Session 8
Traffic Noise Modeling: Best Practices for Modeling and Review of Models

- Facilitator: Tom Hanf, Michigan DOT
- Participants:
  - Mark Ferroni, FHWA
  - Josh Kozlowski, Virginia DOT
  - Jim Ozment, Tennessee DOT
  - Mariano Berrios, Florida DOT
  - Carole Newvine, Oregon DOT

Center for Environmental Excellence
Noise Practitioners Summit

Session 8
Traffic Noise Modeling
Best Practices for Modeling and Review of Models

U.S. Department of Transportation
Federal Highway Administration

Baltimore, Maryland: 10.22.2015

Research Topics

Best practices for TNM Object Input

- Sources of quality topographic and geospatial data
- Guidance for development of traffic data
  - Traffic distributions across lanes of a multiple-lane highway
  - Selection of volumes and speeds based on Level-of-Service (LOS) or Design Hourly Volumes (DHV)
- Recommendations for additional FHWA TNM output tables

Best practices for noise barrier design optimization

- Development of a noise barrier optimization tool

Best practices for TNM Quality Assurance (QA) review

Best Practices for the use of the FHWA TNM
Research into State DOT Practices: Q&A

- Availability of geospatial data
  - What type(s) of topographic and GIS data?
  - Are there any fees for the data? Provide a list of agencies and/or clearinghouses for data.
- Answers:
  - LiDAR, Digital Elevation Models (DEM), Google Earth, ESRI ArcGIS files, MicroStation DGN Files, on-line Geographic Information System (GIS) data, USGS Topographic Quadrangle Images (24k, 100k, and 250k)
  - Free of charge or for a nominal fee
  - Numerous sources for data: federal, state, local and tribal government agencies, academia, and the private sector

Best Practices for the use of the FHWA TNM
Research into State DOT Practices: Q&A

- Traffic for multiple-lane highway facilities
  - Any guidelines and/or Best Practices for distribution of traffic across multiple-lane highway facilities?
  - Any lane-by-lane traffic count data?
- Answers:
  - 3 have guidelines and/or Best Practices
    - Uniform distribution of traffic across all general-purpose lanes; i.e. excluding special use lanes (collector-distributor, HOV, etc.)
  - 2 occasionally collect lane-by-lane traffic counts
    - 1 mentioned that while lane-by-lane counts may be collected, the data are not used for noise studies

Best Practices for the use of the FHWA TNM
Research into State DOT Practices: Q&A

- Volumes and speeds
  - What volumes are used in noise analyses? LOS, DHV, other?
  - What speeds are used? LOS, DHV, posted speeds, other?
- Answers:
  - 6 answered “Design-Hour Traffic”
  - 2 indicated AADT or AM/PM Peak Hour
  - 1 uses “Level-of-Service” traffic data
  - Posted speed limits are used most often;
    - If posted speed limits are unknown, Design Hour speeds used
    - If vehicles don’t reach the posted speed limit under prevailing traffic conditions, operational speeds used

Best Practices for the use of the FHWA TNM Research into State DOT Practices: Q&A

- Any suggestions for additional TNM output tables?
- Answers:
  - Functionality similar to Microsoft® Excel, e.g. hidden columns/rows, color formatting, sorting by noise level and noise reduction
  - Exporting to Microsoft® Excel
  - "Live" tables that update during calculation
  - A roadway segment sound level contributions table and/or a graphical method to convey roadway segment sound level contributions

Best Practices for the use of the FHWA TNM
Research into State DOT Practices: Q&A

- Methods for noise barrier design optimization
  - What methods have you used to weigh competing views on what constitutes an optimum design?
  - Any tools for noise barrier optimization?
- Answers:
  - Half of the respondents have guidelines for optimization and the methods varied
  - Only 1 reported having a tool for optimization

Best Practices for the use of the FHWA TNM Research into State DOT Practices: Q&A

- Topic 3: Best practices for Quality Assurance (QA)
- Questions:
  - Do you have QA/QC procedures:
    - To ensure that accuracy of TNM models?
    - For Noise Study Reports?
  - Do you have guidelines to ensure the consistent presentation of results in the Noise Study Report (e.g. a report template)?
  - Have you developed QA/QC checklists for:
    - The review of TNM models?
    - For Noise Study Reports (NEPA, noise barrier design studies)?

Best Practices for the use of the FHWA TNM
Research into State DOT Practices: Q&A

- Topic 3: Best practices for Quality Assurance (QA)
- Answers:
  - 5 have QA/QC procedures for TNM models
  - 1 requires submittal of the final TNM runs along with the Noise Study Report when the report is reviewed by the state
  - 8 have guidelines for the consistent presentation of results in the Noise Study Report
  - 7 have report outlines or templates
  - 6 use checklists either for TNM models or Noise Study Reports

ENTRADA IMPORT / WORST NOISE HOUR WORKSHEET

ENTRADA IMPORT / WORST NOISE HOUR WORKSHEET

- **ENTRADA**
  - **VDOT Traffic Worksheet**
  - **Hourly Peak Hour Volumes**
    - Directional / Two Way
  - **Medium / Heavy Truck Percentages**
  - **Posted / Operational Speeds**
  - **Capacity / LOS**

ENTRADA IMPORT / WORST NOISE HOUR WORKSHEET

- **What does “The Worksheet” do?**
  - **Extracts information from Entrada Sheet**
- **Perform Worst Noise Hour Screening**
  - **Choose Directional / Two Way Volumes**
  - **Hourly or Daily Truck Percentages**
  - **Posted or Operational Speed**
  - **Check for Overcapacity**
    - Marked with ***** in ENTRADA
  - **Resolve ENTRADA errors / blank cells**

ENTRADA IMPORT / WORST NOISE HOUR WORKSHEET

A	B	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	D
VERSION 0.721		FINAL ADJUSTED TRUCK PERCENTAGES												
Import ENTRADA sheet		EXISTING				NO-BUILD				BUILD				
Compatible with ENTRADA v. 2013-09														
Roadway	HOURS	EB or NB Med Trks	EB or NB Hvy Trks	WB or SB Med Trks	WB or SB Hvy Trks	EB or NB Med Trks	EB or NB Hvy Trks	WB or SB Med Trks	WB or SB Hvy Trks	EB or NB Med Trks	EB or NB Hvy Trks	WB or SB Med Trks	WB or SB Hvy Trks	
Zone 1A	6:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	7:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	8:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	9:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	10:00	**5.3%**	**10.7%**	**5.3%**	**10.7%**	**5.3%**	**10.7%**	**5.3%**	**10.7%**	**5.3%**	**10.7%**	**5.3%**	**10.7%**	
	11:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	12:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	13:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	14:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	15:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	16:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	17:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	18:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	19:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	
	20:00	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	5.3%	10.7%	

ENTRADA IMPORT / WORST NOISE HOUR WORKSHEET

A	B	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY
VERSION 0.721		FINAL ADJUSTED FREE FLOW SPEEDS									
Import ENTRADA sheet		EXISTING			NO-BUILD			BUILD			
Compatible with ENTRADA v. 2013-09		EB or NB Hourly Un-interrupted Speed (mph)	WB or SB Hourly Un-interrupted Speed (mph)	FFS Speed (two way) (mph)	EB or NB Hourly Un-interrupted Speed (mph)	WB or SB Hourly Un-interrupted Speed (mph)	FFS Speed (two way) (mph)	EB or NB Hourly Un-interrupted Speed (mph)	WB or SB Hourly Un-interrupted Speed (mph)	FFS Speed (two way) (mph)	
Roadway	HOURS										
Zone 1A	6:00	60.0	66.3	66.5	60.0	65.6	66.5	60.0	66.0	66.5	
	7:00	60.0	64.8	66.5	60.0	60.0	66.5	60.0	61.8	66.5	
	8:00	60.0	65.1	66.5	60.0	60.1	66.5	60.0	62.7	66.5	
	9:00	63.6	64.7	66.5	60.0	60.0	66.5	60.0	61.7	66.5	
	10:00	**64.2**	**64.8**	**66.5**	**60.0**	**60.0**	**66.5**	**60.5**	**62.0**	**66.5**	
	11:00	63.6	64.0	66.5	60.0	60.0	66.5	60.0	60.0	66.5	
	12:00	64.0	63.6	66.5	60.0	60.0	66.5	60.0	60.0	66.5	
	13:00	62.8	63.7	66.5	60.0	60.0	66.5	60.0	60.0	66.5	
	14:00	62.1	60.6	66.5	60.0	60.0	66.5	60.0	60.0	66.5	
	15:00	61.5	60.0	66.5	60.0	60.0	66.5	60.0	60.0	66.5	
	16:00	62.5	60.0	66.5	60.0	60.0	66.5	60.0	60.0	66.5	
	17:00	63.5	60.0	66.5	60.0	60.0	66.5	60.0	60.0	66.5	
	18:00	64.5	60.0	66.5	60.0	60.0	66.5	60.0	60.0	66.5	
	19:00	65.9	64.5	66.5	63.8	60.0	66.5	62.9	60.0	66.5	
	20:00	66.3	65.7	66.5	65.8	62.7	66.5	65.6	61.6	66.5	

ENTRADA IMPORT / WORST NOISE HOUR WORKSHEET

A	B	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB	GC
VERSION 0.721		Volume Processing				ROADWAY CAPACITY CHECK													
Import ENTRADA sheet		*This section checks if roadway direction total volume is over capacity. *If capacity is exceeded based on # of lanes, lane capacity, and volume, cannot be loudest hour.																	
		Existing						No Build						Build					
Compatible with ENTRADA v. 2013-09						Capacity Exceeded?						Capacity Exceeded?						Capacity Exceeded?	
Roadway	HOURS	EB or NB Volume	WB or SB Volume	EB or NB Capacity	WB or SB Capacity	EB or NB	WB or SB	EB or NB Volume	WB or SB Volume	EB or NB Capacity	WB or SB Capacity	EB or NB	WB or SB	EB or NB Volume	WB or SB Volume	EB or NB Capacity	WB or SB Capacity	EB or NB	WB or SB
Zone 1A	6:00	1897	702			No	No	2803	1037			No	No	2429	898			No	No
	7:00	2160	1215			No	No	3241	1823	·		YES	No	2809	1580			No	No
	8:00	1978	1162			No	No	2933	1723	·		YES	No	2542	1493			No	No
	9:00	1396	1238			No	No	2079	1843			No	No	1800	1597			No	No
	10:00	**1315**	**1214**			**No**	**No**	**1954**	**1804**			**No**	**No**	**1693**	**1563**			**No**	**No**
	11:00	1394	1340			No	No	2083	2001			No	No	1805	1734			No	No
	12:00	1340	1395			No	No	2002	2083			No	No	2147	2235			No	No
	13:00	1489	1375			No	No	2209	2039			No	No	2369	2187			No	No
	14:00	1555	1685			No	No	2314	2507			No	No	2482	2689			No	No
	15:00	1613	2420			No	No	2418	3628		·	No	YES	2594	3891		·	No	YES
	16:00	1514	2938		·	No	YES	2250	4367		·	No	YES	2413	4684		·	No	YES
	17:00	1399	2717			No	No	2083	4044		·	No	YES	2235	4338		·	No	YES
	18:00	1257	1966			No	No	1880	2941		·	No	YES	2016	3154		·	No	YES
	19:00	911	1258			No	No	1373	1895			No	No	1472	2033			No	No
	20:00	632	989			No	No	956	1495			No	No	1025	1604			No	No

ENTRADA IMPORT / WORST NOISE HOUR WORKSHEET

A	B	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV
VERSION 0.721		TRAFFIC INPUTS FOR WORST CASE NOISE HOUR CALCUATION																	
Import ENTRADA sheet		*This section calculates volumes for each each vehicle type for each direction of travel																	
		Existing						No Build						Build					
Compatible with ENTRADA v. 2013-09		EB or NB			WB or SB			EB or NB			WB or SB			EB or NB			WB or SB		
Roadway	HOURS	Autos	Med	Heavy	Autos	Med	Heavy	Autos	Med	Heavy	Autos	Med	Heavy	Autos	Med	Heavy	Autos	Med	Heavy
Zone 1A	6:00	1594	101	202	590	37	75	2354	149	299	871	55	111	2040	130	259	755	48	96
	7:00	1815	115	230	1021	65	130	2723	173	346	1532	97	194	2359	150	300	1327	84	169
	8:00	1662	106	211	976	62	124	2464	156	313	1447	92	184	2135	136	271	1254	80	159
	9:00	1172	74	149	1040	66	132	1746	111	222	1548	98	197	1512	96	192	1341	85	170
	10:00	**1104**	**70**	**140**	**1019**	**65**	**129**	**1641**	**104**	**208**	**1515**	**96**	**192**	**1422**	**90**	**181**	**1313**	**83**	**167**
	11:00	1171	74	149	1125	71	143	1749	111	222	1681	107	213	1516	96	193	1457	92	185
	12:00	1126	71	143	1172	74	149	1681	107	214	1750	111	222	1803	115	229	1877	119	238
	13:00	1251	79	159	1155	73	147	1855	118	236	1713	109	217	1990	126	253	1837	117	233
	14:00	1307	83	166	1415	90	180	1944	123	247	2106	134	267	2085	132	265	2258	143	287
	15:00	1355	86	172	2033	129	258	2031	129	258	3047	193	387	2179	138	277	3268	208	415
	16:00	1272	81	161	2468	157	313	1890	120	240	3669	233	466	2027	129	257	3935	250	500
	17:00	1176	75	149	2282	145	290	1750	111	222	3397	216	431	1877	119	238	3644	231	463
	18:00	1056	67	134	1651	105	210	1579	100	201	2470	157	314	1694	108	215	2649	168	336
	19:00	765	49	97	1056	67	134	1153	73	146	1592	101	202	1237	79	157	1708	108	217
	20:00	531	34	67	831	53	106	803	51	102	1256	80	159	861	55	109	1347	86	171

ENTRADA IMPORT / WORST NOISE HOUR WORKSHEET

JJ10 =IF($JD10="","",10*LOG(10^(JD10/10)+10^(JE10/10)+10^(JF10/10)))

	A	B	HA	HB	HC	JD	JE	JF	JG	JH	JI	JJ	JK	JL	JM	JN	JO
1	VERSION 0.721																
2																	
3	Import ENTRADA sheet		TNM Model Sound Level Results Leqs at 200 ft			Build - 200 ft Test Receiver									Loudest Hour (200 ft.)		
4						EB or NB			WB or SB			EB or NB	WB or SB	200 ft			
5																	
6	Compatible with ENTRADA v. 2013-09																
7																	
8	Roadway	HOURS				Auto	Med Trk	Heavy Trk	Auto	Med Trk	Heavy Trk	Leq	Leq	Combined	NB	SB	Combined
9			Auto	Med Trk	Heavy Trk												
10	Zone 1A	6:00	30.1	36.4	39.6	63.2	57.5	63.7	58.9	53.2	59.4	67.0	62.7	68.4	7:00	14:00	14:00
11		7:00	30.1	36.4	39.6	63.8	58.2	64.4	61.3	55.7	61.9	67.6	65.1	69.6			
12		8:00	30.1	36.4	39.6	63.4	57.7	63.9	61.1	55.4	61.6	67.2	64.9	69.2			
13		9:00	30.1	36.4	39.6	61.9	56.2	62.4	61.4	55.7	61.9	65.7	65.2	68.5			
14		10:00	30.1	36.4	39.6	61.6	56.0	62.2	61.3	55.6	61.8	65.4	65.1	68.3			
15		11:00	30.1	36.4	39.6	61.9	56.2	62.4	61.7	56.1	62.3	65.7	65.5	68.6			
16		12:00	30.1	36.4	39.6	62.7	57.0	63.2	62.8	57.2	63.4	66.5	66.6	69.6			
17		13:00	30.1	36.4	39.6	63.1	57.4	63.6	62.7	57.1	63.3	66.9	66.5	69.7			
18		14:00	**30.1**	**36.4**	**39.6**	**63.3**	**57.6**	**63.8**	**63.6**	**58.0**	**64.2**	**67.1**	**67.4**	**70.3**			
19		15:00	30.1	36.4	39.6												
20		16:00	30.1	36.4	39.6												
21		17:00	30.1	36.4	39.6												
22		18:00	30.1	36.4	39.6												
23		19:00	30.1	36.4	39.6	61.0	55.3	61.6	62.4	56.8	63.0	64.8	66.2	68.6			
24		20:00	30.1	36.4	39.6	59.5	53.8	60.0	61.4	55.7	61.9	63.3	65.2	67.3			
25											MAX	67.6	67.4	70.3			

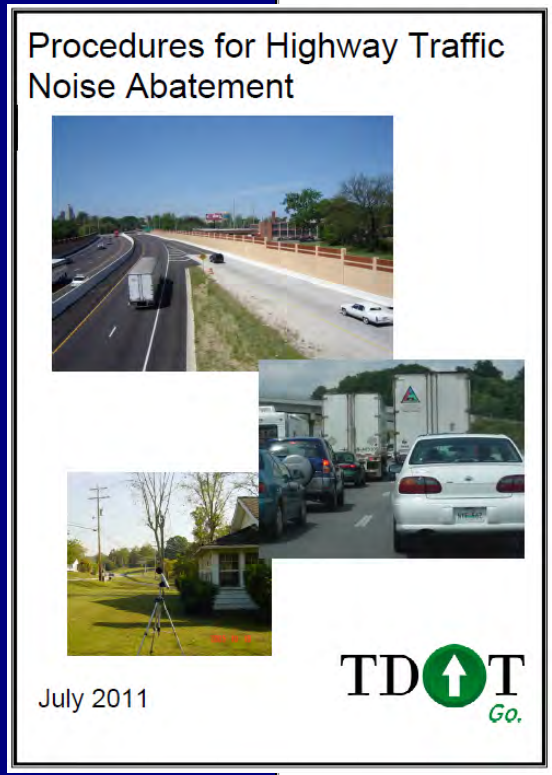
TDOT's TNM Modeling Guidance and QA/QC Process

October 22, 2015

TN TDOT Department of Transportation

TDOT's Noise Procedures

- General guidance on TNM modeling

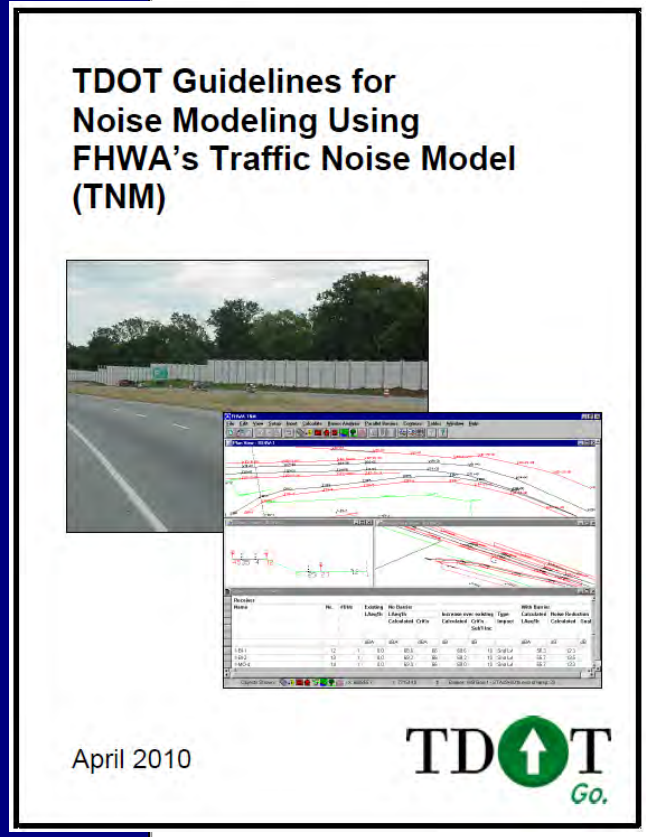


✓ **Modeling shall be done using TDOT's TNM guidelines**

TN TDOT Department of Transportation

TDOT's TNM Guidelines

- **Detailed guidance on TNM modeling**



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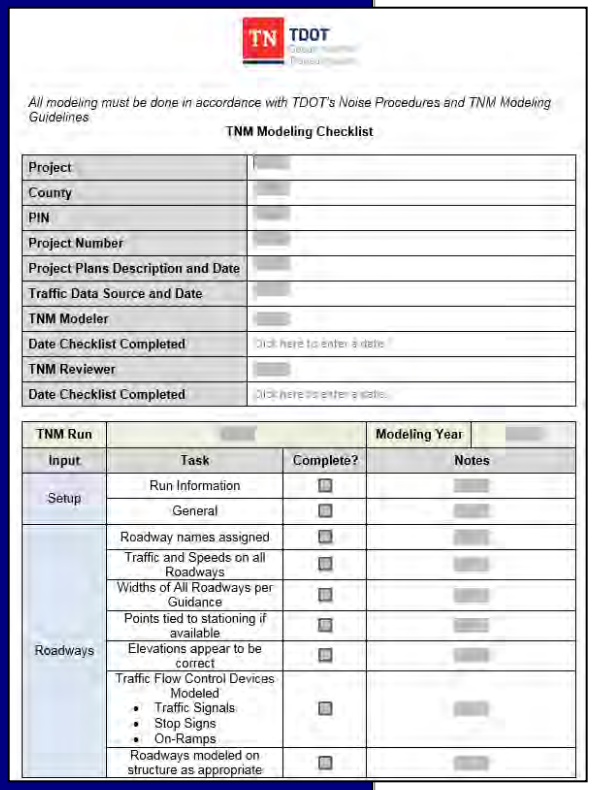
TN TDOT Department of Transportation

QC Process for TNM Modeling

- **TNM modeling checklist must be completed**



TDOT

All modeling must be done in accordance with TDOT's Noise Procedures and TNM Modeling Guidelines

TNM Modeling Checklist

Project	
County	
PIN	
Project Number	
Project Plans Description and Date	
Traffic Data Source and Date	
TNM Modeler	
Date Checklist Completed	Click here to enter a date.
TNM Reviewer	
Date Checklist Completed	Click here to enter a date.

TNM Run			Modeling Year	
Input	Task	Complete?	Notes	
Setup	Run Information	☐		
	General	☐		
Roadways	Roadway names assigned	☐		
	Traffic and Speeds on all Roadways	☐		
	Widths of All Roadways per Guidance	☐		
	Points tied to stationing if available	☐		
	Elevations appear to be correct	☐		
	Traffic Flow Control Devices Modeled • Traffic Signals • Stop Signs • On-Ramps	☐		
	Roadways modeled on structure as appropriate	☐		

TNM Run			Modeling Year	
Input	Task	Complete?	Notes	
Receivers	Receivers named by address or stationing	☐		
	Number of dwelling units set for each receiver (if applicable)	☐		
	Receivers in order of adjacent traffic flow	☐		
	Elevations appear to be correct	☐		
	Elevations at second-story locations at appropriate heights (if applicable)	☐		
	Enough receivers modeled (for impacts and benefits)	☐		
	NAC set per State's Policy for each receiver/ land use	☐		
	Noise Reduction set per State's Policy	☐		
	Substantial Increase set per State's Policy	☐		
Barriers	Significant buildings modeled	☐		
	Parapets, etc. modeled	☐		
	Perturbable barriers modeled as applicable	☐		
	Barrier names assigned	☐		
	Barrier points named by stationing or length	☐		
	Barrier heights assigned	☐		
	Elevations appear to be correct	☐		
	Increment and #up/down assigned	☐		
	Barriers modeled on structure as appropriate and shielded lists are correct	☐		
Building Rows	Building rows modeled per FHWA Guidance	☐		
	Elevations appear to be correct	☐		
	Height and percentage assigned	☐		

TNM Run			Modeling Year	
Input	Task	Complete?	Notes	
Terrain Lines	Significant terrain features modeled	☐		
	Terrain line names assigned	☐		
	Elevations appear to be correct	☐		
Ground Zones	Ground Zones modeled per FHWA Guidance	☐		
	Ground zone names assigned	☐		
	Ground zone types assigned	☐		
Tree Zones	Tree zones modeled per FHWA Guidance	☐		
	Tree zone names assigned	☐		
	Elevations appear to be correct	☐		
Perspective Views	Perspective views checked for accuracy	☐		
Skew Views	Numerous skew views cut and checked for accuracy	☐		
Input Check	Input Check completed and errors fixed/documented	☐		

TN TDOT Department of Transportation

TNM Modeling Checklist Example

Project	**Mack Hatcher Parkway**
County	**Williamson**
PIN	**101454.01**
Project Number	**94092-1224-14**
Project Plans Description and Date	**ROW Year 2015 (101454-01-ROW-Rev-03-13-15.pdf)**
Traffic Data Source and Date	**Year 2040 (PB Traffic Projections April 2015)**
TNM Modeler	Geoff Pratt
Date QC/QC Completed	3/3/2015
TNM Reviewer	Rennie Williamson
Date QC/QA Completed	3/12/2015

TNM Run	**4 lane AM**		
Input	**Task**	**Complete?**	**Notes**
Setup	Run Information	☒	**says "09-02"; should it be "14-21"**
	General	☒	
Roadways	Roadway names assigned	☒	
	Traffic and Speeds on all Roadways	☒	
	Widths of All Roadways per Guidance	☐	**"WB Mack Hatcher Ext Outside Lane" and "WB Mack Hatcher Ext Inside Lane" set at 12'**
	Points tied to stationing if available	☒	
	Elevations appear to be correct	☒	
	Traffic Flow Control Devices Modeled • Traffic Signals • Stop Signs • On-Ramps	☒	**"SB Hillsboro STA 79 - 64": Veh Affected should be 50**

TN TDOT Department of Transportation

TNM Modeling Checklist Example

TNM Run	4 lane AM		
Input	Task	Complete?	Notes
	Roadways modeled on structure as appropriate	☒	
Receivers	Receivers named by address or stationing	☒	
	Number of dwelling units set for each receiver (if applicable)	☒	
	Receivers in order of adjacent traffic flow	☒	Rec's 22-26 not in order of traffic flow
	Elevations appear to be correct	☒	
	Elevations at second-story locations at appropriate heights (if applicable)	☒	n/a
	NAC set per State's Policy for each receiver/ land use	☒	
	Noise Reduction set per State's Policy	☒	(7)
	Substantial Increase set per State's Policy	☒	
Barriers	Significant buildings modeled	☒	
	Parapets, etc. modeled	☒	
	Perturbable barriers modeled as applicable	☒	
	Barrier names assigned	☒	
	Barrier points named by stationing or length	☒	
	Barrier heights assigned	☒	
	Elevations appear to be correct	☒	
	Increment and #up/down assigned	☒	
	Barriers modeled on structure as appropriate and shielded lists are correct	☒	
Building Rows	Building rows modeled per FHWA Guidance	☒	
	Elevations appear to be correct	☒	
	Height and percentage assigned	☒	
Terrain Lines	Significant terrain features modeled	☒	
	Terrain line names assigned	☒	

TNM Run	4 lane AM		
Input	Task	Complete?	Notes
	Elevations appear to be correct	☒	
Ground Zones	Ground Zones modeled per FHWA Guidance	☐	maybe PL in front of Franklin Rec Pool
	Ground zone names assigned	☒	
	Ground zone types assigned	☒	
Tree Zones	Tree zones modeled per FHWA Guidance	☒	
	Tree zone names assigned	☒	
	Elevations appear to be correct	☒	
Perspective Views	Perspective views checked for accuracy	☒	
Skew Views	Numerous skew views cut and checked for accuracy	☒	
Input Check	Input Check completed and errors fixed/documented	☒	

TN TDOT Department of Transportation

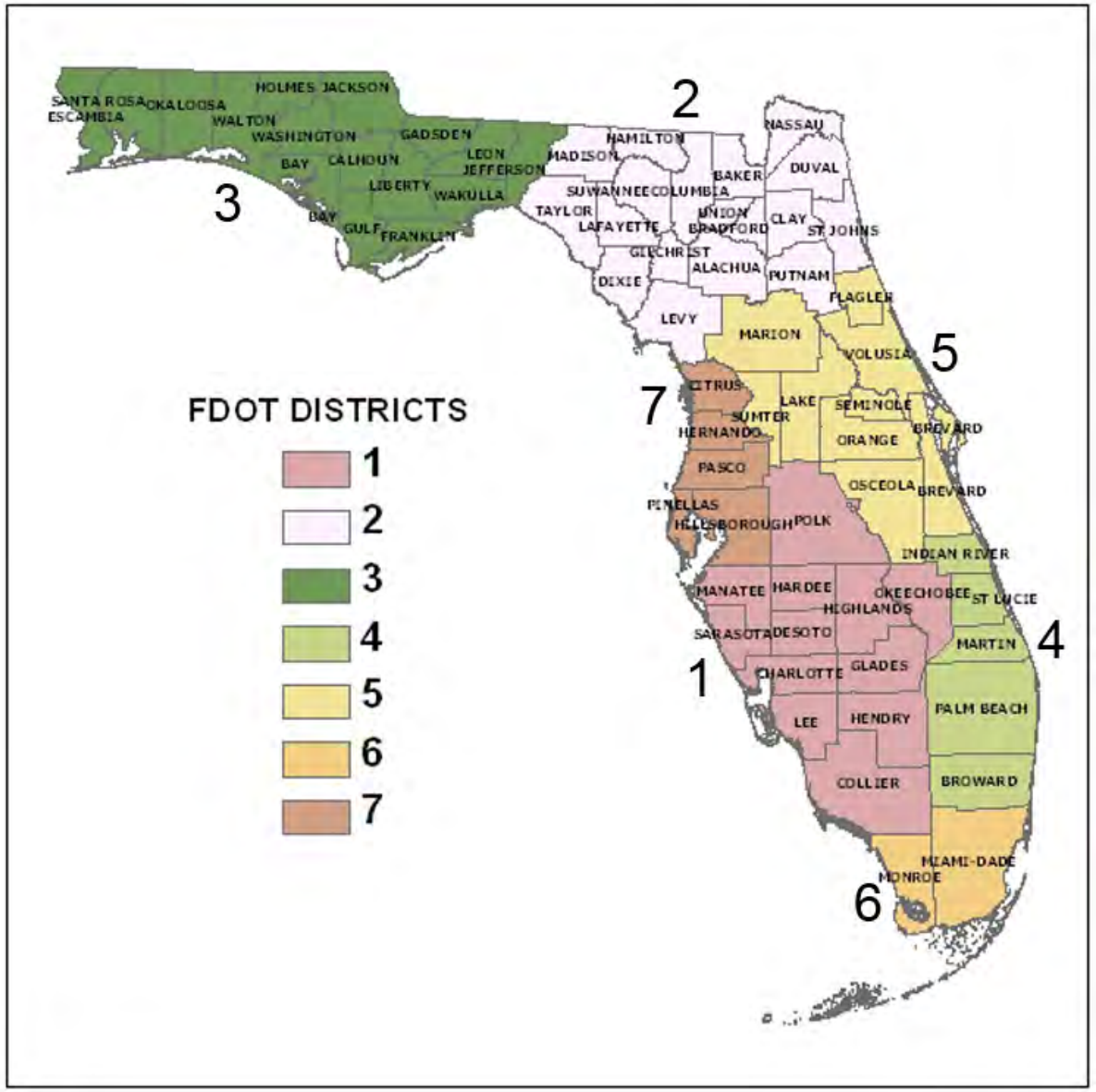
FDOT's
Traffic Noise Modeling
Practitioners Handbook

Why Did We Need a Modeling Guidance Document?

- Decentralized agency structure
- Lack of consistency in noise studies
- “CPR” Initiative
  - “**C**onsistent” agency across all districts
  - “**P**redictable” decision-making framework
  - “**R**epeatable” desired outcomes

Agency Composition

- Central Office
- Seven Districts
- Turnpike Enterprise (Toll Road Authority)



Document Development

- Initial versions called “Traffic Noise Model Users Protocol”
  - Primarily focused on model input
  - Very little guidance on documentation
  - No guidance on public involvement

Document Development

- Title revised to “Traffic Noise Modeling and Analysis Guidelines”
  - Similar to current form
  - Focus on the noise study as a whole

- Another title change, to “Traffic Noise Modeling Practitioners Handbook”

Document Development

- Traffic data (the fun part….)
  - Noise Task Team discussions revealed inconsistencies
  - Often the first component of a noise study to be challenged
  - Development of standard traffic data form
  - Standard scope language

Current Document Composition

- Model input guidance
  - Use of state-plane coordinate system
  - Roadways
  - Receptor placement
  - Noise barriers: optimization and development of recommendations
  - Shielding/building rows
  - Terrain lines and ground zones

Current Document Composition

- Public involvement
  - Expectations for public workshops/hearings
  - Noise barrier-specific public involvement
    - Workshops
    - Noise barrier surveys

Current Document Composition

- Noise study documentation
  - Validation analyses
  - Impact assessment
  - Abatement evaluation
    - “Statement of Likelihood”
  - Noise contours
  - Construction noise and vibration
  - Public involvement

Excerpt from OR DOT Noise Manual
CEE Noise Summit
October 21-22, 2015

NOISE STUDY QC AND REPORT REVIEW CHECKLIST

Project Name: _____
Noise Analyst: _____
Senior Reviewer: _____
Date Reviewed: _____
For checkboxes that are missing or not applicable, please write in explanations.
☐ Table of Contents (optional)

Summary

☐ Concise project description
☐ Noise levels ranges, by year, and alternative and noise impacts (include distance to Oregon NAAC levels for undeveloped land)
☐ Abatement considerations and commitments
☐ Construction Noise
☐ Information to local officials (1–2 sentences)

Introduction

☐ Purpose of the report (Why is this a Type 1 study?)

Excerpt from OR DOT Noise Manual
CEE Noise Summit
October 21-22, 2015

Project Description

- ☐ Description of proposed construction
- ☐ Existing alignment and proposed alignment shown on mapping
- ☐ Number of existing and proposed travel lanes

Land Use

- ☐ Existing houses, apartments, schools, places of worship, parks, businesses, etc. shown on 1:100 or 1:200 mapping
- ☐ Identification of all FHWA-defined activity categories in project area
- ☐ Future Zoning and Comprehensive Land Use Plan designations shown on mapping
- ☐ Displacements due to project construction

Excerpt from OR DOT Noise Manual
CEE Noise Summit
October 21-22, 2015

NOISE STUDY QC AND REPORT REVIEW CHECKLIST (continued)

Methodology

- ☐ Defining area of potential effect
- ☐ Regulatory setting
- ☐ Tables of NACs (include Oregon approach levels)
- ☐ Measurement procedures and equipment
- ☐ Analysis procedures/model/version/model inputs/analysis years
- ☐ **Selection of noise sensitive receivers**
- ☐ **Basis for worse-case noise condition (peak hour or peak truck hour)**
- ☐ Noise abatement requirements

Excerpt from OR DOT Noise Manual
CEE Noise Summit
October 21-22, 2015

NOISE STUDY QC AND REPORT REVIEW CHECKLIST (continued)

Existing Acoustic Environment:

☐ **Selection of noise sensitive receivers including the number of equivalents units selected.**

Noise Measurements:

☐ **Summary of each noise measurement location which includes noise sources present during monitoring**
☐ **Figure of monitoring locations shown on 1:100 or 1:200 mapping**
☐ **Table summarizing date and time of measurements, traffic counts per vehicle type and direction, speed, and Leq levels, distance from monitoring site to roadway.**
☐ **References to noise monitoring sheets and photographs of monitoring locations**

NOISE STUDY QC AND REPORT REVIEW CHECKLIST (continued)

Existing Acoustic Environment (continued)

Model Validation:

- ☐ **Table of model validation including measured (independent variable) and TNM modeled noise levels and difference**
- ☐ **Modeling files include only traffic counts and speeds observed during monitoring.**
- ☐ **Statement confirming that measured and monitored noise levels differ by less than 3 dBA.**
- ☐ **References to modeling files.**

NOISE STUDY QC AND REPORT REVIEW CHECKLIST (continued)

Traffic Noise Analysis

Predicted Leq Levels:

- ☐ **Comparison for worse case between peak hour and peak truck hour**
- ☐ **Table of predicted noise levels for Existing**
- ☐ **Table of predicted noise levels for No-Build Future**
- ☐ **Tables of predicted noise levels for Build Future, all alternatives**
- ☐ **Figures of prediction sites shown on 1:100 or 1:200 mapping**
- ☐ **Discussion in text of noise level ranges for exist, no-build and future build.**

Note: The number of tables used to summarize project noise levels will depend on size of project

Excerpt from OR DOT Noise Manual
CEE Noise Summit
October 21-22, 2015

NOISE STUDY QC AND REPORT REVIEW CHECKLIST (continued)

Traffic Noise Analysis Summary

- ☐ **Summary table of Existing, No-Build Future, and Build Future noise levels that approach or exceed NAC for each alternative**
- ☐ **Noise Abatement Criterion discussed and noise impacts subject to criterion identified**
- ☐ **Substantial Increase Criterion discussed and noise impacts subject to criterion identified**
- ☐ **Existing, No-Build Future, Build Future noise levels that approach or meet NAC shown on 1:100 or 1:200 mapping**

Excerpt from OR DOT Noise Manual
CEE Noise Summit
October 21-22, 2015

NOISE STUDY QC AND REPORT REVIEW CHECKLIST (continued)

Noise Level Contours for Undeveloped land:

☐ Predicted distances to Leq 65 dBA and 70 dBA for Category G

☐ Use 50-foot intervals or discrete locations

☐ Contour maps (optional if discrete Activity G receivers were reported in text)

Evaluation of Noise Abatement Measures

☐ Discussion of alternative noise abatement measures: Alignment shifts, speed restrictions, grade changes, buffer zones, truck restrictions, etc.

Excerpt from OR DOT Noise Manual
CEE Noise Summit
October 21-22, 2015

NOISE STUDY QC AND REPORT REVIEW CHECKLIST (continued)

Noise Abatement Measures

- ☐ **Predicted noise levels without mitigation for each impacted receiver**
- ☐ **Predicted noise levels with mitigation for each impacted receiver**
- ☐ **Number of equivalent-unit impacts (receptors) mitigated per impacted receiver**
- ☐ **Noise level reductions due to mitigation for each impacted receiver**
- ☐ **Percent of impacted equiv units achieving 5 dBA reduction from abatement**
- ☐ **Total number of benefited receptors/equiv. units**
- ☐ **Total number of benefited units receiving 7 dBA reduction in noise levels (design goal requirement)**

Excerpt from OR DOT Noise Manual
CEE Noise Summit
October 21-22, 2015

NOISE STUDY QC AND REPORT REVIEW CHECKLIST (continued)

Noise Abatement Measures (continued)

- ☐ **Total cost as calculated in section 7.4.2 and cost per unit**
- ☐ **Summary table of noise levels without barrier, with barrier, and noise reductions per receiver**
- ☐ **Barrier summary table: length, height, area, cost, cost per equivalent unit, and recommendation**
- ☐ **Locations of barriers shown on 1:100 or 1:200 map and marked as recommended for construction**
- ☐ **Noise abatement likelihood statement**
- ☐ ***Noise Evaluation and Recommendation* form for each noise abatement measure considered**
- ☐ **Discussion of unavoidable impacts (by receiver as necessary)**

Possible Errors

- Verify end treatment of proposed wall
- Verify that TNM features included in model validation are in other TNM scenario files; if in scenario files, features are also in validation modeling
- Building rows vs building structures
- On-structure components
- Could wall height be optimized (shallow residential yards)?
- Check existing conditions in mapping software
  - 2nd stories
  - How receptors counted and assigned to Receivers

***See NCHRP Report 791, *Supplemental Guidance on the Application of FHWA's Traffic Noise Model (TNM).*

SL - Sound Level (dBA)
IL - Insertion Loss (dBA)
TNM File Name: Barrier

Example of Abatement Analysis Results

Table of Results for Southwest Neighborhood Barrier Analysis (Leq in dBA)

Based on Noise Data for a 16ft High Wall

Rec. ID	Existing	Build	Increase Over Existing	8ft - Wall		10ft - Wall		12ft - Wall		14ft - Wall		16ft - Wall		Number of Houses	Receptors with IL ≥ 7 dBA	Benefitted Receptors (≥ 5 dBA)	Impacted Receptors Receiving 5 dBA IL	Impacted Receptors Not Benefitted
				SL	IL	SL	IL	SL	IL	SL	IL	SL	IL					
R1/M1	65	68	3	62	6	61	7	60	8	60	8	59	9	See R19*				
R3	63	67	4	64	3	63	4	62	5	62	5	61	6	5	5	5	5	
R4	67	70	3	62	8	61	9	61	9	60	10	59	11	4	4	4	4	
R7	73	76	3	66	10	65	11	64	12	64	12	63	13	5	5	5	5	
R19	67	70	3	65	5	64	6	63	7	62	8	61	9	3	3	3	3	
R20	54	57	3	57	0	57	0	56	1	56	1	56	1	2				
R21	69	72	3	68	4	66	6	65	7	64	8	63	9	5	5	5	5	
R22	62	66	4	63	3	63	3	62	4	62	4	61	5	5		5	5	
R28	70	74	4	71	3	71	3	71	3	71	3	71	3	2				2
R29	67	71	4	70	1	70	1	70	1	70	1	70	1	1				1
R30	65	68	3	66	2	66	2	65	3	65	3	65	3	4				4
R31	71	74	3	67	7	66	8	65	9	65	9	64	10	4	4	4	4	
R32	65	68	3	64	4	63	5	62	6	61	7	61	7	School				
R33	74	77	3	68	9	67	10	65	12	65	12	64	13	6	6	6	6	
R34	65	69	4	64	5	63	6	62	7	62	7	61	8	3	3	3	3	
R35	60	63	3	62	1	61	2	61	2	60	3	60	3	7				
R36	59	62	3	61	1	60	2	60	2	59	3	59	3	3				
R37	59	63	4	62	1	61	2	60	3	60	3	59	4	3				
R38	71	74	3	68	6	66	8	65	9	64	10	64	10	4	4	4	4	
R39	59	62	3	61	1	61	1	61	1	60	2	59	3	2				
R40	57	60	3	59	1	59	1	59	1	58	2	58	2	2				
R41	55	58	3	57	1	57	1	57	1	57	1	56	2	2				
R44	64	68	4	67	1	67	1	67	1	67	1	67	1	3				3
R45	60	63	3	63	0	63	0	62	1	62	1	62	1	10				
R46	63	66	3	64	2	63	3	63	3	63	3	63	3	4				4
R47	61	64	3	61	3	60	4	60	4	59	5	59	6	2		2		
R48	60	63	3	60	3	60	3	59	4	59	4	58	5	3		3		
R49	63	67	4	66	1	65	2	65	2	65	2	65	2	2				2
															Total Receptors:	49	44	16

Total Residences Benefitted (≥ 5 dBA Each):		49
Recommended Wall Height (ft):		16
Length of Wall (ft):		3211
Wall Area (sq. ft):		51,376
Wall Cost ($/sq. ft)	$	20
Total Cost of Selected Wall ($):	$	1,027,520
Cost Effectiveness ($/Benefitted Residence):	$	20,970
Cost Reasonableness Criteria ($/Benifitted Residence):	$	25,000
Cost Effectiveness < Cost Reasonableness? (yes/no):		Yes

Calculation of Feasible Abatement (a simple majority of impacted receptors receive a minimum of 5 dBA IL):
73 percent
Feasible (>50%)? Yes

Noise Reduction Design Goal: One benefitted receptor must achieve the noise reduction design goal of 7 dBA. Design Goal? Yes

Color Key:

Impacted Receiver (≥ 65 dBA)
Benefitted Receiver (≥ 5 dBA)
Receiver Meets Design Goal (≥ 7 dBA)

* R1/M1 was a monitoring location adjacent to the fence in an empty lot. R19 was added in the yard of the adjacent residence to provide additional data for the mitigation analysis farther back from the shadow zone

Session 8 - Questions

- Jordahl-Larson, MN: MnDOT noise analysis check list; guidance on modeling stationary sources, directly abutting scenarios, reflective noise modeling, loudest hour guidance.
- Alcala, OH: Where/when/how to model all category sites
- If only a small portion of a community is impacted, the entire community must be evaluated for noise abatement, not just the impacts
- TNM Modeling guidance for consistency of results, including revised FAQs

Session 8 - Questions

- What are best practices for model review?
- How to review modeling within a noise technical report
- What is needed for properly identifying impacts?
- How do States review consultant recommendations for abatement? Or do they?

Session 8 - Questions

- Phillips, GA: How to handle future projects in the Transportation Program (considered in the future traffic counts) in your noise modeling? (I.E if widening an interstate and there is a project scheduled for 10-15 years out to construct a new interchange, how do you consider that interchange in your future model and if you do not how do you handle traffic when it is provided for the future considering that future project would exist?)
- Polcak, MD: Maryland has developed a procedure for setting the acoustic profile based on line-of-sight as the starting point, using a spreadsheet in conjunction with TNM.

Session 8 - Questions

- Hanf, MI:
  - Minimum qualifications for state DOT staff performing modeling and barrier analyses QA/QC.
  - Use of remote sensing to obtain topographic or traffic data.
- Umscheid, TX: Have any states done a comparison of LOS C to DHV traffic data for noise modeling? Was one determined to be a worst case analysis?
- Waldschmidt, WI: Is validation (traffic counts, vehicle types, speeds, etc.) really needed every time an SHA does an analysis with TNM? Don’t we know, based on hundreds of past analyses, whether or not the numbers make sense without going through the extra effort and cost?