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Using Vehicle Probe Data to Evaluate Speed Limits, Year 3

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16. Abstract
Speed limits are among the most visible and routinely enforced traffic control devices motorists encounter in their everyday driving. Speed limits are set using speed zone studies. This research project investigated how to make speed zone studies and speed zone decisions more effective and efficient. Researchers explored the thresholds for speed zone factors, applying the previously developed suggested speed limit based on a probe data (SSL_Probe) protocol for corridors to determine if improvements are needed. Researchers also used the findings from these efforts to refine the guidelines on how to use probe data within a speed zone study. The SSL_Probe protocol was used to estimate the 85th percentile speed needed for a speed zone study for 32 freeway corridors and 246 non-freeway corridors. The suggested speed limits based on the estimated 85th percentile speeds were similar to the suggested speed limits identified using on-site speed data or were generally within 5 mph. While the Texas Department of Transportation (TxDOT) *Procedures for Establishing Speed Zones* manual would need to be revised prior to being able to use probe data in a speed zone study, the use of these predicted 85th percentile speeds can provide a quick check on the need for a speed zone study. Based on discussions with TxDOT staff, reviews of other recent research studies, and the research team's engineering judgment, researchers suggest new factors for use in a speed zone study.

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DISCLAIMER

This research was sponsored by the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

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CHAPTER 1: INTRODUCTION

BACKGROUND

Speed limits are among the most visible and routinely enforced traffic control devices motorists encounter in their everyday driving. Speed limits are associated with safety in a broad range of forums, from neighborhood residents concerned with their children's safety to national safety agencies concerned that a high percentage of roadway fatalities involve speeding or pedestrians. Recently, the rationale for speed-limit-setting procedures via speed zone studies used by nearly all engineering practitioners has been called into question, especially with regard to non-freeway conditions. Given this high degree of exposure and scrutiny, speed limits—and the practices and procedures used to develop them, inform drivers about them, and help enforce them—are frequently an area of concern and discussion with a broad range of stakeholders. This research project investigated how to make speed zone studies and speed limit decisions more effective and efficient.

OVERVIEW OF SETTING REGULATORY SPEED LIMITS

The *Texas Manual on Uniform Traffic Control Devices* (TxMUTCD), previously the 2014 version (*1*) and currently the 2025 version (*2*), and the Texas Department of Transportation (TxDOT) *Procedures for Establishing Speed Zones* (Speed Zone Manual) (*3*) contain TxDOT's policies for setting regulatory speed limits, also known as posted speed limits (PSLs). Regulatory speed limits are set based on the 85th percentile speed of free-flowing passenger cars and various site-specific considerations, particularly geometry, access, and crash history. The Speed Zone Manual describes the methodology TxDOT uses to set regulatory speed limits. This methodology requires a speed zone study of vehicles in the field to set or revise regulatory speed limits.

PROJECT OBJECTIVES AND SCOPE

This report documents the work accomplished in year 3 of Project 0-7156-01. Efforts accomplished in year 1 and 2 are documented in other reports (*4*, *5*). Year 3 of Project 0-7156 included the following specific technical objectives:

- Explore the thresholds for the speed zone factors used to identify when to lower the 85th percentile speed in the Speed Zone Manual.
- Apply the previously developed suggested speed limit using probe data (SSL_Probe) protocol (*6*) to several corridors to investigate whether the SSL_Probe protocol should be refined and to identify challenges with using the protocol.
- Use the findings from these efforts to refine the guidelines on how to use probe data within a speed zone study.

REPORT ORGANIZATION

This report consists of five chapters. In addition to this introductory chapter, the report contains the following material:

- Chapter 2 summarizes the interviews to identify potential refinements to the speed zone roadway factors.
- Chapter 3 discusses the lessons learned from using the suggested speed limit protocol on multiple corridors.
- Chapter 4 summarizes the work being done in the TxDOT Dallas District to create a DAL Speed Zone Dashboard.
- Chapter 5 summarizes researchers' findings and provides recommendations for future action.

CHAPTER 2: TXDOT PRACTITIONER INTERVIEWS

BACKGROUND

Chapter 3 Section 4 of the Speed Zone Manual (*3*) provides the following two lists of qualitative factors that can be considered in setting a regulatory speed limit in addition to the 85th percentile speed:

- Crash Rate Greater than the Statewide Average Crash Rate for Similar Types of Roadways.
- Additional Roadway Factors.

Table 1 summarizes these lists.

Table 1. Roadway Factors in the TxDOT *Procedures for Establishing Speed Zones* (*3*) Considered in Setting Regulatory Speed Limits.

Factor	List One: Crash Rate (Reduce by up to 12 mph below 85th Percentile	List Two: Additional Roadway Factors (Reduce by up to 10 mph [Typical] or 12 mph [High Crash Rate] below 85th Percentile	Notes (from List Two)
Narrow roadway pavement	X	X	20 feet or less, for example
Horizontal and vertical curves	X	X	Possible limited sight distance
Hidden driveways and other developments	—	X	Possible limited sight distance
High driveway density	X	X	The higher the number of driveways, the higher the potential for encountering entering and turning vehicles
Lack of striped, improved shoulders	X	X	Constricted lateral movement
Crash history	X	X	(No note)
Rural residential or developed areas	—	X	Higher potential for pedestrian and bicycle traffic

Notes: An X denotes the factor was considered. A dash denotes the factor was not included.

The Speed Zone Manual explains that these criteria can be used to justify setting a regulatory speed limit as much as 10 mph below the 85th percentile speed, or as much as 12 mph below the 85th percentile speed if the speed zone of interest has a crash rate higher than the statewide average crash rate for similar facilities.

To explore how these factors are currently being used along with suggestions on what should be considered, the research team held discussions with TxDOT staff who are performing speed studies.

INTERVIEW STRUCTURE

The research team developed a list of interview questions to obtain information from TxDOT district practitioners about speed zone study practices. The interview consisted of 19 questions and was implemented in a 1-hour meeting in person or online. The interview included the following questions.

Zone Categorization

Researchers asked the following questions concerning zone categorization:

1. Do you consider area type (urban versus rural) and roadway type (freeway and non-freeway) when evaluating whether to modify the 85th percentile speed?
    a. If yes, what kind of categorization do you use to consider area type and roadway type? (See the example table [Table 2].)
    b. If no, do you think that your agency should consider some kind of categorization?
2. Approximately what percentage of your speed zone studies fall within the categories in the example table (Table 2)?

Table 2. Speed Zone Studies Distribution.

Roadway Type	Area Type Urban	Area Type Rural
Freeway	—	—
Non-freeway	—	—

Note: Dashes denote areas where practitioners were asked to provide information.

Thresholds

Researchers presented the following to practitioners.

For the questions in the following section, please specify if there are multiple answers depending on area type, roadway type, and/or other variables to categorize speed zones. These questions focus on roadway factors provided in two sections of the Speed Zone Manual, Crash Rate Greater than the Statewide Average Crash Rate for Similar Types of Roadways and Additional Roadway Factors, which are found in Chapter 3 Section 4 (Speed Zone Design), pages 3-18 to 3-20. These two lists provide qualitative factors to consider when deviating from the 85th percentile speed. The lists largely overlap each other.

3. How do you define “high driveway density”?

4. When considering crash history, how is the geographic distribution of crashes considered in the analysis? Possible responses may include:

    a. Decide based on crash rate for entire speed zone, without concern for geographic distribution
    b. Identify "hot spots" and deviate from the 85th percentile speed if too many hot spots exist and/or cannot be treated in other ways
    c. Deviate from the 85th percentile speed if the geographic distribution of crashes is so general that other treatments are not feasible
    d. Other

5. How is crash severity distribution (i.e., distribution based on the KABCO scale) considered in the analysis, if at all?
6. How do you define "narrow pavement width"? Possible responses may include:

    a. Total surface width
    b. Lane width
    c. Shoulder width
    d. Other

7. How do you account for horizontal curves? Possible responses may include:

    a. Number of curves in the zone
    b. Percentage of zone length that is curved
    c. Radius of sharpest curve
    d. Number of curves in the zone below a threshold radius (which threshold?)
    e. Sight distance restrictions due to horizontal curvature and roadside obstacles
    f. Other

8. How do you account for vertical curves? Possible responses may include:

    a. Number of curves in the zone
    b. Percentage of zone length that is curved
    c. Sight distance restrictions due to vertical curvature
    d. Other

9. On which types of roads have you deviated from the 85th percentile speed due to lack of striped, improved shoulders?
10. Can other cross-sectional features (e.g., curb and gutter section on urban roads) serve the same purpose as striped, improved shoulders in the analysis?
11. How are other types of roadway users (e.g., pedestrians or bicyclists) considered in the speed zone study process?

12. How many factors have to be present before you decide to deviate from the 85th percentile speed by:

    a. 5 mph?
    b. 10 mph (or 12 mph based on crash history)?

13. Should any factors be added to or removed from the lists?
14. Should the two lists of factors be merged into one? Why/why not?

Other Issues

15. Do you plot locations of all crashes in the speed zone on the bottom portion of the strip map? (The Speed Zone Manual does call for this practice, and the map legend shows it, but is it still happening?)
16. What is the cost of conducting a speed zone study? ($ per mile and/or staff-hours per mile)
17. How do you define the endpoints of your speed zones?
18. At how many locations do you measure speeds within a given speed zone?
19. How are school zones considered relative to any of the adjustment factors, if at all?

The research team sought to obtain responses from a distribution of districts by size (metropolitan, urban, or rural) and region (north, east, south, or west). Table 3 shows the distribution of TxDOT districts by size using TxDOT's District Classification Map (*7*), and Table 4 shows the region using the region categories defined in Project 0-7083 (*8*). The research team interviewed practitioners in the districts listed in the second column of the table. Researchers conducted these interviews in August and September 2025. The practitioners included engineers and technicians responsible for traffic operations, particularly speed zone study data collection and analysis.

Table 3. Distribution of TxDOT Districts by Size.

Size	Districts Interviewed	Other Districts
Metropolitan	DAL, FTW, HOU, PHR, SAT	AUS
Urban	BMT, ELP, LBB, WAC	BRY, CRP, LRD, ODA, PAR, TYL
Rural	ATL, CHS, LFK, WFS	ABL, AMA, BWD, SJT, YKM

ABL – Abilene District, AMA – Amarillo District, ATL – Atlanta District, AUS – Austin District, BMT – Beaumont District, BRY – Bryan District, BWD – Brownwood, CHS – Childress District, CRP – Corpus Christi District, DAL – Dallas District, ELP – El Paso District, FTW – Fort Worth District, HOU – Houston District, LBB – Lubbock District, LFK – Lufkin District, LRD – Laredo District, ODA – Odessa District, PAR – Paris District, PHR – Pharr District, SAT – San Antonio District, SJT – San Angelo District, TYL – Tyler District, WAC – Waco District, WFS – Wichita Falls District, YKM – Yoakum District.

Table 4. Distribution of TxDOT Districts by Region.

Region	Districts Interviewed	Other Districts
North	ATL, DAL, FTW, WAC, WFS	BWD, PAR, TYL
East	BMT, HOU, LFK	BRY
South	PHR, SAT	AUS, CRP, LRD, YKM
West	CHS, ELP, LBB	ABL, AMA, ODA, SJT

INTERVIEW RESPONSES

After completing the interviews, the research team reviewed and tabulated the practitioners' responses. The following sections summarize the responses to the three sets of questions (zone categorization, thresholds, and other issues).

Zone Categorization

Question 1 asked whether the practitioners consider area type (urban versus rural) and roadway type (freeway versus non-freeway) when deciding whether to deviate from the 85th percentile speed when setting regulatory speed limits. As Table 5 shows, the most common response was that the district considers only area type (rural versus urban) when it categorizes speed zones; six districts provided this answer. Two of these districts observed that they have little or no freeway mileage in their jurisdiction. Five other districts named other variables that they use to categorize speed zones, including roadway type (freeway versus non-freeway), functional class, highway system (interstate, U.S. highway, state highway, or farm-to-market road), or annual average daily traffic (AADT). Practitioners in two districts explained that they do not explicitly categorize their speed zones but believe that the necessary categorizations are captured in the measuring of the 85th percentile speed and other relevant roadway factors, such as driveway density.

Table 5. Categorization of Speed Zones.

Number of Responses	Categorization Method
2	Rural vs. urban and freeway vs. non-freeway
2	Rural vs. urban and functional class or highway system (interstate, U.S. highway, state highway, or farm-to-market road)
6	Rural vs. urban
1	Functional class and AADT
2	No explicit categorization

Question 2 called for specifying the approximate percentages of speed zone studies that fall within the 2×2 matrix of area type (rural versus urban) and roadway type (freeway versus non-freeway). Table 6 provides the distributions for the district size and region categories. Across all interviewed districts, almost 80 percent of speed zone studies were conducted on non-freeways, with rural non-freeways being the most abundant category at 46 percent. Across all districts and each district category, no more than 21 percent of speed zone studies were conducted on freeways, likely a reflection of the centerline mileage of roadway types in the state.

Table 6. Distribution of Speed Zone Studies.

District Category	Percentage of Studies for Urban Freeways	Percentage of Studies for Rural Freeways	Percentage of Studies for Urban Non-freeways	Percentage of Studies for Rural Non-freeways
Metropolitan	12	12	50	26
Urban	15	15	30	40
Rural	2	6	16	76
North	9	11	32	48
East	10	23	22	45
South	5	5	58	32
West	13	3	32	52
All districts	10	11	33	46

Thresholds

Question 3 asked if the districts have a definition for "high driveway density." Table 7 lists the responses to this question. Five of the districts use quantitative definitions, while eight use engineering judgment while considering various qualitative factors. One district mentioned that it considers the guidance in the *Access Management Manual* (*9*) regarding driveway density; this district also considers the driveway density to be "high" if the existing number of driveways exceeds the number that would be allowed based on current driveway permitting policies. Districts that do apply quantitative definitions for high driveway density use values ranging from 10 to 30 driveways per mile, sometimes with consideration of area type.

Table 7. Definitions of High Driveway Density.

Number of Responses	Description
1	20–30 driveways/mile (urban), no threshold (rural)
1	20–25 driveways/mile, not based on area type
1	10 driveways/mile
1	3 or more driveways within ¼ mile of speed zone study location
1	More than allowed in the TxDOT *Access Management Manual* or current driveway permitting policies
8	Engineering judgment (may qualitatively consider driveway clusters, driveway spacing, conflict points, development level, and/or comparison of subject roadway to adjacent similar roadways)

Question 4 asked how the districts consider the geographic distribution of crashes when analyzing crash history in a speed zone study. The interview form provided the following possible answers:

- Decide based on crash rate for entire speed zone, without concern for geographic distribution.
- Identify "hot spots" and deviate from the 85th percentile speed if too many hot spots exist and/or cannot be treated in other ways.

- Deviate from the 85th percentile speed if the geographic distribution of crashes is so general that other treatments are not feasible.
- Other (please specify).

Table 8 lists the responses to this question. Most districts mentioned that they consider the crash rate for the entire speed zone because the Speed Zone Manual procedure calls for comparing the overall crash rate to the statewide average crash rate for similar facilities. Additionally, most districts consider geographic distribution of crashes in the speed zone, and these districts stated several reasons for doing so. In some cases, the districts identified crash hot spots for the purpose of identifying other safety treatments or to determine whether the deviation from the 85th percentile speed should be 5 mph or 10–12 mph. Four districts stated that if the distribution of crashes within a long speed zone was not consistent, they would not necessarily use the overall crash rate to justify lowering the regulatory speed limit for the entire speed zone. Instead, they would consider subdividing the speed zone and lowering the regulatory speed limit on the portion that experienced crash hot spots, or they would consider revising the break points between adjacent speed zones if the regulatory speed limit on the adjacent speed zone is lower than that of the subject speed zone.

Table 8. Methods for Geographic Distribution of Crashes.

Number of Responses*	Description
9	Decide based on crash rate for entire speed zone, without concern for geographic distribution
9	Identify “hot spots” and deviate from the 85th percentile speed if too many hot spots exist and/or cannot be treated in other ways
3	Deviate from the 85th percentile speed if the geographic distribution of crashes is so general that other treatments are not feasible
1	Not applicable (crash rates have not affected their speed zone studies)

* The total number exceeds the number of interviewed districts because some districts use multiple methods.

Question 5 asked how the districts consider the crash severity distribution (on the KABCO scale) when analyzing crash history in a speed zone study. Table 9 lists the responses to this question. The most common response (five districts) was to consider all crash severities but give more weight to fatal (K), incapacitating/serious (A), and non-incapacitating/minor (B) crashes; possible (C) and property-damage-only (O) crashes were given less weight. Several practitioners observed that the statewide average crash rates used in the analysis are computed for KAB crashes and for all crashes, and that other safety analysis procedures used by TxDOT (e.g., the Highway Safety Improvement Program) involve assigning higher weight to KA crashes.

Table 9. Consideration of Crash Severity Distribution in Speed Zone Studies.

Number of Responses*	Description
1	Consider KAB crashes only
5	Consider all crash severities but give more weight to KAB crashes
2	Consider all crash severities but give more weight to KA crashes
2	Consider all crash severities but give more weight to K crashes
1	Pay extra attention to crashes coded with contributing factors of "failed to control speed" or "excessive speed"
1	Analyze all K crashes to determine if speed was a factor
3	Consider all crashes without consideration of severity

* The total number exceeds the number of interviewed districts because some districts use multiple methods.

Question 6 asked how the districts define "narrow pavement width." The interview form provided the following possible answers:

- Total surface width.
- Lane width.
- Shoulder width.
- Other.

Table 10 lists the responses to this question. Most districts specified either 24 ft (four districts) or 20 ft (three districts) as their definition of "narrow." Four districts stated that they also define a road as narrow if it lacks striped shoulders. One district stated that it is considering but has not yet adopted total surface width thresholds of less than 26 ft to allow regulatory speed limits no greater than 70 mph, or 20–22 ft to allow regulatory speed limits no greater than 65 mph. This district is rural and contains many two-lane roads that were raised to 75 mph in the early 2010s, and is considering re-lowering some of the 75-mph regulatory speed limits because of narrow pavement widths.

Table 10. Definition of Narrow Pavement Width.

Number of Responses	Description
2	Total surface width < 24 ft or lacks striped shoulders
4	Total surface width < 24 ft
1	Total surface width < 22 ft or shoulder width < 4 ft
1	Considering total pavement width < 26 ft for a maximum of 70 mph and < 20–22 ft for a maximum of 65 mph
3	Total surface width < 20 ft
1	Total surface width < 20–22 ft and lacks striped shoulders
1	Qualitative, based on total pavement width for rural roads or lane width for urban roads

Question 7 asked how the districts account for horizontal curvature in the speed zone study process. The interview form provided the following possible answers:

- Number of curves in the zone.
- Percentage of zone length that is curved.
- Radius of sharpest curve.
- Number of curves in the zone below a threshold radius (which threshold?).
- Sight distance restrictions due to horizontal curvature and roadside obstacles.
- Other.

Table 11 lists the responses to this question. The most common response (nine districts) was the number of curves in the speed zone, with no threshold value to specify how many curves per mile are needed to justify deviating from the 85th percentile speed. Four districts consider horizontal curvature based on the radius of the sharpest curve in the speed zone but without a specified threshold radius value. Generally, the practitioners mentioned that horizontal curvature is separately addressed in the curve advisory speed study process. One district mentioned considering both issues (regulatory speed zoning and curve advisory speed setting) together, in that the district will try to adjust regulatory speed limits to minimize the need for chevrons if a speed zone has many curves with sufficiently low advisory speeds that they would require chevrons. (The TxMUTCD [*1*] recommends chevrons if the difference between the regulatory and advisory speeds is 10 mph and requires them if the difference is 15 mph or greater.)

Table 11. Consideration of Horizontal Curvature in the Speed Zone Study Process.

Number of Responses*	Description
9	Number of curves in the speed zone (no specified threshold value)
4	Radius of sharpest curve (no specified threshold radius value)
2	Sight distance restrictions
1	Consider horizontal curve signing requirements (e.g., try to avoid 15-mph differences between regulatory and advisory speeds to minimize need for chevrons)
1	Consider horizontal curvature for other analyses (e.g., setting advisory speeds) but not in the speed zone study process
1	Percentage of speed zone length that is curved (no specified threshold percentage value)
1	Advisory speeds of curves (if much of the speed zone length is curved)
1	Distances between curves
2	No specific method

* The total number exceeds the number of interviewed districts because some districts use multiple methods.

Question 8 asked how the districts account for vertical curvature in the speed zone study process. The interview form provided the following possible answers:

- Number of curves in the zone.

- Percentage of zone length that is curved.
- Sight distance restrictions due to vertical curvature.
- Other.

Table 12 lists the responses to this question. The most common responses were sight distance restrictions (six districts) and number of curves in the speed zone but with no specific threshold value (four districts). One district stated that it considers deviating from the 85th percentile speed if more than half of the speed zone has vertical curvature. Six districts stated that they either do not have a specific method to consider vertical curvature or that vertical curvature is seldom significant enough to affect speed zone study results.

Table 12. Consideration of Vertical Curvature in the Speed Zone Study Process.

Number of Responses*	Description
6	Sight distance restrictions
4	Number of curves in the speed zone (no specified threshold value)
1	More than 50 percent of speed zone curved
1	Percentage of speed zone length that is curved (no specified threshold percentage value)
1	Grade exceeds 3 percent
6	No specific method/seldom applicable for the district

* The total number exceeds the number of interviewed districts because some districts use multiple methods.

Question 9 asked on which types of roads the districts have deviated from the 85th percentile speed due to lack of striped, improved shoulders. All districts stated that they have only applied this adjustment to rural two-lane highways, and this adjustment is rarely needed. One interviewee observed that roads without striped, improved shoulders are usually low-volume rural highways and are already signed at no more than 55 mph.

Question 10 asked if other cross-sectional features, such as a curb-and-gutter section on urban roads, can serve the same purpose as a striped, improved shoulder in the speed zone study process. In other words, if a road does not have striped, improved shoulders but does have a curb-and-gutter section, would this road be considered "not narrow" for the purpose of applying the speed zone study factors? Six districts said yes, four said no, and three said that consideration of curb-and-gutter section presence is not an issue for their speed zone studies.

Question 11 asked how other types of roadway users (e.g., pedestrians or bicyclists) are considered in the speed zone study process. Table 13 lists the responses to this question. The most common response (eight districts) was that pedestrians and bicyclists are assumed to be present in a speed zone that is located in an urban area or a rural town, or that their presence correlates with other variables, such as the 85th percentile speed, cross-sectional widths, and driveway density. No districts conducted pedestrian or bicyclist counts as part of their speed zone study process, and one district observed that there is no quantitative guidance on volume thresholds for pedestrians or bicyclists.

Table 13. Consideration of Pedestrians and Bicyclists in the Speed Zone Study Process.

Number of Responses*	Description
8	The needs of pedestrians and bicyclists are reflected in other variables, such as the 85th percentile speed, area type (particularly urban or rural town), cross-sectional widths, and driveway density
2	Engineering judgment/qualitative observation of pedestrian or bicyclist presence
2	Considered in other aspects of speed zoning, such as design of school zones or transitions
2	Considered during reviews of K crashes
2	Not considered/not applicable for the district

* The total number exceeds the number of interviewed districts because some districts use multiple methods.

Question 12 asked how many of the factors in Table 1 have to be present before the district would deviate from the 85th percentile speed by 5 mph, and by 10–12 mph based on crash history. Table 14 lists the responses to this question. The most common response (four districts) was that one factor has to be present to deviate by 5 mph and two or more factors have to be present to deviate by 10–12 mph. One district providing this response stated that it may consider future plans for the road in addition to existing conditions. Three districts stated that they have no standards for this issue. One district described a context-sensitive approach that considers which factors are present and the 85th percentile speed instead of just the number of factors. This district explained that if the 85th percentile speed is 55 mph (i.e., relatively low compared to many rural highways in Texas), then it would likely post the regulatory speed limit at 55 mph even if the narrow roadway pavement factor was present. This district would also deviate from the 85th percentile speed by 10–12 mph if the crash history factor was met even if no other factors were present.

Table 14. Number of Factors Present When Deviating from the 85th Percentile Speed.

Number of Responses	Number of Factors to Deviate from 85th Percentile by 5 mph	Number of Factors to Deviate from 85th Percentile by 10–12 mph
1	1	1
4	1	2 or more
1	2	2 or more
1	1	3 or more
1	1 if the factor is crash history; 1–2 otherwise	3 or more
1	1	1 if the factor is narrow roadway pavement or development; 2 or more otherwise
1	Depends on roadway context	Depends on roadway context
3	No standard	No standard

Question 13 asked if any factors should be added to or removed from the lists of roadway factors shown in Table 1. Table 15 lists the responses to this question. Seven districts suggested no changes to the roadway factors lists. No districts suggested removing factors though one district suggested combining the factors of narrow pavement width and lack of striped, improved shoulders. Some of the suggested additions to the factors lists (e.g., school zone presence, intersections, and city limits) appear to relate more to the design of speed zone transitions than the setting of regulatory speed limits, but the practitioners explained that they sometimes need flexibility to deviate from the 85th percentile speed to design proper transitions. Other suggested additions included future developments and traffic signals (though one practitioner observed that a re-study should occur when these conditions change in a speed zone), weather, pavement condition, and regulatory speed limits on adjacent segments on the subject roadway (to improve continuity).

Table 15. Suggested Changes to Roadway Factors Lists.

Number of Responses	Description
7	No additions or removals needed
3	Add consideration of school presence or school zones (for transition design and/or setting the regulatory speed limit)
2	Add consideration of future developments
1	Add consideration of future traffic signals
1	Add consideration of intersections (for transition design and/or setting the regulatory speed limit)
1	Add consideration of city limits (for transition design and/or setting the regulatory speed limit)
1	Add consideration of weather
1	Add consideration of pavement condition
1	Add consideration of regulatory speed limits on adjacent segments of the same roadway to improve continuity
1	Combine the narrow pavement width and lack of striped, improved shoulders factors

Question 14 asked if the two lists of roadway factors shown in Table 1 should be merged into a single list. Eleven of the districts said yes, and their stated reasons were to simplify the guidance, encourage consistency, and/or minimize confusion. One of these practitioners further suggested that one maximum adjustment of either 10 mph or 12 mph should be chosen for consistency and simplicity. Of the two districts opposing merging the lists, one stated that each list has its own purpose, and the other stated that it would be difficult to capture all relevant factors in one list because combinations of factors must be considered.

Other Issues

Question 15 asked if the districts routinely plot the locations of crashes on strip maps. Table 16 lists the responses to this question. This practice is still specified in the Speed Zone Manual, but the research team has observed that it was not always done on strip maps requested during several recent research projects. Most districts stated that they plot crashes on their strip maps though not necessarily all crashes. For instance, three districts plot just KAB crashes. Three districts stated that they plot crashes on strip maps only if requested by the TxDOT Traffic Safety Division (TRF) or if they are deviating from the 85th percentile speed because of crash history. Two districts stated that they document crash locations with other map resources (e.g., Google Earth or geographic information system [GIS] maps) but not on strip maps.

Table 16. Crash Location Plotting Practices.

Number of Responses	Description
4	All crashes are plotted on strip maps
1	KABC crashes are plotted on strip maps
3	KAB crashes are plotted on strip maps
2	Crashes are plotted on strip maps only if deviating from the 85th percentile speed because of crash rates
1	Crashes are plotted on strip maps only if requested by TRF
2	Crashes are plotted on other map resources but not strip maps

Question 16 addressed the cost of conducting speed zone studies. Districts answered this question in terms of dollars and/or staff time. Answers included:

- 16 hours plus drive time per study if collecting speed data at ¼-mile intervals.
- 5 hours plus drive time per study if collecting speed data at 2-mile intervals.
- $2000 per study for a spot location, with this amount doubled or tripled including time spent communicating with TRF.
- 3 hours per mile for data collection plus 16–24 hours to generate the strip map.
- $1000 per mile for farm-to-market roads if done by a consultant.
- $2000 per mile for field data collection by a consultant, plus 12–15 hours to generate the strip map.
- 40 hours of field data collection, 24 hours of data analysis, and 32 hours to generate the strip map for each study.
- $1200 per mile.
- 2–3 weeks of effort, including all steps of the study.
- 4 miles of study per day, including all field and office efforts.
- 8 hours of data collection and processing, plus 8–16 hours to generate the strip map.

Question 17 asked how the districts define the endpoints of their speed zones. Table 17 lists the responses to this question. The most common answers included jurisdictional boundaries (five districts), changes in area type or development (four districts), control sections (three districts), major intersections (three districts), and school zones (two districts).

Table 17. Speed Zone Endpoint Definition Practices.

Number of Responses*	Description
5	Jurisdictional boundaries, such as city limits or county lines
4	Changes in area type (rural vs. urban) or development patterns
3	Control sections
3	Major intersections
2	School zones
1	Feasible locations to post signs in the field (e.g., avoid driveways, intersections, bridges, and culverts)
1	Truck facilities
1	Changes in the roadway factors listed in the Speed Zone Manual
1	Locations of crash hot spots
1	0.2-mile increments on transitions

* The total number exceeds the number of interviewed districts because some districts use multiple methods.

Question 18 asked how many speed measurement locations the districts typically include in their speed zone studies. Table 18 lists the responses to this question. The responses are generally consistent with the guidance in the Speed Zone Manual. One district commented that the frequency of speed measurement locations also depends on availability of "safe" measurement sites along a route (i.e., a wide shoulder). This presents a challenge in performing speed studies on freeways because districts are often not comfortable being on shoulders in high and fast traffic conditions. Districts try to use overpasses but are often limited to infrequent locations. This safety limitation, in conjunction with the slowing down bias when motorists pass by a parked vehicle on the side of the highway, may elevate the need to consider alternative data collection methods or sources such as vehicle probe or telemetric data.

Table 18. Number of Speed Measurement Locations in Studies.

Number of Responses*	Description
3	Follow the guidance in the Speed Zone Manual (every ¼ or less for urban areas; every ¼ mile or more for rural areas)
2	Every 2 miles (rural)
1	Every "several" miles based on the roadway and development (rural)
2	Every ½ –1 mile
3	Every ¼ mile (urban)
2	Approximately every ⅕ mile
2	Can increase spacing if the segment is homogeneous and lacks entrances, exits, and curves
1	At least one location in each transition zone
2	Every ½–1 mile
1	At least 3 locations in each rural speed zone
1	At least 1 location in each regulatory speed limit
2	2–3 locations per mile
1	Locations near zone ends, in the middle of the zone, and possibly more for long zones

* The total number exceeds the number of interviewed districts because some districts use multiple methods.

Question 19 asked how school zones are considered relative to any of the roadway factors listed in Table 1. Nine districts stated that school zones are important for transition design but not for setting the regulatory speed limit outside school hours. The remaining districts stated that they try to treat adjacent schools together in a consolidated zone to avoid having several speed limit changes in a short distance, a request for a new or updated school zone may trigger a re-study of the overall speed zone, or schools have not been an issue for their speed zone studies.

In addition to documenting the question responses, the research team also noted whether the practitioners provided comments on other issues related to speed zone studies. The following sections summarize these comments by theme.

Disagreements between Jurisdictions

Two districts (one metropolitan and one urban) mentioned concerns about cases where the results of TxDOT's speed zone study differ from the regulatory speed limit value desired by city practitioners. One of these districts explained that if the city does not implement the results of the speed zone study, the posted regulatory speed limit is not enforceable. The other district typically takes the position of deferring to city practitioners. The practitioners in this district have seen cases where cities wanted to reduce a regulatory speed limit, and the speed zone study data did not justify the reduction, but the district chose to defer to the city because it did not see a reason to oppose the reduction. The district practitioners observed that this scenario requires additional communication with TRF to explain and document the decision.

Frequency and Timing of Speed Zone Studies

Though the Speed Zone Manual calls for periodic re-study of speed zones, two districts (both metropolitan) acknowledged that their speed zone studies are more often conducted in response to requests from cities and changes in roadway conditions such as development or crash history. One of these districts observed that they seldom follow the guidance for 5-year re-studies because they have too much roadway mileage to sustain that pace of re-study.

Data Assembly Tools

One metropolitan district suggested that new software (not MicroStation) is needed to facilitate assembly of strip maps. Another urban district (the El Paso District) shared a resource that it had developed to assemble speed zone study results and strip maps in a dashboard type of format for holistic review. This resource provides one-page summaries that include crossing roadways, a distance scale, driveway counts, average daily traffic (ADT), average and KAB crash rates, 5-year crash totals by severity, 85th percentile speeds, variance factors, the existing regulatory speed limit, and the proposed regulatory speed limit. Figure 1 and Figure 2 provide two example demonstrations of this resource, which are shared and referenced with the El Paso District's permission.

MP 0.0	0.5 1.0 1.5 2.0	2.5 3.0 3.5 4.0 4.5	5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5	10.0 10.5 11.0 11.5 12.0	12.5 13.0 13.5	14.0 14.5	15.0 15.5
DRIVEWAYS	104	138	7	164	66		
AVG ADT	10,926	14,613	17,187	24,816	22,220		
3 YEAR AVG KAB CRASHES (2018-2020)	9.7	14.3	3.3	18.7	17.3		
3 YEAR AVG CRASH RATE (2018-2020)	123.75	102.32	47.15	71.66	147.15		
CRASHES (2016-2021)	K (2) A(5) B(12)	K (4) A(12) B(31)	K (0) A(7) B(16)	K (6) A(15) B(40)	K (2) A(4) B(18)		
85TH PERCENTILE SPEED AVERAGE	34 MPH	43 MPH				56 MPH	60 MPH
85TH VARIANCE FACTORS	Existing Speed Limit to Remain	Existing Speed Limit to Remain	Crash History, Developed Area, & School Zone	Existing Speed Limit to Remain	Driveway Density, Crash History, Residential Area, & Developed Area	Existing Speed Limit to Remain	Existing Speed Limit to Remain
EXISTING SPEED LIMIT	30 MPH	40 MPH	45 MPH	40 MPH	45 MPH	50 MPH	55 MPH
PROPOSED SPEED LIMIT	30 MPH	40 MPH				50 MPH	55 MPH

AVG KAB Crash Rate (2018-2020) Statewide = 4 OR MORE LANES, UNDIVIDED (111.57)

K = Fatal; A = Serious Injury; B = Minor Injury

Figure 1. Speed Zone Dashboard Demonstration (1 of 2).

SPEED CHECK MILE POINT	0.179	0.620	1.040	1.410	1.870	2.380	2.870	3.400	3.915	4.367	4.729	4.997	5.692	6.205	6.596	7.032	7.552	7.800
85TH PERCENTILE SPEED (MPH)	41	50	50	41	41	46	55	58	56	54	51	54	58	56	54	48	47	43
SPEEDING																		
85TH PERCENTILE SPEED ZONE AVERAGE (MPH)	47			43			55										45	
85TH PERCENTILE SPEED OVERALL AVERAGE (MPH)	50																	
EXISTING SPEED LIMIT (MPH)	55			45			55										45	
PROPOSED SPEED LIMIT (MPH)	45			45			45										45	
MEETS SPEED REDUCTION THRESHOLD	✓			✓			✓										✓	
DRIVEWAYS	10			29			136										17	
TRAFFIC SIGNALS	3			4			4										1	
CRASHES (2018-2022)	K(0) A(0) B(13)			K(0) A(3) B(27)			K(1) A(8) B(22)										K(1) A(0) B(3)	
KAB CRASH RATE AVERAGE (2018-2022)	24.85			54.38			41										32.73	
CRASH RATE AVERAGE (2018-2022)	172.63			470.68			276.97										264.36	
STATEWIDE CRASH RATE AVERAGE (2018-2022)	216.60 by Highway System and 202.03 by Road Type																	
85TH VARIANCE FACTORS	Crash History, Developed Area			Existing Speed Limit to Remain			Crash History, Developed Area, High Driveway Density, School Zone										Existing Speed Limit to Remain	

K= Fatal Injury; A= Suspected Serious Injury; B=Suspected Minor Injury

Figure 2. Speed Zone Dashboard Demonstration (2 of 2).

Issues with Trial Run Guidance

Two urban districts mentioned the use of trial runs in their speed zone re-check practices. One of these districts explained that it often performs speed study trial runs to provide an initial filter for locations where more detailed speed zone studies are needed. If the trial runs do not indicate a value different than the posted regulatory speed limit, then the location is not listed for a full speed zone study. The other district expressed a need for more guidance in the Speed Zone Manual about doing trial runs in rural areas.

DISCUSSION

Generally, the interviewed practitioners acknowledged that much of the Speed Zone Manual's guidance for setting regulatory speed limits is qualitative and requires engineering judgment to implement. Practitioners made this observation in response to several questions, including the questions about area type and roadway type (question 1), narrow pavement width (question 6), horizontal curves (question 7—two districts), vertical curves (question 8), pedestrians and bicyclists (question 11), the count of factors needed to deviate from the 85th percentile speed (question 12—two districts), and revisions to the roadway factors list (questions 13 and 14). Collectively, these practitioners represented 7 of the 13 interviewed districts. One practitioner asked if strip maps should be required to be signed and sealed by a professional engineer because of all the engineering judgment required in the speed zone study process. Three practitioners stated that quantitative thresholds would help simplify the process.

A district considered the TxDOT *Access Management Manual* (*9*) when evaluating driveway density. Table 2-2 of the *Access Management Manual* (*9*) provides minimum connection spacing criteria for all state highway system routes that are not new highways on new alignments, freeway main lanes, or frontage roads by posted regulatory speed limit. Converting those distances into driveway density resulted in the criteria listed in the final column of Table 19.

Table 19. Driveway Density Criteria Based on TxDOT *Access Management Manual* (*9*) Spacing Distance Criteria.

Access Management Manual **Posted Speed Limit (mph)**	*Access Management Manual* **Distance (ft)**	**Calculated Driveway Density (Driveways/Mile)**
≤ 30	200	26
35	250	21
40	305	17
45	360	15
≥ 50	425	12

Regarding categorization of speed zones, the practitioners occasionally described sensitivity to area type and roadway type. For example, several practitioners observed that defining a roadway as “narrow” based on a 24-ft threshold would only apply to rural two-lane highways, and one practitioner suggested that a definition of “narrow” for urban roadways would more appropriately be based on the number of lanes (but did not suggest a threshold value). The practitioners made similar observations about the factor of striped, improved shoulders; specifically, practitioners understood that the lack of striped, improved shoulders generally would not be considered a factor if the speed zone of interest is an urban roadway with a curb and gutter. There was also a common acknowledgment that if the speed zone is categorized as urban, then it is presumed that pedestrians and bicyclists are present though without specific consideration of volumes for these users. However, the practitioners generally acknowledged that these considerations all require the use of judgment, except for crash rate. To consider crash rate, the analyst must categorize the roadway and compare it to roadways using the categories defined for the statewide average crash rates. The published 2024 statewide traffic crash rates (*10*) are available in two tables. The first table provides rates for rural and urban area types and the following highway systems:

- Interstate.
- U.S. highway.
- State highway.
- Farm-to-market road.

The second table provides rates for rural and urban area types and the following road types:

- Two lane, two way.
- Four or more lanes divided.
- Four or more lanes undivided.

The current edition of the TxMUTCD (*1*) is being revised with consideration of the 2023 *Manual on Uniform Traffic Control Devices* (MUTCD) (*11*). Therefore, it is reasonable to expect that the next edition of the TxMUTCD may have language similar to that present in the 2023 MUTCD with regard to factors to consider in a speed zone study. The language regarding factors was revised in the 2023 MUTCD from previous versions and is as follows:

> Guidance:
>
> 07 Among the factors that should be considered when conducting an engineering study for establishing or reevaluating speed limits within speed zones are the following:
>
> A. Roadway environment (such as roadside development, number and frequency of driveways and access points, and land use), functional classification, public transit volume and location or frequency of stops, parking practices, and pedestrian and bicycle facilities and activity;
>
> B. Roadway characteristics (such as lane widths, shoulder condition, grade, alignment, median type, and sight distance);
>
> C. Geographic context (such as an urban district, rural town center, non-urbanized rural area, or suburban area), and multi-modal trip generation;
>
> D. Reported crash experience for at least a 12-month period;
>
> E. Speed distribution of free-flowing vehicles including the pace, median (50th-percentile), and 85th percentile speeds; and
>
> F. A review of past speed studies to identify any trends in operating speeds.

POTENTIAL REFINEMENTS TO ROADWAY FACTORS

Table 20 provides the list of factors suggested by the research team for inclusion in a revised Speed Zone Manual based on the results of the interviews along with the research team's engineering judgment. In some cases, existing factors are combined. In other cases, new factors are suggested. The factors are now sensitive to whether the roadway segment speed zone is in a rural or urban (and rural town) context.

Table 20. Speed Zone Roadway Factors Suggested for Setting Regulatory Speed Limits.

Factor	Urban or Rural Town	Rural	Comments
Crash history	X	X	Consider the statewide average crash rate for similar facilities.
Narrow roadway pavement or lane width	X	X	Consider the driving surface area. For example, narrow roadway pavements include roads without striped shoulders or a total surface width < 24 ft (or 20 ft, depending on region). For lane width, an average lane width of 10 ft or less could be considered a narrow lane width.
Horizontal and vertical curves	X	X	Consider possible limited sight distance; for example, driveways or other developments could be hidden from the driver.
High access density	X	X	Consider that the higher the number of access points (e.g., driveways and unsignalized intersections), the higher the potential for encountering entering and turning vehicles. The *Access Management Manual* (Table 2-2) provides driveway spacing criteria. Using those criteria, the following access densities were generated for consideration: • 26 points/mile for ≤ 30 mph • 21 points/mile for 35 mph • 17 points/mile for 40 mph • 15 points/mile for 45 mph • 12 points/mile for ≥ 50 mph
Public transit	X	—	Consider the volume and location or frequency of stops.
On-street parking	X	—	Consider that the presence of on-street parking is associated with additional vehicle stops and maneuvers.
Pedestrian and bicycle facilities and activity/residential or developed areas	X	X	Consider the potential for higher pedestrian and bicycle traffic.
Transition design	X	X	Consider schools, intersections, city limits, jurisdictional boundaries, changes in area type or development, or speed limit for nearby segments.

Notes: An X denotes the factor is suggested. A dash denotes the factor is not suggested.

In general, if one factor is present, consider a 5-mph reduction. If two or more factors are present, consider a 10-mph reduction. A 12-mph deviation can be used when crash history is a factor within the speed zone.

Appendix D of *Speed Limits in Texas* provides other suggestions for changes to the Speed Zone Manual (*12*).

CHAPTER 3: USE OF PROBE DATA IN CORRIDOR SPEED ZONE STUDIES

BACKGROUND

The goal of this effort was to apply the Project 0-7156 guide (*6*) to several corridors to explore if the protocol needs to be modified or if the guide document needs revisions or expansion to better document how to conduct a speed zone study with probe data. Speed zones were identified using two approaches using:

- Speed zones in Denton County that the Texas A&M Transportation Institute Dallas office obtained from the TxDOT Dallas District.
- Corridors where spot speed data were collected in 2024 as part of another TxDOT study, Strategic Planning for Expedited Enterprise-wide Data Innovations (called Speedi).

For the Dallas District speed zones, the details of the speed zone were pulled from the printed strip maps for each speed zone. For the spot speed study sites, the research team requested the speed zone strip maps from the appropriate district. For those cases when the strip map was not available, the research team estimated the speed zone limits by locating PSL signs using Google Earth street view and Google Earth historical view. Researchers used archived roadway imagery to confirm the PSL at the time of speed data collection. Google Earth street view and Google Earth historical view were also used to confirm the PSLs for the Dallas District sites.

A speed zone was removed from this evaluation if:

- The data did not provide speeds for all of the INRIX segments within the speed zone.
- The speed zone was for a frontage road.
- The speed zone was in an area transitioning from a freeway (limited access) to a non-freeway road.

The number of speed zone corridors used in this research evaluation included:

- 246 speed zones for non-freeways:
    - 66 Speedi speed zones (unique direction).
    - 180 TxDOT speed zones (unique direction).
- 32 speed zones for freeways:
    - 12 Speedi speed zones (unique direction).
    - 20 TxDOT speed zones (unique direction).

The efforts to conduct speed zones studies for the 278 speed zones identified several challenges. Some challenges related to pulling in the probe speed data, and others related to implementing a prescriptive approach in how speed zone factors are considered—rather than using engineering judgment for the factors—within the speed zone study process. This chapter documents these challenges in the following areas:

- Obtaining data from TxDOT roadway inventory databases.
- Working with probe speed data.
- Calculating the 85th percentile speed.
- Obtaining relevant crash data.
- Collecting data regarding horizontal curves for a speed zone.
- Conducting the suggested speed limit (SSL)–setting procedure including the consideration of the TxDOT speed zone factors.
- Selecting the SSL for a speed zone.

CHALLENGES

Obtaining Data from TxDOT Roadway Inventory Databases

Table 21 lists the variables needed for conducting the speed zone studies available in a TxDOT roadway inventory database by road type. These variables are primarily needed to convert the probe speed data into an estimated 85th percentile speed.

Table 21. Variables Needed from the TxDOT Roadway Inventory Database.

Non-freeway Variables	Freeway Variables
RU_F_SYSTE ADT_CUR S_WID_O LANE_WIDTH NUM_LANES K_FAC	RU_F_SYSTE ADT_CUR S_WID_O S_WID_I LANE_WIDTH S_TYPE_I D_FAC K_FAC TRK_DHV_PC

ADT_CUR = current average annual daily traffic (AADT), D_FAC = Directional distribution factor, K_FAC= peak factor, LANE_WIDTH = lane width, NUM_LANES = number of through lanes, RU_F_SYSTEM = functional classification, S_TYPE_I = inside shoulder type, S_WID_I = inside shoulder width, S_WID_O = outside shoulder width, TRK_DHV_PCT = truck design hourly volume (percent).

In gathering the data for the sample set of speed zones, researchers determined that the TxDOT roadway inventory database can include several subsections within a specific speed zone or within a specific INRIX segment. The reason that having several subsections can present a challenge is that the subsections may not have the same value for the given variable across all the subsections. An example of this challenge is when the RU_F_SYSTE variable varies, such as when it has both rural and urban subsections. This matters because the speed prediction equations are based on whether the speed zone is in a rural or urban area (defined as developed and undeveloped for non-freeway segments). Another example of when this can have a major impact is when variables that are considered when comparing the speed zone crash rate to the statewide average crash rate vary within the speed zone. These variables include ADT and the number of lanes.

This 278-speed-zone sample included several cases when the crash factor was triggered for only some of the subsections within a given speed zone. This resulted in up to a 10-mph difference between the average SSL and the maximum or minimum SSL.

The regression equations used to predict the 85th percentile speed need geometric values that are not available in existing TxDOT databases, such as signal density. These values can be obtained from Google Earth, which provides the benefit of the technician not needing to travel to the site.

Working with Probe Speed Data

Using INRIX speed data requires identification of the correct INRIX segments for the speed zone. During this step, researchers found several locations where the direction within the TxDOT database did not match the direction for the INRIX segments. For example, one database may use south as the direction, while the other database uses west. The team used visual checks to verify these matches.

This research identified several short INRIX segments within the speed zones being studied. Figure 3 illustrates a speed zone that includes five INRIX segments. These segments—moving from north to south (left to right in Figure 3)—have the following lengths: 0.089, 0.029, 0.260, 0.011, and 0.759 miles. Based on researchers' engineering judgment, the recommendation was to remove segments that were shorter than about 0.1 miles (500 ft). For the speed zone example in Figure 3, the segments with lengths of 0.260 miles and 0.759 miles would be retained in the analysis.

Figure 3. Example of INRIX Segments within a Speed Zone (FM 2281).

With INRIX segments typically being between 0.01 and 1 mile, a speed zone can have several INRIX segments. Should the procedure use the maximum, the minimum, or an average of the INRIX speed values for a speed zone? Or should that decision be left to the technician doing the speed zone study? It is reasonable to leave such a decision to the technician. However, if the goal is to automate speed zone studies for a large region, a decision rule is needed. Discussions with technicians who have conducted a number of speed zone studies indicated that averaging the results for multiple stations within a speed zone is a common approach. The section "Whether to Use Minimum, Maximum, or Average When Multiple INRIX Segments Are Present" includes additional observations regarding whether to use minimum, maximum, or average values.

Calculating the 85th Percentile Speed

With the availability of big data, additional sources may be able to identify the 85th percentile speed for use in the speed zone study. As part of Project 0-7156, the team developed regression equations to predict the 85th percentile speed (*4*).

Efforts within another TxDOT study generated estimated 85th percentile speeds using connected car data (*13*). To aid in developing the estimated 85th percentile speeds, that research team collected speed data for individual drivers at 82 sites using portable weigh-in-motion sensors along with both portable and permanent side-fire radar. A site reflects unique directions for a road; in other words, a road with two-way traffic could have up to two sites. The sites were selected to provide a representative sample of locations across Texas with a mix of traffic volume and regions. The speeds at the individual spots were filtered to remove vehicles that were not free flowing (a gap of 3 seconds or less) and to remove trucks. The 85th percentile speed was determined from this filtered data and called *ground truth data*. For these sites, the ground truth data were compared to the estimated 85th percentile speeds using connected car data, as shown in Figure 4. The estimated 85th percentile speeds using connected car data are similar to the ground truth findings with an average absolute error of 2.3 mph.

The Project 0-7156 equations were used to predict the 85th percentile speed using the Project 0-7156 equations for the same sites. Table 22 provides the results for the 14 freeway stations that are within the 12 freeway speed zones, while Table 23 provides the results for the 66 non-freeway sites. The Project 0-7156 equations predicted speeds that were within 2.70 mph for freeways and 2.68 mph for non-freeway roads.

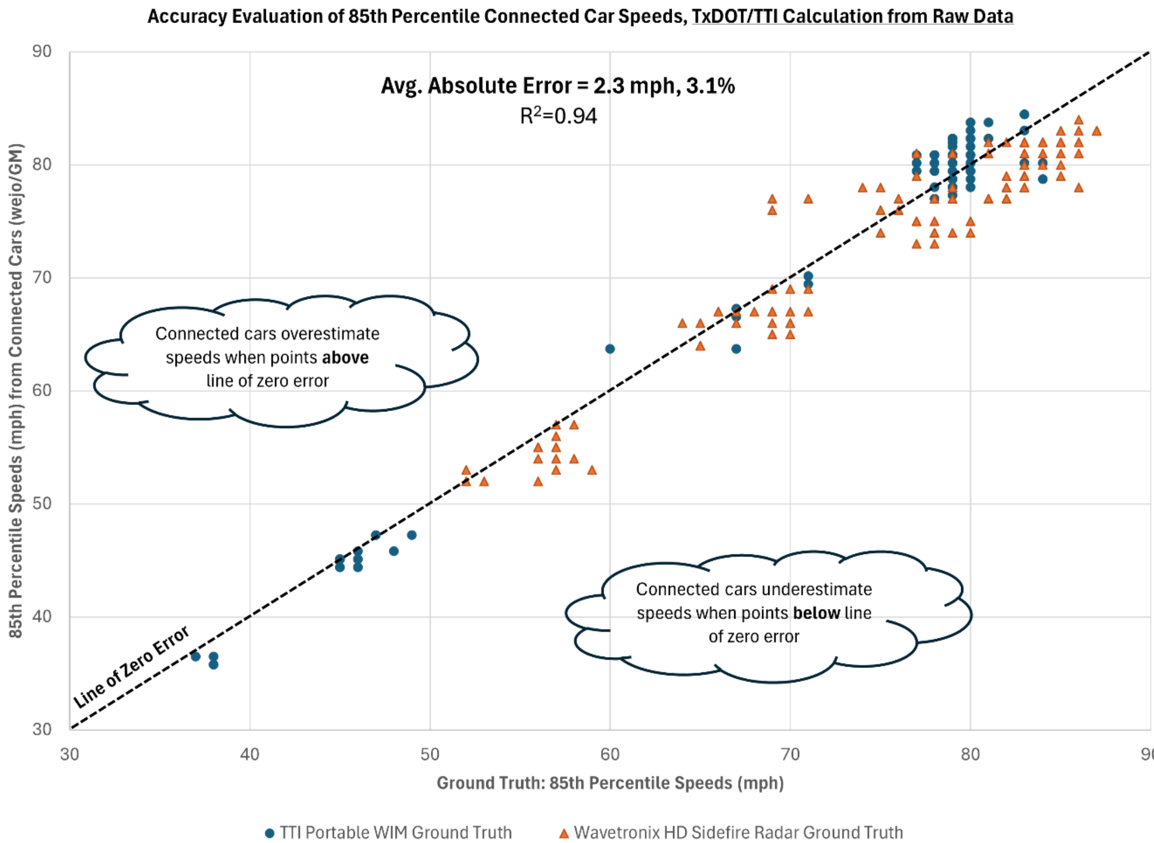

Figure 4. Comparison of Connected Car Data with Ground Truth Data (*13*).

Table 22. Speeds for Freeways.

RU_F_ SYSTE	Definition	Posted Speed Limit (mph)	Count	Average Spd85_ Onsite (mph)	Average Spd85_ INRIX (mph)	Average Pred-Spd85 (mph)	Absolute (Spd85_ Onsite − Pred-Spd85) (mph)
R1	Rural interstate	75	2	83	71	82	0.94
R2	Rural other freeway and expressway	65	4	83	71	79	3.80
R3	Rural other principal arterial	70	2	84	72	81	2.87
U2	Urban other freeway and expressway	70	2	79	73	81	2.63
U3	Urban other principal arterial	70	3	84	73	82	2.67
U5	Urban major collector	70	1	83	72	81	1.77
All	All	All	14	82	72	81	2.70

Table 23. Speeds for Non-freeways.

RU_F_ SYSTE	Definition	Count	Average Spd85_ Onsite (mph)	Average Spd85_ INRIX (mph)	Average Pred-Spd85 (mph)	Absolute (Spd85_Onsite − Pred-Spd85) (mph)
R3	Rural other principal arterial	25	75	67	72	2.87
R4	Rural minor arterial	18	77	68	72	2.97
R5	Rural major collector	4	72	67	70	0.95
U3	Urban other principal arterial	15	60	53	57	2.74
U4	Urban minor arterial	4	58	48	55	1.89
All	All	66	71	63	68	2.68

Obtaining Relevant Crash Data

The crash data counts were obtained from the TxDOT Crash Records Information System (CRIS) database. Researchers faced challenges with crash data for frontage roads, which frequently also included crashes that occurred on the nearby freeway.

Collecting Data Regarding Horizontal Curves for a Speed Zone

The research team obtained horizontal curve data from the TxDOT highway curves inventory (*14*). A spatial proximity approach was used to associate roadway curves with individual speed study locations. For each speed study corridor, a 250-ft buffer was generated using a GIS application. The statewide Texas horizontal curve inventory was then superimposed on these buffered corridors, and all curves within the defined spatial extent were identified using a GIS-based spatial join. Following this automated extraction, a manual quality-control review was conducted to ensure network consistency. Curves located on adjacent, parallel, or intersecting facilities were excluded to retain only those geometrically and functionally connected to the speed zone study corridor.

To further stratify the sample, curves were grouped according to critical radius thresholds derived from prior empirical research. A 750-ft radius cutoff was applied based on findings by Bonneson et al. (*15*), which demonstrated that on rural highways with tangent approach speeds between 50 and 60 mph, horizontal curvature begins to exert a measurable influence on operating speeds at or below this radius. Similarly, a 1500-ft threshold was adopted from Pratt et al. (*16*), who reported that on rural freeways with approach speeds of 70–80 mph, curve geometry significantly affects vehicle speeds when radii are approximately 1500 ft or smaller.

Conducting the Suggested Speed-Limit-Setting Procedure Including the Consideration of the TxDOT Speed Zone Factors

The speed data collected in the field—either by TxDOT or by the TxDOT Speedi project—generated an 85th percentile speed. When available, the average speed (SpdAve) was also recorded.

For the speed zones being considered, the INRIX segments that overlapped any portion of those speed zones were identified. The INRIX segments with a length of less than 0.1 miles were discarded. In a few cases, INRIX speed data were not available for the study years of interest, and those INRIX segments were also discarded. The speed readings in 5-minute and 1-hour increments for the given years were obtained. When all 5-minute readings are present a total of 102,240 speed measurements would be available for the INRIX segment. The 85th percentile speed and the average speed of these measurements were calculated for each INRIX segment. This 85th percentile speed was called Spd85_AllHrAllDay_INRIX-SpdYrData.

The Spd85_AllHrAllDay_INRIX-SpdYrData measure was then used in the Project 0-7156 speed prediction equations to generate the following:

- Pred-Spd85 (Use:AllHrAllDay_INRIX_YrData).
- Pred-SpdAve (Use:AllHrAllDay_INRIX_YrData).

The SSL was then calculated for each TxDOT speed station (SSL_TxDOT-Spd85) and for each INRIX segment (SSL_Pred-Spd85) with adjustments made when the TxDOT speed zone factors were applicable at the site. The percentages of segments or stations where the speed zone factor was triggered for non-freeway segments are as follows:

- Narrow lane width: 6 percent for developed and 6 percent for undeveloped.
- Horizontal curves: 0 percent.
- Driveway density: 16 percent for developed and 1 percent for undeveloped.
- Narrow shoulders: 5 percent for developed and 27 percent for undeveloped.
- Above average crash rate: 45 percent for developed and 55 percent for undeveloped.

The percentages of segments or stations where the speed zone factor was triggered for freeway segments are as follows:

- Lane width: 0 percent (because all the segments had 12-ft lanes).
- Grade: 0 percent (because the road was always assumed to be level).
- Horizontal curves: 0 percent.
- Shoulders, outside: 10 percent in rural and 28 percent in urban.
- Shoulders, inside: 59 percent in rural and 86 percent in urban (average shoulder less than 6 ft).

- Crashes: 54 percent in rural and 43 percent in urban.

For a few of the non-freeway segments, more than one factor was triggered. When the segment had an above-average crash rate, the reduction was always 12 mph. When one non-crash factor was triggered, the reduction was 5 mph. When two non-crash factors were triggered, the reduction was 10 mph. Table 24 shows the number and percentage of non-freeway segments where a speed zone factor was triggered by whether the segment was in a developed (urban) area or an undeveloped (rural) area. Table 25 provides similar data for freeway segments.

Table 24. Number and Percentage of Segments Where a Speed Zone Factor Was Triggered for Non-freeway Segments.

Crash (Non-crash) Factors Triggered	Developed Number of Segments	Undeveloped Number of Segments	Developed Percent of Segments	Undeveloped Percent of Segments	Non-freeway Number of Segments	Non-freeway Percent of Segments
No (0)	330	419	34%	57%	749	44%
No (1)	58	108	6%	15%	166	10%
No (2)	0	18	0%	2%	18	1%
Subtotal	388	545	41%	74%	933	55%
Yes (all)	569	194	59%	26%	763	45%
Grand total	957	739	100%	100%	1,696	100%

Table 25. Number and Percentage of Segments Where a Speed Zone Factor Was Triggered for Freeway Segments.

Crash Factor Triggered	Non-crash Factors Triggered	Rural Number of Segments	Urban Number of Segments	Freeway Number of Segments	Rural Percent of Segments	Urban Percent of Segments	Freeway Percent of Segments
No	0	79	28	107	46%	26%	38%
No	1	0	33	33	0%	31%	12%
Subtotal no	All	79	61	140	46%	58%	50%
Yes	0	77	45	122	45%	42%	44%
Yes	1	17		17	10%	0%	6%
Subtotal yes	All	94	45	139	54%	42%	50%
Grand total	All	173	106	279	100%	100%	100%

Of the 1696 non-freeway segments—which represent stations from a TxDOT speed zone study, spots where the Speedi project collected data, or INRIX segments—about half (45 percent) of the segments used a 12-mph reduction from the 85th percentile speed because the crash rate was above the statewide average. About 1 percent of the segments had two factors triggered, which resulted in a 10-mph reduction from the 85th percentile speed. For the freeway segments, half of the segments used a 12-mph reduction from the 85th percentile speed because the crash rate was above the statewide average.

Selecting the Suggested Speed Limit for a Speed Zone

Whether to Use Minimum, Maximum, or Average When Multiple INRIX Segments Are Present

Because several of the speed zones considered in this evaluation had multiple stations where speed data were collected by TxDOT or as part of the Speedi project or had multiple INRIX segments, the question was whether the maximum, minimum, or average SSL should be considered. Based on discussions with TxDOT staff, the typical practice is to use the average SSL.

The inclusion of INRIX segments in the process presents the situation where a speed zone may have many additional speed readings compared to the traditional approach of measuring speed on site. Therefore, the research team wanted to determine if a different approach is suggested with regard to how the multiple INRIX segments are considered. The research team calculated the difference between the existing PSL and the SSL based on four approaches for the 246 non-freeway speed zones and the 32 freeway speed zones. A negative value indicates that the SSL is less than the current PSL, while a positive value indicates that the SSL is higher than the current PSL. The four approaches compared are:

- SSL_Tx − PSL: the difference between the SSL and the PSL when using only on-site speed measurements (either from TxDOT or from Speedi), where the SSL is the rounded average to the nearest 5-mph increment of all stations within the speed zone.
- SSL_I-Max − PSL: the difference using the maximum SSL based on the INRIX segments within the speed zone.
- SSL_I-Ave − PSL: the difference using the rounded average to the nearest 5-mph increment for the INRIX segments within the speed zone.
- SSL_I-Min − PSL: the difference using the minimum SSL based on the INRIX segments within the speed zone.

Table 26 provides the number of non-freeway speed zones by the differences between SSL and PSL for the four conditions. To help visualize the differences, Figure 5 provides a cumulative distribution graph for these four conditions. Overall, the curves appear to be similar for the non-freeway road type. Table 27 provides the differences for freeway speed zones, and Figure 6 shows the cumulative distribution graph. Because of the smaller sample size for freeways, there appear to be more differences for the freeway speed zones.

Table 26. Number of Non-freeway Speed Zones by Difference between Suggested Speed Limits and the Posted Speed Limit.

SSL − PSL	Number Speed Zone for SSL_Tx − PSL	Number Speed Zone for SSL_I-Max − PSL	Number Speed Zone for SSL_I-Ave − PSL	Number Speed Zone for SSL_I-Min − PSL
−30	2	0	0	0
−25	1	2	2	11
−20	10	3	7	20
−15	43	16	20	46
−10	45	30	45	51
−5	51	40	59	46
0	43	69	53	43
5	43	48	39	17
10	6	25	13	7
15	2	10	7	5
20	0	3	1	0
25	0	0	0	0
All	246	246	246	246

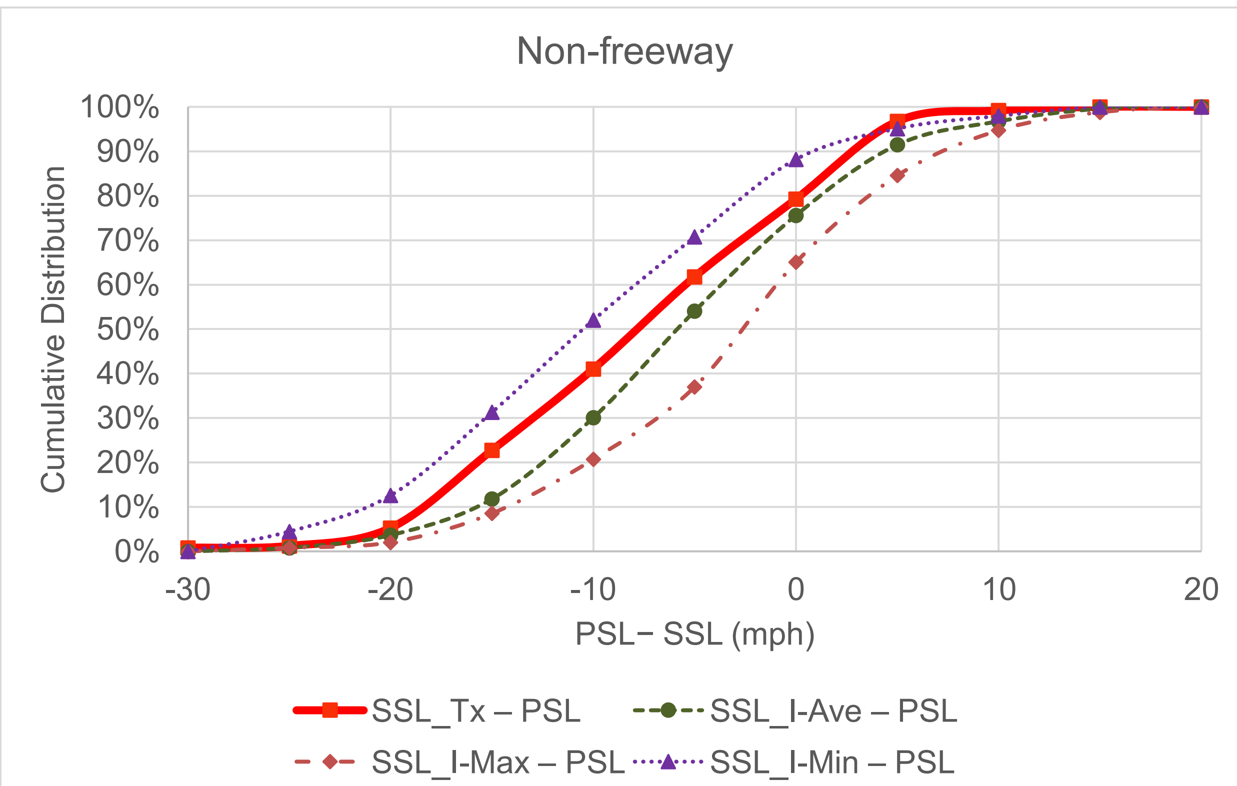

Figure 5. Cumulative Distribution for Non-freeway Speed Zones.

Table 27. Number of Freeway Speed Zones by Difference between Suggested Speed Limits and the Posted Speed Limit.

SSL − PSL	Number Speed Zone for SSL_Tx − PSL	Number Speed Zone for SSL_I-Max − PSL	Number Speed Zone for SSL_I-Ave − PSL	Number Speed Zone for SSL_I-Min − PSL
−20	0	0	0	0
−15	2	0	0	0
−10	9	0	1	7
−5	4	6	11	9
0	3	10	7	6
5	7	6	5	3
10	6	9	7	6
15	1	1	1	1
All	32	32	32	32

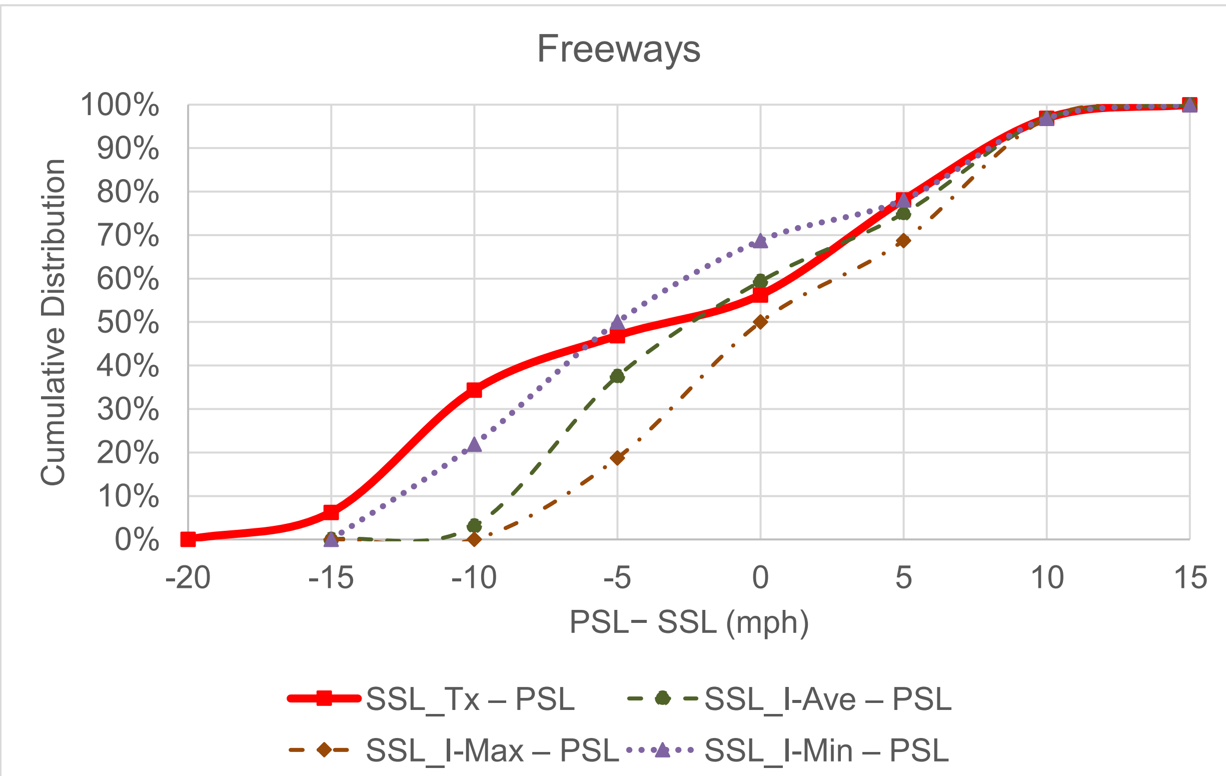

Figure 6. Cumulative Distribution for Freeway Speed Zones.

A chi-square test was conducted to determine if any of the results for the INRIX segments were significantly different from the distribution based on the on-site speed readings (SSL_Tx − PSL). Basically, the chi-square test is used to determine whether the differences between observed and expected frequencies are greater than would be expected by chance. This allows the analysis to move beyond descriptive statistics and assess whether a meaningful association exists between on-site speed readings and INRIX-based speed readings.

The chi-square results have two main components: the X-squared value and the p-value. The X-squared value shows the magnitude of the association, while the p-value shows the level of statistical significance. The p-value helps determine whether the two datasets are statistically significantly associated. Considering a p-value of 0.05 as the standard for decision-making, results with a p-value of 0.05 or less indicate significant association or relationship between the two categorical variables (e.g., SSL_Tx − PSL versus SSL_I-Ave − PSL).

Table 28 presents the results of the chi-square tests. For all comparisons, the chi-square tests found a statistically significant association between the pairs. When the p-value is 0.05 or less, the null hypothesis (H0, i.e., the categorical variables are independent or not related/associated) is rejected, and there is a statistically significant association or relationship between the two categorical variables. In other words, the distribution of results for the different ways of considering INRIX segments (i.e., using minimum, maximum, or average) is similar to the distribution of results when using on-site speed measures. While the statistical test did not indicate a preference, current TxDOT practice is to use the average of multiple stations within a speed zone. Therefore, the research team suggests that an average of the INRIX segment results be used.

Table 28. Chi-Square Test Results.

Road Type	Comparison	X-Squared	Degree of Freedom	p-Value
Non-freeway	SSL_Tx – PSL vs. SSL_I-Max – PSL	434.09	81	<2.2e-16
Non-freeway	SSL_Tx – PSL vs. SSL_I-Ave – PSL	353.53	81	<2.2e-16
Non-freeway	SSL_Tx – PSL vs. SSL_I-Min – PSL	210.38	72	1.753e-15
Freeway	SSL_Tx – PSL vs. SSL_I-Max – PSL	61.96	24	3.357e-05
Freeway	SSL_Tx – PSL vs. SSL_I-Ave – PSL	48.05	30	0.01961
Freeway	SSL_Tx – PSL vs. SSL_I-Min – PSL	50.41	30	0.01125

Selecting a Speed Zone Speed Limit

The procedure produces SSLs by direction and the SSL results per direction would be combined to provide a single SSL for a speed zone on an undivided road or the unique per direction SSL values, even if different, could be used per direction for a divided segment. The TxDOT Speed Zone Manual recognizes this possibility in the Directional Differences section. The manual states: "the 85th percentile speeds may differ considerably by direction at some locations. Such conditions are usually caused by relatively heavy development on one side of the road. Next to the development, motorists will tend to drive slower because of interference from traffic to and from the development. On divided highways, the zone speeds should conform to the 85th percentile speed even though this may require zoning for different speeds in opposite directions. On undivided roadways, the zones in opposite directions should be the same for enforcement purposes."

In automating the development of speed zone speed limits, suggested rules for undivided roads could be:

- When the SSL differ by 5 mph, use the higher SSL.
- When the SSL differ by 10 mph, go with the average SSL.
- When the SSL differ by more than 10 mph, flag the segment and examine the data and the road conditions. If using on-site data, review the data to see if there are errors. If using INRIX data, review each INRIX segment for appropriateness and remove segments as needed and recalculate SSL. Also examine the speed zone to determine if it should be subdivided.

Closer Look at Select Results

A speed zone with a large difference between the SSL values and the PSL was examined to identify conditions that are causing such a large difference or as a check on the procedures used in this examination. Several decisions made during this procedure were automated. For example, the procedure accepted the values from the TxDOT roadway inventory database without additional review, and these values may be outdated. The current TxDOT speed zone process provides several opportunities for checking this type of information, which allows engineering judgment decisions on whether variable values need to be updated, a speed zone needs to be subdivided, or other decisions or additional data are needed.

The site where the SSL is 30 mph below the current posted speed is on FM 2931. Table 29 provides various speed measures identified during this study. In 2021, the 85th percentile speed based on speed data collected on site was 40 mph in the south direction and 43 mph in the north direction. Because this speed zone has a crash rate greater than the statewide average crash rate, the SSL is notably below the on-site speed data. The SSL based on the TxDOT on-site data is 30 mph, which is 30 mph below the current PSL. The predicted speeds based on the 2021 and 2024 speed data from INRIX segments are higher. The operating speed based on INRIX data is 56 mph, resulting in an SSL of 45 mph after considering that the crash rate for the zone is above the statewide average crash rate.

Table 29. Various Speed Measurements for Test Speed Zone.

Speed Zone Location	Dir	PSL (mph)	Year TxDOT Speed Data	Spd85 TxDOT (mph)	INRIX 2021 (mph)	INRIX 2024 (mph)	Pred-Spd85 INRIX 2024	SSL TxDOT-Spd85	SSL Pred-Spd85
FM2931_SZ-04	S	60	2021	40	43.09	45.14	55.95	30	45
FM2931_SZ-04	N	60	2021	43	48.34	46.62	57.19	30	45

Note: S denotes south, and N denotes north.

With the current PSL of 60 mph and the SSL of 30 mph (based on TxDOT data) or 45 mph (based on INRIX data), this site needs additional examination to determine if conditions have changed since 2021, the location of the original TxDOT on-site speed readings were representative of the entire speed zone, and other improvements or changes are needed. This exercise also demonstrates a potential use of the INRIX data in identifying sites where additional site investigations could be needed.

SPEED ZONE FACTORS REFINEMENT

As part of Task 2 of this research project, suggestions were made for refining the speed zone factors. Table 20 presents the revised roadway factors identified as part of Task 2. To integrate these suggested factors into the procedure, the following changes would be needed:

- Refine the break point for when a narrow pavement or lane width factor is triggered.
- Refine the break point for when access density is triggered.
- Add questions regarding horizontal and vertical curves, public transit, on-street parking, pedestrian and bicycle facilities, and transition design.

CHAPTER 4: TXDOT DAL SPEED ZONE DASHBOARD

OVERVIEW

The TxDOT DAL Speed Zone Dashboard aims to provide TxDOT Dallas District engineers and planners with map-based speed zone and PSL information to more effectively and efficiently manage the district's speed zones. The dashboard currently features two primary data layers:

- Speed zone segments.
- Speed zone stations (observed 85th percentile and top speeds).

These layers offer a comprehensive view of the speed zone environment, enabling more informed analysis and decision-making. Users can apply built-in filters to visualize applicable speed zones or stations by year, highway, or county, supporting both day-to-day operations and broader planning efforts.

DASHBOARD

The dashboard addresses several longstanding operational challenges such as:

- Communication gaps: Responding to citizen requests and coordinating with district area offices or local governments are difficult without an easily accessible, up-to-date visual reference that can be shared on demand.
- Zone limits and PSL discrepancies: Identifying discrepancies between the Statewide Planning Map and where speed zone limits differ in strip maps can be challenging. This could be due to highway realignment (bypass) or the mile point or distance-from-origin value being beyond the control section limits. Another discrepancy could be where municipalities have not installed the new PSLs even though they have been approved by minute order.
- Inefficient file sharing: Current distribution relies on hard copies or emailed electronic files—with no centralized repository—making it prone to outdated records and duplicated effort.

The overall benefits of the dashboard include the following:

- Provide engineers and planners with a visualization tool to more effectively and efficiently manage the district's speed zones.
- Present a comprehensive view of the speed zone environment.
- Offer visual access for area office and maintenance staff.
- Help identify discrepancies.
- Store current and past speed zone information.

- Assist with future planning by allowing quick oversight of the last speed study for corridors.
- Provide material for the budget needs of studies.
- Improve records management.

By developing a process to digitize speed studies depicted in strip maps, researchers have been able to create an online dashboard (see the example in Figure 7) with the following information:

- Speed zone segments: showing key attributes such as highway, control section, study date, zone speed, and minute order.
- Speed zone stations: showing key attributes such as highway, control section, study date, 85th percentile speeds, and predicted 85th percentile probe speed or connected vehicle speed (if available).
- PSL segments: current PSLs in the field.
- School speed zone segments: showing key attributes such as highway and school zone speed.
- Various filters (left side).
- Attribute tables (right side).
- Various charts (far right side).

Over 10 years of speed studies have been digitized (2006–2025) for the Dallas District to date. These studies allow district engineers to quickly research when the last speed study was done and assess how often certain roadways are updated, such as to indicate changes in development or citizen complaints.

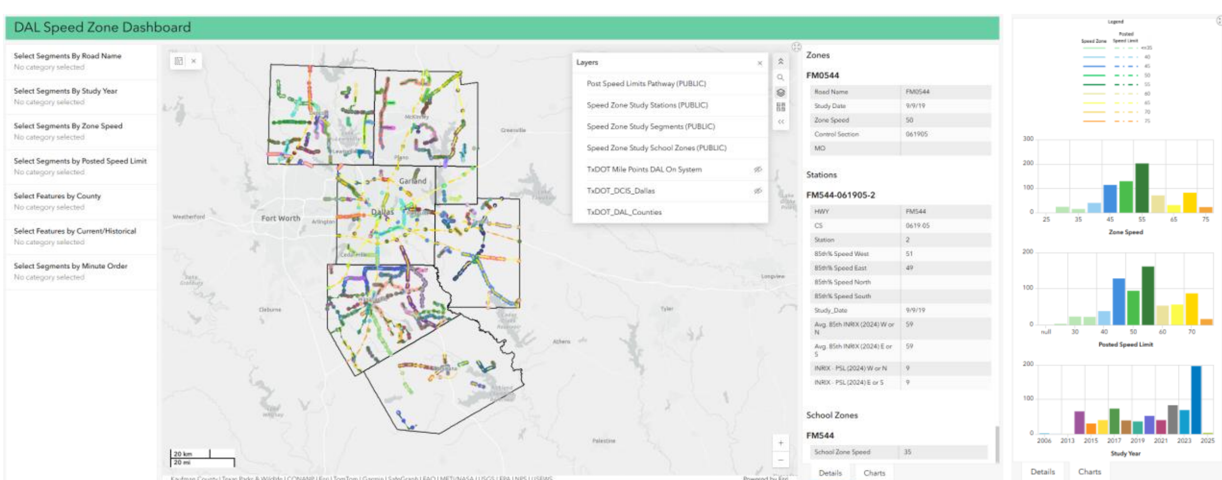

Figure 7. DAL Speed Zone Dashboard.

One of the primary goals of the dashboard is to allow users to compare speed zones or current PSLs with operational speeds. Thus, researchers integrated the Project 0-7156 results such as the predicted 85th percentile probe speeds and the SSLs analyzed within Denton County. This information can help the district investigate discrepancies between operating speeds (derived from probe data) and the observed 85th percentile speed collected at stations. The district can also investigate discrepancies between SSLs and the zone speed or the PSLs. For example, researchers reviewed the distribution of the speed differential between the 85th percentile predicted probe speed and the PSL (left side of Figure 8) and the binned differences (right side of Figure 8). This information will be incorporated into the dashboard filters. Similarly, the differences between the SSL_Probe and the PSLs are shown on the left and right side of Figure 9, respectively. Ultimately, this information can help the district prioritize where it should consider performing a speed study (per TxDOT's procedures) to update the speed zone and the PSL.

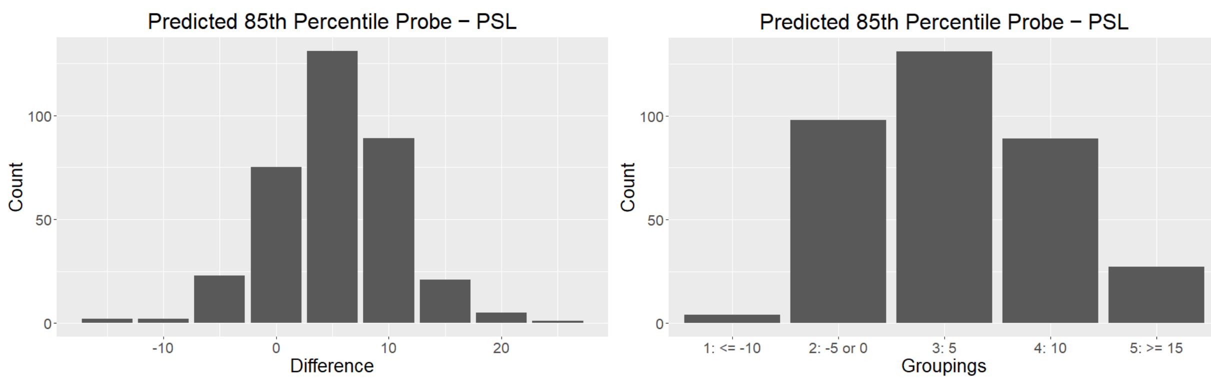

Figure 8. Differences between the Predicted 85th Percentile Probe Speed and Posted Speed Limit.

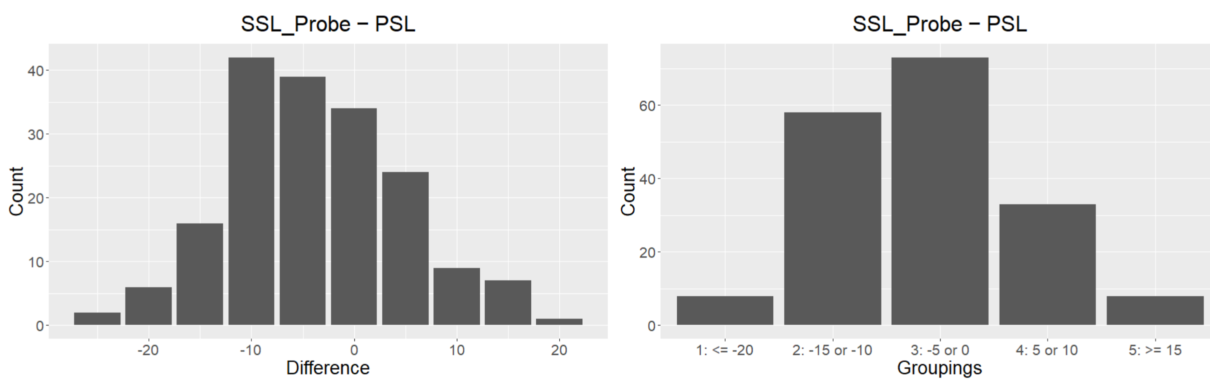

Figure 9. Differences between SSL_Probe Speed and Posted Speed Limit.

PLANS FOR DASHBOARD

Looking ahead, researchers are developing future datasets that will allow users to identify discrepancies between PSLs and current operating speeds by incorporating probe speed or connected vehicle speed data. This will provide actionable insights, helping users pinpoint locations with major discrepancies and prioritize follow-up studies, as needed.

CHAPTER 5: SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

OVERVIEW

Speed limits are among the most visible and routinely enforced traffic control devices motorists encounter in their everyday driving. Speed limits are set using speed zone studies. This research project investigated how to make speed zone studies and speed zone decisions more effective and efficient. The research included exploring the thresholds for speed zone factors, applying the previously developed SSL_Probe protocol (*6*) to corridors to determine if improvements are needed, and using the findings from these efforts to refine the guidelines on how to use probe data within a speed zone study. The refined guidelines are included in the updated guide (*17*).

SUMMARY OF FINDINGS

This section provides a brief summary of the findings from this research.

TxDOT Practitioner Interviews

Chapter 2 documents the interviews of TxDOT practitioners about speed zone study practices, with a focus on the decision process for setting regulatory speed limits and application of roadway factors specified in the Speed Zone Manual. The chapter provides a copy of the interview questions, tabulation of the responses received from practitioners in 13 TxDOT districts, and discussion of some general principles discussed in the interviews. Table 20 provides the research team's suggestions for the factors that could be included in a revision of the TxDOT Speed Zone Manual. Appendix D of the Project 0-7049 report (*12*) provides additional suggestions for changes to the TxDOT Speed Zone Manual.

Use of Probe Data in Corridor Speed Zone Studies

As described in Chapter 3, this research explored the challenges and potential changes to the SSL procedure based on an examination of 246 non-freeway speed zones and 32 freeway speed zones. Key points or challenges for the SSL procedure follow.

Key Points with Using Probe Data

A key step in the process of automating the SSL procedure is to have the details of the speed zones in a database. This database would need the speed zone start and end points in a format that would permit the efficient gathering of the needed data from TxDOT roadway inventories and CRIS.

The procedure researched and developed in this TxDOT project focused on freeways and non-freeways. Future research will need to address how to handle transitions zones or when the speed zone includes both non-freeway and freeway characteristics (sometimes called an expressway).

While this examination demonstrated that the procedure requires effort, it avoids the collection of speed data in the field and the associated risks of working within the roadway right of way. Therefore, the procedure can serve as an initial check in helping districts set priorities. However, the procedure does not replace local knowledge of conditions within a speed zone.

Key Challenges with Using Probe Data

Key challenges with using probe data include the following:

- **Obtaining Speed Zone Details.** No statewide database exists for speed zones. Paper copies of strip maps were used to gather data for this research project. Effectively automating a speed zone review county-wide or district-wide would require entering all existing speed zone details into a GIS or database format.

- **Obtaining Data from TxDOT Roadway Inventories.** Typically, a speed zone includes several roadway inventory sections. The technician may need to review the available inventory data for specific variables (e.g., roadway context or shoulder width) when that variable has different values across the roadway inventory sections within the speed zone. The technician then selects the most appropriate value for the speed zone.

- **Collecting Needed Data Currently not Available in TxDOT Roadway Inventories.** Existing TxDOT roadway inventories do not have all the variables needed (e.g., signal density), and the technician will need to use other approaches (e.g., Google Earth or a site visit) to obtain those values.

- **Conducting Visual Checks of Segments.** Regarding working with probe speed data, the technician may need to conduct visual checks to verify the matching of the TxDOT speed zone with the INRIX segment. The research team recommends removing short INRIX segments, defined as 0.1 miles or less, from the evaluation.

- **Conducting Visual Checks for Curve Data.** Collecting data regarding horizontal curves may need visual checks, especially if ramps are involved, because the database considers curved ramps as curves. Also, the database only covers freeways and some major arterials.

- **Calculating the 85th Percentile Speed.** Speeds predicted using the Project 0-7156 equations were compared to ground truth findings at 82 sites, with the absolute average difference being 2.71 mph. Based on findings from this research along with discussions with TxDOT staff, the suggestion is that the predicted 85th percentile speeds for the individual INRIX segments within the speed zone be averaged after removing INRIX segments that are short (0.1 miles or less) or for other reasons, such as the INRIX segment having a Stop sign at one end.

- **Obtaining Relevant Crash Data.** If using GIS, the matching process may identify crashes on neighboring facilities (e.g., the freeway rather than just the frontage road of interest, or a cross street when the speed zone is near an overpass). Visually reviewing the crash data may be needed to confirm that the number of crashes is correct.

- **Conducting the SSL-Setting Procedure Including the Consideration of the TxDOT Speed Zone Factors.** The triggering of speed zone factors can result in large differences in the SSL. For example, the crash factor can result in a 12-mph decrease. Whether the crash factor is triggered is a function of the input data, including values like ADT or number of lanes. Because these values may vary within a speed zone, whether the crash factor is triggered or not may not be consistent within the entire speed zone. A review of these variables will be needed.

- **Selecting SSL for a Speed Zone.** Selecting the SSL for a speed zone may need to consider several suggested values within the speed zone. The research team suggests that the average of the SSLs be used when a speed zone has numerous INRIX segments.

- **Conducting Quality Control Checks.** The procedure used in this research did not include the numerous checks that would be conducted during a traditional TxDOT speed zone study, such as accepting large differences in ADT values for the subsections of a single speed zone or a change in the number of lanes. Such conditions could result in needing to subdivide a speed zone. Automating the speed zone process, however, provides the opportunity for quickly checking a region and identifying speed zones of priority for future study.

TxDOT DAL Speed Zone Dashboard

The TxDOT's DAL Speed Zone Dashboard, discussed in Chapter 4, aims to provide Dallas District area engineers and planners with map-based speed zone and PSL information to more effectively and efficiently manage the district's speed zones. the dashboard currently features two primary data layers:

- Speed zone segments.
- Speed zone stations (observed 85th percentile and top speeds).

CONCLUSIONS

This research project was designed to investigate whether quality probe speed data were available for use in speed zone studies and, if so, whether the data generate SSLs that are similar to those suggested based on speed data collected on site. The SSL_Probe protocol shows how probe speed data can be used within prediction equations to estimate the 85th percentile speed needed for a speed zone study. When used in the TxDOT speed zone method, the calculated predicted speeds resulted in SSLs that were similar to the SSLs identified using on-site speed data or were generally within 5 mph.

The companion *Guide on Using Alternative Data Sources for a Texas Speed Zone Study* (*6*) provides the step-by-step procedure for the SSL_Probe protocol along with four case study examples.

While the Speed Zone Manual (*3*) would need to be revised prior to being able to use probe data in a speed zone study, the use of these predicted 85th percentile speeds can provide a quick check on the need for a speed zone study.

As part of this research effort, the factors currently in the Speed Zone Manual (*3*) were investigated. Based on discussions with TxDOT staff, reviews of other recent research studies, and the research team's engineering judgment, researchers suggest the factors listed in Table 20 for the next edition of the Speed Zone Manual. If one of these factors is present within the speed zone, a 5-mph speed reduction from the 85th percentile speed is suggested. If two or more factors are present, then the technician could consider a 10-mph speed reduction. If crash history for the speed zone is a factor, then the current recommendation of a 12-mph deviation is still supported based on the reviews conducted as part of the Project 0-7156 research.

RECOMMENDATIONS FOR FUTURE RESEARCH

Suggestions for future research include the following:

- Further research can explore how to best identify SSLs within a transitional zone.
- The research conducted as part of Project 0-7156 identified several speed zones where a speed limit change is needed, in some cases by as much as 15–20 mph. This check may be identifying locations where speed management is necessary rather than changing the speed limit. Research is desirable to determine if this finding is more of an issue in certain areas or certain roadway characteristics such as by roadway context (e.g., urban, rural, or suburban), roadway type (e.g., freeways, arterials, or local), transitional areas near cities, transitional areas through small towns, multilane roads, or other categorizations to be determined. If specific areas or roadway characteristics are identified, then speed management countermeasures applicable for those areas or characteristics can be researched to identify which would be most successful in managing operating speeds. The current TxDOT Project 0-7220 is researching speed management countermeasures for arterial roadways. The research into speed management techniques by area type or roadway characteristic type should consider non-engineering countermeasures such as enforcement or public campaigns.
- The Project 0-7156-01 research identified refinements and new factors (see Table 20) for the next edition of the Speed Zone Manual (*3*). Research is needed to identify appropriate levels for these new factors. For example, should the following new factors just be a

binary yes or no based on engineering judgment, or should there be specific levels: public transit, on-street parking, pedestrian and bicycle facilities and activity, and transition design? The previous high driveway density factor was updated to become the high access density factor. Data from the *Access Management Manual* Table 2-2 (*9*) was used to identify potential criteria that varied depending on the existing PSL for the road. What are the impacts of implementing these new criteria?

- National Cooperative Highway Research Program Project 17-133 (*18*) is exploring the use of the 85th percentile speed for freeways and rural highways. Research can explore the use of the 85th percentile speed for other roadway types and roadway contexts. Are there conditions where not considering the 85th percentile speed is reasonable?
- Research could develop methods for obtaining the data needed with the SSL protocol that are not currently available in TxDOT databases, such as access density. This research should consider innovative methods such as using connected vehicle trajectory data to reveal driveways (and possible usage level) and/or using computer vision technology to extract driveway information from dashcam videos, such as TxDOT's Pathway video logs of all on-system roadways.
- The Speed Zone Manual acknowledges horizontal and vertical curvatures as issues to be considered in setting regulatory speed limits, mainly because of possible concerns with sight distance. The number of horizontal curves in the speed zone is usually considered in the speed zone study process but without quantitative thresholds to account for number, severity, or spacing of horizontal curves. One interviewed practitioner suggested that on highways with many horizontal curves, an analysis that accounts for the spacing and severity of curves could be applied to reduce the need for supplemental Horizontal Alignment signs, particularly Chevron Alignment signs. This type of analysis could both reduce sign installation and maintenance costs and improve safety on winding rural highways.
- A limitation to the implementation of automating speed zone studies is the need to have site characteristic data in a readily available database or GIS platform. Research is needed to frame the limitations so that the implementation of the solution is effective. For example, what data are critical, such as existing PSL, speed zone limits, etc.? What software or computer resources are needed to effectively communicate between existing TxDOT resources, such as crash data? What are other data needs, such as land uses (development), horizontal and vertical curves, traffic control devices for signal density, etc.? Ideally, the solution would need to have access to all the necessary data (e.g., speed study and site characteristics) on a single platform. The developed system may only semi-automate the process because several engineering judgment points will still be needed for conducting speed zones to appropriately consider local conditions.

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