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MEMORANDUM

Date: December 16th, 2020

To: Derek Leuer, P.E. -MnDOT

From: Ross Tillman, P.E.

Chloe Weber, EIT

Subject: Regional Solicitation Before and After Study Phase II: HSIP CMF Guide
Project No.: T41.121214

Depending on staffing at various agencies who may apply for HSIP funds, the level of expertise in terms of safety analysis widely varies. In addition, there are times when two applications for a similar project will utilize different CMFs with varying levels of anticipated crash reductions. Based on these factors, there is a desire to simplify the process as well as consolidate a list of CMFs for use to the extent possible. Certain projects will always require further research and analysis using the Highway Safety Manual or CMF Clearinghouse, but a simple guide could satisfy the needs for most other projects.

Our team began by collecting the 2016 and 2018 HSIP project information. Frequency of CMFs utilized was determined as a starting point to understand which CMFs to include in an overall guide. See **Table 1**.

Table 1: CMFs applied per category, from 2016 and 2018 application data

CMF Applied per Category											
Lighting Improvement or Installation	Frequency	Roundabout Improvement or Construction	Frequency	Signal Improvements or Construction	Frequency	Turn Lane Construction	Frequency	Pedestrian Improvements	Frequency	Roadway Construction	Frequency
578	5	227	3	1414	3	3948	2	175	3	8111	1
192	1	228	3	1419	1	3950	1	4123	3	1967	4
193	1	229	1	1420	6	253	1			6942	1
433	3	207	1	1428	4	255	3			2265	3
		211	1	1485	3	268	2			2276	3
		230	1	2334	2	272	2			2841	2
		206	4	1993	3	287	2			6703	2
		210	1	4140	1	583	1			1516	1
		225	1	4177	3	8431	1				
		4699	1	8790	1						
		4700	2	5272	6						
		4927	1	6858	2						
				7684	3						
				7690	3						
				3072	1						
				8824	2						

Ultimately, the team incorporated all the used CMFs into the guide based on relevancy and overall effort. This information was sorted by CMF to include and compare the details of the CMFs used in those years' HSIP applications. These details include the value of the CMF, the standard error, if it is listed in the HSM, the star rating, crash type, and crash severity. These details differentiate one CMF from the next and allow applicants to find the CMF that best fits the scenario of the project being applied for. From

there, counterpart CMFs (rural vs. urban, for example) were added from the CMF Clearinghouse to round out the options one might want to consider when choosing a CMF for an HSIP application. The guide was split into two parts to differentiate between CMFs that apply to all/property damage only crashes and those that are focused on injury crashes only.

Lastly, the team developed a simple step by step list for use of the guide and application of CMFs, intended to go along with the guides in future HSIP applications as an attachment. This list walks users through the categories in the guide, as well as highlights specific measures to be aware of when choosing a CMF for a project.

Steps for using the CMF guides and applying CMFs:

1. Look through the project types and sub-types that may be applicable to the project
2. Consider additional qualifiers that may help fit the CMF to the project (often, these are existing conditions of what is to be improved)
3. Choose which area type the project exists in (Urban, Rural, Suburban, etc.)
4. Consider the crash types and crash severities
5. Select a CMF for use that best fit the project as well as context of the area. Some projects may require the use of multiple CMFs to best represent the improvements, although the use of more than two is not recommended for most HSIP projects
6. Ensure you are applying the CMF to the correct crash severities and types. CMFs that cover all severities and types should be used with caution
7. Ensure that the crashes utilized match the timeframe/conditions of the application. Use whole calendar years

See the attached CMF guide information which could be appended to future HSIP solicitation packets.

CMF Guide (All-Severity and Property Damage Only Crashes)

Project Type	Additional Qualifiers	Area Type	CMF	Value	Adjusted Standard Error	Star Rating	In HSM?	Crash type	Crash Severity
Pedestrian									
Median Construction	Marked, Uncontrolled Pedestrian Crossing	Urban/Suburban	175	0.54	0.48	3	No	Veh/Ped	All
Median Construction	Uncontrolled Pedestrian Crossing, Marked or Unmarked	Urban/Suburban	8800	0.742	NA	4	No	All	All
High Visibility Crosswalk	High Visibility Crosswalk	Urban	4123	0.6	NA	2	No	Veh/Ped	All
Install Shared Path	No Share Path Present	Urban	9250	0.75	NA	3	No	Veh/Bicycle	All
Install Bike Lanes	No Bike Facilities Present	Urban	2159	1.05	NA	3	No	All	All
Install Bike Lanes	No Bike Facilities Present	Urban	4658	0.855	NA	3	No	Veh/Ped	All
Reduced Conflict Intersections*									
RCUT	Previously Signalized or Stop Controlled	All	10382	0.8	NA	4	No	All	All
RCUT	Previously Two Way Stop Controlled	All	10384	0.42	NA	4	No	All	All
J-Turn	Previously Two Way Stop Controlled	Rural	5555	0.652	NA	4	No	All	All
Intersection									
Turn Lane	Install Left Turn Lane	Urban	3950	0.8	NA	3	No	All	PDO
Turn Lane	Install Left Turn Lane	Rural	7853	0.69	NA	2	No	All	All
Turn Lane	Left Turn Lane on One Major Approach	Rural	253	0.56	0.07	4	Yes	All	All
Turn Lane	Left Turn Lane on Both Major Approaches	Rural	268	0.52	0.04	5	Yes	All	All
Turn Lane	Two Way Left Turn Lanes	Rural	583	0.64	0.04	5	No	All	All
Turn Lane	Improve Angle of Channelized Right Turn Lane	Not Specified	8431	0.937	0.397	4	No	Right Turn, Other	All
Single Lane Roundabout	Originally Stop Controlled	All	227	0.56	0.05	5	Yes	All	All
Single Lane Roundabout	Originally Stop Controlled	Rural	229	0.29	0.05	5	Yes	All	All
Single Lane Roundabout	Originally Stop Controlled	Rural	207	0.42	0.13	4	No	All	All
Single Lane Roundabout	Originally Stop Controlled	Urban	206	0.28	0.11	4	No	All	All
Single Lane Roundabout	Originally Signalized, Stop Controlled, and Non-Controlled	Rural	9333	0.48	NA	3	No	Other	All
Single Lane Roundabout	Originally Signalized	All	225	0.52	0.06	4	Yes	All	All
Single Lane Roundabout	High Speed	Rural	4699	0.26	NA	4	No	All	All
Multi-Lane Roundabout	Originally No Control, Yield, TWSC, AWSC, or Signal Control	All	4926	1.062	NA	4	No	All	All
Signal Head	Add Signal (Additional Primary Head)	Urban	1414	0.72	NA	3	No	All	All
Signal Head	Add Signal (Additional Primary Head)	Urban	1419	0.65	NA	2	No	Angle	All
Signal Head	Add Signal (Additional Primary Head)	Urban	1416	0.69	NA	3	No	All	PDO
Signal Head	Convert Signal From Pedestal-Mounted to Mast Arm	Not Specified	1420	0.51	NA	3	No	All	All
Signal Head	Convert Signal From Pedestal-Mounted to Mast Arm	All	1428	0.26	NA	3	No	Angle	All
Signal Head	Add Signal (One Over Each Approach Lane)	Urban	1485	0.54	NA	2	No	Angle	All
Signal Head	Replace 8" Red with 12"	Not Specified	2334	0.97	NA	3	No	All	All
Signal Phasing	Leading Pedestrian Interval	Urban	1993	0.413	NA	3	No	Veh/Ped	All
Intersection Traffic Control	Change Permissive Left to Protected or Protected/Permissive	Urban	4140	0.58	NA	2	No	All	All
Intersection Traffic Control	Change Protected/Permissive to Flashing Yellow Arrow	Urban	4177	0.806	NA	4	No	Left Turn	All
Intersection Traffic Control	Install Pedestrian Countdown Timer	Not Specified	8790	0.912	NA	4	No	All	All
Intersection Traffic Control	Install Pedestrian Countdown Timer	Not Specified	5272	0.3	NA	4	No	Veh/Ped	All
Intersection Traffic Control	Install Adaptive Traffic Signal Control	Urban/Suburban	6858	0.79	NA	4	No	All	All
Intersection Traffic Control	Change from Permissive Only to Flashing Yellow Arrow	Not Specified	7684	0.598	NA	2	No	Left Turn	All
Intersection Traffic Control	Change from Protected Only to Flashing Yellow Arrow	Not Specified	7690	0.901**	NA	4	No	All	All
Intersection Traffic Control	Change Number of Traffic Signal Cycles Per Hour on Arterial with Signal Coordination From X to Y	Urban/Suburban	3072	e^-0.0444(Y-X)	NA	3	No	Rear End	All
Advanced Technology and ITS	Install Red-Light Indicator Lights	Not Specified	8824	0.713	NA	4	No	Other	All
Access Management	Create Directional Median Openings to Allow Left-Turns and U-Turns	Not Specified	1516	0.49	NA	2	No	All	All
Roadway									
Lighting	Illumination	Not Specified	496	0.69	0.36	3	No	All	PDO
Lighting	Highway Lighting	All	193	0.83	0.07	4	Yes	Nighttime	PDO
Wet-Reflective Pavement Markings	Previously Standard Markings	Not Specified	8111	0.538	NA	4	No	Run Off Road	All
Median	Install Cable Median Barrier (High Tension)	Not Specified	1967	0.04	0.06	3	No	Cross Median, Frontal and Opposing Direction Sideswipe, Head On	All
Install Centerline and Shoulder Rumble Strips	No Existing Rumble Strips	Rural	6942	0.653	NA	4	No	All	All
Improve Pavement Friction	Increase Skid Resistance	All	2265	0.589	0.216	3	No	All	All
Improve Pavement Friction	Increase Skid Resistance	All	2276	0.304	0.086	3	No	Rear End	All
Road Diet	Previously Four Lane Undivided	Suburban	2841	0.53	NA	4	No	All	All
Road Diet	Previously Four Lane Undivided	Urban	5553	0.748	NA	4	No	All	All
Shoulder Treatments									
Widen Shoulder	Previously Narrow Paved Shoulder	Rural	6703	0.67	NA	4	Yes***	Fixed Object, Head on, Run Off Road, Sideswipe	PDO

*Minnesota study underway

**Results in Minnesota have indicated an increase in crashes

***See section 13.4.2.4 in the HSM for additional shoulder CMF information

CMF Guide (Injury Crashes)

Project Type	Additional Qualifiers	Area Type	CMF	Value	Adjusted Standard Error	Star Rating	In HSM?	Crash type	Crash Severity
Pedestrian									
Median Treatment for Ped/Bike Safety	Install Various Treatments Such as Fencing, Planters, Pedestrian Islands	Urban	9121	0.91	NA	4	No	All	K, A, B
Install Sidewalk	No Exisitng Sidewalk	Urban	9240	0.41	NA	2	No	Veh/Bicycle	K, A
Install Bike Lanes	No Bike Facilities Present	Urban	4660	0.946	NA	3	No	All	K, A, B, C
Reduced Conflict Intersections*									
J-Turn	Previously Two Way Stop Controlled	Rural	5559	0.14	NA	2	No	All	A
Intersection									
Turn Lane	Install Left Turn Lane	Urban	3948	0.79	NA	3	No	All	K, A, B, C
Turn Lane	Install Left Turn Lane	Rural	7852	0.73	NA	3	No	All	K, A, B, C
Turn Lane	Left Turn Lane on One Major Approach	Rural	255	0.45	0.1	4	Yes	All	K, A, B, C
Turn Lane	Left Turn Lane on Both Major Approaches	Rural	272	0.42	0.04	5	Yes	All	K, A, B, C
Turn Lane	Right Turn Lane on One Major Approach	All	287	0.77	0.08	4	Yes	All	K, A, B, C
Lighting	Provide Intersection Illumination	Not Specified	433	0.62	0.13	4	Yes	Nighttime	A, B, C
Single Lane Roundabout	Originally Stop Controlled	All	228	0.18	0.04	5	Yes	All	A, B, C
Single Lane Roundabout	Originally Stop Controlled	Rural	211	0.18	0.16	4	No	All	A, B, C
Single Lane Roundabout	Originally Stop Controlled	Rural	230	0.13	0.04	5	Yes	All	A, B, C
Single Lane Roundabout	Originally Stop Controlled	Urban	210	0.12	0.14	4	No	All	A, B, C
Single Lane Roundabout	High Speed	Rural	4700	0.11	NA	4	No	All	A, B, C
Multi-Lane Roundabout	Originally No Control, Yield, TWSC, AWSC, or Signal Control	All	4927	0.367	NA	4	No	All	K, A, B, C
Single or Multi-Lane Roundabout	Originally TWSC	All	4931	0.65	NA	4	No	All	K, A, B, C
Roundabout	Originally AWSC	All	4933	0.544	NA	3	No	All	K, A, B, C
Low Speed Roundabout	Originally No Control, Yield, TWSC, AWSC, or Signal Control	All	5228	0.473	NA	4	No	All	K, A, B, C
Roadway									
Lighting	Illumination	Urban	578	0.69	0.07	4	No	All	A, B, C
Lighting	Illumination	All	571	0.31	0.36	3	No	All	K
Lighting	Highway Lighting	All	192	0.72	0.06	4	Yes	Nighttime	A, B, C
Median	Install Cable Median Barrier (High Tension)	Rural	8214	0.47	NA	3	No	Other	K, A
Shoulder Treatments									
Widen Shouler	Previously Narrow Paved Shoulder	Urban	6705	0.74	NA	3	No	Fixed Object, Head on, Run Off Road, Sideswipe	A, B, C

*Minnesota study underway