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Responsible Senior Program Officer: Andrew C. Lemer

Research Results Digest 318

AN EXPERT SYSTEM FOR RECOMMENDING SPEED LIMITS IN SPEED ZONES

This digest presents the results of NCHRP Project 3-67, "Expert System for Recommending Speed Limits in Speed Zones." The study was conducted by a team led by the University of North Carolina Highway Safety Research Center with Wade Trim Associates, Inc. and PB Farradyne, Inc. Raghavan Srinivasan, Senior Transportation Research Engineer at the Highway Safety Research Center, was the Principal Investigator.

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SUMMARY

This digest describes research conducted to develop a knowledge-based expert system decision-support tool for recommending speed limits in speed zones on highways and local roads that are considered credible and enforceable. The tool is intended to assist responsible authorities in setting speed-zone limits to enhance traffic safety and operating efficiency. The system has been designed to be useful for all types of primary roadways, from rural two-lane segments to urban freeway segments. The system does not address statutory limits such as maximum limits set by legislatures for Interstates and other major classes of roadways, temporary or part-time speed limits such as those posted in work zones and school zones, or variable speed limits that change as a function of traffic, weather, and other conditions. The expert system is designed to be implemented as a web-based software application.

The digest is based primarily on the final report for NCHRP Project 3-67, "Expert System for Recommending Speed Limits in Speed Zones" (available from the project description page of the TRB website: http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=821). The project reviewed current literature on guidelines, criteria, and procedures used for setting speed limits in speed zones in the United States and experience with use of XLIMITS, USLIMITS, and other existing speed-limit expert systems. A group of subject-matter experts engaged in setting and enforcing speed limits was convened to provide underlying decision rules for the expert system. The software application was developed with consideration of user needs and requirements for long-term management and maintenance of the expert system. (The application can be accessed through the Internet at http://www2.uslimits.org and is available for download and installation on an Internet server from the TRB website at http://www.trb.org/news/blurb_detail.asp?id=7568.)

This digest is organized into three sections and an appendix. The first section describes the motivation for the research and the scope of NCHRP Project 3-67. The second section describes the decision rules embedded in the expert system and how

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these rules were derived. The third section describes the software application and its use. The appendix contains diagrams of the decision rules and logic of their application.

RESEARCH SCOPE AND MOTIVATION

The control of traffic speed is generally acknowledged to be a significant factor influencing road safety and operating efficiency. The setting of speed limits and their role in controlling traffic speed are nevertheless controversial. Engineers, public safety officials, and others involved in setting and enforcing speed limits may disagree on the appropriate balance between safety and road-user convenience that should prevail on particular road segments, considering conditions of topography, weather, adjacent activities, and traffic. Motorists, other road users, and roadway neighbors have their own perspectives on this balance and may or may not abide by the professionals' judgments. The inherent complexity of factors influencing traffic behavior and crash experience as well as the difficulties of observing and measuring these factors make it difficult to draw definitive and generalizable conclusions from analysis of observations at specific locations.

Most jurisdictions have adopted laws defining absolute speed limits; traveling at a speed above the absolute limit is by definition illegal and presumably imprudent and unreasonable. Responsible authorities are empowered to lower or raise speed limits on a particular road segment if they judge that these altered limits are reasonable and safe under conditions found to exist at that location. Engineering and traffic studies typically provide the basis for making such speed-zone judgments. These studies generally consider such factors as the physical features of the roadway, crash experience, traffic characteristics and control (for example, signals and other control devices), and the length of the roadway segment under consideration (speed-limit changes should not be too frequent or applied to very short road segments).

One of the factors that many experts consider very important for setting a speed limit is the prevailing vehicle speed. The *Manual on Uniform Traffic Control Devices* (MUTCD) is quite explicit, stating that "when a speed limit is to be posted, it should be within 10 km/h or 5 mph of the 85th percentile speed of free-flowing traffic" (MUTCD 2003). However, the manual also indicates other factors that may also influence the appropriate speed limit, including roadway characteristics such as shoulder condition, grade alignment, and sight distance; pace speed; roadside development and environment; parking practices and pedestrian activity; and reported crash experience for at least a 12-month period.

Neither the MUTCD nor other sources offer specific guidance and procedures for setting limits in speed zones, requiring engineers or other officials to rely on their experience and judgment in weighing various factors to decide on appropriate speed limits. The situation can sometimes result in inconsistencies in how speed limits are set from one jurisdiction to another and can be confusing to drivers. If the regulation of speed is to be effective, these experts suggest, the posted limit must be generally consistent with speeds that drivers feel are safe and proper. While too high a speed limit can reasonably be anticipated to increase the likelihood and severity of crashes, inappropriately low speed limits can lead to poor compliance and large variations in speed within the traffic stream, also increasing crash risk.

Enforcement is widely recognized to be crucial to the success of speed limits as a means for making roads safer. If law enforcement officers and the courts are confident that speed limits have been developed on a reasonable basis, their enforcement of the limits will be more effective. Some professionals have argued that speed limits should be set generally at levels that are self-enforcing so that law enforcement officials can concentrate their efforts on the worst offenders.

In 1998, TRB published *TRB Special Report 254* (*Managing Speed: Review of Current Practices for Setting and Enforcing Speed Limits*), which reported the results of a study—requested and funded by NHTSA, FHWA, and the Centers for Disease Control and Prevention—that reviewed current practice for setting and enforcing speed limits on all types of roads. *TRB Special Report 254* notes that the practice of setting speed limits at the 85th percentile or some other statistic derived from prevailing traffic reflects an assumption that most drivers are capable of judging the speed at which they can safely travel. However, this assumption raises the question of why speed limits are then necessary at all. The report suggests at least three reasons:

- Drivers impose significant risks on others. For example, a driver with poor understanding of

risk or higher tolerance for risk may decide to drive faster than might be considered by others to be appropriate for roadway conditions. The higher speed increases the probability of a crash involving property damage and possibly injury or death for the driver and others. Even if the speeding driver is traveling alone and is involved in a single-vehicle crash, the medical and property damage costs typically are not fully paid by the driver, but are distributed among other insured drivers, government agencies, and a larger community.

- Some drivers are unable to judge correctly the capabilities of their vehicles (e.g., stopping distances) and to anticipate road conditions sufficiently to determine appropriate driving speeds. Inexperienced drivers or experienced drivers operating in unfamiliar surroundings may be more susceptible to this problem, underestimating risk and making inappropriate speed choices.
- Drivers may underestimate the effects of speed on crash probability and severity, even if they understand in principle the risk of a crash. Young and inexperienced drivers are most often prone to such misjudgments.

The speed limits set in speed zones reflect a balance of several considerations specific to the roadway segment to be regulated. Traffic engineers normally conduct an engineering study of the segment and apply principles of current engineering practice to recommend what the speed limit should be. Law enforcement officials may be involved in the development of a recommendation, taking into consideration the issues likely to be associated with enforcement of the limit; *TRB Special Report 254* suggests that such involvement should be standard practice. Citizens groups and elected officials also may be involved when community concerns about traffic speed have been raised. The resulting limit set in a speed zone is then often the product of complex negotiation and may differ from the speed that any single group or individual might have considered most reasonable.

A tool that could be used by traffic engineers, enforcement officials, and others to set speed-zone limits, embodying best current practices and taking into account the myriad factors influencing determination of an appropriate limit, could be quite valuable. Such a tool could enhance the consistency and quality of both the process for setting limits on a particular road segment and the result, thereby improving road safety. By increasing users' confidence that speed limits are being reasonably determined, such a tool could also improve the effectiveness of enforcement efforts and further improve safety.

Such reasoning led several states in Australia to undertake development of such a tool. The decisions and judgments made to set a speed-zone limit were thought to be particularly well suited to an expert system approach. An expert system is a computational algorithm, generally computerized, that seeks to mimic the thought process of an expert. Such systems are based on rules and representative judgments derived from knowledgeable people, the "experts."

Such a system for providing advice on speed limits for speed zones was developed in the 1980s by the Australian Road Research Board (ARRB) for the state of Victoria. That initial tool was developed further for use in other Australian states and New Zealand. The original system, VLIMITS, was a DOS-based program that prompted users to respond to a series of questions about the road segment and then recommended a speed limit. The system's logic was "hard coded," meaning that the system did not learn with experience, as some expert systems do. The most recent versions of the program use a multistep process to recommend a speed limit with warnings about specific factors that should be studied further before the limit is imposed.

The ARRB, under contract to FHWA, adapted the logic of these earlier programs to develop USLIMITS specifically for application in the United States. One of the changes made to suit conditions in this country was to force the recommended speed limits to be within the 50th- to 85th-percentile range. The system is considered proprietary, and its logic and decision rules are not available to the user. Hence, users cannot be certain which variables influence the final recommendation or nature of that influence. Although many USLIMITS users surveyed as part of the NCHRP research thought that the speed limits recommended by the system are reasonable, they also thought that more information should be made available regarding the decision rules and the factors used or not used in developing the final recommendation. Also, USLIMITS is available through the Internet (www.uslimits.com), but a username and password are required.

NCHRP Project 3-67 was designed to produce an expert system to succeed USLIMITS. The new system would be made available with complete information about the system's logic and factors influencing speed-limit recommendations. That new system, the product of this research, is USLIMITS2. The following sections of this digest describe the decision rules embodied in the expert system and their bases, and what hardware and software are required to use USLIMITS2. More complete descriptions of the application and its development, including a users' guide for the expert system, are contained in the final project report (available from the project description page of the TRB website: http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=821).

EXPERT SYSTEM DECISION RULES AND THEIR DERIVATION

The core of USLIMITS2 is a set of decision rules developed with the help of two selected groups of experts: an expert panel that participated in meetings and conferences and a larger expanded panel that responded to questionnaires and surveys. These groups included traffic engineers; law enforcement officials; other road safety professionals; and other experienced officials familiar with the setting, enforcement, and adjudication of speed limits for speed zones. Altogether, 17 individuals participated in the expert panel, but the decision rules for each of the several categories of roadway in the expert system are based on judgments made by 7 to 12 individuals. The expanded panel included a total of 148 individuals.

Members of the expert panels participated in several meetings and teleconferences to discuss what factors are important in setting speed-zone limits and to consider how these factors would influence their judgments of the appropriate speed limit for particular road segments. In the first meeting, the expert panel members were invited to review a set of photographs and accompanying text and statistics (for example, operating speeds and crash experience), referred to by the researchers as "case studies" and "scenarios." The combined set of case studies and scenarios was selected by the research team to compose a standardized sample of typical situations for which a speed limit might be set. The set included two-lane and multilane roadways that were located in developed and undeveloped areas, had high-speed and low-speed traffic, and were designed to Interstate or less stringent geometric standards. Panel members were also asked to discuss their reasoning in developing their recommendations. The information gathered from this exercise was used to develop critical variables for freeways and multilane and two-lane arterial streets (see Table 1).

Following the meeting of the expert panel, the research team developed a larger set of case studies and scenarios that were sent to the expanded panel. Forty-four individuals responded to these case studies and scenarios with judgments about appropriate speed limits. The research team used the information from these responses to develop statistical models relating the recommended speed limits to site characteristics. These models were presented to the expert panel during a second meeting. Information

Table 1 Critical variables identified by panel members

	Roadway type	
Critical variables	**Freeway**	**Multilane and two-lane arterial**
Operating speed	X	X
Roadway geometrics	X	X
Cross section (includes clear zone)	X	X
Crash statistics	X	X
Roadside friction		X
Major intersection/interchange spacing	X	X
Pedestrian or bicycle activity		X
Road classification (i.e., through or local)		X
Proximity to a school zone		X

gathered from this second meeting was used by the research team to develop a set of decision rules and the logic for application of these rules; the rules and logic became the basis for USLIMITS2. The decision rules and the prototype expert system were sent to the expanded panel for their review. The comments from the expanded panel were discussed during a teleconference with the expert panel. The researchers used information gathered from this teleconference to refine the decision rules and logic. The research team reported that panel members were sometimes divided in their opinions on critical variables and their relative importance, especially regarding determination of appropriate speed limit on roads with a large number of crashes. The methods used in identification of critical variables and development of decision rules did not yield indicators of statistical significance, validity, or reliability.

The decision rules and logic of their application are illustrated in the appendix. The USLIMITS2 program calculates a recommended speed limit using two approaches, based on either safety surrogates or operating speeds and crash experience.

For the first approach, the research team used expert panel opinion and other sources to identify designated ranges of selected characteristics of a roadway segment as "safety surrogates," essentially, indicators of the safety hazard associated with traffic on such a segment. For example, the recommended speed limit that a freeway segment with average interchange spacing of less than 0.5 mile and annual average daily traffic (AADT) greater than 180,000 would be the 5-mph multiple closest to the 50th-percentile speed; for an otherwise similar segment with interchange spacing between 0.5 and 1 mile and lower AADT, the recommended limit would be the 5-mph multiple obtained by rounding down the 85th-percentile speed. Other safety surrogates designated for other types of segments include roadside hazard rating, presence and usage of on-street parking, number of traffic signals, and the number of driveways and unsignalized access points.

For the second approach, crash frequency and severity experience on a segment and on other comparable roadways are used to calculate critical crash and injury rates that are used in a manner similar to the safety-surrogate ranges of the first approach. That is, if the observed crash or injury rate is higher than the corresponding critical rates or at least 30% higher than the corresponding average rates, a reduced speed limit may be recommended.

Whether one or the other approach is used is determined by the availability of data. Both approaches may be used to produce recommended speed limits. Under either approach, the recommended speed limit may be modified if other features of the roadway warrant such modification, for example, if the segment is short or has design profile deficiencies.

THE SOFTWARE APPLICATION AND ITS USE

USLIMITS2 is implemented as a web-based application. Users will require only a computer with web-browsing software and a connection to the Internet. Any web browser version developed in 2003 or later will be able to access the application; results are output to the user's computer screen. Users will not need any special skills to access and use the system.

However, the application must be hosted and made available on the Internet for users to access it. The system host configuration must include a web server, an application server, and a database server. The host machine should be server grade, with sufficient memory and disk space to accommodate the selected server software. The server, operating system, web server, and application server are an integrated package. The minimum requirements for the application installed on a UNIX server include an UltraSPARC IIIi® processor, 2048 MB RAM, and a SCSI or RAID disk subsystem. Minimum requirements for a Microsoft® Windows server are a Pentium IV® 2.8 GHz processor, 1024 MB RAM, and SCSI or SATA disk subsystem. The application was developed using Macromedia ColdFusion®, which the application server must have installed as well.

The application can be accessed from http://www2.uslimits.org. The application is also available for download and installation on a suitable server from the TRB website at http://www.trb.org/news/blurb_detail.asp?id=7568.

APPENDIX: EXPERT SYSTEM DECISION RULES AND LOGIC FOR USLIMITS2

This document contains flow charts (numbered K-3 through K-30) describing the decision rules for the expert system for recommending speed limits in speed zones that was developed as part of NCHRP Project 3-67.

TERMS

Closest 85th—the 5-mph increment that is closest to the 85th-percentile speed (e.g., if the 85th-percentile is 63 mph, the closest_85th will be 65 mph)

Rounded-down 85th—the 5-mph increment obtained by rounding down the 85th percentile to the nearest 5-mph increment (e.g., if the 85th-percentile speed is 63 mph, the rounded-down_85th will be 60 mph)

Closest 50th—the 5-mph increment that is closest to the 50th-percentile speed (e.g., if the 50th-percentile speed is 58 mph, the closest_50th will be 60 mph)

SL_1—speed limit calculated using safety surrogates

SL_2—speed limit calculated using crash data from the crash module

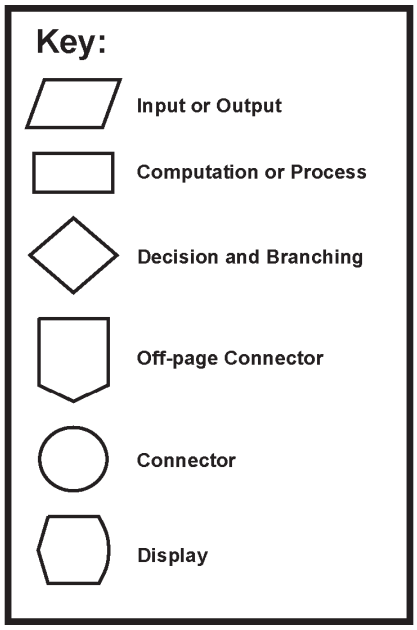
SL—recommended speed limit

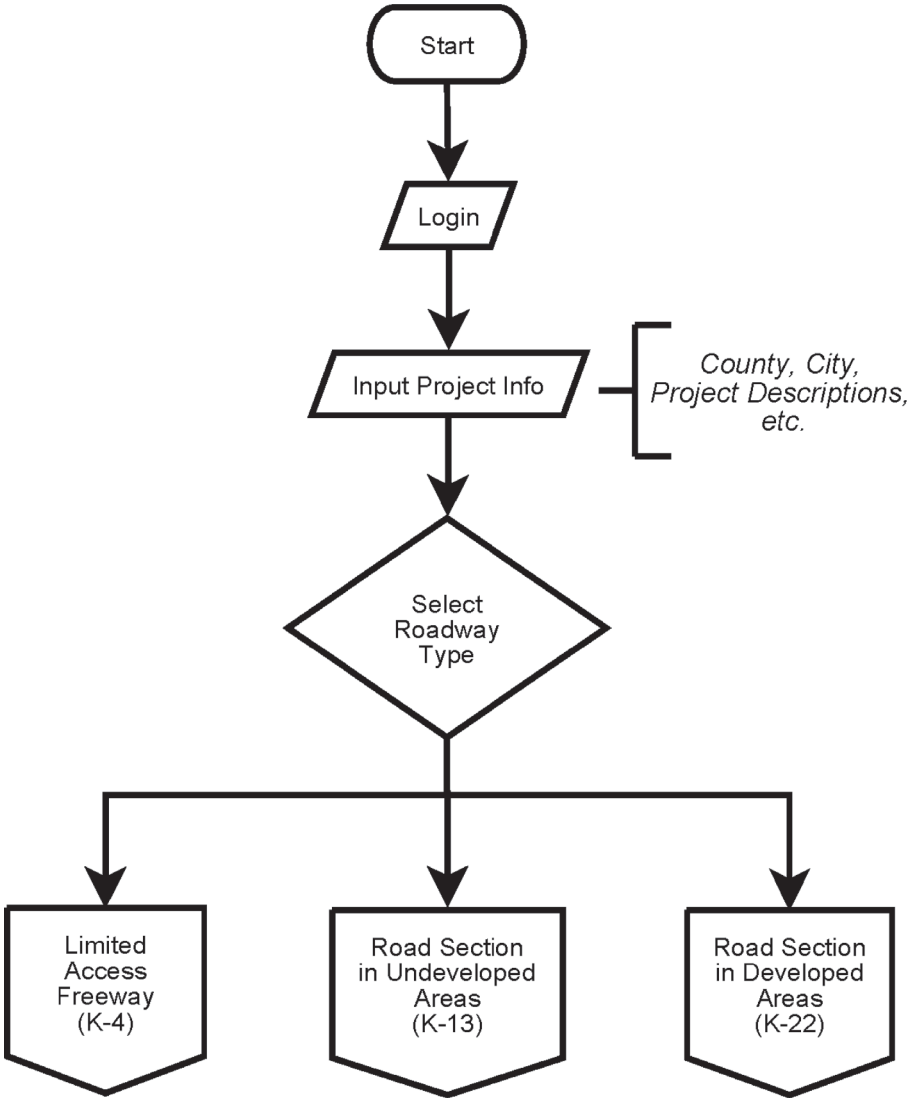
L.A.F.—Limited Access Freeway

C.M.F.F.—Crash Module for Freeways

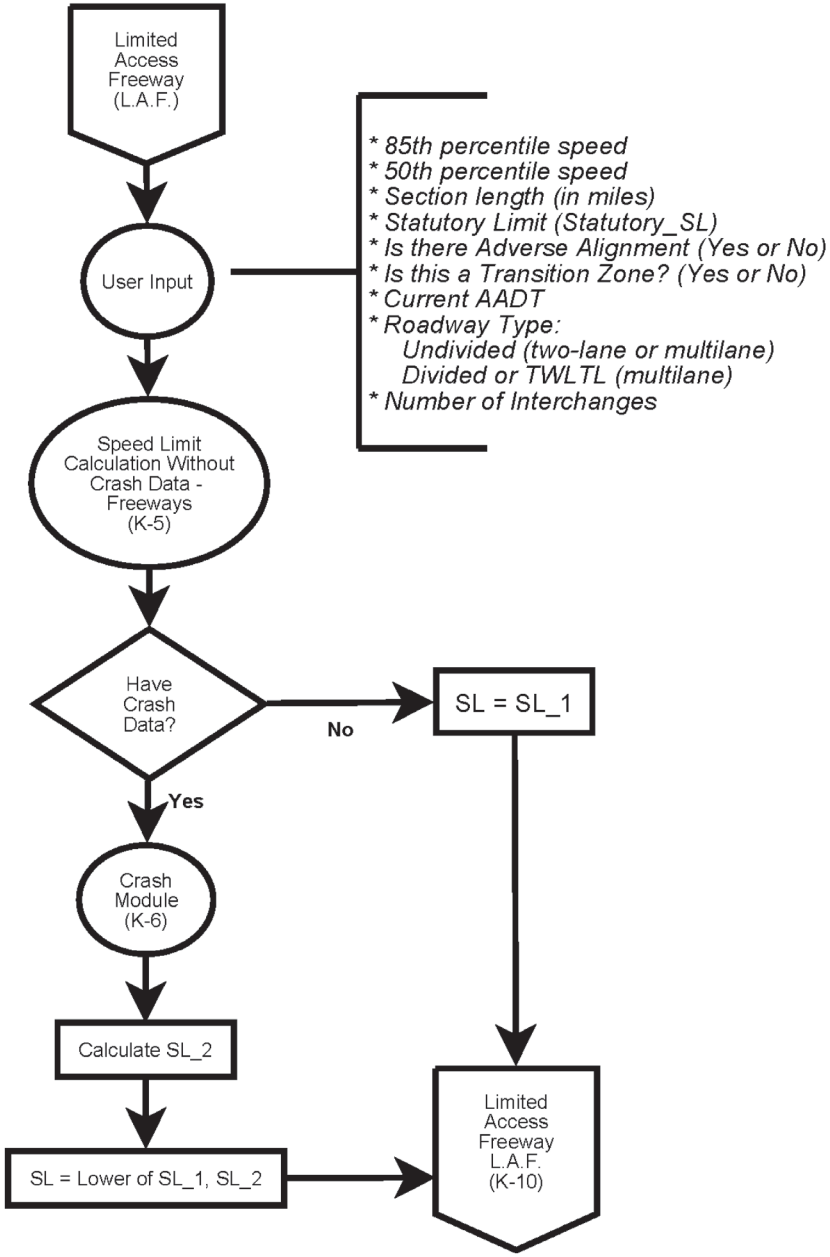
R.S.I.U.A.—Road Sections in Undeveloped Areas

R.S.I.D.A.—Road Sections in Developed Areas



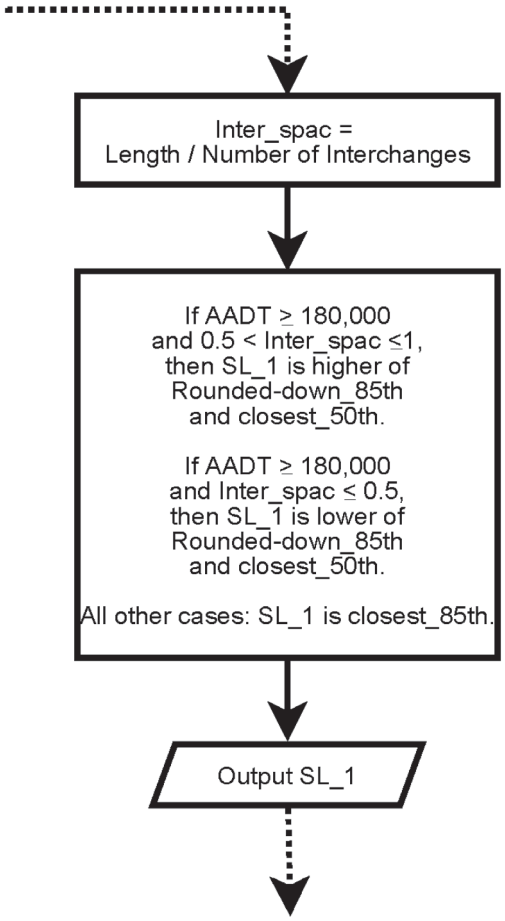

Start
Login
Input Project Info
County, City, Project Descriptions, etc.
Select Roadway Type
Limited Access Freeway (K-4)
Road Section in Undeveloped Areas (K-13)
Road Section in Developed Areas (K-22)

K-3

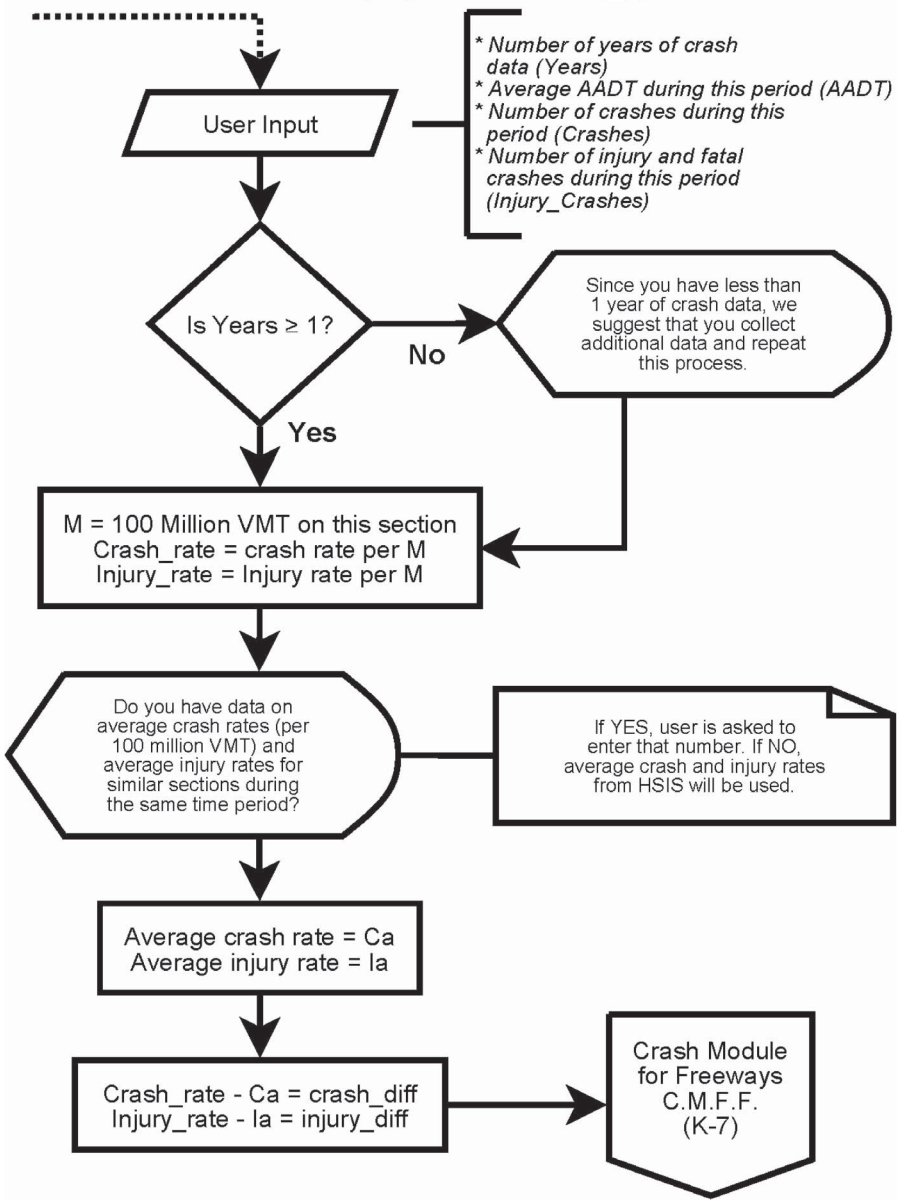

Limited Access Freeway (L.A.F.)
User Input
* 85th percentile speed
* 50th percentile speed
* Section length (in miles)
* Statutory Limit (Statutory_SL)
* Is there Adverse Alignment (Yes or No)
* Is this a Transition Zone? (Yes or No)
* Current AADT
* Roadway Type:
Undivided (two-lane or multilane)
Divided or TWLTL (multilane)
* Number of Interchanges
Speed Limit Calculation Without Crash Data - Freeways (K-5)
Have Crash Data?
No
SL = SL_1
Yes
Crash Module (K-6)
Calculate SL_2
SL = Lower of SL_1, SL_2
Limited Access Freeway L.A.F. (K-10)

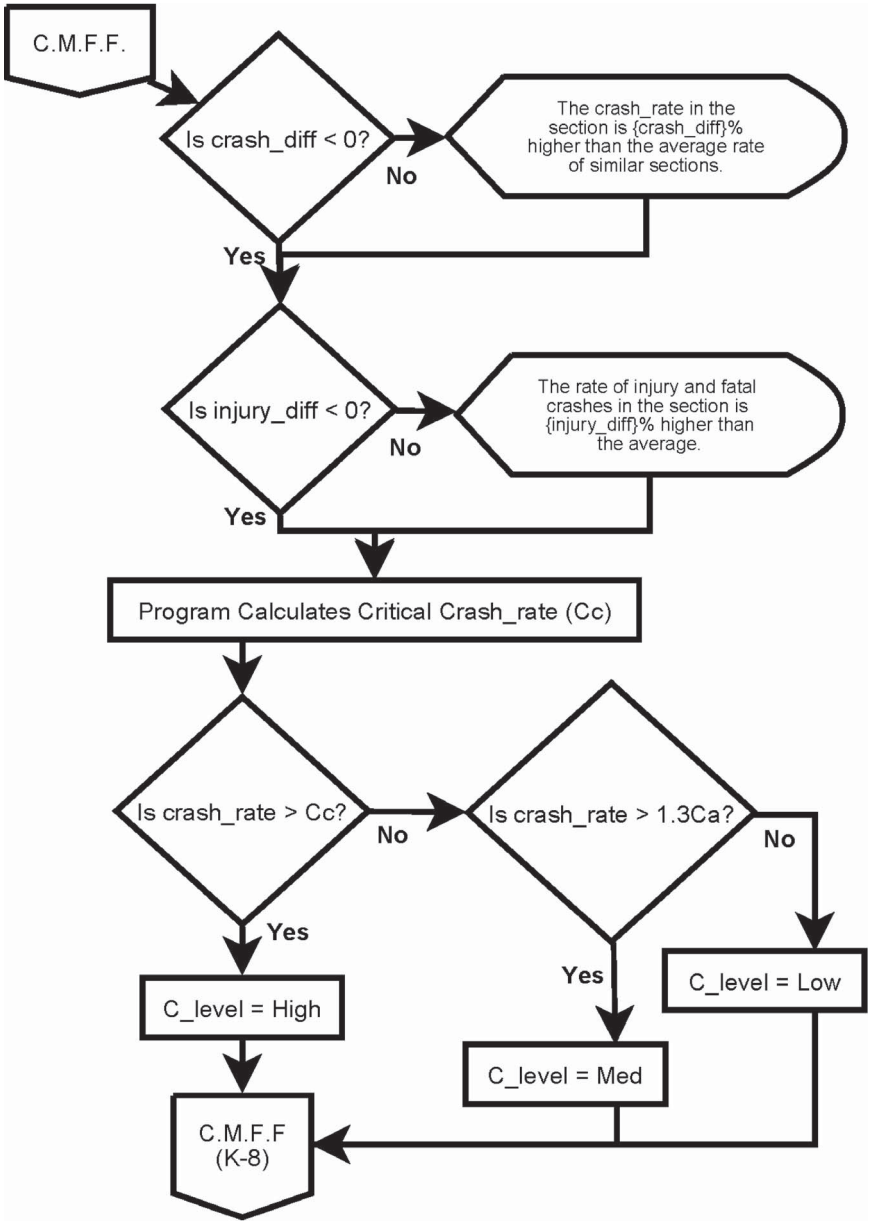
K-4

Speed Limit Calculation Without Crash Data (to calculate SL_1) (Limited Access Freeway)

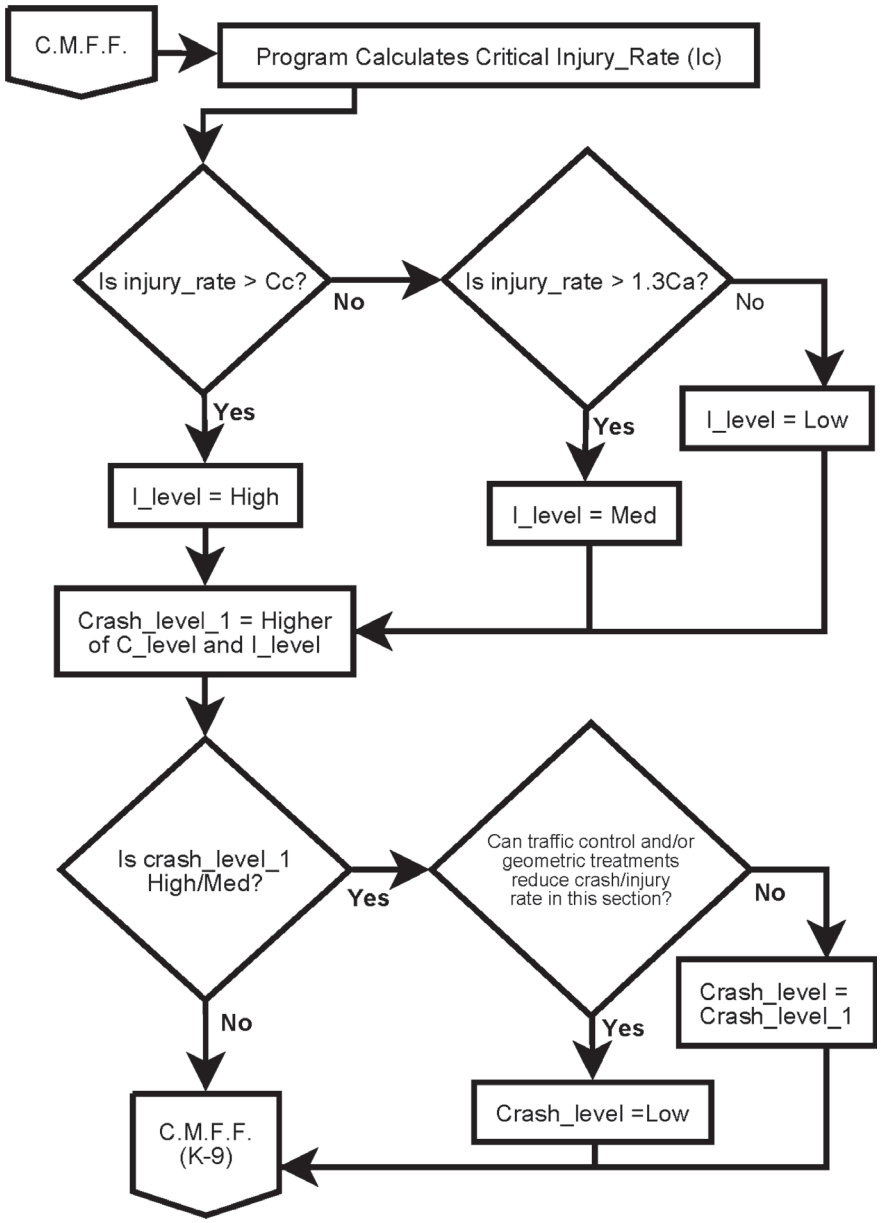


Crash Module for Freeways (to calculate SL_2)

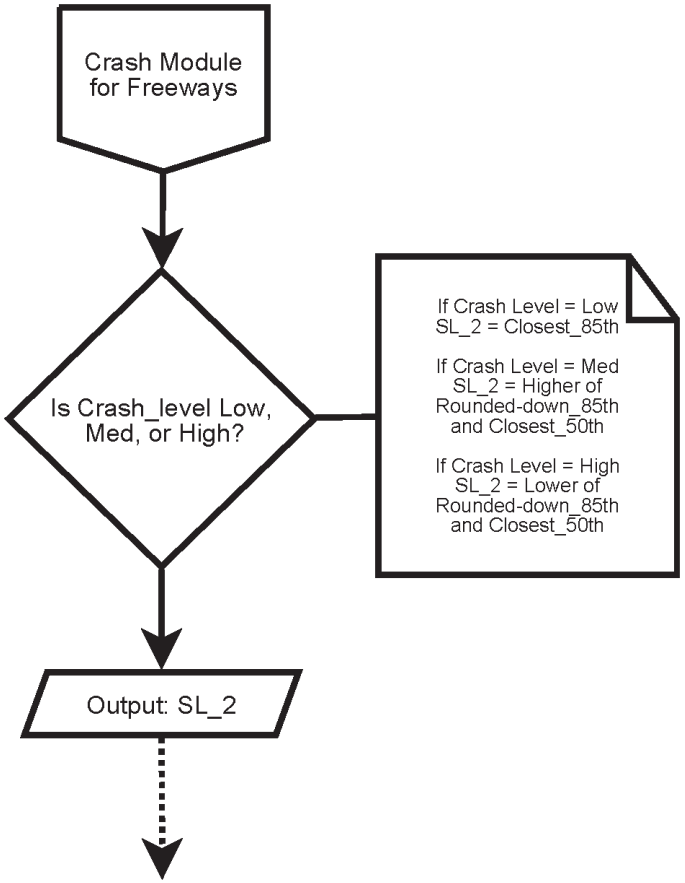



C.M.F.F.
Is crash_diff < 0?
No
The crash_rate in the section is {crash_diff}% higher than the average rate of similar sections.
Yes
Is injury_diff < 0?
No
The rate of injury and fatal crashes in the section is {injury_diff}% higher than the average.
Yes
Program Calculates Critical Crash_rate (Cc)
Is crash_rate > Cc?
No
Is crash_rate > 1.3Ca?
No
Yes
C_level = High
Yes
C_level = Med
C_level = Low
C.M.F.F (K-8)

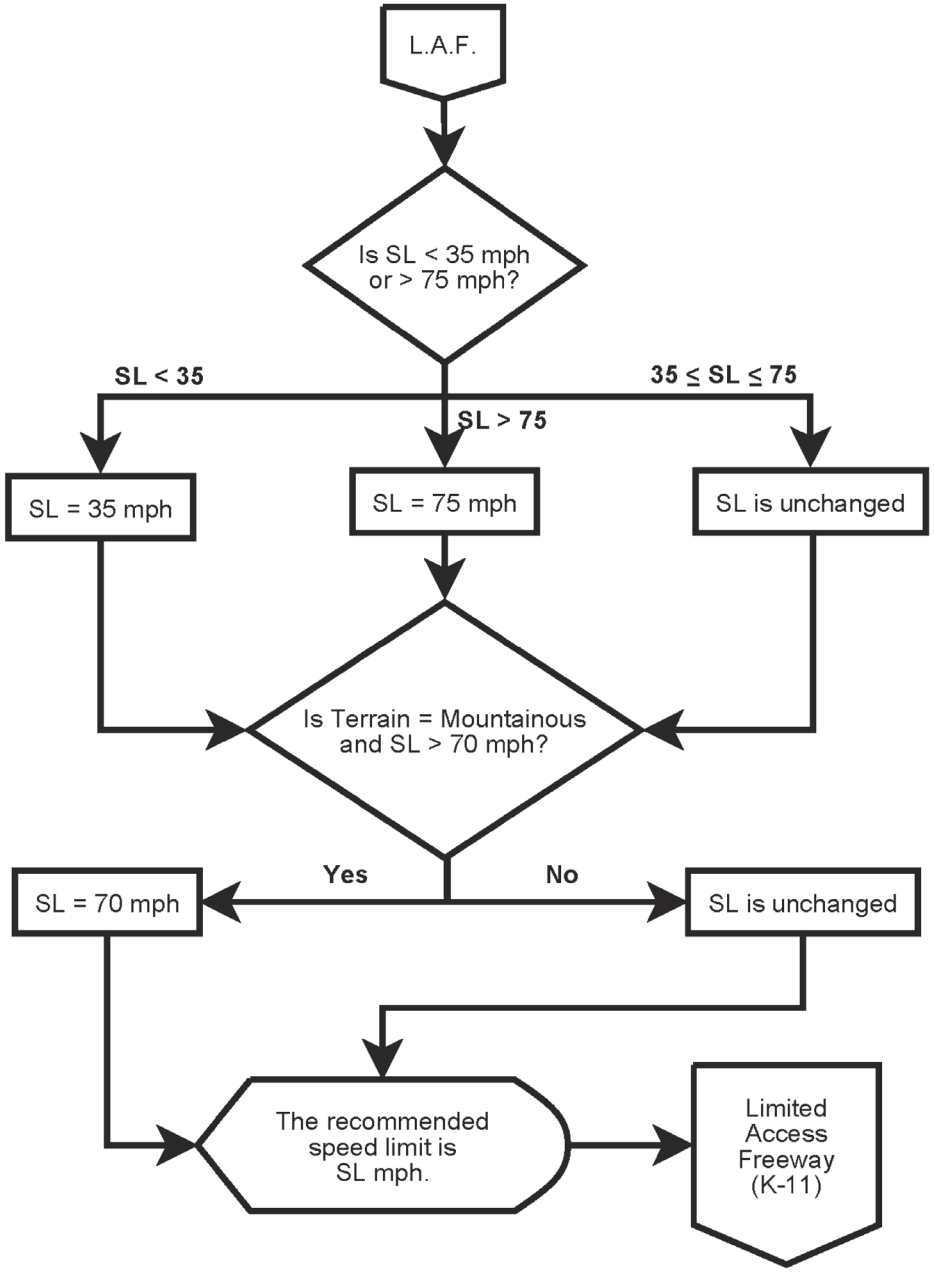
K-7


C.M.F.F.
Program Calculates Critical Injury_Rate (Ic)
Is injury_rate > Cc?
No
Is injury_rate > 1.3Ca?
No
Yes
I_level = Low
Yes
I_level = High
I_level = Med
Crash_level_1 = Higher of C_level and I_level
Is crash_level_1 High/Med?
Yes
Can traffic control and/or geometric treatments reduce crash/injury rate in this section?
No
Crash_level = Crash_level_1
No
Yes
Crash_level =Low
C.M.F.F. (K-9)

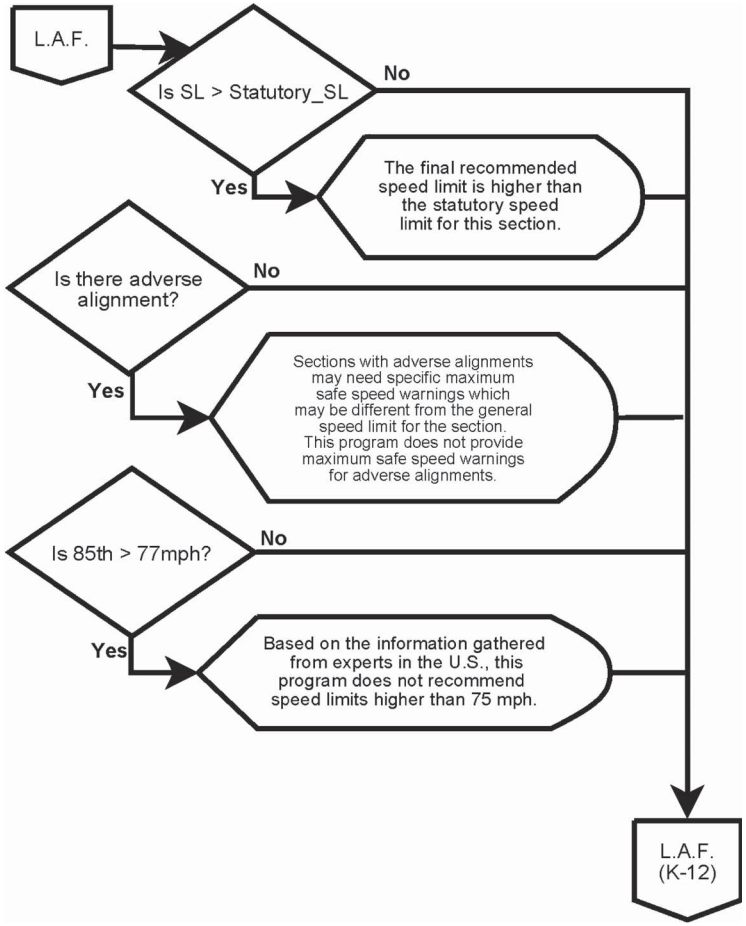
K-8


Crash Module for Freeways
Is Crash_level Low, Med, or High?
If Crash Level = Low
SL_2 = Closest_85th
If Crash Level = Med
SL_2 = Higher of Rounded-down_85th and Closest_50th
If Crash Level = High
SL_2 = Lower of Rounded-down_85th and Closest_50th
Output: SL_2

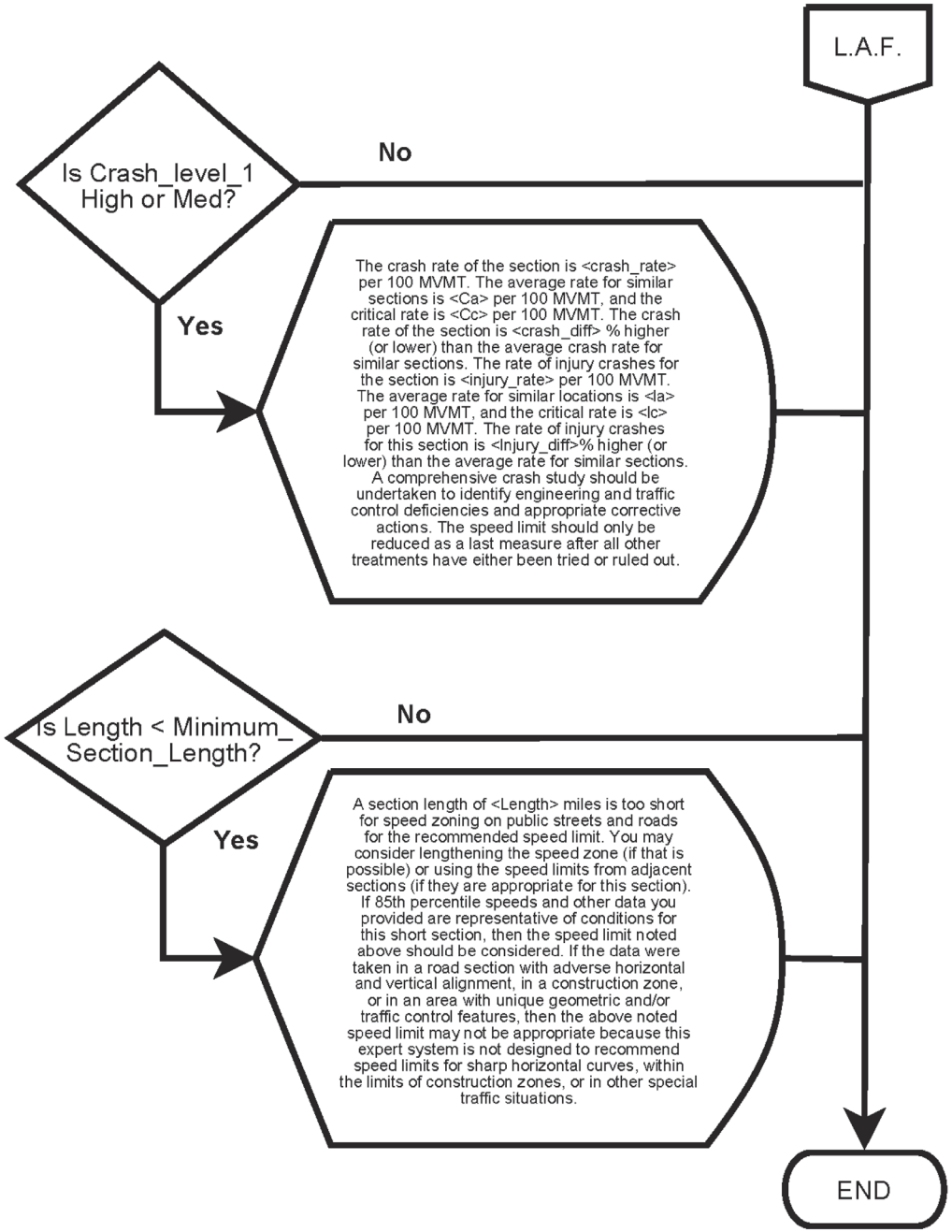
K-9


L.A.F.
Is SL < 35 mph or > 75 mph?
SL < 35
SL > 75
35 ≤ SL ≤ 75
SL = 35 mph
SL = 75 mph
SL is unchanged
Is Terrain = Mountainous and SL > 70 mph?
Yes
No
SL = 70 mph
SL is unchanged
The recommended speed limit is SL mph.
Limited Access Freeway (K-11)

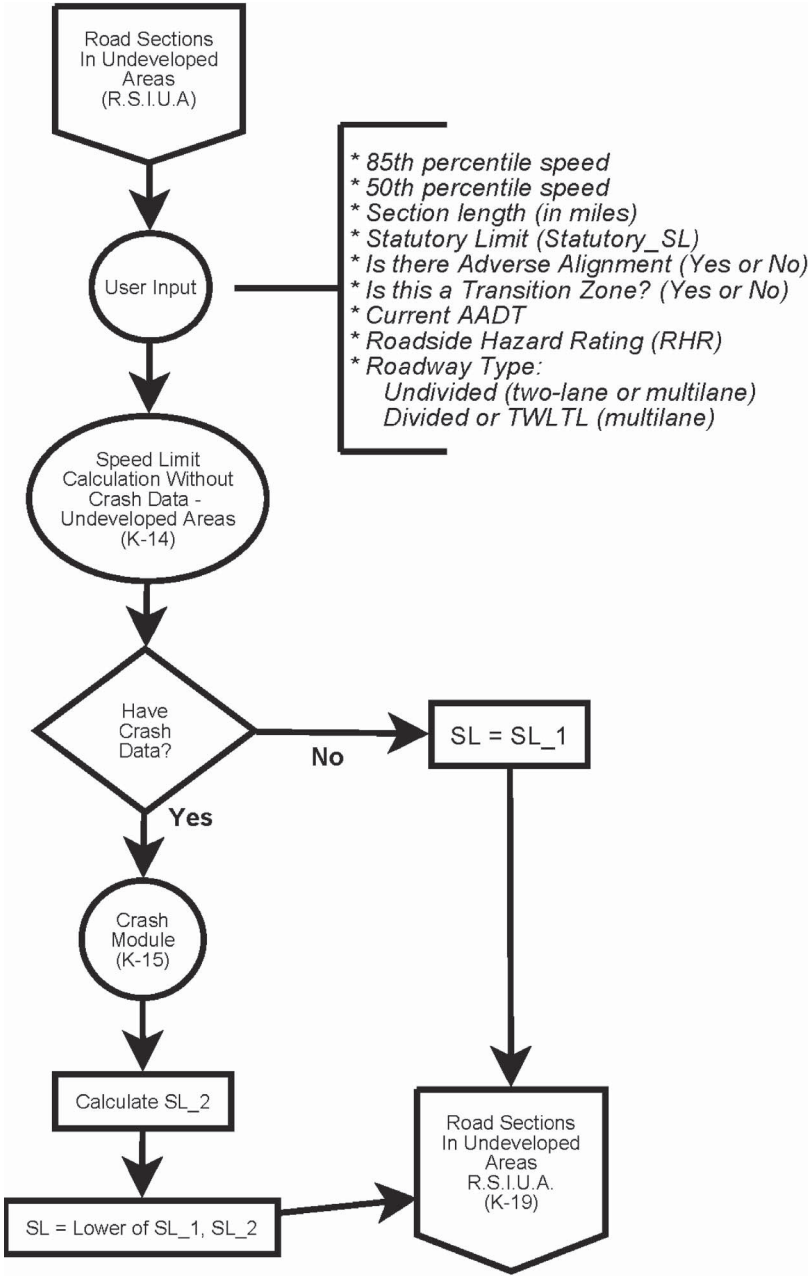
K-10


L.A.F.
Is SL > Statutory_SL
No
Yes
The final recommended speed limit is higher than the statutory speed limit for this section.
Is there adverse alignment?
No
Yes
Sections with adverse alignments may need specific maximum safe speed warnings which may be different from the general speed limit for the section. This program does not provide maximum safe speed warnings for adverse alignments.
Is 85th > 77mph?
No
Yes
Based on the information gathered from experts in the U.S., this program does not recommend speed limits higher than 75 mph.
L.A.F. (K-12)

K-11

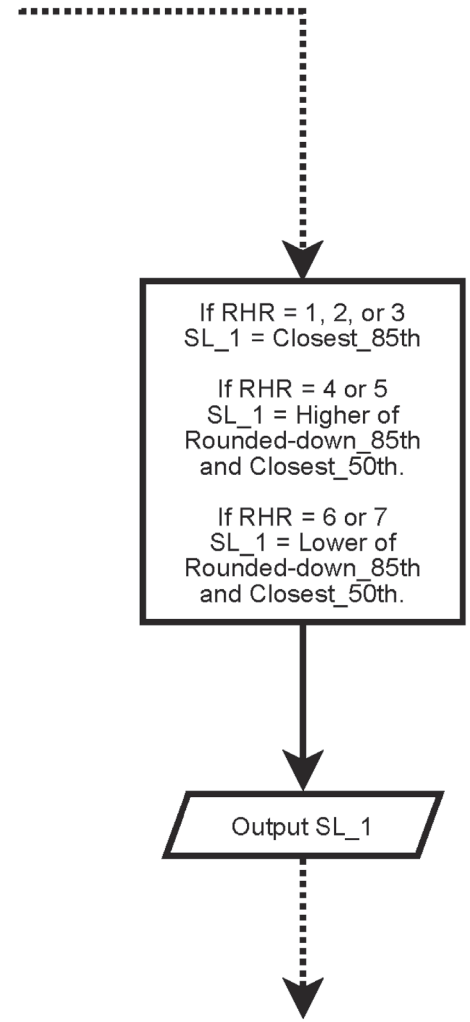

L.A.F.
Is Crash_level_1 High or Med?
No
Yes
The crash rate of the section is <crash_rate> per 100 MVMT. The average rate for similar sections is <Ca> per 100 MVMT, and the critical rate is <Cc> per 100 MVMT. The crash rate of the section is <crash_diff> % higher (or lower) than the average crash rate for similar sections. The rate of injury crashes for the section is <injury_rate> per 100 MVMT. The average rate for similar locations is <Ia> per 100 MVMT, and the critical rate is <Ic> per 100 MVMT. The rate of injury crashes for this section is <Injury_diff>% higher (or lower) than the average rate for similar sections. A comprehensive crash study should be undertaken to identify engineering and traffic control deficiencies and appropriate corrective actions. The speed limit should only be reduced as a last measure after all other treatments have either been tried or ruled out.
Is Length < Minimum_ Section_Length?
No
Yes
A section length of <Length> miles is too short for speed zoning on public streets and roads for the recommended speed limit. You may consider lengthening the speed zone (if that is possible) or using the speed limits from adjacent sections (if they are appropriate for this section). If 85th percentile speeds and other data you provided are representative of conditions for this short section, then the speed limit noted above should be considered. If the data were taken in a road section with adverse horizontal and vertical alignment, in a construction zone, or in an area with unique geometric and/or traffic control features, then the above noted speed limit may not be appropriate because this expert system is not designed to recommend speed limits for sharp horizontal curves, within the limits of construction zones, or in other special traffic situations.
END

K-12



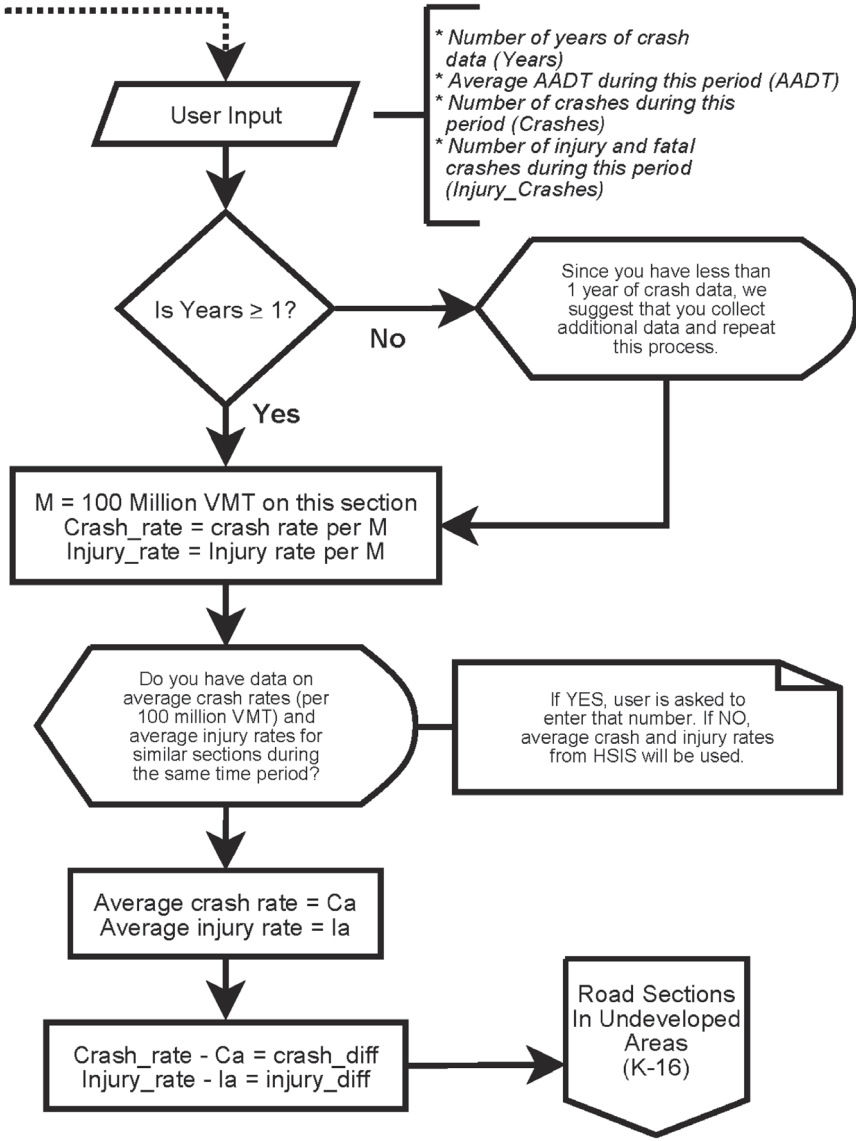
K-13

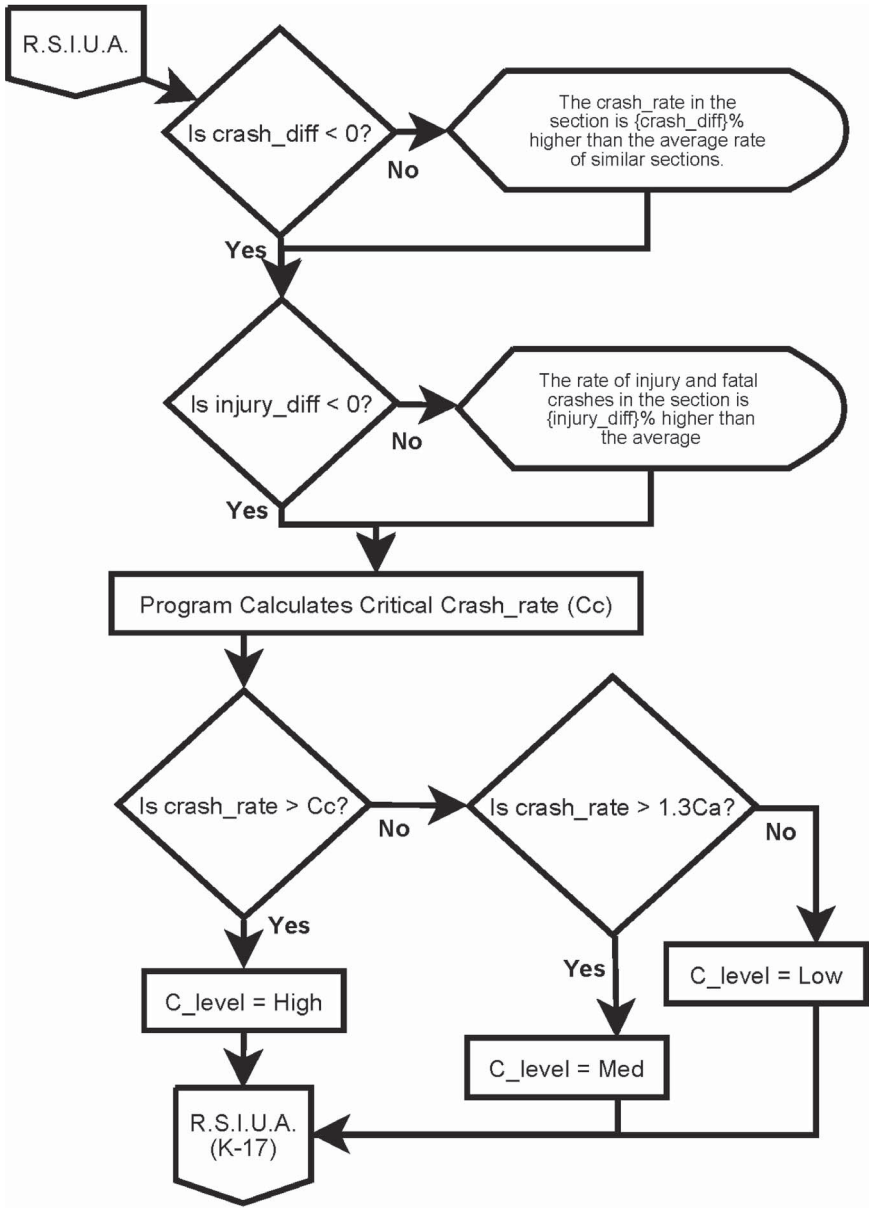
Speed Limit Calculation Without Crash Data (to calculate SL_1)
(Road Sections In Undeveloped Areas)

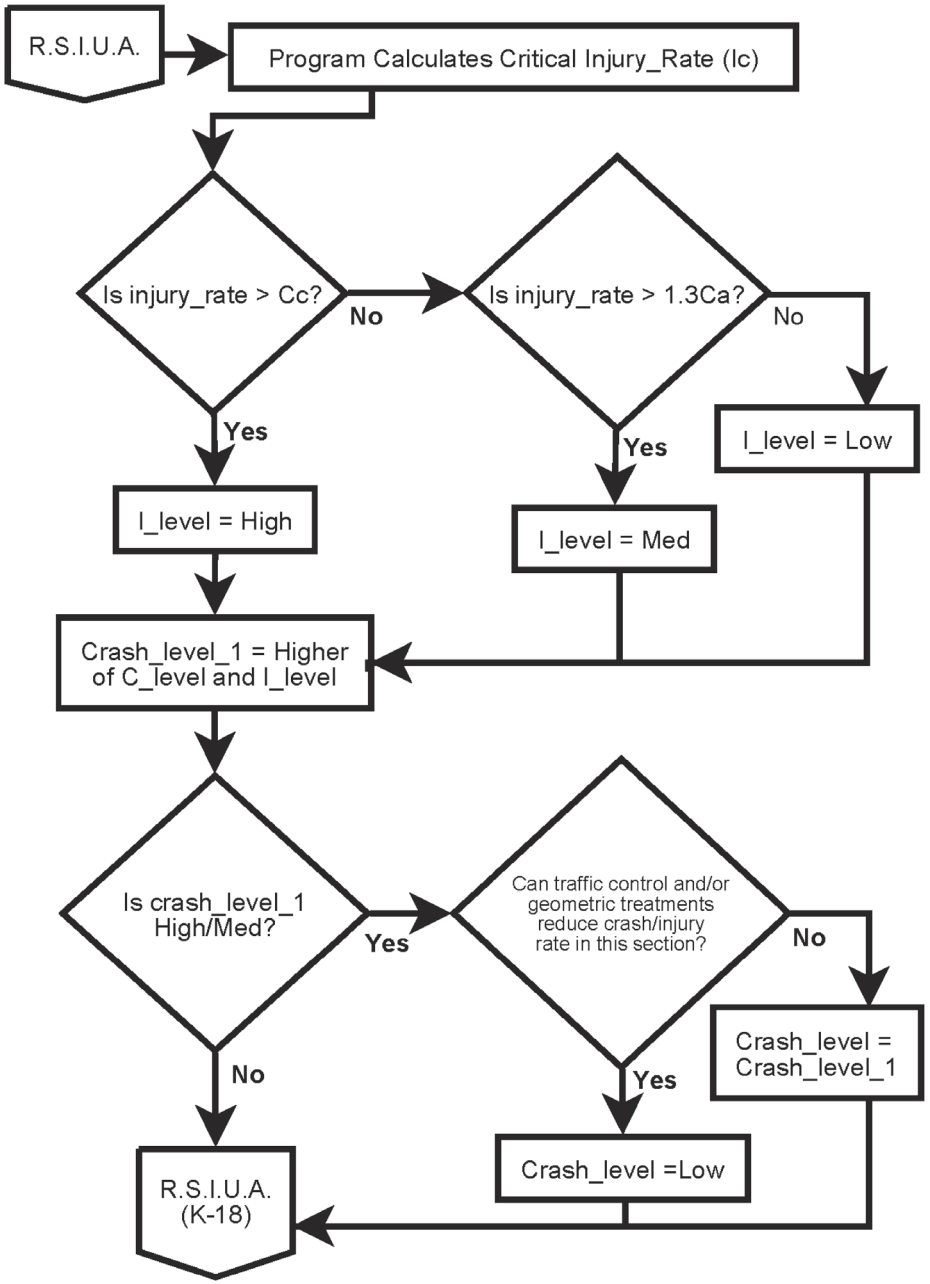


K-14

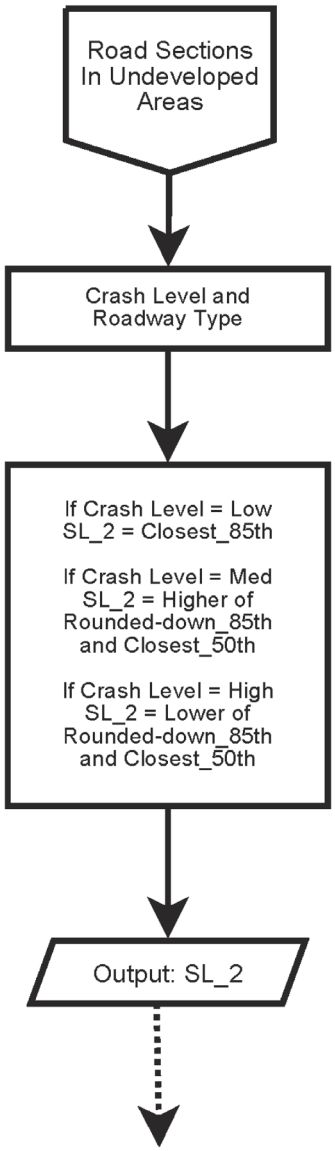
Crash Module for Road Sections in Undeveloped Areas (to calculate SL_2)



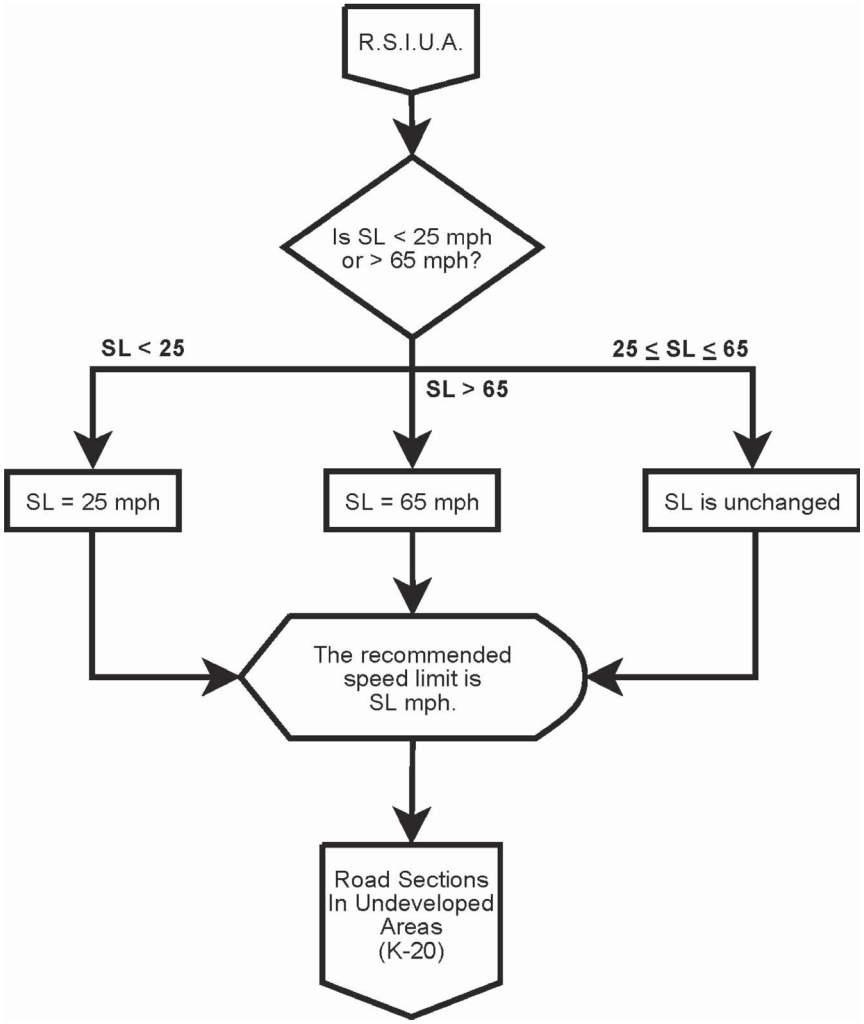



R.S.I.U.A.
Program Calculates Critical Injury_Rate (Ic)
Is injury_rate > Cc?
No
Is injury_rate > 1.3Ca?
No
Yes
Yes
I_level = Low
I_level = High
I_level = Med
Crash_level_1 = Higher of C_level and I_level
Is crash_level_1 High/Med?
Yes
Can traffic control and/or geometric treatments reduce crash/injury rate in this section?
No
Crash_level = Crash_level_1
No
Yes
Crash_level =Low
R.S.I.U.A. (K-18)

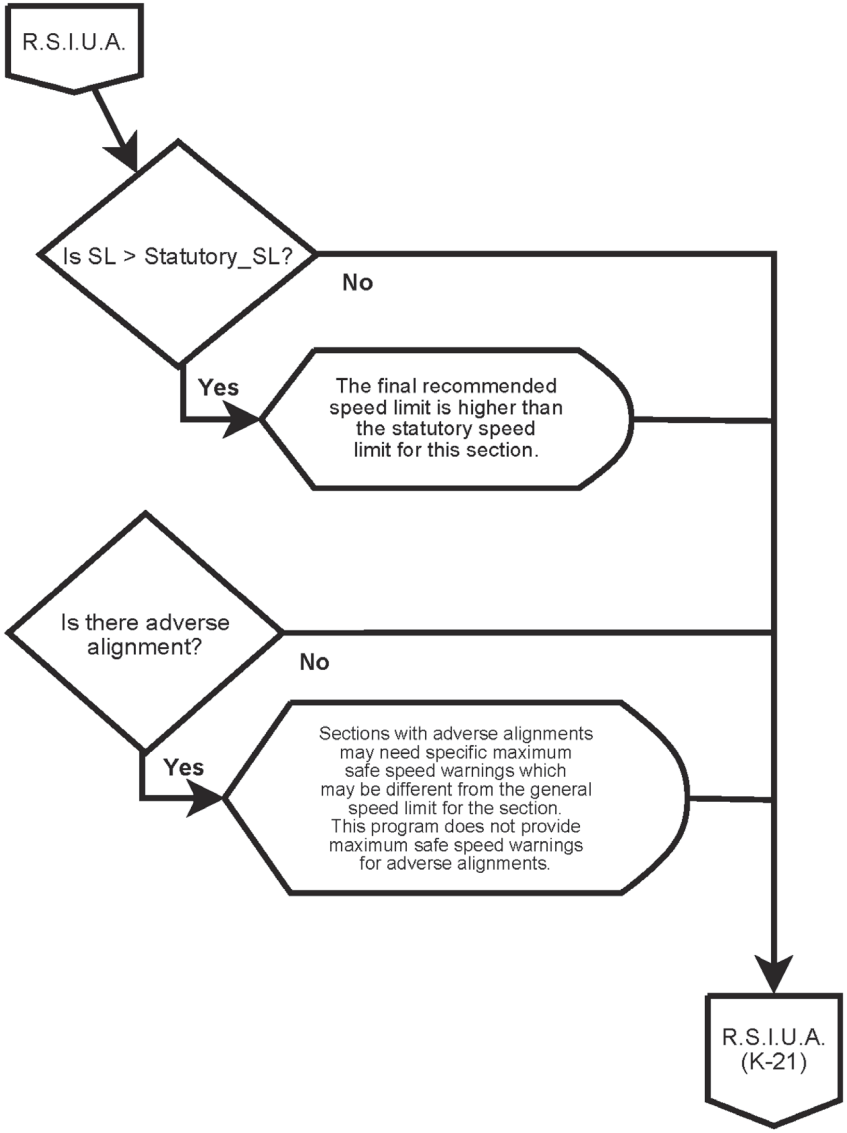
K-17


Road Sections In Undeveloped Areas
Crash Level and Roadway Type
If Crash Level = Low SL_2 = Closest_85th
If Crash Level = Med SL_2 = Higher of Rounded-down_85th and Closest_50th
If Crash Level = High SL_2 = Lower of Rounded-down_85th and Closest_50th
Output: SL_2

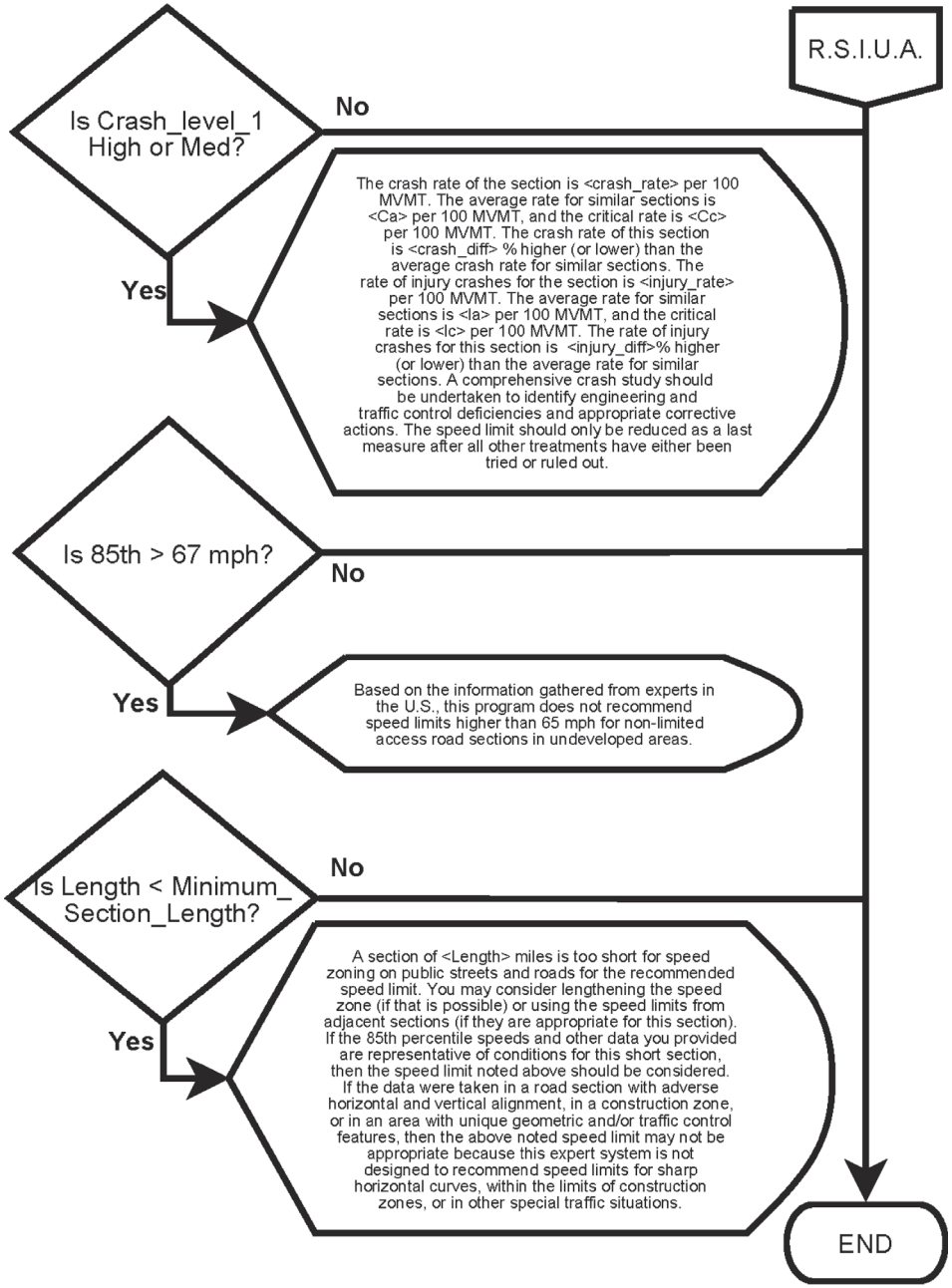
K-18


R.S.I.U.A.
Is SL < 25 mph or > 65 mph?
SL < 25
SL > 65
25 ≤ SL ≤ 65
SL = 25 mph
SL = 65 mph
SL is unchanged
The recommended speed limit is SL mph.
Road Sections In Undeveloped Areas (K-20)

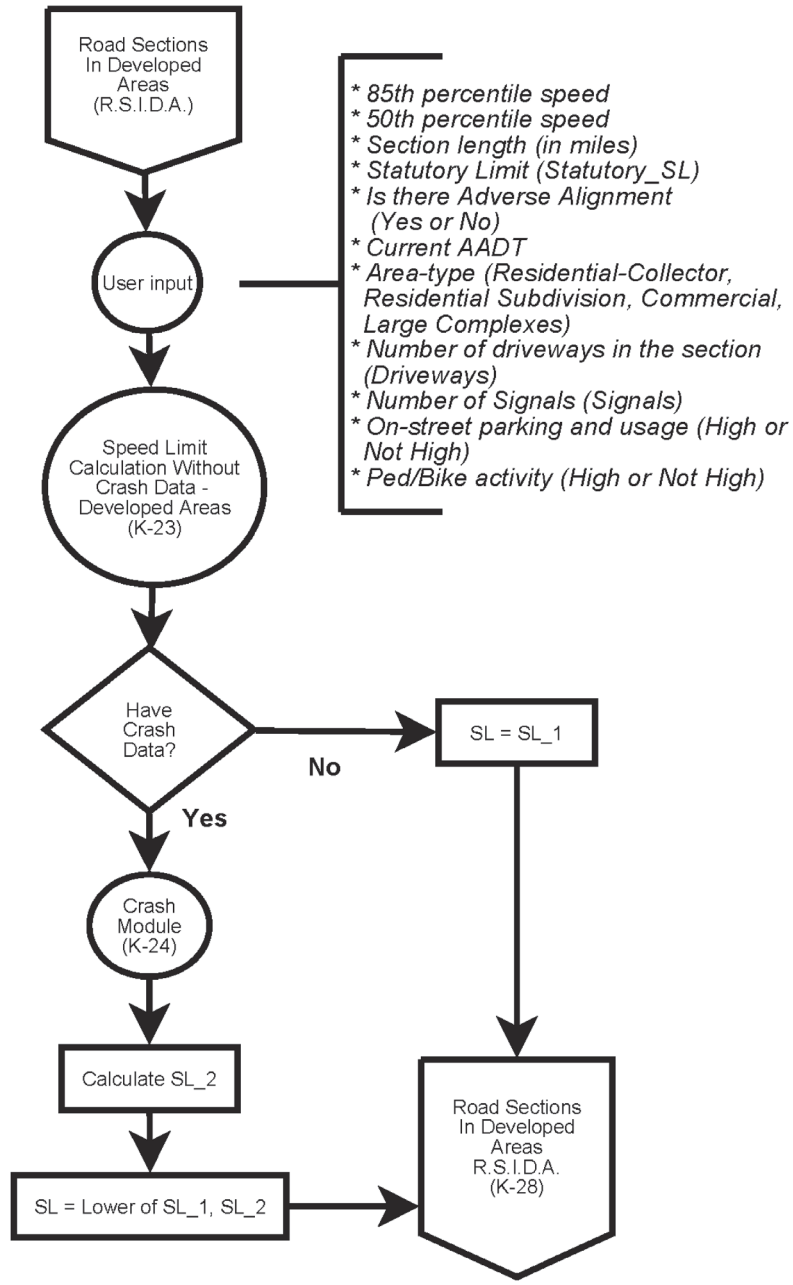
K-19


R.S.I.U.A.
Is SL > Statutory_SL?
No
Yes
The final recommended speed limit is higher than the statutory speed limit for this section.
Is there adverse alignment?
No
Yes
Sections with adverse alignments may need specific maximum safe speed warnings which may be different from the general speed limit for the section. This program does not provide maximum safe speed warnings for adverse alignments.
R.S.I.U.A. (K-21)

K-20

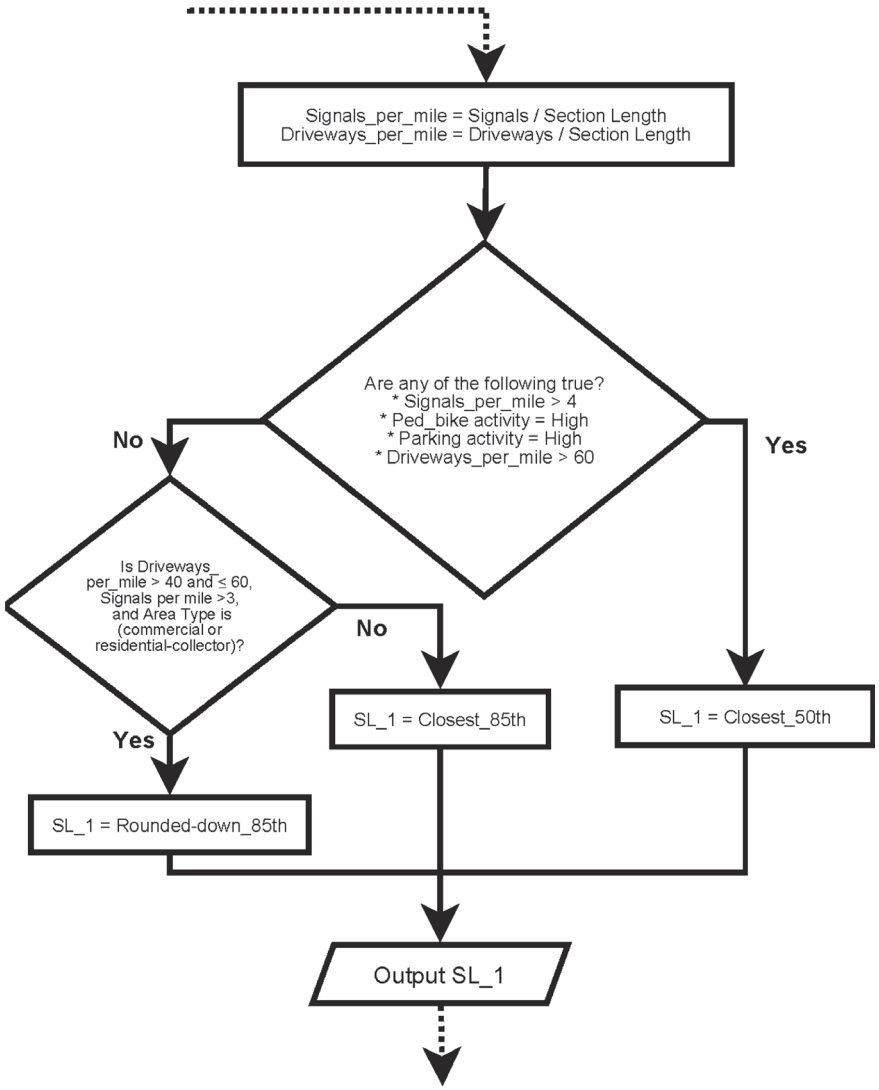

R.S.I.U.A.
Is Crash_level_1 High or Med?
No
Yes
The crash rate of the section is <crash_rate> per 100 MVMT. The average rate for similar sections is <Ca> per 100 MVMT, and the critical rate is <Cc> per 100 MVMT. The crash rate of this section is <crash_diff> % higher (or lower) than the average crash rate for similar sections. The rate of injury crashes for the section is <injury_rate> per 100 MVMT. The average rate for similar sections is <Ia> per 100 MVMT, and the critical rate is <Ic> per 100 MVMT. The rate of injury crashes for this section is <injury_diff>% higher (or lower) than the average rate for similar sections. A comprehensive crash study should be undertaken to identify engineering and traffic control deficiencies and appropriate corrective actions. The speed limit should only be reduced as a last measure after all other treatments have either been tried or ruled out.
Is 85th > 67 mph?
No
Yes
Based on the information gathered from experts in the U.S., this program does not recommend speed limits higher than 65 mph for non-limited access road sections in undeveloped areas.
Is Length < Minimum_ Section_Length?
No
Yes
A section of <Length> miles is too short for speed zoning on public streets and roads for the recommended speed limit. You may consider lengthening the speed zone (if that is possible) or using the speed limits from adjacent sections (if they are appropriate for this section). If the 85th percentile speeds and other data you provided are representative of conditions for this short section, then the speed limit noted above should be considered. If the data were taken in a road section with adverse horizontal and vertical alignment, in a construction zone, or in an area with unique geometric and/or traffic control features, then the above noted speed limit may not be appropriate because this expert system is not designed to recommend speed limits for sharp horizontal curves, within the limits of construction zones, or in other special traffic situations.
END

K-21

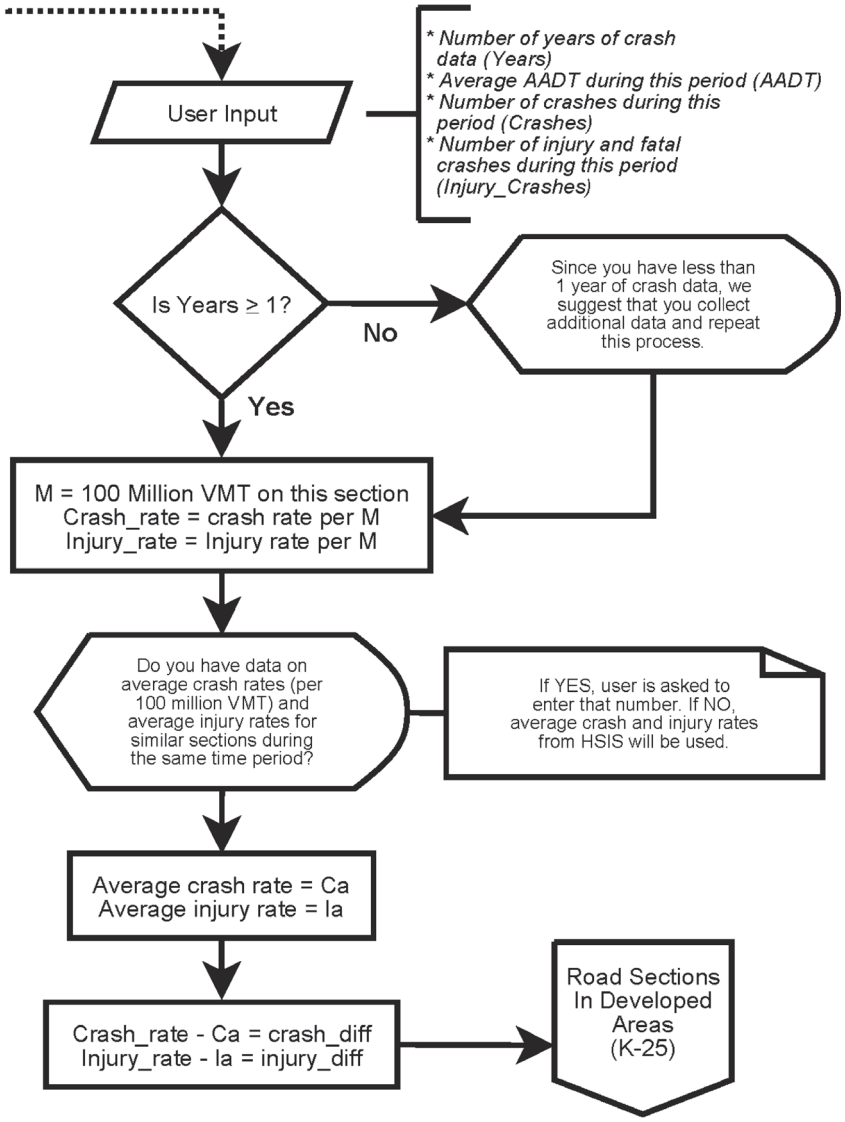

Road Sections In Developed Areas (R.S.I.D.A.)
User input
* 85th percentile speed
* 50th percentile speed
* Section length (in miles)
* Statutory Limit (Statutory_SL)
* Is there Adverse Alignment (Yes or No)
* Current AADT
* Area-type (Residential-Collector, Residential Subdivision, Commercial, Large Complexes)
* Number of driveways in the section (Driveways)
* Number of Signals (Signals)
* On-street parking and usage (High or Not High)
* Ped/Bike activity (High or Not High)
Speed Limit Calculation Without Crash Data - Developed Areas (K-23)
Have Crash Data?
No
SL = SL_1
Yes
Crash Module (K-24)
Calculate SL_2
SL = Lower of SL_1, SL_2
Road Sections In Developed Areas R.S.I.D.A. (K-28)

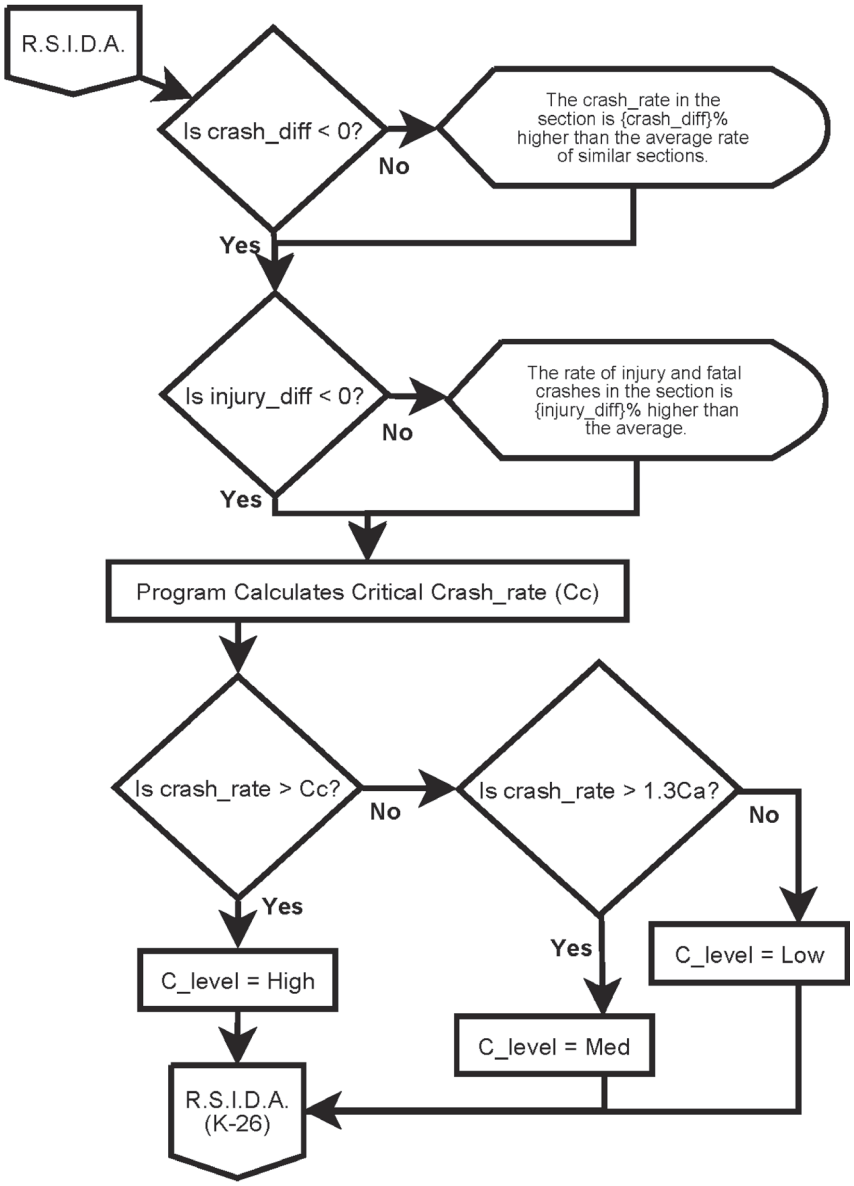
K-22

Speed Limit Calculation Without Crash Data (to calculate SL_1) (Road Sections In Developed Areas)

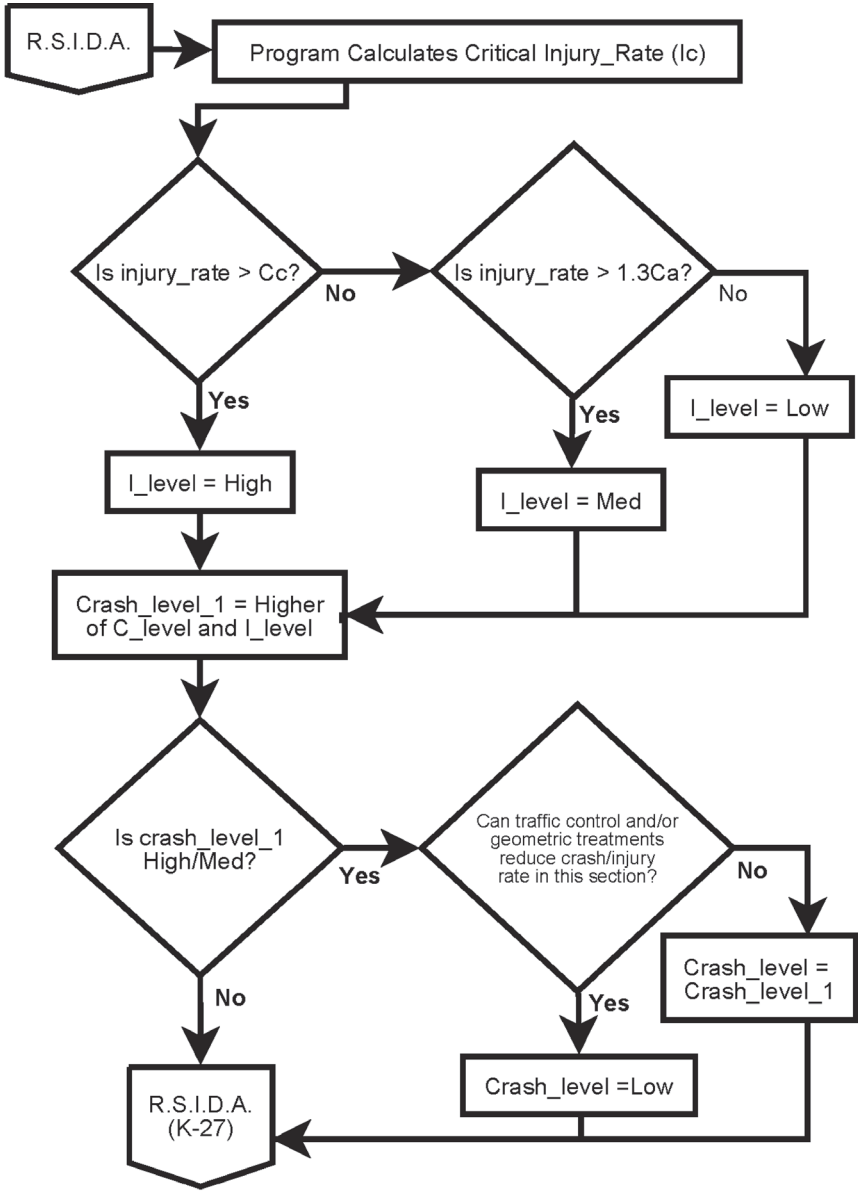


Crash Module for Road Sections in Developed Areas (to calculate SL_2)

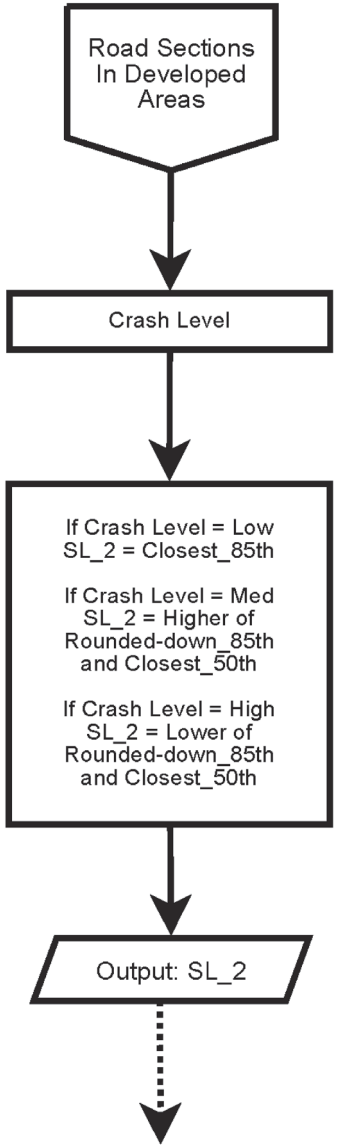



R.S.I.D.A.
Is crash_diff < 0?
No
The crash_rate in the section is {crash_diff}% higher than the average rate of similar sections.
Yes
Is injury_diff < 0?
No
The rate of injury and fatal crashes in the section is {injury_diff}% higher than the average.
Yes
Program Calculates Critical Crash_rate (Cc)
Is crash_rate > Cc?
No
Is crash_rate > 1.3Ca?
No
Yes
C_level = High
Yes
C_level = Low
C_level = Med
R.S.I.D.A. (K-26)

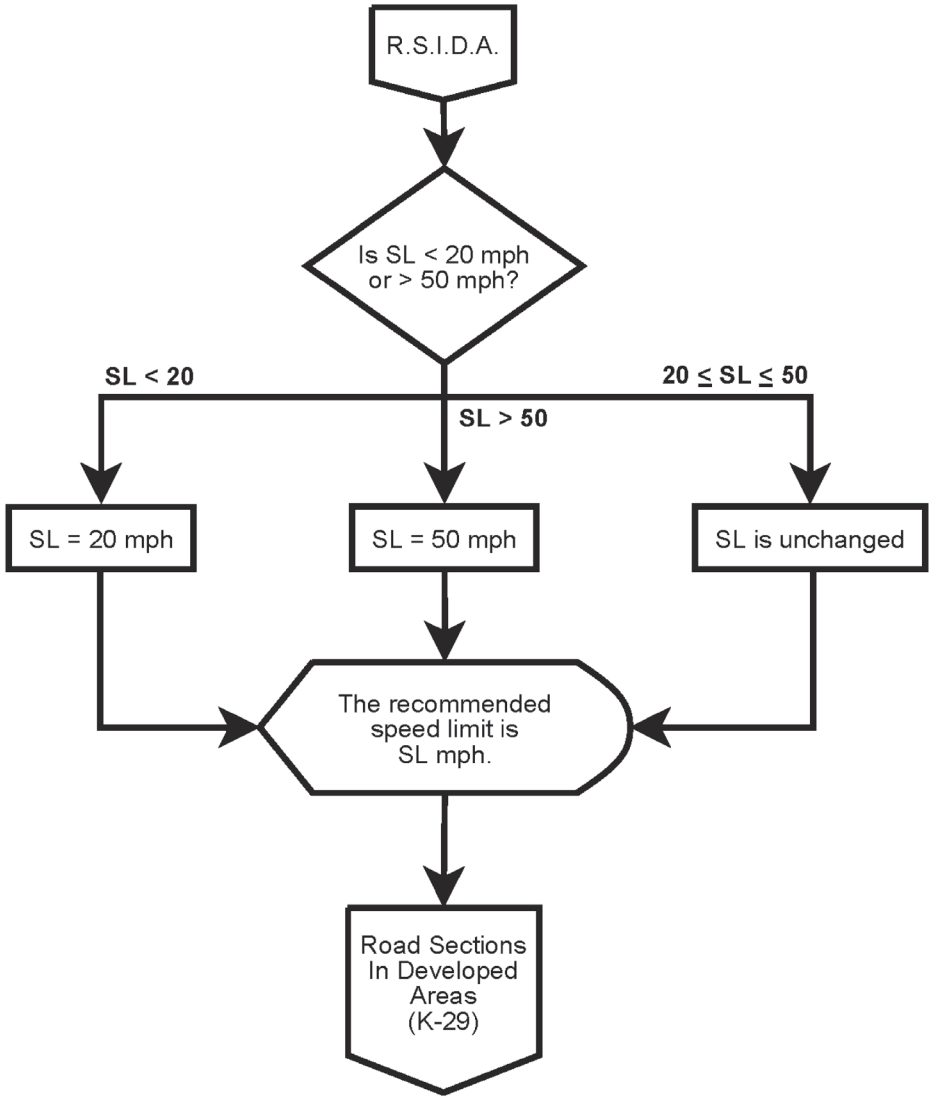
K-25


R.S.I.D.A.
Program Calculates Critical Injury_Rate (Ic)
Is injury_rate > Cc?
No
Is injury_rate > 1.3Ca?
No
Yes
I_level = Low
Yes
I_level = High
I_level = Med
Crash_level_1 = Higher of C_level and I_level
Is crash_level_1 High/Med?
Yes
Can traffic control and/or geometric treatments reduce crash/injury rate in this section?
No
Crash_level = Crash_level_1
No
Yes
Crash_level =Low
R.S.I.D.A. (K-27)

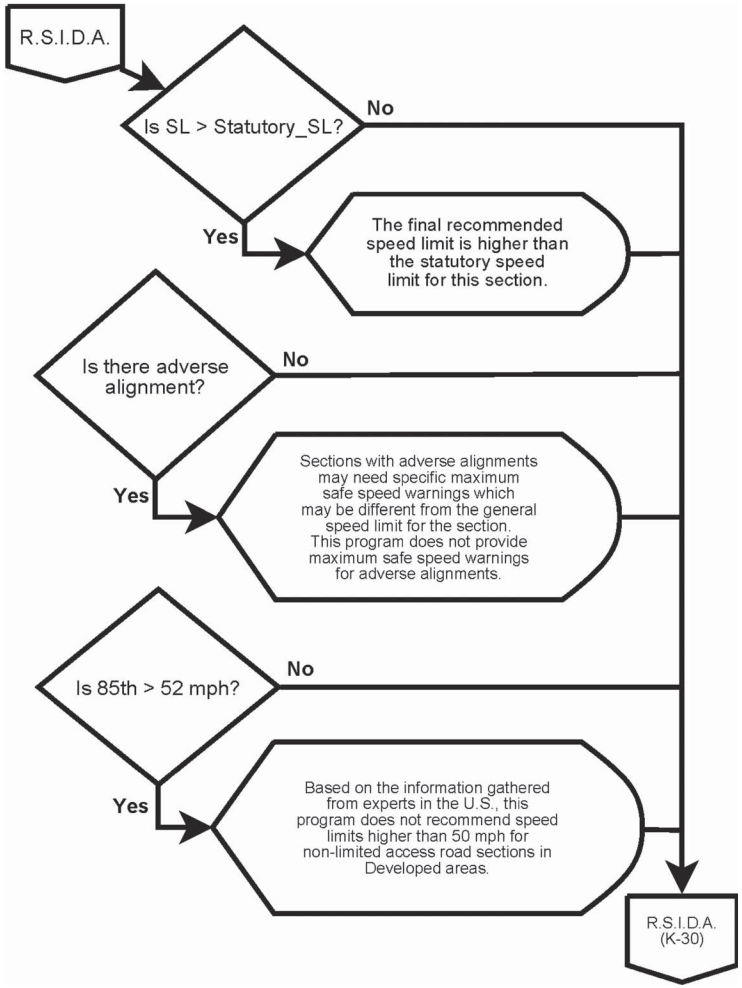
K-26


Road Sections In Developed Areas
Crash Level
If Crash Level = Low
SL_2 = Closest_85th
If Crash Level = Med
SL_2 = Higher of Rounded-down_85th and Closest_50th
If Crash Level = High
SL_2 = Lower of Rounded-down_85th and Closest_50th
Output: SL_2

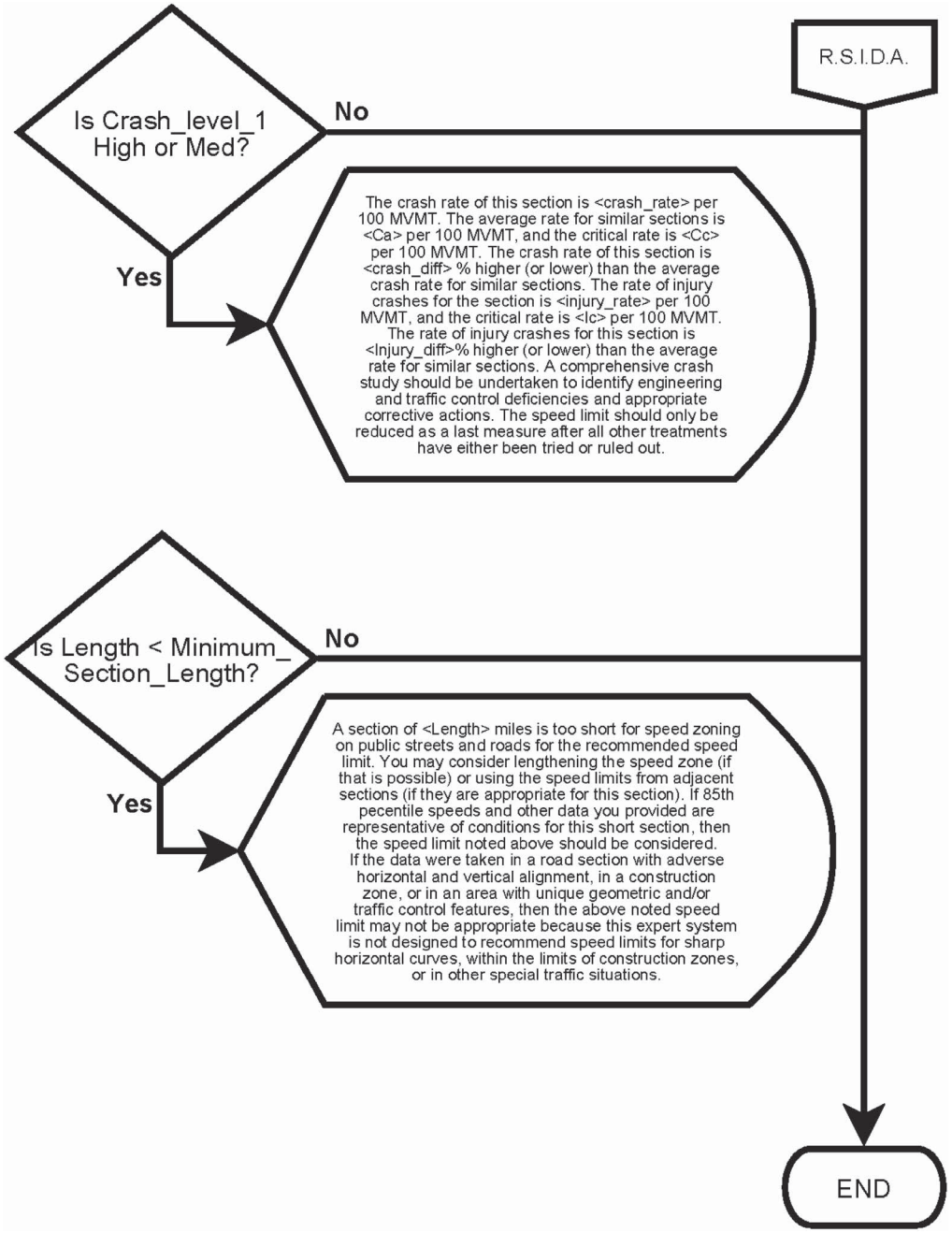
K-27


R.S.I.D.A.
Is SL < 20 mph or > 50 mph?
SL < 20
SL > 50
20 ≤ SL ≤ 50
SL = 20 mph
SL = 50 mph
SL is unchanged
The recommended speed limit is SL mph.
Road Sections In Developed Areas (K-29)

K-28


R.S.I.D.A.
Is SL > Statutory_SL?
No
Yes
The final recommended speed limit is higher than the statutory speed limit for this section.
Is there adverse alignment?
No
Yes
Sections with adverse alignments may need specific maximum safe speed warnings which may be different from the general speed limit for the section. This program does not provide maximum safe speed warnings for adverse alignments.
Is 85th > 52 mph?
No
Yes
Based on the information gathered from experts in the U.S., this program does not recommend speed limits higher than 50 mph for non-limited access road sections in Developed areas.
R.S.I.D.A. (K-30)

K-29


R.S.I.D.A.
Is Crash_level_1 High or Med?
No
Yes
The crash rate of this section is <crash_rate> per 100 MVMT. The average rate for similar sections is <Ca> per 100 MVMT, and the critical rate is <Cc> per 100 MVMT. The crash rate of this section is <crash_diff> % higher (or lower) than the average crash rate for similar sections. The rate of injury crashes for the section is <injury_rate> per 100 MVMT, and the critical rate is <Ic> per 100 MVMT. The rate of injury crashes for this section is <Injury_diff>% higher (or lower) than the average rate for similar sections. A comprehensive crash study should be undertaken to identify engineering and traffic control deficiencies and appropriate corrective actions. The speed limit should only be reduced as a last measure after all other treatments have either been tried or ruled out.
Is Length < Minimum_ Section_Length?
No
Yes
A section of <Length> miles is too short for speed zoning on public streets and roads for the recommended speed limit. You may consider lengthening the speed zone (if that is possible) or using the speed limits from adjacent sections (if they are appropriate for this section). If 85th pecentile speeds and other data you provided are representative of conditions for this short section, then the speed limit noted above should be considered. If the data were taken in a road section with adverse horizontal and vertical alignment, in a construction zone, or in an area with unique geometric and/or traffic control features, then the above noted speed limit may not be appropriate because this expert system is not designed to recommend speed limits for sharp horizontal curves, within the limits of construction zones, or in other special traffic situations.
END

K-30

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