TNM 3.0 Update

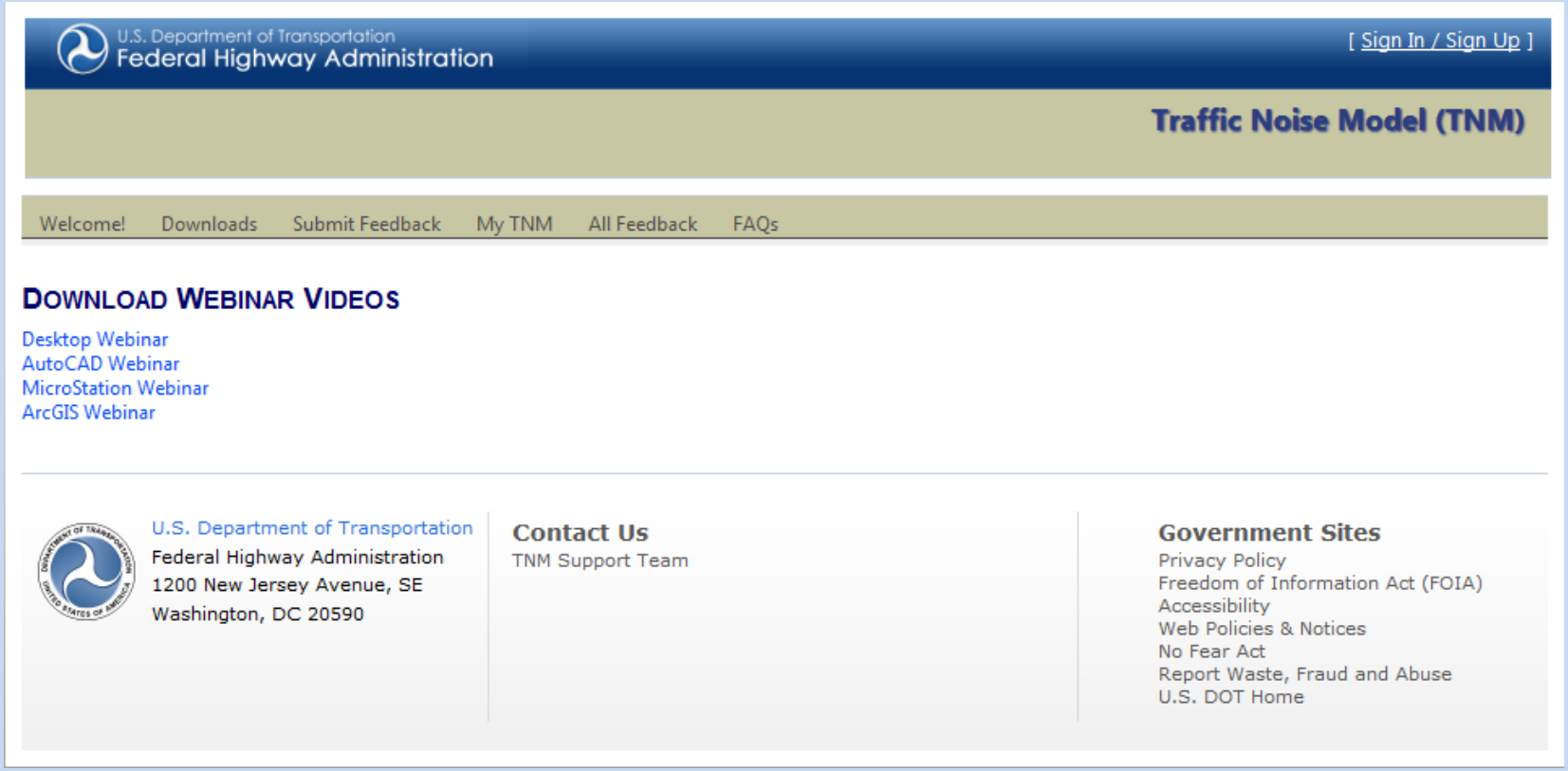
Caltrans Division of Environmental Analysis

TNM 3.0

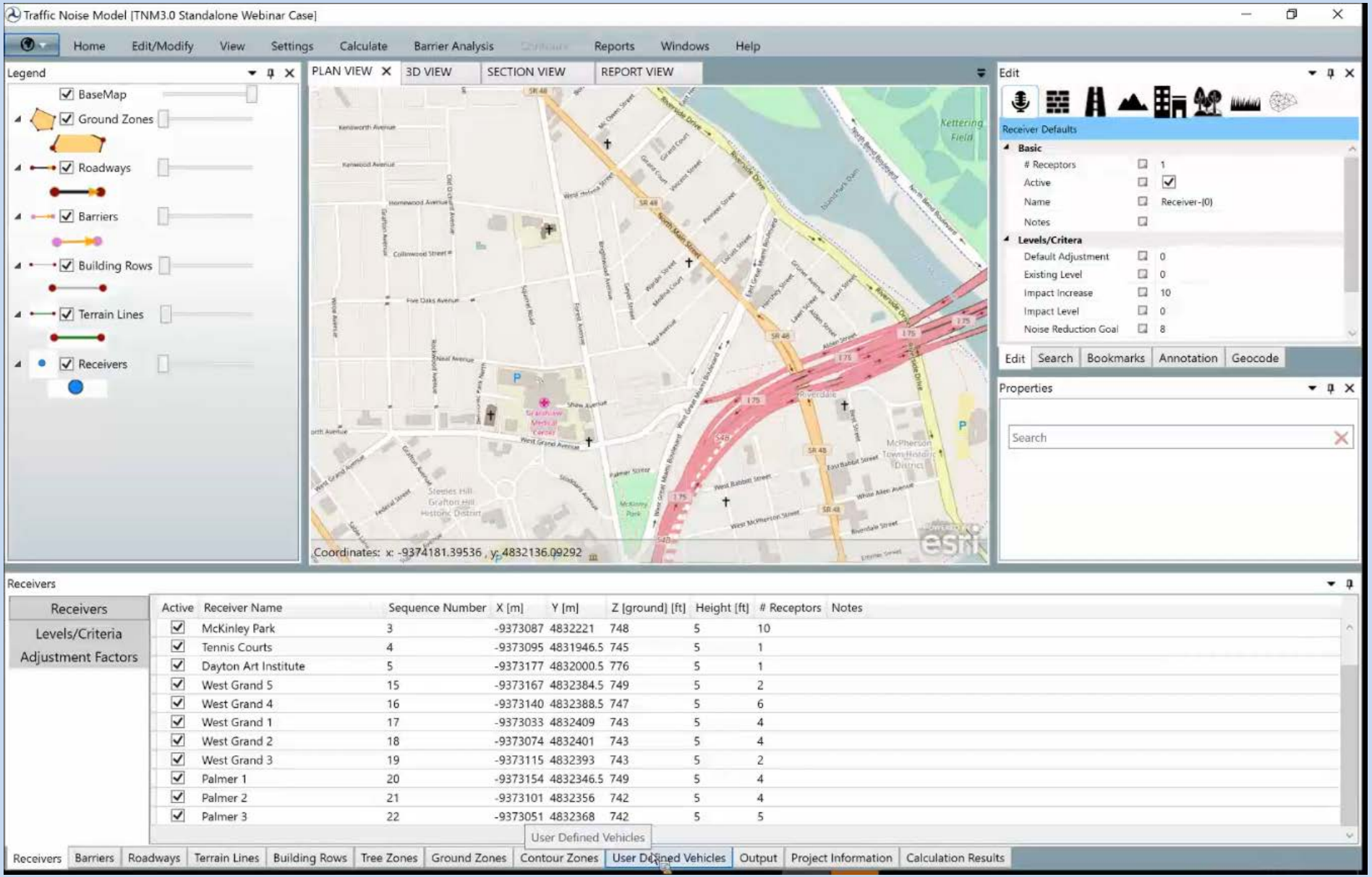
- March 1, 2017 Limited Beta Evaluation ; closed comments Sept 15, 2017
- Improved GUI
- Works w/ ACAD, Esri ArcGIS, Micro Station "Esri runtime built into beta test TNM 3.0 software, have to have active license key to activate this map feature."
- Requires fast PCs and generates huge files; easily overwhelmed w too many receptors
- A few adjustments to TNM acoustic calculations and algorithms

Caltrans

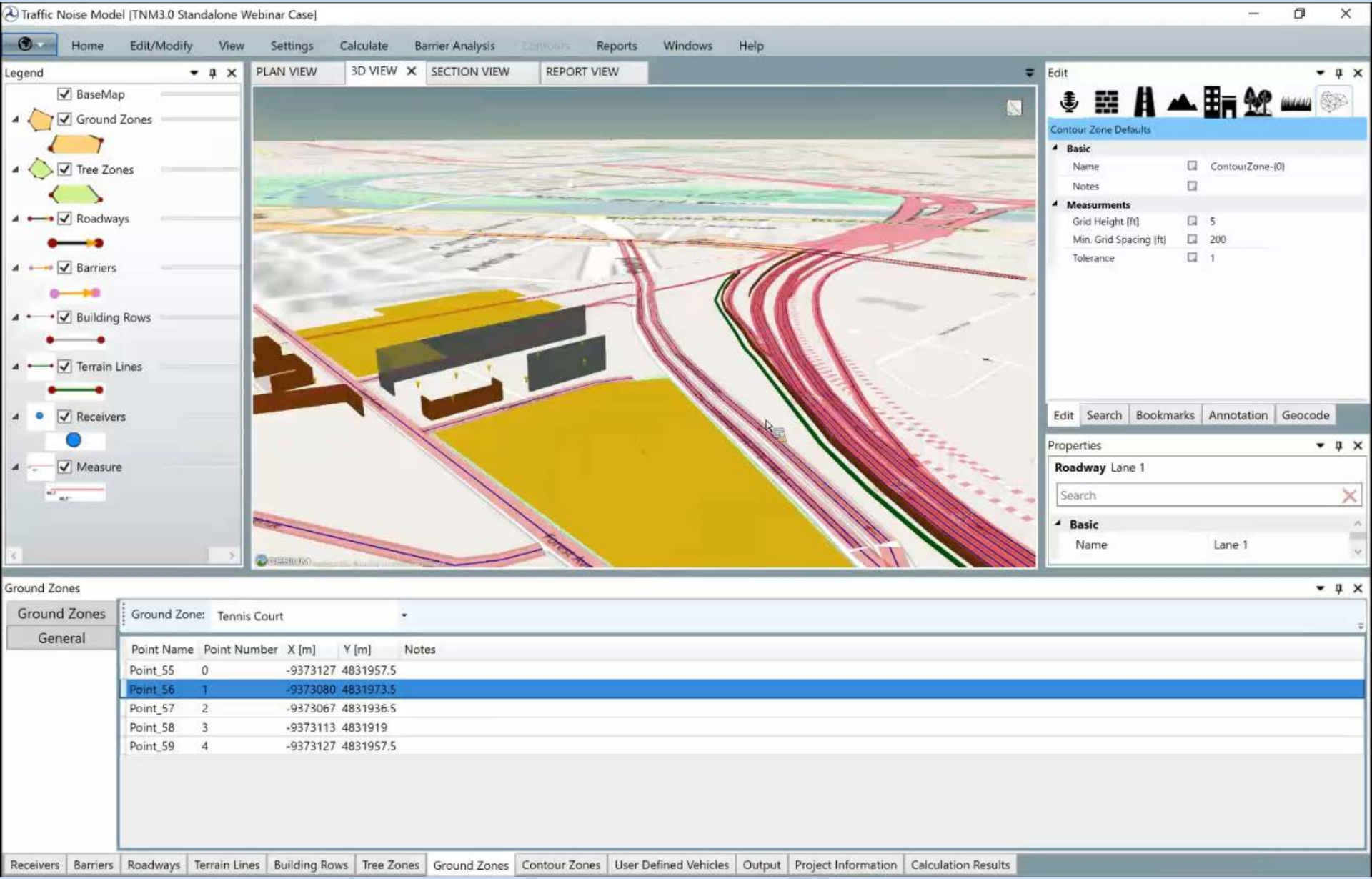
Four Online Webinars Available at: https://hostedsites.volpe.dot.gov/DraftTNM3/Downloads/DownloadWebinars30



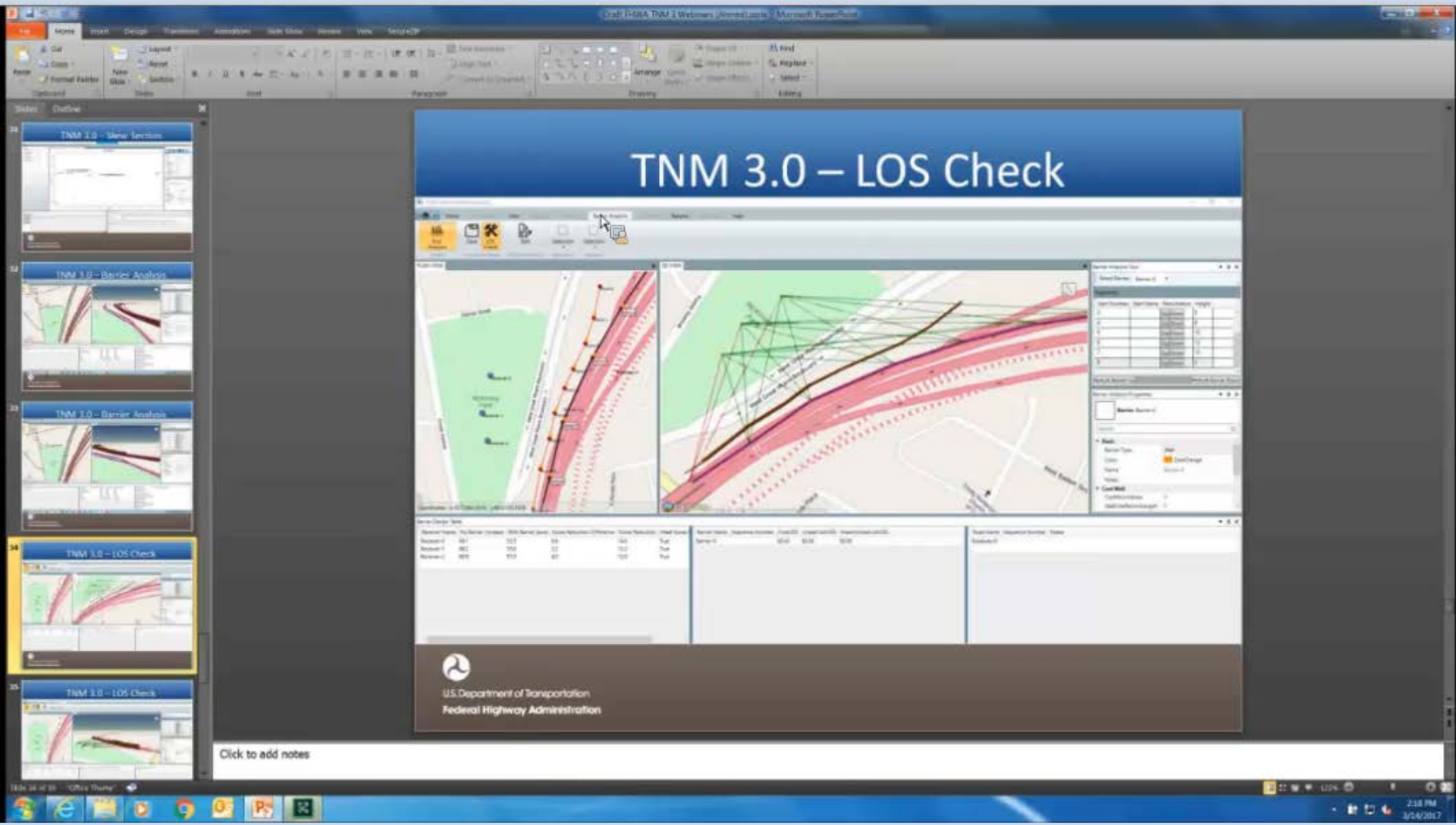
Greatly Improved GUI



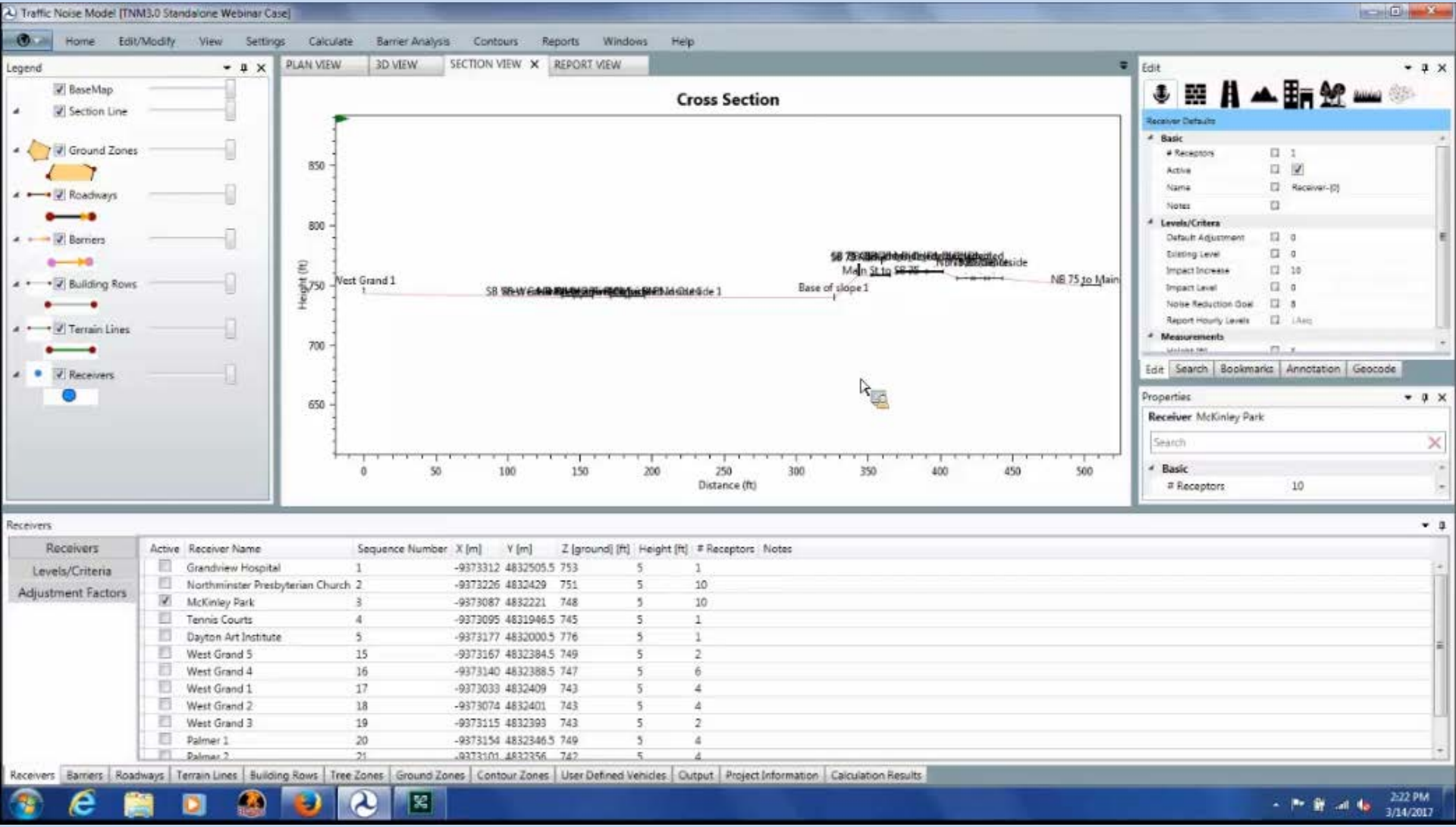
3D View


Traffic Noise Model [TNM3.0 Standalone Webinar Case]
Home
Edit/Modify
View
Settings
Calculate
Barrier Analysis
Reports
Windows
Help
Legend
BaseMap
Ground Zones
Tree Zones
Roadways
Barriers
Building Rows
Terrain Lines
Receivers
Measure
PLAN VIEW
3D VIEW
SECTION VIEW
REPORT VIEW
Edit
Contour Zone Defaults
Basic
Name
ContourZone-(0)
Notes
Measurments
Grid Height [ft]
5
Min. Grid Spacing [ft]
200
Tolerance
1
Edit
Search
Bookmarks
Annotation
Geocode
Properties
Roadway Lane 1
Search
Basic
Name
Lane 1
Ground Zones
Ground Zones
General
Ground Zone:
Tennis Court
Point Name
Point Number
X [m]
Y [m]
Notes
Point_55 0 -9373127 4831957.5
Point_56 1 -9373080 4831973.5
Point_57 2 -9373067 4831936.5
Point_58 3 -9373113 4831919
Point_59 4 -9373127 4831957.5
Receivers
Barriers
Roadways
Terrain Lines
Building Rows
Tree Zones
Ground Zones
Contour Zones
User Defined Vehicles
Output
Project Information
Calculation Results

LOS Check


TNM 3.0 – LOS Check
U.S. Department of Transportation
Federal Highway Administration
Click to add notes

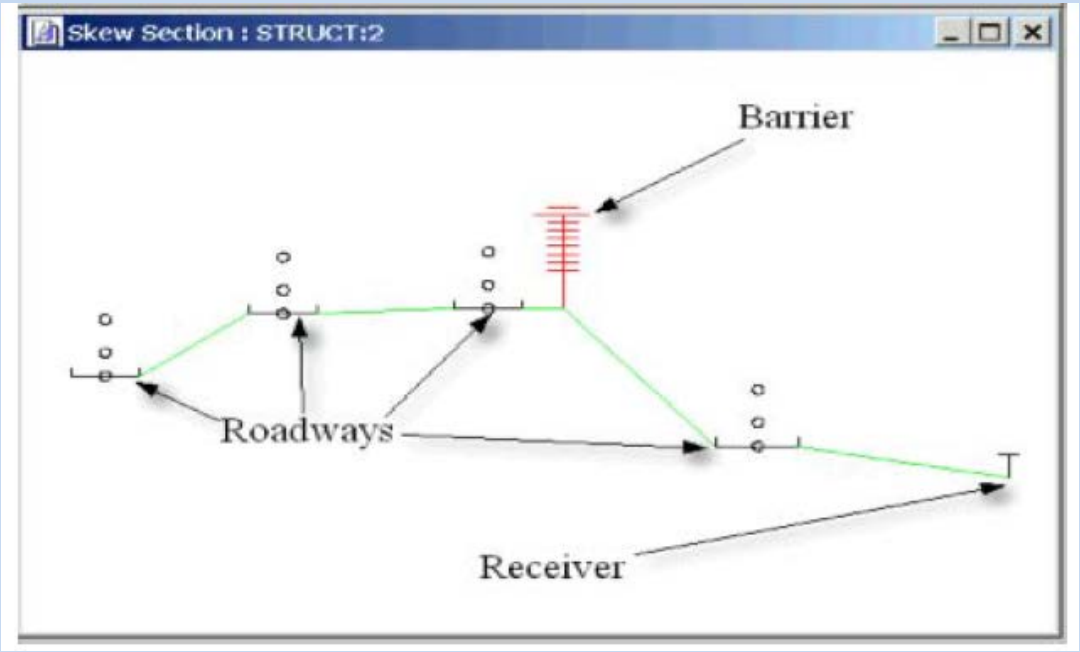
Cross Section View



- Goal: Release late 2017 or Early 2018 (FHWQA has promised for 10 Yrs)
- Experienced trouble with 3rd party software issues in past iterations of TNM.
- Numerous GUI and Acoustic Algorithm bugs reported
- USDOT Volpe Acoustic Center develops TNM & subcontracts technical support to FHWA - $$
- Personnel turnover at DC – FHWA
- FHWA will develop training (or select 3rd Party)

Caltrans

TNM 2.5 Sub Source Heights Sound Energy Distribution



Examples of Percentage Split Between Upper and Lower Source Heights (Cruise)

		Low Frequencies (500 Hz and below)	High Frequencies (2000 Hz and above)
AUTO	5 ft	27%	2%
	0 ft	73%	98%
	12 ft	57%	46%
HEAVY TRUCK			
	0 ft	43%	54%

Source: Bowlby and Assoc., TNM 2.5 Caltrans Training Course Oct 2016

Caltrans LOS 10.5 ft.?

Measurements of the Vertical Distribution of Truck Noise Sources under Cruise

Paul Donavan
Bruce Rymer

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality

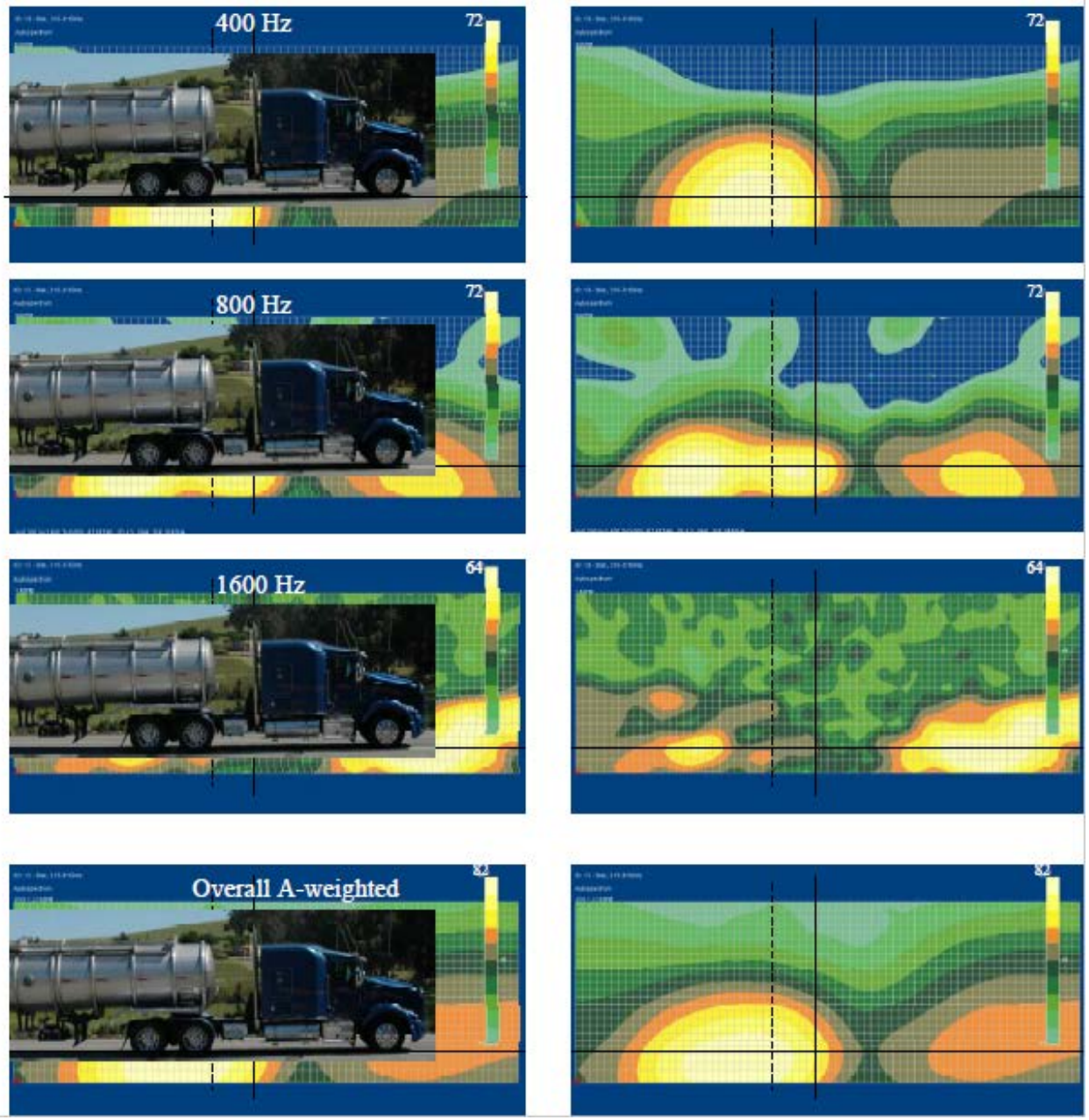
TRB 88th Annual Meeting
January 11-15, 2009
Washington, DC

Acoustic Beam Forming Applied to Trucks

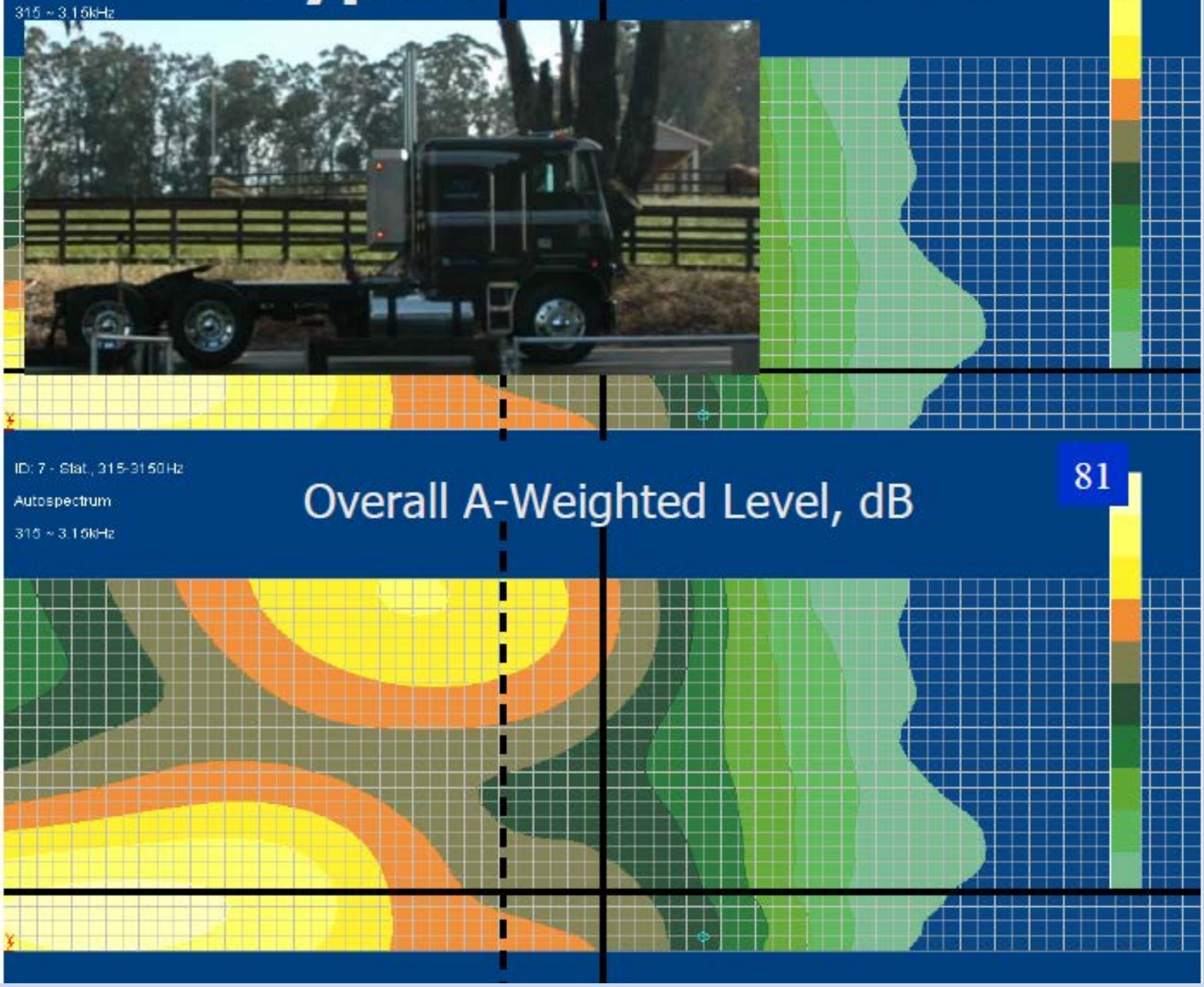
Measurements

- Acoustic "snap-shots" of vehicle passbys on actual highway
  - B&K 90 mic array & processing
  - Internal Matlab based processing
- Test Matrix
  - 3 sites with 3 AC pavements – 55 mph posted speed
  - Over 200 heavy truck passby events
  - Some medium trucks & light vehicles
- Objective
  - Assess vertical distribution truck noise sources for traffic noise modeling purposes
  - Improve understanding of in-service truck noise sources

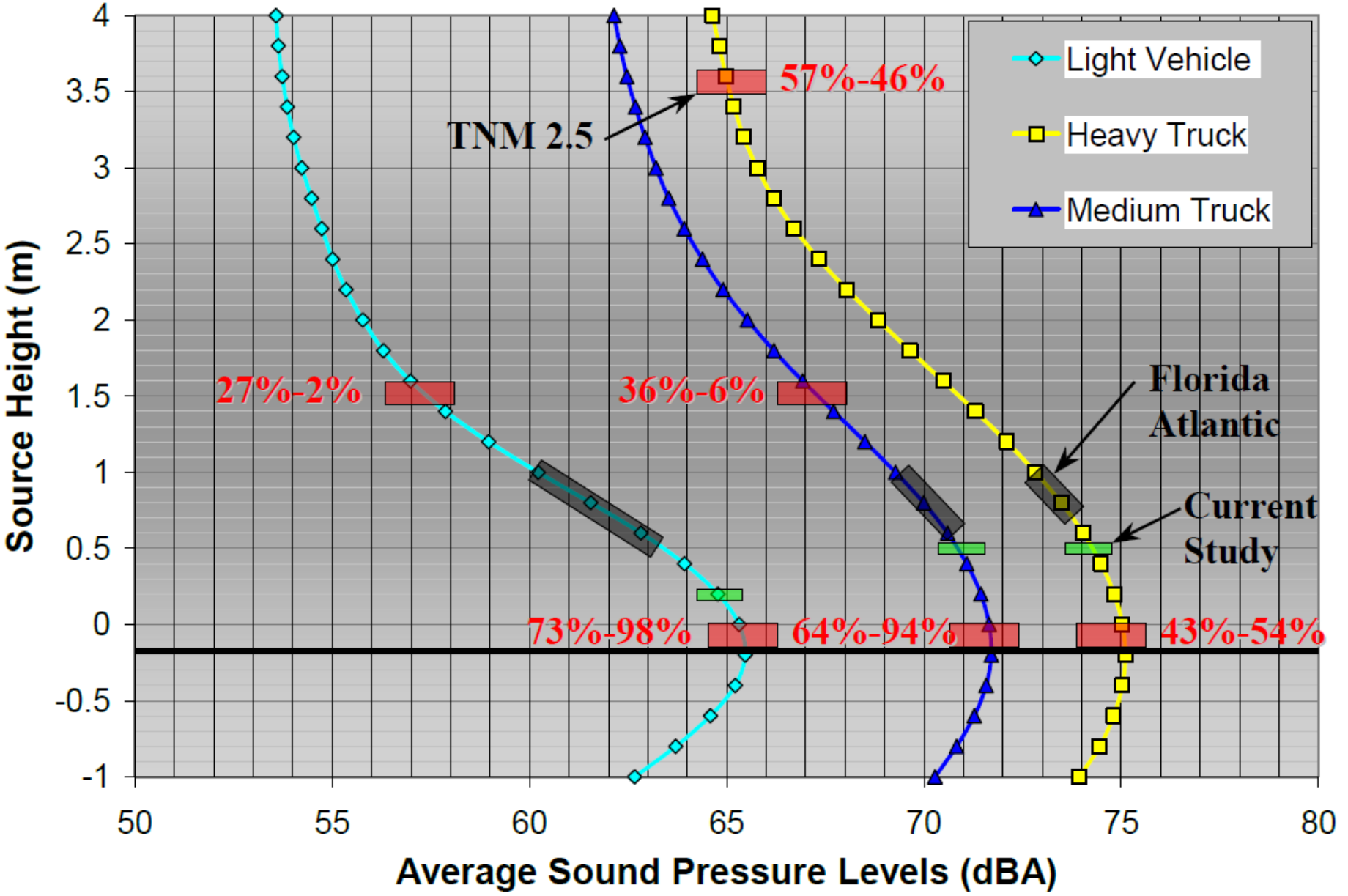
Typical Images for Heavy Trucks



Atypical Exhaust Case



Comparison of Source Distributions



Applications of Heavy Truck Noise Profiles Determined in NCHRP 25-45

Paul Donavan
Carrie Janello

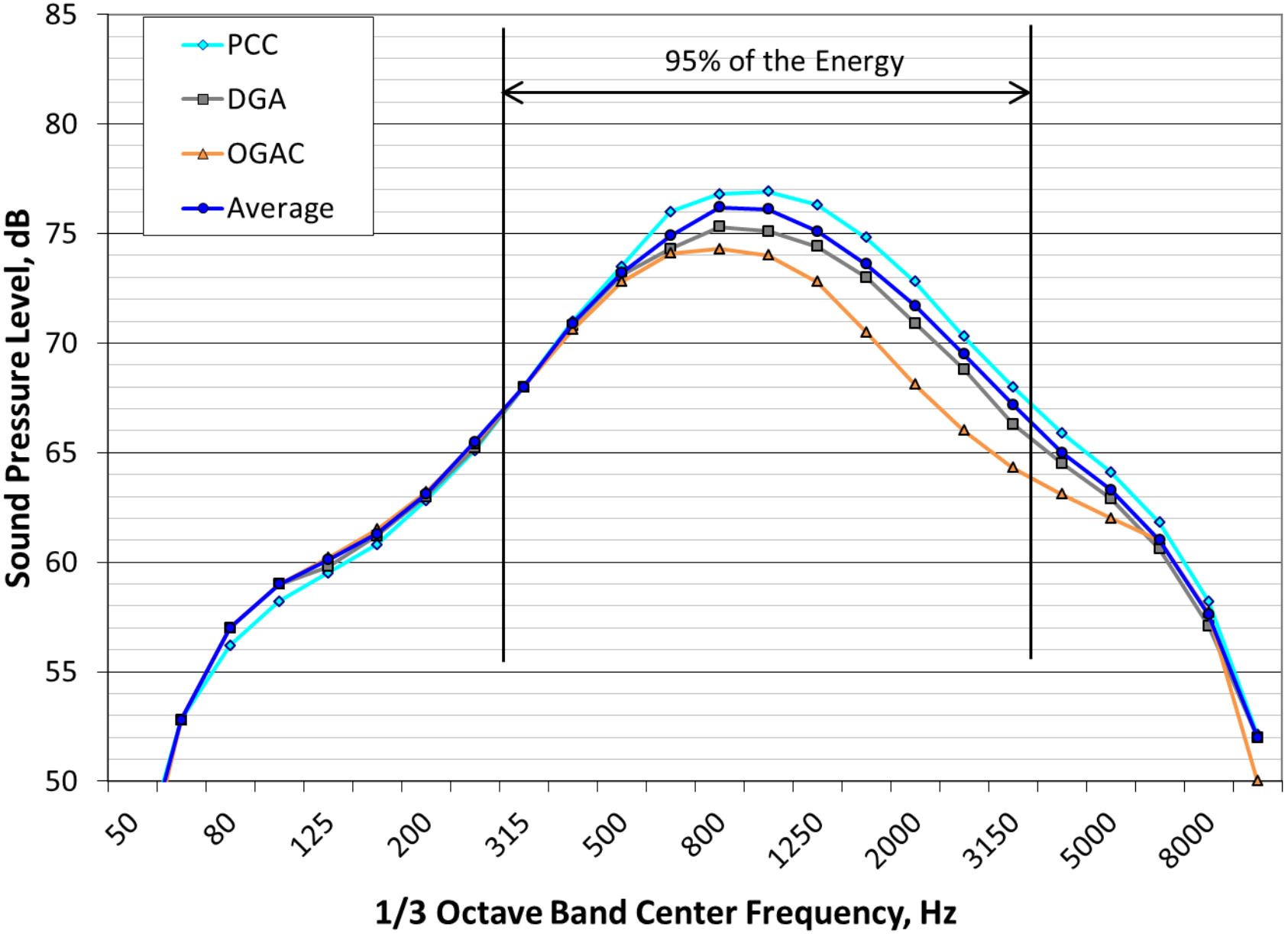
TRB 97th Annual Meeting
January 7-11, 2018
Washington, DC

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality

Acoustic Beam Forming System

- Type WL9x6D2509 Foldable wheel Array
- Equal length arms
- 8.2ft in diameter
- 54 microphones
- Acquisition by B&K PULSE system
- Data processed by delay & sum method
- 315 to 4,000 Hz

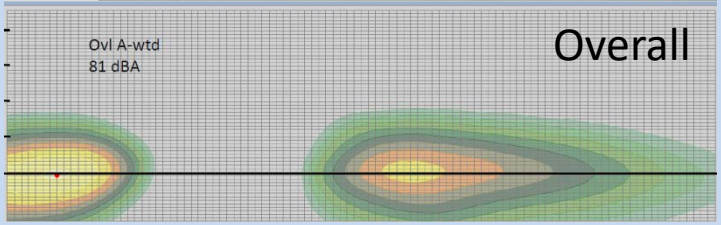
REMELS Heavy Truck Spectrum

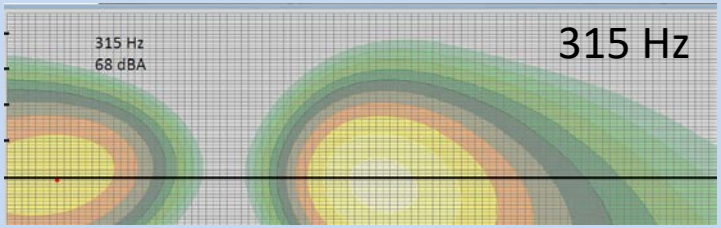


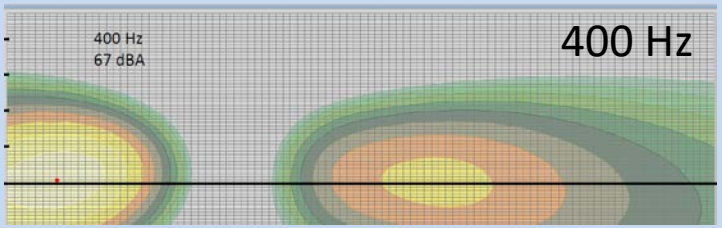
Measurement Program

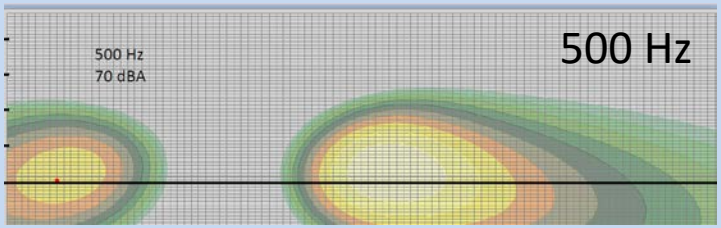
- 20 measurement sites – 4 in California & 16 in North Carolina
  - 6 Level
  - 6 Uphill
  - 5 Downhill
  - 3 Lower speed sites
- 1,289 truck pass-bys
- 29 to 66 mph average speed range
- Pavement types
  - Asphalt – 11, dense graded (9), open graded (2)
  - Concrete – 7, ground (3), transverse tined (4)

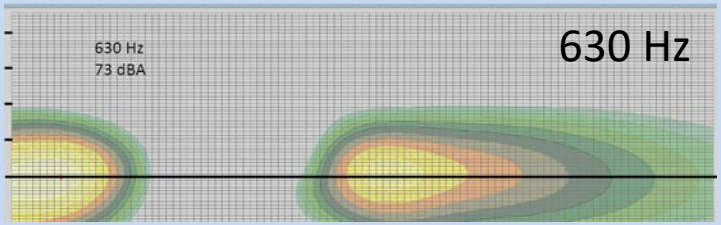

RANCHER'S
Reserve
Exclusively at SAFEWAY


Ovl A-wtd
81 dBA
Overall

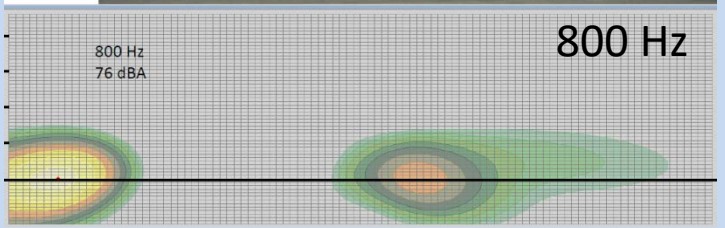

315 Hz
68 dBA
315 Hz

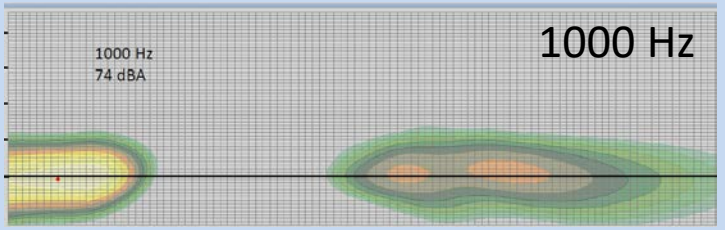

400 Hz
67 dBA
400 Hz

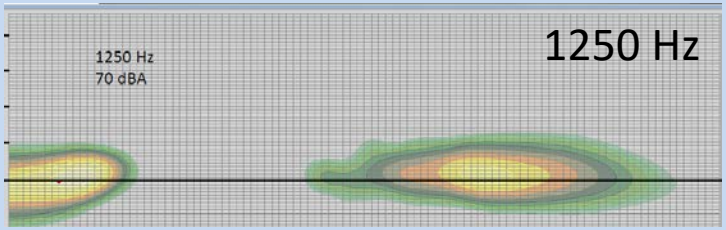

500 Hz
70 dBA
500 Hz

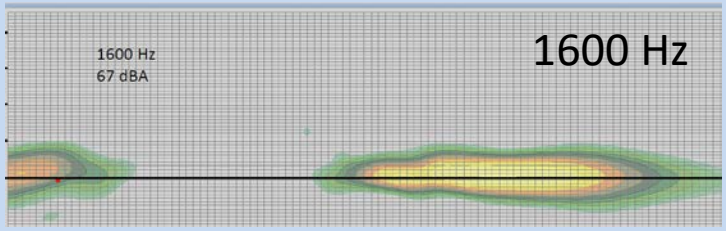

630 Hz
73 dBA
630 Hz

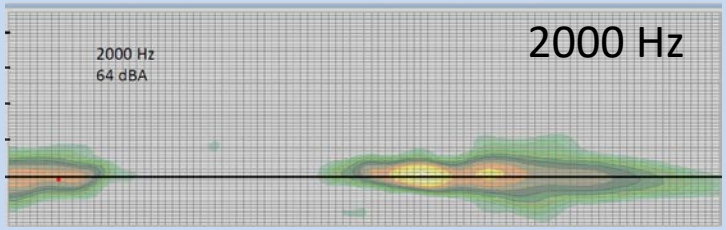

RANCHER'S
Reserve
Exclusively at SAFEWAY


800 Hz
76 dBA
800 Hz


1000 Hz
74 dBA
1000 Hz


1250 Hz
70 dBA
1250 Hz


1600 Hz
67 dBA
1600 Hz


2000 Hz
64 dBA
2000 Hz

2-Point Source Distribution Approximation

1/3 Octave Band Frequency Band	Lower Source			Upper Source		
	Height	Level	Source Strength	Height	Level	Source Strength
315 Hz	0ft (0m)	80.5 dBA	44%	3.3ft (1m)	81.5 dBA	56%
400 Hz	0ft (0m)	82.5 dBA	56%	3.3ft (1m)	81.6 dBA	44%
500 Hz	0ft (0m)	86.6 dBA	65%	3.3ft (1m)	84.0 dBA	35%
630 Hz	0ft (0m)	87.0 dBA	59%	2.3ft (0.7m)	85.5 dBA	41%
800 Hz	0ft (0m)	88.5 dBA	67%	2.3ft (0.7m)	85.5 dBA	33%
1,000 Hz	0ft (0m)	88.0 dBA	67%	2.3ft (0.7m)	85.0 dBA	33%
1,250 Hz	0ft (0m)	85.5 dBA	74%	2.3ft (0.7m)	81.0 dBA	26%
1,600 Hz	0ft (0m)	82.5 dBA	69%	1.6ft (0.5m)	79.0 dBA	31%
2,000 Hz	0ft (0m)	80.0 dBA	78%	1.6ft (0.5m)	74.5 dBA	22%
2,500 Hz	0ft (0m)	77.3 dBA	77%	1.6ft (0.5m)	72.0 dBA	23%
3,150 Hz	0ft (0m)	73.8 dBA	62%	1ft (0.3m)	71.7 dBA	38%
4,000 Hz	0ft (0m)	71.2 dBA	65%	1ft (0.3m)	68.5 dBA	35%

Point Source Summary

- A source at 12ft is unrealistic for matching average truck profile any split
- Upper source height must vary with frequency to match average truck profiles from 3.3 to 1.3 ft
- Splits between upper & ground level sources must vary independently
- Future modeling should use 25-45 profile or equivalent two point source model

Barrier/Distribution Observations

- Height distributions are substantially modified by barriers
- Distributions used in TNM do not reflect actual trucks measured in open conditions
- TNM distributions show higher sensitivity to increasing barrier height
  - **Could result in higher walls**
  - **Could result in more walls being not feasible or reasonable**

TNM Analysis

Making Sausage

Questions ?

Early Caltrans Beamforming Measurements
April 2007 in D-4 Petaluma, CA

Time Saving Workflows with FHWA TNM 2.5 and 3.0

AASHTO Meeting June 27-28, 2018

What is the role of Noise staff at DOT?

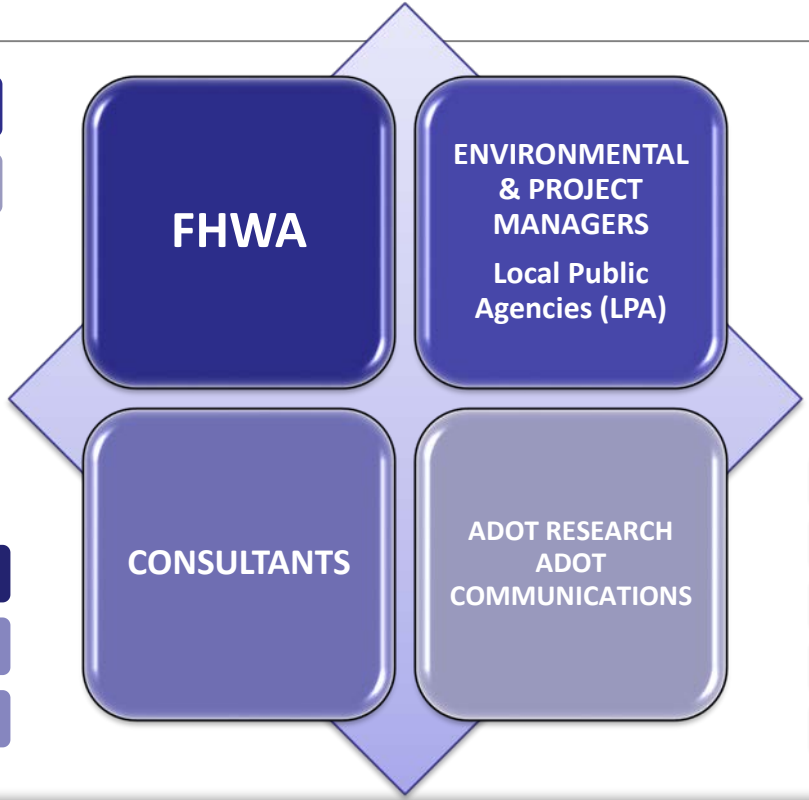
Noise Abatement Policy – for approval

Noise Wall Inventory

Scope of works - review

Instructions and guidance

Review of Traffic Noise Analysis Report



Scope of works - review

Traffic Noise Analysis

- **Screening**
- Reports, **re-evaluations**
- Construction Noise Analysis

Public meetings

Ad hoc impact studies (**fog seal, chip seal**)

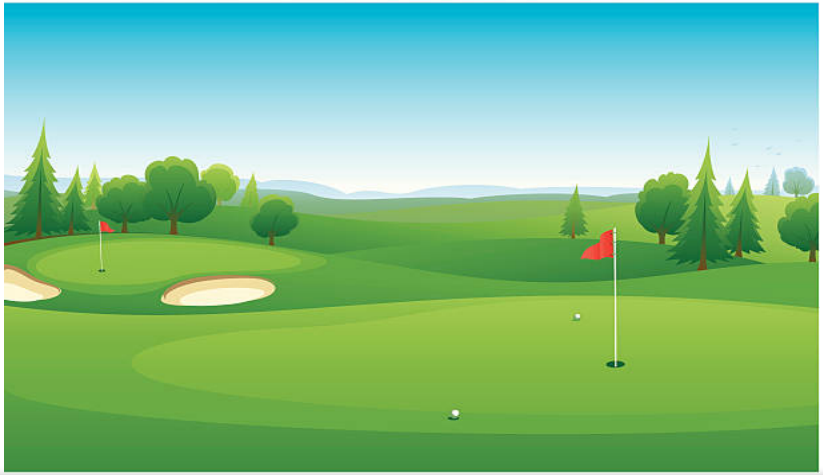
Continuous improvement

Facts about noise & FAQ

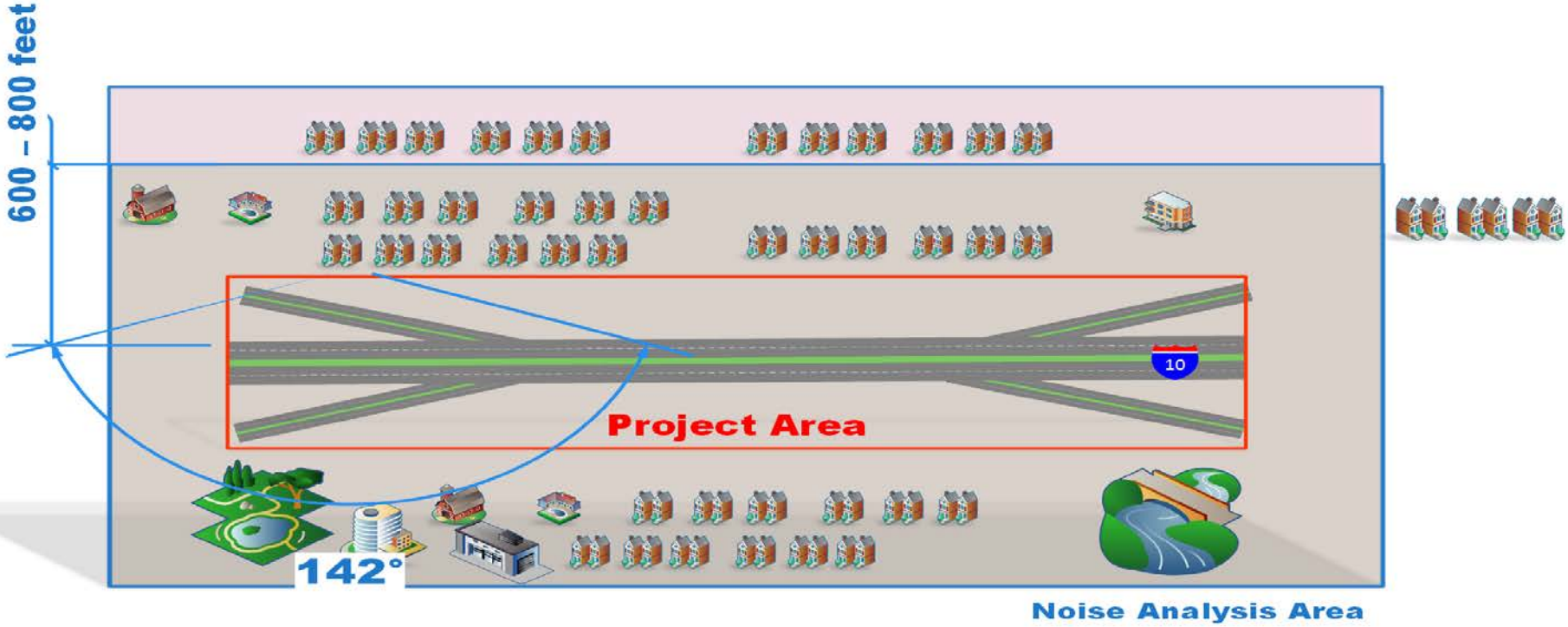
Noise inquiries response & measurements

Public meetings

What is STREAMLINING?



Land Use Determination—Distance from project area



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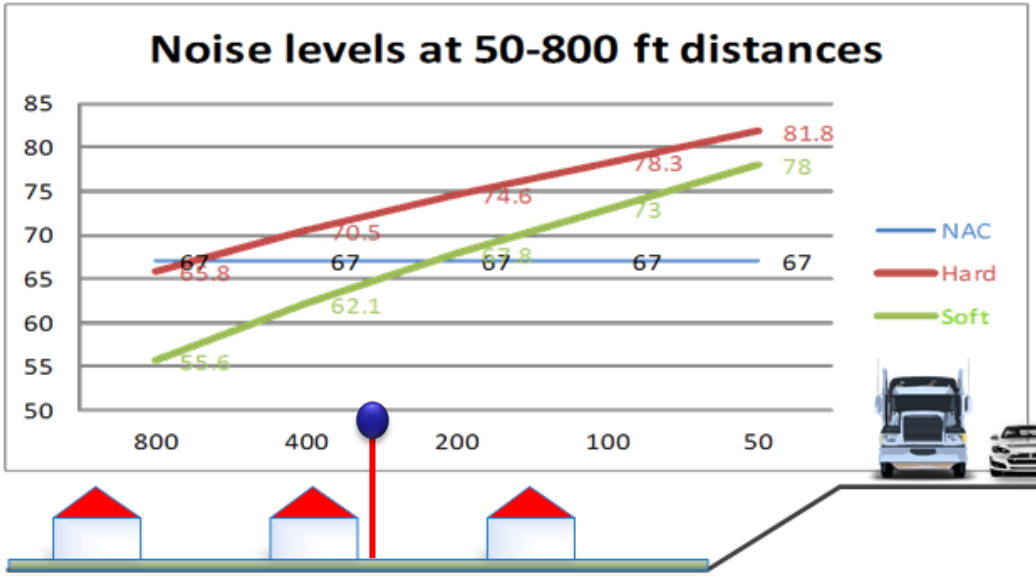


Hourly volume	7500	%	mph
	Auto	90	70
	MedTruck	5	70
	HevTruck	5	70

ADOT distance for undeveloped land

Work Breakdown Structure - WBS+Time+Budget

BUDGET STRUCTURE									
DIRECT EXPENSES								INDIRECT EXPENSES	TOTAL EXPENSES
Humans resources			Equipment	Material	Outsourding	Other expenses	TOTAL DIRECT	Overhead	SUM OF DIRECT ANF INDIRECT EXPENSES
HOURS	rate	Total						% of Direct Expenses	
	$/h	In US$					US$	Rate (%) in calc. 0%	US$
								US$	
6.00	115.00	690.00					690.00	0.00	690.00
5.00	115.00	575.00					575.00	0.00	575.00
3.00	115.00	345.00					345.00	0.00	345.00
17.00	95.00	1,615.00					1,615.00	0.00	1,615.00
5.00	95.00	475.00					475.00	0.00	475.00
4.00	95.00	380.00					380.00	0.00	380.00
2.00	140.00	280.00					280.00	0.00	280.00
42		4,360.00							4,360.00


TNM 3.0 improvement
Hours
25
20
15
10
5
0
PROJECT ADMINISTRATION
PROJECT DATA COLLECTION - (all...
Data review and assessment
Noise measurement in the field
Modeling using FHWA TNM 2.5
TNM Model validation
Noise Abatement Measures evaluation
NOISE ANALYSIS REPORT
PUBLIC PRESENTATION OF NOISE...
Assessment of consultants team...

From planning to EIS Tier 1 analysis - TNM 3.0 screening

Preliminary Alternatives Selection Determination

- Long-term studies
- Stakeholders inputs

Selection of Alternatives

- List of Alternatives with Segments
- Evaluation

EIS Tier 1

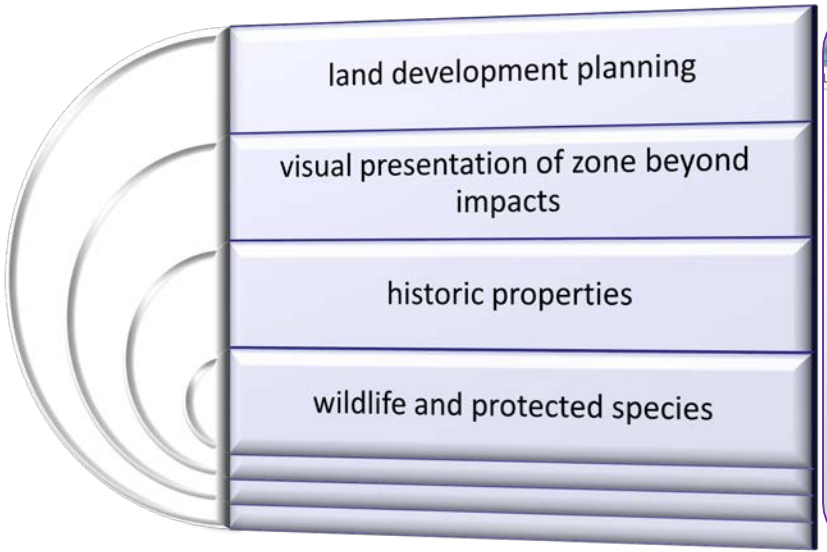
- Alternative 1 (Segments 1, 2, 3)
- Alternative 2 (Segments 4, 5, 6)

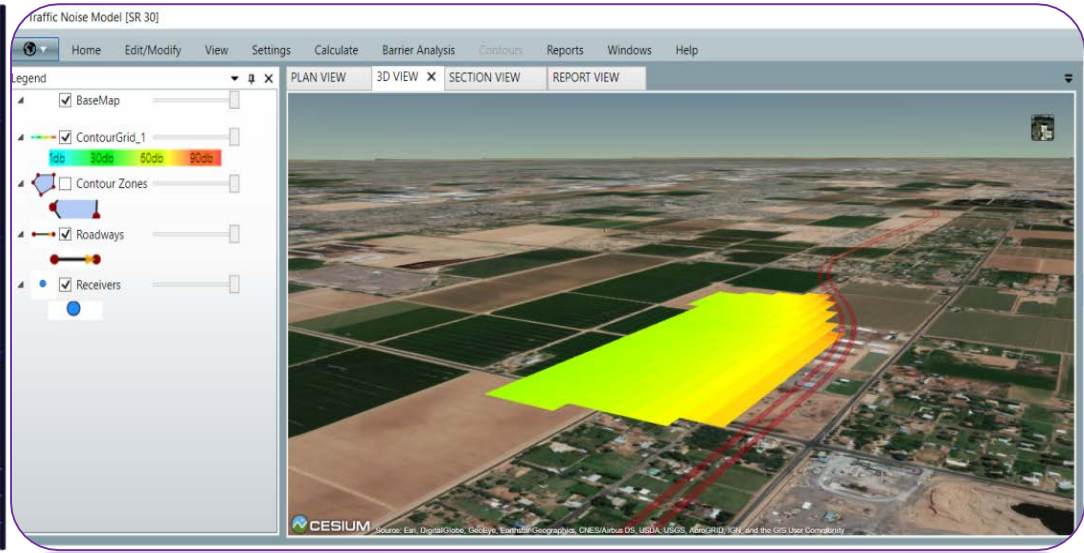
EIS Tier 2

- Qualitative Evaluation of Selected Alternatives

- Quantitative Evaluation of Selected Alternative and Segments

EIS Tier 1 analysis
- TNM 3.0 screening and contours





Pavement treatment
Site equivalency by TNM 3.0

- Modeling median barrier
- Modeling reflections off median barrier
- Single vs multilane modeling
- Atmospheric conditions temperature and humidity

NOISE LEVELS - MEASURED

Pre-lay	Day after	Week after	Month after	
27-Apr	29-Apr	4-May	25-May	
Location 1 – 3A				**Increase**
14:00	17:52	13:05	12:56	
77.3	78.3	79.3	81.1	
76.9	78.7	78.4	81.7	
76.9		78.9	81.2	
77.0	78.5	78.9	81.3	4.3
Location 2				**Increase**
14:39	18:35		13:37	
76.0	76.4		77.3	
75.5	75.4		77.4	
74.9			76.9	
75.5	75.9		77.2	1.7
Location 3				**Increase**
15:30		13:33	14:15	
77.1		79.3	79.7	
77.6		78.9	79.1	
77.4		79.2	79.3	
77.4		79.1	79.4	2.0
Location 4				**Increase**
16:15	15:29		15:21	
74.2	72.8		74.1	
74.1	73.3		75.2	
73.5	72.6		75.4	
73.9	72.9		74.9	1.0
Location 5				**Increase**
16:54	16:08	14:16	15:57	
76.6	76.4	78.6	79.4	
76.7	77.0	76.6	79.0	
77.0	76.9	75.9	79.7	
76.8	76.8	77.0	79.4	2.6
Location 6				**Increase**
17:54	16:45	15:14	16:43	
76.8	78.7	81.5	79.9	
77.0	78.6	81.1	79.7	
	78.6		80.1	
76.9	78.6	81.3	79.9	3.0
			AVERAGE	2.4
			MEDIAN	2.3

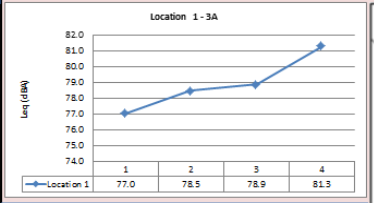
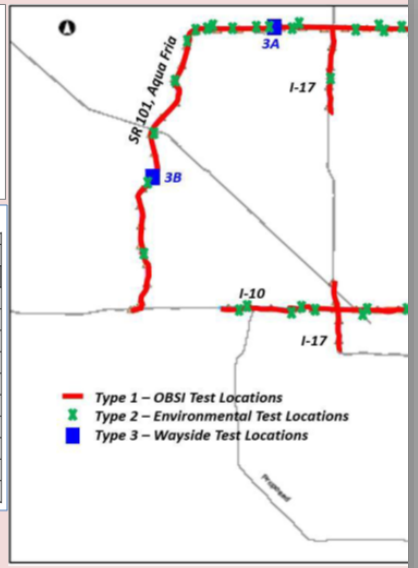


Table 6. Comparison of Average Measured and Modeled Site 3A Wayside Traffic Noise Levels

Testing Period	Average Measured L_{eq} dBA				Average Modeled L_{eq} dBA			
	50ft/ 12ft	50ft/5ft	100ft/ 5ft	175ft/ 5ft	50ft/ 12ft	50ft/5ft	100ft/ 5ft	175ft/ 5ft
Pre-Overlay (Aug 03)	82.5	82.3	76.7	--	79.8	79.9	77.5	74.7
Post-Overlay (Oct 03)	74.6	74.2	--	--	81.1	81.1	--	--
1-Year (Sep 04)	74.8	75.1	71.3	66.9	79.5	79.5	77.3	74.6
1.5-Year (Apr 05)	75.1	75.0	70.4	65.1	79.2	79.2	76.9	74.1
2.5-Year (Mar 06)	75.8	75.7	72.1	67.6	79.8	79.8	77.4	74.6
7-Year (Nov 10)	76.9	77.2	72.1	67.0	79.2	79.2	76.7	73.9
8-Year (Nov 11)	77.0	76.9	71.2	65.2	79.4	79.5	77.0	74.1
9-Year (Oct 12)	77.5	77.6	72.3	66.3	79.7	79.7	77.3	74.4
10-Year (Oct 13)	77.9	77.9	73.1	67.3	79.0	79.1	76.6	73.8
11-Year (Oct 14)	78.2	77.9	73.0	66.9	79.2	79.3	76.8	73.9
12-Year (Oct 15)	78.4	78.4	74.0	68.1	79.2	79.2	76.9	74.0



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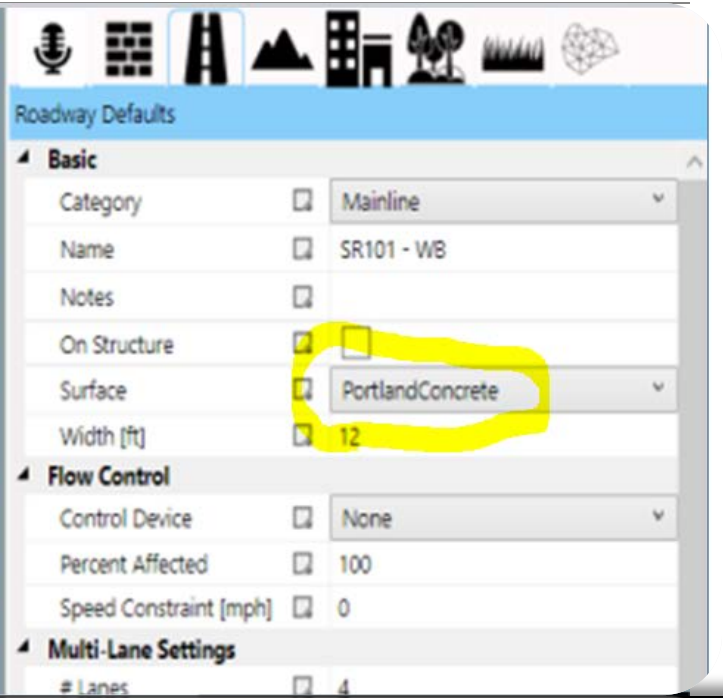


Noise Impact Determination

Methodology meeting

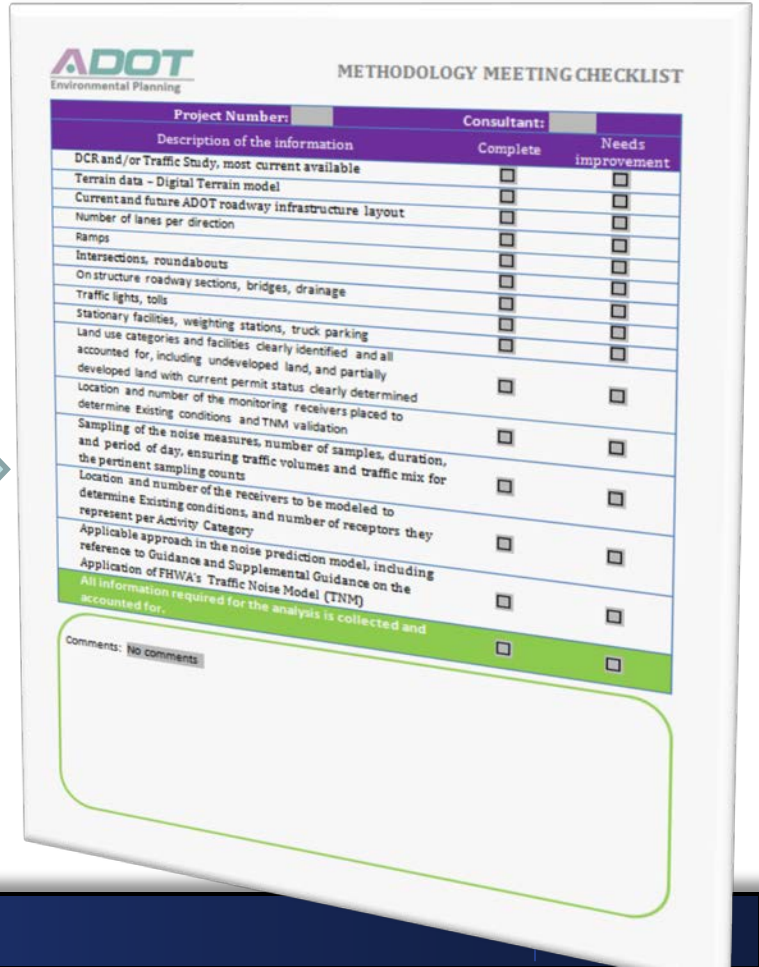
FHWA TNM Inventory Features

- DCR, Traffic Study,
- Terrain data
- Engineering documents
- Highway Infrastructure
- Land use inventory

Noise measurements

- Sites
- Procedure

FHWA TNM modeling approach



ADOT Environmental Planning

METHODOLOGY MEETING CHECKLIST

Project Number:	Consultant:	
Description of the information	Complete	Needs improvement
DCR and/or Traffic Study, most current available	☐	☐
Terrain data – Digital Terrain model	☐	☐
Current and future ADOT roadway infrastructure layout	☐	☐
Number of lanes per direction	☐	☐
Ramps	☐	☐
Intersections, roundabouts	☐	☐
On structure roadway sections, bridges, drainage	☐	☐
Traffic lights, tolls	☐	☐
Stationary facilities, weighting stations, truck parking	☐	☐
Land use categories and facilities clearly identified and all accounted for, including undeveloped land, and partially developed land with current permit status clearly determined	☐	☐
Location and number of the monitoring receivers placed to determine Existing conditions and TNM validation	☐	☐
Sampling of the noise measures, number of samples, duration, and period of day, ensuring traffic volumes and traffic mix for the pertinent sampling counts	☐	☐
Location and number of the receivers to be modeled to determine Existing conditions, and number of receptors they represent per Activity Category	☐	☐
Applicable approach in the noise prediction model, including reference to Guidance and Supplemental Guidance on the Application of FHWA's Traffic Noise Model (TNM)	☐	☐
All information required for the analysis is collected and accounted for.	☐	☐

Comments: No comments

Methodology meeting

Preparation for Methodology meeting,

A phase where consultant acquires relevant information for the noise analysis

Methodology meeting

A phase where both consultant and ADOT EP Noise discuss noise analysis requirements in detail

Field Measurement, Existing conditions TNM modeling and model calibration

A phase where consultant prepares TNM model for ADOT EP Noise preliminary review

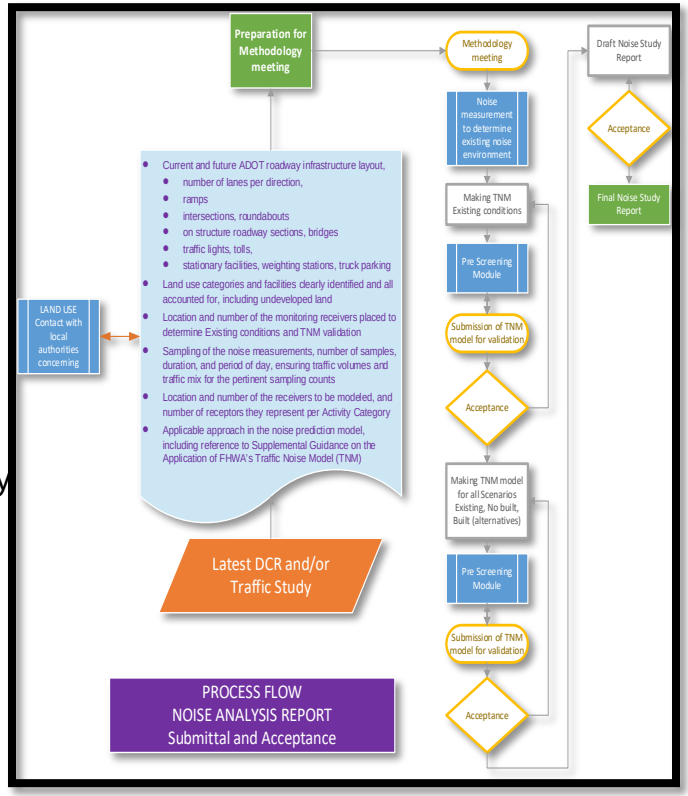
Acceptance of TNM model for Existing conditions by ADOT EP Noise

Future prediction TNM modeling, with impact determination and abatement measures consideration, internal review by consultant, following Pre-screening module

Acceptance of TNM model for Future conditions, with impact determination and abatement measures consideration, by ADOT EP Noise

Submittal draft report, and acceptance

Acceptance of the Final Report



Conclusion

- *"a modernized and streamlined State government is one that moves at the **speed of business**… State government thinks and does business as one enterprise."*

https://ams.az.gov/

LEAN, *removing **Muda** (waste), **Muri** (overburden) and **Mura** (unevenness)*

In Noise, by removing

- *Squirrels*
- *Bells, and*
- *Whistles*

Beverly Chenausky
Joonwon Joo

Tremaine Wilson
Angie Newton
Joe D'Onofrio

Fred Garcia

AdotAirNoise@azdot.gov