Adding Surrogate Safety Analysis to the Toolbox

Joe DeVore, PE, PTOE | KLJ

Intersection and corridor safety have largely been a reactionary process over the past 50 years. This process has consisted of looking at the historical crash trends through network screening, diagnosing high-risk locations, considering improvements to address those issues, and hoping that the benefits of those improvements will match the benefit shown through statistical analysis of similar intersections. Being able to address human factors, site specific issues, and addressing the randomness of crashes with any confidence has been a tough task for traffic engineers and planners in our vision towards zero deaths. However surrogate safety analysis offers a predictive option to look at how this randomness changes in the future based upon site specific information.

Existing Countermeasure Selection Methodology

One of the biggest concerns with addressing site-specific roadway safety issues is the accurate selection of what countermeasure will provide the highest safety benefit. The Highway Safety Manual (HSM) and CMF Clearinghouse are two resources that help to prioritize the ability of improvements to address existing safety issues. The studies that develop these Crash Modification Factors (CMFs) analyze before and after studies for certain intersection improvements and usually prioritize many data points vs site similarities to provide a more statistically sound study. However, the tradeoff with this methodology is that site specific comparisons are generalized which result in comparing improvements with a high standard of error.
### EXECUTIVE COMMITTEE

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<tr>
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<th>Name</th>
<th>Company/Department</th>
<th>Contact Information</th>
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### STANDING COMMITTEES

<table>
<thead>
<tr>
<th>Committee</th>
<th>Chair</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>Hailey Pederson, Spack Solutions</td>
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### TECHNICAL COMMITTEES

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<tr>
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<td>Intersection Traffic Control</td>
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<tr>
<td>ITS</td>
<td>Mike Kronzer, MnDOT</td>
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<tr>
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### STUDENT CHAPTERS

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<td><a href="mailto:dtsoduluth@gmail.com">dtsoduluth@gmail.com</a></td>
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### MIDWESTERN ITE

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<tr>
<td>District Director</td>
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www.nc-ite.org
Greetings! I hope everyone had a great holiday season and that your 2020 is off to a great start. I’m honored to be serving as the 2020 NCITE President and am excited about all of the section meetings, professional development opportunities, socials gatherings, and committee events that we already have planned for the year. The year started off with our January Section Meeting featuring Kristine Elwood of MnDOT providing updates on a variety of MnDOT initiatives including the statewide radio communications project. Then in early February NCITE hosted a booth at the Minneapolis Public Schools STEM Expo and showed students about the world of transportation – what a great opportunity to influence future generations!

The next few months will continue to be busy for NCITE, providing many opportunities for technical presentations, professional networking, and of course some fun. Highlights include:

- **February Section Meeting** – February 25th at Jax Café. Derek Leuer of MnDOT will present on the 2020-2024 Strategic Highway Safety Plan (SHSP) over a delicious breakfast at Jax Café.
- **Civil Engineering Day** – February 29th at the Science Museum. NCITE will host an interactive booth get students thinking about transportation. Attend the event with your family or help staff the NCITE booth (contact Kevin Peterson if interested).
- Ski and Snowboarding – February 29th at Afton Alps. Join the Younger Member Committee and enjoy a day of fun in the outdoors! Contact Kristin Carlson for more information.
- **Ethics Training** – March 24th at Urban Growler. Join NCITE and WTS for this ethics training opportunity followed by a social and networking hour.
- **April Section Meeting** – Stay tuned for more info as NCITE takes our April Section Meeting on the road to Mankato!
- **ATS TPM Workshop** – NCITE is working to host an all-day workshop in May on Automated Traffic Signal Performance Measures – more info to come!

All of these great events would not be possible without you – our NCITE members! I encourage you to find a way to get involved with NCITE in 2020 whether it be a section meeting, technical committee, or other event. We strive to keep our members up-to-date on what is happening through regular emails, our website, and this newsletter. However, don’t forget to check out our LinkedIn page, Twitter, or YouTube channel for other timely updates.

I’d be remiss not to acknowledge the 2020 NCITE Executive Board who is already hard at work planning our events and keeping NCITE at the forefront of the transportation industry. Feel free to reach out to anyone on the Board if you have any questions, comments, or ideas for NCITE.

President; **Jacob Folkeringa**, SRF Consulting Group
Vice President: **Kevin Peterson**, Washington County
Secretary: **Tyler Krage**, Alliant Engineering
Treasurer: **Natalie Sager**, HDR
Director: **Morgan Hoxsie**, Kimley-Horn
Director: **Jeremy Melquist**, KLJ
Director: **Hoki Tse**, Metro Transit
Past President; **Jeff Preston**, Stantec
Minnesota Transportation Conference
March 3-4, 2020
St Paul River Center | St Paul, MN

Midwestern + Great Lakes
Joint District Meeting
Chicago, IL

2020 Midwestern + Great Lakes District Meeting
June 3-5, 2020
Holiday Inn Chicago-Mart Plaza River North | Chicago, IL

Attend an Upcoming NCITE Technical Committee Meeting!
Check out upcoming topics here.
For more information on the committees and how you can get involved:
https://nc-ite.org/Committee_Listing

For professional development opportunities:
http://nc-ite.org/content.php?page=Professional_Development_Meetings

Upcoming NCITE Events:
http://nc-ite.org/calendar.php
Get to know the 2020 board!!

**Jake Folkeringa, 2020 NCITE President**

Job Title & Employer: Senior Associate, SRF Consulting Group  
Past Work: SEH (intern), WSN (intern), Subway Sandwich Artist!  
Education: Bachelor of Civil Engineer, University of Minnesota, 2008  
Where You Live: Elk River, MN  
Family: Rachel (Wife), Aanya (4 months old)  
Pets: Nala (Nova Scotia Duck Tolling Retriever)  
Hometown: Brainerd, MN  
Hobbies: Hunting, fishing, four-wheeling  
Interesting Facts:  
- I am a reserve police officer.  
- I love anything Google.  
- I was a trumpet player in the University of Minnesota Marching Band.  
- I’ve sung as tenor in multiple barbershop quartets.  
Favorite Restaurant: Raising Cane’s  
Best Vacation: Hunting in northern MN  
Biggest Accomplishment: Becoming a parent. Everyone told me my life would change but, you don’t truly understand it until it happens.

**Kevin Peterson, 2020 NCITE Vice President**

Job Title & Employer: Engineer II, Washington County Public Works  
Past Work: SEH Inc., Bonestroo (intern), Papa Charritos (bus-boy, cook, bartender)  
Education: NDSU  
Where You Live: Stillwater, MN  
Family: Meghan (wife), Felix (6.5), Lucy (4)  
Pets: Maddie, German Shepard (9)  
Hometown: Hastings, MN  
Hobbies: Travel, Family Time, Getting Outside, Local Beer  
Interesting Facts:  
- The very first kindergarten soccer game I coached led to three children crying (one of them was mine)  
- I skipped a chemistry test to road trip to the Salt Lake City Olympics.  
Favorite Podcast: Radio Lab  
Favorite Food: Poke  
Favorite Restaurant: D-Spot Wings  
Biggest Accomplishment: 2018 NCITE Young Transportation Professional of the Year  
Instruments Played: Piano, armpit  
Best Vacation: Honeymoon in Peru
Get to know the 2020 board!!

**Tyler Krage, 2020 NCITE Secretary**

Job Title & Employer: Professional Engineer at Alliant Engineering  
Past Work: Intern at U of M Parking and Transportation Services, then Alliant Intern  
Education: BS in Civil Engineering from University of Minnesota, 2014  
Where You Live: Minneapolis  
Family: Wife, Meredith  
Pets: Rab-Dad to 2 Netherland Dwarf Rabbits, Pepper and George  
Hometown: Houston, MN  
Hobbies: Live Music, Rock Climbing, Camping, Biking, Travel  
Interesting Facts:  
- I grew up on an elk farm.  
- I once hit 2 deer with my car in 24 hours.  
- I used to love gardening and plants, but my current home has awful sunlight, now leading to a constant state of keeping plants barely alive.  
Favorite TV Show: Big Mouth and Chopped  
Favorite Music: All over, but trending more Alternative. At the same time trying to kick a bad Grateful Dead habit.  
Favorite Book: The Sun Also Rises—Hemingway  
Favorite Car: 1992 Geo Prizm  
Most Embarrassing Moment: Butt dialing a friend while belting out tunes in the car.

**Natalie Sager, 2020 NCITE Treasurer**

Job Title and Employer: Traffic Engineer at HDR  
Past Work: Traffic Counter at Alliant and Student Worker at Scott County  
Education: Bachelor’s in Civil Engineering, University of Minnesota – Twin Cities, 2014  
Where You Live: Maple Grove, MN  
Family: Husband (Tom), no kids yet!  
Pets: Siberian Cat (Maya)  
Hometown: Shoreview, MN  
Hobbies: Hiking, Traveling, Camping, Recreational Soccer, and am trying to learn cross country skiing.  
Interesting Facts:  
- I emphasized in structural engineering throughout college, not realizing how great the transportation field is.  
- I was on the U of M concrete canoe team and was a captain my last year (*The Gemini*, 2014).  
- My favorite meals are shared over bonfires, or mid-hike with a view of water.  
- I once fell through a window during a band trip to Italy while racing my friends and skipping backwards… luckily I was on my teacher’s good side and sustained no injuries.  
- I was born a surprise identical twin on Friday the 13th and am a participant in the MN Twin Study.  
Favorite TV Show: Game of Thrones  
Favorite Podcast: Crime Podcasts  
Desired Superpower: Teleportation  
Instruments Played: Flute
MEET THE 2020 EXECUTIVE BOARD

Get to know the 2020 board!!

Morgan Hoxsie, 2020 NCITE Director
Job Title and Employer: Transportation Engineer at Kimley-Horn
Past Work: In college I was an intern at MDOT and an intern at OHM Advisors.
Education: Michigan State University, BS Civil Engineering & BA Spanish
Where You Live: South Saint Paul
Family: Fiancé - Jacob Nelson, My parents live in Michigan and I have three siblings.
Pets: I grew up with three dogs – Murray, Charlotte, Wrangler
Hometown: Clarkston, Michigan
Hobbies: I love to bike, hike, explore new places and drink craft beer.
Interesting Facts:
• This summer I am participating in my fourth RAGBRAI which is a bicycle ride across the state of Iowa!
• I grew up going to and still love visiting Mackinac Island in Michigan.
• I have been a vegetarian my whole life.
• I lived in Atlanta for six months for work and didn’t have a car so I got to walk, bike, transit, and ride-share everywhere.
• I volunteer at Feed My Starving Children once a month with friends. Let me know if you ever want to join.
Favorite Restaurant: Anywhere with a good draft beer list
Favorite Car: My fiancé’s Tesla
Desired Superpower: Be in two places at once
Biggest Accomplishment: Passing the PE Exam in Fall 2019!
Best Vacation: In college, my sisters and I traveled to Rwanda to visit a friend who was teaching in a school in Kigali. We enjoyed seeing her life there and exploring where she called home.

Jeremy Melquist, 2020 NCITE Director
Job Title and Employer: Professional Traffic Engineer (KLJ)
Past Work: Bolton & Menk, MnDOT, Minnesota Traffic Observatory, Xcel Energy
Education: BS in Civil Engineering from the University of Minnesota-Twin Cities
Where You Live: New Brighton, MN
Family: Wife (Jess)
Hometown: Woodbury, MN
Hobbies: Sports, Hiking/Camping, Country Music
Interesting Facts:
• I have an identical twin. He graduated from the University of Wisconsin and now lives in California.
• I’ve tried 240 different beers.
• I started backpacking last year and have multiple trips planned this year.
• I’ve gotten food poisoning 2 of the last 3 times I’ve been out of the United States.
Favorite TV Show: Breaking Bad
Favorite Food: Buffalo Chicken Wraps
Favorite Restaurant: Raising Canes
Best Vacation: Road trips
Get to know the 2020 board!!

**Hoki Tse, 2020 NCITE Director**

**Job Title and Employer:** ITS Engineer, Metro Transit  
**Past Work:** Civil Engineer at City of San Jose  
**Education:** BSCE and MSCE, both at Georgia Tech  
**Where You Live:** Saint Paul, Minnesota  
**Family:** Yiyi (wife) and Leonard (son)  
**Hometown:** Hong Kong, China  
**Hobbies:** Soccer, Restaurant hopping, travel, Video game (FIFA only)  

**Interesting Facts:**
- I haven't owned a car since 2017.  
- I fly between Minneapolis and Louisville every few weeks to see my wife and son.  
- I have never been to the Twin Cities, not even MSP airport, before moving here for my job.  
- The only pizza I order is the Stuffed Crust from Pizza Hut.  
- My dream career was to become a bus driver, which I am one step closer now working in a transit agency.  

**Favorite TV Show:** I don't watch TV...  
**Favorite Podcast:** ITE Talks!  
**Favorite Music:** Beethoven 5th Symphony  
**Favorite Food:** Malaysian Laksa Noodle Soup  
**Favorite Restaurant:** On's Thai  
**Favorite Book:** Rejection Proof by Jia Jiang  
**Favorite Car:** Volkswagen Buzz (due in 2022)  

**Biggest Accomplishment:** NCITE Board of Directors!  
**Most Embarrassing Moment:** Concede 6 goals as goalie in Intramural Soccer  
**Best Vacation:** Eating poke in Hawaii
The Younger Member Committee has some exciting events lined up for 2020.

Upcoming Events:
The YMC is hosting a ski/snowboarding event on Feb. 29th at Afton Alps. RSVP here!

During the January YMC planning meeting at Number 12 Cider House in Minneapolis, the 2020 events calendar was discussed.
Tentative 2020 YMC Schedule:
**February:** Ski/Snowboard event at Afton Alps, Feb. 29th
**March/April:** Volunteer event (Baaken museum or Open Arms)
**April:** APWA younger member joint networking event
**May:** Planning meeting
**June:** Annual bike/brewery event
**July:** Planning meeting
**Late July/Early August:** Kickball/volleyball event (Utepils?)
**September:** Gopher tailgate with ITSO on 9/26
**October:** Planning meeting
**October:** Potentially trivia or low-key event
**November:** Annual meeting with YMC happy hour

If you would like to be added to the YMC email list, or know of any new hires/coworkers that would enjoy our events, please send email addresses to
Kristin Carlson (carl4498@umn.edu) or Jack Olsson (Jack.Olsson@kimley-horn.com)
Defining Surrogate Safety
One method that is allowing professionals an alternative to countermeasure selection that will work on a site-specific level is surrogate safety. Safety professionals have begun to use surrogate measures, such as conflicts (near misses), avoidance maneuvers, and the time to collision if no evasive action is taken, to determine the level of safety risk and identify site-specific problems. This analysis also allows safety problems to be identified that may exist in locations that do not have a demonstrated history of crashes. This is especially true for pedestrians and bicyclists, since crashes involving these road users may be infrequent and appear random at first sight.

Roadway safety professionals are using surrogate measures to fill in these gaps to address the actual safety risk at a subject intersection through use of computer learning and recent advances in computer processing. Companies such as Microtraffic use intersection video data to analyze both the speed and number of near-miss conflicts at study intersection to identify underlying safety concerns. This process of identifying high-risk locations should also be used when considering a site-specific safety improvement.

Integrating FHWA’s SSAM Analysis
The FHWA’s Surrogate Safety Assessment Model (SSAM) takes a proactive approach to crash prediction along roadways. SSAM uses microsimulation vehicle trajectory files from VISSIM, AIMSUN, Paramics, etc. to analyze vehicle-to-vehicle interactions. This analysis is used to identify conflict events and near-miss conflicts for existing and future intersection configurations and volumes. SSAM compares these conflicts based on the angle of interaction comparing to right-angle, rear-end, and sideswipe crashes that can be used to address these specific safety deficiencies found during network screening. Analysis is based on all the factors within the microsimulation model including velocity, deceleration, volumes, and site-specific vehicle paths to quantify predicted conflicts.

SSAM methodology also allows traffic professionals to consider safety benefits of alternative intersections, considering at-grade to grade separated improvements, multiple improvements in a corridor, and to minimize the standard of error found in CMF methodology by being able to run simulations until a desired confidence interval is reached. While the quantity of conflict points can sometimes be misleading from the analysis, the percentage change between scenarios gives a very detailed investigation into the safety improvements being considered and can be used as a more detailed option to crash modification factors. This methodology also allows for analysis of how the future crash rate will increase exponentially compared to the growing traffic volumes.
Comparing Results to CMF Factors
One of the main arguments against surrogate safety analysis has been the limited before and after comparison analysis. The results of FHWA validation efforts have demonstrated that the surrogate measures derived from traffic simulation models were significantly correlated with existing crash data collected in the field. In simple terms; conflicts increase at the same rate as crashes are expected to as roadway volumes increase or decrease. This comparison can be further calibrated for existing conditions through balancing the tradeoff between operational delays and the safety of a movement caused by priority rule gap acceptancy. Just like a traffic operations model needs to be calibrated to existing operations, so too can it be calibrated to the existing safety conditions.

Summary
A surrogate safety analysis methodology can help traffic engineers and planners address the inaccuracy and standard error with using crash modification factors for site-specific intersection treatments. By providing a statistically significant reduction in right-angle, rear end, and sideswipe crashes, SSAM can address existing crash deficiencies with more certainty than just using CMF factors. Traffic engineers should look for opportunities to implement this intersection safety methodology in our shared goal of reducing vehicular crashes and specifically in our goal towards zero roadway deaths.

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A 24-hour conflict comparison using SSAM between an existing intersection and the benefit of at-grade and grade separated alternatives.
TECHNICAL COMMITTEE UPDATE

Geometric Design Technical Committee
Committee Chair: Ben Hobert—bhobert@srfconsulting.com
Recent Agenda Items: Met on Oct 14, 2019 - Continuous Green T-Intersections
Future Agenda Items: Innovative Intersections Presentation
Next Meeting: Wednesday March 4, 8:00am-10:00am.

Intersection Traffic Control Technical Committee
Committee Chair: Pravin Dhakal
Recent Agenda Items: Meeting on Feb 11, 2020 - Synchro upgrade discussion, SNCTC updates, 2020 topics.
Future Agenda Items: TBD
Next Meeting: TBD

ITS Technical Committee
Committee Chair: Michael Kronzer - michael.kronzer@state.mn.us
Recent Agenda Items: Met on Oct 1, 2019 - MnROAD Automated Truck Project by Mike Kronzer of MNDOT.
Future Agenda Items: TBD
Next Meeting: TBD

Pedestrian and Traffic Safety Technical Committee
Committee Chair: Stephen Smith
Recent Agenda Items: Pedestrian Beacons and Signals in Higher Speed, Non-Urban Areas
Future Agenda Items: Brainstorming future meeting ideas and identifying topic champions
Next Meeting: Thursday 2/27 at 4pm at Blackstack Brewing

Planning Methods and Applications Technical Committee
Committee Chair: Krista Anderson - kanderson@srfconsulting.com
Recent Agendas Items: New Met Council population synthesizer update, STOPS model discussion, Activity Based Model User’s Guide
Future Agendas Items: ABM peak hour trip table development, Regional roadway network update, TBD
Next Meeting: TBD

Traffic Operation and Maintenance Discussion Group
Committee Chair: Adam Bruening - adam.bruening@co.washington.mn.us
Recent Agenda Items: Met on Feb 5, 2020 - What agencies are doing when installing new or updated signals, Ideas for new sign trucks, road sign inventory program
Future Agenda Items: TBD
Next Meeting: TBD

Simulation and Capacity Analysis Technical Committee
Committee Chair: Mark Powers - Mark.Powers@stantec.com
Recent Agenda Items: The SimCap group last met in Dec. We discussed the previous year’s meetings, what went well, what we could do better in the future, and what we would like to see in the upcoming year.
Future Agenda Items: TBD
Next Meeting: TBD
AECOM recently supported Metro Transit with planning and designing of Transit Signal Priority (TSP) operations along the Route 2 between Hennepin Avenue in the uptown area of Minneapolis and the University of Minnesota campus in Minneapolis. The purpose of the effort will support Metro Transit in improving the speed and reliability of the route as TSP equipment is installed along the corridor in 2020. TSP is an operational strategy that allows for transit vehicles to request an extended green light or a shortened red light from the traffic signal, while not disrupting the signal cycle in the same way that signal preemption is provided to emergency vehicles. It is anticipated that TSP operations will reduce transit travel times on the corridor between 5 and 10 percent of the current end-to-end transit travel times.

AECOM first performed a comprehensive review of the traffic signals through which the Route 2 travels to assess the transit and traffic characteristics of each traffic signal and its feasibility for providing a transit advantage to the route with TSP technology. Metro Transit provided transit data from their Automated Vehicle Locator (AVL) system that indicated average bus speeds and which traffic signals were experiencing the highest passenger delays. The City of Minneapolis also provided Synchro files that were used to understand which signals had available time within the signal cycles that could be used for TSP operations.

Based on a review of this data, a total of 13 traffic signals were selected for TSP operations based on the transit data and traffic data gathered. One of these intersections at Franklin and Bloomington may receive additional equipment to enable a transit queue jump for eastbound travel. In addition, Metro Transit has requested a right turn only phase to be implemented at Oak and Washington on the University campus in the westbound direction to improve westbound travel time. Refer to the project map for further detail on TSP locations along the corridor.
AECOM then worked with the City of Minneapolis to gather traffic signal timing files and signal layout sheets to review the signal times and phasing in greater detail. This included gathering the minimum green times, clearance times, and pedestrian intervals to calculate the phase extension and reduction times for the signal phases that would provide Metro Transit buses along the Route 2 with signal priority when requested. It also included calculations of the Time of Service Desired (TSD) and Time of Estimated Departure (TED) for the bus at every intersection.

In addition, AECOM calculated Metro Transit detection zones based on the estimated time available for TSP at each intersection. These detection zones are specific to the vendor of TSP equipment that is installed on Metro Transit buses and enable the bus to make a request for TSP to the traffic signal when the equipment has detected it is within the correct zones. In an Advance Detection Zone, a notification is sent from the bus to the traffic signal that it will be arriving soon, while the actual TSP request is made within the TSP activation zone. An example below shows the detection zones and proposed TSP signal timing parameters for the Franklin and Blaisdell intersection.

AECOM then summarized the proposed TSP signal timing parameters and the TSP detection zones into an 11x17 plan sheet layout for each intersection. Previously, these parameters and zones would be contained in separate files by the City and Metro Transit. Summarizing the information into a plan sheet will help both Metro Transit and the City understand how TSP is operating and assist in making adjustments as needed after TSP becomes operational on the corridor.
Freeway-to-freeway interchanges are large, complex, and costly features of transportation infrastructure. They are also highly important components of the system, facilitating high-volumes of commuters, freight, and transit between major corridors. Freeway system interchanges can be sources of congestion as well, when traffic growth has exceeded original designs and regional movements can result in limited capacity or conflicting vehicle maneuvers.

Meanwhile, improvements to these components of the transportation system are often highly complicated and expensive, due to the bridges and grade-separated connections that allows these interchanges to function within limited right of way. These factors limit the number or magnitude of such locations that can be addressed with resources currently anticipated for mobility investments in our region.

MnDOT and Metropolitan Council recognized these challenges and have undertaken the Freeway System Interchange Study over the past 18 months. This objective of the study was to systematically evaluate all of the freeway-to-freeway interchanges in the region, to:

- Assess where the most pressing mobility and safety issues are located
- Develop a range of solutions scaled to the observed issues
- Identify opportunities for future investments

Study Interchanges
First step was to determine interchanges to be evaluated in detail as part of this study. There are many types of interchanges, ranging from local land-access interchanges to major system interchanges. There are also several locations that fall somewhere in between, perhaps having characteristics of system interchanges, but also not exhibiting all features of a freeway.

All interchanges connecting existing freeways were carried forward from this stage of the study. Additional locations were also included if the exhibited both of: 1) has a system interchange design (i.e. no signals), and 2) connected existing or potential future freeways. This resulted in identification of 56 system interchanges that would be evaluated further.

Focus Locations
Performance measures were calculated for each approach at all study interchanges to evaluate current operating conditions. These measures included:
To evaluate each of the 222 approaches, measures were weighted based on results of a poll conducted with members of the study’s Technical Advisory Committee. This allowed all locations to be compared across all measures, even when some approaches had higher scores in some categories than others. Natural break points were observed in the distribution of approach scores, revealing 64 locations that stood out among the rest. The locations would be investigated further to assess the role of the system interchange in these measures. In addition, all interstate-to-interstate approaches also advanced, given their importance in supporting regional mobility and economic activity.

Solution Locations
While the performance measures evaluated for the focus locations provided an important assessment of current conditions at system interchanges, they did not isolate the root causes of the mobility and safety deficiencies occurring there. To do that, more granular evaluation of freeway geometry and traffic movements was necessary. Freeway lane assignment was implemented for each of the high-scoring locations to identify the bottleneck within each interchange approach. This method uses the lane configuration, entrance and exit ramp locations, and origin-destination volumes to assess lane-changing behavior and identify where conflicts and over-capacity hot spots are expected.

The results of these evaluations revealed bottlenecks that may be upstream, downstream, or within the system interchange. Given the study objective of developing solutions for freeway system interchanges, those found to have primary bottlenecks within the interchange would undergo solution development. Others, that were observed to have congestion caused by upstream or downstream bottlenecks, were not investigated further, as these issues would require different types of solutions such as mainline capacity or local access modification that were beyond the scope of this study.

Right-Sized Solutions
The solution development process included three distinct steps, making this a complex phase in the process. First, several solutions were developed for each location ranging from low to medium to high-cost categories.

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<th>Measure</th>
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<td>Freight</td>
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Right-Sized Solutions
The solution development process included three distinct steps, making this a complex phase in the process. First, several solutions were developed for each location ranging from low to medium to high-cost categories.
Second, solutions were evaluated to estimate the expected mobility and safety performance, and capital cost. The same lane assignment procedure from the previous step was updated with the lane geometry and volume changes associated with each solution to evaluate congestion reduction. Safety benefits were derived from a reduction of crashes based on reduced conflicts and congestion. Project construction costs were estimated using unit cost estimates for pavement, bridges, and other components, along with a generous risk factor reflecting the uncertainty associated with major freeway projects.

The third step was to compute the return on investment based on the costs and benefits estimated for each solution. This measure was defined as the “return period”, or in other words the length of time needed for the initial project investment to pay for itself in terms of benefit to the public. Solutions with return periods of 20 years or less were considered cost-effective, as this time horizon coincides with MnDOT current benefit-cost guidance for project evaluations. In addition, numerous solutions had costs under $10 million and return periods of under five years. These solutions were specifically noted as “lower-cost/high-return” projects that may be considered for shorter-term implementation.

Regional Opportunities
The final phase in the study was to add context to the right-sized solutions in the form of potential upcoming investment needs. Key planning resources were referenced to assess where and when future pavement and bridge preservation activities are likely to be undertaken. These include the State Highway Improvement Program (STIP), Capital Highway Investment Plan (CHIP), Bridge Replacement and Improvement Management (BRIM), and Transportation Policy Plan (TPP). Each of these resources provides detail on the type of investment anticipated and a potential time range for implementation.

This context was combined with the right-sized solution evaluation results to outline regional opportunities for system interchanges across the region. These system interchanges generally feature right-sized solutions at a range of cost levels, and have preservation investments anticipated in the coming decades. These are presented by location, along with a likely time horizon that may be most suitable to enhance preservation projects with safety and mobility improvements identified through this study.
Conclusions & Lessons Learned
This multidisciplinary effort employed a number of transportation engineering and planning methods to create a blueprint for the region’s system interchange investment opportunities. Performance measures, traffic analysis, highway design, and economic evaluation were all utilized to distill interchange locations with significant safety and mobility concerns, and where cost-effective solutions have been identified. The results will provide a roadmap for MnDOT, the Metropolitan Council, and partners in the region to optimize implementation of cost-effective system interchange improvements over the years to come.

Acknowledgements
The authors would like to acknowledge the many contributors that were instrumental in achieving the outcomes of this study:

Project managers Michael Corbett of MnDOT and Tony Fischer of Metropolitan Council
Members of the Project Management Team and Technical Advisory Committee
Consultant team partners at Sambatek, Kimley-Horn & Associates, and Associated Consulting Services
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Source: Dilbert.com from 12/17/19.
The NCITE community was saddened to learn of the passing of one of our long-time members, Bruce Boje. Bruce died unexpectedly on Saturday, November 30, 2019, of heart failure.

Bruce worked for many years as a partner in the firm BBB (Bather, Belrose, Boje) where one of his lines of work was porting and selling European traffic signal optimization software packages (written in metric) to customers in the United States. Bruce later moved to Westwood Professional Services in Eden Prairie where he spent many years as a respected consultant providing signal timing optimization and other signal operations services.

Two of Bruce's co-workers, Vern Swing and Nick Erpelding, were also friends with Bruce at the bridge table. They offered these remembrances: Bruce was passionate about life, his wife and family, his career and his hobbies. He was an avid cyclist, loved pickleball, enjoyed his techy toys, loved Mexican food and beer, and loved bridge. Bruce relished the coming of spring so he could get on his bike again and get his 50-mile rides done on the days he wasn’t playing pickleball. In his younger days he raced throughout the summers. When Bruce was introduced to pickleball he dove headlong long into the game. He and Joyce played many tournaments and were considered experts. He was generous with his time and knowledge and encouraged anyone to start playing and offered to teach newcomers the basics, and at the same time was active in the local organization as President, then Treasurer.

“Bruce loved his gadgets and could tell you how to remotely open his garage door from his phone, remotely control the temperature in his house from his phone, and how the Tesla he and Joyce bought was getting bi-weekly software updates and what those updates did. He was passionate about alternative energy, and as was always the case with Bruce, if he was passionate about a subject, he was very well studied. Bruce could explain to you in detail how solar panels worked and what to expect in the upcoming decades. Needless to say, I was devastated when I received the call from Joyce in the evening of the November 30th, that Bruce had passed away. I will greatly miss my good friend.” - Vern Swing

“I first met Bruce after taking a job at Westwood. Bruce was a long-time expert in the traffic engineering industry and I was semi-new to the field. Bruce took me under his wing and helped me learn the how-to’s of traffic signal operations. Bruce was a tech lover and tech expert. He was a whiz with computers and spreadsheets. Several of the tools I use in my work to this day are modeled after templates Bruce developed decades ago. His knowledge of 80's era (and earlier!) equipment still used to operate modern traffic signals was amazing. Even after his retirement, and after I had moved on to SRF, I would still reach out to him for advice and guidance, and he would happily provide it.

On one of our work road trips, Bruce asked if I knew how to play bridge, and was more than slightly surprised when I said "Yes!" From that point forward we spent many hours discussing bridge, playing together as partners occasionally. In bridge and beyond, Bruce knew how to motivate me like a parent in order to learn from my mistakes and improve for the future.

I will greatly miss my friend and mentor.” - Nick Erpelding
If you or a friend has changed jobs or moved, we would like to stay in touch. Members, please update your information by visiting http://www.ite.org/membership/index.asp. To access this area, you will need to know your membership number. Your “username” is your membership number, and your “password” is the first 6 letters of your last name (e.g. Johnson=Johnso). Non-members please contact Jack Olsson via phone (651.393.6158) or email (Jack.Olsson@kimley-horn.com) for assistance. Please provide you name, title, employer, complete street address (including mailstop, if applicable), telephone number, fax number, and email address.