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**Date:** November 14, 2017

**To:** Region Directors  
Attn: Regional System Planning and Operations Sections

**From:** Brian Porter, PE, PTOE  
State Traffic Safety Engineer

**Subject:** 2016 Statewide Average Crash Rates

## **Statewide Average Crash Rates and Upper Control Limits**

**Table 1** shows the Wisconsin statewide average crash rates for the five year period from January 1, 2012 to December 31, 2016. Crashes involving deer have been removed.

**Table 1** includes the statewide average crash rates for the State Trunk Highway network broken out by Meta-Manager Peer Group. The Meta-Manager Peer Groups are intended to represent a group of roadway segments throughout the state with similar characteristics (i.e. number of lanes, amount of access, presence of median, etc.). These are often referred to as reference populations. Each year, the peer groups are created based on the characteristics that define each group. Other minor modifications are made to the Peer Groups so these crash rates should not be compared to previous statewide average crash rates.

**Table 1: 2016 Statewide Average Crash Rates, KAB Crash Rates, and UCLs for State Highways**

Meta-Manager Peer Group		Total Crash Rate (crashes per HMVMT)		KAB Crash Rate (crashes per HMVMT)	
		Average	UCL	Average	UCL
110	6-lane Freeways with AADT ≤ 90,300 vpd	60.13	$= 60.13 + 523.42 \sqrt{\frac{60.13}{AADT * L * Y}}$	6.67	$= 6.67 + 523.42 \sqrt{\frac{6.67}{AADT * L * Y}}$
120	6-lane Freeways with AADT > 90,300 vpd	101.95	$= 101.95 + 523.42 \sqrt{\frac{101.95}{AADT * L * Y}}$	7.76	$= 7.76 + 523.42 \sqrt{\frac{7.76}{AADT * L * Y}}$
130	4-lane Freeways	45.29	$= 45.29 + 523.42 \sqrt{\frac{45.29}{AADT * L * Y}}$	6.40	$= 6.40 + 523.42 \sqrt{\frac{6.40}{AADT * L * Y}}$
210	65 mph Expressways*	47.62	$= 47.62 + 523.42 \sqrt{\frac{47.62}{AADT * L * Y}}$	8.65	$= 8.65 + 523.42 \sqrt{\frac{8.65}{AADT * L * Y}}$
220	55 mph Expressways*	79.81	$= 79.81 + 523.42 \sqrt{\frac{79.81}{AADT * L * Y}}$	12.55	$= 12.55 + 523.42 \sqrt{\frac{12.55}{AADT * L * Y}}$
310	Multilane Divided Highways Posted at 45 mph or higher	187.67	$= 187.67 + 523.42 \sqrt{\frac{187.67}{AADT * L * Y}}$	21.57	$= 21.57 + 523.42 \sqrt{\frac{21.57}{AADT * L * Y}}$
320	Multilane Divided Highways Posted at 40 mph or lower	400.87	$= 400.87 + 523.42 \sqrt{\frac{400.87}{AADT * L * Y}}$	48.24	$= 48.24 + 523.42 \sqrt{\frac{48.24}{AADT * L * Y}}$
330	Multilane Undivided and One-Way Highways	434.66	$= 434.66 + 523.42 \sqrt{\frac{434.66}{AADT * L * Y}}$	52.69	$= 52.69 + 523.42 \sqrt{\frac{52.69}{AADT * L * Y}}$
410	Rural 2-lane Highways with AADT ≤ 2,000	100.65	$= 100.65 + 523.42 \sqrt{\frac{100.65}{AADT * L * Y}}$	24.42	$= 24.42 + 523.42 \sqrt{\frac{24.42}{AADT * L * Y}}$
420	Rural 2-lane Highways with 2,000 < AADT < 7,000	75.77	$= 75.77 + 523.42 \sqrt{\frac{75.77}{AADT * L * Y}}$	17.53	$= 17.53 + 523.42 \sqrt{\frac{17.53}{AADT * L * Y}}$
430	Rural 2-lane Highways with AADT ≥ 7,000	90.57	$= 90.57 + 523.42 \sqrt{\frac{90.57}{AADT * L * Y}}$	18.36	$= 18.36 + 523.42 \sqrt{\frac{18.36}{AADT * L * Y}}$
440	2-Lane Highways Posted at 40 mph or lower	292.29	$= 292.29 + 523.42 \sqrt{\frac{292.29}{AADT * L * Y}}$	34.46	$= 34.46 + 523.42 \sqrt{\frac{34.46}{AADT * L * Y}}$

**AADT = Average Annual Daily Traffic (vehicles per day)   L = Segment Length (miles)   Y = Years**  
**HMVMT = 100 million vehicle miles traveled**

\* "Expressway" means a state trunk highway that, as determined by the department, has 4 or more lanes of traffic physically separated by a median or barrier and that gives preference to through traffic by utilizing interchanges or limiting at-grade access to selected public roads and public driveways. WI State Statutes: 346.57 (1)(ag)

Previous statewide average crash rate summaries can be found here:

<http://wisconsindot.gov/Pages/doing-bus/local-gov/traffic-ops/manuals-and-standards/manuals.aspx>

# Calculating Statewide Average Crash Rates and Upper Control Limits

To assist with screening for potential safety issues, WisDOT provides statewide average crash rates and UCLs for 12 different categories of state roadways and 2 categories of non-state roadways. The following instructions are provided so segment crash rates are calculated and compared using consistent methodologies. In addition, information is provided to assist users in taking the appropriate actions based on the results of the comparisons.

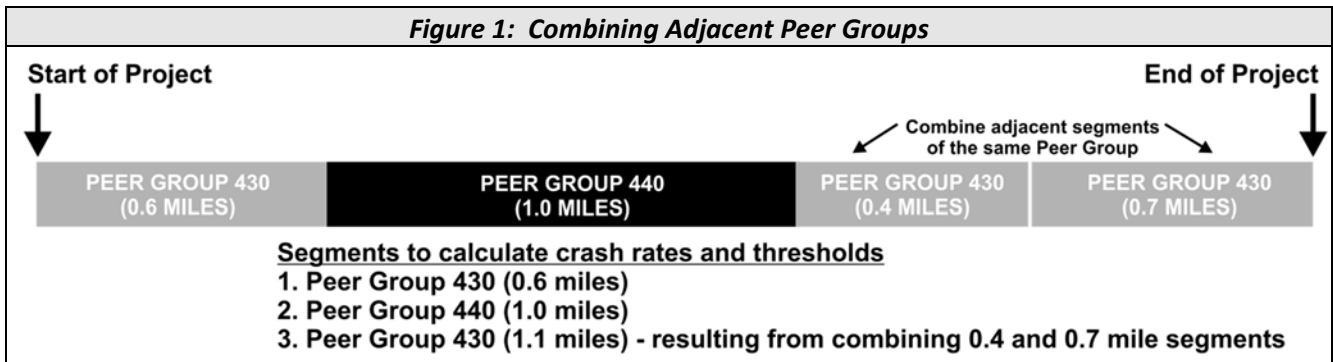
There are six steps involved with calculating and comparing segment crash rates and UCLs:

- Step 1: Identify Segments
- Step 2: Determine Total Number of Crashes and KAB Crashes
- Step 3: Determine AADT
- Step 4: Calculate Crash Rates and KAB Crash Rates
- Step 5: Calculate Rate UCLs and KAB Crash Rate UCLs
- Step 6: Compare Crash Rates and KAB Crash Rates to UCLs and Choose Action

Detailed instructions for each of the six steps are provided below:

**Step 1:** Identify the roadway segments on your project. If multiple Peer Groups exist on your project, crash rates and UCLs should be calculated for each Peer Group by combining adjacent segments of the same Peer Group per the example in **Figure 1**.

- ⇒ Segments 0.1 miles or less should be excluded from crash rate comparisons unless combined with other segments.
- ⇒ Segments should not exceed 5 miles in length. If necessary, break a long segment into segments less than 5 miles.

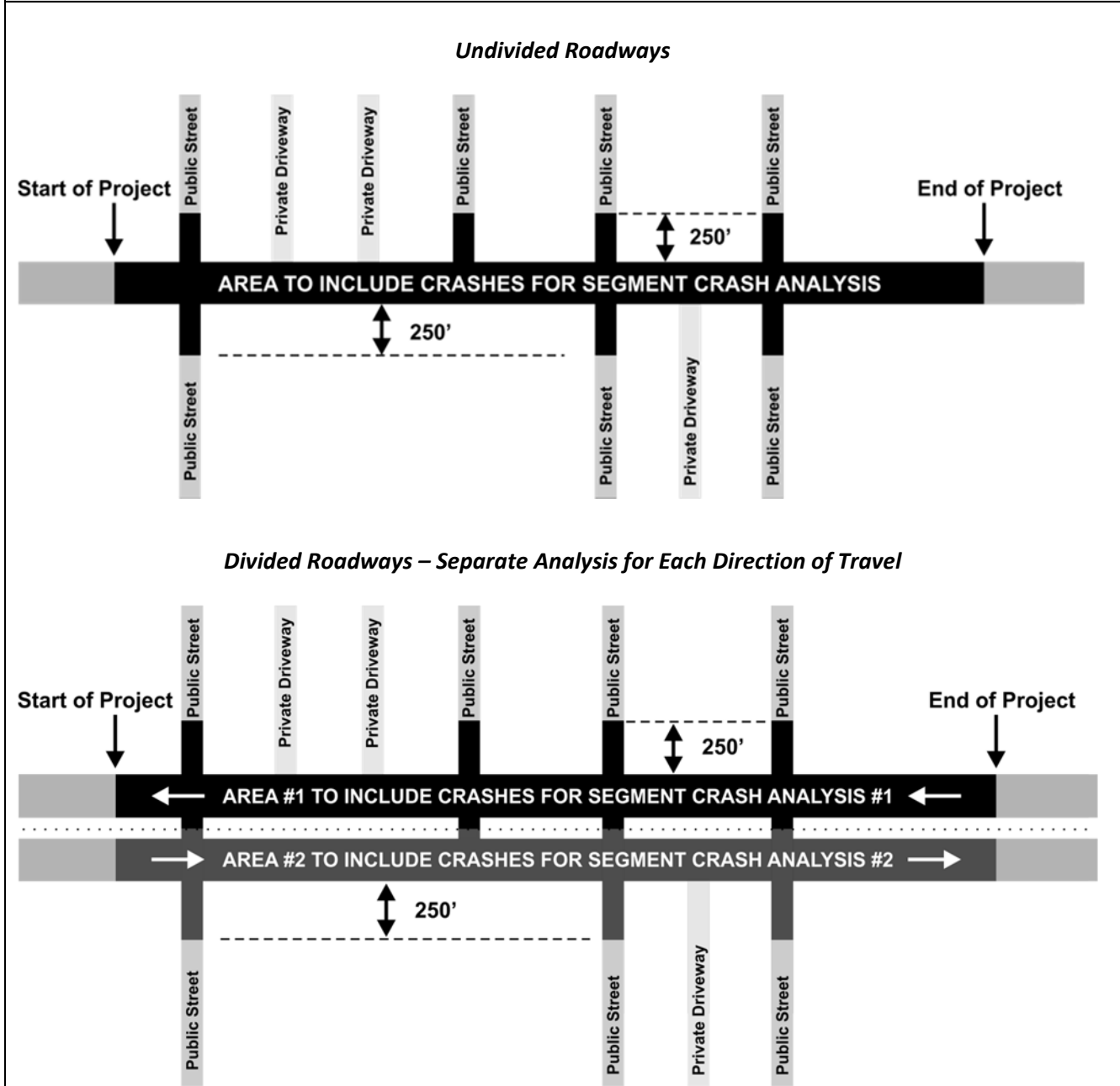


**Step 2:** Determine the total number of crashes for each segment on your project and the sum of KAB crashes (K-Level, A-Level, and B-Level). Severity definitions are provided on page 6.

The total number of crashes should include all reportable non-deer related crashes occurring on the roadway, including crashes on intersecting public streets within a distance of 250 feet from the roadway (see **Figure 2** for an illustration of the areas where crashes should be included). Crashes occurring on private driveways should not be included in crash rate calculations.

**IMPORTANT:** Divided roadways (i.e., Peer Groups 110, 120, 130, 210, 220, 310, and 320) should have each direction of travel analyzed separately to be consistent with the methods used to calculate the statewide average crash rates. AADT volumes should be determined for each direction of travel on divided roadways.

**Figure 2: Crashes to Include in Segment Crash Rates**



**Severity Definitions**

Crashes are broken out based on the KABCO injury severity scale according to the following definitions:

**Fatal (K)** = Any injury from a traffic crash which results in death within 30 days of the crash.

**A-level** = Incapacitating Injury - Any injury other than a fatal injury, which prevents the injured person from walking, driving, or from performing other activities, which he/she performed before the crash. Starting in 2017, the definition of A-level crashes changed. This does not affect the crashes used to calculate the 2016 crash rates. Additional information will be provided with the 2017 statewide average crash rates.

**B-level** = Non-incapacitating Injury - Any injury, other than fatal or incapacitating, which is evident at the scene. Evidence of injury may include known symptoms of an injury, which are not directly observable.

**C-level** = Possible Injury - Any injury which is not observable or evident at the scene but is claimed by the individual or suspected by the law enforcement officer.

**PDO** = Property Damage Only - The definition of a reportable crash is based on reporting thresholds of \$1000 for property damage to any one person's property, \$1000 for government-owned vehicles, or \$200 for any other government-owned property, such as traffic control devices or guardrail. Any crash that meets these criteria is categorized as Property Damage Only (PDO).

**Step 3:** Identify or calculate the AADT for each segment on your project (see Step 1 for instructions about combining adjacent segments with the same Peer Group). If multiple AADTs exist within the same Peer Group, use **Equation 1** to calculate a pro-rated AADT. AADT volumes should be determined for each direction of travel on divided roadways.

**Equation 1: Pro-Rated AADT**

Pro-rate AADTs when combining adjacent segments of the **same Peer Group** that have varying AADTs.

The diagram illustrates three adjacent segments of a roadway. Above the segments, horizontal double-headed arrows indicate their lengths: L<sub>1</sub> for the first segment, L<sub>2</sub> for the second, and L<sub>i</sub> for the third. Below the segments, a horizontal bar is divided into three sections, each labeled 'PEER GROUP 430'. Underneath each section, the corresponding AADT value is listed: AADT<sub>1</sub> for the first segment, AADT<sub>2</sub> for the second, and AADT<sub>i</sub> for the third.

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$$AADT_{PR} = \frac{L_1 * AADT_1 + L_2 * AADT_2 + L_i * AADT_i}{L_1 + L_2 + L_i} = \text{Pro-Rated Annual Average Daily Traffic}$$

$L_1$  = Length of Segment #1 (miles)  
 $AADT_1$  = Annual Average Daily Traffic of Segment #1  
 $L_2$  = Length of Segment #2 (miles)  
 $AADT_2$  = Annual Average Daily Traffic of Segment #2  
 $L_i$  = Length of Segment #i (miles)  
 $AADT_i$  = Annual Average Daily Traffic of Segment #i

Notes:

1. If multiple AADTs are provided for a particular segment (e.g., Year 2012  $AADT_1 = 5,000$  and Year 2015  $AADT_1 = 6,500$ ), use engineering judgment to calculate an AADT that best represents the five year average.
2. Engineering judgment should be used when determining where AADT counts begin and end. Roadway characteristics that affect traffic volumes are typically good places to define AADT limits. For example, major intersections, driveways to traffic generating businesses, and transitions in surrounding land uses (e.g., urban to rural) are commonly used as start/stop points for AADTs.

**Step 4:** Calculate segment crash rates (see **Equation 2**) and KAB Crash Rates (see **Equation 3**) for each segment on your project (see Step 1 for instructions about combining adjacent segments with the same Peer Group).

**Equation 2: Segment Crash Rate**

$$\text{Segment Crash Rate} = \frac{C * 100,000,000}{AADT * L * Y * 365} = \text{Crashes per 100 million vehicle miles traveled (HMVMT)}$$

- C = Number of crashes in five year period (years 2012-2016)
- AADT = Annual Average Daily Traffic (if AADT varies along the roadway, see **Equation 1**)
- L = Length of segment (miles)
- Y = Number of years analyzed (5)

**Equation 3: KAB Crash Rate**

$$\text{KAB Crash Rate} = \frac{C_{KAB} * 100,000,000}{AADT * L * Y * 365} = \text{KAB Crashes per HMVMT}$$

- C<sub>KAB</sub> = Sum of K-level, A-level, and B-level crashes in five year period (years 2012-2016)
- AADT = Annual Average Daily Traffic (if AADT varies along the roadway, see **Equation 1**)
- L = Length of segment (miles)
- Y = Number of years analyzed (5)

**Step 5:** Calculate crash rate and KAB Crash Rate UCLs for each segment on your project per the formulas provided in **Table 1**. Example calculations are provided below:

*Example UCL Calculations*

Rural Two-Lane Highway

AADT = 4,500

Length = 2.0 Miles

Crash Rate = 70 crashes per 100 MVM

KAB Crash Rate = 50 KAB crashes per 100 MVM

Classification: Peer Group (420) Rural 2-lane Highway with 2,000 < AADT ≤ 7,000

*Example UCL Calculations for Peer Group (420) – See Table 1 to find equations for UCLs*

$$\text{Crash Rate UCL} = 75.77 + 523.42 \sqrt{\frac{75.77}{\text{AADT} * L * Y}}$$

$$\text{Crash Rate UCL} = 75.77 + 523.42 \sqrt{\frac{75.77}{4,500 * 2.0 * 5}} = 97.25 \text{ Crashes per 100 MVM}$$

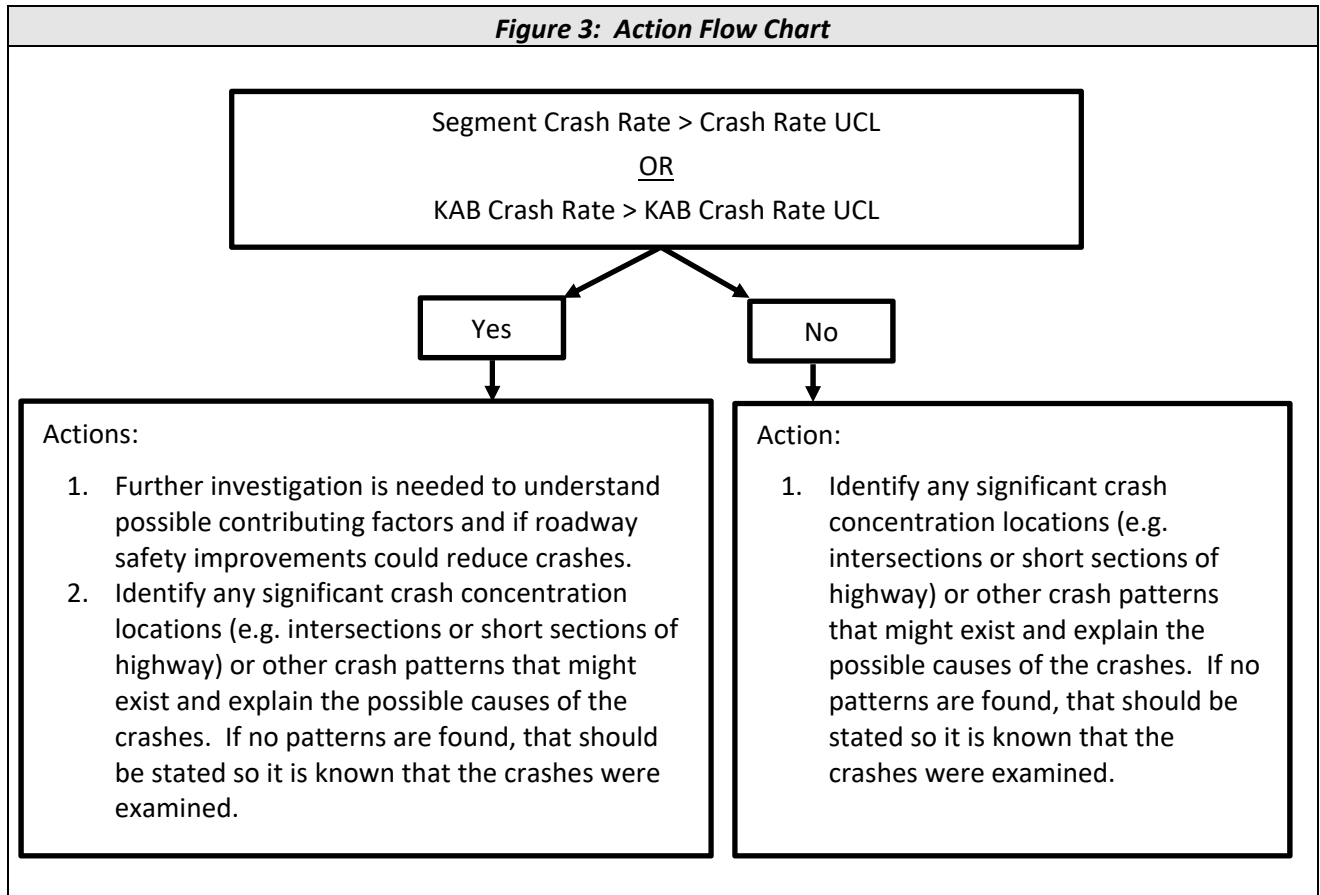
$$\text{KAB Rate UCL} = 17.53 + 523.42 \sqrt{\frac{17.53}{\text{AADT} * L * Y}}$$

$$\text{KAB Rate UCL} = 17.53 + 523.42 \sqrt{\frac{17.53}{4,500 * 2.0 * 5}} = 27.86 \text{ KAB Crashes per 100 MVM}$$

*Results:* The segment’s crash rate of 70 crashes per 100 MVM is less than the crash rate UCL of 97.25, but the segment’s KAB Crash Rate of 50 crashes per 100 MVM is higher than the KAB Crash Rate UCL of 27.86. See Step 6 for how to interpret these results and what actions are suggested.



**Step 6:** Compare your segment's crash rate and KAB Crash Rates to the calculated UCLs. Use the flowchart in **Figure 3** to determine what action should be taken.



## Local Road Crash Rates

**Table 2** includes statewide average crash rates for local roads which are broken into Urban Street and Rural County Trunk Highways. The Urban Street category includes urban city streets, rural city streets and urban county trunk highways.

The local road crash rates and KAB segment crash rates have been consolidated to a five year average for two peer groups. UCLs are provided to help identify where further analysis might be beneficial.

**Table 2: 2016 Statewide Average Crash Rates, KAB Crash Rates, and UCLs for Local Roads**

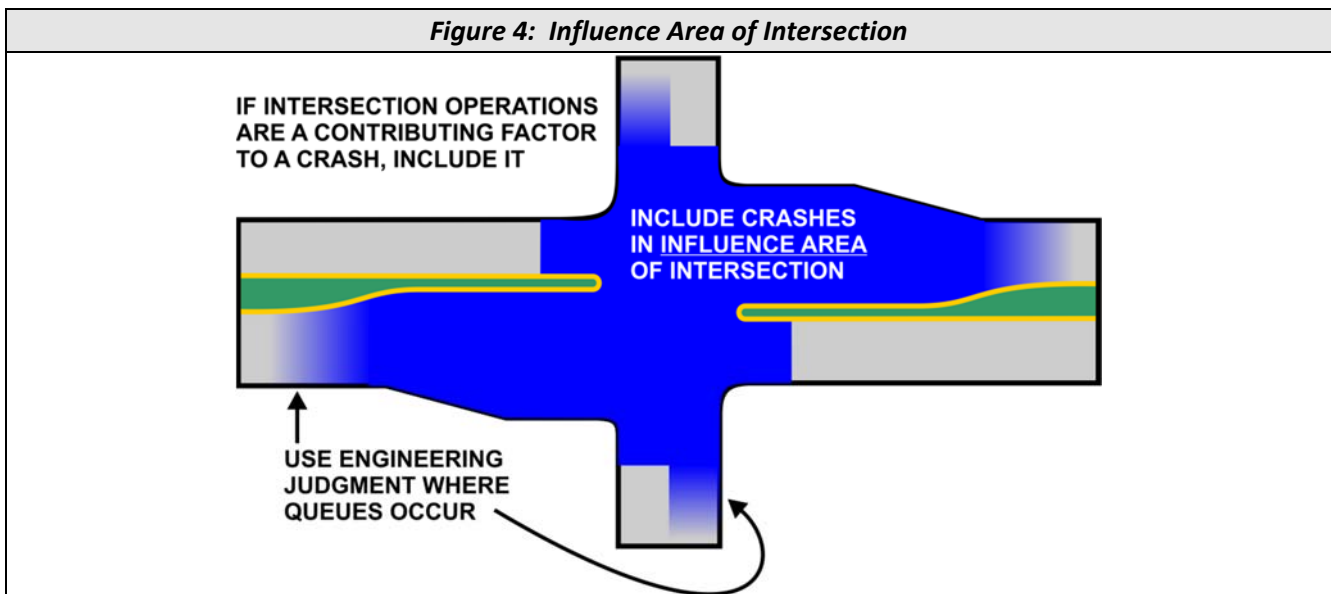
Local Road Group	Crash Rate (crashes per HMVMT)		KAB Crash Rate (crashes per HMVMT)	
	Average	UCL	Average	UCL
Urban Streets	356.54	$= 356.54 + 523.42 \sqrt{\frac{356.54}{AADT * L * Y}}$	39.76	$= 39.76 + 523.42 \sqrt{\frac{39.76}{AADT * L * Y}}$
Rural County Trunk Highways	99.22	$= 99.22 + 523.42 \sqrt{\frac{98.66}{AADT * L * Y}}$	22.32	$= 22.32 + 523.42 \sqrt{\frac{22.32}{AADT * L * Y}}$

**AADT = Average Annual Daily Traffic (vehicles per day)    L = Segment Length (miles)    Y = Years**  
**HMVMT = 100 million vehicle miles traveled**

## Intersection Crash Rates

WisDOT does not produce statewide intersection crash rates or utilize a specific threshold crash rate for screening potential intersection safety issues. WisDOT is in the process of developing statewide intersection crash data for use in intersection safety analyses. When this information is ready, it will be included in future publications of this document with guidance regarding its use.

If intersection crash rates are calculated, they should be calculated using the crashes that occurred in the past five years within the influence area of the intersection. See **Figure 4** for an illustration of the influence area of an intersection. If operational characteristics of the intersection (such as queueing) appear to be related to the cause of the crash, the crash should be included in the intersection crash rate analysis.



**Equation 4** shows the calculation for intersection crash rates.

**Equation 4: Intersection Crash Rate**

$$\text{Intersection Crash Rate} = \frac{C * 1,000,000}{AADT_{ent} * Y * 365} = \text{Crashes per 1 million entering vehicles (MEV)}$$

C = Number of crashes in the time period analyzed (preferably 5 years) within the influence area of the intersection

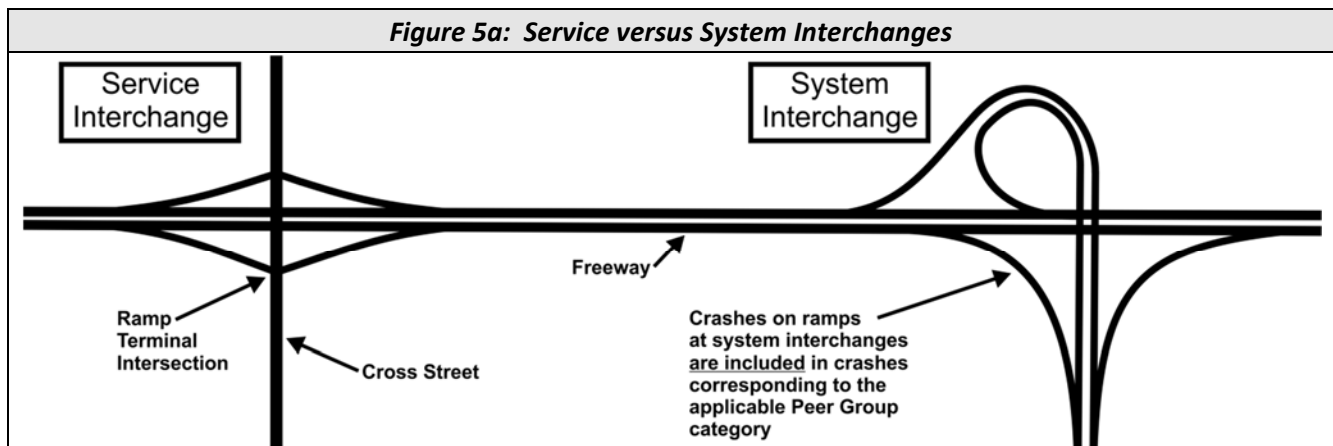
AADT<sub>ent</sub> = Annual Average Daily Traffic entering the intersection

Y = Number of years analyzed (preferably 5)

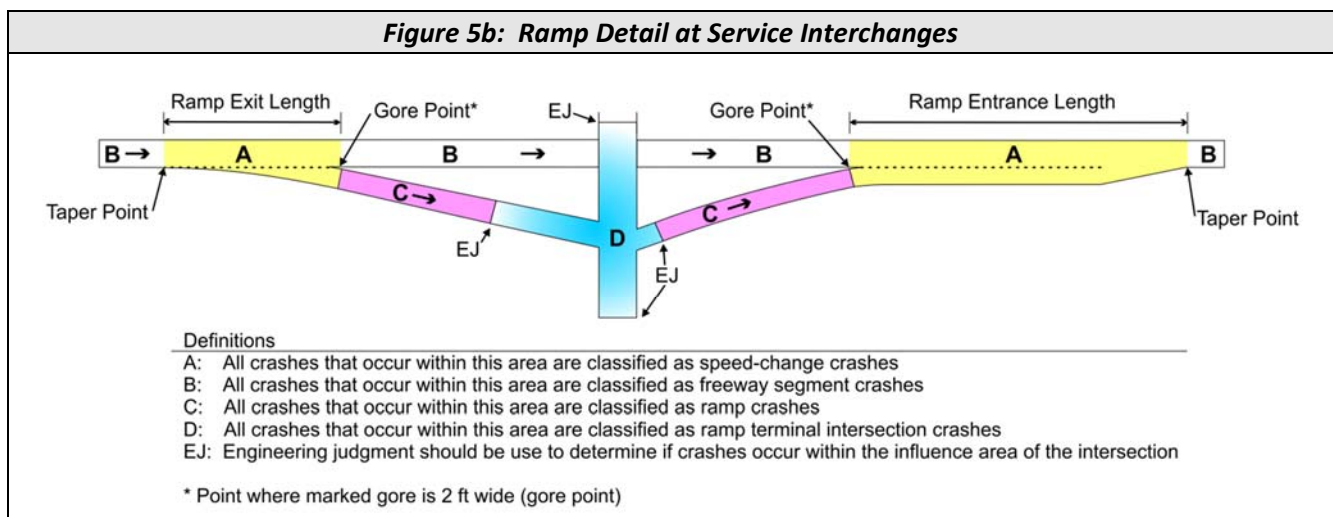
## Ramp Crash Rates

Crashes that occurred on ramps at service interchanges **are not** included in the crashes used to calculate the statewide average crash rates for roadways. WisDOT is in the process of developing statewide ramp crash information for use in comparisons. When this information is ready, it will be included in future publications of this document with guidance regarding its use.

Crashes that occurred on ramps at system interchanges (i.e., freeway to freeway) **are** included in the crashes used to calculate the corresponding freeway Peer Group average crash rates. Please see **Figure 5a** for an illustration of service versus system interchanges.



At service interchanges, the variability in ramp designs and interchange configurations present challenges for conducting consistent analysis. If crash analysis is conducted at a service interchange, it is suggested the analysis be conducted using the segmentation shown in **Figure 5b**.



The definitions shown in **Figure 5b** for speed-change areas and freeway segments are based on definitions in the Enhanced Interchange Safety Analysis Tool (ISETe): User Manual, published May 31<sup>st</sup>, 2012 through the National Cooperative Highway Research Program (NCHRP). **Figure 5b** also includes guidance about defining ramps and the influence area of intersections, which are definitions specific to WisDOT business practices.