

TRANSPORTATION RESEARCH BOARD

TRB Webinar: Guidance for Setting Speed Limits

July 26, 2021

2:00- 3:30 PM Eastern

@NASEMTRB
#TRBwebinar

PDH Certification Information:

- 1.5 Professional Development Hours (PDH) – see follow-up email for instructions
- You must attend the entire webinar to be eligible to receive PDH credits
- Questions? Contact Beth Ewoldsen at Bewoldsen@nas.edu

#TRBwebinar

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.



REGISTERED CONTINUING EDUCATION PROGRAM

Learning Objectives

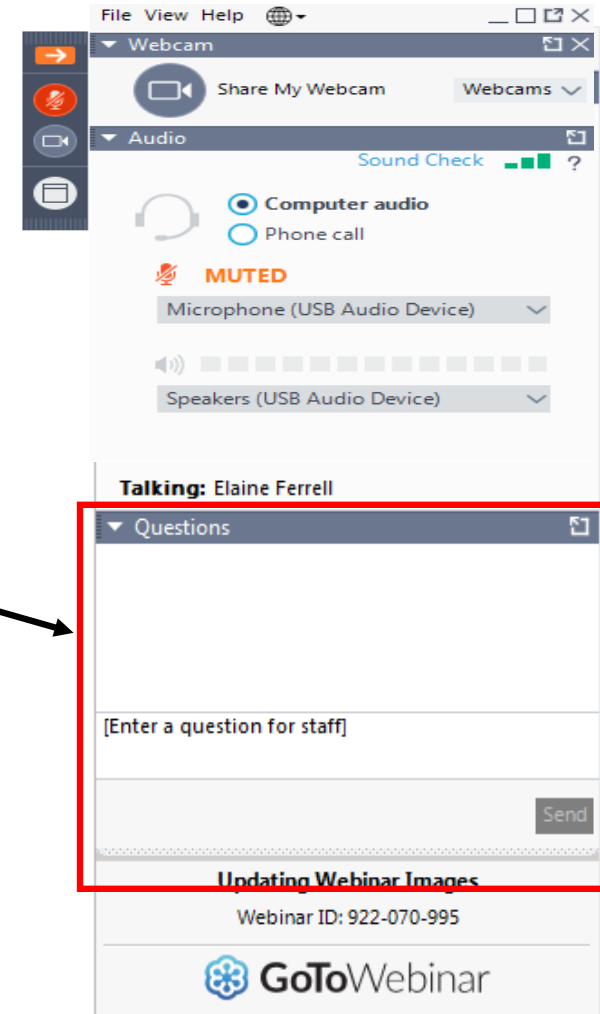
- Identify factors that determine speed limits
- Compute a suggested speed limit using the SLS tool

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Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



#TRBwebinar



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NCHRP 17-76

Guidance for the Setting of Speed Limits

Kevin Haas, Oregon Department of Transportation
Kay Fitzpatrick, Texas A&M Transportation Institute
Tim Gates, Michigan State University
Mike Pratt, Texas A&M Transportation Institute

TRB Webinar, July 26, 2021



SPEED
LIMIT
55



SPEED
LIMIT
30
SCHOOL ZONE
CRIME WATCH
ANY TIME

Presentation Outline

- Reason for NCHRP 17-76 (Haas)
- Overview of Speed Limits & NCHRP 17-76 (Fitzpatrick)
- Findings from Michigan data (Gates)
- Findings from Texas data (Fitzpatrick)
- SLS-Procedure / SLS-Tool (Pratt)
- Conclusions / research needs (Fitzpatrick)
- Discussion (All)

Kevin Haas

REASON FOR NCHRP 17-76

Background

- Original draft problem statement focused on rural conditions
- Panel recognized the need to provide holistic review of the setting of speed limits
- Recent events support that need

Other Publications

(After NCHRP 17-76 Started)

- **NACTO 2017** policy: “State rules or laws that set speed limits at the 85th percentile speed should be repealed”
- **NACTO 2020** report: *City Limits, Setting Safe Speed Limits on Urban Streets*
- **National Transportation Safety Board** (*Reducing Speeding-Related Crashes Involving Passenger Vehicles*) provides specific recommendations, such as removing guidance in MUTCD that speed limits should be within 5 mph of the 85th percentile speed
- Several **state initiatives**

Other Approaches (After NCHRP 17-76 Started)

- Neighborhood slow zones
- Citywide speed limits (25 mph):
 - Boston, Massachusetts
 - New York City, New York
 - Seattle, Washington
 - Austin, Texas
 - Portland, Oregon (residential streets at 20 mph)

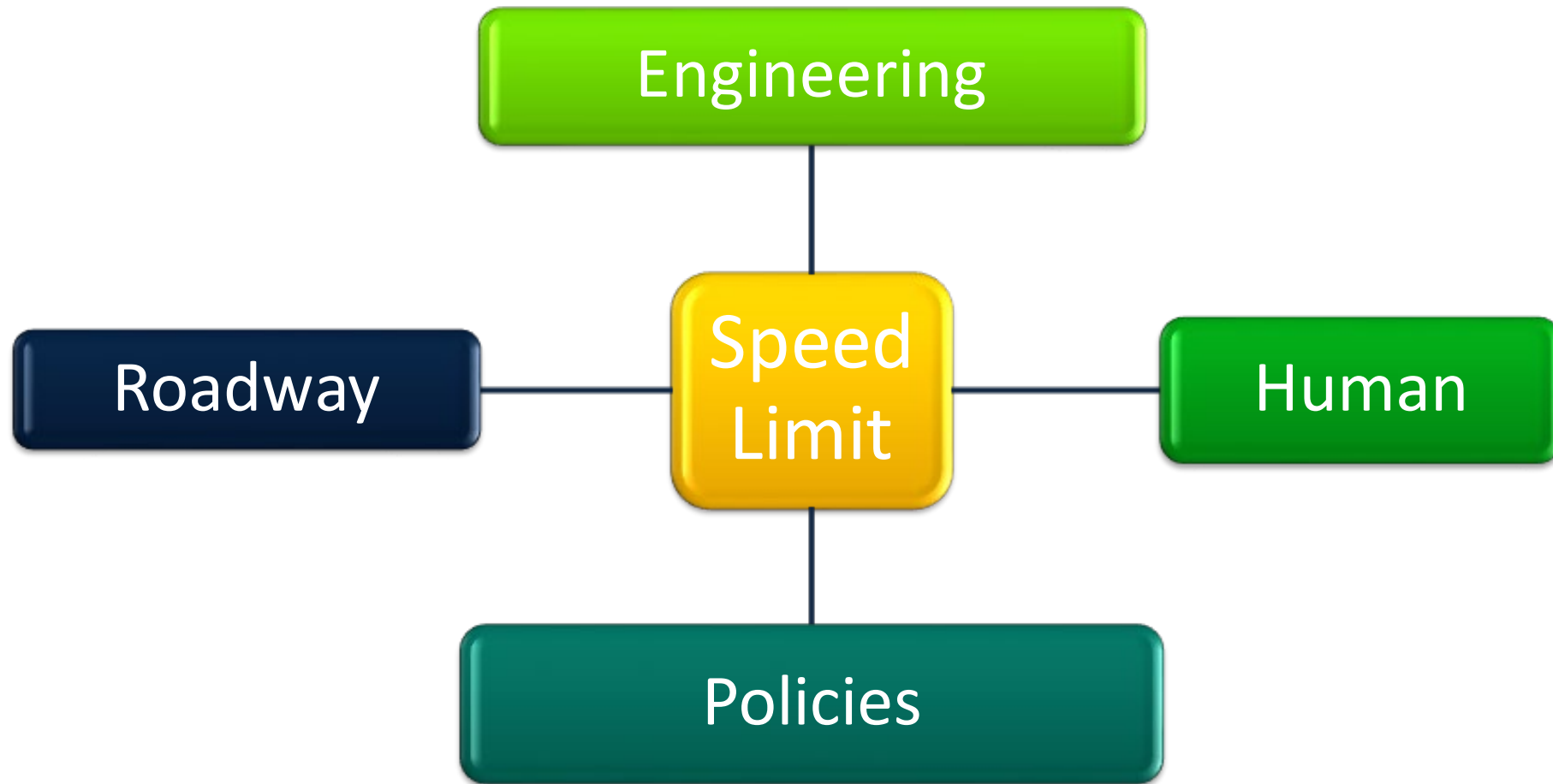
NCHRP 17-76 Objectives

- Identify and describe factors that influence operating speed
- Provide guidance (**User Guide** and **Tool**) to make informed decisions related to establishing speed limits on roadways

Kay Fitzpatrick

OVERVIEW OF SPEED LIMITS & NCHRP 17-76

Setting of Speed Limits



How Are States Setting PSL?

Frequency	Factor Used by 31 States
All or Most of States	<ul style="list-style-type: none">● 85th percentile speed● Crash history
Over half of states	<ul style="list-style-type: none">● Roadside development or land use● Traffic (pedestrians, bicyclists) condition or volume● Maximum or minimum speed allowed in state● Sight distance
About 1/3 states	<ul style="list-style-type: none">● Parking, shoulder, pavement condition, access
<1/3 states, but > 3 states	<ul style="list-style-type: none">● Functional class, pedestrians, transitions, urban streets● Alignment (e.g., grade, horizontal and/or vertical curves)● Cross section (e.g., lane width, roadway width)● Traffic control devices

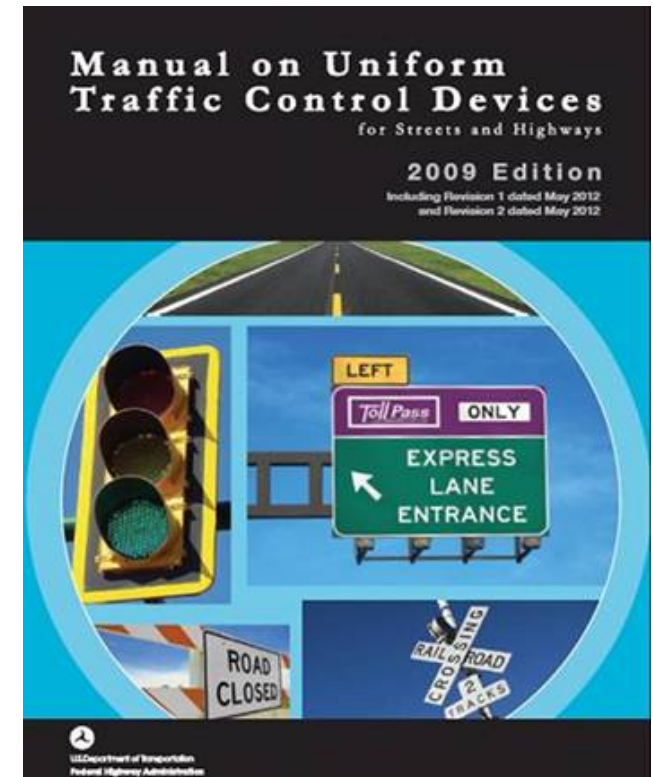
Existing Guidance

- **MUTCD**

- Traffic study using 85th percentile speed of free-flowing traffic along with consideration of other factors

- **Several other resources** available

- FHWA website and reports, USLIMITS2, ITE website, state documents, NACTO, etc.



NCUTCD Task Force on Speed Limits

- Task Force addressing recommendations from NTSB
- Key direction / suggested changes to MUTCD:
 - Keep MUTCD general (detailed procedure => guides)
 - Emphasize that other factors have a role in setting speed limits (in addition to 85th) / reorganized list of factors
 - Retain reference to 85th percentile, particularly for freeways, expressways, and rural areas

NCHRP 17-76 User Guide and Tool

Guiding Principles

- Easy to explain (relatively)
- Consistent results – use of decision rules
- Defendable – demonstrate sources of decision rules
- Avoid “black box” feel
- Flexible so future knowledge can update decision rules

Developing Guide and Tool Guiding Principles (Continued)

- Can be used for all roadway types / contexts
- Group similar roadway types / contexts
- Different set of decision rules for each roadway type / context groups

Developing Decision Rules

- Previous literature
- Key reference documents
- A portion of NCHRP 17-76 Phase II funds set aside for original research
 - Focus on suburban / urban arterials
 - Data from:
 - Michigan (roadway geometric, volume, and crash data)
 - Texas (also able to consider operating speed data)

Tim Gates

FINDINGS FROM MICHIGAN

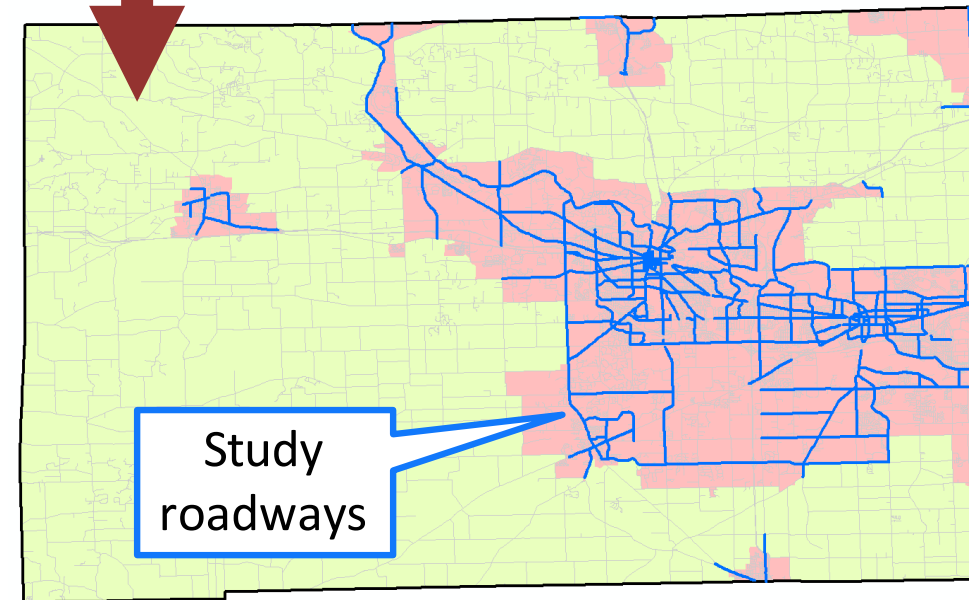
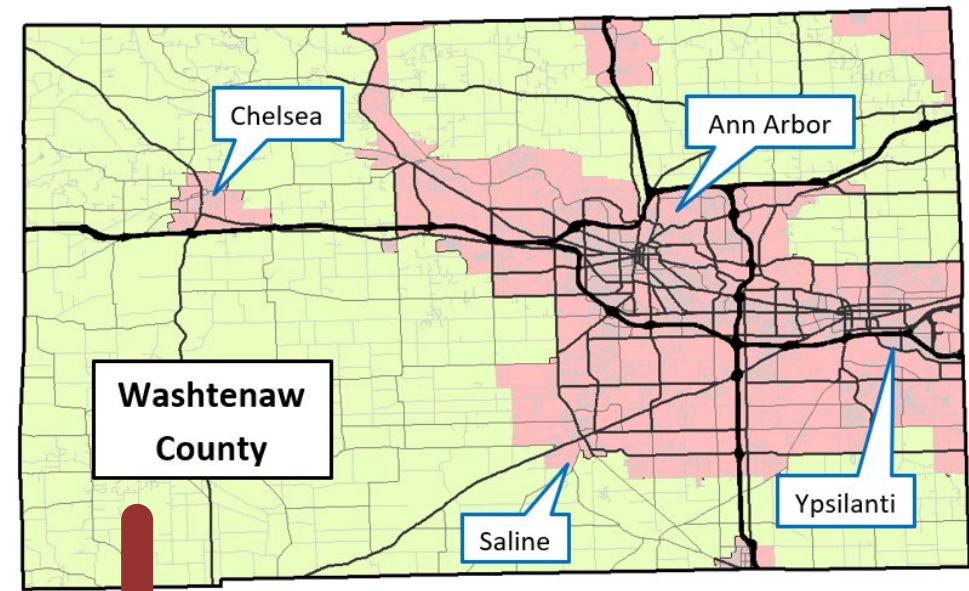
Analysis of Data from Washtenaw County, Michigan

- Intent to conduct original research to support the development of speed limit setting decision rules
- Collected roadway inventory, traffic and crash data, as well as other geometric and roadway characteristics
- Conducted analysis to determine relative safety performance of **urban/suburban non-freeways** vs. posted speed limit

Washtenaw County Roadway Inventory Data

- Approximately **313 miles** out of ~3,000 miles of public roadway selected for safety analysis which **met criteria for inclusion**

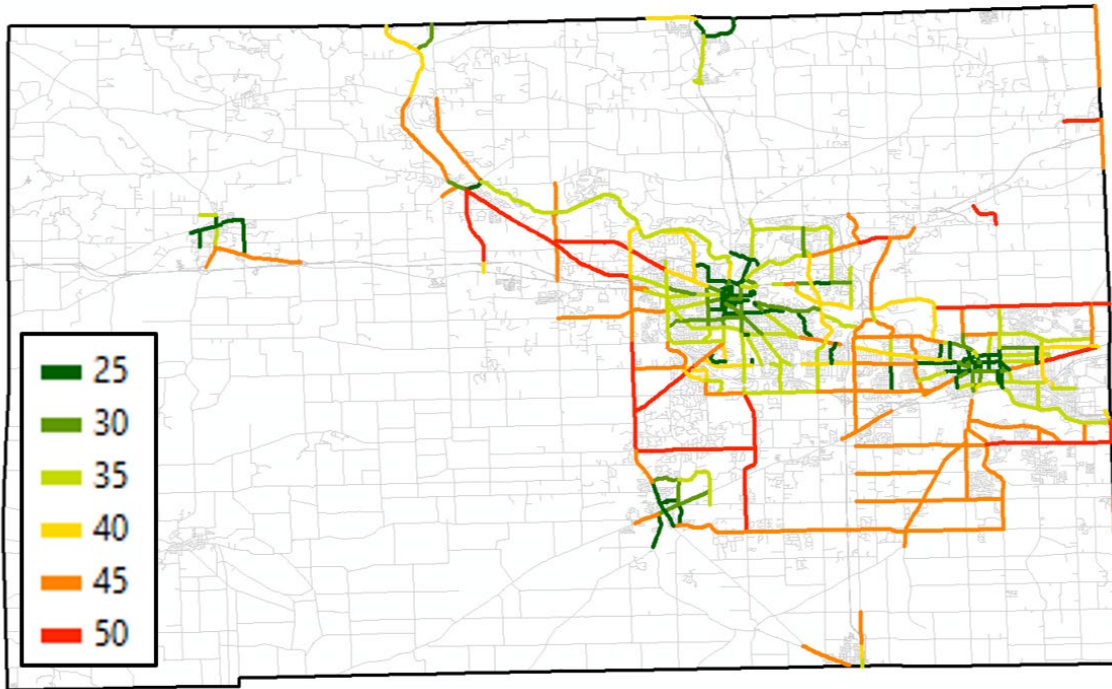
Characteristic	Criteria
Posted Speed Limit	25 to 50 miles per hour
National Functional Class	Includes Other Principal Arterial, Minor Arterial, Major Collector, Minor Collector Excludes Interstates, Other Freeways, and Local
Historical Traffic Volume	Must include recent AADT estimate
Urban Boundary	Includes roadways which fall within or extend from urban census boundary



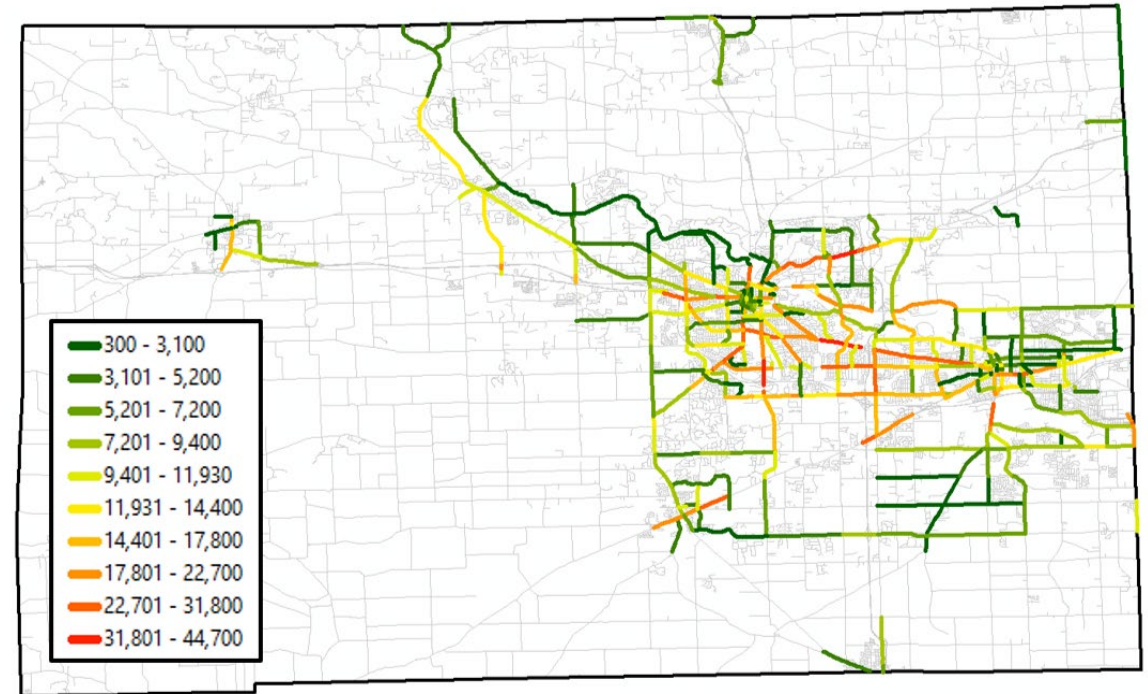
Segmentation of Study Road Segments



Data Includes Range of Posted Speed Limits and Daily Traffic Volumes

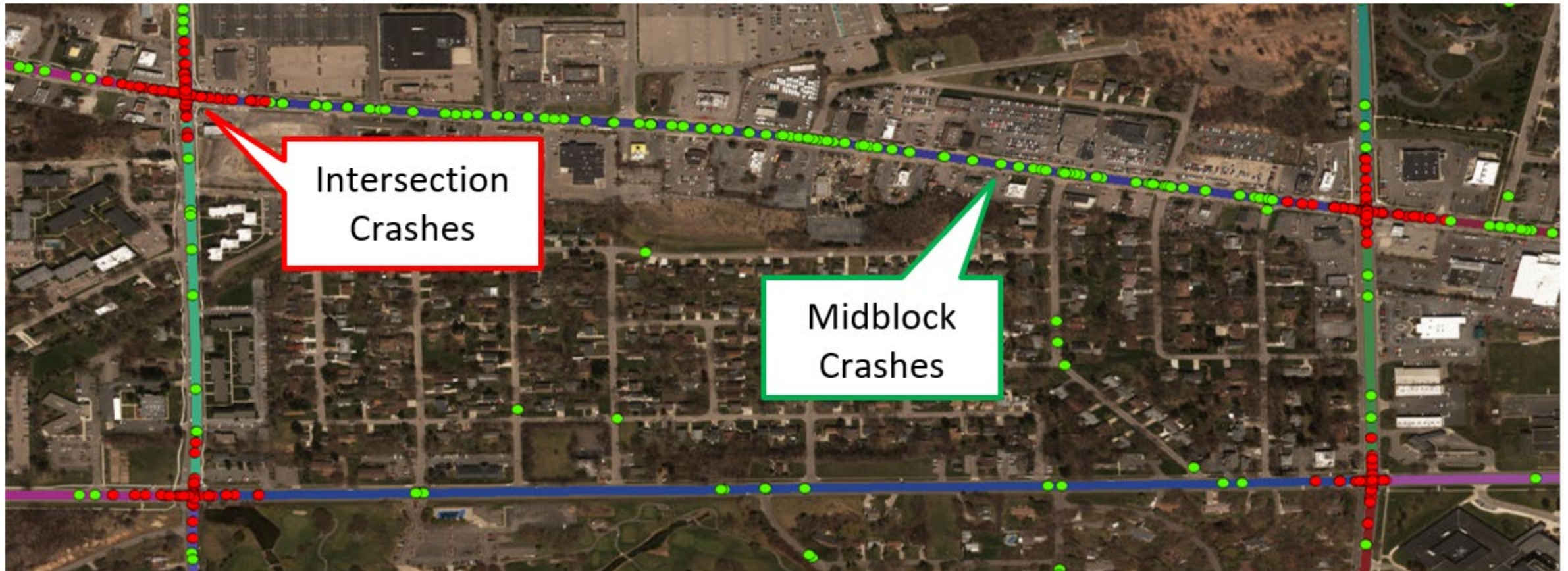


Posted Speed Limit



AADT

Traffic Crash Data Collection



Additional Geometric and Roadway Characteristics

- Access Point Density
- Bicycle Lane Present
- Bus Stop Present
- Midblock Crosswalk Present
- Curb and Gutter Present
- Surrounding Land Use
- Horizontal Alignment
- End Point Intersection Type
- Lane Width
- Median Type and Width
- Number of Lanes
- On Street Parking
- Sidewalk Present
- Distance Between Sidewalk and Travel Lane
- Surface Width
- Adjacent School Present

NB Models for FI and Total Midblock Crashes

FI Crash (KABC) Model

Variable	Level	DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	-4.9187	0.8432	-6.5713	-3.2660	34.03	<.0001
FuncClass	Coll	1	-0.5925	0.1736	-0.9328	-0.2522	11.65	0.0006
FuncClass	MinArt	1	-0.3516	0.1111	-0.5693	-0.1338	10.01	0.0016
FuncClass	PrinArt	0	0.0000	0.0000	0.0000	0.0000	.	.
Crosswalk		1	0.2588	0.1013	0.0602	0.4574	6.53	0.0106
PedAuto		1	0.0103	0.0047	0.0011	0.0195	4.85	0.0276
POSTED_SPE		1	0.0227	0.0065	0.0100	0.0354	12.22	0.0005
Sidewalk_1yes		1	-0.2930	0.1453	-0.5778	-0.0081	4.06	0.0439
AccessDen	LT40	0	0.0000	0.0000	0.0000	0.0000	.	.
AccessDen	40to60	1	0.2009	0.1164	-0.0272	0.4291	2.98	0.0843
AccessDen	GT60	1	0.3669	0.1109	0.1496	0.5843	10.95	0.0009
LnVol		1	0.6812	0.0805	0.5234	0.8389	71.65	<.0001
Dispersion		1	0.3813	0.0487	0.2969	0.4897	NR	NR

Total Crash (KABCO) Model

Variable	Level	DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.2141	0.6991	-3.5844	-0.8439	10.03	0.0015
FuncClass	Coll	1	-0.5590	0.1462	-0.8455	-0.2725	14.63	0.0001
FuncClass	MinArt	1	-0.3256	0.1027	-0.5268	-0.1243	10.05	0.0015
FuncClass		0	0.0000	0.0000	0.0000	0.0000	.	.
Crosswalk		1	0.3108	0.0903	0.1338	0.4879	11.84	0.0006
Median	Raised	1	-1.3487	0.4191	-2.1701	-0.5272	10.35	0.0013
Median	TWLTL	1	-0.2722	0.1410	-0.5485	0.0041	3.73	0.0535
Median	None	0	0.0000	0.0000	0.0000	0.0000	.	.
MedWidth		1	0.0330	0.0101	0.0132	0.0529	10.63	0.0011
PedAuto		1	0.0112	0.0043	0.0028	0.0196	6.80	0.0091
Sidewalk_1yes		1	-0.5020	0.1223	-0.7418	-0.2622	16.84	<.0001
NumSigInt		1	0.1844	0.0671	0.0529	0.3159	7.56	0.0060
AccessDen	LT40	0	0.0000	0.0000	0.0000	0.0000	.	.
AccessDen	40to60	1	0.1879	0.1046	-0.0171	0.3928	3.23	0.0725
AccessDen	GT60	1	0.2376	0.0939	0.0535	0.4217	6.40	0.0114
LnVol		1	0.6337	0.0729	0.4908	0.7766	75.56	<.0001
Dispersion		1	0.5145	0.0421	0.4382	0.6040	NR	NR

Relationships between Roadway Characteristics and Posted Speed Limit

Variables Associated with Posted Speed Limit ($\alpha < 0.05$)

- Access Point Density
- Functional Classification
- Horizontal Curve Present
- Median Present
- On-Street Parking
- Distance between Travel Lane and Sidewalk

Variables Not Associated with Posted Speed Limit ($\alpha > 0.05$)

- Surrounding Land Use
- Lane Width
- Signalized Intersections
- Surface Width
- Adjacent School Present

Michigan Data's Impact on Decision Rules

- Data support the inclusion of two variables which were previously included in USLIMITS2, consistent with Texas data:
 - Traffic signal density
 - Access point density (with break points of 40 and 60 per mile)
- Also provides evidence for including **median type**
 - Only used for identifying average crash rates for similar roadways in USLIMITS2
 - Raised medians performed better than no median or TWLTL
 - TWLTs performed better than no median

Kay Fitzpatrick

FINDINGS FROM TEXAS

Roadway & Traffic Variables

- Bike lane
- Curb vs shoulder
- Development (residential or other)
- Access density (driveways & unsig)
- Signal density
- Intersection #legs (segment ends)
- Length of segment
- Presence of horizontal curves
- Type of median
- On-street parking
- Posted speed limit (PSL)
- Presence of school zone
- Presence of sidewalk
- Daily volume
- Presence of midblock ped crossing
- Distance between vehicle and sidewalk
- Functional class

Crash Data

- Obtained from TxDOT
- Used non-intersection (segment) crashes (NID)
 - Not intersection crash
 - Driveway-related crash
- Considered both KABCO and KABC severity level groups
 - K = fatal, A or B = injury, C = compliant, O = no injury

Speed Data

- City of Austin traffic count data
 - 2016 and 2017 data
 - Most on 2-lane streets (residential or collectors)
- Sites collected as part of NCHRP 17-76
 - 2018 data
 - Arterials, typically 4 lanes

Posted Speed Limit (mph)	# Segments	Length (mi)
25	169	52
30	318	138
35	68	36
40	51	37
45	43	28
50	12	13
55	2	2
Grand Total	663	305

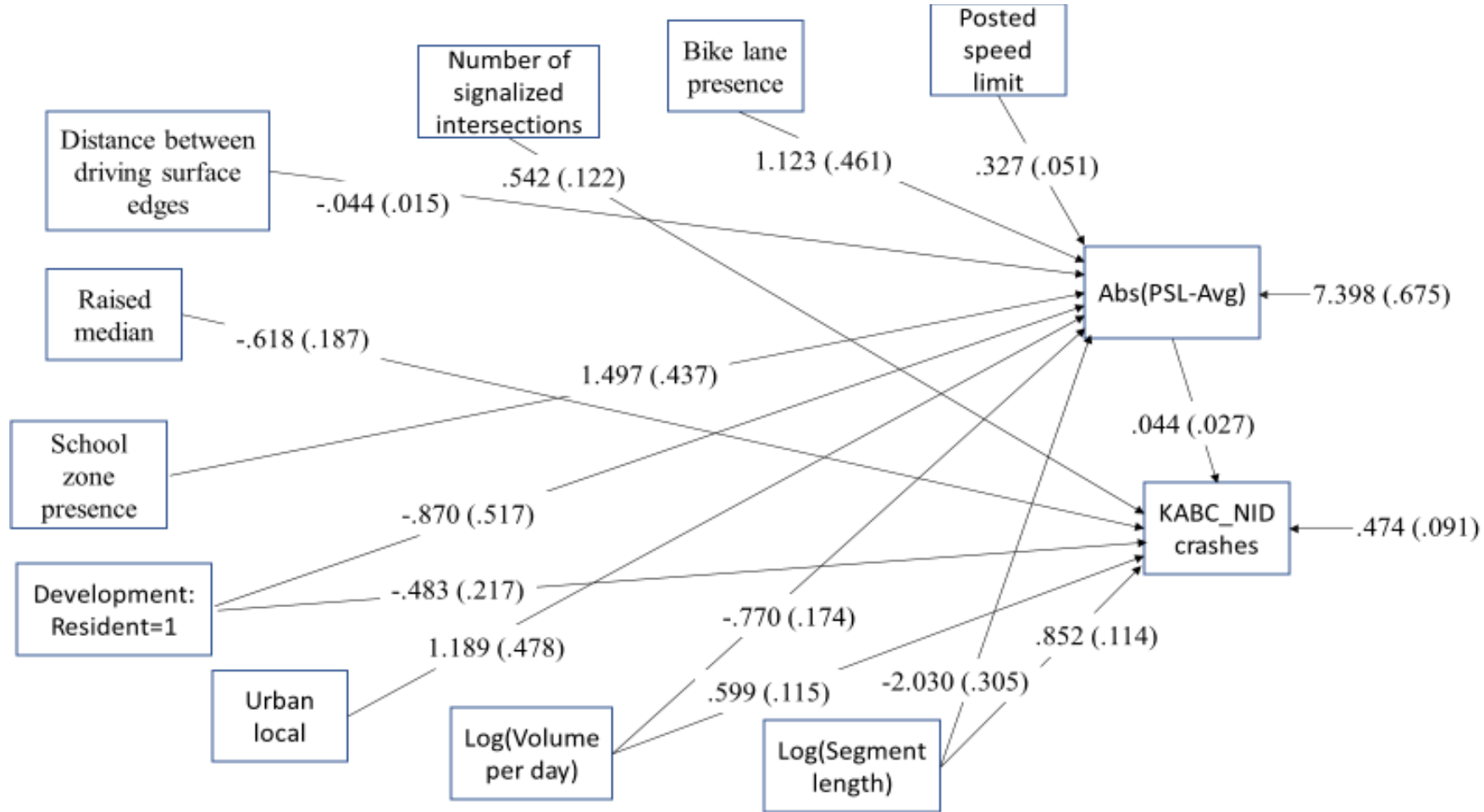
Speed Measures

Speed Measures	Description
Abs(PSL–Avg)	Absolute value of posted speed limit minus average speed (mph)
CoefVar	Coefficient of variation of speed
Pace	Percent of vehicles in 10-mph pace for the site (%)
PerOvPSL	Percent of observations over the speed limit for the site (%)
PSL	Posted speed limit (mph)
PSL–Avg	Posted speed limit minus average speed (mph)
PSL–S85	Posted speed limit minus 85th percentile speed (mph)
S85–Avg	85th percentile speed minus average speed (mph)
SpdAve	Average speed (mph)
StdSpd	Standard deviation (mph)

Path Statistical Analysis

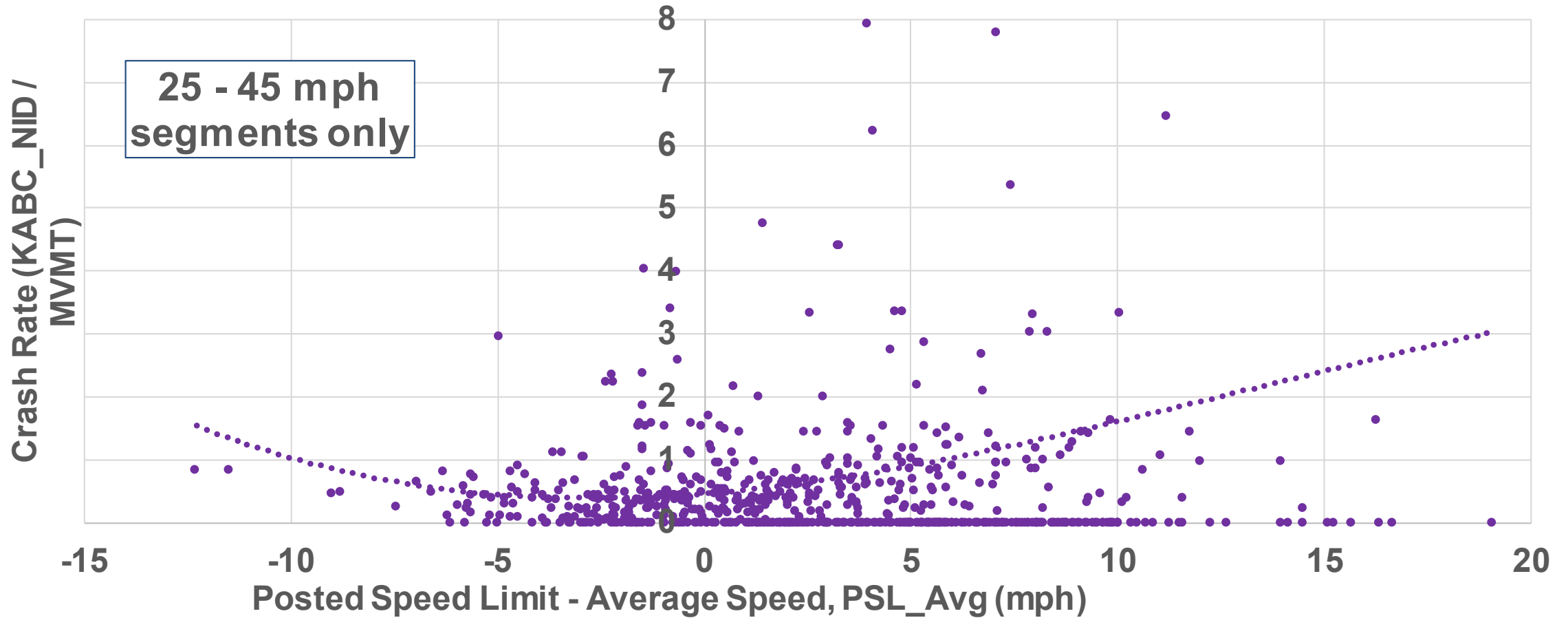
- Goal = consider the effect of speed on crashes while accounting for the effects of other roadway characteristics on speed and crashes
 - Perhaps PSL affects crashes through operating speed (i.e., indirectly affects crashes)
 - Perhaps other roadway characteristics also affect crashes through operating speed

Path Analysis – Segments w/PSL 20-45



Box → Variable
 Line connecting input variable with outcome variable → Coefficient (standard error)

Crash Rate and PSL-Average Speed



Other Key Findings

- Number of signals / signal density
 - More crashes with higher signal densities
- On-street parking
 - More crashes with on-street parking
- Median type
 - Fewer crashes for raised median as compared to no median or TWLTL

Mike Pratt

SLS-PROCEDURE / SLS-TOOL

Speed Limit Setting Procedure

Roadway Segment Context and Type

- Context = rural, rural town, suburban, urban, or urban core
- Type = limited access, arterial, collector, or local

Speed Distribution

- Consideration of the speed drivers are selecting on the segment

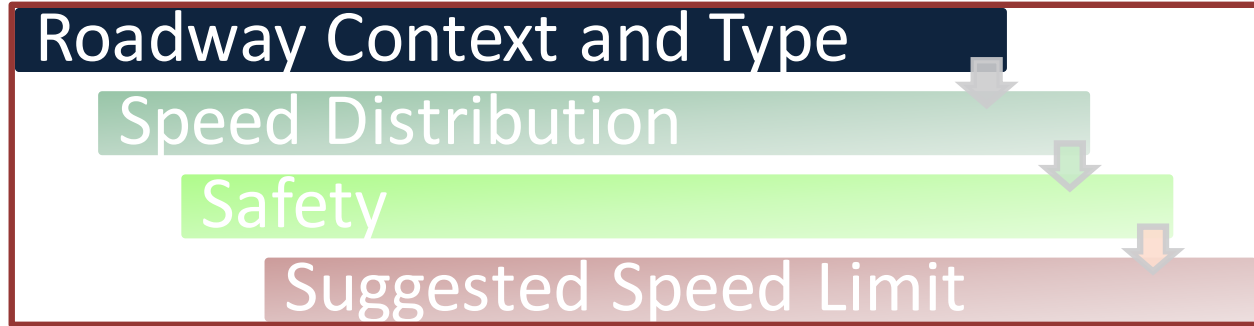
Safety






- Consideration of crash potential based on roadway characteristics

Suggested Speed Limit

- Calculated value based on consideration of roadway type/context, speed distribution (human factors), and safety (roadway characteristics/crashes)

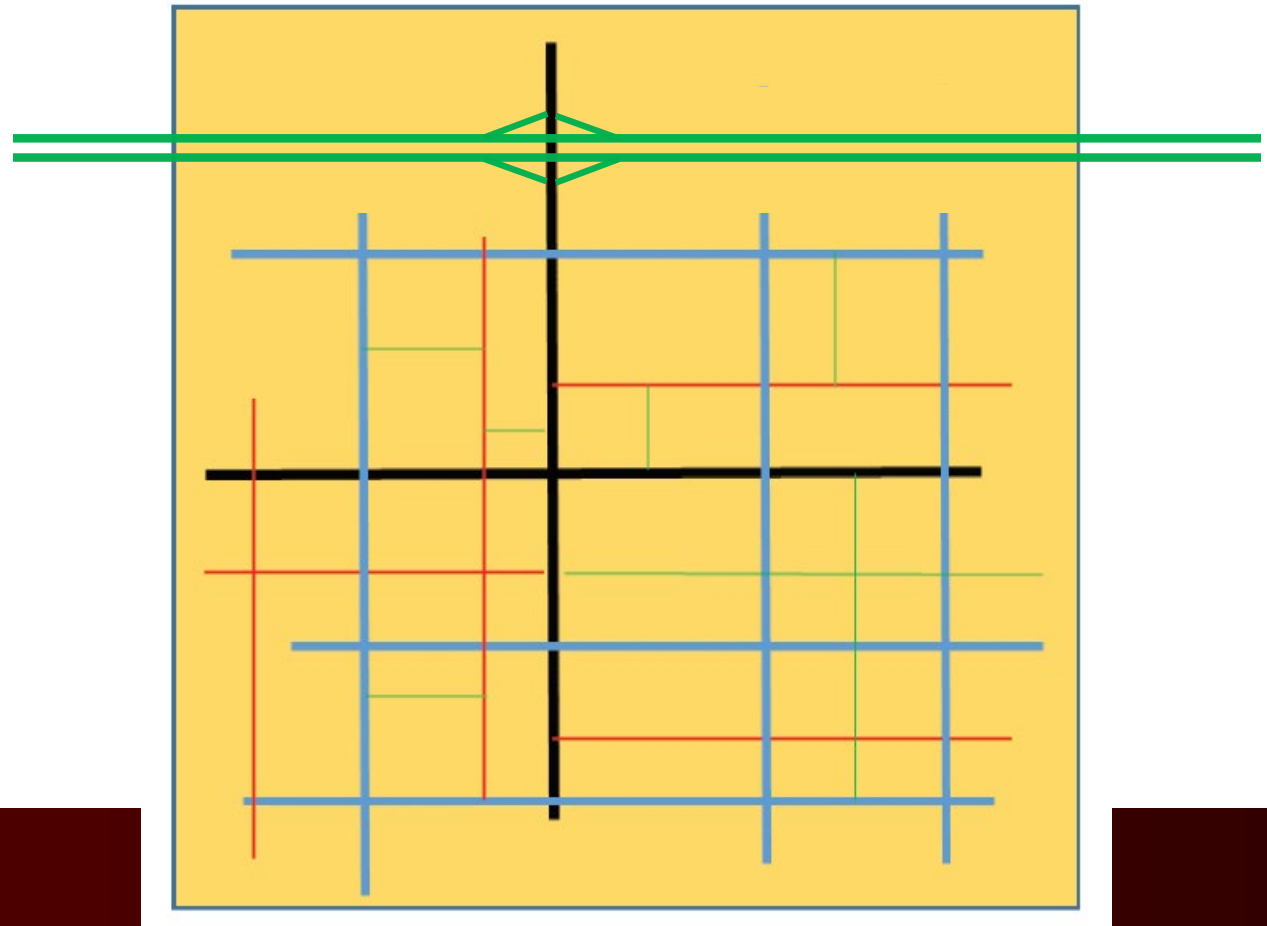
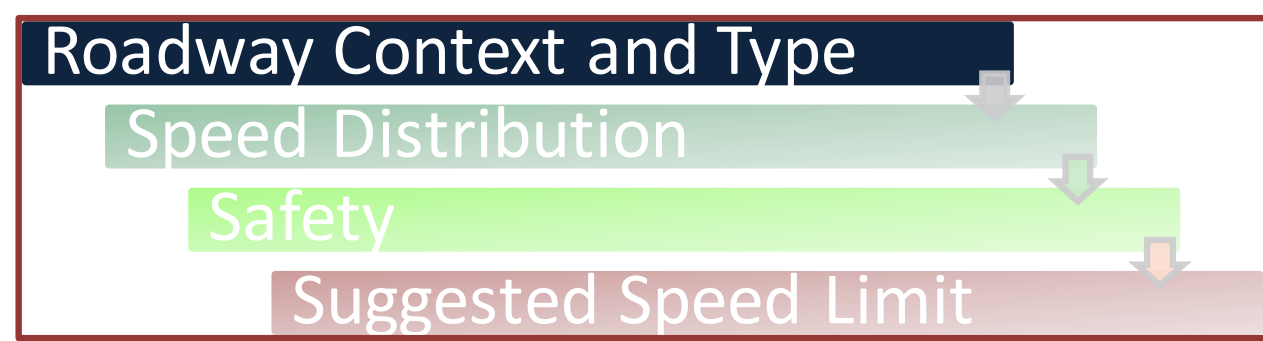
Roadway Context (NCHRP Report 855)



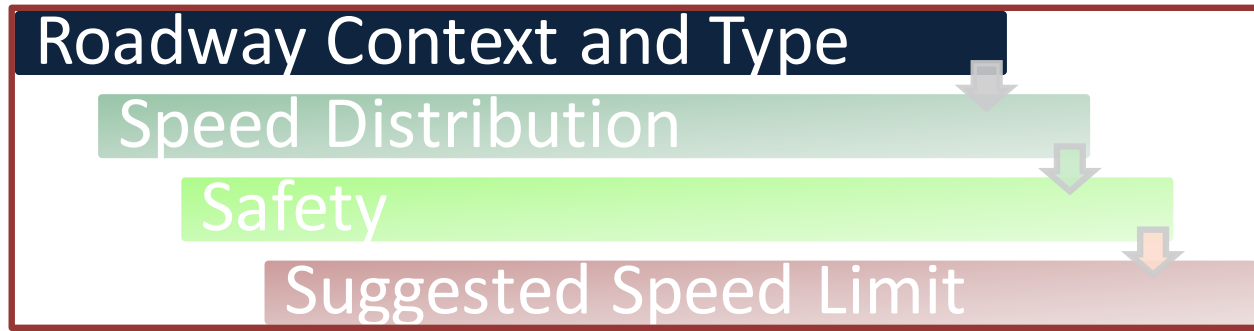
Context	Density	Illustration
Rural	Lowest (few houses or other structures)	
Rural Town	Low to medium (single family houses and other single purpose structures)	
Suburban	Low to medium (single and multifamily structures, multi-story commercial)	
Urban	High (multi-story, low rise structures with designated off-street parking)	
Urban Core	Highest (multi-story and high-rise structures)	

Roadway Type (NCHRP Report 855)

- Interstate/Freeway/Expressway
- Principal Arterial
- Minor Arterial
- Collector
- Local road

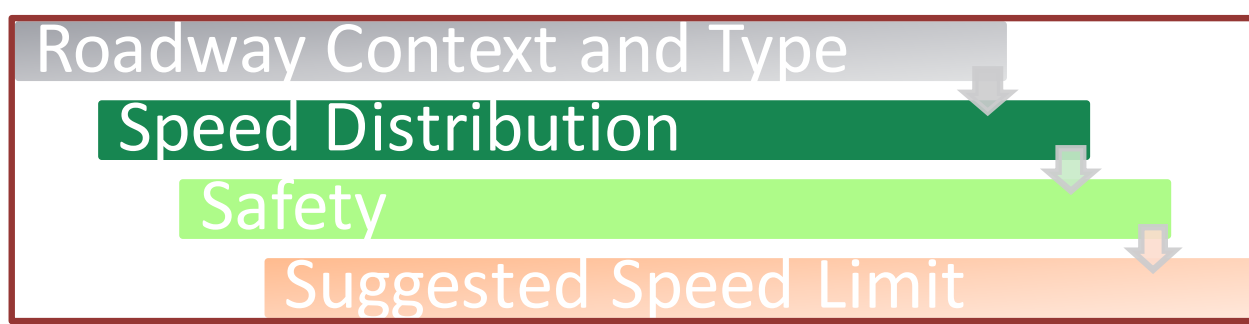


Speed Limit Setting Groups



Context \ Type	Rural	Rural Town	Suburban	Urban	Urban Core
Freeway	Limited Access	Limited Access	Limited Access	Limited Access	Limited Access
Principal Arterial	Undeveloped	Developed	Developed	Developed	Full Access
Minor Arterial	Undeveloped	Developed	Developed	Developed	Full Access
Collector	Undeveloped	Full Access	Developed	Full Access	Full Access
Local	Undeveloped	Full Access	Full Access	Full Access	Full Access

Suggested Speed Limit Starting Point...



Speed Limit Setting Groups	Method, Engineering	
<ul style="list-style-type: none"> Limited access Undeveloped Developed 	<ul style="list-style-type: none"> Closest 85th (C85) 	<ul style="list-style-type: none"> Roadway conditions OK
	<ul style="list-style-type: none"> Rounded down from 85th (RD85) 	<ul style="list-style-type: none"> Between
	<ul style="list-style-type: none"> Closest 50th (C50) 	<ul style="list-style-type: none"> Not favorable to all users or crashes a significant concern
<ul style="list-style-type: none"> Full Access (< 30 mph typically) 	<ul style="list-style-type: none"> Closest 50th (C50) 	<ul style="list-style-type: none"> Roadway conditions OK
	<ul style="list-style-type: none"> Rounded down from 50th (RD50) 	<ul style="list-style-type: none"> Not favorable to all users or crashes a significant concern

Why Speed Distribution?



- Retains connection with drivers
- Adjusted to consider roadway characteristics (via decision rules)
- Adjusted to consider crashes as drivers may not be aware of conditions (via decision rules)

Considering Safety and Roadway Characteristics



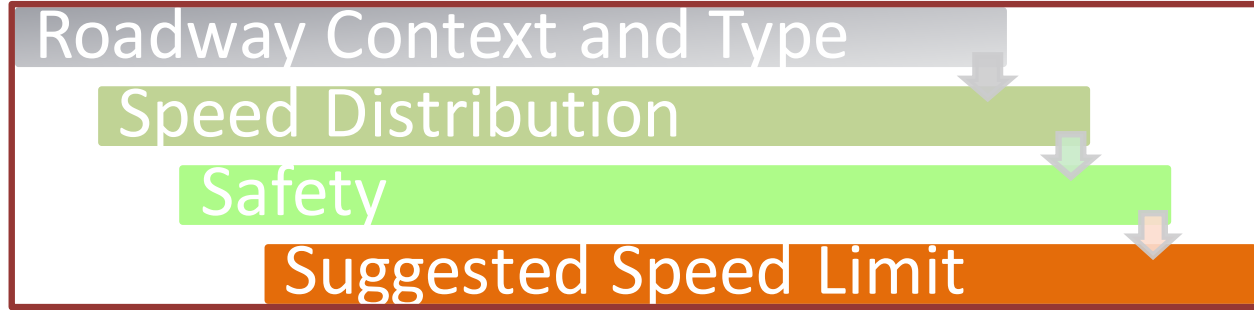
- Decision rules for each speed limit setting group
 - Considers geometric variables, human factors, and safety
- Decision rules identify:
 - Which speed distribution measure to start with (85th or 50th)
 - How to round (rounding closest or rounding down)

Developing Decision Rules in 17-76



- Findings from research, especially:
 - Freeways: NCHRP Project 17-45, NCHRP Report 783
 - Developed: Austin and Washtenaw data (17-76 data)
 - Undeveloped: Stapleton et al, Das et al, Gates et al
 - Rules used in USLIMITS2
- Guidance documents (*Green Book, Highway Safety Manual*)
- Expert opinions (research team, project panel)

Suggested Speed Limit



Analysis Results		Advisory, Calculated, or Warning Messages
Limited-access	Speed limit setting group	
70	Suggested speed limit (mph)	This value is determined by speed data & site characteristics.

Developing Speed Limit Setting Tool (SLS-Tool)

Guiding Principles for Spreadsheet

- Most or all data on one screen
- Colors to indicate what user should **enter** / what is being **calculated**, also **warning** / **advisory** notes
- Data input organized by type (e.g., site description, speed data, site characteristics, and crashes)
- Only show needed site characteristics for the particular speed limit setting group

Tool Demonstration

Example 1: Limited Access - Spreadsheet

NCHRP 17-76 Speed Limit Setting Tool			
Site Description Data		Color-Coding Legend	
Urban	Roadway context	Clear all data	Aqua = basic input cell
Freeway	Roadway type		Denim = basic input cell with drop-down menu
Yes	Are crash data available?	Enter default data	Orange = optional input cell (not needed for calculations)
User	Analyst		Green = optional input cell (use if data are available, leave blank otherwise)
12/31/2019	Date	Test macros	Rose = intermediate calculations
Example 1	Roadway name		Purple = final analysis results
65	Current speed limit (mph)		Yellow = field data or agency policy value — <i>adjust with caution and justification</i>
	Notes		Note: The "Test macros" button provides a message to verify proper macro operation.
Analysis Results		Advisory, Calculated, or Warning Messages	
Limited-access	Speed limit setting group		
70	Suggested speed limit (mph)	This value is determined by speed data & site characteristics.	
Speed Data		Advisory, Calculated, or Warning Messages	
70	Maximum speed limit (mph)		
71	85th-percentile speed (mph)		
67	50th-percentile speed (mph)		
Site Characteristics		Advisory, Calculated, or Warning Messages	
6.5	Segment length (mi)		
130,000	AADT (two-way total) (veh/d)		
6	Number of lanes (two-way total)		
200	Directional design-hour truck volume (trk/hr)		
5	Number of interchanges	1.3 miles between interchanges	
60	Design speed (mph)		
2	Grade (%)		
10	Outside shoulder width (ft)		
2	Inside shoulder width (ft)	Rounded-Down 85th	
No	Adverse alignment present?		
Crash Data		Advisory, Calculated, or Warning Messages	
3	Number of years of crash data		
25,000	Average AADT for crash data period (veh/d)		
16	All (KABCO) crashes for crash data period	Observed KABCO crash rate = 8.99 crashes / 100 MVMT	
4	Fatal & Injury (KABC) crashes for crash data period	Observed KABC crash rate = 2.25 crashes / 100 MVMT	
	Average KABCO crash rate (crashes / 100 MVMT)	HSIS average KABCO crash rate = 79.8 crashes / 100 MVMT	
	Average KABC crash rate (crashes / 100 MVMT)	HSIS average KABC crash rate = 21.24 crashes / 100 MVMT	
103.7	1.3 x average KABCO crash rate (crashes / 100 MVM)		
27.6	1.3 x average KABC crash rate (crashes / 100 MVMT)		
91.1	Critical KABCO crash rate (crashes / 100 MVMT)		
27.2	Critical KABC crash rate (crashes / 100 MVMT)		
Welcome Analysis Support Tables (+)			

Example 1: Limited Access - Spreadsheet

NCHRP 17-76 Speed Limit Setting Tool

Site Description Data		Color-Coding Legend	
Rural	Roadway context	<input type="button" value="Clear all data"/>	Aqua = basic input cell
Freeway	Roadway type	<input type="button" value="Enter default data"/>	Denim = basic input cell with drop-down menu
Yes	Are crash data available?		Orange = optional input cell (not needed for calculations)
MP	Analyst	<input type="button" value="Test macros"/>	Green = optional input cell (use if data are available, leave blank otherwise)
12/17/2019	Date		Rose = intermediate calculations
SH 23	Roadway name		Purple = final analysis results
	Description		Yellow = field data or agency policy value — <i>adjust with caution and justify</i>
65	Current speed limit (mph)		
	Notes		Note: The "Test macros" button provides a message to verify proper

Analysis Results		Advisory, Calculated, or Warning Messages
Limited-access	Speed limit setting group	
70	Suggested speed limit (mph)	This value is determined by speed data & site characteristics.

The basis for the suggested speed limit decision is noted here

Example 1: Limited Access - Spreadsheet

Variables that influence the calculated suggested speed limit are noted with advisory or calculated messages

2	Grade (%)	
10	Outside shoulder width (ft)	
2	Inside shoulder width (ft)	
No	Adverse alignment present?	Rounded-Down 85th
Crash Data		Advisory, Calculated, or Warning Messages
3	Number of years of crash data	
25,000	Average AADT for crash data period (veh/d)	
16	All (KABCO) crashes for crash data period	Observed KABCO crash rate = 8.99 crashes / 100 MVMT
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103.7	1.3 x average KABCO crash rate (crashes / 100 MVM)	
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91.1	Critical KABCO crash rate (crashes / 100 MVMT)	
27.2	Critical KABC crash rate (crashes / 100 MVMT)	
Welcome		Analysis
		Support Tables

Kay Fitzpatrick

CONCLUSIONS / RESEARCH NEEDS

Conclusions

- Selecting posted speed limit influenced by many factors
 - Add **ROADWAY CONTEXT & TYPE** to the list
- Operating speed most common but other techniques gaining in use in other countries and in US cities
- Draft MUTCD language – includes suggested changes
- NCHRP 17-76 SLS-Tool
 - Fact-based decision rules that consider driver speed choice and safety

Research Needs

- Relationship(s) among operating speed, roadway characteristics, posted speed limit, crashes
 - More is needed
- Specific criteria for ped / bike volume, bike lane type, sidewalk characteristics
- Alternative speed limit approaches for city streets
- Speed management techniques

NCHRP 17-76 Deliverables

<http://www.trb.org/main/blurbs/182038.aspx>

Research Report



User Guide and Tool



Posted Speed Limit Setting Procedure and Tool: User Guide

Several factors are considered within engineering studies when determining the posted speed limit to minimize crashes.

The TRB National Cooperative Highway Research Program's *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool* including both driver speed choice and safety associated with the roadway. This report also provides

- [N17-76 SLS-Tool \(with macros\)](#) and [N17-76 SLS-Tool \(without macros\)](#).

The "without macros" version is made available for users who are not able to use macro codes on their computers.

NCHRP 17-76

Guidance for the Setting of Speed Limits

Questions?





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Other TRB events for you

- *August 4:* TRB Webinar: Reducing Crashes through Systemic Safety Analysis
- *August 18:* TRB Webinar: Changing the Manual to Support Deployment of Automated Vehicles

<https://www.nationalacademies.org/trb/events>

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