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To: Region Systems Planning and Operations Sections

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Subject: 2018 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, 2014 to December 31, 2018. Crashes involving deer were removed from the dataset before completing the calculations.

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, type of access, presence of median, etc.). These are often referred to as reference populations. Each year, the peer groups are created by combining Meta-Manager roadway segments that have the characteristics which 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: 2014-2018 Statewide Average Crash Rates, KAB Crash Rates, and UCLs for State Highways

		Total Crash Rate (crashes per HMVMT)		KAB Crash Rate (crashes per HMVMT)	
Meta-Manager Peer Group		Average	UCL	Average	UCL
110	6-lane Freeways with AADT ≤ 90,300 vpd	70.28	$= 70.28 + 523.42\sqrt{\frac{70.28}{AADT * L * Y}}$	8.18	$= 8.18 + 523.42\sqrt{\frac{8.18}{AADT * L * Y}}$
120	6-lane Freeways with AADT > 90,300 vpd	106.47	$= 106.47 + 523.42\sqrt{\frac{106.47}{AADT * L * Y}}$	8.99	$= 8.99 + 523.42\sqrt{\frac{8.99}{AADT * L * Y}}$
130	4-lane Freeways	50.89	$= 50.89 + 523.42\sqrt{\frac{50.89}{AADT * L * Y}}$	7.06	$= 7.06 + 523.42\sqrt{\frac{7.06}{AADT * L * Y}}$
210	65 mph Expressways*	47.48	$= 47.48 + 523.42\sqrt{\frac{47.48}{AADT * L * Y}}$	9.31	$= 9.31 + 523.42\sqrt{\frac{9.31}{AADT * L * Y}}$
220	55 mph Expressways*	74.33	$= 74.33 + 523.42\sqrt{\frac{74.33}{AADT * L * Y}}$	12.75	$= 12.75 + 523.42\sqrt{\frac{12.75}{AADT * L * Y}}$
310	Multilane Divided Highways Posted at 45 mph or higher	206.87	$= 206.87 + 523.42\sqrt{\frac{206.87}{AADT * L * Y}}$	24.24	$= 24.24 + 523.42\sqrt{\frac{24.24}{AADT * L * Y}}$
320	Multilane Divided Highways Posted at 40 mph or lower	424.99	$= 424.99 + 523.42\sqrt{\frac{424.99}{AADT * L * Y}}$	52.22	$= 52.22 + 523.42\sqrt{\frac{52.22}{AADT * L * Y}}$
330	Multilane Undivided and One-Way Highways	464.01	$= 464.01 + 523.42\sqrt{\frac{464.01}{AADT * L * Y}}$	57.46	$= 57.46 + 523.42\sqrt{\frac{57.46}{AADT * L * Y}}$
410	Rural 2-lane Highways with AADT ≤ 2,000	101.39	$= 101.39 + 523.42\sqrt{\frac{101.39}{AADT * L * Y}}$	24.53	$= 24.53 + 523.42\sqrt{\frac{24.53}{AADT * L * Y}}$
420	Rural 2-lane Highways with 2,000 < AADT < 7,000	79.25	$= 79.25 + 523.42\sqrt{\frac{79.25}{AADT * L * Y}}$	18.51	$= 18.51 + 523.42\sqrt{\frac{18.51}{AADT * L * Y}}$
430	Rural 2-lane Highways with AADT ≥ 7,000	96.34	$= 96.34 + 523.42\sqrt{\frac{96.34}{AADT * L * Y}}$	20.04	$= 20.04 + 523.42\sqrt{\frac{20.04}{AADT * L * Y}}$
440	2-Lane Highways Posted at 40 mph or lower	298.56	$= 298.56 + 523.42\sqrt{\frac{298.56}{AADT * L * Y}}$	35.64	$= 35.64 + 523.42\sqrt{\frac{35.64}{AADT * L * Y}}$

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 Crate Rate UCLs and KAB Crash Rate UCLs
Step 6: Compare Crash Rates and KAB Crash Rates to UCLs and Choose Action

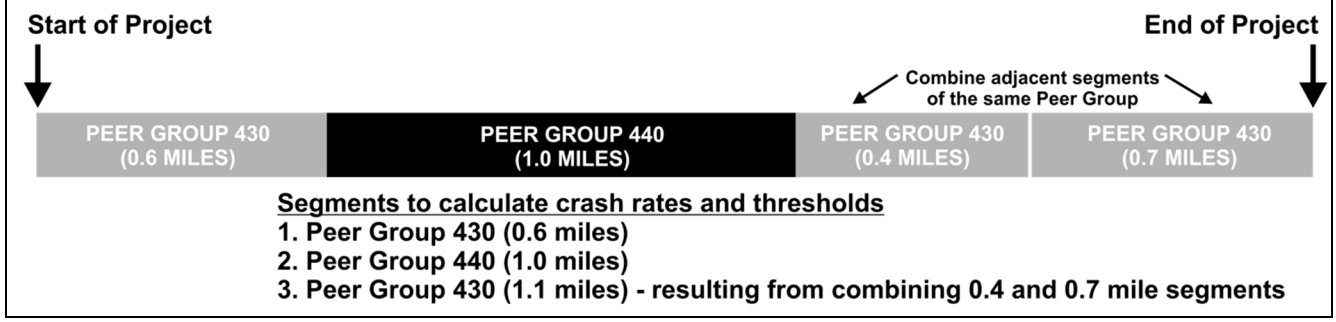
Detailed instructions for each of the six steps are provided below:

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.

Figure 1: Combining Adjacent Peer Groups



Segments to calculate crash rates and thresholds
1. Peer Group 430 (0.6 miles)
2. Peer Group 440 (1.0 miles)
3. Peer Group 430 (1.1 miles) - resulting from combining 0.4 and 0.7 mile segments

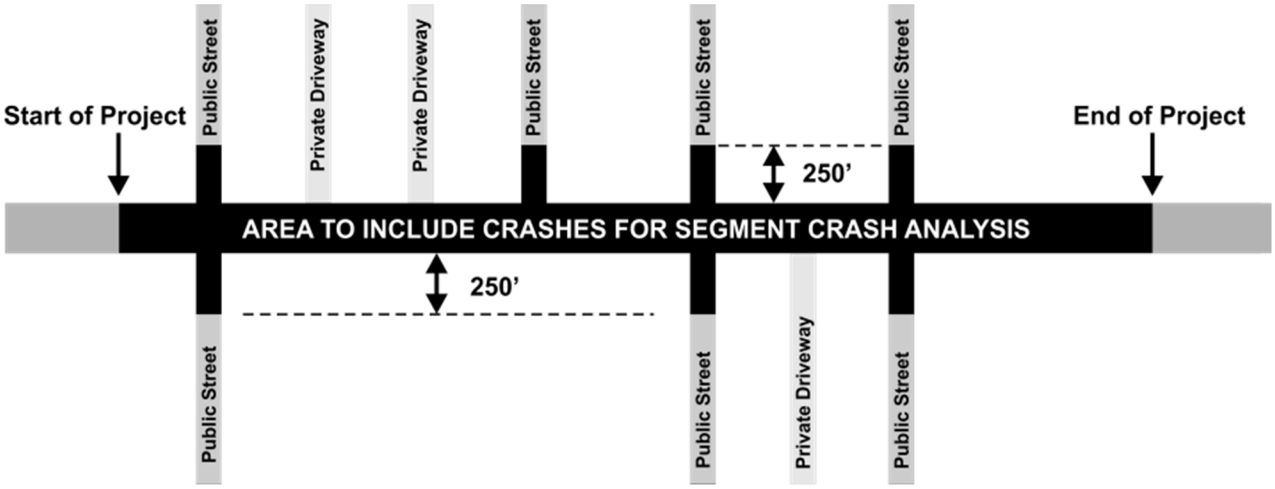
Step 2: Determine the total number of crashes for each segment on your project and the sum of KAB crashes (K-Level, A-Level, and B-Level). Severity definitions are provided on page 6.

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.

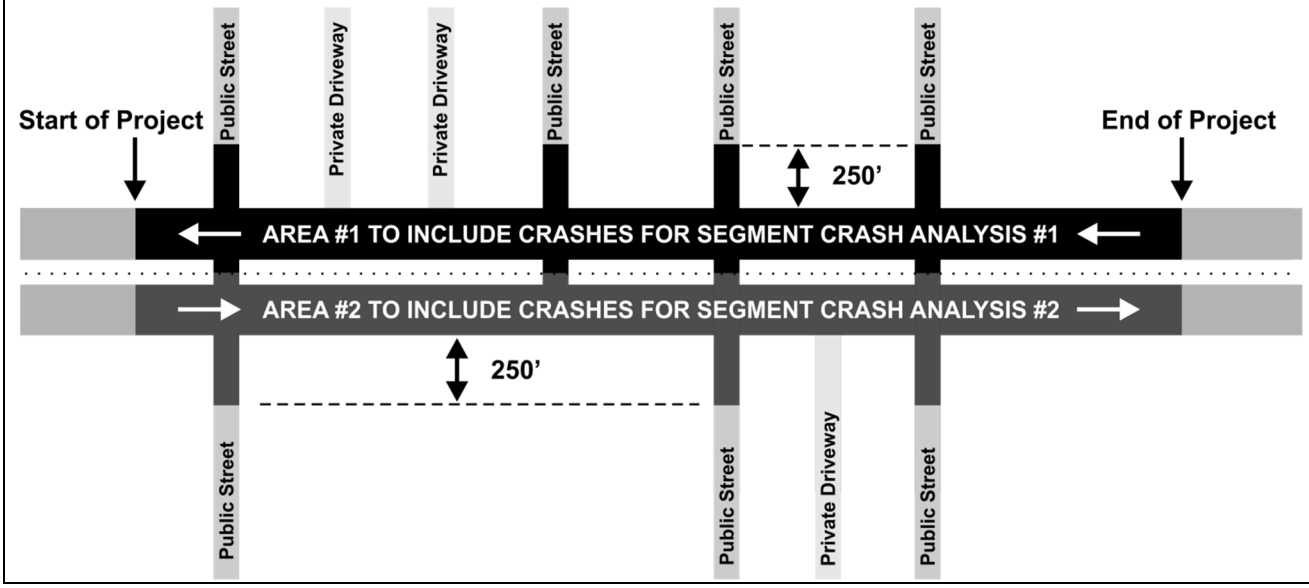
IMPORTANT: Divided roadways (i.e., Peer Groups 110, 120, 130, 210, 220, 310, and 320) should have each direction of travel analyzed separately to be consistent with the methods used to calculate the statewide average crash rates. AADT volumes should be determined for each direction of travel on divided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

Figure 2: Crashes to Include in Segment Crash Rates

Undivided Roadways



Divided Roadways – Separate Analysis for Each Direction of Travel



Crash Severity

The severity of a crash is based on the most severe injury to any person involved in the crash. Crash severity is 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 = Suspected Serious Injury – Any injury other than fatal which results in one or more of the following:

- Severe laceration resulting in exposure of underlying tissues/muscle/organs or resulting in significant loss of blood, broken or distorted extremity (arm or leg), crush injuries, suspected skull, chest or abdominal injury other than bruises or minor lacerations, significant burns (second and third degree burns over 10% or more of body), unconsciousness when taken from the crash scene, or paralysis.

B-level = Suspected Minor Injury – Any injury that is evident at the scene of the crash other than fatal or serious injuries.

- Examples include lump on the head, abrasions, bruises, minor lacerations (cuts on the skin surface with minimal bleeding and no exposure of deeper tissue/muscle).

C-level = Possible Injury – Any injury reported or claimed which is not fatal, suspected serious or suspected minor injury.

- Examples include momentary loss of consciousness, claim of injury, limping, or complaint of pain or nausea. Possible injuries are those which are reported by the person or are indicated by his/her behavior, but no wounds or injuries are readily evident.

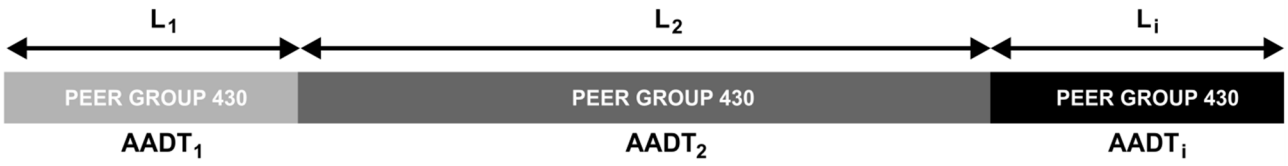
O-level = Property Damage Only / No Apparent Injury - No reason to believe that the person received any bodily harm from the motor vehicle crash. There is no physical evidence of injury and the person does not report any change in normal function.

A reportable crash is any crash that results in an injury or fatality. Additionally, a reportable crash is a crash in which damage to an individual's property totals more than $1,000 or damage to government property (e.g. traffic control devices, guardrail, etc.) totals more than $200.

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.



$AADT_{PR} = \frac{L_1 * AADT_1 + L_2 * AADT_2 + L_i * AADT_i}{L_1 + L_2 + L_i}$ = 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 2014 $AADT_1$ = 5,000 and Year 2017 $AADT_1$ = 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

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

C = Number of crashes in five-year period (years 2014-2018)
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

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

C_{KAB} = Sum of K-level, A-level, and B-level crashes in five-year period (years 2014-2018)
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*

$$Crash\ Rate\ UCL = 79.25 + 523.42\sqrt{\frac{79.25}{AADT * L * Y}}$$

$$Crash\ Rate\ UCL = 79.25 + 523.42\sqrt{\frac{79.25}{4{,}500 * 2.0 * 5}} = 101.22\ Crashes\ per\ 100\ MVM$$

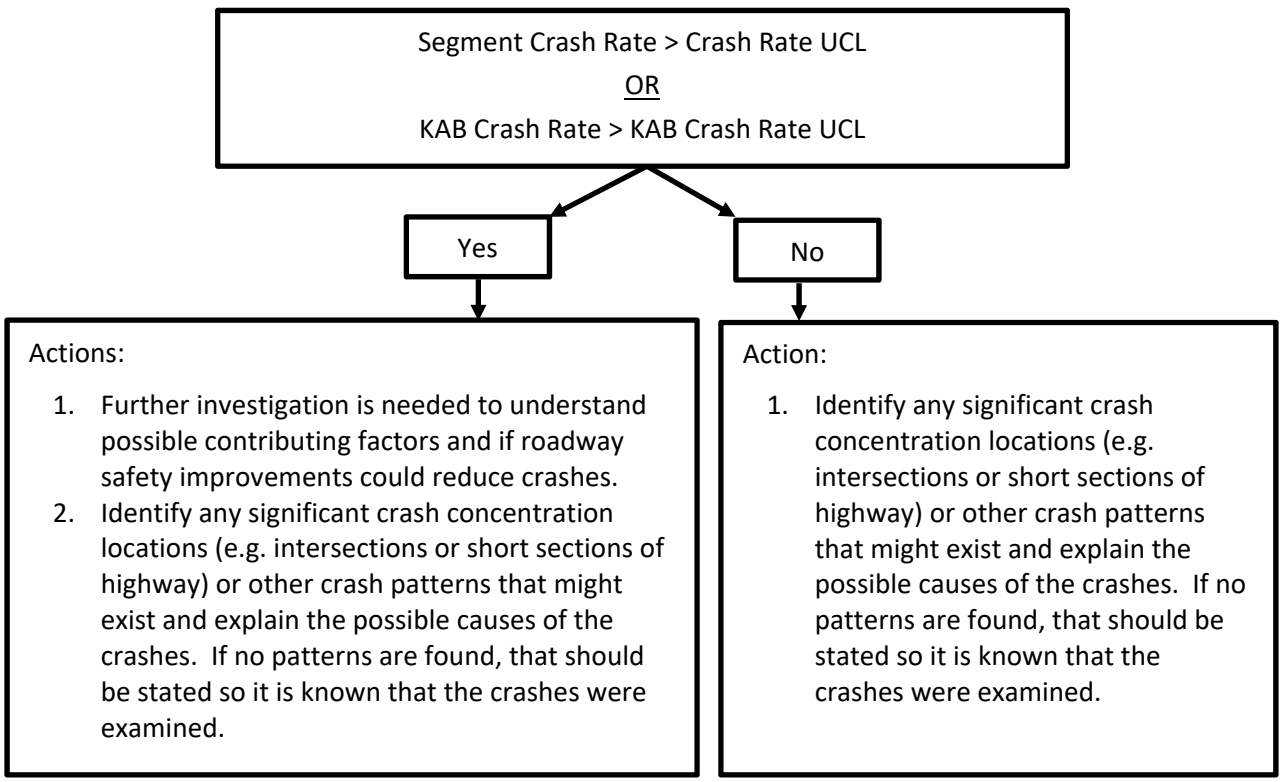
$$KAB\ Rate\ UCL = 18.51 + 523.42\sqrt{\frac{18.51}{AADT * L * Y}}$$

$$KAB\ Rate\ UCL = 18.51 + 523.42\sqrt{\frac{18.51}{4{,}500 * 2.0 * 5}} = 29.13\ KAB\ Crashes\ per\ 100\ MVM$$

Results: The segment's crash rate of 70 crashes per 100 MVM is less than the crash rate UCL of 101.22, but the segment's KAB Crash Rate of 50 crashes per 100 MVM is higher than the KAB Crash Rate UCL of 29.13. 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.

Figure 3: Action Flow Chart



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: 2014-2018 Statewide Average Crash Rates, KAB Crash Rates, and UCLs for Local Roads

	Crash Rate (crashes per HMVMT)		KAB Crash Rate (crashes per HMVMT)	
Local Road Group	**Average**	**UCL**	**Average**	**UCL**
Urban Streets	349.89	$= 349.89 + 523.42\sqrt{\frac{349.89}{AADT * L * Y}}$	39.90	$= 39.90 + 523.42\sqrt{\frac{39.90}{AADT * L * Y}}$
Rural County Trunk Highways	92.87	$= 92.87 + 523.42\sqrt{\frac{92.87}{AADT * L * Y}}$	20.93	$= 20.93 + 523.42\sqrt{\frac{20.93}{AADT * L * Y}}$

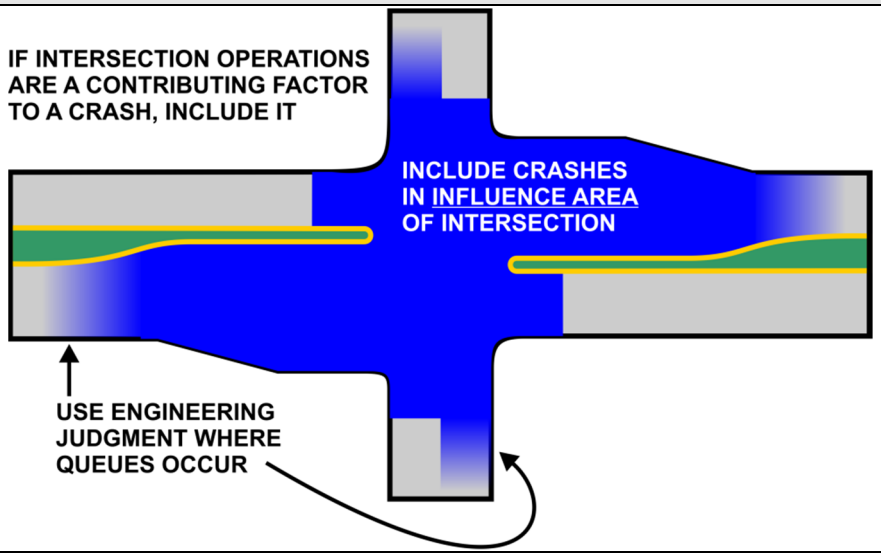
AADT = Average Annual Daily Traffic (vehicles per day) L = Segment Length (miles) Y = Years
HMVMT = 100 million vehicle miles traveled

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.

Figure 4: Influence Area of Intersection



Equation 4 shows the calculation for intersection crash rates.

Equation 4: Intersection Crash Rate

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

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

$AADT_{ent}$ = Annual Average Daily Traffic entering the intersection

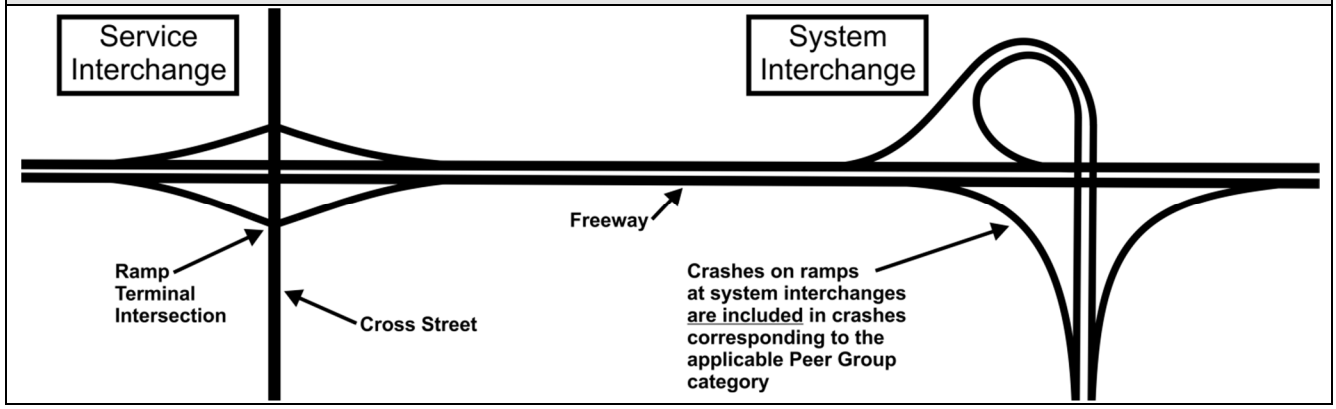
Y = Number of years analyzed (preferably 5)

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.

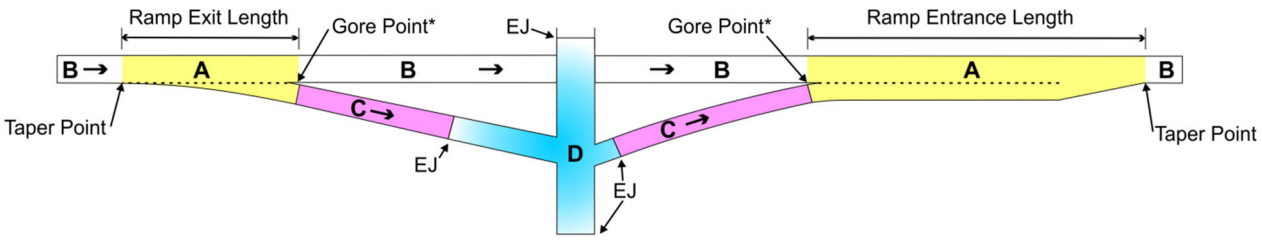
Crashes that occurred on ramps at system interchanges (i.e., freeway to freeway) **are** included in the crashes used to calculate the corresponding freeway Peer Group average crash rates. Please see ***Figure 5a*** for an illustration of service versus system interchanges.

Figure 5a: 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***.

Figure 5b: Ramp Detail at Service Interchanges



Definitions

A: All crashes that occur within this area are classified as speed-change crashes
B: All crashes that occur within this area are classified as freeway segment crashes
C: All crashes that occur within this area are classified as ramp crashes
D: All crashes that occur within this area are classified as ramp terminal intersection crashes
EJ: Engineering judgment should be use to determine if crashes occur within the influence area of the intersection

* Point where marked gore is 2 ft wide (gore point)

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 31st, 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.