Grand Forks - East Grand Forks
METROPOLITAN
PLANNING ORGANIZATION

TECHNICAL ADVISORY COMMITTEE MEETING
WEDNESDAY, MARCH 13TH, 2024 – 1:30 P.M.
EAST GRAND FORKS CITY HALL TRAINING ROOM

PLEASE NOTE: Due to ongoing public health concerns related to COVID-19 the Grand Forks/East Grand Forks Metropolitan Planning Organization (GF/EGF MPO) is encouraging citizens to provide their comments for public hearing items via e-mail at: info@theforksmpo.org. To ensure your comments are received prior to the meeting, please submit them by 5:00 p.m. one (1) business day prior to the meeting and reference the agenda item(s) your comments address. If you would like to appear via video or audio link for comments or questions, please also provide your e-mail address and contact information to the above e-mail. The comments will be sent to the Technical Advisory Committee members prior to the meeting and will be included in the minutes of the meeting.

MEMBERS

Palo/Peterson _____	Mason/Schroeder_____	West _____
Ellis _____	Zacher/Johnson _____	Magnuson/Ford ____
Emery/Fanfulik _____	Kuharenko/Hunter _____	Sanders _____
Brooks/Edwardson _____	Bergman _____	Christianson _____
Riesinger _____		

1. CALL TO ORDER

2. CALL OF ROLL

3. DETERMINATION OF A QUORUM

4. MATTER OF APPROVAL OF THE FEBRUARY 14, 2024, MINUTES OF THE TECHNICAL ADVISORY COMMITTEE

ACTION ITEMS

5. MATTER OF FUNCTIONAL CLASSIFICATION UPDATE .... KOUBA

NON-ACTION ITEMS

6. MATTER OF UND INTERN UPDATE .... HALFORD

7. MATTER OF MPO 101 PRESENTATION .... HALFORD

8. OTHER BUSINESS
   a. 2024/2025 Unified Work Program Project Update .... HALFORD
   b. MPO Updates:
      - April TAC Agenda Items .... HALFORD
         - SS4A Update .... HALFORD
   c. Agency Updates

9. ADJOURNMENT

PROCEEDINGS OF THE
TECHNICAL ADVISORY COMMITTEE
Wednesday, February 14th, 2024

CALL TO ORDER

Stephanie Halford, Chairman, called the February 14th, 2024, meeting of the MPO Technical Advisory Committee to order at 1:32 p.m.

CALL OF ROLL

On a Call of Roll the following member(s) were present: Wayne Zacher, NDDOT-Local Government; Andrea Edwardson, Grand Forks Planning; George Palo, NDDOT-Local District; Nancy Ellis, East Grand Forks Planning; Jon Mason, MnDOT District 2; Steve Emery, East Grand Forks Engineering; Rich Sanders, Polk County Engineer; Tom Ford, Grand Forks County; and Nick West, Grand Forks County Engineer.

Absent: Ryan Brooks, Ryan Riesinger, David Kuharenko, Ryan Riesinger, Troy Schroeder, Carter Hunter, Michael Johnson, Lane Magnuson, Dale Bergman, Nels Christianson, and Jason Peterson.

Guest(s) present: Kristen Sperry, FHWA-Bismarck; and Blue Webber, Bolton and Menk.

Staff: Stephanie Halford, GF/EGF MPO Executive Director; Teri Kouba, GF/EGF MPO Senior Planner; Tyler Manske, MPO Planner; and Peggy McNelis, GF/EGF MPO Office Manager.

DETERMINATION OF A QUORUM

Halford declared a quorum was present.

INTRODUCTIONS

Halford asked that guests attending the meeting please introduce themselves.

MATTER OF APPROVAL OF THE JANUARY 10, 2024, MINUTES OF THE TECHNICAL ADVISORY COMMITTEE

MOVED BY EDWARDSON, SECONDED BY ELLIS, TO APPROVE THE JANUARY 10, 2024, MINUTES OF THE TECHNICAL ADVISORY COMMITTEE, AS PRESENTED.

MOTION CARRIED UNANIMOUSLY.

ACTION ITEMS:

MATTER OF GRAND VALLEY FP AMENDMENT

Manske reported that this is nothing you haven't seen before; previously when we released this RFP we didn't get any bids on it, so we chatted with the City of Grand Forks folks and they said that they wanted to put it back out again, so all the changes you see were submitted, and you can find the bulk of them on Pages 10 and 11, and they are just changes to the dates to update the new timeline.

Manske referred to Page 11 and commented that they also changed the proposal evaluation criteria and weight, they did change the weights so that they are more focused on the firms dedicated team members knowledge, rather than the firm's knowledge itself because we have a lot of the same firms applying for these things over and over again and, as Dave Kuharenko brought up. we want to make sure that whoever is brought on to these projects has relevant experience; that the team members that are being assigned to these projects from these companies have that relevant experience, so that is the reason for that change, but otherwise it has remained pretty much the same as what you approved before, so staff is seeking approval of the amended RFP for the Grand Valley Study.

Palo asked if they knew of any particular reason why there wasn't any interest in the project when the first RFP went out, have we reached out to anybody to see what the conflict was or why there wasn't any interest. Manske responded that we did hear from a couple of consultants, and it is his understanding that a few of them were putting all their eggs in the Safe Streets For All basket and they didn't feel comfortable splitting their team up in the event they would get both contracts, so it was just a timing and/or staffing issue, so we are hoping that this time around, we give a little bit of a buffer between, we will have a little bit more interest.

Halford commented that when she did hear from several of the consultants, they did say that they would be interested in it in a couple of months, so we should see some interest in it this time.

MOVED BY PALO, SECONDED BY EMERY, TO APPROVE FORWARDING A RECOMMENDATION TO THE MPO EXECUTIVE POLICY BOARD THAT THEY APPROVE THE AMENDED GRAND VALLEY RFP, AS PRESENTED.

Voting Aye: Emery, Palo, Sanders, Ellis, West, Mason, Edwardson, Zacher, and Ford.
Voting Nay: None.
Abstain: None.
Absent: Peterson, Riesinger, Schroeder, Brooks, Bergman, Johnson, Hunter, Magnuson, Kuharenko, and Christianson.

MATTER OF MINNESOTA CARBON REDUCTION PROGRAM FUNDING SOLICITATION

Kouba reported that this is kind of, it will work into our T.I.P. as well, it is part of the T.I.P. amendment as well, but basically MnDOT has allocated various amounts from 2024 through 2027, and possibly 2028, but we are still waiting to hear if they are going to actually have additional funds, but it sounds like they will be doing additional Carbon Reduction Program funding as well.

Kouba said, though, that given that there is such a small amount for each given year, East Grand Forks would like for all the years to be kind of combined so that they can use it to fund the project that they have on 5th Avenue N.W. and 4th Street N.W., so basically we worked with the ATP and they agreed that they will reduce what carbon reduction funds they have for 2025, since that is the year that they haven't solicitated for yet, and then our next several years will then go to the ATP for that funding, so basically we are advance constructing that project.

Kouba stated that, basically we solicit for this funding source, and so if you approve this work process for these funds then we will put it into the T.I.P. amendment.

MOVED BY ELLIS, SECONDED BY SANDERS, TO APPROVE FORWARDING A RECOMMENDATION TO THE MPO EXECUTIVE POLICY BOARD THAT THEY APPROVE USING THE ATP'S 2025 CARBON REDUCTION PROGRAM FUNDING TO DO THE SIDEWALK PROJECT ON 5TH AVENUE N.W. AND 4TH STREET N.W. AND ZERO OUT THE REMAINING YEARS FUNDING.

Voting Aye:	***Emery, Palo, Sanders, Ellis, West, Mason, Edwardson, Zacher, and Ford.***
Voting Nay:	***None.***
Abstain:	***None.***
Absent:	***Peterson, Riesinger, Schroeder, Brooks, Bergman, Johnson, Hunter, Magnuson, Kuharenko, and Christianson.***

MATTER OF APPROVAL OF 2024-2027 T.I.P. AMENDMENT

Kouba reported that we received a rehab project from the NDDOT. She stated that it is a multi-county project and the cost shown is for the whole project, which includes areas outside of the MPO area, so it is for all of eastern North Dakota, and it is maintenance projects. She added that this project was not previously in our T.I.P., so the whole project is new.

Kouba stated that we are changing out, we are adding in the advanced construction, and putting in, so that the project in East Grand Forks can be included.

Zacher referred back to the NDDOT rehab project, 120004, and stated that they added a CPR prefix to that project as well. He said that it doesn't affect the funding, the splits are the same, and he is working to get this into an April bid opening, so he will have a CPM coming up and that type of thing as well. He asked if it has local costs identified on it. Kouba responded that it does. Zacher said that the cost estimate they got is in this general area, plus or minus, but they are within 5% so they are okay with what is shown, so he doesn't think we need to necessarily change anything, he just wanted you to be aware that they did add an Alpha prefix to this project.

Zacher said that on that ATR project, yes, it is all eastern North Dakota, but it is only one site in Grand Forks or inside the MPO boundaries, so yes those funds are the entire project costs but there is only one withing the MPO area.

Zacher asked, since the text for previous amendments stay red, can we add a date on there? He said that he evidentially looks at things too quickly to see the difference between a 1, 2, and a 3. He stated that it doesn't need to be red, but as we are moving forward can we through a date on there, because it does say "date modified" in that column. Kouba responded that she will try to make sure to do that, but it is a small box. Zacher said that she is right, but he is just trying to figure out if there is a way to make it clearer even if we change the text for old amendments to black, that would work as well.

Kouba stated that we do need to hold a public hearing on this.

Kouba opened the public hearing. There was no one present for discussion. Kouba closed the public hearing.

Kouba reported that we didn't receive any input on-line or in person from the public either.

Emery referred to the East Grand Forks CRP project and said that it shows project year 2025, the project year will be 2024 but he is assuming with MnDOT's fiscal cycle that starts July 1st that is why it is shown as 2025. Kouba responded that basically it is so that that funding, basically we are shown advance construction funds, that it is coming from 2025, and the bundle years basically, and moving them to 2024, so basically, we are saying it is happening in 2024 but 2025 is the payback year. Emery said, then, that we will be able to use those funds after July 1st then. Mason responded that he would have to work with Brian Kettenring on an AC Agreement and then the reimbursement will flow through that process. Sanders added that you typically won't see the money until close to October 1st, but you get to advance construct it whenever you want to.

MOVED BY ELLIS, SECONDED BY SANDERS, TO APPROVE FORWARDING A RECOMMENDATION TO THE MPO EXECUTIVE POLICY BOARD THAT THEY APPROVE THE 2024-2027 T.I.P. AMENDMENT, AS PRESENTED.

Voting Aye:	***Emery, Palo, Sanders, Ellis, West, Mason, Edwardson, Zacher, and Ford.***
Voting Nay:	***None.***
Abstain:	***None.***
Absent:	***Peterson, Riesinger, Schroeder, Brooks, Bergman, Johnson, Hunter, Magnuson, Kuharenko, and Christianson.***

NON-ACTION ITEMS:

MATTER OF FUNCTIONAL CLASSIFICATION UPDATE

Kouba reported that generally once we have gotten our urbanized area established, and approved by FHWA and FTA we start looking at the roadways to make sure that the functional classification of each roadway matches the urbanized area or rural area. She said that we did do a pretty significant review of all the functionally classified roadways in Grand Forks back in 2019, they weren't approved until 2021 however, so in reviewing, just at a staff level, all of these there hasn't been anything too drastic, but North Dakota did send out a letter advising us that they wanted an update by April 1st for preliminary approval of any changes to the functional classified system.

Kouba stated that she didn't see any need for any revisions, other than what needs to be done for the purpose of whether it is classified as an urban collector or a rural major collector, especially in the south end of town, as well as along U.S. #2, and on North Washington. She said that it would just be changing them from rural to urban.

Kouba added that, just to be thorough, Minnesota doesn't really distinguish between rural and urban so she doesn't see a need for changes on the Minnesota side, but she wanted to get this in front of everybody, and in the end it doesn't really change the percentages as we look at them overall for everything, so she really wants to hear if we need to sit down with everybody individually or get a little group together. She said that she knows that mostly it will be on the North Dakota side since she doesn't see any reason to change anything on the Minnesota side as they aren't really pushing forward on anything right now.

Edwardson commented that she knows that David Kuharenko is going to want to have those small group meetings because it is kind of hard going back and forth. She stated that some of the discussion they had is planning for the 47th Avenue Interchange, and if it is not on here the distinction between rural and urban and trying to figure that out, so they have some follow-up questions that they are trying to kick around on the south end, both on the west side of the interstate here, at 40th Avenue South, and stuff like that, kind of pushing it that way, and how that future planning should go to 47th, is it too early to put it in now, or kind of those different things, so she knows there will be follow-ups.

Kouba asked if they are looking more on the south end of town; things are going to change for functional class as things become built out. She asked if Wayne could maybe answer some of that. She stated that she is trying to remember if there is a wait until it is actually being built; it has always been considered future then. Zacher responded that he believes that it needs to be built. He said that usually it has to be constructed already or construction is eminent is how he believes it has to be, but Kristen could explain more, and then you need to make sure that the functionally classified ties to the new functionally classified.

Kouba stated that that would have been her question; how to differentiate between when it is built and when it isn't built. She said that she would contact David and set something up. Halford asked who they wanted in that meeting. Edwardson responded it would probably be David, Carter, and herself.

Halford asked if anyone from the Minnesota side would want a meeting to touch base or are you good with no changes. Mason responded that it might be good to touch base with Erika, he isn't sure with where MnDOT is sitting on the functional classification updates. Kouba stated that so far what we've heard from Erika is that they aren't looking at anything right now. Halford added that we are a little ahead of the game is what Erika said. Zacher commented that, just a heads up, there is a federal deadline for those updates, it is out a little way, but that is kind of how they landed on April for their preliminary stuff because with the last census things did drag on a little bit longer than they probably should have, so this time around there is a federal deadline on those classification changes. He said that he believes it is a year or two out, so we do have time.

Kouba asked if Nick West wanted to be part of the conversation as well since we are moving some of those functionally classified from rural to urban. She said that she is setting up a one-on-one with David, Carter, and Andrea to talk about some of these locations and looking at the functional class, especially since these are moving from a rural functional classification to an urban functional classification. West responded that he would like to be involved.

Kouba stated that she will contact everyone and set something up so that we can get something together that is preferred by everyone for our March MPO meeting so we can get at least preliminary approval before we send it to the NDDOT.

Information only.

MATTER OF UND INTERN UPDATE

Halford reported that they were planning on a presentation to get an update on where this project is at and where it is going but we had a couple of key members from the committee that are out today that would like to hear the presentation and be part of the conversation and ask some questions, so they requested it be tabled to the March Technical Advisory Committee meeting, so if there is anything to update with this project she will make sure it is in the packet for next month's meeting but until then it probably wouldn't hurt to kind of review it, it just gives you that little bit more time so when we do bring it back in March you can come with any questions you might have for them because she thinks it is June or July when they are finishing up this project.

Edwardson said that that was her other question when they requested to push the update back was if they were going to impact UND's schedule if they can accommodate us. Halford responded that they were good with that. She said that they did ask for Carter and David's contact information so she thinks they will be reaching out to them with a few questions, but we will just bring this back next month if everyone is okay with that.

Information only.

OTHER BUSINESS

a. 2024/2025 Unified Work Program Project Update:

Halford said that we finished up the Street and Highway Plan and we started the ITS Architecture Update, and again just a reminder that the deadline was pushed up to the August/September timeframe because of the ATAC Contract, so we can keep it in the contract we currently have with them.

Halford stated that Tyler already gave an update on Grand Valley, so we are still in the RFP process so we will get that out after the Executive Policy Board meeting next week. She said that she doesn't see why they wouldn't approve it, so we will get that back out on the street again and hopefully we will get nibbles this time.

Halford said that Safe Streets For All did get three proposals and we did interview all three and are moving forward with contract negotiations right now so hopefully we will have a draft contract today and we will bring it forward to the Executive Policy Board for them to review and sign, and then we will get going like gang busters. She added that this project is scheduled to finish up in September of 2025.

Halford stated that, again, we have started talking about functional classification, and we did give an update on that already.

Manske said that the bike maps we do every year, and we had created a new draft and shared it with the Bicycle Advisory Committee and the Greenway Technical Committee and got some really good feedback, so we finally have a final draft that has been looked over by members of the public and we are looking at getting the maps printed, about 2,000 copies through Knight Printing. He added that we literally just got a quote back from Knight Printing this morning before this meeting so we will continue moving forward with that and hopefully by the end of the month or early March we will have the bike maps in hand.

b. Agency Updates:

Zacher said that he talked a little bit earlier during the T.I.P. review about getting the Grand Forks Regional Signals Project moving, they did remove a few of the signals that have railroad preemption on them, just due to the timing that the Railroad was going to require for coordination, but again, looking for probably an April bid date on that. He stated that it is a two-year project; the first year will be more the sandblast and paint type rehab projects and then the arc signals, which he believes are all on DeMers Avenue; and then the second year would be more the replacements, and they will need that lead time anyway for poles and that type of thing.

Zacher stated that, as a reminder, and Stephanie is well aware of it because she gets to create the agenda, but they have their MPO Director's meeting coming up on March 15th, so any topics can be sent to Stephanie, and she can add to the agenda if you wish.

Zacher commented that Central Dakota MPO does have their Executive Director position posted, so that is out there as well if anyone is interested.

Halford said that she does have a question; the Red River Flood Study, from Grand Forks basically to the Canadian border, do you have any kind of update or summary that you can share with the group. Zacher responded that he guesses he could. He said that he received an email the other day that said that the consultant working on it sent an update email as to where things were at, and talked about going through the PEL process and the Scope-of-Work, and then at the end talked about that the study is currently on pause because the cities are submitting a Federal Raise Grant application for the planning side of things. He stated that on the periphery of that he knows that Kristen Sperry, FHWA, has been involved a little bit on it, but the local agencies have decided to pause further development on the PEL study due to the Raise Grant being submitted and MnDOT published an internal memo saying that they would not be starting any new PEL studies until further guidance is developed, so that is what he has at this time, but he doesn't know if you are looking for something different or not. Halford responded that she just heard from the consultant that they are starting interviews, or they are looking at doing interviews next week or something like that. Zacher asked what they were doing interviews for. Halford responded that maybe they are talking about two different projects. Zacher said that he thought she was talking about the inter-city bridges. Halford responded that she was talking about the Red River Valley Flood Study. Zacher said that he is not involved with that study other than probably telling Stephanie about it whether he should have or not, but he saw that the RFP went out, but he hasn't heard how many consultants responded, he has heard when there will be interviews, he hasn't heard much of anything, but he could do some digging if you are interested. Halford stated that she reached out to a couple of the partners to let them know that the RFP is on the street, and if there are people she missed, that would find it interesting, she wanted to bring it up here. Zacher said that he thinks that in talking with their Bridge Division, they are doing a study, along with MnDOT and the Corps of Engineers, along various reaches along the Red River, and they put Grand Forks in there as kind of a known location type thing, a general point of reference, so the exact locations of the flood study haven't necessarily been determined yet, but it sounds like costs are being shared between the Corps of Engineers, the NDDOT, and MnDOT, and from that standpoint, again, it goes into various reaches at various locations, and it is his understanding is it is not a continuous study, it is various spots that either have gapped information, looking at information again to see if anything else needs to be done, and as far as he is aware it sounds like the scope is still kind of up in the air but it also sounded like it would be run by the Corps of Engineers, so he doesn't know if they put the RFP out more as just to say it is coming, but he thinks the Corps of Engineers is kind of taking the lead on it, but he may be completely off base. Halford stated that if anyone is interested, she can forward the link to them with that information.

Palo reported that the contracts have been awarded for the first leg of the Washington Street/Railroad Bridge Underpass project, they are just waiting for it to be signed, so the next couple of years if you utilize DeMers and Washington you will want to avoid that intersection.

Information only.

ADJOURNMENT

MOVED BY ELLIS, SECONDED BY EMERY, TO ADJOURN THE FEBRUARY 14TH, 2024 MEETING OF THE TECHNICAL ADVISORY COMMITTEE AT 2:09 P.M.

MOTION CARRIED UNANIMOUSLY.

Respectfully submitted by,

Peggy McNelis, Office Manager

MPO Staff Report

Technical Advisory Committee:

March 13, 2024

MPO Executive Board:

March 20, 2024

RECOMMENDED ACTION: Preliminary Approval of Functional Classification Changes.
TAC RECOMMENDED ACTION:

Matter of approval of the discussion of the functional classification.

Background:
In 2023, MPO staff worked with all our partners to adjust the Census defined Urbanized Area to an Urbanized Area that reflects the urban area we live and work in every day. The next step is for roadway functional classification to match the new urban boundary.

On January 8, 2024, North Dakota Department of Transportation (NDDOT) sent a letter requesting that Forks MPO begin the update of the roadway functional classification. NDDOT asks for a preliminary review to be submitted by April 1, 2024. Once NDDOT reviews and comments, the MPO has until July 1, 2024 to submit the final functional classification system.

After discussion with our partners, the only changes will be to designate functionally classified road way urban that was previously rural. This only affects the pots of funding that can be used on the roadways.

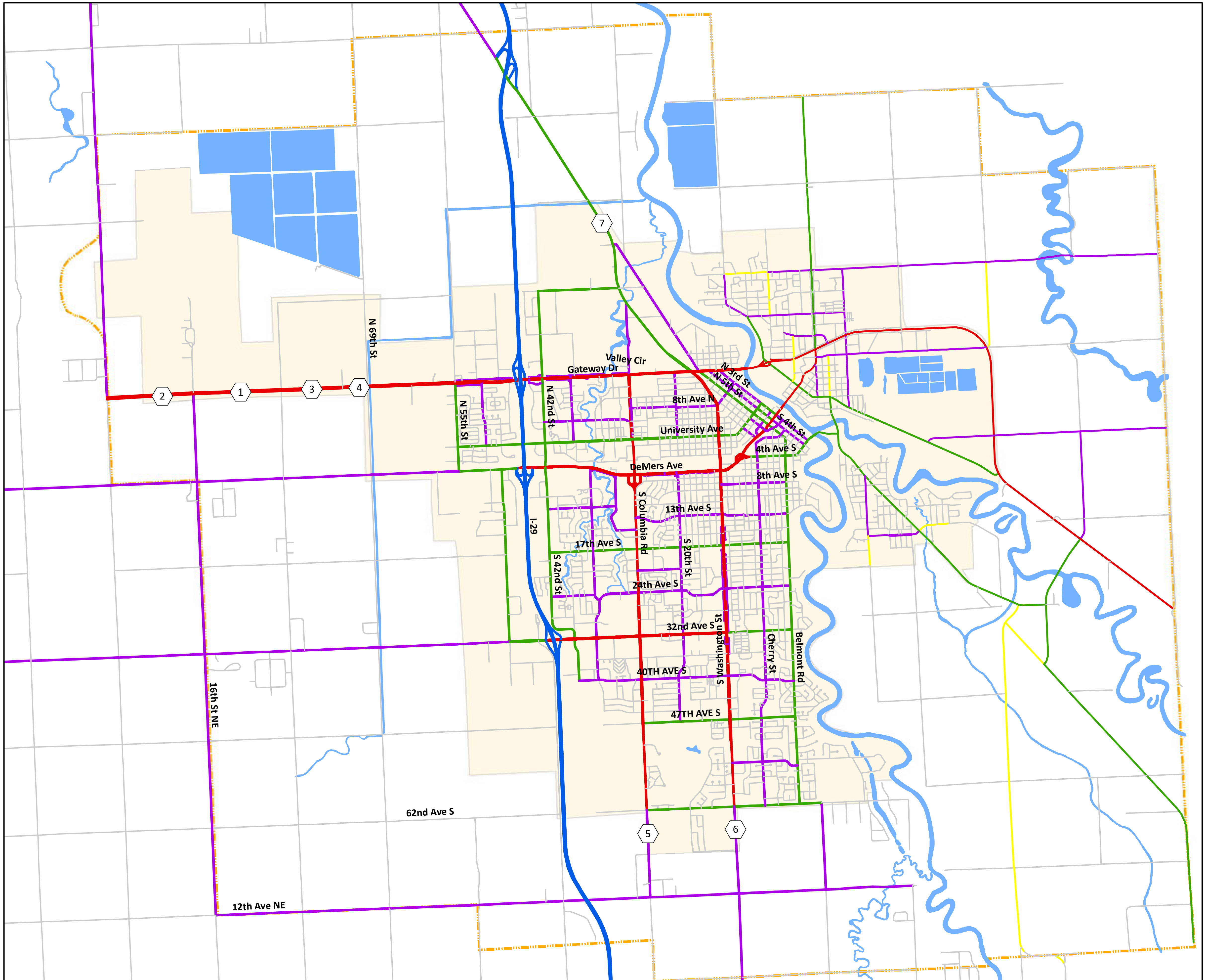
Findings and Analysis

- The changes are only to functionally classified roadway that are now in the adjusted urbanized area.
- When NDDOT reviews and sends comments, staff will update and bring forward for final approval.

Support Materials:

- Map of functional classification changes.
- Table of functional classification changes.
- Mileage tables.
- NDDOT Letter

Forks MPO Functional Classification



- Interstate
- Principal Arterial
- Minor Arterial
- Major Collector
- Minor Collector
- Local
- Urbanized Area
- MPO Planning Area
- Water
- X Table Number

N W E S

0 1 2 Miles

Grand Forks - East Grand Forks Metropolitan Planning Organization

ID	Road	From	To	Changes From	Final Classification	Surface	Justification	Jurisdiction	Segment Length (In Miles)
1	US-2/Gateway Dr	N 83rd St	Airport DR	Principal Arterial	Principal Arterial	Paved	This section is now in the urbanized area.	State	1.02
2	US-2/Gateway Dr	Airport Dr	0.42 mi East of 17th St NE	Principal Arterial	Principal Arterial	Paved	This section is now in the urbanized area.	State	0.58
3	US-2/Gateway Dr	73rd Cir N	15th St NE	Principal Arterial	Principal Arterial	Paved	This section is now in the urbanized area.	State	0.71
4	US-2/Gateway Dr	N69th St	73rd Cir N	Principal Arterial	Principal Arterial	Paved	This section is now in the urbanized area.	State	0.29
5	S Columbia Rd	62nd Ave S	69th Ave S	County Major Collector	Collector	Paved	This section is now in the urbanized area.	County	0.47
6	S Washington St	62nd Ave S	69th Ave S	County Major Collector	Collector	Paved	This section is now in the urbanized area.	County	0.48
7	US-81B/N Washington St	40th Ave N	Mill Rd	Minor Arterial	Minor Arterial	Paved	This section is now in the urbanized area.	State`	0.57

System Mileage by Functional Classification 2024 (miles)

Classification	North Dakota MPA	Percent in ND MPA	Minnesota MPA	Percent in MN MPA	Total MPA	Percent for MPA
Interstate	16.2	4.1%	0.0	0.0%	16.2	3.0%
Principal Arterial	24.4	6.2%	8.2	5.7%	32.6	6.1%
Minor Arterial	31.8	8.1%	15.9	11.1%	47.7	8.9%
Collector/Major Collector	62.9	16.1%	16.1	11.3%	79.0	14.8%
Minor Collector	0.0	0.0%	8.5	6.0%	8.5	1.6%
Local	255.8	65.4%	94.0	65.9%	349.8	65.5%
All Road Total	391.1	100.0%	142.7	100.0%	533.8	100.0%

Note: MPA= Metropolitan Planning Area

From: FHWA Highway Functional Classification Concepts, Criteria, and Procedures 2023 Edition

Classifications in MPO Area	Percent Range*
Interstate	1% - 3%
Other Principal Arterials	4% - 9%
Minor Arterials	7% - 14%
Collector/Major Collector	3% - 16%
Minor Collector	3% - 16%
Local	62% - 74%

* We are using the definition of rural state based on our lead being North Dakota.

Note: The review was based on an urban system for the Grand Forks and East Grand Forks Adjusted Urban Area.

Grand Forks Change in Urban Mileage by Functional Classification

Classification	2021	2024	Change
Interstate	10.0	10.0	0.0
Principal Arterial	21.4	24.0	2.6
Minor Arterial	30.9	29.8	-1.1
Collector/Major Collector	39.8	40.5	0.7
Minor Collector	0.0	0.0	0.0
Local	171.0	191.0	20.0
All Road Total	273.1	295.3	22.2

NORTH Dakota | Transportation
Be Legendary.

January 8, 2024

Stephanie Halford
Executive Director
Grand Forks-East Grand Forks MPO
P.O. Box 5200
Grand Forks, ND 58206-5200

Dear Mrs. Halford:

SUBJECT: ROADWAY FUNCTIONAL CLASSIFICATION UPDATES TO ADJUSTED URBANIZED AREA BOUNDARY

Thank you for your efforts to complete the Adjusted Urbanized Area boundary before the Federal Highway Administration (FHWA) deadline of December 29, 2023. The next step in the update process related to the 2020 US Decennial Census is for the MPO to update the roadway functional classification to match the new boundary.

The North Dakota Department of Transportation (NDDOT) is requesting that you begin the update to the roadway functional classification system. The functional classification system identifies the roadways that will qualify for federal funding within various NDDOT funding programs. The functional class system needs to be well defined and make sense for the context of the roadway being classified. Roadway classification will consider various criteria such as, lane and shoulder widths, daily traffic volumes, access control, facility type, roadway function and any other contextual items relevant to the classification.

FHWA has prepared a guidance document for reference in updating the functional classification system. The document is called *Highway Functional Classification Concepts, Criteria and Procedures*, 2023 Edition. Here is a link to the document: https://www.fhwa.dot.gov/planning/processes/statewide/related/hwy-functional-classification-2023.pdf. This document provides real world examples as well as detailed information on each roadway classification. Please utilize this reference in your update process. There are a couple of exceptions to the guidance:

1. NDDOT will only recognize one classification of Principal Arterials.
2. NDDOT will only recognize one classification of Collectors.
3. NDDOT will recognize the design characteristics as desired for new functional classification requests, but they will not be a requirement for previously approved classifications.

After the MPO has prepared a draft functional classification map, please submit the information to NDDOT for a preliminary review no later than April 1, 2024. NDDOT will review the submittal and provide comments back to the MPO, as necessary. The MPO's submittal must be a cooperative and coordinated effort with its member jurisdictions.

Once all comments have been addressed, the MPO must submit their final functional classification system via electronic copy no later than July 1, 2024. Submittals shall include a letter requesting approval of the functional classification updates, a breakdown of roadway mileage between classes, a map of the updated system and GIS files. All correspondence for submittals may be made to the following:

Sengaroun Marohl
Local Government Division
NDDOT
smarohl@nd.gov
701-328-4448

Please note that unless other arrangements have been made with NDDOT, failure to meet the June 1, 2024 final submittal date will result in NDDOT making functional classification changes on the MPO's behalf.

If you should have any questions during the updating process, please contact Seng or Michael E. Johnson at 701-328-2118.

Thank you for your work in responding to changes necessitated by the 2020 US Census release.

With gratitude,

Paul M. Benning

Paul M. Benning
Local Government Engineer

38/mej

c: Ed Pavlish, Grand Forks District
Al Grasser, City of Grand Forks
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MPO Staff Report

Technical Advisory Committee:

March 13, 2024

MPO Executive Board:

Grand Forks - East Grand Forks
METROPOLITAN
PLANNING ORGANIZATION

STAFF RECOMMENDED ACTION: Update from the University of North Dakota on the intern conducting a Traffic Speed Study.

TAC RECOMMENDED ACTION:

Matter of an update from the University of North Dakota (UND) on the intern conducting a Traffic Speed Study.

Background:

This discussion started over a year ago as a great partnership opportunity with the University of North Dakota (UND) and Grand Forks/East Grand Forks Metropolitan Planning Organization. The main objectives of the study include:

- Analyze traffic safety and speeding tickets data for South Grand Forks and determine locations that need more detailed speed studies.
- Determine the effects of traffic calming techniques on driver behavior and pedestrian safety.
- Recommend approaches to address traffic safety concerns.

Findings and Analysis:

- Effect of traffic calming techniques on traffic speed and pedestrian safety

Support Materials:

- Presentation
- Progress report

Traffic Speed, Traffic Calming Techniques, and Safety Implications for Pedestrians and Bicyclists

Wednesday, Feb 14, 2024

Mulugeta D. Amare
PhD Student

Daba S. Gedafa, Ph.D., P.E., ENV SP, F. ASCE
Chair and Professor

CIVIL ENGINEERING
UNIVERSITY OF NORTH DAKOTA.

Outline

- ❖Introduction
- ❖Objectives
- ❖PART I - Traffic Data Analysis
- ❖PART II - Effect of In-crosswalk traffic signs
- ❖Conclusions and Future Works

Introduction

- Traffic safety
  - Traffic speed
  - Traffic speed calming techniques

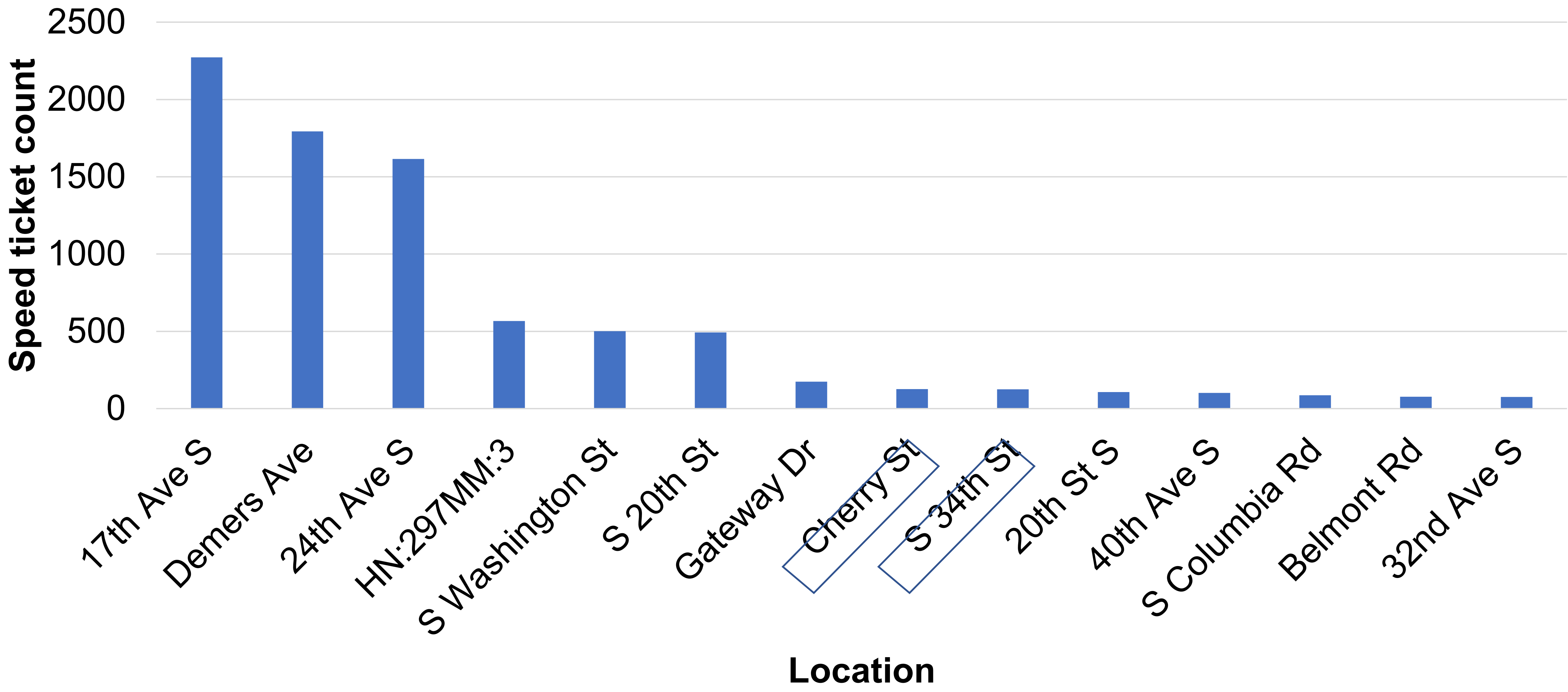
Objectives

- ❖Evaluate the impact of traffic calming methods,
- ❖Analyze traffic crash and speeding citation data of Grand Forks,
- ❖Analyze the effect of YIELD and STOP signs in-crosswalk signs, and
- ❖Recommend approaches to address traffic safety concerns.

Part I - Traffic Data Analysis

- Speeding ticket data analysis
  - Speeding ticket summary
  - Speeding ticket and crash data mapping

Speeding Ticket Data



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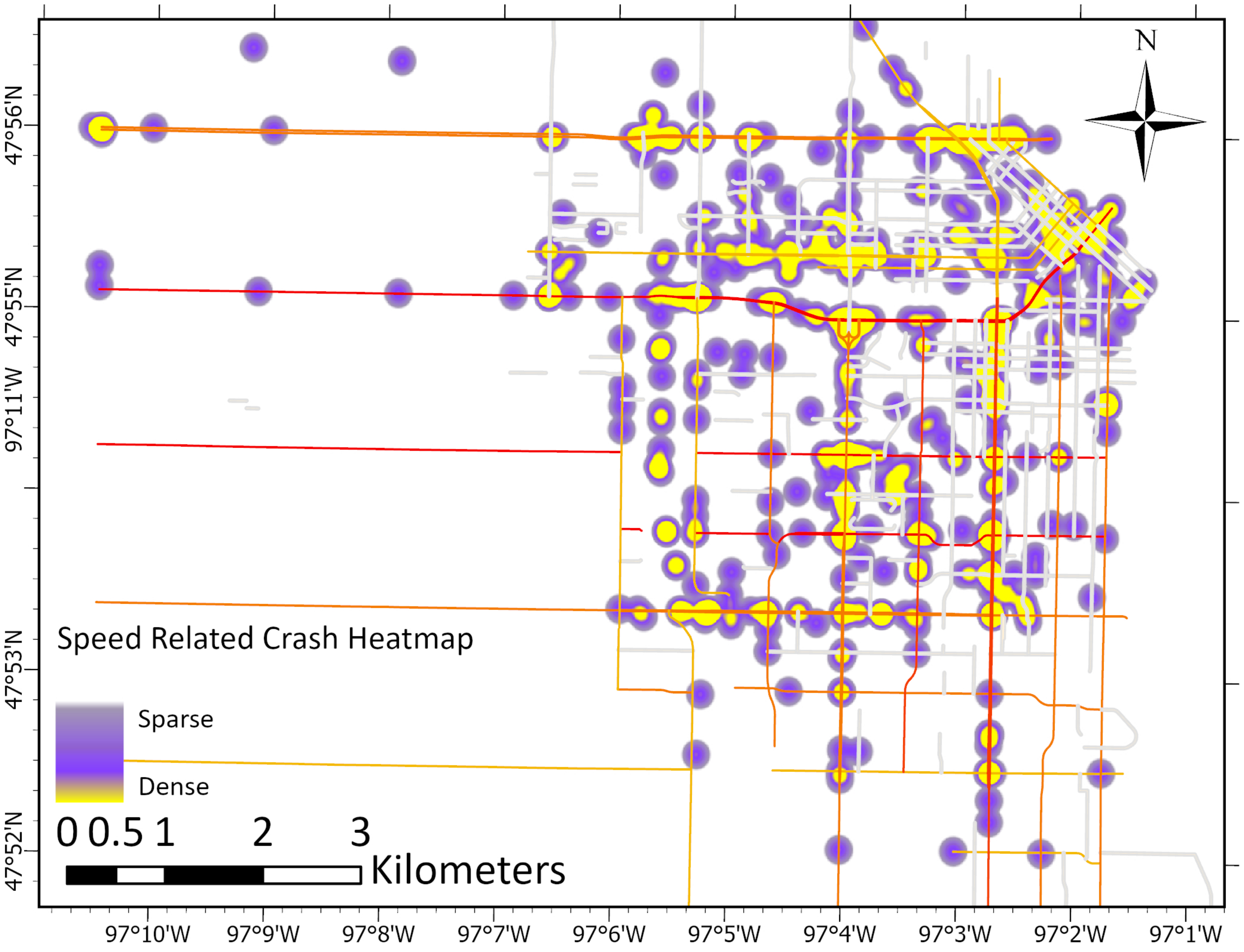
Speed-Related Crash Heatmap



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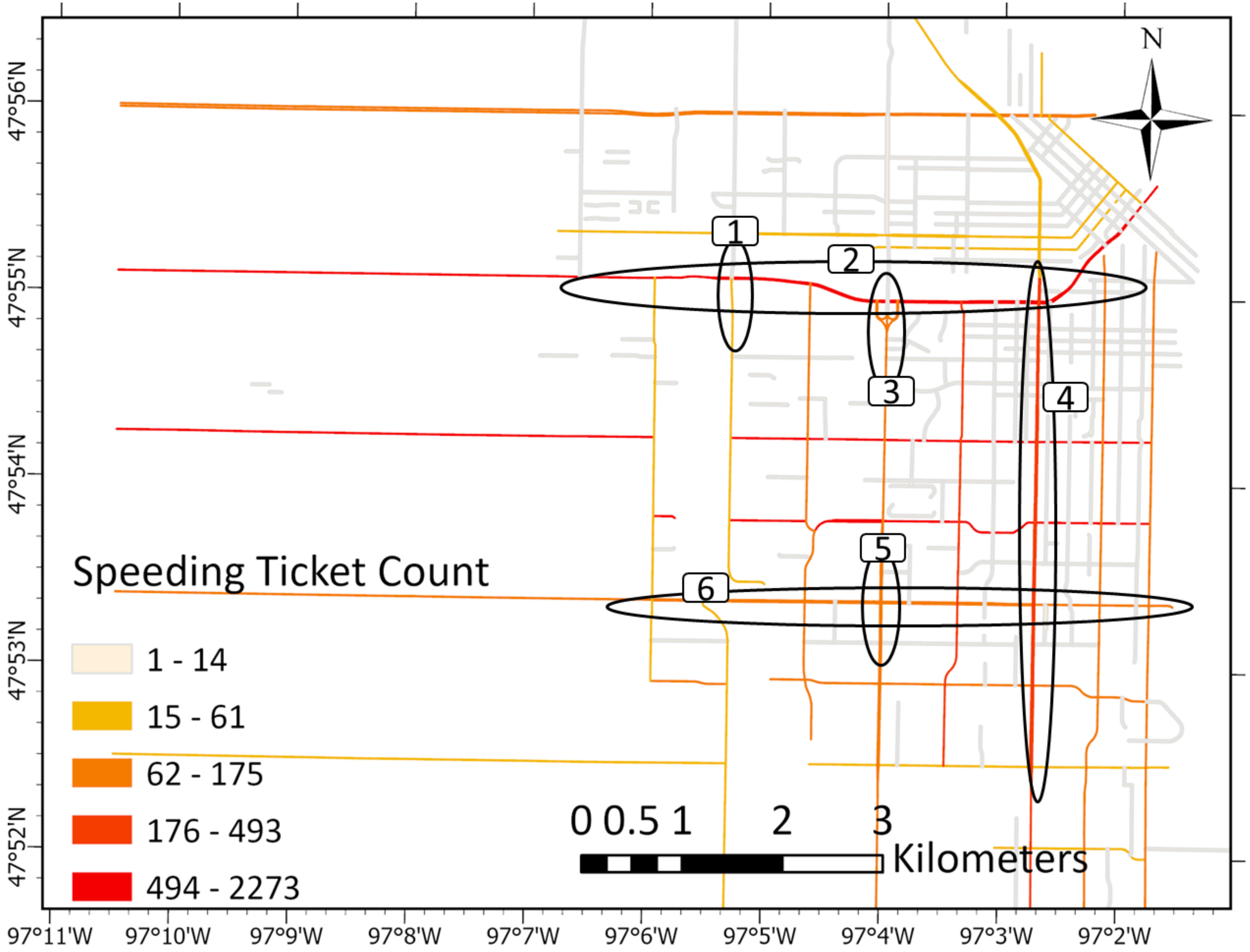
Hotspot Areas



Id.	Location Name
1	Demers Ave and S 42ND ST Intersn.
2	Demers Ave
3	Demers Ave and S Columbia Rd Intersn.
4	S Washington St
5	32^{nd} Ave S
6	32^{nd} Ave S and S Columbia Rd Intersn.

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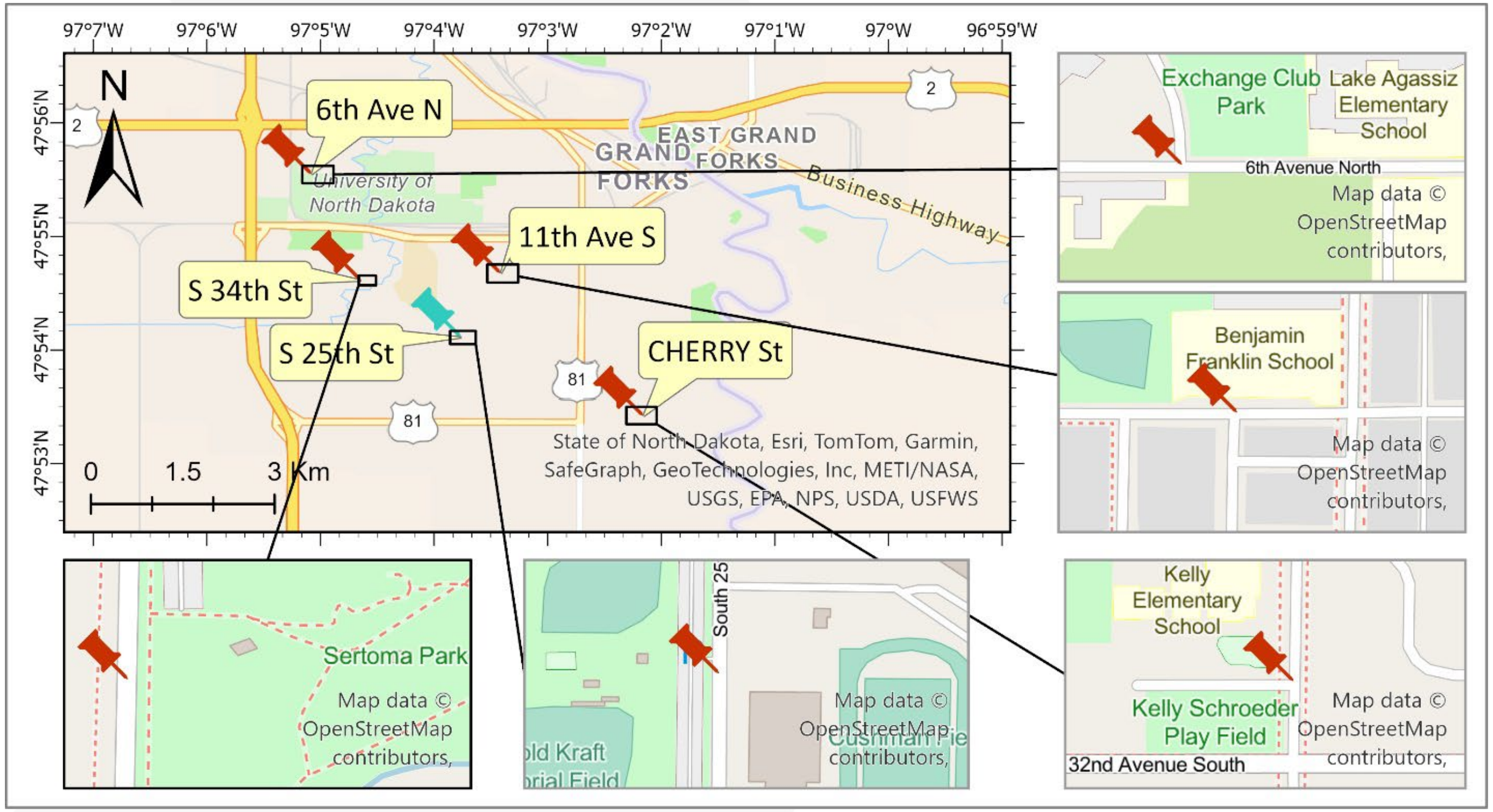
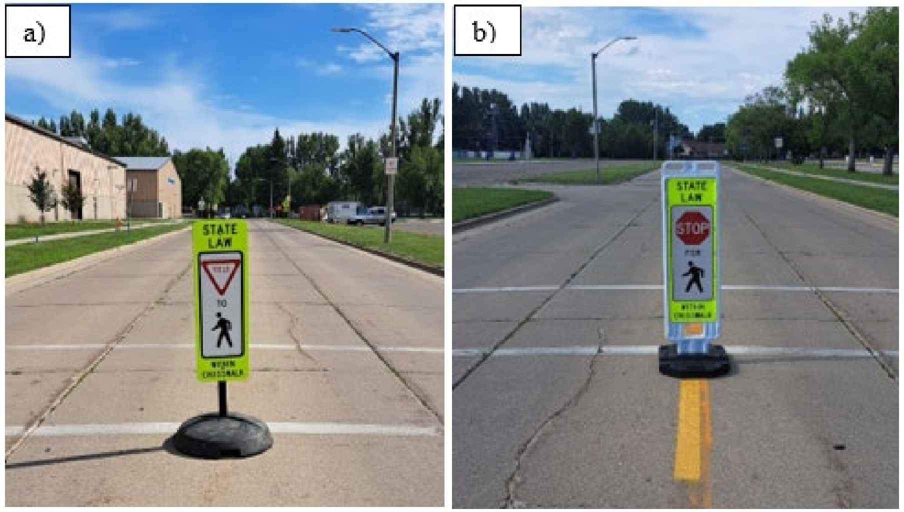
Part II - Effect of In-crosswalk Traffic Signs



Study area



In Crosswalk signs a) YIELD to Pedestrians and b) STOP to Pedestrians at S 25th St (0 ft)

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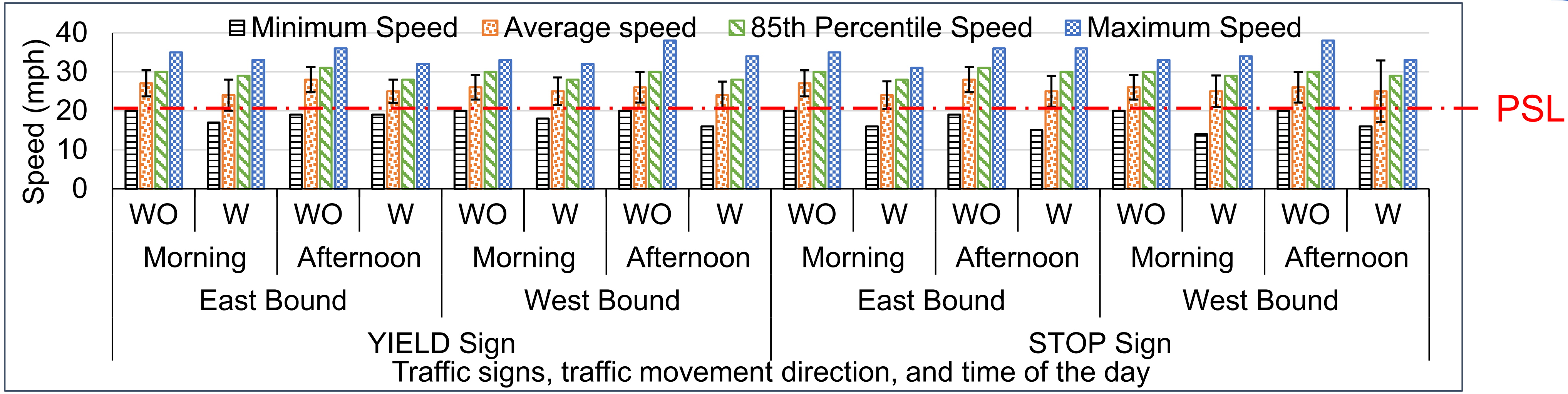
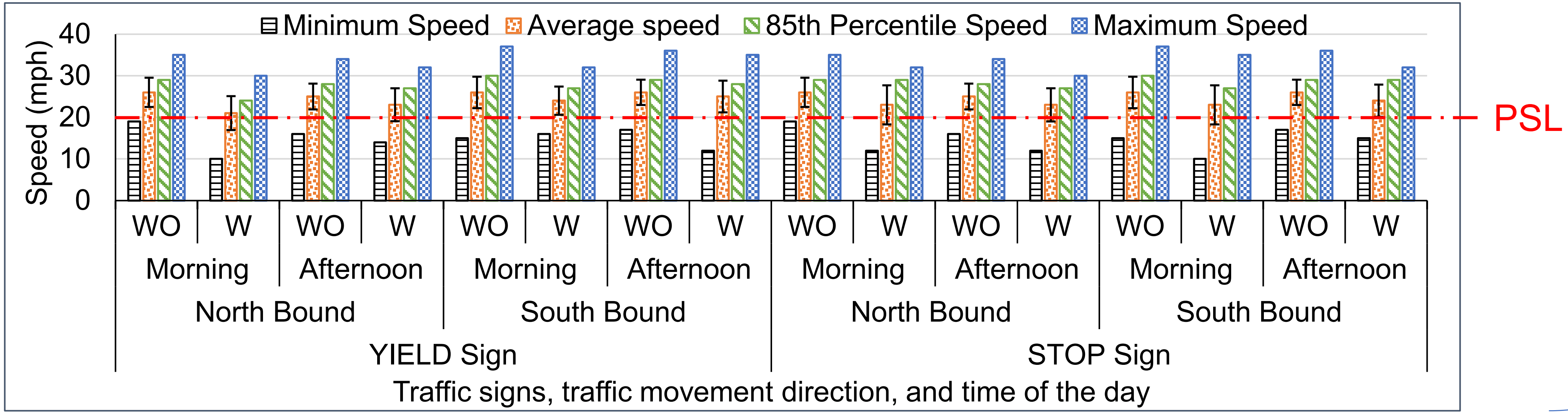
Effect of Signs on Speed When School is not in Session

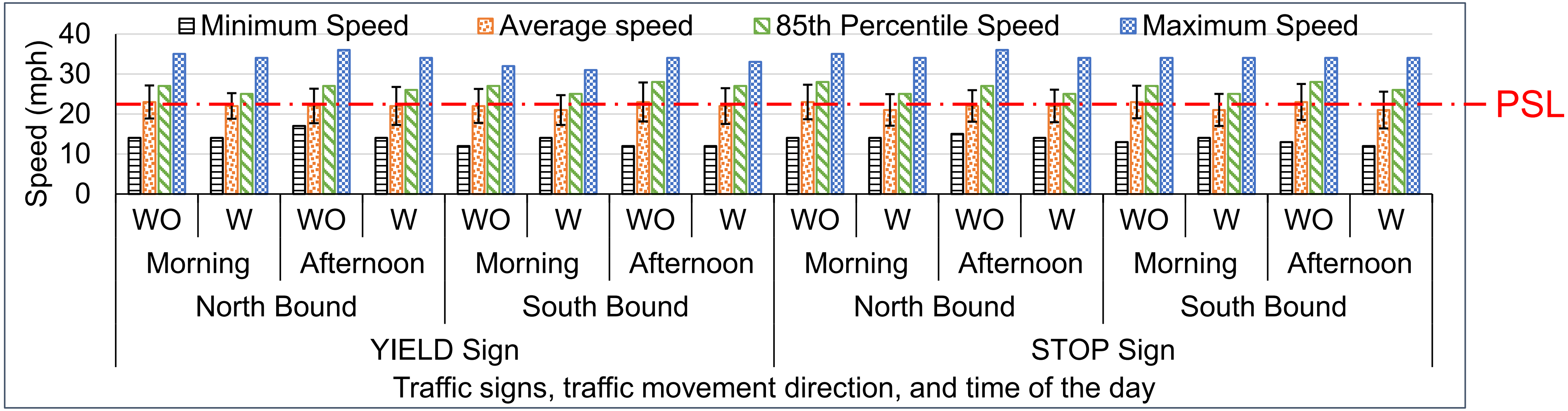


a) 25th Ave S

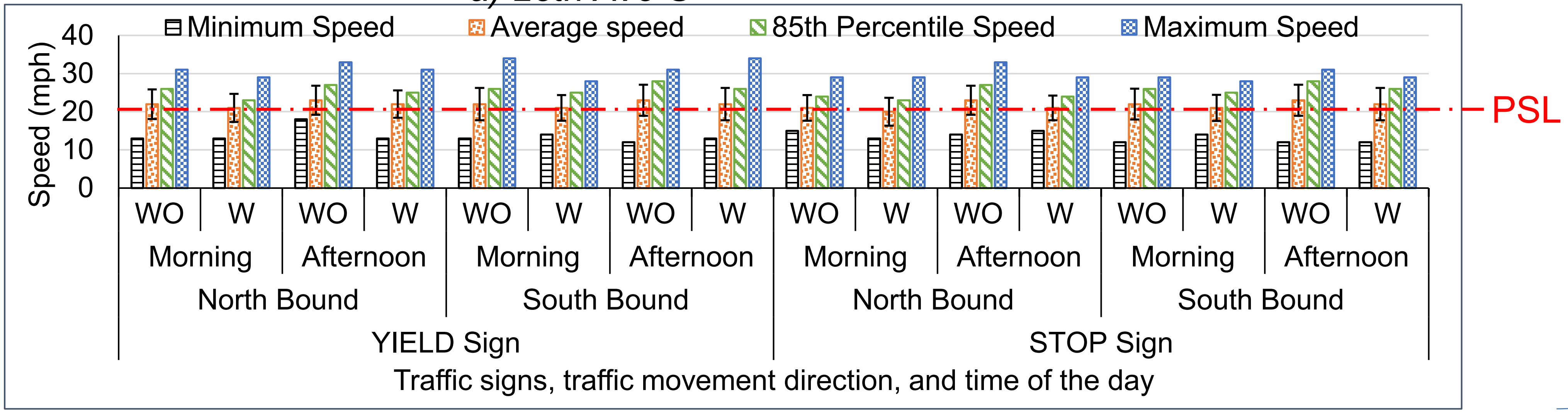


b) Cherry St

Effect of Signs on Speed During School Sessions



a) 25th Ave S



b) Cherry St

Effect of Signs on Yielding for Pedestrians

YIELD Sign							
Street name	Direction	Time of the day	Yielding data (Proportion)		Significance test		Combined
			WO	W	χ2 (p-value)	z-score, (p-value)	
Cherry St	North	M	90 (68.9)	84 (83.8)	4.951 (0.026) S	-2.225 (0.026) S	-2.950 (0.0032) S
		A	83 (71.1)	81 (77.8)	0.964 (0.326) N	-0.982 (0.327) N	
	South	M	80 (68.8)	84 (81.0)	3.254 (0.071) N	-1.804 (0.072) N	
		A	70 (82.9)	76 (86.8)	0.452 (0.501) N	-0.672 (0.503) N	
S 25th St	North	M	73 (74.0)	78 (92.3)	9.176 (0.002) S	-3.029 (0.002) S	-4.804 (<0.00001) S
		A	75 (76.0)	73 (86.3)	2.559 (0.109) N	-1.599 (0.109) N	
	South	M	83 (75.9)	87 (92.0)	8.191 (0.004) S	-2.862 (0.004) S	
		A	80 (73.8)	85 (87.1)	4.669 (0.031) S	-2.161 (0.031) S	
STOP Sign							
Cherry St	North	M	81 (69.1)	78 (89.7)	10.26 (0.001) S	-3.203 (0.001) S	-4.273 (<0.00001) S
		A	74 (73.0)	77 (84.4)	2.958 (0.085) N	-1.720 (0.085) N	
	South	M	70 (72.9)	73 (83.6)	2.412 (0.120) N	-1.553 (0.121) N	
		A	73 (76.7)	75 (89.3)	4.198 (0.041) S	-2.049 (0.040) S	
S 25th St	North	M	79 (74.7)	82 (90.2)	6.781 (0.009) S	-2.604 (0.009) S	-4.761 (<0.00001) S
		A	88 (73.9)	75 (88.0)	5.128 (0.024) S	-2.265 (0.024) S	
	South	M	76 (68.4)	79 (83.5)	4.875 (0.027) S	-2.208 (0.027) S	
		A	79 (69.6)	74 (86.5)	6.289 (0.012) S	-2.508 (0.012) S	

S Significant at a 0.05 significance level, N Not significant at a 0.05 significance level.

Comparison of the Effects of Signs on Traffic Speed

Location	No-school Session				Sig. Diff (95% CI)	In-School Session				Sig. Diff (95% CI)
	YIELD sign		STOP sign			YIELD sign		STOP sign		
	Avg Speed	n	Avg Speed	n		Avg Speed	n	Avg Speed	n	
6th Ave N	24.1	606	23.5	416	0.0017 S	24.2	312	24.1	356	0.6599 N
11th Ave S	24.8	291	24.9	283	0.7064 N	23.0	247	23.2	229	0.5866 N
Cherry St	23.2	331	23.4	287	0.5447 N	21.3	288	21.0	290	0.3122 N
S 25th St	23.1	243	23	216	0.7359 N	21.2	248	21.3	267	0.8949 N
Overall	23.9	1471	23.7	1202	0.3410 N	22.5	1095	22.5	1142	0.8144 N

S Significant at a 0.05 significance level, N Not significant at a 0.05 significance level.

Comparison of the Effect of Signs on Yielding

Location	YIELD	STOP	z-score (p-value)	Combined z-score (p-value)
6th Ave N	255 (85.9)	279 (87.5)	-0.535 (0.596) N	-0.497 (0.617) N
11th Ave S	227 (92.5)	204 (91.2)	0.506 (0.610) N	
Cherry St	325 (82.2)	303 (86.8)	-1.603 (0.110) N	
S 25th St	323 (89.5)	310 (87.1)	1.036 (0.298) N	

S Significant at a 0.05 significance level, N Not significant at a 0.05 significance level.

Conclusions

- 17th Ave S, Demers Ave, and 24th Ave S have more speed citation record.

- Most of the speed-related crashes occurred near intersections.

- Demers Ave, S Washington St, S Columbia Rd, 32nd Ave S, and the intersections of these roads have more frequent speed violations and crashes.

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Conclusions *(Continued)*

- The presence of in-crosswalk STOP and YIELD signs led to a decrease in both average and 85th percentile speeds.

- The presence of the traffic signs significantly improved yielding behavior toward pedestrians.

- There was no significant difference between the impact of the two types of traffic signs on speeding and yielding behaviors.
  - Transportation planners have the flexibility to use either sign.

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Future Works

- ❖Review work and cross-sectional analysis for the application of traffic calming techniques will be done.

- ❖Analysis for signal warrants at intersections will be done. The hot spot analysis result will be used as an initial criterion.

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Thank you

Questions and Comments?

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Traffic Speed, Traffic Calming Techniques, and Safety Implications for Pedestrians and Bicyclists

Report submitted by: Mulugeta Amare and Daba Gedafa

Principal Investigator: **Daba S. Gedafa, Ph.D., P.E., ENV SP, F. ASCE**

Chair and Michael & Sitney Lodoen Endowed Professor

UND Civil Engineering

Proposed Budget: $**30,000.00**

Proposed Time Period: **November 16, 2022-July 15, 2024**

UND UNIVERSITY OF NORTH DAKOTA

Civil Engineering Department

January 2024

Table of Contents

List of Figures

List of Tables

ABSTRACT
Transportation involves the movement of road users on a given corridor, and the safety aspect is the primary concern for the transportation system. Previous reports have documented that traffic speeding is a safety concern for pedestrians and bicyclists, contributing to 29 percent of fatalities and 13 percent of injuries. Pedestrian fatalities have increased by 77% over the past decade, constituting a 5% increase in pedestrian fatalities per the overall number of traffic-related fatalities. Identifying hotspot crash locations is the critical parameter for creating an informed safety measure; however, previous studies on traffic safety have primarily focused on using crash frequency as a fundamental parameter. Moreover, studies have investigated the application of different regulatory traffic signs but did not make a significant comparison between different sign types in different areas and time settings. This study presents a review of the safety implications of traffic speed for pedestrians and bicyclists and the traffic speed calming techniques on non-interstate highways. Moreover, the study evaluates the spatiotemporal clustering of traffic crashes using Geographic Information System tools. In addition, a comparative analysis was conducted to evaluate the effectiveness of in-crosswalk traffic signs, such as "YIELD TO PEDESTRIAN" and "STOP FOR PEDESTRIAN," as a potential solution for improving pedestrian safety. The findings from the spatiotemporal analysis revealed that more crashes occurred during winter, and the hotspot identification results from the Getis-Ord (Gi*) and Anselin Local Moran's (I) statistics were compelling. Furthermore, the results from the traffic sign data analysis show that the change in vehicle speed due to both traffic signs was significant in mornings and afternoons, as well as whether or not schools were in session. The yielding to pedestrians was improved in the presence of the traffic signs. However, the difference between the impacts of the two traffic signs on speed and yielding was not significant. Hence, the signs can be used interchangeably.

1. INTRODUCTION

Agencies work closely with law enforcement entities, state traffic safety offices, and the National Highway Traffic Safety Administration (NHTSA) to plan and implement policies that can help reduce the number of crashes to combat high costs, injuries, and deaths. One approach is through the Four Es of traffic safety: Enforcement, Engineering, Education, and Emergency Medical Services. The Four Es play an important role in road safety. Each component is essential and, when taken together as a unified approach, has achieved the lowest crash rates in decades. There were 5.5 million police-reported traffic crashes in 2009. Law enforcement officers work diligently to prevent crashes by enforcing traffic safety laws such as seat belt use, child passenger protection, traveling over the speed limit, impaired driving, and distracted driving. Studies have indicated that increased enforcement and educational campaigns can yield significant changes in driver behavior.

A national awareness campaign called "Click It or Ticket" has increased seatbelt use by as much as 85 percent between 2005 and 2009, saving an estimated 72,000 lives. The NHTSA, state DOTs, law enforcement, and traffic safety offices can prevent crashes by holistically addressing the four components. Technology can also improve how traffic safety advocates, engineers, and other vital stakeholders use the Four Es. The Four Es approach has contributed to a steady decline in fatality and injury rates over the past few years. The ultimate safety goal is Toward Zero Deaths (TZD) on all highways, a data-driven highway safety strategy focusing on changing driver culture. The TZD initiative relies on data from crashes and police stops, in concert with the four Es, to determine priority areas and make policy and program changes that will reduce the current fatality rate per million vehicle miles traveled (VMT) from 1.14 to zero.

Data used in analysis includes vehicle speed, traffic volume, law-enforcement crash investigation information, emergency medical response information, road sensors, design data, and the effectiveness of public education campaigns. This data can be analyzed holistically to assist decision-makers in creating strategies for comprehensive traffic safety improvement plans. Local, state, and federal agencies host this data in various databases, formats, and types of hardware, creating a challenge when integrating this information to create the holistic view of traffic safety needed to coordinate an approach that prevents crashes. Data analysis enables road designers, law enforcement officers, emergency medical responders, and those designing public education campaigns to identify trends and develop highway safety plans and interventions with the best return on investment.

2. PROBLEM STATEMENT

Safety and traffic concerns arise from increased vehicle traffic, excessive speed, and a disregard for stop signs. The speed of the vehicles is a function of the roadway quality, driver behavior, time of the day, and other roadway elements like traffic signals. United States traffic safety ranks lowest among developed countries (WHO 2021). Speed and careless driving contributed to 34% of North Dakota's fatal crashes in 2021 (NDDOT 2021a). Crashes involving speeding occurred every two and a half hours, and fatalities occurred once, approximately every ten days.

The 2022 North Dakota Department of Transportation (NDDOT) report (NDDOT 2022) reveals that Grand Forks County is ranked second and third in crash rate per million vehicle miles traveled (MVMT) and the number of crashes, respectively. Speeding is a perceived issue in general near the Intersection of Belmont Rd and 55th Ave S in particular. A pedestrian struck by a speeding vehicle in a residential neighborhood with low posted speed limits will have a much higher mortality rate. Suppose a driver increases a speed from 20 mph to 30 mph. In that case, the pedestrian fatality rate may increase by 40%, especially since the driver's ability to stop quickly decreases as their speed increases. That ten mph increase in speed affects a driver's stopping distance by about 85 feet, significantly impacting their ability to stop suddenly, especially under wet, snowy, and icy conditions prevalent in Grand Forks.

Despite all the efforts and measures, crashes still occur at a considerable rate. Identifying the specific locations where a significant number of traffic crashes occur and understanding the underlying causes of these crashes are crucial factors that play a pivotal role in making informed decisions regarding safety measures (Herbel et al. 2009; Varhelyi 2016). The crash frequency has been used as a hotspot screening by agencies. However, crash hotspot analysis should include the effect of traffic volume and crash severity.

Some methods that can increase a driver's adherence to yielding for pedestrians and reduce their traffic speed are the installation of "Stop for Pedestrian" and "Yield to Pedestrians" within crosswalk signs. The Manual on Uniform Traffic Control Devices (MUTCD) by the Federal Highway Administration (FHWA) includes in-roadway "Yield to Pedestrians within Crosswalks" signs that can be placed at uncontrolled marked crosswalks (FHWA 2009). Past studies have also documented the significance of within-crosswalk traffic signs in reducing traffic speed and increasing the drivers' yielding behavior (Ellis et al. 2007; Gedafa et al. 2014; Huang et al. 2000; Pulugurtha et al. 2012). In-roadway signs may be effective since they are directly in the motorist's field of view.

A study on the impacts of alternative yield sign placement on pedestrian safety (Gedafa et al. 2014) determined that placing a yield sign at a crosswalk was the most effective way of increasing the likelihood of a vehicle yielding for pedestrians; however, the authors recommended research on the repeatability of their results at other sites to increase the robustness of their findings. The impact of traffic signs on speeding and yielding may differ based on the type of within-crosswalk sign. A comparison of signage impacts in various time circumstances, as well as during school and non-school sessions, was not investigated.

Therefore, Part 1 of this paper reviews the safety concerns regarding traffic speed and engineering traffic speed-calming techniques, preferred locations, and their effect on pedestrians and bicyclists by reducing traffic speed. Part 2 entails an analysis of traffic crash data along with speed citation data, employing ArcGIS geospatial analysis tools to pinpoint critical areas. Part 3 illustrates the effect of YIELD and STOP in crosswalk signs on vehicle speed and yield to pedestrians.

3. OBJECTIVES OF THE PROJECT

The main objectives of this study include the following:

- Evaluate the impact of traffic calming methods on the reduction of vehicle speed and enhancement of pedestrian and bicyclist safety,
- Analyze traffic crash and speeding citation data of Grand Forks and determine locations that need more detailed studies,
- Analyze the effect of yield and STOP in crosswalk signs on drivers' yielding and speeding behavior and the associated safety implications on pedestrians and bicyclists, and
- Recommend approaches to address traffic safety concerns.

4. LITERATURE REVIEW

Road crashes are a significant global issue, leading to thousands of human fatalities and injuries and incurring substantial resource loss. The growing concern for public safety and transportation network optimization has recently highlighted the need for accurate traffic crash analysis and assessing traffic safety in cold regions, which poses a critical challenge for developing sustainable and resilient infrastructure. The complex interplay of factors, including weather conditions, road maintenance, and driver behavior, significantly impacts transportation system safety (Maze et al.

2006). This section covers a review of traffic hotspot areas analysis, crash factors analysis techniques, and traffic calming techniques.

4.1. Traffic Speed and Safety

Increasing vehicle traffic, excessive speed, and disregard for stop signs pose safety and traffic concerns. According to the World Health Organization's report (WHO 2021), the United States is way behind other developed countries regarding traffic safety concerns. The Road Traffic Death Rate per 100,000 population in the USA is 12.7, more than twice the rate in Canada, which is second place on the list. The 2020 traffic safety fact report from NHTSA shows that 29% of the total 38,824 fatalities and 13% of the total 1,974,002 injuries across the nation were due to speeding. Moreover, speeding-related fatalities have increased by 17% from 2019 to 2020 (NHTSA 2022). Speed and aggressive driving were a factor in 34% of fatal crashes in North Dakota in 2021. In addition, a speed driving-related crash occurred every two and half hours, and fatality occurred once in nearly ten days (NDDOT 2022).

Figure 1 presents the percent contribution of speeding towards fatalities and injuries. For the ten years of data in the USA, the average contribution of speeding is 28% and 15% for fatality and injuries, respectively. Other factors like belt non-use, helmet non-use, distraction, alcohol involvement and causation, and absence of traffic signs and signals account for the remaining percentage.

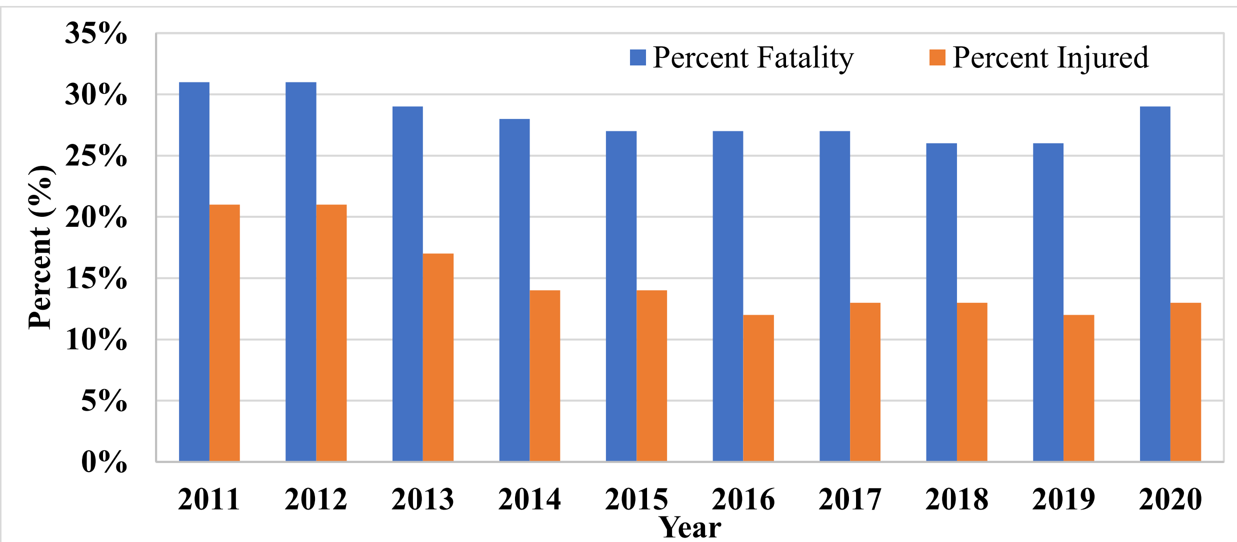


Figure 1 Percent fatality and injury due to traffic speeding, 2020 USA (NHTSA 2022)

In a Crash Summary Report by the North Dakota Department of Transportation (NDDOT), more than 50% of the traffic citations for five consecutive years, 2011-2016, reports were due to speeding. Moreover, in 2021, 27% of the fatalities were due to speeding. Among all the counties in North Dakota, Grand Forks is ranked second and third in crash rate per million vehicle miles traveled (MVMT) and the number of crashes, respectively. In 2021, nearly every six and three days, one bicyclist and one pedestrian were involved in a crash (NDDOT 2022).

The NHTSA fact sheet data (NHTSA 2022) for ten consecutive years, 2011-2020, documented the fatality exposures experienced by five groups of road users. The passenger car occupants are the most affected, followed by light trucks and non-occupants. Figure 2 summarizes the percentage fatality of each passenger type in the USA in 2020. From this, it is evident that at least one out of five persons killed is non-occupant, mainly pedestrians and bicyclists.

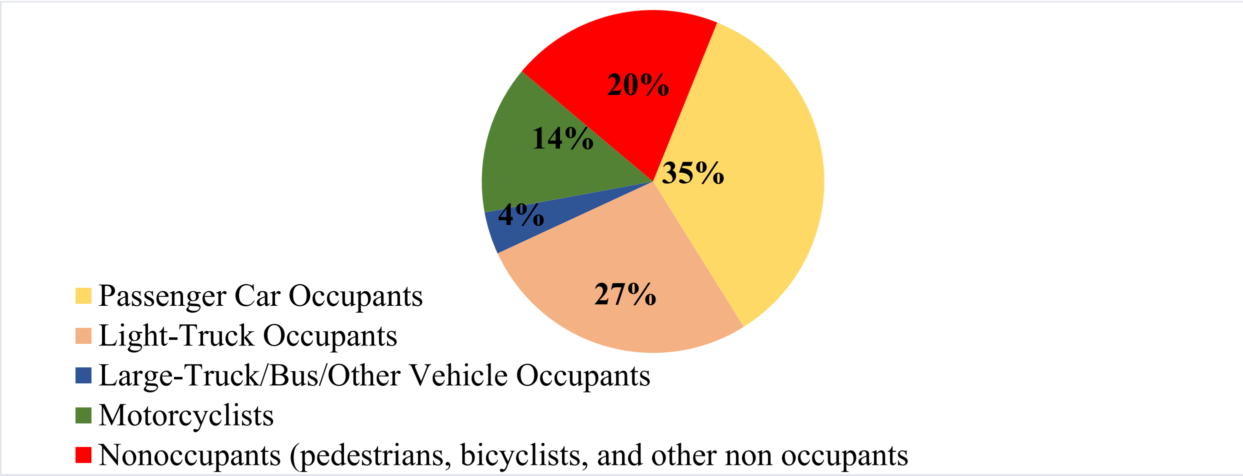


Figure 2 Percentage of traffic fatality per occupant type, 2020 USA (NHTSA 2022)

The relationship between the risk of fatality of a given passenger hit by a vehicle and the speed of the vehicle during collision or impact is calculated using a single logistic regression model, and it is called risk factor (Kong and Yang 2010; Li et al. 2015; Nie et al. 2014; Nie et al. 2010; Tefft 2013). The trend of the fatality curve is similar for all curves, and the risk of pedestrian death looks inevitable for speed values greater than 40mph. Figure 3 summarizes the results of regression models developed by researchers for different countries (considering other parameters like age, impact location, and pedestrian height are constant).

By reducing vehicle speeds and enhancing safety for non-motorized street users, traffic calming can enhance the quality of life for locals living along affected roadways. By improving the safety, mobility, and comfort of non-motorists, traffic calming supports the livability and vitality of residential and commercial districts. These goals are often met by lowering vehicle speeds or densities on a single route or a network of streets. Road-side, vertical, lane-narrowing, and other elements that use self-enforcing physical or psycho-perception mechanisms to achieve desired results are included in traffic-calming measures (FHWA 2017).

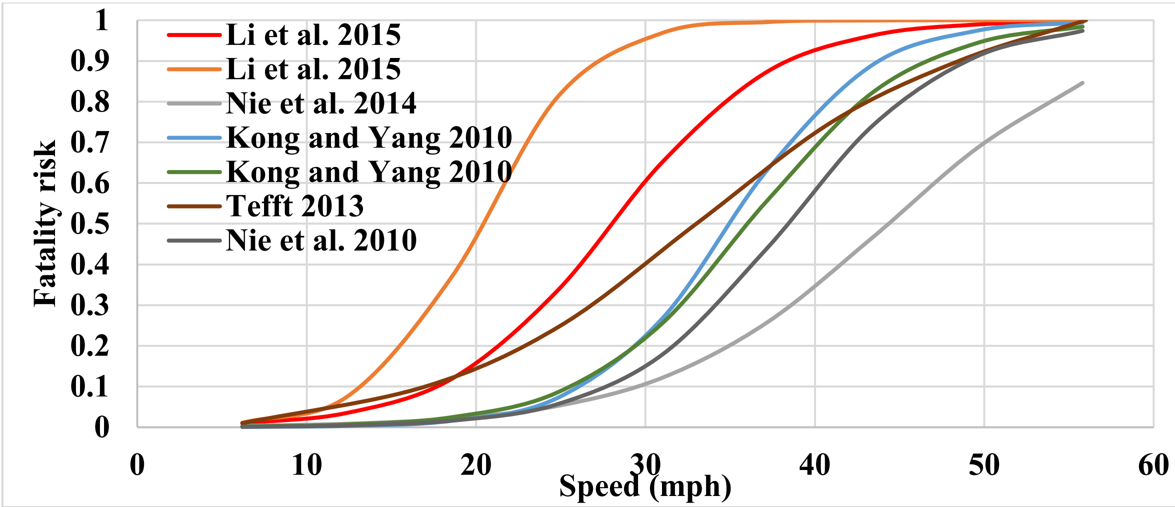


Figure 3 Vehicle speed vs. Fatality risk for pedestrians

4.2. Traffic Hotspot Area and Crash Contributing Factors Analysis

Identifying the specific locations where a significant number of traffic crashes occur and understanding the underlying causes of these crashes are crucial factors that play a pivotal role in making informed decisions regarding safety measures (Herbel et al. 2009; Varhelyi 2016). State-of-the-art Geographic Information System (GIS) tools are instrumental in effectively pinpointing frequently occurring traffic crash locations (Amiri et al. 2021; Audu et al. 2021; Ivajnsic et al. 2021; Lee and Khattak 2019). Additionally, employing advanced Association Rule Mining (ARM) methods can yield valuable perspectives into the multitude of factors and situations statistically associated with these crashes (Das et al. 2019; Yang et al. 2022).

Previous research has investigated the use of GIS-based techniques, including Hotspot Analysis using Getis Ord Gi*, Global Moran's I, Mean Center, Emerging Hotspot Analysis, and Kernel Density Estimation-KDE to discern spatial and temporal crash distribution patterns (Amiri et al. 2021; Le et al. 2020; Mesquitela et al. 2022). These tools can be integrated with road network screening methods, such as Crash Rate (CR) and Equivalent Property Damage Only (EPDO), and increase result accuracy (Le et al. 2020). Researchers have compared GIS tool performance as it relates to identifying hotspot areas (Le et al. 2020; Lee and Khattak 2019; Mafi et al. 2019; Mesquitela et al. 2022). A study comparing five cluster mapping techniques (Amiri et al. 2021) revealed that Moran's I method was the most accurate and precise tool for hotspot identification and clustering pattern identification. Alternative tools, such as KDE and Gi*, are also effective in pinpointing hotspot areas. Integrating weighted crash parameters, such as severity index, using these GIS tools enhances the rationality of hotspot identification (Le et al. 2020).

Creating associations between crashes and contributing factors significantly affects traffic safety analysis. These associations can be revealed using state-of-the-art data analysis approaches such as Association Rule Mining (ARM) (Hossain et al. 2022; Lan et al. 2023; Rahman et al. 2021). Previous studies have explored traffic incident data; however, they could not often establish clear causal relationships between contributing factors; therefore, identifying root causes remains elusive (Basheer Ahmed et al. 2023; Li et al. 2018; Zaitouny et al. 2022). Previous research has not fully utilized advanced data mining techniques, such as Association Rule Mining (ARM), for comprehensive incident data analysis.

4.3. Effect of Traffic Calming Techniques on Traffic Safety

The Institute of Transportation Engineers defines traffic calming as the combination of measures that reduce the adverse effects of motor vehicle use, alter driver behavior, and improve conditions for non-motorized street users. Traffic calming consists of physical design and other measures put in place on existing roads to reduce vehicle speeds and improve safety for pedestrians and cyclists. For example, vertical deflections (speed humps, speed tables, and raised intersections), horizontal shifts, and roadway narrowing are intended to reduce speed and enhance the street environment for non-motorists. Closures that obstruct traffic movements in one or more directions, such as median barriers, are intended to reduce cut-through traffic. Traffic calming measures can be implemented at an intersection, street, neighborhood, or area-wide level (USDOT 2021). Table 1 summarizes traffic calming techniques and case study areas registered by FHWA.

Table 1 Summary of traffic-calming countermeasures (FHWA 2017; Johnson 2005; Zegeer et al. 2013)

Calming measures	Purpose	Main Considerations	Case study area
Temporary Installations for Traffic Calming	Change the entire look of a street to send a message to drivers that the road is not for fast driving.	Check for the cost of measures and use them for specific and emergency cases.	Fifth Street Traffic Calming, Tempe, Arizona
Chokers	Designed to slow vehicles at a mid-point along the street through	Ensure that bicyclist safety and mobility are not diminished	Fifth Street Traffic Calming, Tempe, Arizona
Chicanes	Reduce vehicle speeds on local streets and add greener (landscaping).	Reduce on-street parking	Berkshire Street Traffic Calming, Cambridge, Massachusetts
Mini-circles	Reduce speed and manage traffic at intersections where volumes do not warrant a stop sign or a signal.	Use yield, not stop, controls, and do not make generous allowances for motor vehicles.	Seventh Avenue Traffic Calming, Naples, Florida
Speed Humps and Speed Tables	Enhance the pedestrian environment at pedestrian crossings.	It is not recommended in a sharp curve.	Corridor Traffic Calming, Albemarle, Virginia
Gateways	Create an expectation for motorists to drive more slowly and watch for pedestrians entering a commercial, business, or residential district from a higher-speed roadway. They can also create a unique image for an area.	Traffic-slowing effects will depend upon the chosen device and the area's overall traffic-calming plan.	Leland Street Redesign Bethesda, Montgomery County, Maryland
Specific Paving Treatments	Send a visual to motorists about the function of a street and create an aesthetic enhancement of a street. It can be used to delineate separate spaces for pedestrians or bicyclists.	Slippery and bumpy surfaces should be treated.	Downtown Revitalization Partnerships, Clemson, South Carolina
Serpentine Design	Change the entire look of a street to send a message to motorists to drive slowly on this street.	Most cost-effective to build as a new street or where a street will soon undergo significant reconstruction	Old Town Improvements, Eureka, California
Curb Ramps	Provide access to street crossings and improve sidewalk accessibility for people with mobility restrictions.	Consideration of disabled pedestrians	
Speed Cushion	preferred alternative primary emergency response route or on a transit route with frequent service	Cutouts width design	

"Road diets" are one approach to traffic calming. Road diets reduce the width or number of vehicular travel lanes and reallocate that space for other uses such as bicycle lanes, pedestrian crossing islands, left turn lanes, or parking. Safety and operational benefits for vehicles and pedestrians include (USDOT 2021):

- decreasing vehicle travel lanes for pedestrians to cross,
- providing room for a pedestrian crossing median,
- improving safety for bicyclists when bicycle lanes are added,
- providing an opportunity for on-street parking (which also serves as a buffer between pedestrians and vehicles),
- reducing rear-end and side-swipe crashes,
- improving speed limit compliance and
- decreasing crash severity when crashes do occur.

Implementing traffic calming measures can reduce traffic speed, reduce motor-vehicle collisions, and improve safety for pedestrians and cyclists. These measures can also increase pedestrian and bicycling activity (USDOT 2021).

Table 2 summarizes the effect of traffic calming techniques on 85th percentile vehicle speed in different states of Canada and the US. The traffic calming techniques, in most cases, were effective in terms of reducing vehicle speed.

Table 2 Summary traffic calming techniques effect on 85th percentile vehicle speed (FHWA 2014; FHWA 2017)

Traffic Calming Technique	85th %tile Speed (mph)			Study area	No. of site	Location
	Before	After	Change			
Speed Hump	35	27	-8	Various	178	Straight section and pedestrian crossing
	36	31	-5	WA	8	Excessive speeds and cut-through traffic
	37	29	-8	FL	1	In rural residential streets
	28	22	-6	IA	3	At a pedestrian crossing of a rural community street
Speed Table	37	31	-6	Various	72	In straight sections of featured community streets
	38	29	-9	GA	19	At continuous intervals on residential streets
	33	29	-4	IA	1	At a pedestrian crossing of a rural community street
	28	22	-6	IA	3	At a pedestrian crossing of a rural community street
Raised Intersection	37	38	1	Various	2	At entire sections of intersections and junctions
	30	30	0	NY	1	At medium-traffic street intersections
Chicanes	31	22	-9	WA	4	At the community road-side straight section
Center Island	35	33	-2	IA	3	At the intersection and straight section center of main streets
	36	35	-1	IA	2	
Transverse Rumble Strips	55	54	-1	TX	11	Edge of rural roads and at straight sections near intersections and curves
	49	52	3	KY	3	Horizontally curved rural roads
Converging Chevrons	53	52	-1	TX	-	At the freeway-to-freeway connector ramp
	53	53	0	TX	-	
	37	33	-4	OH	1	At intersection and curve approaches
Speed Activated Speed Limit Sign	36	30	-6	CO	1	In streets near schools and restricted speed zones
	39	34	-5	CO	2	
	37	33	-4	CO	3	
	37	32	-4	CO	1	
Speed Feedback Sign with Action Message	65	63	-2	TX	1	At curved road sections
	59	52	-7	IA	1	
	34	32	-4	WA	9	
	33	31	-5	WA	3	
	36	31	1	WA	1	

With a significant contribution from the SRC, West Fargo's project team developed a list of traffic-calming solutions that can be implemented (METROCOG 2021). Some criteria used to come up with the list were feasibility, effectiveness, maintenance, and other measures such as emergency services or vehicular impacts. The list includes lane narrowing, curb extension, pinch-point, chicane, median island, mini roundabout, speed hump, pavement material, diverter, and landscaping.

4.4. Effects of YIELD and STOP Signs on Pedestrian Safety and Traffic Speed

Engineers have traditionally marked crosswalks for three reasons: to increase pedestrian safety by identifying the safest location to cross the street, to alert drivers to the possibility of pedestrians crossing at that location, and to increase a pedestrian's level of service and safety (Van Houten et al. 2002). Crosswalk markings and their correlation to increased pedestrian safety have been the subject of much debate. A study on the safety effects of marked versus unmarked crosswalks at uncontrolled locations (Zegeer et al. 2001) compared 1,000 marked and 1,000 unmarked crosswalks in 30 USS cities. Their study indicated only one instance where there was a significant difference in the number of crashes between marked and unmarked crosswalks: crosswalks on multilane roads with an uncontrolled approach had significantly more crashes than unmarked crosswalks if the road had average annual daily traffic (AADT) above 12,000. The study also indicated that more than 70% of pedestrians cross at marked locations, most notably those younger than 12 and more than 64 years old. Research indicates that marked crosswalks can lead to a false sense of security; however, behavioral data collected from multiple sites before and after crosswalks were installed contradicted this hypothesis. This data indicated that marked crosswalks were associated with higher pedestrian-observing behavior and lower driver speeds (Knoblauch et al. 1999).

Several studies have demonstrated that "YIELD to Pedestrian" signs placed in roadways can increase the percentage of motorists yielding for pedestrians (Ellis et al. 2007; FHWA 2009; Huang et al. 2000; Kannel et al. 2003; Strong and Ye 2010). In-roadway signs were also evaluated in other studies (Turner et al. 2006). The research team collected data on motorist yielding behavior at 42 crosswalks in different regions of the United States. The results indicated that the in-roadway signs were associated with yielding rates of 87% for two-lane roads and were highly cost-effective in increasing yielding behavior. Gedafa et al. (2014) also determined that yield signs installed at any location result in vehicles yielding to pedestrians. The placement of the sign at a crosswalk is the most effective method for increased yielding, and the presence of a yield sign results in a lower average traffic speed. These findings imply that the risk to pedestrians and bicyclists is lower in the presence of the sign. These studies need to be validated with additional studies at different locations.

Research conducted in Iowa analyzed the effects before and after implementing the State Law – Yield to Pedestrians at three locations and concluded that the sign positively affected driver behavior (Kannel et al. 2003). An observational study focused on the spillover effects of within-crosswalk signs reported that the signs positively impact and enhance motorist and pedestrian behaviors (Strong and Ye 2010). Another study comparing the single and gateway configurations of in-crosswalk signs discovered that all setups effectively increased the yielding percentage (Bennett et al. 2014).

Pedestrian's right of way in crosswalk includes driver and pedestrian responsibilities according to North Dakota Century code: when traffic-control signals are not in place or not in operation, the driver of a vehicle shall yield the right of way, slow down or stop if need be to yield so, to a pedestrian crossing the roadway within a crosswalk when the pedestrian is upon the half of the roadway upon which the vehicle is traveling, or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger; and no pedestrian may suddenly leave a curb or other place of safety and walk or run into the path of a vehicle which is so close as to constitute an immediate hazard.

5. MATERIALS AND METHODS

5.1. Study Area and Materials

The Grand Forks city, which had an estimated population of 58,692 in 2022, is located in the Great Plains region; therefore, there are notable climate variations between the summer and winter seasons, with the lowest temperatures typically recorded in winter months, such as January, February, and December, and occasional snowfall extending into April (Bangsund et al. 2022; NOAA 2022).

I) Traffic Hotspot Area and Crash Contributing Factors Analysis

The hotspot analysis focused on traffic crashes in the city of Grand Forks, North Dakota, USA, from 2017 to 2022. Crash hotspot analysis requires a minimum of three to five years of data (Cheng and Washington 2005; FHWA 2011). This study used six years of data from the Grand Forks City Police Department, including 2,048 police-reported crashes. All traffic crashes were used for the crash hotspot analysis. The study used street centerline data and AADT generated from the Grand Forks Data Hub website. Figure 4 illustrates the study area and crash data map. All crash points were geocoded on the road networks using ArcGIS Pro version 3.1.2.

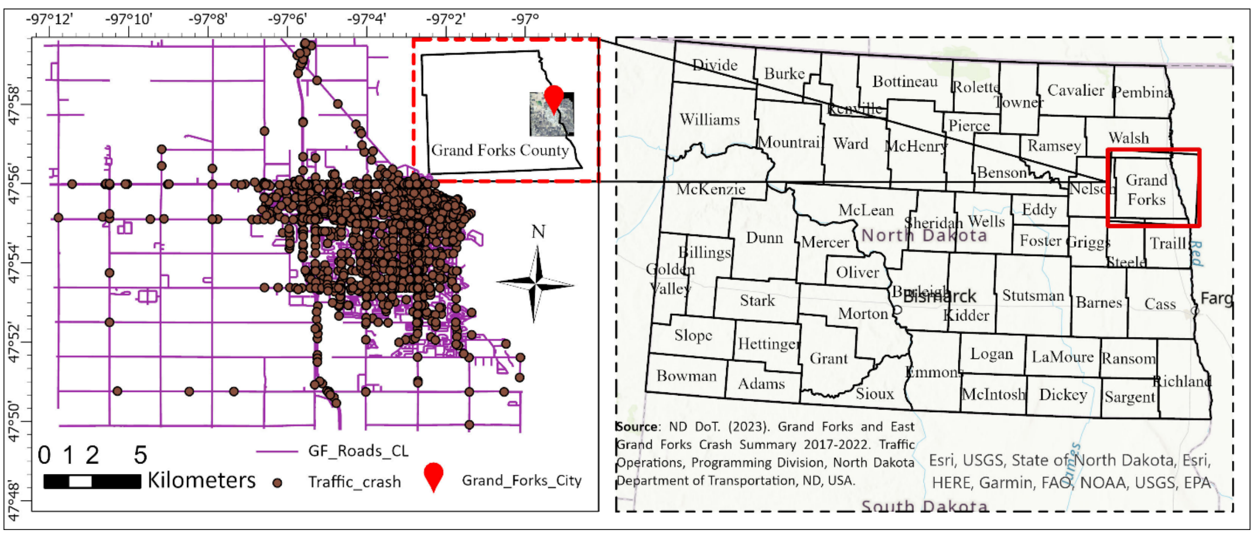


Figure 4 Crash map of Grand Forks city

II) Effect of In-Crosswalk Traffic Signs on Pedestrian Safety

The traffic speed and yield data were collected at five locations in Grand Forks, North Dakota, USA. The main facilities in the city include business areas, residence areas, schools, and recreational parks. The city streets that are close to the recreational parks and schools experience more pedestrians and bicyclists; therefore, those regions were selected for data collection. The streets selected for the study were 6th Ave N, S 25th St, Cherry St, 11 Ave S, and S 34th St. Figure 5 indicates the location of the study areas selected for speed and yield data collection.

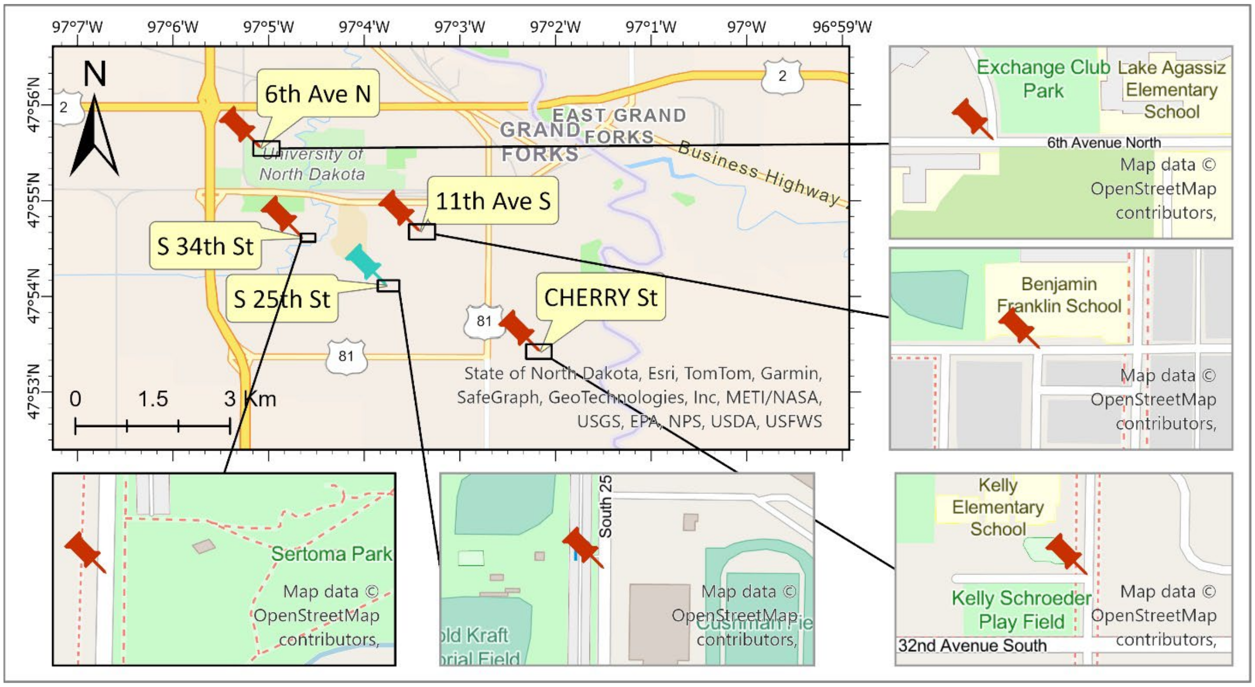


Figure 5 Study area for in-crosswalk signs

The speed data were collected during in-school hours and times when schools were not in session at all locations; however, the yield data were collected at all locations for the in-school sessions only. Table 3 summarizes the main features and collected data types at each location.

Table 3 Study location features (NDDOT 2021)

Location	Number of Lanes	AADT (2020)	Posted Speed Limit (mph)	Collected Data: Speed - School	Collected Data: Speed - No-School	Collected Data: Yield - School	Collected Data: Yield - No-School
6^{th} Ave N	Two-lane with turning-lane	3908	25	*	*	*	
11^{th} Ave S	Two lane	2320	20	*	*	*	
Cherry St	Two lane	3065	20	*	*	*	
S 25th St	Two lane	1550	20	*	*	*	
S 34th St	Two lane	3160	30		*		

5.2. Methods

This study used various GIS analysis tools to analyze traffic crash hotspot locations and their temporal patterns. The analysis consisted of two parts: a) a spatiotemporal analysis using Emerging Hotspot Analysis and b) a hotspot spatial analysis using Anselin Local Moran's I and Getis-Ord Gi*.

Crash frequency has been used in the past to identify areas with significant safety concerns (Abdulhafedh 2016; Lord and Mannering 2010); however, safety analyses using crash frequencies are biased toward higher traffic volume areas and do not take the effect of traffic volume and crash severity into account. Equivalent Property Damage Only (EPDO) and Crash Rate (CR) values were calculated to factor in the effect of severity and traffic volume, respectively.

The EPDO technique applies a weighting factor and converts the fatality and injury severity levels to an equivalent Property Damage Only-PDO level (Bonneson 2010; Wemple et al. 2014). The weighting factors related to the societal costs for each severity level could be variable for different regions. The study used the NDDOT's KABCO injury classification and weighting factors of 100, 55, 17, 11, and 1 for fatal, incapacitating, non-incapacitating, possible, and PDO injury levels, respectively (NDDOT 2021b). Equation 1 is used to calculate the EPDO Weighted total.

$$EPDO\ Weighted\ Total = 100K + 55A + 17B + 11C + O \tag{1}$$

Where K, A, B, C, and O represent fatal, incapacitating, non-incapacitating, possible, and PDO injury, respectively.

Crash rate (Equation 2) was used to identify hotspot areas and consider the effects of traffic volume and vehicle miles traveled. The CR considers traffic and road network parameters, such as Million Vehicle Miles Travelled (MVMT), road length, and AADT (NDDOT 2021b; Wemple et al. 2014).

$$Crash\ Rate, CR = \frac{n * 1{,}000{,}000}{AADT * 365 * t * l} \tag{2}$$

Where n is the number of crashes per street, AADT is the average annual daily traffic, t is years, and l is road length in miles.

Hotspot Spatial Analysis

Crash hotspot analysis can be performed using either the original crash point data or data that has been integrated into the road network (Le et al. 2020; Mafi et al. 2019; Mesquitela et al. 2022). It is advisable to assess the data's global spatial pattern before conducting any local spatial analysis (Mesquitela et al. 2022). The Global Moran's I-statistic was used to determine if the crashes exhibited clustering, dispersion, or random distribution. This statistic ranges from -1 to 1, where values near -1, 0, and 1 indicate random dispersion, complete geographic randomness, and clustered patterns, respectively. The I statistic calculates a Z-score, which is a standard deviation that measures statistical significance and checks spatial relation (ESRI 2019). An 800-meter bandwidth was selected after several trials since it yielded the highest Z-score.

The Gi* tool calculates a statistic that yields high and low spatial point clusters (ESRI 2019). This study calculated Gi * statistics for the road network. The areas with statistically high and low feature attributes were identified. Each feature's Z-score is the dataset's Gi* statistic. The hotspot intensity, a cluster of high values, is proportional to the Z-score value for positively significant statistical data. A near-zero Z-score implies no spatial clustering. A significance level of α=0.05 was considered. The Gi* statistic is computed as:

$$G_i^* = \frac{\left(\sum_{j=1}^{n} W_{i,j}X_j - \left(\frac{\sum_{j=1}^{n} X_j}{n}\right)\sum_{j=1}^{n} W_{i,j}\right)}{\sqrt{\frac{\sum_{j=1}^{n} X_j^2}{n} - (\bar{X})^2} * \sqrt{\left(\frac{n * \sum_{j=1}^{n} W_{i,j}^2 - \left(\sum_{j=1}^{n} W_{i,j}\right)^2}{n-1}\right)}} \tag{3}$$

Where Xj is the attribute value for feature j, Wi,j is the spatial weight between i and j, and n is the number of features.

The I-statistic (Equation 4) identifies clustered and outlier data points at a confidence level of 95%. The Anselin Local Moran's I tool was used to identify high and low clusters and outliers. The outliers are locations of statistically significant points with high values surrounded by low-value segments, or vice versa (Anselin 1995; ESRI 2019). A positive I value implies a clustered feature with similarly high or low neighboring attribute values; however, a negative I value indicates an outlier. The results could be clusters of high values - HH, low values - LL, outliers of high values surrounded by low values – HL, or low values surrounded by high values - LH (ESRI 2019).

$$I_i = \frac{(x_i - \bar{X}) * \sum_{j=1, j\neq i}^{n} w_{i,j}(x_i - \bar{X})}{\sum_{j=1, j\neq i}^{n} \frac{(x_i - \bar{X})^2}{n-1}} \tag{4}$$

Where x_i is a feature of the i attribute, $\bar{X}$ is the corresponding attribute mean, $w_{i,j}$ is the spatial weight between i and j, and n is the total feature number.

Spatiotemporal Analysis

The Emerging Hotspot Analysis is a location and time pattern tool used to identify the space-time clustering of points using other tools, such as the Create Space Time Cube By Aggregating Points from Defined Locations and Multidimensional Raster Layer tools (ESRI 2019). This study used the Aggregating Points tool as a preliminary step before conducting the Emerging Hotspot Analysis. The crash data was incorporated, and the study area, situated in the northern hemisphere, was subdivided into the four primary seasons: winter, spring, summer, and autumn (Trenberth 1983).

Association Rule Mining (ARM)

Association rule mining is a powerful method used to uncover interesting relationships between variables within extensive datasets. Association Rule Mining (ARM) facilitates the extraction of insights regarding the causes, consequences, and likelihood of various outcomes. This technique is distinctive due to its simplicity, making it straightforward to implement and understand; however, it has a significant disadvantage when managing complex datasets with many variables since it can generate irrelevant rules. This study extracted patterns with high frequency and confidence values to address this issue.

Apriori Algorithm

There are several ARM algorithms, such as Apriori, LP-growth, eclat, and FP-Growth (Chee et al. 2019); however, this study used the Apriori algorithm due to its advantages of shorter mining times and lower memory consumption when mining frequent item sets. The algorithm uses three key metrics, support, confidence, and lift, to select interesting rules from many potential rule sets. Support is the number of times that item sets co-exist (Equation 5).

$$Support\ (A \rightarrow B) = P(A \cap B) = \frac{N(A \cap B)}{N(ALL)} \tag{5}$$

Where A is a factor, B represents a consequence, $N(A \cap B)$ represents the frequency of occurrence of A and B together, and N(ALL) is the total frequency of all incidents.

Confidence is a conditional probability, which refers to the probability of B occurring if B has already occurred (Equation 6).

$$Confidence\ (A \rightarrow B) = P\left(\frac{B}{A}\right) = \frac{P(A \cap B)}{P(A)} \tag{6}$$

Where $P(B/A)$ is the probability of effect B occurring given that factors A have occurred, P(A∩B) is the probability of two events co-occurring, and P(A) is the probability of A occurring.

Lift quantifies how much more likely it is for the items to occur together than if they were independent (Equation 7).

$$Lift\ (A \rightarrow B) = \frac{Support(A \rightarrow B)}{\left(Support(A) * Support(B)\right)} \tag{7}$$

Where Support(A→B) is the support of the rule A → B (the co-occurrence of items A and B), and Support(A) and Support(B) are the individual supports of items A and B, respectively.

Figure 6 illustrates the approach used to extract association patterns between cause factors and their impacts from crash data through association rule mining. Crash reports were initially gathered, and variables were categorized into distinct subgroups. Association rules were then applied to identify the relationships between these factors and their effects. Strong association rules were subsequently extracted and subject to discussion.

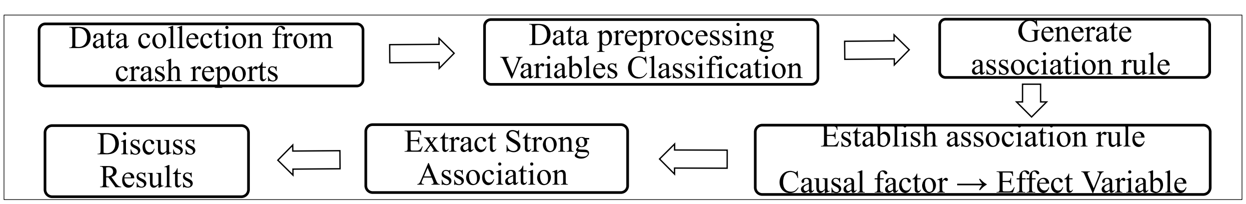


Figure 6 Framework for extracting the cause and effect of a traffic crash

Speed and Yield Data Analysis

The regulatory in-street traffic signs described in Section 2B.12 of the FHWA Manual on Uniform Traffic Control Devices (FHWA 2009) were used. Figure 7 presents the two traffic signs placed at the edge of the crosswalk lines at 25th Ave S. Vehicle speed data were collected using a Scout Wireless Handheld Traffic Radar Gun by Decatur.

The speed and yield data were collected at the test streets with (W) and without (WO), the two within-crosswalk traffic signs. The data were collected twice a day from May 2023 to October 2023, during the morning (M) and afternoon (A) hours at 20-minute intervals. The speed and yield data were collected at free-flow traffic conditions and peak-hour conditions, respectively. These free-flow conditions are usually observed during off-peak hours (Manual 2000). The traffic signs were placed at the most effective location: the intersection of the road center line and crosswalk line (Ellis et al. 2007; Gedafa et al. 2014).

The minimum, average, 85th percentile, and maximum speeds were calculated. The 85th percentile speed is a fundamental element in setting speed limits (Forbes et al. 2012). The speed for turning vehicles was excluded from the analysis since the drivers reduced speed even without the presence of the traffic signs. The yield data were collected at peak hours and only during school sessions. The drivers were scored according to how they interacted with the pedestrians.

The leading vehicle's speed and yield score were considered when vehicles traveled closely. The stopping sight distance (SSD) determined vehicle proximity, and roads were marked at this distance from the pedestrian crossing line. The SSD was calculated based on posted speed limits at each site and consisted of brake reaction distance and braking distance (AASHTO 2011). Vehicles following another within a distance shorter than the SSD were excluded from the analysis. Drivers received a yielding score if they stopped or yielded for pedestrians. Drivers also received a yielding score if pedestrians appeared after drivers passed the SSD mark. A driver was marked as not yielding if the pedestrian reached the road crossing before the driver reached the SSD mark and did not yield. Any conflict between a driver and a pedestrian was considered as not yielding.

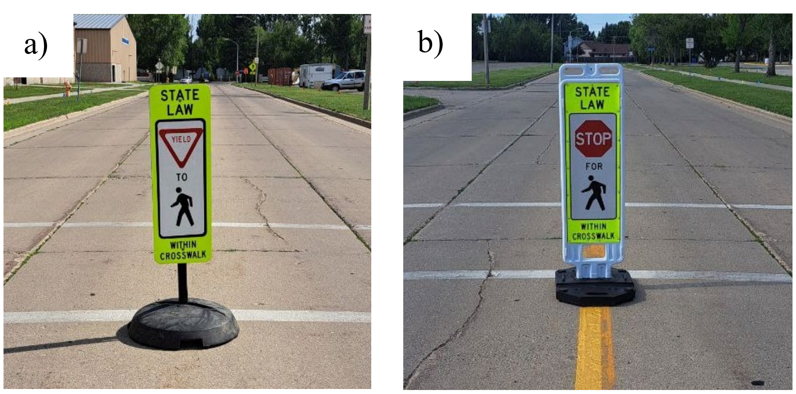


Figure 7 Within-crosswalk traffic signs at S 25th St: a) YIELD to Pedestrians: R1-6 and b) STOP to Pedestrians: R1-6a

Significance Difference Tests

Statistical tests were used to check the significant difference between the with and without traffic sign yield and speed data. A 95% confidence level was used for all statistical tests. An independent t-test was used to test for the significant difference between the average speeds with and without traffic signs. This test can be used to make inferences about two independent means (Ott and Longnecker 2015). The null hypothesis for the t-test stated that the means of the two samples were not significantly different and could be rejected when the p-value was less than the selected significance level (Mendenhall et al. 2012).

Chi-squared and two-proportion tests were used to check the yielding proportion difference between the with and without conditions. The tests were used to test the significant difference between two categorical variable proportions, and the null hypothesis for these tests stated that there was no significant difference between the two sample proportions (Mendenhall et al. 2012; Ott and Longnecker 2015). Figure 8 summarizes the main steps followed while conducting this study.

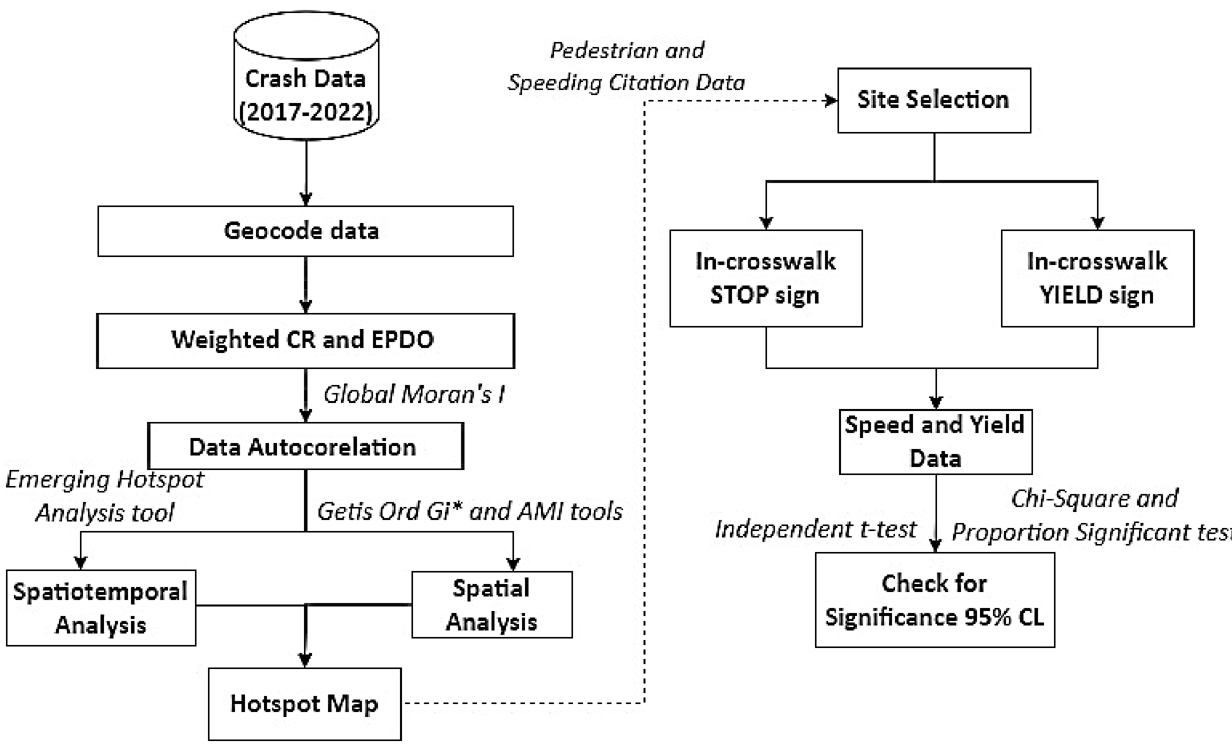


Figure 8 Study flowchart

6. RESULTS AND DISCUSSIONS

6.1.Preliminary Analysis

Different crash pattern summaries were done before the hotspot area analysis. There were more than 22 factors reported as a cause for each crash. Figure 9 presents the total number of crashes caused by each contributing factor except the unknown factors. The reasons for 797 crashes were reported as unknown. The major contributing factors for the crashes were Failure to Yield (16%), Too Fast for Conditions (16%), Following Too Close (15%), Careless Driving (12%), and Weather (11%). The crashes due to animals in the roadway and disregarding road markings were one. According to the NDDOT vision zero initiative definition, speeding includes driving too fast for the conditions, following too close, and recklessly operating a vehicle. Hence, speed-related factors accounted for 45% of the crashes with known causes and 28% of the total reported crashes with known and unknown reasons.

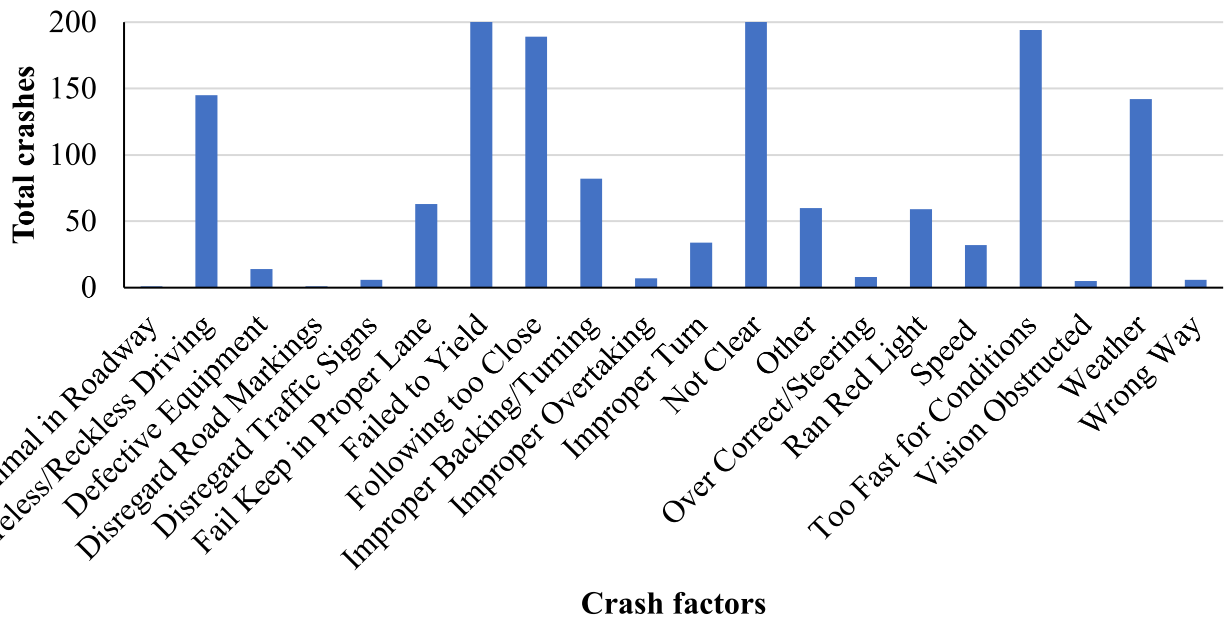


Figure 9 Crash contributing factors and percent total crash

Alcohol use increases the possibility of a crash and severity (Beaulieu et al. 2022). Figure 10 presents the number of crashes for the corresponding alcohol use and severity level conditions. Only 5% of the total crashes involved alcohol. The severity level data shows 81% of the crashes were property damage only (PDO), 10% were non-incapacitating injuries, 8% were possible injuries, and 2% were fatal and incapacitating injuries. Most of the fatal crashes involve drivers with no alcohol use. For all severity cases, the number of crashes due to alcohol use is less than no alcohol use. The higher alcohol use rate was seen for incapacitating injuries, where crashes due to alcohol use accounted for 19% of the total incapacitating injuries.

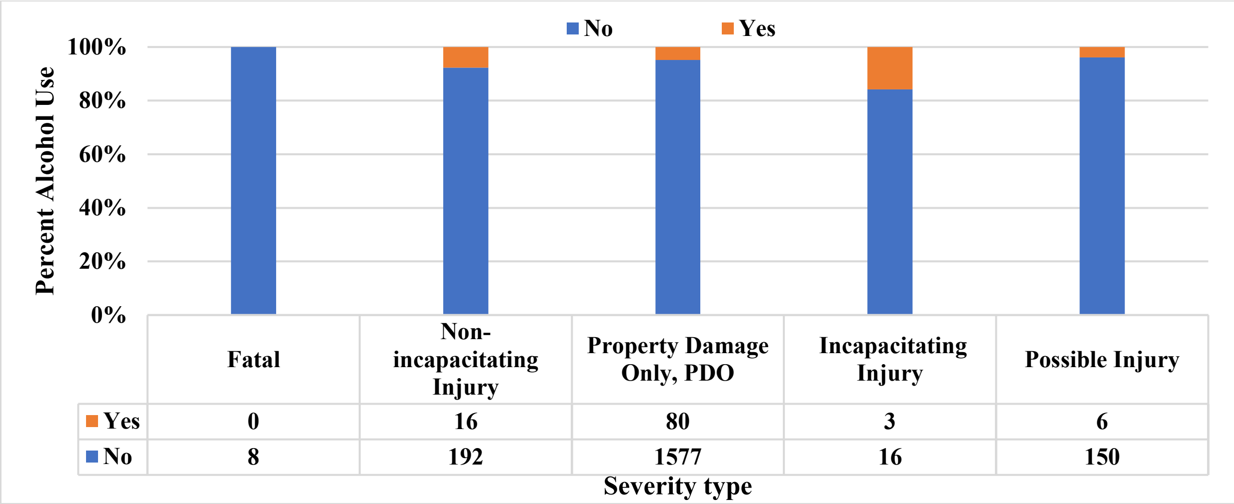


Figure 10 Percent crash severity levels due to alcohol use

The safety equipment (seat belts and helmets) that the drivers or passengers used during the crashes could significantly affect the severity level (Egly and Ricca 2023). The safety equipment should be appropriately used to minimize the extent of the injury (Kashani et al. 2022). Table 4 shows the total number of crashes under each safety equipment. The data showed that crashes 63% of drivers involved in crashes use lap and shoulder belts.

Table 4 Safety equipment use data

Safety equipment type	Number of crashes
Restraint use unknown	1118
Not in use	43
Lap and shoulder	2191
Shoulder belt	27
Helmet worn	3
Lap belt only	40
Not applicable	32
Child safety seat (prop)	1

Figure 11 depicts the total number of male and female drivers involved in the crash for each age category. The number of male drivers involved was higher in 87% of the age categories. However, the number of female drivers involved in crashes was higher than male drivers for the age category of 19 years and younger. The male and female driver crash exposure was equal for those between 80 and 84 years. There were 3169 drivers involved in traffic crashes.

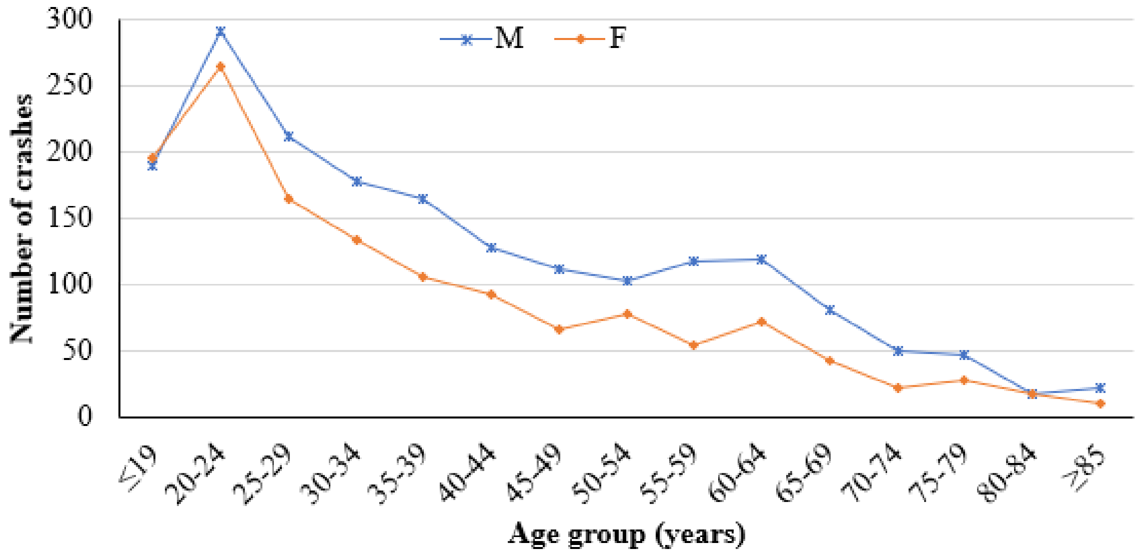


Figure 11 Age group and sex of drivers

The prevailing weather and road surface conditions affect the severity and probability of crash occurrence (Hammad et al. 2019; Malin et al. 2019; Zhai et al. 2019). Table 5 shows the crash scenes under each surface and weather conditions. Unfavorable weather and surface conditions can increase crashes. Of the total crashes, 41% occurred on dry pavement and clear sky conditions, while 17% occurred on icy roads and clear sky conditions.

Table 5 Road surface and weather conditions during the crash scene

Weather Condition	Surface Condition					
	Dry	Snow	Ice / Compacted Snow	Mud Dirt Gravel	Wet	Slush
Unknown	46	6	11	1	0	0
Clear	841	170	350	0	42	17
Cloudy	110	79	89	0	48	7
Rain	0	0	7	0	46	0
Snow	0	78	26	0	3	7
Blowing Snow	1	14	12	0	0	1
Sleet/Hail/Freezing Rain	0	6	18	0	2	1
Fog / Smoke / Dust	2	0	1	0	3	0
Severe Wind	1	0	1	0	1	0

Speed Violation Data Analysis

The speed data that spans from 2015 to 2022 was analyzed. The results show that roads such as 17th Ave S, Demers Ave, 24th Ave S, S Washington St, HN:297mm:3, S 20th St, Gateway Dr, 32nd

Ave S, Cherry St, Belmont Rd, And University Ave have higher rates of driver speed violation records. Most of the top-ranked roads have relatively higher traffic volume than the others. Table 6 summarizes the top 16 streets with the highest number of citations.

Table 6 Speeding Ticket Summary

Location	No. of ticketed drivers	Location	No. of speed violation
17th Ave S	2270	40th Ave S	159
Demers Ave	1861	Cherry St	158
24th Ave S	1681	S 34th St	150
Hn:297mm:3	567	S Columbia Rd	141
S 20th St	531	20th Ave S	129
S Washington St	501	32nd Ave S	107
Gateway Dr	414	N Washington St	97
Belmont Rd	179	S 48th St	80

6.2. Road Network Hotspot Analysis

The total number of hotspots for each analysis case, Gi* from EPDO, Gi* from CR, I_i from EPDO, *and* I_i from CR, were compared. Figure 12 a) and b) present the Gi* output using the EPDO and CR input parameters, respectively. The Central-East and Central-West parts of the Grand Forks city streets were identified as hotspots. The red graduated colors on the map depict the hotspot areas at confidence intervals of 90%, 95%, and 99%. Most hotspots were observed at intersections where streets with high traffic volumes intersect. The CR input only yielded hotspot areas at a CI of 95% and 99%. The CR input at p=0.05 established that only 1% of the road networks were hotspots, while 7% were statistically significant at p=0.01. The EPDO technique revealed that there were 17% and 4% statistically significant hotspots at 0.01 and 0.05 p-values, respectively. Table 7 summarizes the Gi* statistic outputs for EPDO and CR input parameters under each p-value. There were more hotspot road segments for the hotspot analysis using EPDO than CR.

Table 7 Getis Ord Gi* results summary

Input Parameter	Coldspot (%)			Hotspot (%)			Not Significant (%)
	p=0.01	p=0.05	p=0.1	p=0.01	p=0.05	p=0.1	
EPDO	5	10	6	17	4	1	57
CR	0	0	0	7	1	0	92

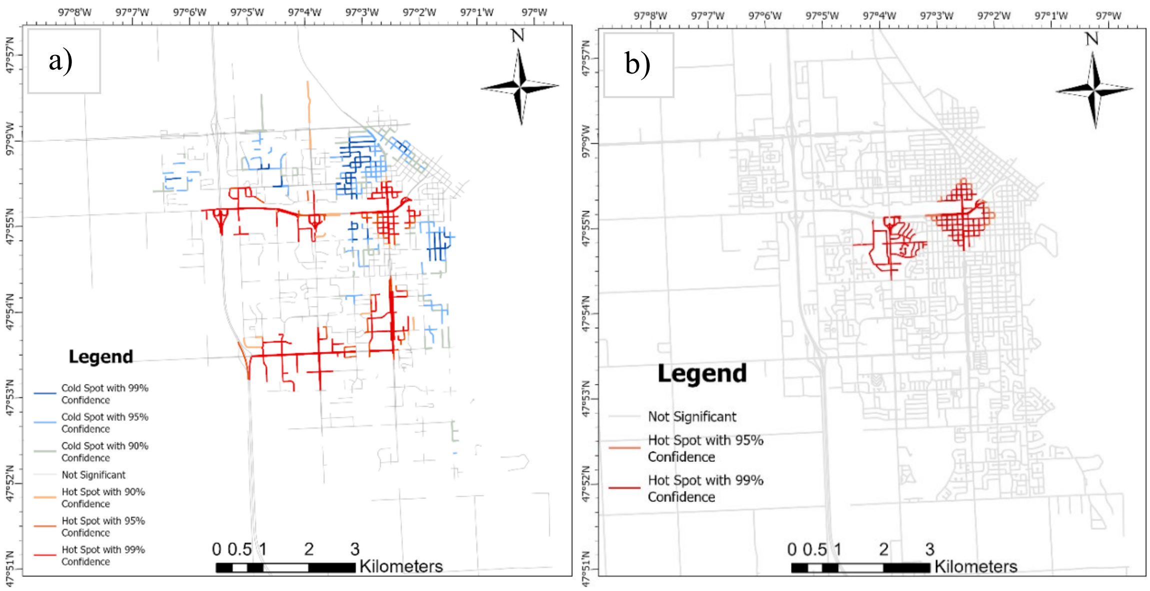


Figure 12 Hotspot results using a) Gi* - EPDO and b) Gi* - CR

The Anselin Local Moran's (AMI) I statistics were also calculated to check the consistency of the output variation for the EPDO and CR input parameters. Figure 13 a) and b) demonstrate the I-statistic cluster and outlier outputs from EPDO and CR, respectively. There were more HH clusters for the EPDO input parameter than the CR. The HL and LH outliers from the EPDO analysis were dispersed. Most road networks were identified as LL clusters for the CR analysis, with a p-value of 0.05. The LL-clustered roads are surrounded by roads with low CR values.

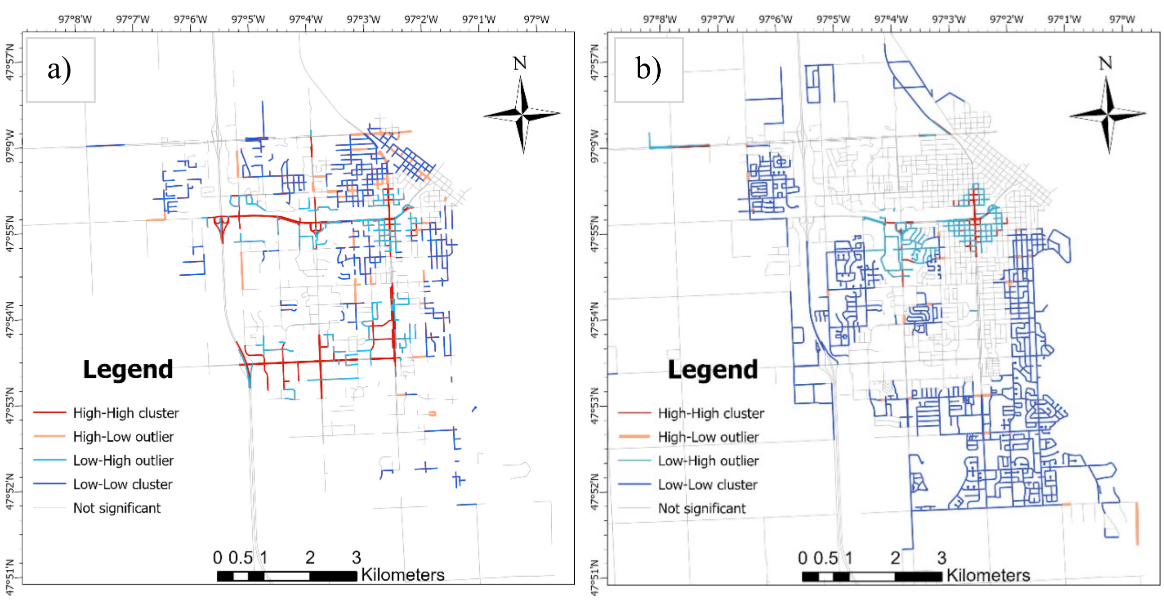


Figure 13 Crash hotspots using a) AMI - EPDO and b) AMI - CR

Table 8 provides road segment percentage summaries for each output cluster and outlier category. The percentage of outliers and clusters for the EPDO was higher than the CR. The I-statistic with a 0.05 p-value revealed that 10% and 3% of the road networks were identified as HH clusters from EPDO and CR, respectively. The non-significant road networks for CR were higher than the EPDO, consistent with the Gi* statistic summary. The p-values for clusters and outliers were less than 0.05 with different Z-scores, negative for outliers, and positive for clusters. The Z-score for the non-significant road segments was between -1 and 1, while the p-values were above 0.05.

Table 8 AMI (I_i) results summary

Input Parameter	HH Cluster (%)	HL Outlier (%)	LH Outlier (%)	LL Cluster (%)	Not significant (%)
EPDO	10	4	13	28	44
CR	3	1	5	31	60

6.3.Spatio-Temporal Analysis

The Emerging Hotspot Analysis results established the spatiotemporal correlation between crashes. Figure 14 a) depicts the crash data temporal summary analyzed from the raw crash data. The crashes occurred predominantly during the winter season, which comprises December, January, and February. Figure 14 b) presents the statistical summary of the hotspot areas. There were no spatiotemporal patterns for the majority of the crashes. Only 16 spatiotemporal patterns were detected out of the total 235 location bins. The detected patterns included Diminishing Hotspots, Sporadic Hotspots, and New Coldspots. There were 13 sporadic hotspots and two diminishing hotspot areas. The sporadic areas were spatial bins under observation and continually switched from being a hotspot to not being a hotspot and to being a hotspot again. The hotspots had a p-value less than 0.05 and a negative Z-score. The percent significance for the diminishing hotspots was 94%, while it ranged from 61% to 88% for the sporadic hot zones. The New Coldspot region had a 5.5% significance and p-value higher than 0.05. A post-comparison of the raw data and the spatiotemporal analysis indicated that the sporadic and diminishing hotspots were primarily due to the crashes that occurred in the winter.

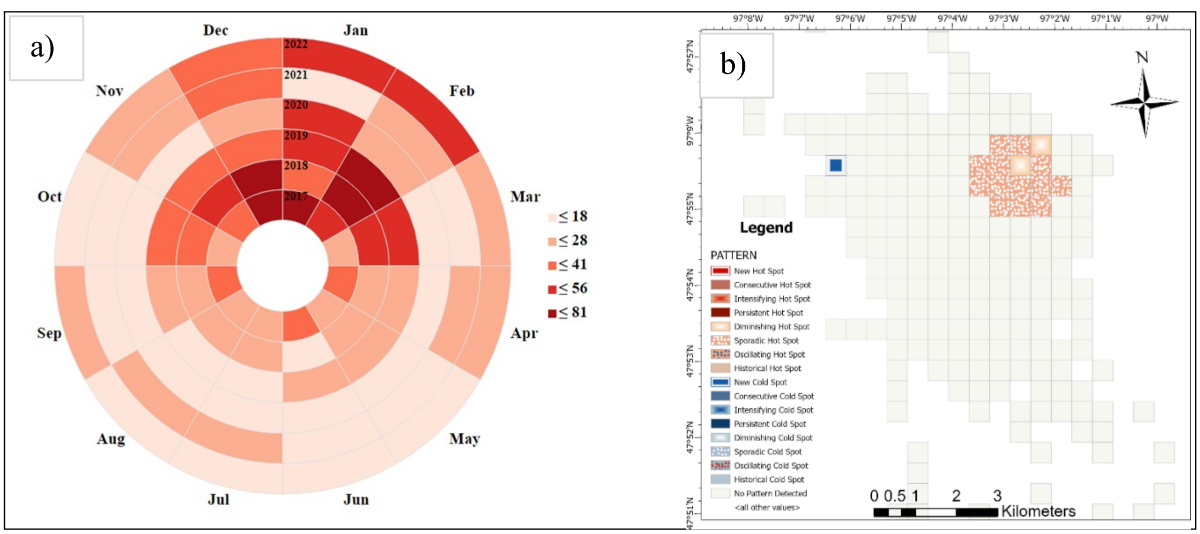


Figure 14 a) Crash Data Clock and b) Emerging Hotspot Spatiotemporal Analysis

Similarity Test

The Hotspot Analysis Comparison tool was used to compare and check the spatial association between the hotspots from the EPDO and CR input parameters. Table 9 presents the percentage of EPDO hotspots within the CR hotspot at each confidence interval. Only 15.79% of the CR hotspots were identified as EPDO hotspots at the given CI. The similarity value-SV, including the non-significant road segments, was 0.72, and the expected similarity value-ESV between the two results was 0.59. The Spatial Fuzzy Kappa, which scales the SV by ESV, was computed as 0.31. The Kappa value between 0.2 and 0.4 revealed that the hotspot results had a fair spatial association.

Table 9 Hotspot results comparison using the significance level

CR-Hotspot Significance Level	EPDO-Hotspot Significance Level						
	Coldspot 99%	Coldspot 95%	Coldspot 90%	Not Significant	Hotspot 90%	Hotspot 95%	Hotspot 99%
Coldspot 99%	0	0	0	0	0	0	0
Coldspot 95%	0	0	0	0	0	0	0
Coldspot 90%	0	0	0	0	0	0	0
Not Significant	5.96	10.72	7.04	62.18	0.95	2.54	10.6
Hotspot 90%	0	0	0	0	0	0	0
Hotspot 95%	0	0	0	31.58	10.53	15.79	42.11
Hotspot 99%	0	0.53	0	13.76	2.12	12.7	70.9

6.4. Association Rule Mining

This study obtained relevant patterns meeting both relatively high frequency and confidence criteria through filtering. Table 10 summarizes the statistical association summary between variables in the dataset.

Table 10 Association between crash variables

Rule	Frequency	Support	Confidence	Lift
First Harmful Event → Manner of Collision				
Collision with an object (Not fixed) → Angle Collision	660	0.32	100.00%	1.17
Intersection Type → Manner of Collision				
Multi-leg intersection → Angle Collision	660	0.20	61.52%	1.86
Intersection Type → Crash Severity Class				
Non-intersection →Fatal Injury	27	0.01	66.67%	1.17
Light Description → Manner of Collision				
Daylight → Angle Collision	651	0.29	84.02%	1.12
Relation to Junction Location → Crash Severity Class				
Non-Junction → Fatal Injury	27	0.01	55.56%	1.13
Relation to Junction Location → Manner of Collision				
Interchange Related → Single Vehicle Crash	42	0.01	57.14%	1.91
Weather Condition → Manner of Collision				
Hazardous → Single Vehicle Crash	169	0.03	40.24%	1.41

The support metric specifies the frequency of the rule in the dataset, while confidence measures how often the rule is true when the antecedent (left side) is true. Lift indicates the strength of the association between the rule's antecedent and consequent (right side), with values greater than 1 indicating a positive association. These rules can be valuable for understanding and potentially mitigating the causes and consequences of traffic incidents. For instance, in incidents involving "Collision with an object (Not fixed)," there is a high likelihood (100% confidence) of an "Angle Collision" as the collision manner. The support of 0.32 indicates that this pattern is relatively common in the dataset. The lift of 1.17 suggests that this association is slightly more likely to occur than if the two events were independent.

6.5. Trafic Crash and Speeding Data Analysis

On the reported data, the exact location for most of the speeding citations was not reported, and the citations were assumed to exist at any point along the reported road section. Figure 15 summerizes the streets with more number of traffic speeding citation. The cited drivers were assumed to travel with the same speed along the street. The streets such as 17th Ave S, Demers Ave, and 24th Ave S had the highest speeding citation records.

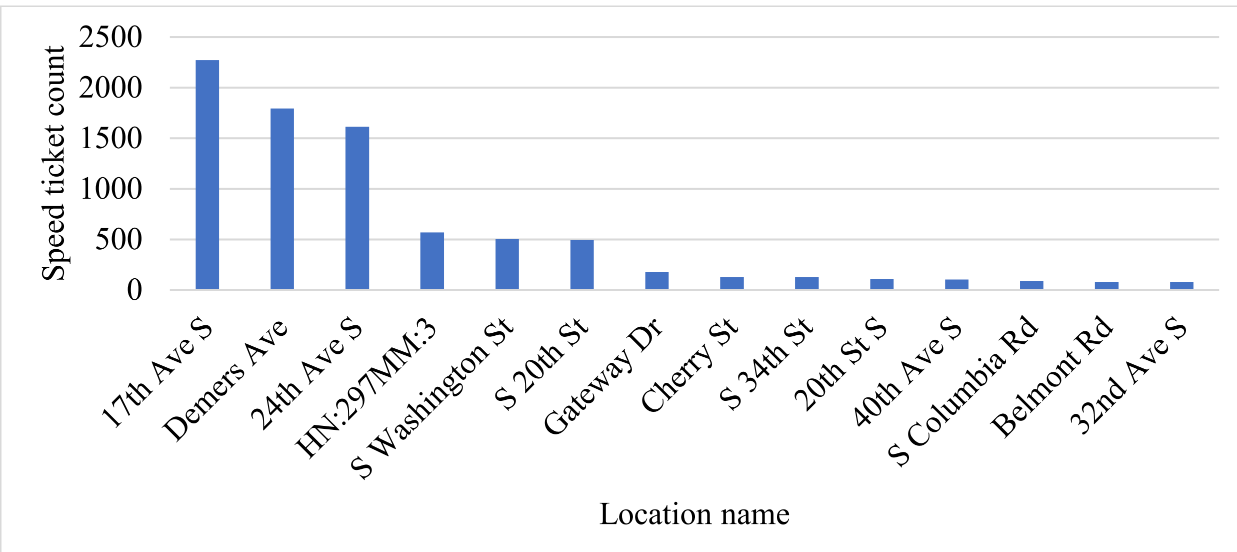


Figure 15 Speed ticket count per street

The speed-related crashes were extracted and the heatmap for those crashes were mapped using ArcGIS Pro software. Figure 16 presents heatmap for speed-related traffic crashes. The regions with a solid yellow color were found to have more dense speed-related traffic crashes, and the purple colors signify areas of sparse crash records. The heatmap shows that the speed-related crashes were mostly found near intersections.

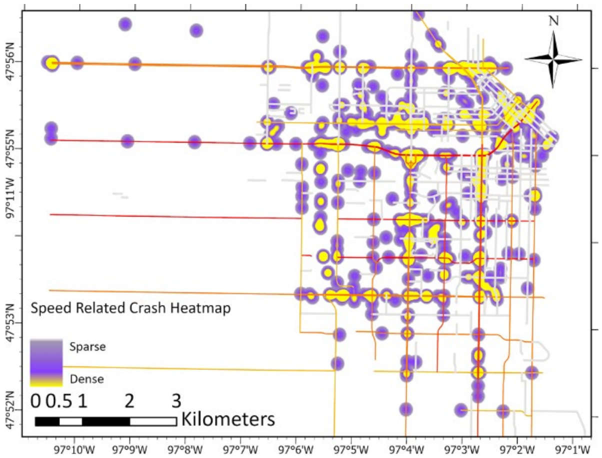
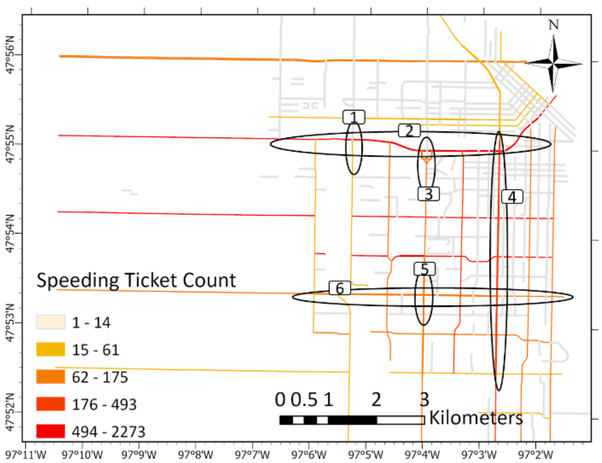


Figure 16 Speed-related traffic crashes heatmap

The areas from identified from the speed-related crashes and speeding ticket data are a major concern. Figure 17 depicts areas of significant traffic crashes, speed-related crashes, and speed violations. The areas highlighted with black oval shapes experience significant traffic crash areas and a higher number of speed violations. The areas along Demers Ave, S Washington St, 32nd Ave, and S Columbia Rd have higher speeding and crash rates during the study period. Though the other roads, such as 17th Ave S, 24th Ave S, and S 20th St, have more speeding violation records, the crashes near these areas were not significant.

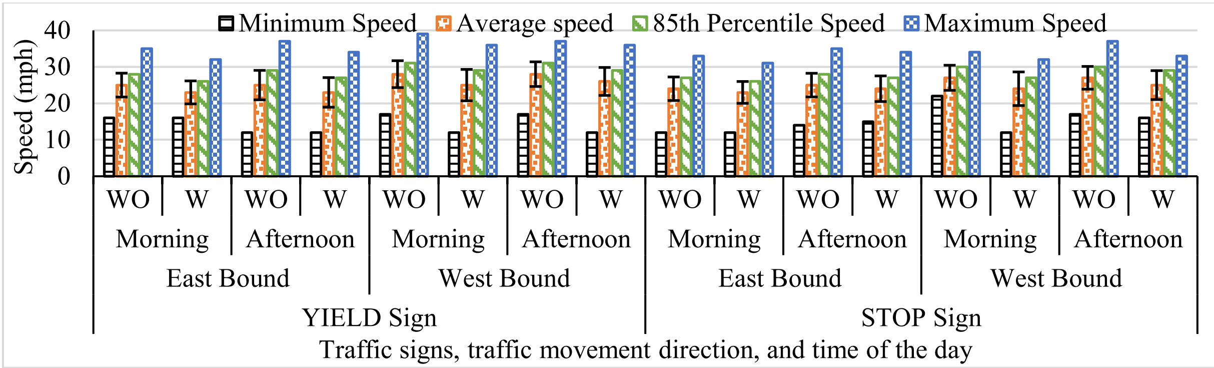


Id	Location Name
1	Demers Ave and S 42ND ST Intersn.
2	Demers Ave
3	Demers Ave and S Columbia Rd Intersn.
4	S Washington St
5	32nd Ave S
6	32nd Ave S and S Columbia Rd Intersn.

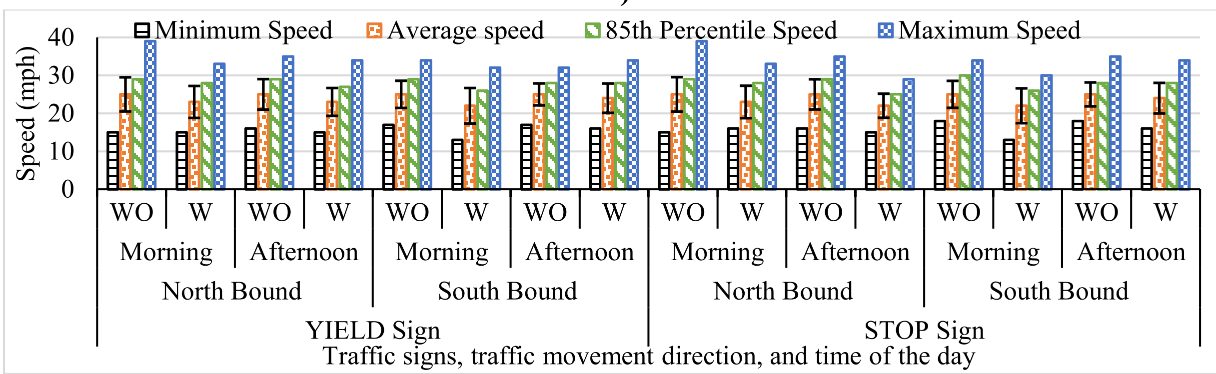
Figure 17 Roads with high speeding citation records and significant crashes

6.6. Effect of Traffic Signs on Speed

The minimum, average, 85th percentile, and maximum speeds at all locations were calculated from the collected data. The presence of the within-crosswalk signs resulted in a lower average speed for both in-school sessions and times when schools were not in session. The 85th percentile speed was also lower when the traffic signs were present on the road crosswalk. The minimum and maximum speeds observed were generally higher for the without conditions, and there were some exceptions where the drivers traveled at a higher speed regardless of the traffic signs. Figure 18 summarizes the speed data and standard deviation when schools were not in session.



a)



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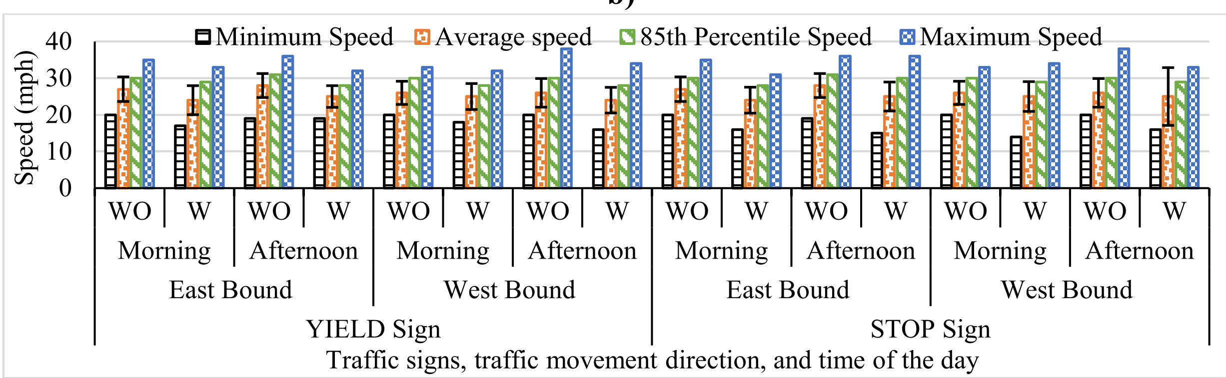

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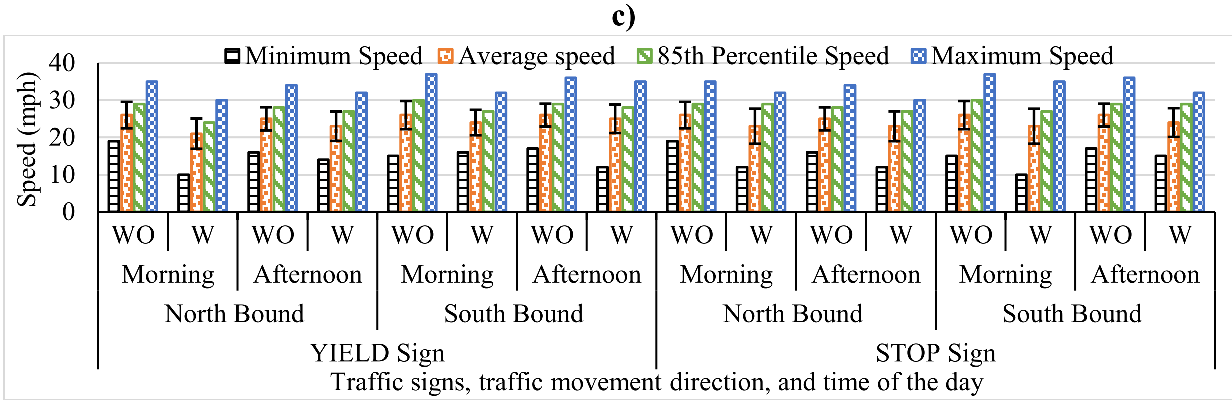
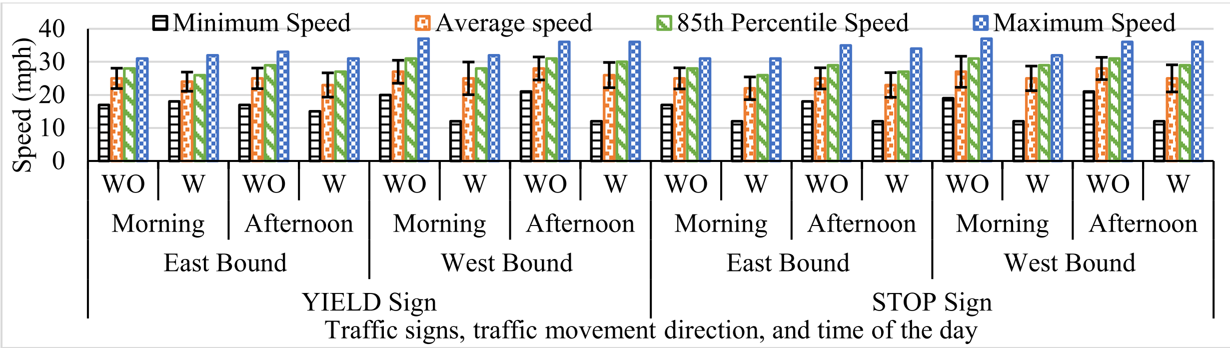


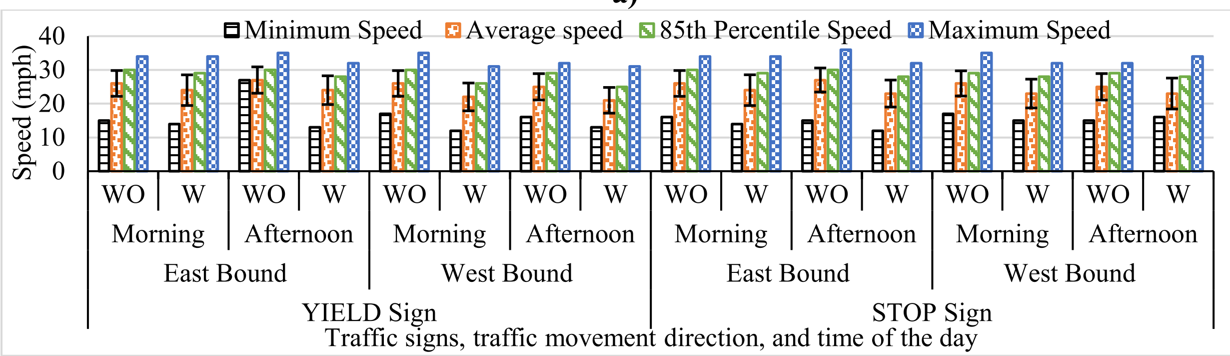
d)

Figure 18 Speed data summary: no-school session a) 6th Ave N, b) 11th Ave S, c) 25th Ave S, and d) Cherry St

The speed reduction pattern was also similar for the in-school session data. Figure 19 summarizes the speed analysis results with standard deviation for the in-school session data.



a)



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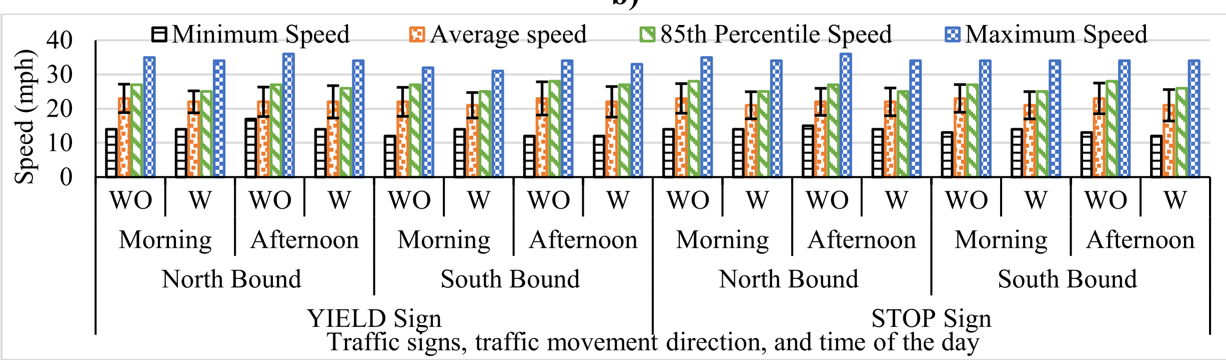

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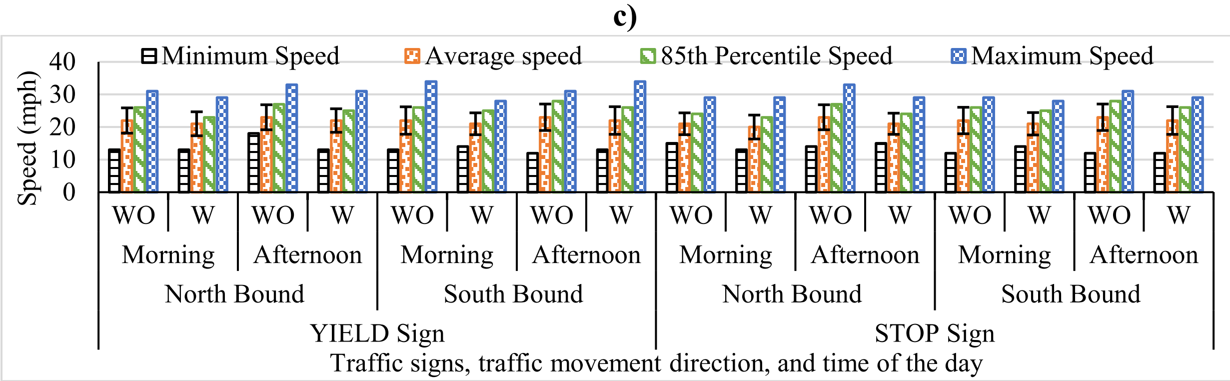

d)

Figure 19 Speed data summary: in-school session a) 6th Ave N, b) 11th Ave S, c) 25th Ave S, and d) Cherry St

An independent t-test with a significance level of 0.05 indicated the presence of significant differences in the average speeds at the two conditions. The study areas have similar features, and the individual values can be added to check the overall significance of the differences (Gedafa et al. 2014). The overall tests revealed that the speed reduction due to the traffic signs significantly reduced the average speed; therefore, the null hypothesis was rejected.

Table 11 presents the statistical test summary for both traffic signs during in-school sessions and times when schools were not in session. The results indicate that the presence of traffic signs resulted in a significant reduction in the average speed of drivers at all locations. A significant average speed reduction was observed in more than 93% and 87% of the total cases for the YIELD and STOP signs, respectively, when schools were not in session. Likewise, 81% and 75% of the cases attributed to YIELD and STOP signs, respectively, indicated a decrease in speed during in-school sessions. The standard deviation for more than 99% of the cases ranged from 3 mph to 5mph.

The study areas have similar features, and the individual values can be added to check the overall significance of the differences (Gedafa et al. 2014). The overall tests revealed that the speed reduction due to the traffic signs significantly reduced the average speed; therefore, the null hypothesis was rejected.

Table 11 Significant difference test for traffic speed

Street name	Direction	Time	YIELD sign				Sig. Diff. p-value (95% CI)	STOP sign				Sig. Diff. p-value (95% CI)
			WO		W			WO		W		
			Avg Speed	n	Avg Speed	n		Avg Speed	n	Avg Speed	n	
No- School session												
6th Ave N	EB	M	25	193	23	168	<0.0001 S	24	168	23	153	0.0005 S
		A	25	138	23	152	<0.0001 S	25	161	24	145	0.0016 S
	WB	M	28	129	25	128	<0.0001 S	27	68	24	60	<0.0001 S
		A	28	155	26	158	<0.0001 S	27	86	25	58	0.0158 S
11th Ave S	EB	M	27	40	25	52	0.0017 S	27	50	24	67	0.0001 S
		A	28	63	25	86	<0.0001 S	28	56	25	76	<0.0001 S
	WB	M	26	45	25	79	0.0372 S	26	52	25	73	0.0732 N
		A	26	59	24	74	0.0005 S	26	62	25	67	0.0193 S
Cherry St	NB	M	26	53	21	64	<0.0001 S	26	63	23	49	0.0017 S
		A	25	100	23	94	<0.0001 S	25	88	23	82	0.0008 S
	SB	M	26	70	24	89	0.0002 S	26	61	23	66	0.0005 S
		A	26	99	25	84	0.0279 S	26	111	24	90	<0.0001 S
S 25th St	NB	M	25	50	23	63	0.0095 S	25	49	23	52	0.0308 S
		A	25	56	23	67	0.0044 S	25	54	22	56	<0.0001 S
	SB	M	25	57	22	55	0.0006 S	25	44	22	50	0.0004 S
		A	25	84	24	58	0.1942 N	25	68	24	58	0.2206 N
S 34th St	NB	M	32	114	30	98	<0.0001 S	35	53	31	80	<0.0001 S
		A	33	104	30	94	<0.0001 S	34	71	31	76	<0.0001 S
	SB	M	30	69	27	79	<0.0001 S	30	69	28	60	0.0003 S
		A	30	95	27	87	0.0018 S	30	96	27	94	0.0020 S
Overall		M	25.7	820	23.6	875	<0.0001 S	25.4	677	23.8	710	0.0021 S
		A	25.9	952	23.9	954	<0.0001 S	26.1	853	23.9	802	<0.0001 S
School session												
6th Ave N	EB	M	25	102	24	92	0.0015 S	25	96	22	89	<0.0001 S
		A	25	94	23	88	<0.0001 S	25	85	23	94	<0.0001 S
	WB	M	27	73	25	60	0.0004 S	27	89	25	99	0.0039 S
		A	28	67	26	72	0.0067 S	28	80	25	74	0.0003 S
11th Ave S	EB	M	26	70	24	76	0.0023 S	26	60	24	67	0.0011 S
		A	27	62	24	69	0.0035 S	27	73	23	55	<0.0001 S
	WB	M	26	56	22	48	<0.0001 S	26	52	23	45	0.0011 S
		A	25	44	21	54	<0.0001 S	25	43	23	62	0.0027 S
Cherry St	NB	M	22	78	21	80	0.0362 S	21	94	20	83	0.2887 N
		A	23	90	22	71	0.0063 S	23	55	21	67	0.0148 S
	SB	M	22	81	21	62	0.0211 S	22	73	21	81	0.6718 N
		A	23	98	22	75	0.2132 N	23	69	22	59	0.0487 S
S 25th St	NB	M	23	57	22	71	0.1697 N	23	59	21	78	0.0060 S
		A	22	77	22	61	0.4975 N	22	53	22	66	0.3385 N
	SB	M	22	67	20	54	0.0419 S	23	79	21	73	0.0122 S
		A	23	70	21	62	0.0308 S	23	64	21	50	0.1740 N
Overall		M	24.1	584	22.3	543	<0.0001 S	23.9	602	22.4	615	<0.0001 S
		A	24.4	602	22.8	552	<0.0001 S	24.7	522	22.6	527	<0.0001 S

S: Significant at a 0.05 significance level, N: Not significant at a 0.05 significance level.

6.7. Effect of Traffic Signs on Yielding to Pedestrians

The proportion of drivers who yielded to pedestrians to the total number of scored drivers for each location was calculated and used for the statistical analysis. Table 12 presents the summary of the significant tests. The raw data illustrates that the YIELD and STOP signs both increased the proportion of drivers yielding to pedestrians; however, the yielding proportion was significant for only 56% and 68% of the individual cases for YIELD and STOP signs, respectively. The traffic sign conditions resulted in higher yielding proportions; however, sites such as 6th Ave N and Cherry St exhibited more cases where the results were insignificant. This discrepancy might be linked to higher driving speeds and relatively elevated instances of speeding violations at these locations.

The statistical tests demonstrated that the presence of traffic signs significantly increased the proportion of drivers yielding to pedestrians across all locations. Specifically, the STOP sign condition exhibited a higher number of significant cases. The null hypothesis can be rejected based on the calculated overall p-values, which were all below the significance level.

6.8.Comparison of the Effect of In-Crosswalk YIELD and STOP Signs

Table 13 summarizes the effectiveness comparison of the traffic signs on speeding. The results indicate that the overall effectiveness of the within-crosswalk STOP and YIELD signs was comparable. The effectiveness of the signs was significantly different at 6th Ave N at times when schools were not in session. The STOP signs resulted in a relatively lower average speed value than the YIELD signs; however, the average speeds for both cases had p-values higher than the confidence level at the other three locations. Furthermore, the differences in average speed values at all locations due to the traffic signs were insignificant. The null hypothesis cannot be rejected since the p-values for the overall cases were higher than 0.05.

Another comparison between the effectiveness of the two signs was performed using the effect on yielding to pedestrians. Table 14 presents the yielding proportion differences between the two signs. The significance proportion test indicated that the yielding proportion differences between the two signs were insignificant at all locations; therefore, the signs had a comparable effect and can be used to reduce speed and increase yield to pedestrians on two or three-lane streets.

Table 12 Significant difference test using Chi-square (χ2) and Proportion test for yielding

Street name	Direction	Time of the day	Yielding data (Proportion) WO	Yielding data (Proportion) W	Significance test χ2 (p-value)	Significance test z-score, (p-value)	Combined
YIELD Sign							
6th Ave N	East	M	57 (66.7)	64 (89.1)	8.964 (0.003) S	-2.994 (0.003) S	-4.627 (<0.00001) S
		A	66 (69.7)	67 (91.0)	9.634 (0.002) S	-3.104 (0.002) S	
	West	M	63 (69.8)	56 (83.9)	3.270 (0.071) N	-1.808 (0.070) N	
		A	59 (67.8)	68 (79.4)	2.216 (0.137) N	-1.487 (0.136) N	
11th Ave S	East	M	54 (72.2)	61 (90.2)	6.177 (0.012) S	-2.485 (0.013) S	-4.492 (<0.00001) S
		A	63 (76.2)	60 (91.7)	5.406 (0.020) S	-2.325 (0.020) S	
	West	M	53 (84.9)	47 (91.5)	1.023 (0.312) N	-1.011 (0.313) N	
		A	56 (76.8)	59 (96.6)	9.955 (0.002) S	-3.155 (0.002) S	
Cherry St	North	M	90 (68.9)	84 (83.8)	4.951 (0.026) S	-2.225 (0.026) S	-2.950 (0.0032) S
		A	83 (71.1)	81 (77.8)	0.964 (0.326) N	-0.982 (0.327) N	
	South	M	80 (68.8)	84 (81.0)	3.254 (0.071) N	-1.804 (0.072) N	
		A	70 (82.9)	76 (86.8)	0.452 (0.501) N	-0.672 (0.503) N	
S 25th St	North	M	73 (74.0)	78 (92.3)	9.176 (0.002) S	-3.029 (0.002) S	-4.804 (<0.00001) S
		A	75 (76.0)	73 (86.3)	2.559 (0.109) N	-1.599 (0.109) N	
	South	M	83 (75.9)	87 (92.0)	8.191 (0.004) S	-2.862 (0.004) S	
		A	80 (73.8)	85 (87.1)	4.669 (0.031) S	-2.161 (0.031) S	
STOP Sign							
6th Ave N	East	M	58 (60.7)	74 (93.2)	11.908 (0.001) S	-3.451 (0.001) S	-3.753 (0.0002) S
		A	59(76.3)	70 (80.0)	0.262 (0.609) N	-0.512 (0.610) N	
	West	M	63 (76.2)	64 (84.4)	1.345 (0.246) N	-1.159 (0.246) N	
		A	65 (75.4)	71 (91.5)	6.539 (0.011) S	-2.557 (0.011) S	
11th Ave S	East	M	58 (72.4)	67 (91.0)	5.949 (0.015) S	-2.439 (0.015) S	-4.070 (<0.00001) S
		A	63 (73.0)	68 (92.6)	5.556 (0.018) S	-2.357 (0.018) S	
	West	M	56 (83.9)	49 (91.8)	1.507 (0.219) N	-1.227 (0.219) N	
		A	46 (73.9)	43 (90.7)	4.246 (0.039) S	-3.061 (0.039) S	
Cherry St	North	M	81 (69.1)	78 (89.7)	10.26 (0.001) S	-3.203 (0.001) S	-4.273 (<0.00001) S
		A	74 (73.0)	77 (84.4)	2.958 (0.085) N	-1.720 (0.085) N	
	South	M	70 (72.9)	73 (83.6)	2.412 (0.120) N	-1.553 (0.121) N	
		A	73 (76.7)	75 (89.3)	4.198 (0.041) S	-2.049 (0.040) S	
S 25th St	North	M	79 (74.7)	82 (90.2)	6.781 (0.009) S	-2.604 (0.009) S	-4.761 (<0.00001) S
		A	88 (73.9)	75 (88.0)	5.128 (0.024) S	-2.265 (0.024) S	
	South	M	76 (68.4)	79 (83.5)	4.875 (0.027) S	-2.208 (0.027) S	
		A	79 (69.6)	74 (86.5)	6.289 (0.012) S	-2.508 (0.012) S	

S: Significant at a 0.05 significance level, N: Not significant at a 0.05 significance level.

Table 13 Significant difference test between YIELD and STOP signs: Speed data summary

Location	No-school Session				Sig. Diff (95% CI)	In-School Session				Sig. Diff (95% CI)
	YIELD sign		STOP sign			YIELD sign		STOP sign		
	Avg Speed	n	Avg Speed	n		Avg Speed	n	Avg Speed	n	
6th Ave N	24.1	606	23.5	416	0.0017 S	24.2	312	24.1	356	0.6599 N
11th Ave S	24.8	291	24.9	283	0.7064 N	23.0	247	23.2	229	0.5866 N
Cherry St	23.2	331	23.4	287	0.5447 N	21.3	288	21.0	290	0.3122 N
S 25th St	23.1	243	23	216	0.7359 N	21.2	248	21.3	267	0.8949 N
Overall	23.9	1471	23.7	1202	0.3410 N	22.5	1095	22.5	1142	0.8144 N

S Significant at a 0.05 significance level, N Not significant at a 0.05 significance level.

Table 14 Significant difference test between YIELD and STOP signs: Yield data summary

Location	YIELD	STOP	z-score (p-value)	Combined z-score (p-value)
6th Ave N	255 (85.9)	279 (87.5)	-0.535 (0.596) N	-0.497 (0.617) N
11th Ave S	227 (92.5)	204 (91.2)	0.506 (0.610) N	
Cherry St	325 (82.2)	303 (86.8)	-1.603 (0.110) N	
S 25th St	323 (89.5)	310 (87.1)	1.036 (0.298) N	

S Significant at a 0.05 significance level, N Not significant at a 0.05 significance level.

7. CONCLUSIONS

The subsequent conclusions can be drawn based on the results of the analysis:

- The Emerging Hotspot Analysis is effective in identifying spatiotemporal crash clustering. There were more crashes in the winter when snow accumulation was high and the weather was cold.
- The Anselin Local Moran's I and Getis Ord Gi* statistical tools can be used to identify hotspots in a road network, which are areas that need significant attention.
- The EPDO and CR can be used as input parameters to identify hotspots; however, the EPDO input parameter yields more hotspots than the CR.
- The streets such as 17th Ave S, Demers Ave, and 24th Ave S roads have more speed citation record. Moreover, Demers Ave, S Washington St, S Columbia Rd, 32nd Ave, and the intersections between these roads have more frequent speed violations and crashes.
- The introduction of crosswalk STOP and YIELD signs led to a decrease in both average and 85th percentile speeds, establishing significant reductions in speed.
- The changes in vehicle speed were significant across various times, including mornings, afternoons, and whether or not schools were in session. Implementing these regulatory signs could effectively lower the risk of speed-related traffic crashes.
- The presence of traffic signs significantly enhanced yielding behavior toward pedestrians. Placing these signs at the crosswalk could potentially reduce traffic-related pedestrian crashes.
- There was no significant difference between the impact of the two types of traffic signs on speeding and yielding behaviors. This finding implies that transportation planners have the flexibility to use either sign to enhance pedestrian and overall road safety.

FUTURE WORKS

- Analysis of the effectiveness of other traffic calming measures will be done using a cross-sectional approach, and safety approach recommendations that consider the context of Grand Forks will be made.
- Analysis for signal warrants at intersections will be done. The hot spot analysis result will be used as an initial criterion.

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The Forks MPO

What is an MPO?

Grand Forks - East Grand Forks
METROPOLITAN
PLANNING ORGANIZATION

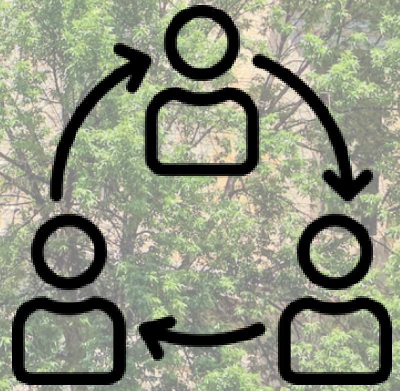
ROLE OF THE MPO

A METROPOLITAN PLANNING ORGANIZATION (MPO) IS THE POLICY BOARD OF AN ORGANIZATION CREATED AND DESIGNATED TO CARRY OUT THE METROPOLITAN TRANSPORTATION PLANNING PROCESS. MPOS ARE REQUIRED TO REPRESENT LOCALITIES IN ALL URBANIZED AREAS (UZAS) WITH POPULATIONS OVER 50,000, AS DETERMINED BY THE U.S. CENSUS.

What do we mean by the 3Cs?

- **Continuing** – ongoing, bringing forward the work of the past and re-evaluating as more is known, to continuously plan for the future.

- **Cooperative** – working in cooperation with the public, local agencies, state agencies, and federal agencies. Sometimes delaying the needs of one jurisdiction for the needs of the greater good.



- **Comprehensive** – thorough, studying all modes of transportation, all transportation needs, and all potential scenarios in a multi-disciplinary approach.

Grand Forks - East Grand Forks
Metropolitan Planning Organization

Why do MPOs exist?

The MPO is the required "forum for cooperative transportation decision-making for the metropolitan area". 23CFR 450.104

The MPO is the engine driving regional collaboration and coordination.

The MPO must plan for regional transportation needs while being responsive to community interests and local policies.

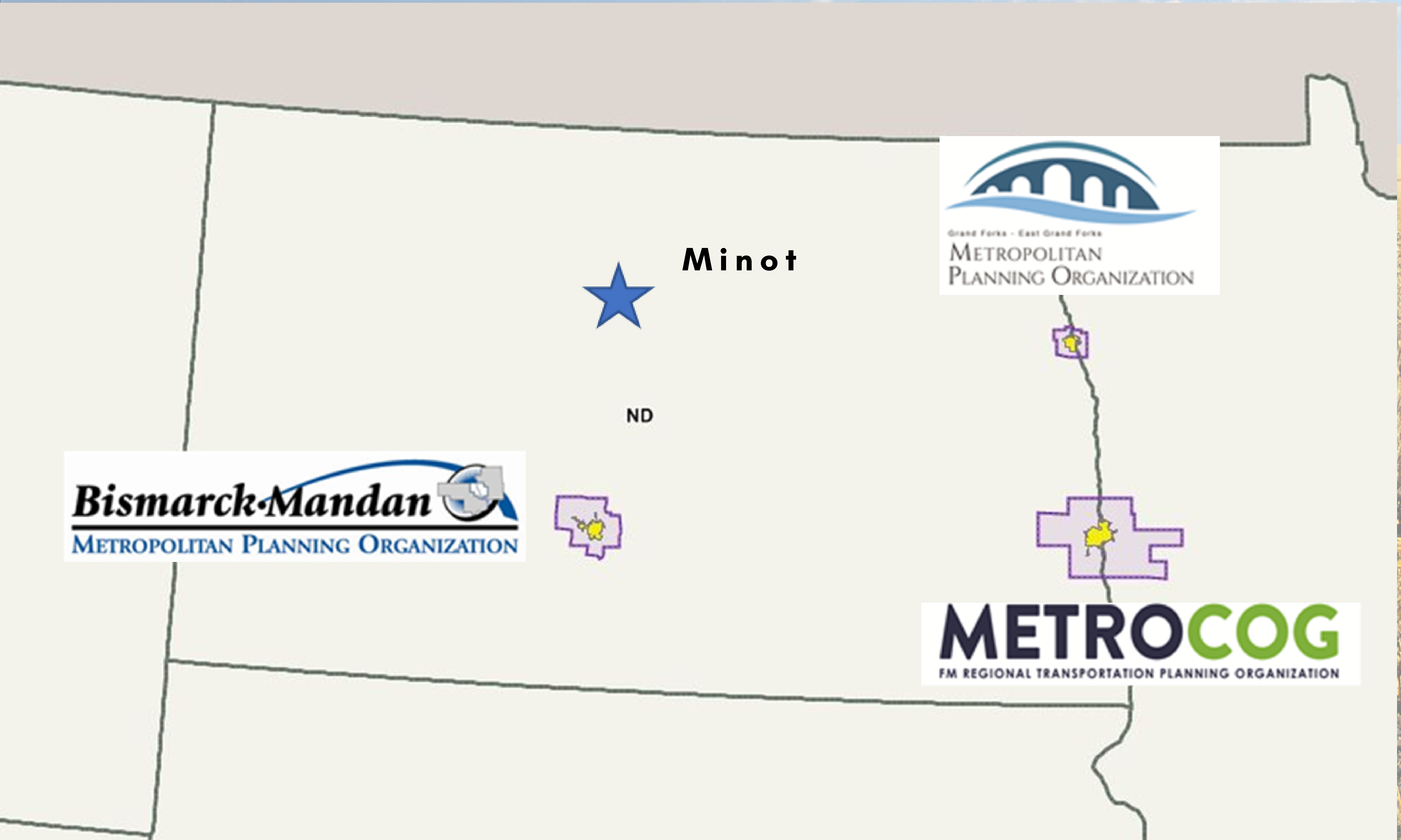
MPO planning involves many contributing agencies and must involve the public.

Grand Forks - East Grand Forks
Metropolitan Planning Organization

Our MPO History

1. **January 26, 1981 meeting**
    i. we are now a Designated Urbanized Area
2. **Letters dated October 5, 1982 and November 24, 1982**
    i. designating the area as an MPO
3. **Bylaws adopted June 23, 1982**
    i. amended:
        1. June 25, 1992
        2. March 9, 1993
        3. June 26, 1994
        4. August 17, 1998
        5. December 9, 1999

Where do Metropolitan Planning Organizations (MPOs) exist in ND?



Bismarck-Mandan

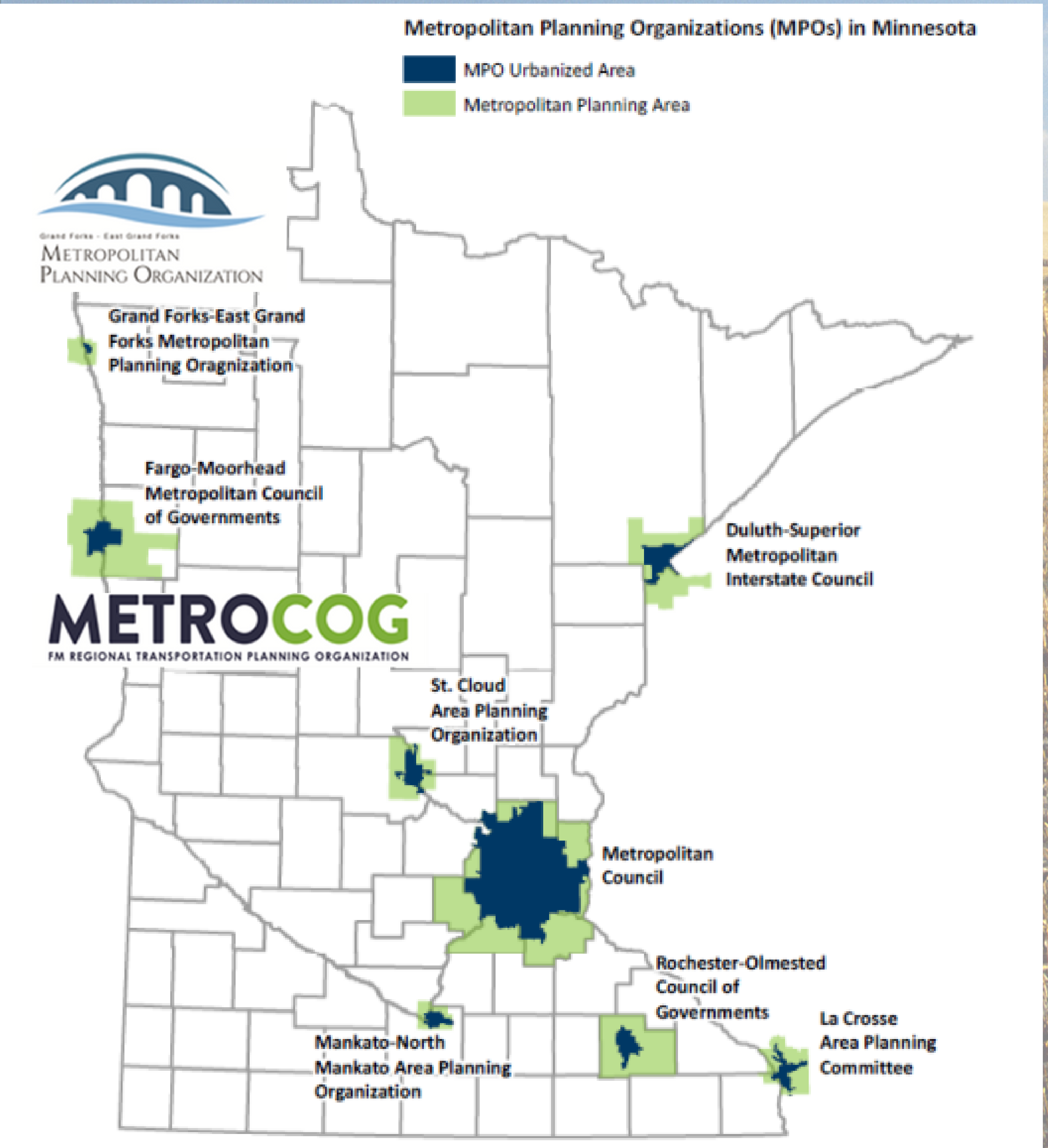
Fargo-Moorhead

Grand Forks-East Grand Forks

Minot – Coming soon

Grand Forks - East Grand Forks
Metropolitan Planning Organization

Where do Metropolitan Planning Organizations (MPOs) exist in MN?



Rochester

Fargo-Moorhead

Grand Forks-East Grand Forks

Mankato/North Mankato

St. Cloud

La Crosse

Duluth - Superior

Grand Forks - East Grand Forks
Metropolitan Planning Organization

MPO Required Planning Activities:

1. **Unified Planning Work Program (UPWP)**
   i. Tasks to accomplish planning activities
2. **Transportation Improvement Plan (TIP)**
   i. Projects to implement the LRTP
3. **Metropolitan Transportation Plan (MTP)**
   i. Goals, objectives, actions
4. **Public Participation Plan**
   i. Communication with the public and key affected groups

Grand Forks - East Grand Forks
Metropolitan Planning Organization

MPO Structure

Technical Advisory Committee (TAC)

FHWA – Kristen Sperry
FTA – Ranea Tunison
NDDOT – Wayne Zacher/Michael Johnson
MNDOT – Erika Shepard
GF Engineering – David Kuharenko/Carter Hunter
EGF Engineering – Steve Emery/Dustin Fanfulik
GF County – Lane Magnuson/Tom Ford/Nick West
MNDOT District 2 – Jon Mason/Troy Schroeder
Polk County – Rich Sanders
GF Planning – Ryan Brooks/Andrea Edwardson
EGF Planning – Nancy Ellis
GF Transit – Dale Bergman
BNSF – Nels Christianson
GF Airport – Ryan Riesinger

Grand Forks - East Grand Forks
Metropolitan Planning Organization

MPO Structure

Executive Policy Board

GF County – Mark Rustad
Polk County – Warren Strandell
EGF City Council – Brian Larson
EGF Planning & Zoning – Mike Powers
GF Planning & Zoning – Al Graser
GF City Council – Tricia Lunski
EGF City Council – Clarence Vetter
GF City Council – Ken Vein

Grand Forks - East Grand Forks
Metropolitan Planning Organization

Looking at it differently

Asking the question

"WHY THIS WAY?"

Grand Forks - East Grand Forks
Metropolitan
Planning Organization

Grab that

SMART

I-29 and TMC
Joint Application

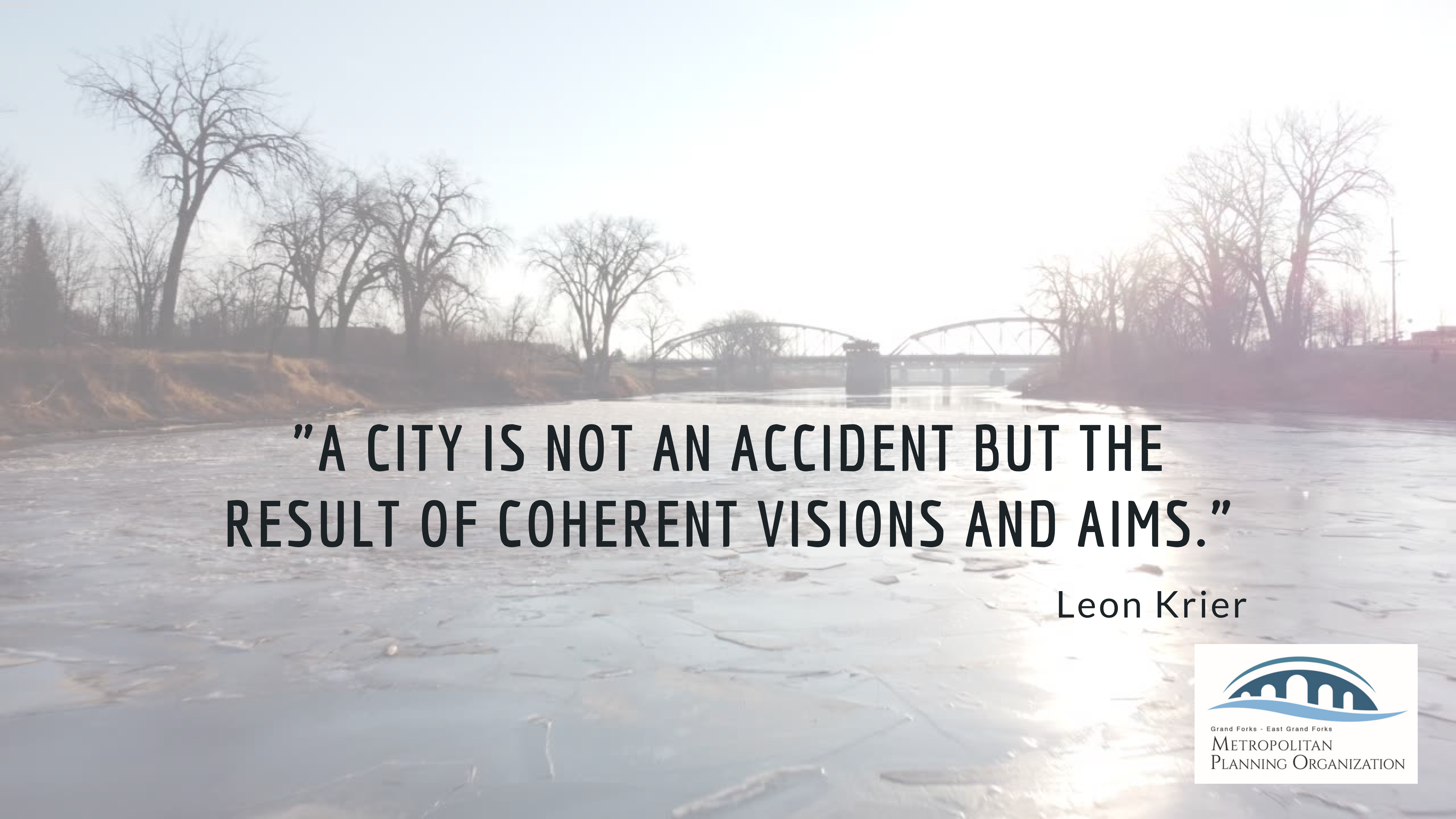
NORTH DAKOTA
FIGHTING HAWKS

Internship
Partnership

SS4A

MPO area
Joint Application

Grand Forks - East Grand Forks
Metropolitan
Planning Organization


"A CITY IS NOT AN ACCIDENT BUT THE RESULT OF COHERENT VISIONS AND AIMS."
Leon Krier
Grand Forks - East Grand Forks
Metropolitan Planning Organization

MPO Unified Planning Work Program 2024-2025

Task	Update	% Completed	Local Adoption	State/ Federal Approval
Street & Highway Plan / MTP	Final Approval	100%	Nov./Dec. 2023	Jan. 2024
ATAC - Planning Support Program	On-going			
TIP Adoptions and Amendments	On-going			
ITS Architecture	Gathering information and stakeholders	10%	Aug./Sep. 2024	Sep. 2024
ATAC - Traffic Counting Program	On-going			
Land Use Plan	2025/2026		Oct./Nov. 2026	Dec. 2026
Future Bridge Discussions/Assistance	On-going/As needed			
Updating Policy and Procedures/By-Laws	On-going			
Micro Transit Study	2025 Project		Oct./Nov. 2025	Dec. 2025
Grand Valley Study	RFP is currently being readvertised, proposals due 3/28	5%	TBD	TBD
Safe Streets For All (SS4A) Grant	Contract has been signed	5%	TBD	Sep. 2025
Functional Class	2024 Project	80%	April 1/July 1 2024	
One-way Pairs	2024/2025 Project		TBD	TBD
Safety Targets	On-going			
Bike Map	2024 Bike Maps are printed	100%		