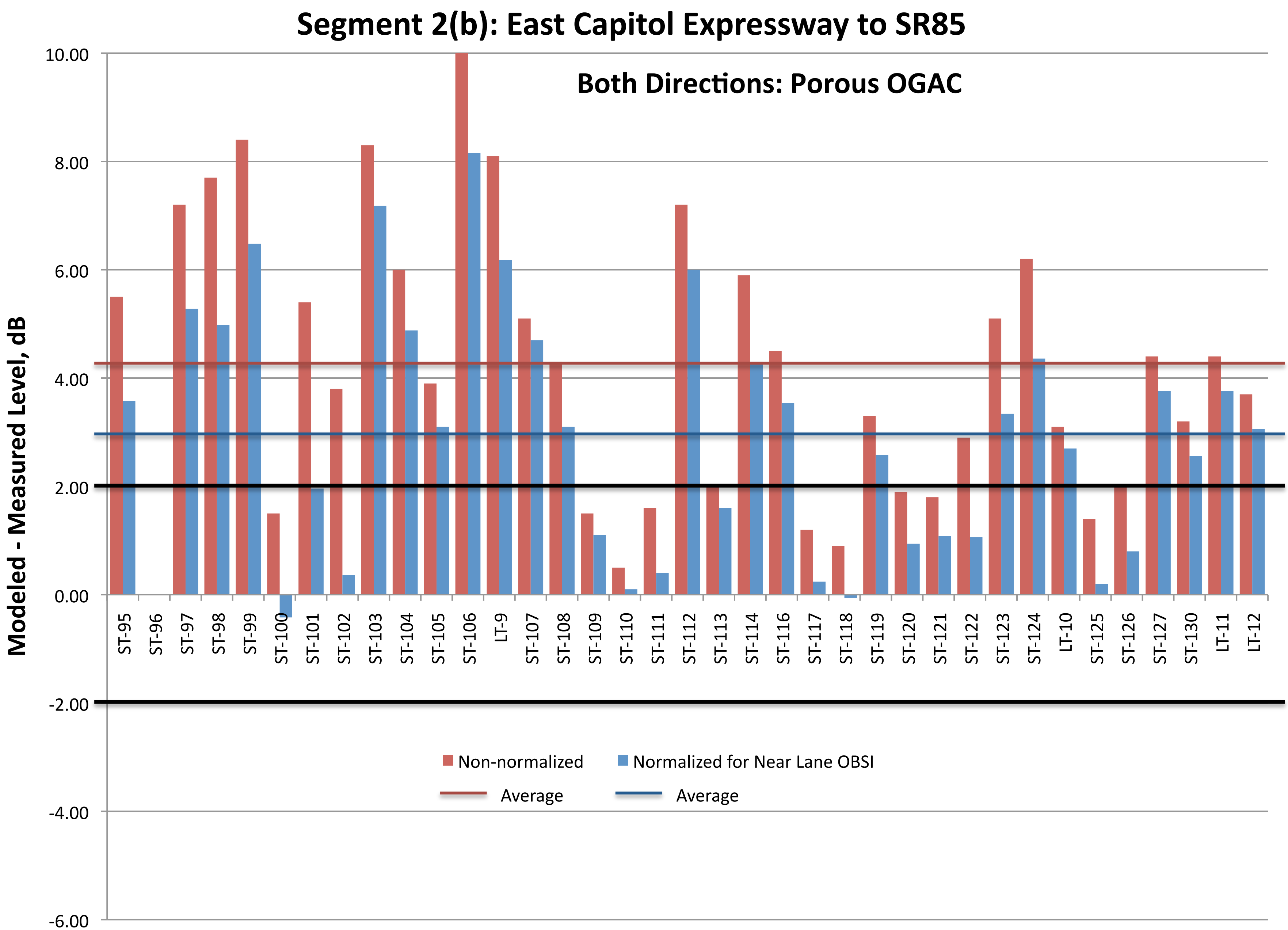
•Although the correlation was 'not improved', differences were typically minimal, indicating scatter in the data rather than poor correlation



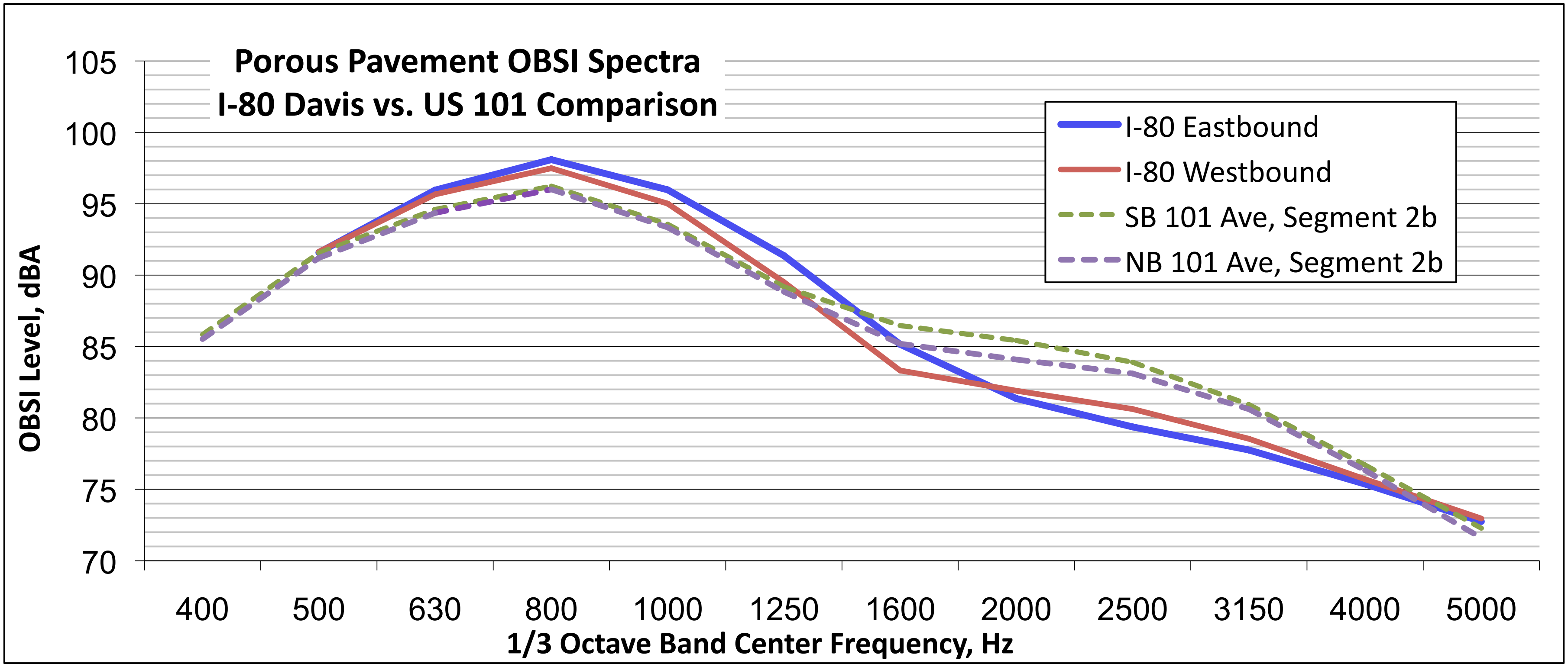
Segment 1: SR85 to SR87
NB: Various AC, SB: PCC
Modeled - Measured Level, dB
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
Non-Normalized
Normalized for Near Lane OBSI
Average
Average
ST-2
ST-3
LT-1
ST-5
ST-6
ST-8
ST-13
ST-15
ST-21
ST-22
ST-23
ST-24
ST-25
ST-26
ST-27
ST-28
ST-29
ST-30
ST-31
ST-32
ST-33
ST-35
ST-36
ST-37
ST-38
LT-5

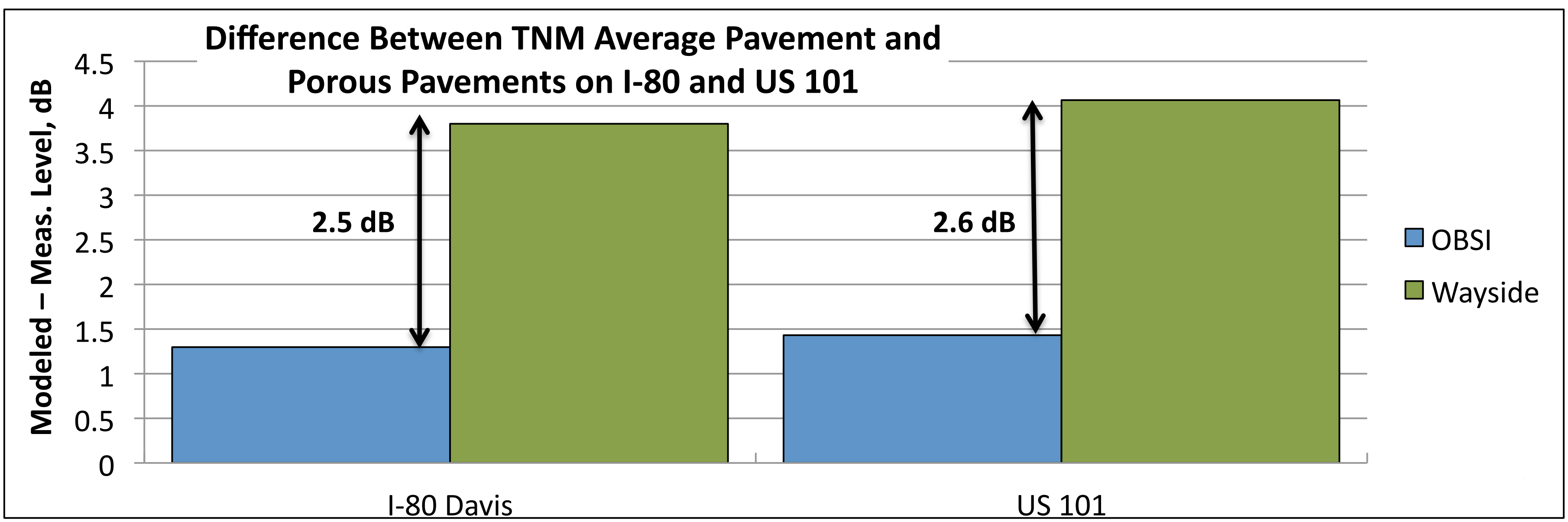

Segment 2(a): SR87 to East Capitol Expressway
NB: Various AC, SB: Non-porous AC
Data Located on NB 101 ONLY
Non-normalized
Normalized for Near Lane OBSI
Average
Average
Modeled - Measured Level, dB
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
ST-54
ST-58
ST-59
ST-63
ST-64
LT-6
ST-69
ST-73
ST-76
ST-77
ST-79
ST-80
ST-83
ST-85
ST-86
ST-91
ST-92
ST-93
PCC @ underpass


Segment 2(a): SR87 to East Capitol Expressway
NB: Various AC, SB: Non-porous AC
Data Located on SB 101 ONLY
Non-normalized
Normalized for Near Lane OBSI
Average
Average
Modeled - Measured Level, dB
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
ST-39
ST-41
ST-42
ST-43
ST-44
ST-45
ST-46
ST-47
ST-48
ST-49
ST-50
ST-55
ST-56
ST-57
ST-61
ST-65
LT-7
ST-66
ST-67
ST-70
ST-71
ST-72
ST-74
ST-75
ST-78
ST-81
LT-8
ST-82
ST-84
ST-87
ST-88
ST-89
ST-90
ST-94
PCC @ underpass



Segment 2(b): East Capitol Expressway to SR85
Both Directions: Porous OGAC
Modeled - Measured Level, dB
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
ST-95
ST-96
ST-97
ST-98
ST-99
ST-100
ST-101
ST-102
ST-103
ST-104
ST-105
ST-106
LT-9
ST-107
ST-108
ST-109
ST-110
ST-111
ST-112
ST-113
ST-114
ST-116
ST-117
ST-118
ST-119
ST-120
ST-121
ST-122
ST-123
ST-124
LT-10
ST-125
ST-126
ST-127
ST-130
LT-11
LT-12
Non-normalized
Normalized for Near Lane OBSI
Average
Average


Porous Pavement OBSI Spectra
I-80 Davis vs. US 101 Comparison
OBSI Level, dBA
105
100
95
90
85
80
75
70
I-80 Eastbound
I-80 Westbound
SB 101 Ave, Segment 2b
NB 101 Ave, Segment 2b
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
1/3 Octave Band Center Frequency, Hz


Difference Between TNM Average Pavement and
Porous Pavements on I-80 and US 101
Modeled – Meas. Level, dB
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2.5 dB
2.6 dB
OBSI
Wayside
I-80 Davis
US 101

Conclusions: General

- OBSI does help to explain contribution of pavement to existing traffic noise levels
- Use of a 'moving average' OBSI level would allow the correlation of a localized OBSI level for each measurement location
- OBSI measurements should be made for each lane of travel
- Need more information on porous pavements

Conclusions: K-Factor

- Use of traditional K-factor does not separate between adjustment factors (Pavement, reflections, transparent shielding, etc)
  - Changes in pavement type or any of the above would not be accounted for in the analysis
  - Use of OBSI adjustments could enable practitioners to account for changes in pavement type under future conditions

Conclusions: Volpe's Experimental Version of TNM

- Accounts for different pavements within the model through the input of OBSI data

- Would allow for the assessment of roadways with varying pavement at receiver locations

Audience Discussion

- Typical Cal-Factors and Modeling Methods?
  - Already discussed on Monday?

- Other methods of using OBSI to validate/ calibrate wayside data?

- Porous Pavements?