DEPARTMENT OF TRANSPORTATION

Pedestrian Risk on Anishinaabe Reservations in Minnesota: Overview and Phase 2 Results

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June 2024

Research Project
Final Report 2024-18

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16. Abstract (Limit: 250 words) Studies by the Federal Highway Administration show that American Indians have higher rates of pedestrian injury and death per capita than any other population group in the United States. The Minnesota Department of Transportation (MnDOT) has identified Native Americans as one of six priority populations in Minnesota that face disproportionate risks as pedestrians. This report summarizes efforts taken between 2016 and 2024 to document and reduce risks to pedestrians on the seven recognized Anishinaabe reservations in Minnesota. Across reservations, researchers monitored pedestrian crossings using video recorders at 23 different sites identified by Tribal transportation managers, including 10 Phase 1 sites (2016-2020) and 13 Phase 2 sites (2019-2024). Monitoring results, including pedestrian counts, interactions with drivers, and yield rates, were used to inform planning and implementation of countermeasures to reduce crash risk at six Phase 1 sites and two Phase 2 sites. These countermeasures included marked crosswalks with pedestrian landing pads, better lighting and signage; ADA-accessible pedestrian access ramps; and a pedestrian hybrid beacon. Additional countermeasures have been scheduled or planned for 2024 or later at six more locations. Post-implementation monitoring at six Phase 1 sites confirmed that countermeasures change pedestrian and driver behaviors, but not all pedestrians or drivers use countermeasures as designed. Implementation of countermeasures may change risk factors and reduce risks, but risks cannot be eliminated and will remain after countermeasures are implemented. Consultation, coordination, and cooperation among Tribal, state, and local transportation planners and engineers are essential to reducing crash risk and increasing pedestrian safety.			
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Pedestrian Risk on Anishinaabe Reservations in Minnesota: Overview and Phase 2 Results

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MnDOT previously has acknowledged past harms and that some of the agency's "*past decisions denied Black and Indigenous communities as well as people with disabilities the full participation of transportation benefits. These and other underserved communities have historically carried disproportionate burdens of transportation decisions.*"
(https://www.dot.state.mn.us/planning/program/advancing-transportation-equity/commitment.html)

We hope this research project and related outcomes — including new infrastructure and countermeasures designed to reduce traffic safety risks to pedestrians — will help reduce existing disparities in pedestrian risk and provide benefits to residents of these reservations for years to come.

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EXECUTIVE SUMMARY

Studies by the Federal Highway Administration (FHWA) show that American Indians have higher rates of pedestrian injury and death per capita than any other population group in the United States. Minnesota is home to 11 federally recognized Tribal Nations, each of which is a unique, sovereign government recognized under the Constitution of the United States and various treaties, statutes, court decisions, and executive orders. Through these documents and policies, the state has established Government-to-Government relationships with the Tribes that provide for continuing "consultation, coordination, and cooperation" with each nation in all matters affecting them, including transportation to and on reservations. The Minnesota Department of Transportation (MnDOT), in establishing these relationships, has acknowledged that Tribal members on reservations experience disparities in access to safe, efficient transportation. MnDOT also has identified Native Americans as one of six priority populations in Minnesota that face disproportionate risks as pedestrians.

This report summarizes two MnDOT projects completed between 2016 and 2024 to document and reduce risks to pedestrians on reservations in Minnesota. In coordination with the Advocacy Council for Tribal Transportation (ACTT), an organization composed of voting members from each of the 11 Tribal Nations, MnDOT invited the tribes to participate in field research to document traffic-related risks to pedestrians on reservations. All seven Anishinaabe Nations eventually participated. Four Bands — the Bois Forte Band of Chippewa, Fond du Lac Band of Lake Superior Chippewa, Grand Portage Band of Lake Superior Chippewa, and Mille Lacs Band of Ojibwe — participated in the initial Phase 1 project (2016–2020). Three Bands — the Leech Lake Band of Ojibwe, the Red Lake Nation, and the White Earth Nation — participated in the Phase 2 project (2019-2024). Phase 2 also included assessment of traffic safety countermeasures implemented on the Fond du Lac, Grand Portage, and Mille Lacs reservations in response to Phase 1 findings.

Across the seven reservations, researchers monitored pedestrian crossings using video cameras and recorders at 23 different locations of concern identified by Tribal transportation managers. These locations included 10 crossing sites in Phase 1 and 13 crossing sites in Phase 2. Most of these locations were unmarked or informal crossing sites used by pedestrians traveling across state or county roadways to and from residential areas to grocery and convenience stores, places of employment such as casinos, schools, or Tribal or US government institutions. Neither the Phase 1 nor the Phase 2 research projects included funding for implementation of countermeasures or related roadway improvements, but three Phase 1 partners — the Fond du Lac, Grand Portage, and Mille Lacs Bands — used monitoring results to help obtain funding for countermeasures that were implemented before or during Phase 2. Phase 2 monitoring included monitoring how pedestrians used the new countermeasures on these locations.

Monitoring results included counts of pedestrians and crossing events, pedestrian interactions with drivers, and pedestrian and driver yield rates. Across the 23 Phase 1 and 2 sites on the seven reservations, the mean number of crossings per day ranged from less than 1 near the intersection of Hwys 1 and 89 west of Red Lake on the Red Lake Reservation to 136 at an unmarked crossing on Hwy 169 on the Mille Lacs Reservation. The percentage of pedestrian crossings that involved interactions

with drivers ranged from 9% at two locations (County State Aid Highway 104 and Farm Road, Bois Forte Reservation; Brevator Rd, Fond du Lac Reservation) to 65% at the signalized Hwy 169 and Casino Road location on the Mille Lacs Reservation. Across all locations, pedestrian yield rates ranged from 50% at the Big Lake Road and Pinewood Drive crossing site on the Fond du Lac Reservation to 100% at three Phase 2 sites. No crashes were observed at any of the 23 monitoring locations.

Following monitoring on each reservation, researchers provided lists of traffic safety countermeasures to project partners and then met with them to discuss results and identify countermeasures that potentially would address safety issues of greatest concern to Tribal leaders. Between 2019 and 2020, Tribal transportation leaders, MnDOT District and Central Office staff, and, in some cases, county engineers collaborated to identify grant funds and/or opportunities to integrate countermeasures into planned roadway projects. Countermeasures were implemented at six crossing locations on three reservations. On the Fond du Lac reservation, the countermeasures included marking crosswalks, installing new pedestrian landing pads with crosswalks, improving lighting and signage at crossing locations, installation of a Rectangular Rapid Flashing Beacon on University Road, construction of a multiuse trail parallel to Big Lake Road in Cloquet, and, on Hwy 210 in Sawyer, reducing speed limits and adding a dynamic speed feedback sign. On the Grand Portage Reservation, new crosswalks were marked and signage was added at both monitoring locations. In addition, at the Hwy 61 and Blazes Pit crossing, pedestrian access stairs, an American Disabilities Act (ADA) compliant pedestrian access ramp, and roadway guardrails were installed. On Hwy 169 in Mille Lacs, a High Intensity Activated CrossWalk beacon known as a HAWK signal was installed. Additional countermeasures have been scheduled or planned for 2024 or later at six additional locations.

Phase 2 (post-implementation) monitoring at the six Phase 1 sites where countermeasures were implemented confirmed countermeasures change pedestrian and driver behaviors, but also showed that not all pedestrians or drivers use countermeasures as designed. For example, most pedestrians crossing Hwy 61 in Grand Portage now use the crosswalk and new stairs or access ramp, but a small percentage still cross elsewhere, jumping a guardrail to do so. At Mille Lacs, not all pedestrians activate the HAWK, even in the presence of traffic, some pedestrians walk before the walk signal is on, some drivers do not wait for the full duration of the red light during the stop phase of the HAWK. In general, the field evaluations of the new countermeasures show that these measures change risk factors and thereby reduce risk, but also that risks cannot be eliminated and will remain following implementation.

The Phase 1 and Phase 2 projects together represent MnDOT's most significant effort to date to address disparities in pedestrian crash risk on reservations in Indian Country. Findings document pedestrian roadway crossing volumes, pedestrian interactions with drivers, pedestrian and driver yield rates, and pedestrian use of new countermeasures. Because countermeasures do not eliminate risk, continued collaboration among Tribal, state, and local transportation engineers and planners will be essential to reducing crash risk and increasing pedestrian safety.

In addition to these technical findings, project partners also gained insight into approaches and strategies for building effective collaborations to reduce risk. Consistent with their Government-to-Government relationship with the Tribes, MnDOT invited Tribes to participate in the projects, asked Tribal transportation managers to identify crossing sites of greatest concern, asked for permission to install video cameras and for approval of proposed monitoring plans, and convened meetings with Tribal transportation managers to review results and identify potential countermeasures. Following Phase 1, MnDOT continued to coordinate with the Tribes to identify new funding and other opportunities to implement their preferred countermeasures. For Phase 2 evaluations of new countermeasures, MnDOT convened meetings with partners to identify monitoring plans and to review results, including technical aspects of the HAWK signal operations in Mille Lacs.

Reflection on the approach and project outcomes yields principles that may be helpful in building future collaborations and partnerships to reduce risk. These principles include:

1. *Mission, vision, and policies matter.* MnDOT's "Government-to-Government" policy that calls for "consultation, coordination, and cooperation" with Minnesota's sovereign Tribal nations provided the foundation for both projects. Grounding project proposals in the context of organizational missions and policies may increase the likelihood of implementation.
2. *Evidence is essential.* The principal objectives of both Phases 1 and 2 were to document pedestrian crossing behaviors on state and local highways on reservations. This evidence proved key to subsequent acquisition of new funding for preferred countermeasures.
3. *Risks are relative, but real.* Project partners acknowledged the numbers of pedestrians crossing roadways on reservations were small but also agreed the risks were real and potentially life-threatening. With MnDOT policies like Vision Zero — the goal of which is to eliminate deaths from crashes — actions to reduce crashes are warranted regardless of relative traffic volumes.
4. *Equity, as well as efficiency, is important*. MnDOT has acknowledged its "*decisions have underserved, excluded, harmed, and overburdened"* Tribal communities and that equity *"requires ensuring underserved communities, especially Black, Indigenous and People of Color, share in the power of decision making."* Addressing disparities resulting from historical discrimination requires consideration of equity in decision making and resource allocation.
5. *Engagement of collaborators is critical.* Tribal relation policies call for "consultation, coordination, and cooperation" with the sovereign Tribes recognized in Minnesota. MnDOT's commitment to these policies — epitomized by its engagement of the Tribes at each step of the research process — was essential for building trust. Countermeasures would not have been implemented without this degree of collaboration.
6. *Engineer with people, not for them*. Post-implementation monitoring at six Phase 1 sites confirmed countermeasures change pedestrian and driver behaviors, but also that not all pedestrians or drivers use countermeasures as designed. Consultation with potential users may increase use of facilities as designed.

7. *Subjective, value-based judgments are inevitable and should be acknowledged.* Engineers are trained and work hard to achieve objectivity and eliminate subjective bias from analyses and project-related decisions. Subjective judgements are inevitable, however, given demands for scarce resources and complex, sometimes conflicting, societal goals. Recognizing and being transparent about the role of professional judgment in reducing crash risk and increasing pedestrian safety is essential to address equity, safety, and other objectives.
8. *Risks can be reduced but not eliminated*. Because countermeasures cannot eliminate risk, continuous collaboration among Tribal, state, and local transportation engineers and planners is essential to reducing crash risk and increasing pedestrian safety.

Chapter 1: Introduction

Studies by the Federal Highway Administration (FHWA) show that American Indians have higher rates of pedestrian injury and death per capita than any other population group in the United States (Lavalley et al. 2004*)*. Minnesota is home to 11 federally recognized Tribal Nations, each of which is a sovereign government recognized under the Constitution of the United States and various treaties, statutes, court decisions, and executive orders. Each of Minnesota's Tribal Nations is unique, and each has a unique legal relationship with the United States and with the state of Minnesota. In Minnesota, despite the sovereign status of the Tribes, the Department of Transportation (MnDOT) historically has built highway infrastructure through Indian reservations with little to no consultation with them. Few if any pedestrian facilities historically have been built on reservations, thereby increasing the risk of crashes between drivers and pedestrians and leading to the types of disparities noted by FHWA.

In 2013, to begin to address these issues, Governor Mark Dayton signed Executive Order (EO) 13-10 that affirmed the Government-to-Government relationships with the Tribes and provided for continuing "consultation, coordination, and cooperation" (MN.gov / EO-13-10). In 2019, Governor Tim Walz signed Executive Order (EO) 19-24 to update and affirm the unique legal relationship between Tribal Governments and the state (MN.gov / EO-19-24). This EO mandates all executive branch agencies to enter formal, timely, and meaningful consultation with the 11 Tribes. In 2021, the Minnesota Legislature passed Minn. Statute 10.65, mandating all state agencies to consult with Tribal Nations on issues with tribal implications (Minn. Statute 10.65). These issues include traffic improvements and safety on MnDOT infrastructure in Indian Country, especially for vulnerable users like pedestrians and bicyclists.

MnDOT adopted Policy AD005, Minnesota Tribal Nations Government-to-Government Relationship with MnDOT, to implement these EOs and the statute (MnDOT Policy AD005). Policy AD005 requires consultation and coordination with Tribal Nations on all MnDOT activities that potentially impact tribal interests. As part of its efforts to implement this policy, MnDOT has acknowledged its complex and layered history with the Tribes, that the Tribes in Minnesota historically have not been engaged fully in decision-making, and that disparities in access to safe, efficient transportation exist on reservations. As part of its commitment to maintaining Government-to-Government relations with Tribal Nations, MnDOT's Office of Tribal Affairs helps foster and facilitate positive relationships between MnDOT, the Tribal Nations, and other stakeholders. These efforts include providing support for the Advocacy Council for Tribal Transportation (ACTT), which discusses roadway policy and issues involving roadways on or near Tribal Nations. Representatives from the 11 Tribal Nations in Minnesota make up the voting membership of ACTT; other members of ACTT include representatives from MnDOT and USDOT.

This project emerged from and was conducted in the context of MnDOT's Government-to-Government relationship with the Tribes and engagement with ACTT. As awareness of the risks to pedestrians on reservations has grown, consultation between MnDOT and the Tribes has increased. In 2016, in *Minnesota* Walks, the state's statewide pedestrian plan, MnDOT identified Native Americans as one of six priority populations in Minnesota that face disproportionate risks as pedestrians (MnDOT & MDH

2016). To address the problem of pedestrian safety on reservations, MnDOT invited Minnesota's Tribal Nations and ACTT to participate in a collaborative project with researchers at the University of Minnesota to document pedestrian crossing behaviors and assess risk on state highways on reservations. Four Anishinaabe Bands — the Bois Forte Band of Chippewa; Fond du Lac Band of Lake Superior Chippewa; Grand Portage Band of Lake Superior Chippewa; and Mille Lacs Band of Ojibwe — participated in the project, now referred to as the Phase 1 project. Observational field monitoring at 10 locations was conducted in 2017, and project partners identified potential countermeasures to address risks (Lindsey et al. 2020). Implementation of countermeasures was not part of the research project, but based on the project's results, three Bands (Fond du Lac, Grand Portage, and Mille Lacs) subsequently worked with MnDOT and other partners to implement countermeasures at six locations between 2019 and 2020. The fourth Band (Bois Forte) used results as evidence in successful applications for FHWA Tribal Transportation Program Safety Fund.

In 2019, based on interim Phase 1 findings, MnDOT funded a second phase of monitoring to observe pedestrian crossings on three additional reservations and to assess pedestrian behaviors at locations where Phase 1 countermeasures had been implemented. The three other Anishinaabe Bands in Minnesota — the Leech Lake Band of Ojibwe, Red Lake Nation, and White Earth Nation — joined the partnership. Phase 2 monitoring initially planned for the summer of 2020 was delayed because of the COVID-19 pandemic. Monitoring at 13 new crossing locations identified by the Fond du Lac, Leech Lake, Red Lake, and White Earth Bands was completed in 2021. Phase 2 monitoring of pedestrian use of six new countermeasures installed on the Grand Portage, Fond du Lac, and Mille Lacs reservations was completed in 2022.

This report summarizes Phase 2 findings and outcomes. Phase 1 results also are included where relevant for context and interpretation of Phase 2 results. Chapter 2 presents background information for the project. Chapter 3 provides an overview of Phase 2 findings, including tabular summaries that permit comparisons of basic statistics (e.g., pedestrian crossing volumes, interactions with drivers, and pedestrian and driver yield rates) across reservations monitored in both Phase 1 and Phase 2. Chapters 4-6 present results from the reservations that participated only in Phase 2: Leech Lake, Red Lake, and White Earth, respectively. Chapters 6–9 summarize findings from monitoring of countermeasures installed following Phase 1 on the Fond du Lac, Grand Portage, and Mille Lacs reservations, respectively. Chapter 10 presents conclusions and lessons learned.

In addition to this report, results from Phase 2 also are summarized in six story maps available online. Links to these story maps are listed below and on MnDOT's website:

- Fond du Lac Reservation
- Grand Portage Reservation
- Leech Lake Reservation
- Mille Lacs Reservation
- Red Lake Reservation
- White Earth Reservation.

Chapter 2: Background, Approach, and Methods

This Phase 2 project functioned as a continuation of a prior MnDOT project, referred to herein as the Phase 1 study (Lindsey et al. 2020). The research context and institutional backgrounds therefore were similar. Phase 2 also followed a similar collaborative approach, and researchers used the same methods to observe, document, and analyze pedestrian crossing behaviors. Phase 2 added assessment of the use of countermeasures built in response to Phase 1 findings and thus, depending on the countermeasure, collected additional types of data. The Phase 1 report therefore provides useful perspective on this Phase 2 project (Lindsey et al. 2020). This chapter summarizes key points related to the research context, institutional background, approach, and methods.

2.1 Research Context

Both phases of the project were undertaken in the context of growing recognition in the U.S. of disparities in access to transportation infrastructure and resources experienced by marginalized populations. With respect to transportation-related disparities faced by American Indians, the Phase 1 report noted (Lindsey et al. 2020, p. 3):

> *… studies have documented the disproportionate rates of fatalities and injuries suffered by American Indians relative to other races and ethnicities (Quick et al. 2019; Iragavarapu et al. 2015; West and Naumann 2011; Mickleson and Corbett 2007; Hilton 2006; Subramanian 2005; Grossman et al 1997). Complex sets of factors, including cultural considerations, must be addressed to reduce crashes, fatalities, and injuries. Tribal transportation managers … cite road quality engineering and repair; reckless driving; seatbelt/car seat use; and pedestrian safety as their top safety-related concerns (Quick et al. 2019). Traffic safety experts assert that coordination, cooperation, and communication among sovereign Tribal governments and county and state departments of transportation is necessary to address the disparities in fatality and injury rates (Martinez et al. 2009; Kozak and White 2003).*

The Phase 1 report also noted (p. 3):

> *Researchers working in collaboration with Tribal transportation leaders and other safety stakeholders have shown that these systematic approaches can help overcome the "limited resources, lack of coordination across jurisdictions, rural nature of many of the roadways, and lack of crash data" that have complicated efforts by tribes to implement effective risk reduction programs (Shinstine and Ksaibati 2013, p. 80; Shinstine and Ksaibati 2015; Shinstine, et al. 2015; Nazneen, et al. 2018; Terrill & Ksaibati 2018; Wempel and Colling 2014). Fewer studies, however, have documented specific strategies or countermeasures to be implemented at specific, high-priority locations identified by Tribal governments and partners.*

The Phase 2 study was designed to address these disparities, including the need for documentation of countermeasures implemented in response to safety concerns at crossing locations prioritized by Tribal transportation managers.

2.2 Institutional Background

MnDOT's vision is to support a "multimodal transportation system that maximizes the health of people, the environment and our economy," and its mission is to "Connect and serve all people through a safe, equitable, and sustainable transportation system" (MnDOT 2024a). One of MnDOT's "Guiding Principles" for realizing its vision and mission is to "use partnerships" and "coordinate across sectors and jurisdictions (MnDOT 2024b). MnDOT has adopted many different policies, programs, and plans to achieve its multimodal vision. *Minnesota Walks*, Minnesota's Statewide Pedestrian System Plan, guides the state's efforts to create safe, walkable communities for all Minnesotans (MnDOT & MDH 2016). As noted in the Phase 1 report (Lindsey et al. 2020, p. 1):

> *… Minnesota Walks identifies the need to work with priority populations who face disproportionate risks when walking. These populations include rural Minnesotans and Minnesota's eleven Native American populations, the majority of whom live on seven Anishinaabe (Chippewa, Ojibwe) reservations and in four Dakota (Sioux) communities.*

With respect to Minnesota's Tribal Nations, MnDOT's Commitment statement is (MnDOT Policy AD005):

> *MnDOT is committed to working with the Tribal Nations in Minnesota through consultation, coordination, and cooperation. For more information on MnDOT's commitment for developing, improving, and maintaining collaborative relationships between MnDOT and the eleven (11) Tribal Nations in Minnesota view the MnDOT's Tribal Nations Government-to-Government Policy. The policy and this website were developed to support these efforts and to improve Tribal-State governmental relations through resource sharing.*

Given the disparities in access to transportation infrastructure and resources experienced by these Tribal Nations, MnDOT's statement on transportation equity is relevant to MnDOT-Tribal partnerships. The statement acknowledges past harms and makes clear MnDOT's commitment to ensuring the benefits and burdens of transportation systems are fair and just and that Tribal Nations and other marginalized populations share in decision-making (MnDOT 2024c).

> ***We are committed to creating an equitable transportation system.***
>
> ***Acknowledgement of past harms***
> *MnDOT acknowledges the transportation system and agency decisions have underserved, excluded, harmed, and overburdened some communities. We understand some of our past decisions denied Black and Indigenous communities as well as people with disabilities the full*

participation of transportation benefits. These and other underserved communities have historically carried disproportionate burdens of transportation decisions.

How we define transportation equity
Transportation equity means the benefits and burdens of transportation systems, services and spending are fair and just, which historically has not been the case. Transportation equity requires ensuring underserved communities, especially Black, Indigenous and People of Color, share in the power of decision making.

Our journey
The journey of transforming our transportation systems, services and decision-making processes will require ongoing listening, learning, changing, implementing and adapting.

Both the Phase 1 and Phase 2 projects were conceived and undertaken in the spirit of these policies.

2.3 Collaborative Approach

MnDOT's "government to government" policy that requires "consultation, coordination, and cooperation" with the Tribes provides the foundation for this project (MnDOT Policy AD005). As noted in the Phase 1 report (Lindsey et al. 2020, in Executive Summary):

> MnDOT's approach to the project was consultative and collaborative. MnDOT's Tribal liaison advised staff and researchers on project development and implementation. Following ACTT's agreement to participate in the project, MnDOT and the researchers:
>
> - Coordinated with Tribal transportation managers who identified priority sites for monitoring.
> - Prepared monitoring plans and obtained approval from Tribes and agencies for monitoring.
> - Installed video equipment and analyzed videos.
> - Reviewed findings with Tribal representatives.
> - Identified potential countermeasures in consultation with Tribes and county engineers.
>
> Multiple representatives from each reservation and county engineers participated in meetings to identify potential countermeasures and review opportunities to integrate them into planned projects. MnDOT and researchers reviewed the literature and:
>
> - Met with Tribal representatives to review results and brainstorm countermeasures;
> - Met with MnDOT safety and district engineers to refine possible countermeasures;
> - Met jointly with Tribal representatives, MnDOT district engineers, and county engineers to finalize short-lists of countermeasures and opportunities to integrate them into scheduled or planned projects.

Project partners continued this approach through Phase 2, broadening it to engage other partners where relevant. Most notably, the Red Lake Nation and the University of Minnesota initiated an unfunded, follow-up project to engage two teams of graduate students to provide conceptual designs for a pedestrian crossing and for "pocket parks" on a multi-use trail proposed to reduce pedestrian walking on state highway road shoulders.

2.4 Monitoring and Analytic Methods

In Phase 2, the research team used the same, standard observation and analytic methods used in Phase 1 to document pedestrian behaviors, including crossing trajectories and interactions with drivers (Lindsey et al. 2020). After project partners agreed on crossing locations to be observed, the Director of the Minnesota Traffic Observatory (MTO) assessed options for deploying video recorders and discussed options with Tribal transportation managers and MnDOT representatives. Following approval of the monitoring plans by MnDOT and the relevant Tribal transportation representatives, the MTO applied for the permits required for installation of video cameras in or near the roadway rights-of-way. After acquiring the permits and obtaining authorization of Tribal representatives, the MTO installed customized battery-powered traffic surveillance systems at each crossing location.

The MTO traffic surveillance systems include a high-resolution video camera mounted to an extendable mast or directly to existing infrastructure with steel bands. A weatherproof steel container houses recording equipment, and batteries are used to power the equipment. The entire system attaches to conveniently placed poles or trees. The cameras operated only during daylight hours, which means that numbers of pedestrians and crossings documented are undercounts and do not reflect risks associated with pedestrian-driver interactions at night. Additional details about the monitoring methods are presented in the Phase 1 project report (Lindsey et al. 2020).

The MTO set a goal of monitoring long enough at each location to observe at least 200 pedestrian crossings. Each video camera continued operating until its batteries were dead. Because several factors affected battery life, the number of days each video camera operated varied across sites. The number of observations that were obtained also varied across sites.

The MTO used the protocols developed for the Phase 1 project to view and reduce the video, count the number of crossings, classify and code interactions between pedestrians and drivers, and analyze results. Specifically (Lindsey et al. 2020, p. 15),

> *Interactions were defined as crossings in which (a) pedestrians altered behaviors in anticipation of, or because of, interactions with a vehicle, or (b) drivers altered behaviors in the presence of pedestrians. Examples of interactions include pedestrians waiting on the shoulder or on the median while vehicles pass or drivers slowing or stopping to allow pedestrians to cross. Data analyses were limited to calculation and presentation of simple descriptive statistics. The project was exploratory in nature, and the scope-of-work did not call for modeling of traffic flows or pedestrian crossings or for formal analyses of risk.*

Pedestrian crossing patterns or trajectories were documented by creating origin and destination zones (e.g., A1, B1, etc.) and then coding the numbers of pedestrians from each zone to all other zones.

Phase 2 differed from Phase 1 in that it included monitoring of pedestrian use of countermeasures at locations on three reservations: Fond du Lac, Grand Portage, and Mille Lacs. At Grand Portage and Fond du Lac, assessing pedestrian use of countermeasures did not require any special protocols other than tracking pedestrian trajectories. However, at Mille Lacs, where a pedestrian-actuated High-Intensity Activated Crosswalk (HAWK) signal was installed, special monitoring protocols were required. Design of pedestrian hybrid beacons (PHBs) like HAWKS is complex because engineers must assess length of time pedestrians take to cross roadways (e.g., a four-lane highway with a raised median in the case of Mille Lacs), determine the time required to cycle through the phases of the traffic signal, and assess the probability that pedestrians and drivers of motor vehicles and bicycles will use the facility as intended.

The Director of the MTO and the project principal investigator met with engineers and planners from the Mille Lacs Band and MnDOT's District and Central Offices to determine the data to be collected from monitoring pedestrian behaviors when crossing at the HAWK signal. The assessment called for collection of 20 different operational measures. Following monitoring and data reduction, the project partners met again to explore possible changes to operation of the HAWK signal to reduce sources of risk identified through post-implementation monitoring. Options included engineering, educational, and enforcement-related interventions.

Chapter 3: Overview of Project Monitoring Results

The primary goals of both Phase 1 and Phase 2 were to document risks experienced by pedestrians when crossing roadways on reservations and to identify countermeasures that potentially could be implemented in future projects to reduce risks. Chapter 3 provides an overview of monitoring results and summarizes related outcomes, including implementation of countermeasures by MnDOT, the Tribes, and local governments in response to evidence of risks at crossing locations. Because Phase 2 also involved monitoring of pedestrian use of countermeasures implemented in response to Phase 1 findings, the results of Phase 1 also are summarized in this chapter. Details related to monitoring at each site, including pictures of crossing locations and documentation of crossing trajectories, are included in Chapters 4 through 9 that present findings on each reservation.

3.1 Phase 1 Monitoring Results

The research team monitored pedestrian traffic at 10 locations on four reservations for 11 to 20 days between May and August 2017 (Table 3.1; Lindsey et al. 2020). Pedestrian crossings were monitored only during daylight hours and therefore do not include all crossings at these locations. The locations identified by the different Bands were near convenience stores or supermarkets (Fond du Lac, Grand Portage, Mille Lacs), Tribal offices or schools (Bois Forte, Fond du Lac, Grand Portage), or casinos (Bois Forte, Grand Portage, Mille Lacs).

Across the 10 locations, the mean number of crossings per day ranged from 3 at the Brevator Road site on the Fond du Lac Reservation to 136 at an unmarked crossing on Hwy 169 on the Mille Lacs Reservation (Table 3.1). Excluding Mille Lacs, the mean number of pedestrians observed per day at the other nine sites ranged 3 to 39. Across the 10 locations, the median mean daily pedestrian crossing volume was approximately 20. The percentage of pedestrian crossings that involved interactions with drivers ranged from 9% at two locations (County State Aid Highway (CSAH) 104 and Farm Road, Bois Forte Reservation; Brevator Rd, Fond du Lac Reservation) to 65% at the signalized Hwy 169 and Casino Road location on the Mille Lacs Reservation (Table 3.1). Across all locations, pedestrians yielded to drivers in at least half of the interactions: pedestrian yield rates ranged from 50% at the Big Lake Road and Pinewood Drive crossing site on the Fond du Lac Reservation to 93% at the Hwy 169 location on the Mille Lacs Reservation.

Following monitoring on each reservation, researchers provided lists of potential countermeasures to project partners and then met with them to discuss results and identify countermeasures that would address safety issues of greatest concern to Tribal leaders (Table 3.2; Lindsey et al. 2020). Although funding for design and implementation of countermeasures was not included in the Phase 1 project, Tribal transportation leaders, MnDOT District and Central Office staff, and, in some cases, County engineers collaborated to identify grant funds and/or opportunities to integrate preferred countermeasures into planned roadway projects. Between 2019 and 2020, countermeasures were

implemented at six crossing locations on three reservations (Tables 3.1 and 3.2). Subsequently, during Phase 2, the research team monitored pedestrian crossings and use of countermeasures at sites where countermeasures had been implemented.

3.2 Phase 2 Monitoring Results

The research team monitored pedestrian traffic at 19 crossing locations on six reservations in Phase 2, including 13 new locations on the Fond du Lac, Leech Lake, Red Lake, and White Earth Reservations and 6 Phase 1 sites on the Fond du Lac, Grand Portage, and Mille Lacs sites where countermeasures had been installed (Tables 3.3 and 3.4). New locations on the Leech Lake, Red Lake, and White Earth Reservations were monitored between August and October 2021 for between 9 and 22 days. Monitoring on the Phase 1 sites occurred on the Mille Lacs Reservation in August 2021 (8 days), the Grand Portage Reservation in August 2022 (12-14 days), and the Fond du Lac Reservation in September 2022 (7-18 days). As in Phase 1, pedestrian crossings were monitored only during daylight hours and therefore do not include all crossings at these locations. Similar to the sites monitored in Phase 1, the locations identified by the different Bands were near convenience stores or supermarkets (Leech Lake, Red Lake, White Earth), Tribal offices or schools (Leech Lake, White Earth), or a casino (Leech Lake).

Across the 13 new locations, the mean number of pedestrians crossing per day ranged from <1 near the intersection of Hwys 1 and 89 west of Red Lake on the Red Lake Reservation to 52 at two locations: the signalized Grant Utley intersection in Cass Lake on the Leech Lake Reservation and in Redby on the Red Lake Reservation (Table 3.5). When groups of pedestrians and divided travel lanes are accounted for, the number of crossing events at these 13 sites ranged from <1 near the Hwy 1-Hwy 89 intersection on the Red Lake Reservation to 72 near the Hwy 2-63rd Avenue NW intersections near the Casino in Cass Lake on the Leech Lake Reservation. In Cass Lake, Hwy 2, is a four-lane divided highway. Therefore, each complete crossing is considered two crossing events because pedestrians experience different risks when crossing each pair of lanes.

The percentage of pedestrian crossings that involved interactions with drivers ranged from 14% at the University Road location on the Fond du Lac Reservation to 50% to the Hwy 19-Hwy 113 intersection in Waubun on the White Earth Reservation (Table 3.5) Across all 13 locations, the percentage of interactions in which pedestrians yielded to drivers ranged from 79% at the University Road crossing to 100% at three locations (Table 3.5).

As in Phase 1, researchers provided a list of potential countermeasures to project partners following monitoring and then met with them to discuss results and identify countermeasures that potentially would address safety issues of greatest concern to Tribal leaders (Tables 3.6 and 3.7). Funding for design and implementation of countermeasures was not included in the Phase 2 project. Since completion of monitoring, Tribal transportation leaders and MnDOT have identified, installed, or scheduled countermeasures to be implemented in the future at two locations (Redby, Hwy 1 crossing, Red Lake Reservation; Hwy 50-Hwy 113 intersection, Waubun, White Earth Reservation). On the Leech

Lake Reservation, monitoring results have been used to inform design alternatives being evaluated in a major study to assess traffic flow and pedestrian safety along and across Hwy 2 in Cass Lake.

Table 3.1 Phase 1 Monitoring results by reservation and location (Lindsey et al. 2020)

Reservation	Crossing Locations*	Days of Data	Pedestrians	Mean Pedestrians / Day	Maximum Pedestrians / Day	Percent Crossings with Interactions	Pedestrian Yield Rate	Vehicle Yield Rate	Rate Both Yielded
Boise Forte	CSAH 104 (Gruben Rd) / T-3256 (Farm Rd)	14	548	39	70	9%	82%	18%	0%
	CSAH 104 (Gruben Rd) / Gold Mine Spur Rd	12	313	26	46	16%	74%	22%	4%
Fond du Lac	CSAH 7 (Big Lake Rd) / CR 115 (Pinewood Dr)	20	578	29	61	29%	50%	36%	14%
	CSAH 7 (Big Lake Rd) / CR 114 Trettel Lane)*	***11***	***339***	***31***	***56***	***29%***	***75%***	***15%***	***10%***
	CSAH 7 (Big Lake Rd) / CSAH 5 (Brevator Road)	11	33	3	8	9%	-	-	-
	Hwy 210 / CSAH 25 (Mission Rd)*	***17***	***206***	***12***	***23***	***33%***	***91%***	***4%***	***4%***
Grand Portage	***Hwy 61 / Blazes Pit Road (n. of Marina Rd****	***16***	***218***	***14***	***38***	***21%***	***89%***	***9%***	***2%***
	Hwy 61 / Stevens Rd*	***13***	***147***	***11***	***23***	***19%***	***82%***	***14%***	***4%***

Table 3.1 (continued) 1 Phase 1 Monitoring results by reservation and location (Lindsey et al. 2020)

Reservation	Crossing Locations*	Days of Data	Pedestrians	Mean Pedestrians / Day	Maximum Pedestrians / Day	Percent Crossings with Interactions	Pedestrian Yield Rate	Vehicle Yield Rate	Rate Both Yielded
Mille Lacs Band of Ojibwe	Hwy 169 / Casino Road	16	63	4	11	65%	66%	32%	2%
	Hwy 169 / n. of Casino Road*	***20***	***2,728***	***136***	***210***	***43%***	***96%***	***2%***	***5%***
	Additional sample Hwy 169 / n. of Casino Road	3	375	125	155	54%	93%	1%	2%

*Bold, italicized font denotes crossing locations where countermeasures were implemented in 2019-2020 following Phase 1 monitoring.

Table 3.2 Summary of potential countermeasures for Phase 1 monitoring locations (Lindsey et al. 2020)

Reservation / Intersection	Crossings / Day	Potential New Countermeasures	Planned Implementation
Bois Forte Reservation			
CSAH 104-Farm Rd	39	● Crosswalk realignment and addition of ADA-compliant truncated domes ● Crosswalk plus: marked crosswalk with advanced warning signs ● Speed display/warning signs ● In-street plastic bollards to reduce speed ● Pedestrian education programs	Not scheduled
CSAH 104-Gold Mine Spur Rd	26	● Improved lighting ● Crosswalk plus: marked crosswalk with advanced warning signs ● Intersection/crosswalk realignment (longer term)	Not scheduled
CSAH 104-New Moon Rd	Not Monitored	● Improved lighting ● Crosswalk plus: marked crosswalk with advanced warning signs	Not scheduled
Fond du Lac Reservation			
Big Lake Rd-Pinewood Dr	29	● RRFB, marked crosswalk, advanced warning signs (uncertain)	Not scheduled
Big Lake Rd-Trettel Ln	31	● Off-road trail/sidewalk	2019
Big Lake Rd-Brevator/University	3	● Off-road trail/sidewalk ● RRFB ● ADA-compliant access ramps ● Access management through parking lot reconfiguration	2019, 2021
TH 210 and Mission Rd	12	● New pedestrian trail along Mission Rd ● Pedestrian landing at TH 210 ● Additional signage (pedestrian crossing signs) ● Vegetation removal and line-of-improvements	2020

Table 3.2 (continued) Summary of potential countermeasures for Phase 1 monitoring locations (Lindsey et al. 2020)

Reservation / Intersection	Crossings / Day	Potential New Countermeasures	Planned Implementation
Grand Portage Reservation			
TH 61-Blazes Pit Rd	14	• Paved ADA-compliant pedestrian ramp to a landing • New lighting • Marked crosswalk and connecting paved trail side • RRFB • Advanced warning (pedestrian crossing) signs • Pedestrian safety educational programs • Shared center turn lanes • Guardrail	2021
TH 61-Stevens Rd	11	• Marked crosswalk • RRFB with advanced warning (pedestrian crossing) signs • Additional lighting • Guardrails	2021
Mille Lacs Reservation			
TH 169-Casino Dr	4	• None required: existing stop light, marked crosswalk	None required
TH 169- unmarked crossing (Ataage Dr)	125-136	• Pedestrian Hybrid Beacon (High-Intensity Activated crossWalK (HAWK) beacon; advance warning signs	2019

Table 3.3 Phase 2 monitoring at new locations on the Leech Lake, Red Lake, and White Earth Reservations (2021)					
Reservation City / Town	**Monitoring Location**	**Pedestrian Safety Concerns**	**# of Cameras**	**Date Deployed (# of cameras)**	**Total Complete Days**
Leech Lake					
Ball Club	Hwy 2 and Arctic Rd	People crossing Hwy 2 to convenience store	1	8.17.2021	19
Bena	Hwy 2 and 1st Ave W (County Rd 8 NE)	People crossing Hwy 2 to gas station and convenience store	1	8.17.2021	17
Cass Lake	Hwy 2 and 63rd (wide view)	Crossing Hwy 2 to and from casino. Pedestrians walking along Hwy 2	1	8.17.2021	10
Cass Lake	Hwy 2 and 63rd (zoom view to identify crossing zones)	Crossing Hwy 2 to and from casino	1		3
Cass Lake	Hwy 2 and Grant Utley Ave. NW - Elm Ave. NW	People, children crossing Hwy 2 midblock to and from elementary school and retail destinations (convenience store)	2	9.7.2021 (2)	18
Cass Lake	Hwy 2 and Grant Utley Ave. NW -- SIGNAL	Controlled intersection: stoplight, faded crosswalk on east side, landing pads, tactile strips	--	9.7.2021	17
Cass Lake	Hwy 2 and School Crossings	Children crossing Hwy 2 midblock going to and from school	--	9.7.2021	18
Cass Lake	Hwy 2 and Maple Ave. NE	Pedestrians crossing Hwy 2 from school	1	9.7.2021	9
Red Lake					
Red Lake	Hwy 1 and Hwy 89	People walking along across Hwy 1, Hwy 89, and W. Bot Dr, including informal paths	2	10.14.2021 (2)	22
Redby	Hwy 1	People crossing Hwy 1 between Central St and BiJogoonce Alley (between markets and US Post Office)	1	10.14.2021	22

Table 3.3 (continued) Phase 2 monitoring at new locations on the Leech Lake, Red Lake, and White Earth Reservations (2021)					
Reservation City / Town	**Monitoring Location**	**Pedestrian Safety Concerns**	**# of Cameras**	**Date Deployed (# of cameras)**	**Total Complete Days**
White Earth					
Mahnomen	Hwy 59 (3rd St. NE) and E. Washington Ave.	People, students crossing Hwy 59 to reach White Earth Tribal and Community College	1	9.7.2021	13
Mahnomen	Hwy 59 (3rd St. NE) and Adams	People, students crossing Hwy 59 to reach White Earth Tribal and Community College	1	9.7.2021	19
Waubun	Hwy 59 and Hwy 113 (Pleasant Ave.)	People, children crossing Hwy 59 to gas station and convenience store	1	9.7.2021	18

Table 3.4 Phase 2 monitoring at Phase 1 and other sites on the Fond du Lac, Grand Portage, and Mille Lacs Reservations					
Reservation City / Town	**Monitoring Location**	**Pedestrian Safety Concerns**	**# of Cameras**	**Date Deployed (# of cameras)**	**Total Complete Days**
Fond du Lac					
Cloquet	Big Lake Rd crosswalk and Trettel Ln	Pedestrians crossing Big Lake Road along Trettel Ln	1	9.05.22 – 9.14.2022	10
Cloquet	Big Lake Rd and crosswalk Brevator Rd	Pedestrians crossing Big Lake Road from Brevator Rd to University Rd	1	9.05.2022 – 9.22.2022	18
Cloquet	Big Lake Rd and Mizhakii Rd (Phase 2 only site)	Pedestrians crossing Big Lake Road going north-south along Mizhakii Rd to T-intersection to school and Tribal buildings	1	9.05.2022 – 9.22.2022	18
Cloquet	University Road crosswalk with RFFB (Phase 2 only site)	Pedestrians crossing east-west across University Road either using crosswalk and RRFB or from parking lot to other Tribal buildings	1	9.06.2022 – 9.25.2022 (excluding 9.21.2022 & 9.23.2022)	18
Sawyer	Hwy 210 crosswalk and Mission Rd crosswalk	Vulnerable users crossing Hwy 210 along Mission Rd to convenience store and USPO	1	9.10.2022 – 9.16.2022	7
Grand Portage					
Grand Portage	Blazes Pit Rd crosswalk with access stairs and ADA ramp	Vulnerable users crossing Hwy 61 from residential areas west of Hwy 61 to Trading Post, US Post Office , and casino on east (Lake Superior) side of Hwy 61	1	8.09.2022 – 8.23.2022 `	15
Grand Portage	Stevens Rd crosswalk	Vulnerable users crossing Hwy 61 from residential areas west of Hwy 61 to Grand Portage Tribal Offices and school on east (Lake Superior) side of Hwy 61	1	8.10.2022 – 8.22.2022 (excluding 8.20.2022) `	12

Table 3.4 (continued) Phase 2 monitoring at Phase 1 and other sites on the Fond du Lac, Grand Portage, and Mille Lacs Reservations					
Mille Lacs					
Mille Lacs	Hwy 169 crosswalk and HAWK signal at Ataage Rr (on west side)	Pedestrians crossing Hwy 169 at site of new HAWK signal from residential and institutional areas on the east side to the supermarket, movie theater, hotel, and casino on the west side	1	7.29.2021 – 8.03.2021 (excluding 7.31.2021) & 8.10.2021-8.14.2021	10

Table 3.5 Phase 2 monitoring results by reservation							
Reservation	**Crossing Site**	**Mean Pedestrians / day**	**Crossing Events per Day**	**% Crossings with Driver Interactions**	**Pedestrian Yield Rate**	**Highest Hourly Pedestrian Volumes**	**Maximum Crossing Volume**
Fond du Lac	Trettel	8	7.5	22%	100%	11:00am and 6:00pm	31 (West leg)
	Brevator	2.72	2.39	19%	Not Calculated	11:00am, 3:00pm, and 5:00pm	11 (East leg crosswalk)
	Mizhakii	2.33	1.5	37%	89%	6:00 PM	25 (Middle crossing)
	University Road (RRFB)	30	24.5	14%	79.40%	12:00 noon	279 (South of crosswalk)
	Sawyer Store Crossing	5	34	21%	100.00%	6:00 PM	11 (West leg)
Grand Portage	Blazes Pit Road	7.6	6.6	16%	100%	7:00am & 4:00pm	83 (On crosswalk)
	Stevens Rd	8.5	8.5	21%	100%	3:00pm & 7:00pm	38 (On crosswalk)
Leech Lake	HWY 2 and 63rd Ave. NW (Wide View)	37	66	22%	99%	7:00am, 12:00 noon, 3:00pm, 6:00pm	314 (East of intersection)
	HWY 2 and 63rd Ave. NW (Zoom View)	48	72	21%	98%	3:00 PM	N/A
	HWY 2 and Grant Utley (signal)	52	Not applicable				
	HWY 2 and Midblock School Crossings	32	53	23%	96%	3:00 PM	290 (North of school)
	HWY 2 and Maple Ave. NE	37	29	42%	99%	7:00am and 3:00pm	265 (West leg)
	HWY 2 and 1st Ave	17	12	24%	96%	9:00am and 6:00pm	222 (West side)
	HWY 2 and Arctic Rd	36	27	25%	93%	3:00pm and 6:00-8:00pm	409 (South to northwest)

Table 3.5 (continued) Phase 2 monitoring results by reservation							
Reservation	**Crossing Site**	**Mean Pedestrians / day**	**Crossing Events per Day**	**% Crossings with Driver Interactions**	**Pedestrian Yield Rate**	**Highest Hourly Pedestrian Volumes**	**Maximum Crossing Volume**
Mille Lacs	HAWK Signal	102	78	55%	Varies – Chapter 9, Table 9.5		
Red Lake	Hwy 1 and Central Street	52	40	19%	96%	11:00am & 6:00pm	516 (West side)
	Hwy 1 and Hwy 89	<1	<1	Not applicable	Not applicable	Not applicable	Not applicable
White Earth	HWY 59 and Washington	36	29	39%	90%	8:00pm & 12 noon	343 (North leg)
	Mahnomen 59 and Adams	8	7	30%	100%	5:00pm & 12:00-2:00pm	81 (South leg)
	59 and 113	4	3	50%	90%	6:00 PM	21 (North leg, near intersection/on road)

Table 3.6 Anishinaabe Bands and risk reduction outcomes on reservations

	Phase 1		Phase 2			
Anishinaabe Band	**Locations Monitored (2017)**	**Counter-measures Installed (2019-2020)**	**Locations Monitored (2019-2021)**	**Countermeasures Evaluated (post-installation)**	**Countermeasures Installed (post 2020)**	**Countermeasures Scheduled/Planned (2024 / future)**
Phase 1 Partner only						
Bois Forte Band of Chippewa	2	0				
Phase 1 and 2 Partners						
Fond du Lac Band of Lake Superior Chippewa	4	3	5	3	0	1
Grand Portage Band of Chippewa	2	2	2	2		
Mille Lacs Band of Ojibwe	2	3	1	1		
Phase 2 Partners						
Leech Lake Band of Ojibwe			6		1	4
Red Lake Nation			2		0	1
White Earth Nation			3		1	0
Totals Phase 2						
Bands Participating – Total	4	3	6	3	2	4
Crossing Locations – Total	10	8	19	6	2	6

Table 3.7 Implemented and potential countermeasures on seven Anishinaabe Reservations

Reservation / Municipality / Monitoring Site	Countermeasures Implemented	Potential Risk Reduction Measures for Consideration
Boise Forte Reservation		
CSAH 104 and Farm Rd (T-3256	None planned as of March 2024.	Vegetation maintenance to maintain lines of sight. Marked crosswalk and sign
CSAH 104 and Gold Mine Spur	None planned as of March 2024.	Marked crosswalk and sign
Fond du Lac Reservation		
Cloquet		
Big Lake Rd (CSAH 7) Corridor	Multiuse Trail parallel to Big Lake Road from Pinewood Dr from CR 115 to Brevator Rd CSAH 5 (2019; Safe Routes to Schools (SRTS) funds); Reduced posted speed limits to 35 mph; Installed SRTS Temporary Demonstration Project (paint, bollards, signs; October 2020); Obtained TTPSF funds based on evidence from crossing observations	
Big Lake Rd (CSAH 7) and Pinewood Dr (CR 115)	To be confirmed	
Big Lake Rd (CSAH 7) and Trettel Ln (CR 114)	Marked north-south crosswalk across Big Lake Road on east side of Trettel and east-west crosswalks across Trettel along Big Lake Road (both north and south sides)	
Big Lake Rd (CSAH 7) and Brevator Rd (CSAH 5)	Marked north-south crosswalk across Big Lake Road on east side of Brevator and east-west crosswalk across Brevator along Big Lake Road (both north side only)	
Big Lake Road (CSAH 7) and Mizhakii	None planned as of March 2024.	
University Road Crossing	Rectangular Rapid Flashing Beacon (RRFB); Marked Crosswalk and crosswalk landing; Pedestrian X-ing Signs	Sidewalk to pedestrian landing pad to increase accessibility to marked crossing

Table 3.7 Implemented and potential countermeasures on seven Anishinaabe Reservations

Reservation / Municipality / Monitoring Site	Countermeasures Implemented	Potential Risk Reduction Measures for Consideration
Fond du Lac Reservation *Sawyer*		
Hwy 210 and Mission Rd (CSAH 25)	Blinking 24/7 advance warning signs and dynamic speed feedback signs on Hwy 210.; Reduced speed limit on Hwy 210 from 60mph to 55mph and narrowed travel lanes through intersection; New lighting at intersection; Marked crosswalk across Hwy 210 (east side of Mission Road); Marked crosswalk across Mission Road (south side of Hwy 210); ADA curb cut and pad for the planned trail along Mission Rd	Multiuse trail on east side of Mission Rd (planned for 2025)
Grand Portage Reservation		
Hwy 61 Corridor	PEDS/BIKES NEXT 1 MILE signs posted in the right-of-way along northbound and southbound lanes	
Hwy 61 and Blaze's Pit	Marked crosswalk (15-foot wide continental block pavement markings) across HWY 61; Lighting at crosswalk; Gate-posted crossing signs (W11-2*); ADA-accessible sidewalk, steps, and ramp to crosswalk on east side of Hwy 61; Guardrails along Hwy 61 to orient pedestrian to crosswalk	
Hwy 61 and Stevens Rd	Marked crosswalk (15-foot wide continental block pavement markings) across HWY 61; Lighting at crosswalk; Gate-posted crossing signs (W11-2*) ; Sidewalk/trail to access crosswalk on west wide of Hwy 61	

Table 3.7 (continued) Implemented and potential countermeasures on seven Anishinaabe Reservations

Reservation / Municipality / Monitoring Site	Countermeasures Implemented	Potential Risk Reduction Measures for Consideration
Leech Lake Reservation		
Cass Lake		
Hwy 2 Corridor	Hwy 2 – Cass Lake Corridor Study (ongoing; https://talk.dot.state.mn.us/hwy-2-cass-lake-corridor-study)	Corridor Study Alternatives 1. Road diet – 2 linear parks 2. Road diet – 1 linear park 3. 4 lanes, pedestrian bridge Alternatives include marked crosswalks, signage, RRFBs, lighting
Hwy 2 and 63rd	Results used in Cass Lake Corridor Study	
Hwy 2 and Grant Utley	Results used in Cass Lake Corridor Study	
Hwy 2 and Elementary School midblock crossings	Results used in Cass Lake Corridor Study	
Hwy 2 and Maple Ave	Results used in Cass Lake Corridor Study	
Bena		
Hwy 2 and 1st Avenue	Curb and gutter installed on Hwy 2 (2024); Painted crosswalk and pedestrian landings on intersection corners; Crossing integrated with multiuse trail; Improved lighting; Additional pedestrian signage	
Ball Club		
Hwy 2 and Arctic Rd	To be determined	Improved lighting Marked crosswalk Additional pedestrian signage
Mille Lacs Reservation		
Hwy 169 and Casino Rd	None (signalized intersection prior to study)	None (signalized intersection prior to study)
Hwy 169 and Ataage Drive	Pedestrian Hybrid Beacon / HAWK signal (signage, marked crossing, pedestrian actuation button, lighting, Tribal education and outreach); Sidewalk access to crossing along Virgo Rd (frontage road parallel to Hwy 169 that connects Ataage Dr and Casino Rd crossings)	

Table 3.7 (continued) Implemented and potential countermeasures on seven Anishinaabe Reservations		
Red Lake Reservation		
Hwy 1 Corridor	Multiuse Trail parallel to roadway (2024) Roadway lighting (funded by TTPSF funds following 2023 study results)	Pocket park concept plans from University of MN capstone collaboration
Redby		
Hwy 1 and Central	To be determine in Hwy 1 resurfacing project (2024)	Hwy 1 Resurfacing (2024): Options include: Marked crosswalk, lighting, signage, green infrastructure; Crossing concept plans from University of MN capstone collaboration)
Red Lake		
Hwy 1 and Hwy 89	None planned as of March 2024.	Continued observation of pedestrian activity on desire lines parallel to Hwy 1.
White Earth Reservation		
Mahnomen		
Hwy 59 and Washington	To be determined	Marked crosswalk, lighting, signage, pedestrian-activated rectangular rapid flashing beacons
Hwy 59 and Adams	To be determined	Marked crosswalk, lighting, signage, pedestrian-activated rectangular rapid flashing beacons
Waubun		
Hwy 59 and Hwy 113	Advisory 45 mph speed limit on Hwy 59; Sidewalk on north side of Hwy 113 between school and Dollar General store; Sidewalk on southside of Hwy 113 (alternative to road shoulder). Pedestrian ramps (in anticipation of future countermeasures)	Roundabout

As noted, Phase 2 also included post-implementation monitoring of pedestrian use of countermeasures implemented at six locations following Phase 1 investigations, including 3 crossing sites on the Fond du Lac Reservation, 2 on the Grand Portage Reservation, and 1 on the Mille Lacs Reservation. Although Phase 2 crossing volumes tended to be slightly lower than in Phase 1, rates of pedestrian-driver interaction and pedestrian yield rates were comparable to rates measured during Phase 1. Pedestrian interaction rates with drivers ranged from 19% at the Big Lake Road/Brevator interaction on the Fond du Lac Reservation to 55% at the Hwy 169 crossing location on the Mille Lacs Reservation. Pedestrian yield rates were 100% in 5 of the six locations. Yield rates were not measured at the sixth location (Big Lake Road and Brevator) because crossing volumes were too low to produce valid measures.

The countermeasures implemented and monitored at these locations differed depending on crossing volumes and contexts (Table 3.7). On Hwy 169 in Mille Lacs, where the highest crossing volume initially was measured, a PHB or HAWK was installed. MnDOT engineers, Tribal transportation officials, and the research team met to develop protocols prior to post-implementation monitoring. Among other results, monitoring showed that a majority of pedestrians did not activate the HAWK signal, but driver yield rates increased. Additional details are presented in Chapter 9.

At both Hwy 61 crossing locations on the Grand Portage Reservation, MnDOT added new marked crosswalks, signage, and lighting (Chapter 8). Distinctive countermeasures on the Hwy 61-Blaze's Pit crossing included stairs and an ADA accessible access ramp coupled with guardrails along Hwy 61. Monitoring results revealed the majority of pedestrians used the crossings as designed.

On the Fond du Lac Reservation (Chapter 7), countermeasures included a new multiuse trail, new marked crossings, signage, and lights, plus other measures. In general, pedestrians used countermeasures as designed, although some pedestrians crossing Hwy 210 in Sawyer used the west side of Mission Road instead of the east side of the road where pedestrian landings had been built in anticipation of a new shared-use path paralleling Mission Road north of Hwy 210.

Chapter 4: Leech Lake Reservation Monitoring Results

Leech Lake Band transportation leaders identified several unmarked crossing locations along Hwy 2 in Ball Club, Bena, and Cass Lake where pedestrians experience the risk of crashes with drivers when crossing the highway for daily activities like going to work or school, visiting a convenience store or shopping, or visiting a casino or Tribal institutions. As noted in Chapter 2, in the summer of 2021, following consultation with Tribal and MnDOT partners, the research team deployed video cameras, observed pedestrians at the specified sites, and analyzed results. Following Table 4.1, which summarizes the locations and dates when cameras were deployed on the Leech Lake Reservation, monitoring results are summarized by community. The total days of monitoring were 19 in Ball Club, 17 in Bena, and ranged from 9 to 19 in Cass Lake (Table 4.1). Video recorders operated only during daylight hours, so monitoring results are undercounts of actual pedestrian volumes.

4.1 Ball Club

Tribal leaders specified the principal source of risk in Ball Club was associated with pedestrians crossing from locations north of Hwy 2 to and from a convenience store on the south side of Hwy 2 at the intersection of Hwy 2 and Arctic Road. Tribal leaders were concerned that the absence of pedestrian facilities increased the risks of crashes between pedestrians and drivers. Figure 4.1 is a picture of a pedestrian crossing Hwy 2 in Ball Club near the convenience store.

The project team observed pedestrian crossings at the specified location (Table 4.1, Table 4.2, Figure 4.2). The mean numbers of pedestrians and crossing events per day were, respectively, 36 and 27 (Table 4.3). Pedestrians interacted with drivers in 25% of the crossing events and yielded to drivers in 93% of those interactions (Table 4.4). The maximum number of pedestrians crossing on any given day exceeded 80 (Figure 4.2). The greatest mean hourly crossings occurred at 5:00 p.m. and 7:00 p.m. (Figure 4.3).

Leech Lake, MnDOT, and UMN partners met following monitoring to discuss results and potential countermeasures. Countermeasures under consideration include additional signage, a marked crosswalk, lighting, and other improvements.

Table 4.1 Leech Lake Reservation: Pedestrian monitoring, August-September 2021					
Reservation City / Town	**Monitoring Location**	**Pedestrian Safety Concerns**	**# of Cameras**	**Date Cameras Deployed (number of cameras)**	**Total Complete Days**
Leech Lake					
Ball Club	Hwy 2 and Arctic Rd	People crossing Hwy 2 to convenience store	1	8.17.2021	19
Bena	Hwy 2 and 1st Ave W (County Rd 8 NE)	People crossing Hwy 2 to gas station and convenience store	1	8.17.2021	17
Cass Lake	1a. Hwy 2 and 63rd (wide view)	Crossing Hwy 2 to and from casino. Pedestrians walking along Hwy 2	1	8.17.2021	10
Cass Lake	1b. Hwy 2 and 63rd (moved camera to zoom/close-up view to better identify crossing zones)	Crossing Hwy 2 to and from casino	1		3
Cass Lake	2a. Hwy 2 and Grant Utley Ave. NW - Elm Ave. NW	People, children crossing Hwy 2 (to DQ from elementary school)	2	9.7.2021 (2)	18
Cass Lake	2b. Hwy 2 and Grant Utley Ave. NW -- SIGNAL	Controlled intersection: stoplight, faded crosswalk on east side, landing pads, tactile strips	--	9.7.2021	17
Cass Lake	3. Hwy 2 and School Crossings	Children crossing Hwy 2 midblock going to and from school	--	9.7.2021	18
Cass Lake	4. Hwy 2 and Maple Ave. NE	People, children crossing Hwy 2 (from elementary school)	1	9.7.2021	9

Figure 4.1 Ball Club: Pedestrian crossing Hwy 2

Table 4.2 Ball Club: Hwy 2 monitoring days and context

Monitoring Days, Period, and Context							
Sites – Camera Views	Total Days of Data	Beginning Date	End Date	Vehicular Travel Lanes	Paved Road Shoulder	Vehicular Speed Limit	Notes
Ball Club: Hwy 2 and Arctic Rd	19	8.18.2021	9.05.2021	2 + 1 turn lane	Yes	40 mph	Speed limit changes from 60 to 45 mph approximately 1100 feet west of the intersection and more than 1100 feet east of the intersection

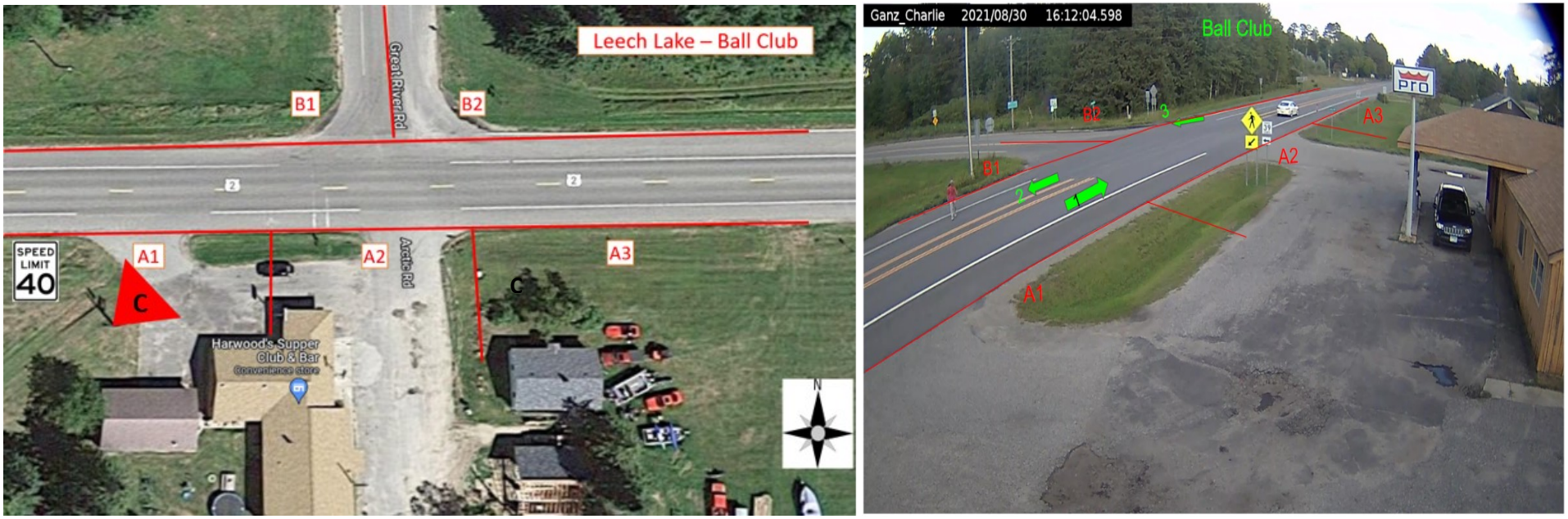


Figure 4.2 Ball Club: Hwy 2 crossing zones and camera location (plan view and camera view)

Table 4.3 Ball Club: Hwy 2 pedestrians, crossing events, and crossing group size

Site	Total Pedestrians Observed	Mean Pedestrians/ Dayx	Crossing Events*	Mean Crossing Events/Day	Mean Pedestrians / Crossing Event	Crossing Group Size = 1 pedestrian	Crossing Group Size = 2 pedestrians	Crossing Group Size = 3 pedestrians	Crossing Group Size ≥ 4 pedestrians
Ball Club: Hwy 2 amd Arctic Rd	676	36	518	27	1.3	78%	17%	3%	2%

Table 4.4 Hwy 2 crossing events, interactions, and yield rates						
Site	Crossing Events	Crossing Events with Interactions	Percent Crossing Events with Interactions	Pedestrian Yield Rate	Driver Yield Rate	Pedestrian and Driver Yield Rate
Ball Club: Hwy 2 and Arctic Rd	518	131	25%	93%	2%	5%

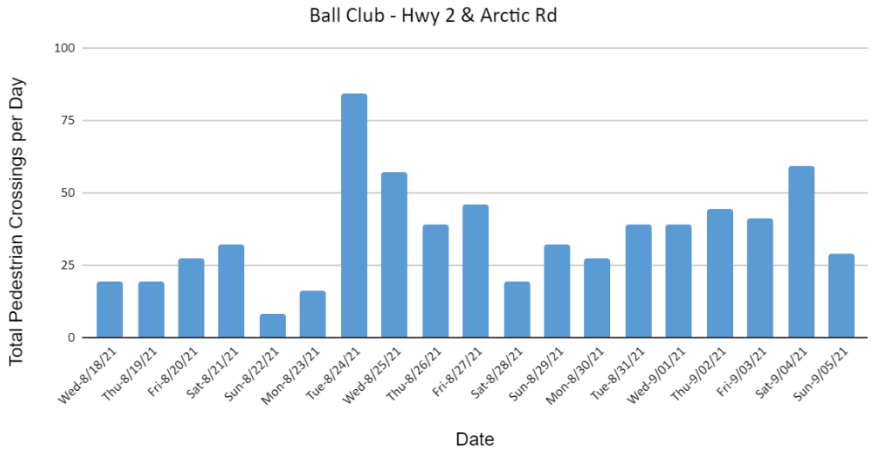


Figure 4.3 Ball Club: Daily variation in pedestrian crossings

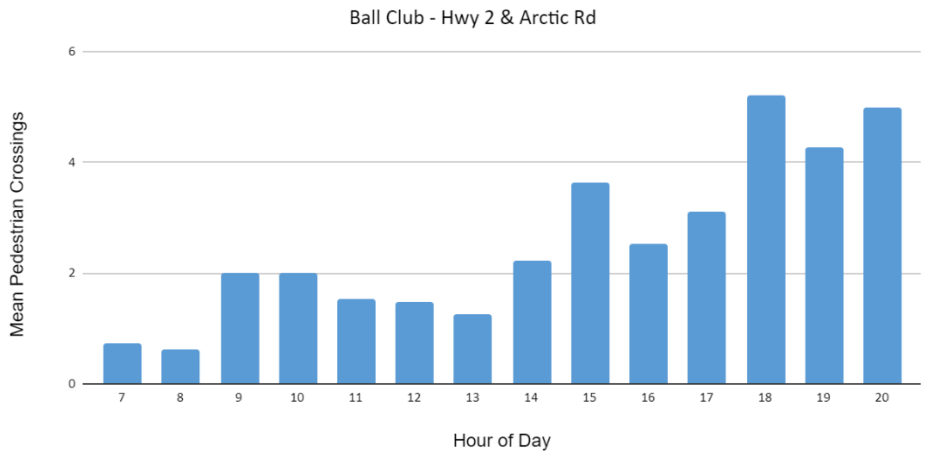


Figure 4.4 Ball Club: Variation in mean hourly pedestrian crossings

4.2 Bena

Tribal leaders specified the principal source of risk in Bena was associated with pedestrians crossing from locations south of Hwy 2 to and from a convenience store at a resort on the north side of Hwy 2 at the intersection of Hwy 2 and 1st Avenue. Tribal leaders were concerned that the absence of pedestrian facilities increased the risks of crashes between pedestrians and drivers. Figure 4.5 is a picture of a pedestrian crossing Hwy 2 near the convenience store in Bena.

The project team observed pedestrian crossings at the specified location (Table 4.1, Table 4.5, Figure 4.6). The mean numbers of pedestrians and crossing events per day were, respectively, 17 and 12 (Table 4.7). Pedestrians interacted with drivers in 24% of the crossing events and yielded to drivers in 96% of those interactions (Table 4.8). The maximum number of pedestrians crossing on any given day was nearly 30 (Figure 4.7). The greatest mean hourly crossings occurred at 9:00 a.m. and 6:00 p.m. (Figure 4.8).

Leech Lake, MnDOT, and UMN partners met following monitoring to discuss results and potential countermeasures that could be included as part of a road resurfacing project planned for the summer of 2023. Subsequently, following further consultation with the Leech Lake Band, MnDOT added a painted crosswalk and pedestrian landings at the intersection, additional signage and lighting, and further integrated the multiuse trail/shared-use path that parallels the north side of Hwy 2 through Bena (Figure 4.9 and Figure 4.10).

Figure 4.5 Bena: Pedestrian crossing Hwy 2 in Bena (before countermeasures

Table 4.5 Bena: Hwy 2 monitoring days and context							
Bena: Hwy 2 and 1st Avenue	18	8.18.2021	9.04.2021	2 + 1 turn lane	Yes	45 mph	• Speed limit changes from 60 to 45 mph approximately 500 feet from the intersection • Multiuse trail near resort – heading west

Table 4.6 Bena: Hwy 2 pedestrians, crossing events, and crossing group size

Site	Total Pedestrians Observed	Mean Pedestrians/ Day	Crossing Events*	Mean Crossing Events/Day	Mean Pedestrians / Crossing Event	Crossing Group Size = 1 pedestrian	Crossing Group Size = 2 pedestrians	Crossing Group Size = 3 pedestrians	Crossing Group Size ≥ 4 pedestrians
Bena: Hwy 2 and 1st Avenue	301	17	212	12	1.4	70%	20%	8%	2%

Table 4.7 Bena: Hwy 2 crossing events, interactions, and yield rates

Site	Crossing Events	Crossing Events with Interactions	Percent Crossing Events with Interactions	Pedestrian Yield Rate	Driver Yield Rate	Pedestrian and Driver Yield Rate
Bena: Hwy 2 and 1st Avenue	212	51	24%	96%	2%	2%

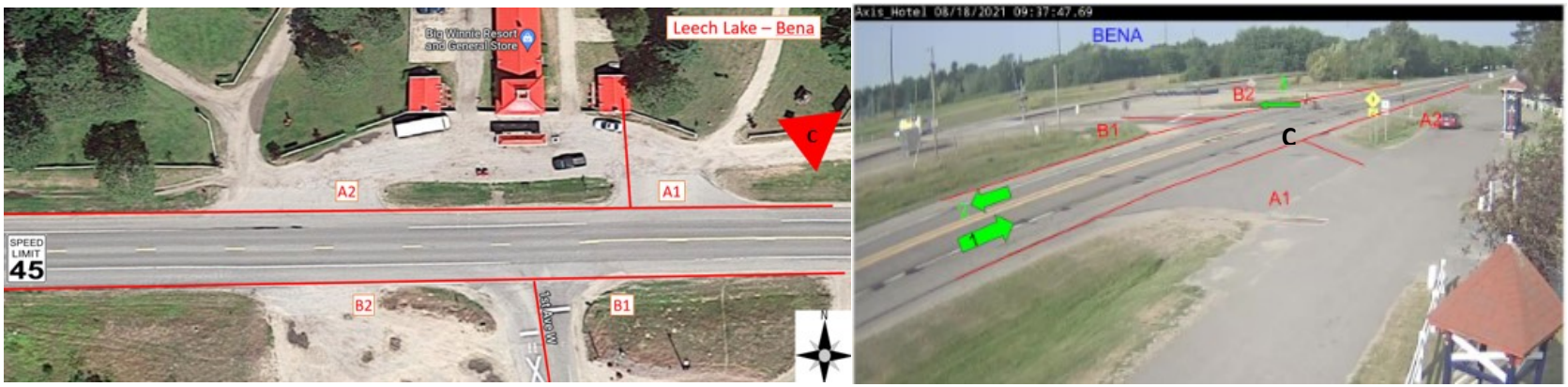


Figure 4.6 Bena: Hwy 2 crossing zones and camera location (plan and camera view)

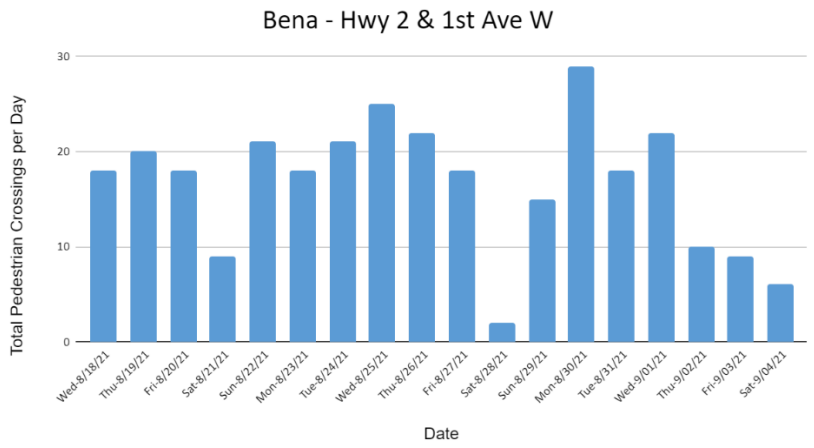


Figure 4.7 Bena: Daily variation in pedestrian crossings

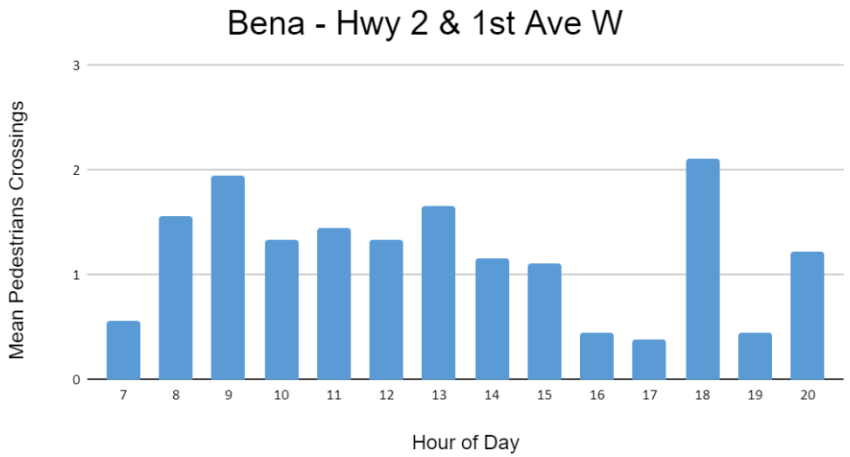


Figure 4.8 Bena: Variation in mean hourly pedestrian crossings

Figure 4.9 Bena: Hwy 2 and 1st Ave countermeasures (2023, from west).

Figure 4.10 Bena: Hwy 2 and 1st Avenue countermeasures (2023, from east).

4.3 Cass Lake

Tribal leaders specified the principal sources of crash risk in Cass Lake were associated with pedestrian crossings along a mile-long stretch of Hwy 2 that extends from the eastern to western boundaries of the community. Through Cass Lake, Hwy 2 expands to a four-lane divided highway bordered by frontage roads on both the northern and southern sides. This stretch of Hwy 2 includes three intersections and multiple desire lines indicating multiple locations where informal highway crossings are made (Table 4.1, Table 4.8, Figures 4.11 and Figure 4.12):

1. HWY 2 and 63rd Ave. NW (+ adjacent midblock crossings)
2. HWY 2 and Grant Utley Ave. NW (+ adjacent midblock crossings)
3. HWY 2 and Midblock School Crossings (multiple midblock crossings)
4. HWY 2 and Maple Ave. NE (+ adjacent midblock crossings).

Tribal leaders expressed concern that the absence of pedestrian facilities increases the risks of crashes between pedestrians and drivers. They noted many employees of the casino access it mid-block east of the Hwy 2 and 63rd Ave NW intersection. They were especially concerned about children crossing Hwy 2 to and from the Cass Lake-Bena Elementary School on the south side of highway to a convenience store and an ice cream store on the north side of the highway. MnDOT and Tribal leaders noted that MnDOT had initiated a corridor study to address transportation concerns in Cass Lake, including pedestrian safety, and that the monitoring results potentially could be used to inform the study.

The project team observed pedestrian crossings at the specified locations (Table 4.8, Table 4.9). At the 63rd Ave NW, Grant Utley, and Elementary School midblock crossings, the number of crossing events is higher than the number of pedestrians because Highway 2 is a four-lane divided highway, and the crossing of lanes in each direction was coded as a separate crossing event. The number of crossing events per day varied across locations, with the highest volume of approximately 70 observed at 63rd Ave NW near the casino (Table 4.9). Across locations, the percentage of pedestrians who interacted with drivers ranged from 21% to 42%. The percentage of pedestrians who yielded to drivers ranged from 96% to 100% (Table 4.10).

Because of the complexity of informal crossing patterns between Grant Utley and the midblock school crossings and at the Maple Avenue intersection, the research team coded crossing trajectories across multiple zones at both of these general locations. These trajectories and patterns are summarized visually in Figures 4.13 and 4.14 and in tabular format in Tables 4.11 and 4.12. These results illustrate the pedestrians' preferences for taking the shortest or most direct route and the complexity of potential interventions to reduce midblock crossings.

Daily and mean hourly crossing volumes varied substantially but mostly as expected throughout the monitoring period at each of the monitoring location. (Figures 4.15 – 4. 18). For example, mean hourly volumes at 63rd Ave near the casino were highest at 7:00 a.m., noon, 3:00 p.m., and 6:00 p.m., times when employees might walk to work, take breaks, or leave for the evening. Near the elementary school and at Maple Avenue near the school, crossing volumes were highest at 3:00 p.m., a time near when

school typically ends for the day. When combined with spatial variation throughout the corridor, this temporal variation complicates planning for countermeasures to reduce pedestrian risk.

Leech Lake, MnDOT, and UMN partners met following the release of monitoring results to discuss results and potential countermeasures that could be included as part of a road resurfacing project planned for the summer of 2023. Because the Highway 2 corridor study for Cass Lake incorporates pedestrian safety, specific countermeasures were not reviewed. Instead, the project partners provided results to the MnDOT District office and to the consultant with principal responsibility for corridor planning. Alternatives to increase pedestrian safety under consideration (and subject to change) as of May 2024 included road diets and development of formal crossings to reduce crossing distances, multiuse or shared paths and a pedestrian bridge, and pedestrian hybrid beacons, among others. The monitoring results near the Cass Lake-Bena Elementary School are informing efforts to reduce risks now experienced by children crossing Hwy 2 to reach the convenience and ice cream stores on the north side of the highway.

Table 4.8 Cass Lake: Hwy 2 monitoring days, period, and context							
Sites – Camera Views	Total Days of Data	Beginning Date	End Date	Vehicular Travel Lanes	Paved Road Shoulder	Vehicular Speed Limit	Notes
1a. Hwy 2 and 63rd (wide view)*	10	8.17.2021	8.28.2021	4 + 1 turn lane	Yes – varies	45 mph / 65 / mph	● No data reported for 8.24.2021 ● Crossing also includes 2 frontage roads ● Crossings occur in area with 65 mph speed limit ● Median present between east and west bound lanes
1b. Hwy 2 and 63rd (zoom view)*	3			4 + 1 turn lane	Yes - Hwy 2 - varies	45 mph	● Crossing also includes 2 frontage roads ● Crossings occur in area with 65 mph speed limit
2a. Hwy 2 and Grant Utley*	18	9.08.2021	9.25.2021	4 travel lanes + 2 turn lanes	Yes	45 mph	● Detailed information for people who did not use signal ● Median present between east and west bound lanes
2b. Hwy 2 and G.U. – Signal*	17			4 travel lanes + 2 turn lanes	Yes	45 mph	● Total count only presented for number of individuals at using signal crossing ● Crossing data not tabulated because intersection is controlled by signal ● Median present between east and west bound lanes
3. Hwy 2 and School crossings*	18	9.08.2021	9.25.2021	4 lanes	Yes	45 mph	● Median present between east and west bound lanes ● At least five desire lines indicating pedestrian crossings (several lead to opening in fence on north side of school
4. Hwy 2 and Maple	9	9.08.2021	9.16.2021	4 lanes + 2 turn lanes	Yes	45 mph	● Median present between east and west bound lanes ● Is faded (barely visible) marked crossing

***Crossings counted separately between north side, median, and south side (all sites except Maple).**

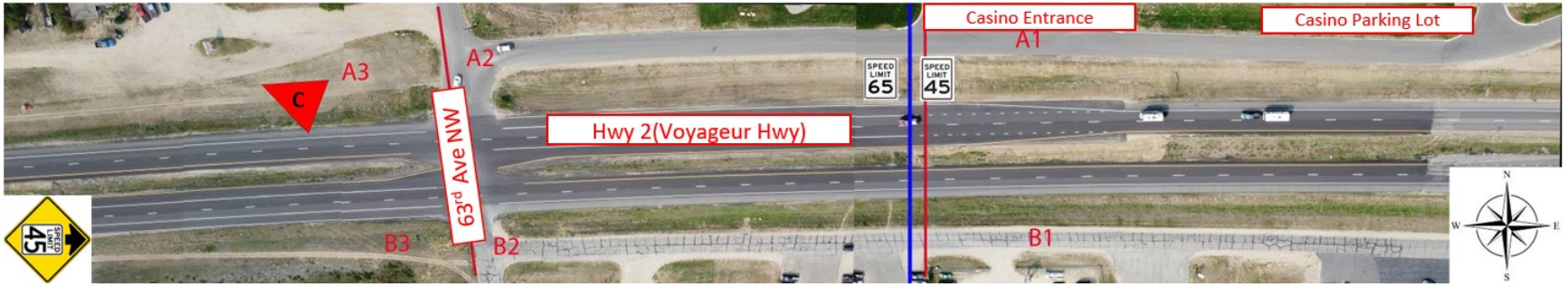


Figure 4.11 Cass Lake: Hwy 2 and 63rd Ave. NW crossing zones and camera location

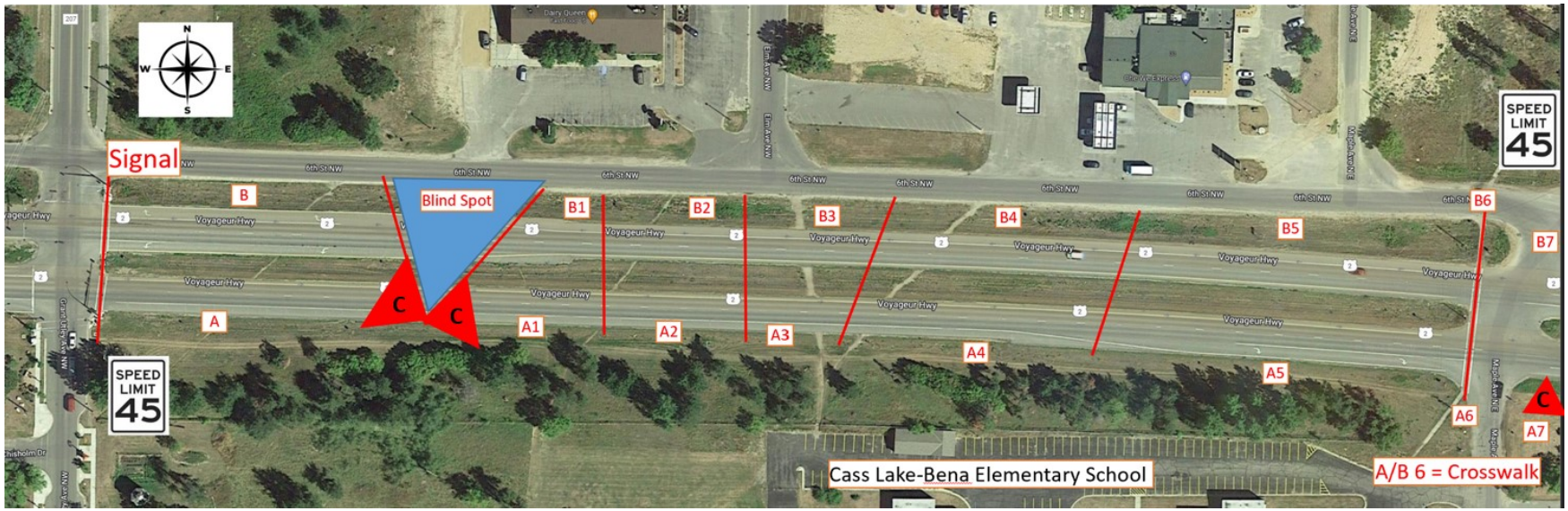


Figure 4.12 Cass Lake: Hwy 2 Corridor crossing zones and camera locations (Grant Utley - Maple Avenue)

Table 4.9 Cass Lake: Hwy 2 pedestrians, crossing events, and pedestrian group size									
Site	Total Pedestrians Observed	Mean Pedestrians/ Day	Crossing Events*	Mean Crossing Events/Day	Mean Pedestrians / Crossing Event	Crossing Group Size = 1 pedestrian	Crossing Group Size = 2 pedestrians	Crossing Group Size = 3 pedestrians	Crossing Group Size ≥ 4 pedestrians
1a. Hwy 2 and 63rd (wide view)*	368	37	661	66	1.1	89%	10%	1%	0%
1b. Hwy 2 and 63rd (zoom view)*	142	48	217	72	1.3	75%	21%	3%	1%
2a. Hwy 2 and Grant Utley*	86	5	164	9	1.1	95%	4%	1%	0%
2b. Hwy 2 and G.U. – Signal*	890	52	NA	NA	NA	NA	NA	NA	NA
3. Hwy 2 and School crossings*	572	32	956	53	1.2	85%	12%	2%	1%
4.Hwy 2 and Maple	315	37	256	29	1.2	79%	15%	4%	2%

***Crossings counted separately between north side, median, and south side (all sites except Maple).**

Table 4.10 Cass Lake: Hwy 2 Crossing events, interactions, and yield rates						
Site	Crossing Events	Crossing Events with Interactions	Percent Crossing Events with Interactions	Pedestrian Yield Rate	Driver Yield Rate	Pedestrian and Driver Yield Rate
1a. Hwy 2 and 63rd (wide view)*	661	146	22%	99%	1%	0%
1b. Hwy 2 and 63rd (zoom view)*	217	46	21%	98%	2%	0%
2a. Hwy 2 and Grant Utley*	164	41	25%	100%	0%	0%
2b. Hwy 2 and G.U. – Signal*	NA	NA	NA	NA	NA	NA
3. Hwy 2 and School crossings*	956	220	23%	96%	4%	<1%
4. Hwy 2 and Maple	256	107	42%	99%	0%	1%

***Crossings counted separately between north side, median, and south side (all sites except Maple).**

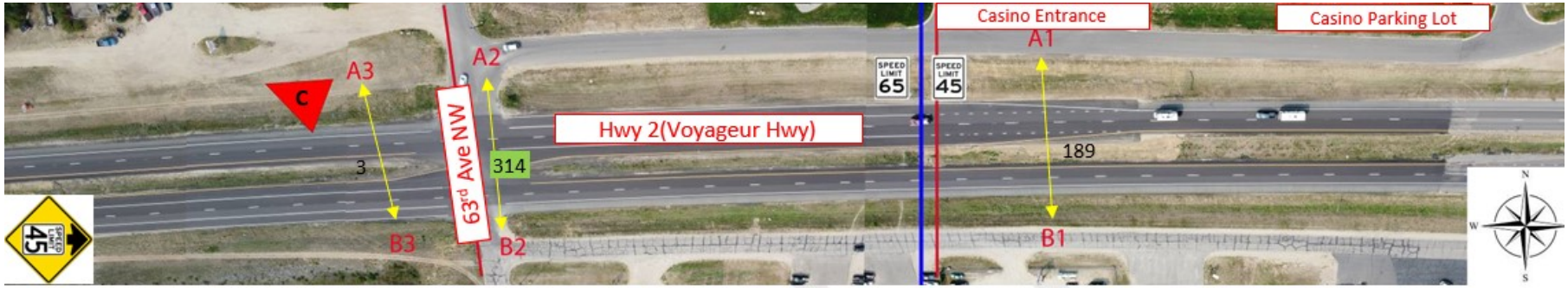


Figure 4.13 Cass Lake: Hwy 2 and 63rd Ave NW crossing volumes and trajectories

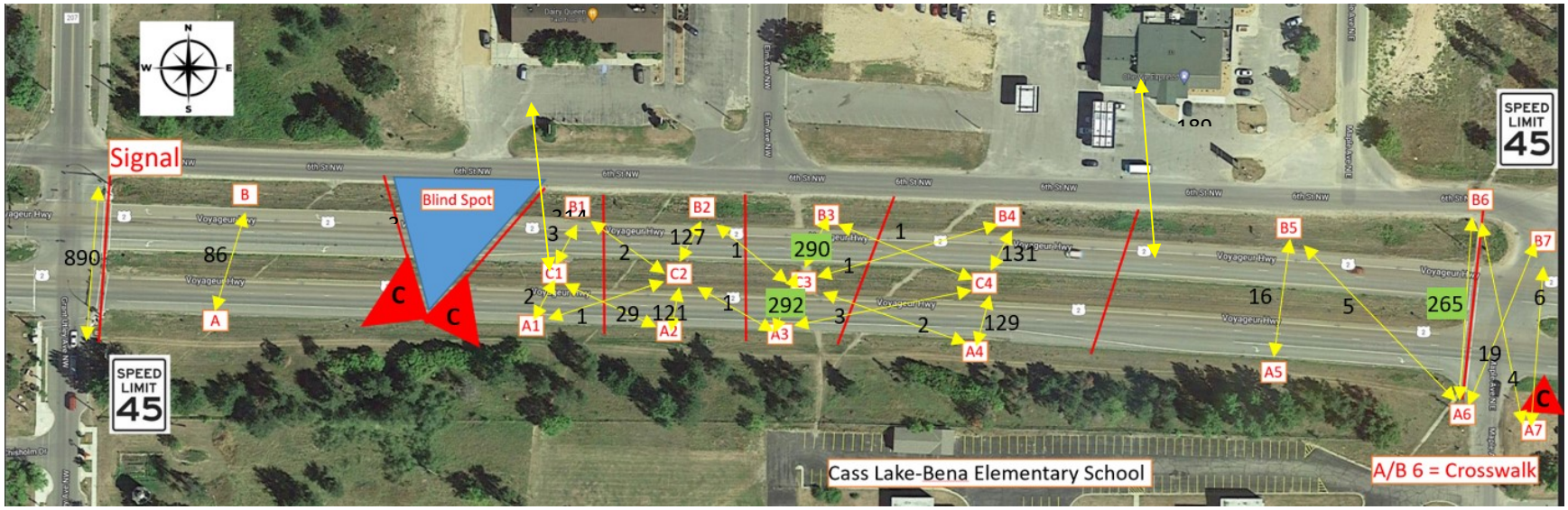


Figure 4.14 Cass Lake: Hwy 2 Corridor crossing volumes and trajectories (Grant Utley - Maple Ave)

Table 4.11 Hwy 2 crossing volumes and trajectories (near Grant Utley and Elementary School)																
Monitoring Locations	**A1-C1**	**A1-C2**	**A1-C3**	**A1-C4**	**A2-C1**	**A2-C2**	**A2-C3**	**A2-C4**	**A3-C1**	**A3-C2**	**A3-C3**	**A3-C4**	**A4-C1**	**A4-C2**	**A4-C3**	**A4-C4**	**Totals**
Grant Utley and School	2	1	0	0	29	121	0	0	0	1	292	3	0	0	2	129	580
	C1-B1	**C1-B2**	**C1-B3**	**C1-B4**	**C2-B1**	**C2-B2**	**C2-B3**	**C2-B4**	**C3-B1**	**C3-B2**	**C3-B3**	**C3-B4**	**C4-B1**	**C4-B2**	**C4-B3**	**C4-B4**	**Totals**
Grant Utley and School	3	0	0	0	2	127	0	0	0	1	290	4	0	0	1	131	559

Table 4.12 Cass Lake: Hwy 2 northbound and southbound flows (Grant Utley and Elementary School)																	
		Pedestrians crossing by Zone as marked in figure															
Grant Utley and School crossings		**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**B1**	**B2**	**B3**	**B4**	**Total Northbound**		**Total Southbound**	
	A1	-	-	-	-	1	1	0	0	-	-	-	-	2	315		
	A2	-	-	-	-	15	68	0	0	-	-	-	-	83			
	A3	-	-	-	-	0	1	166	2	-	-	-	-	169			
	A4	-	-	-	-	0	0	2	59	-	-	-	-	61			
	C1	1	14	0	0	-	-	-	-	3	0	0	0	3	302	15	271
	C2	0	59	0	0	-	-	-	-	2	69	0	0	71		59	
	C3	0	0	126	0	-	-	-	-	0	0	163	3	166		126	
	C4	0	0	1	70	-	-	-	-	0	0	1	61	62		71	
	B1	-	-	-	-	0	0	0	0	-	-	-	-			0	257
	B2	-	-	-	-	0	58	1	0	-	-	-	-			59	
	B3	-	-	-	-	0	0	127	0	-	-	-	-			127	
	B4	-	-	-	-	0	0	1	70	-	-	-	-			71	

Table 4.13 Cass Lake: Hwy 2 crossing volumes and trajectories (Maple Avenue)										
Monitoring Locations	**A5-B5**	**A5-B6**	**A5-B7**	**A6-B5**	**A6-B6**	**A6-B7**	**A7-B5**	**A7-B6**	**A7-B7**	**Totals**
Hwy 2 and Maple	16	0	0	5	265	19	0	4	6	315

Table 4.14 Cass Lake: Hwy 2 northbound and southbound flows (Maple Avenue)												
Hwy 2 and Maple		**A5**	**A6**	**A7**	**B5**	**B6**	**B7**	**Total Northbound A origin**		**Total Southbound B origin**		**Total All Pedestrians**
	A5	-	-	-	7	0	0	7	161	-	-	
	A6	-	-	-	2	144	5	151		-	-	
	A7	-	-	-	0	0	3	3		-	-	315
	B5	9	3	0	-	-	-	-	-	12	154	
	B6	0	121	4	-	-	-	-	-	125		
	B7	0	14	3	-	-	-	-	-	17		

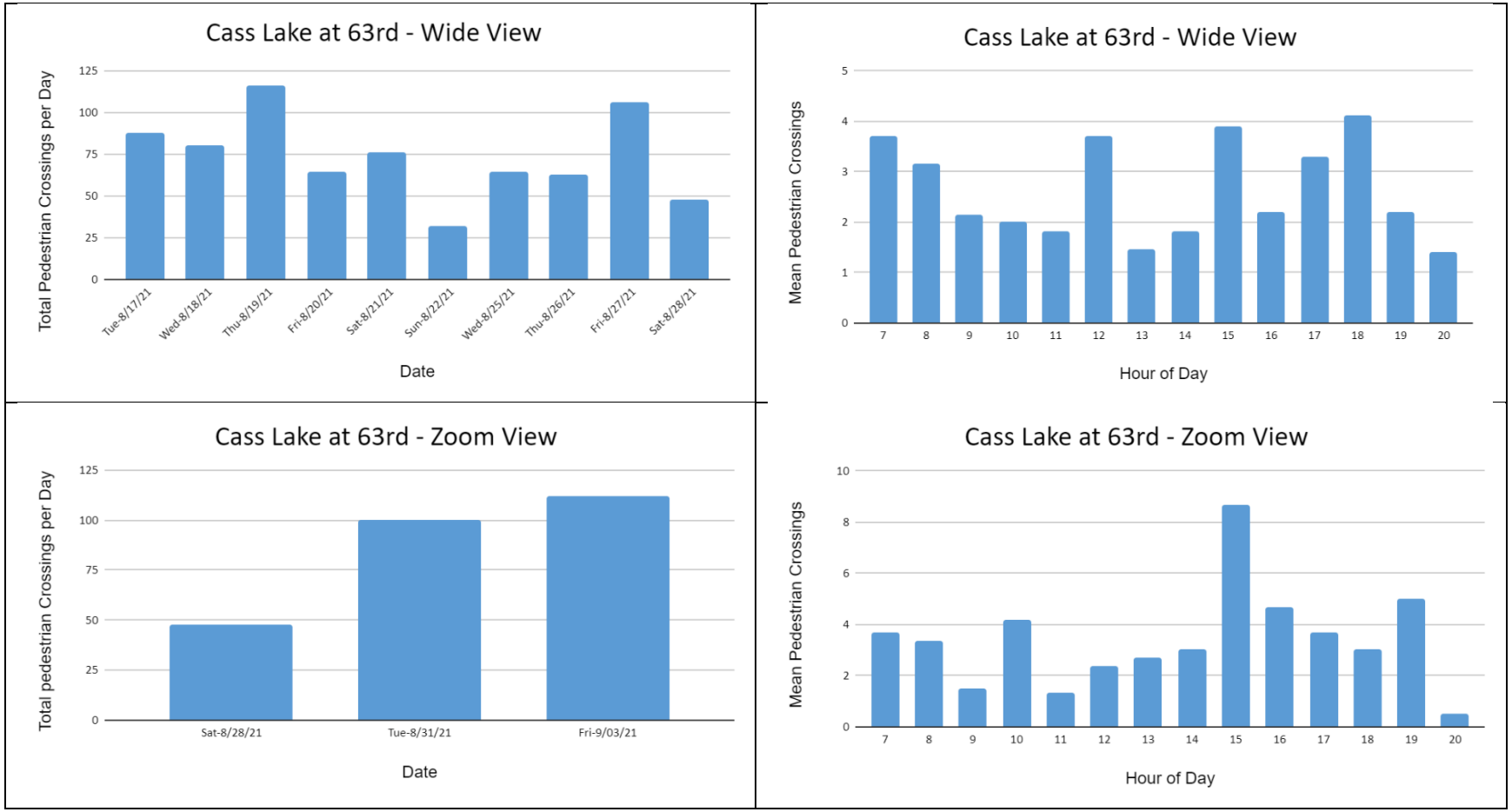


Figure 4.15 Cass Lake: Hwy 2 and 63rd Ave NW daily and mean hourly variation in pedestrian crossings

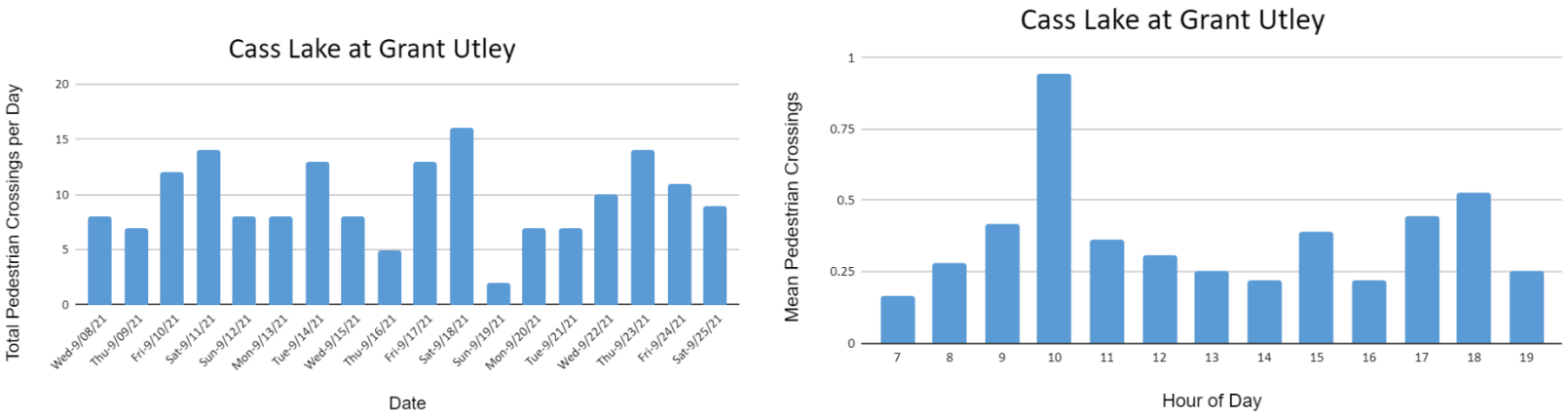


Figure 4.16 Cass Lake: Hwy 2 and Grant Utley daily and mean hourly variation in pedestrian crossings

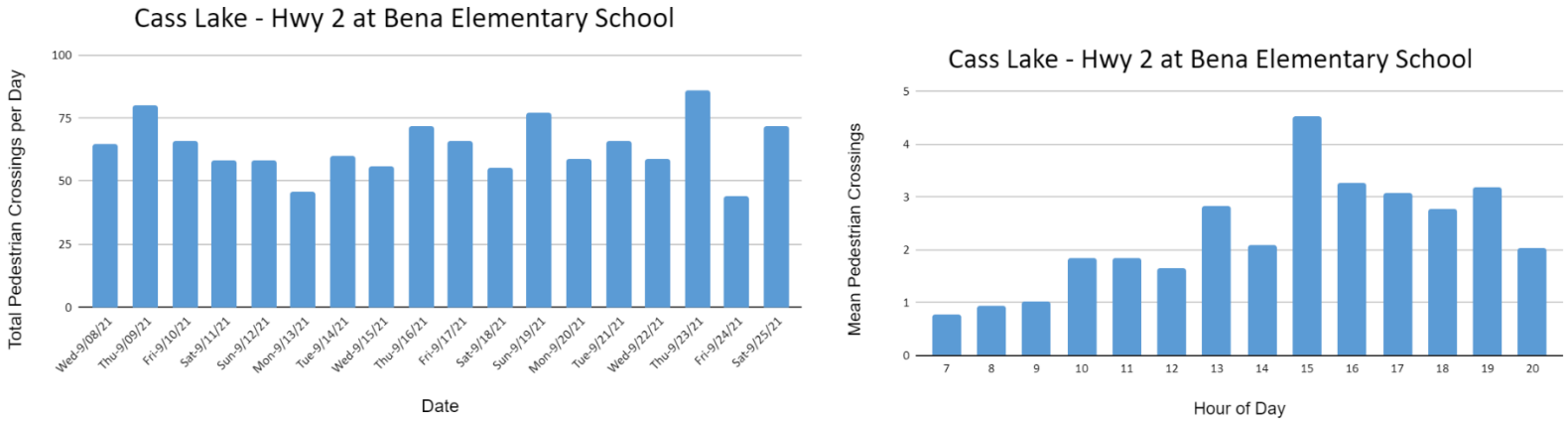


Figure 4.17 Cass Lake: Hwy 2 and Cass Lake-Bena Elementary School daily and mean hourly variation in pedestrian crossings

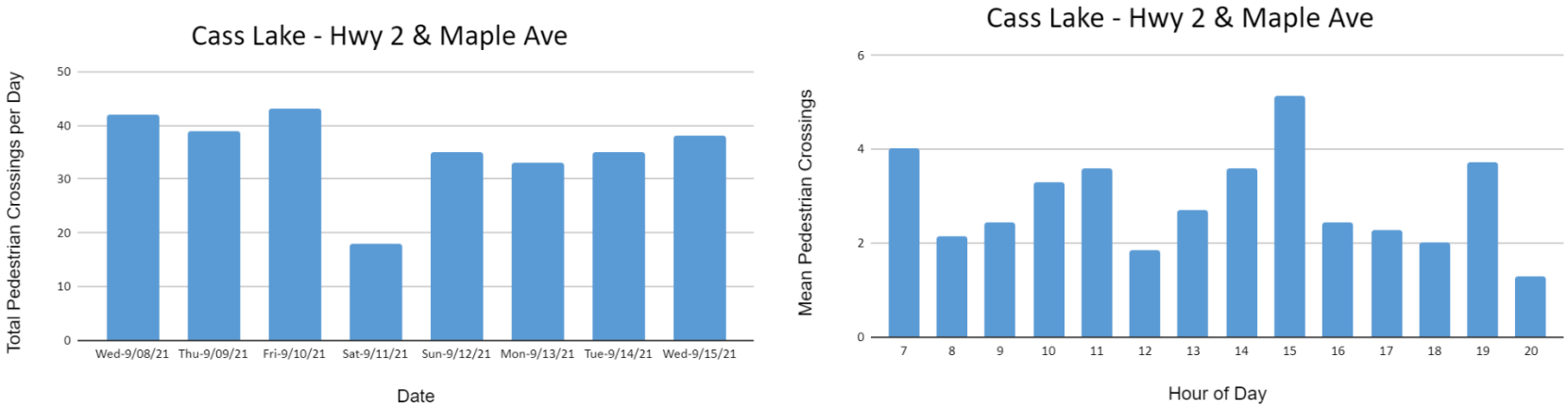


Figure 4.18 Cass Lake: Hwy 2 and Maple Ave daily and mean hourly variation in pedestrian crossings

Chapter 5: Red Lake Reservation Monitoring Results

Red Lake Nation transportation leaders identified two unmarked crossing locations along Hwy 1 on the reservation where pedestrians experience the risk of crashes with drivers when walking along or crossing the highway for daily activities like going to town or visiting a convenience store or Tribal institution. These two locations were west of Red Lake, near the junction of Hwy 1 and Hwy 89, and east of Red Lake in the community of Redby (Figure 5.1). As noted in Chapter 2, in October 2021, following consultation with Tribal and MnDOT partners, the research team deployed video cameras, observed pedestrians at these two sites, and then analyzed results. Table 5.1 summarizes the locations and dates when cameras were deployed. The total days of monitoring were 15 in both Red Lake and in Redby. Video recorders operated only during daylight hours, so monitoring results are undercounts of actual pedestrian volumes.

5.1 Red Lake

Tribal leaders specified the principal risk at the Red Lake location was associated with pedestrians walking along and across Hwy 1 and Hwy 89 when going to and from destinations in Red Lake. Tribal leaders were concerned that the absence of wide road shoulders and pedestrian facilities increased the risks of crashes between pedestrians and drivers (Table 5.1).

The project team observed pedestrian crossings at the specified location (Table 5.2, Table 5.3, Figure 5.2). For the entire 15-day period, only five individuals were observed crossing Hwy 1. However, 8 individuals were observed walking along the north side of Hwy 1, 5 were observed walking along the south side, and an additional 15 were observed on a desire line connecting Hwys 89 and 1. Because the pedestrian crossing volume was so low, interaction and yield rates were not calculated.

Red Lake, MnDOT, and UMN partners met following monitoring to discuss results. The small numbers of pedestrians and pedestrian crossings at Hwy 1 and Hwy 89 may be because the monitoring zone is outside the more developed area of Red Lake and there are no destinations in the immediate monitoring area that would induce crossings. Tribal leaders noted that risks experienced by individuals walking along the highways could be reduced with wider shoulders or shared use paths parallel to the highways.

5.2 Redby

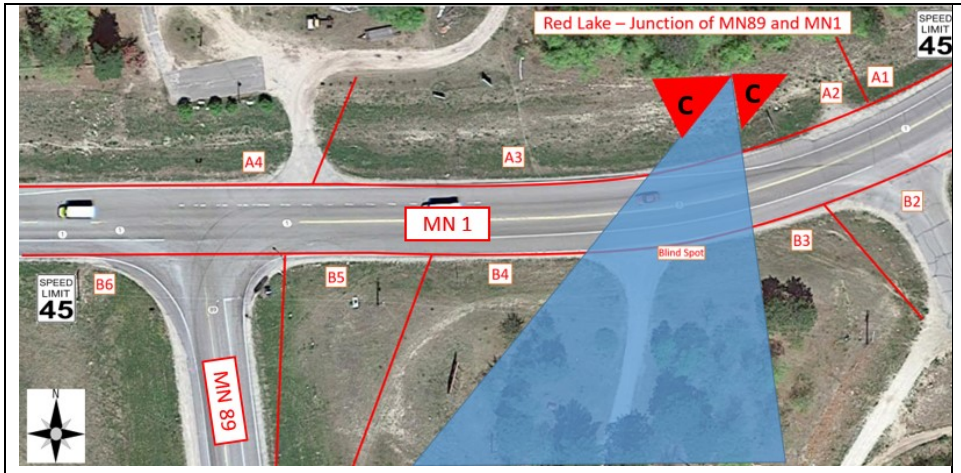
Tribal leaders specified that pedestrians in downtown Redby experience risks of crashes with drivers when crossing Hwy 1 to reach retail (e.g., market, convenience store) and services (e.g., US Post Office). The project team observed pedestrian crossings near the Hwy 1-Central Street intersection in downtown Redby (Figure 5.1, Table 5.1, Table 5.4).

The mean numbers of pedestrians and crossing events per day were, respectively, 52 and 40 (Figure 5.3, Table 5.5, Table 5.6). Pedestrians interacted with drivers in 19% of the crossing events and yielded to drivers in 96% of the interactions (Table 5.6). The crossing patterns in Redby are complex (Figure 5.3).

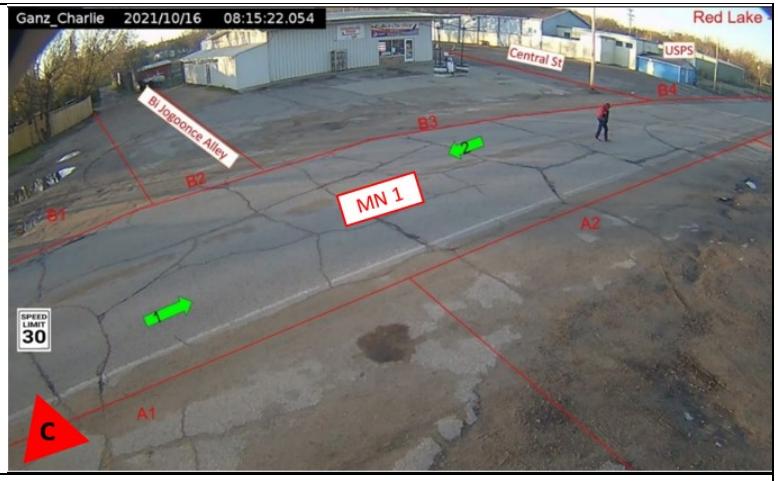
Project team members who observed the video reported many individuals park on one side of Hwy 1, visit a store, then cross the highway to visit another establishment before returning to their vehicle and departing. Tables 5.7 and 5.8 present detailed pedestrian volumes and trajectories for pedestrian origin-destination zones in downtown Redby. Daily pedestrian crossings varied by a factor of three, from just under 30 to just over 90, with a decline from the middle through the end of October. The highest volume of pedestrian crossings occurred at 6:00 p.m.

Potential countermeasures identified by Tribal representatives and MnDOT engineers and planners include a new multiuse trail between Red Lake and Redby to reduce pedestrian traffic on Hwy 1 road shoulders, countermeasures to increase pedestrian safety in downtown Redby, and other livability improvements that can be integrated with transportation infrastructures. The potential countermeasures to reduce risk and increase pedestrian safety include pedestrian crossing signs when entering and leaving Redby, marked crosswalks, RRFBs, and green infrastructure to funnel pedestrians to safe crossing locations in downtown Redby. The detailed origin and destination crossing data may be useful when planning countermeasures and developing designs to minimize pedestrian and driver conflicts.

Although technically not part of the MnDOT funded project, one related, important outcome that emerged during from the Red Lake field observations was the formation of a new, independent collaboration between the University of Minnesota and the Red Lake Nation to support planning for pedestrian safety. The Red Lake planner and archaeologist asked the University about the potential for engaging students to assist with conceptual designs for pocket parks along the multiuse trail to be built from Red Lake to Redby (scheduled for 2024) and for a pedestrian crossing on Hwy 1 in downtown Redby. Two student teams were recruited from the Master of Urban and Regional Planning Program at the Humphrey School of Public Affairs to undertake these projects. Based on online surveys of Red Lake Nation residents conducted by the student teams, one team developed a set of design principles and sketches for the pocket parks (Figure 5.5; Flannery et al. 2023), while the second team developed a set of concept plans for the road crossing that incorporated features preferred by residents of the reservation (Figure 5.6; Bakken et al. 2023). The Red Lake Partner subsequently shared these designs with the MnDOT District Planner and presented them at a regional meeting with the Federal Highway Administration as examples of ways that Tribes could work with universities to gain access to expertise not typically available on the reservations. At the time this project was concluded, these design concepts were being used to inform final designs.



Red Lake: Hwy 1 and 89



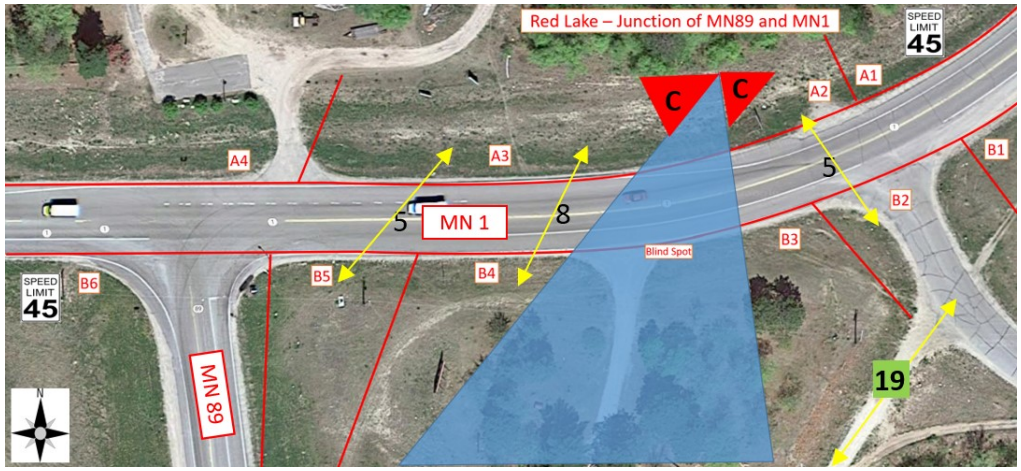
Redby: Hwy 1 and Central Street

Figure 5.1 Red Lake and Redby: Hwy 1 crossing zones

Table 5.1 Red Lake Reservation: Pedestrian monitoring, October 2021					
Reservation City / Town	**Monitoring Location**	**Pedestrian Safety Concerns**	**# of Cameras**	**Date Cameras Deployed (number of cameras)**	**Total Complete Days**
Red Lake	Hwy 1 and Hwy 89	People walking along across Hwy 1, Hwy 89, and W. Bot Dr, including informal paths	2	10.14.2021 (2)	15
Redby	Hwy 1	People crossing Hwy 1 between Central St and Bi Jogoonce Alley (between markets and US Post Office)	1	10.14.2021	15

Table 5.2 Red Lake Hwy 1 and Hwy 89: Monitoring days, period, and context							
Sites – Camera Views	Total Days of Data	Beginning Date	End Date	Vehicular Travel Lanes	Paved Road Shoulder	Vehicular Speed Limit	Notes
Red Lake – Hwy 1 and Rt 89	15	10.15.2021	10.29.2021	2 + 1 turn lane	Yes (Hwy 1)	45 mph	• Number of observed crossings too small to analyze statistically • More pedestrians observed walking on shoulders along Hwy 1 than crossing Hwy 1

Table 5.3 Red Lake Hwy 1 and Hwy 89: Pedestrians and crossing events						
Reservation City / Town	**Crossing Location**	**Mean Pedestrians / Day**	**Mean Crossing Events / Day**	**Percent Crossing Events with Interactions**	**Pedestrian Yield Rate**	**Potential Countermeasures**
Red Lake	Hwy 1 and Hwy 89	<1	<1	--	--	Only 5 crossing events in 15 days. No countermeasures identified or proposed.



Red Lake: Hwy 1 and Hwy 89

Figure 5.2 Red Lake: Hwy 1 near Hwy 89 pedestrian volume

Table 5.4 Redby Hwy 1 and Central St: Monitoring days, period, and context

Sites – Camera Views	Total Days of Data	Beginning Date	End Date	Vehicular Travel Lanes	Paved Road Shoulder	Vehicular Speed Limit	Notes
Redby – Hwy 1 and Central Street	15	10.15.2021	10.29.2021	2	Yes (area is commercial parking)	30 mph	Many pedestrians park vehicles on either the north or south side of Hwy 1, cross, and then cross again to return to vehicles.

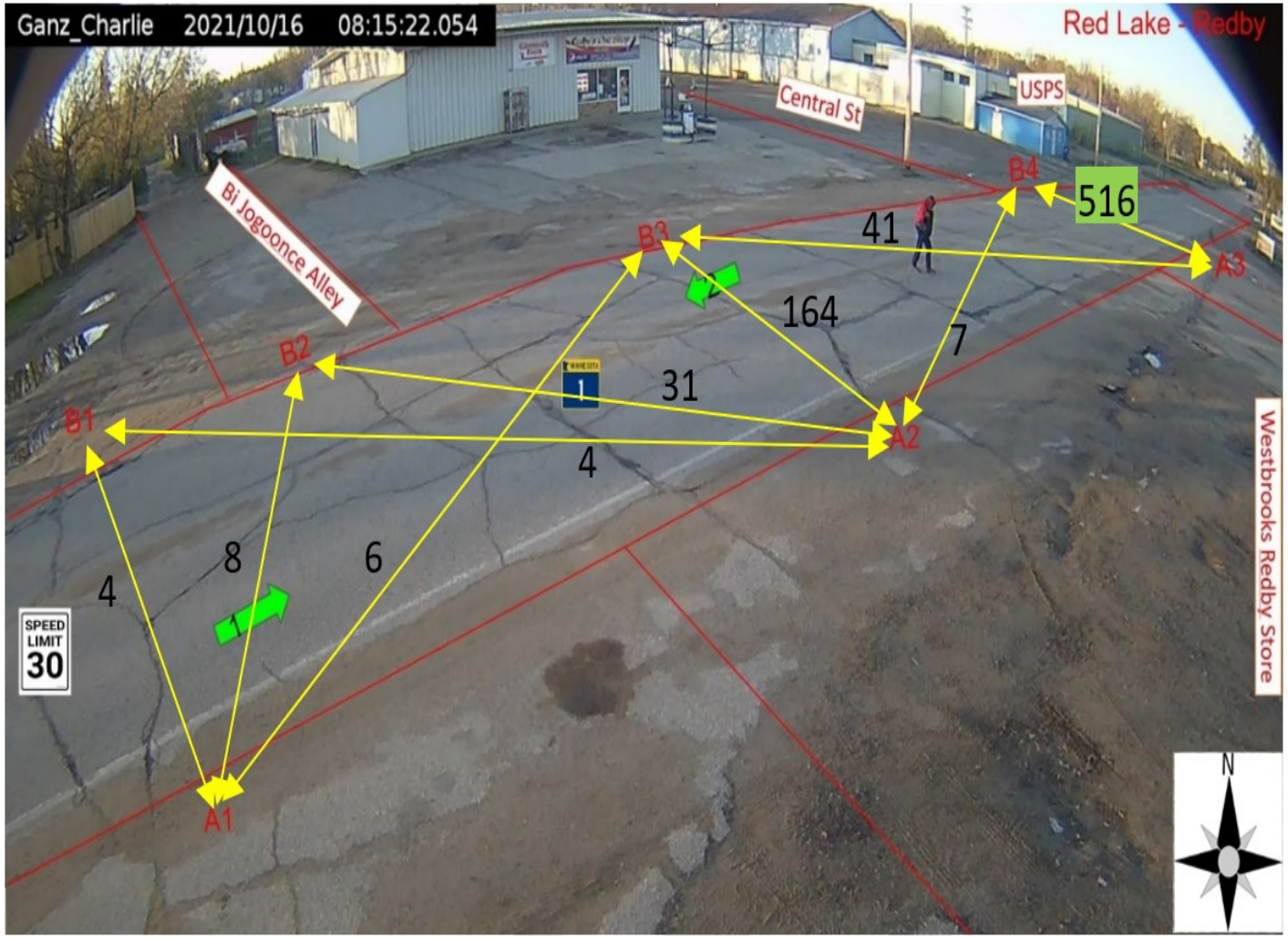


Figure 5.3 Hwy 1 and Central St: Pedestrian crossing volumes and trajectories

Table 5.5 Redby Hwy 1 and Central Street: Pedestrians, crossing events, and pedestrian group size									
Site	Total Pedestrians Observed	Mean Pedestrians / Day	Crossing Events	Mean Crossing Events/Day	Mean Pedestrians / Crossing Event	Crossing Group Size = 1 pedestrian	Crossing Group Size = 2 pedestrians	Crossing Group Size = 3 pedestrians	Crossing Group Size ≥ 4 pedestrians
Redby – Hwy 1 and Central Street	781	52	606	40	1.3	80%	15%	3%	2%

Table 5.6 Redby Hwy 1 and Central Street Total crossings events, interactions, and yield rates						
Site	Crossing Events	Crossing Events with Interactions	Percent Crossing Events with Interactions	Pedestrian Yield Rate	Driver Yield Rate	Pedestrian and Driver Yield Rate
Redby – Hwy 1 and Central Street	606	113	19%	96%	4%	1%

Table 5.7 Table 5.6 Redby Hwy 1 and Central Street Total crossings events, interactions, and yield rates													
Monitoring Locations	**A1-B1**	**A1-B2**	**A1-B3**	**A1-B4**	**A2-B1**	**A2-B2**	**A2-B3**	**A2-B4**	**A3-B1**	**A3-B2**	**A3-B3**	**A3-B4**	**Totals**
Redby – Hwy 1 and Central Street	4	8	6	0	4	31	164	7	0	0	41	516	781

Table 5.8 Redby Hwy 1 and Central Street: Pedestrians crossing by origin-destination zones and direction (see Figure 5.3)*													
Redby – Hwy 1 and Central Street		**A1**	**A2**	**A3**	**B1**	**B2**	**B3**	**B4(B**	**Total South-bound (A origins)**		**Total North-bound (B origins)**		**Total All Zones**
	A1	-	-	-	1	6	5	0	12	372	-	-	781
	A2	-	-	-	1	10	80	3	94		-	-	
	A3	-	-	-	0	0	20	246	266		-	-	
	B1	3	3	0	-	-	-	-	-	-	6	409	
	B2	2	21	0	-	-	-	-	-	-	23		
	B3	1	84	21	-	-	-	-	-	-	106		
	B4	0	4	270	-	-	-	-	-	-	274		
*Approximate Locations Where Pedestrians Entered Video Image													
A1	**A2**	**A3**	**B1**	**B2**	B3	B4							
10	82	278	18	77	45	269							

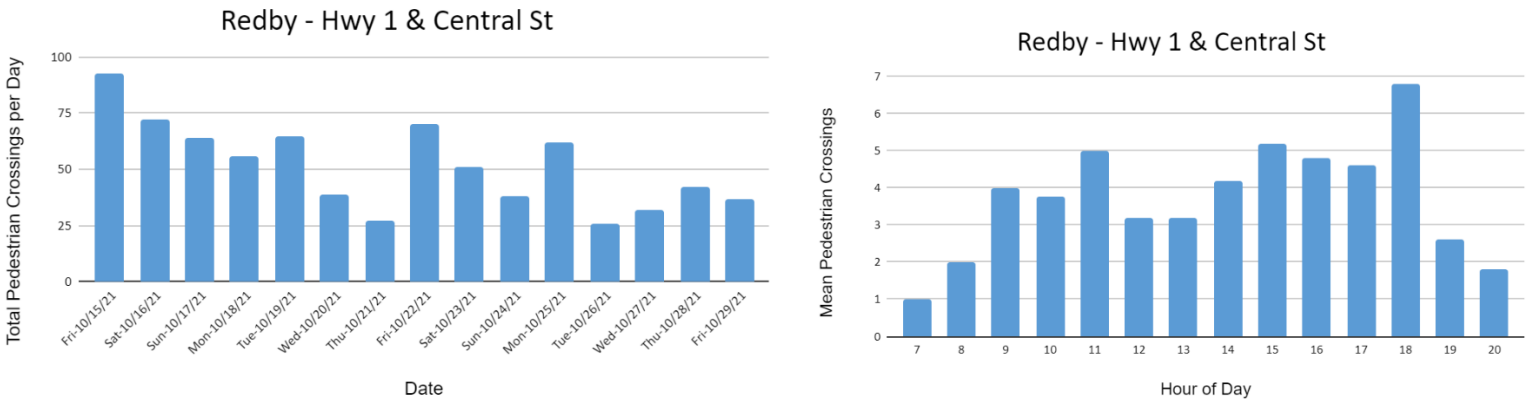
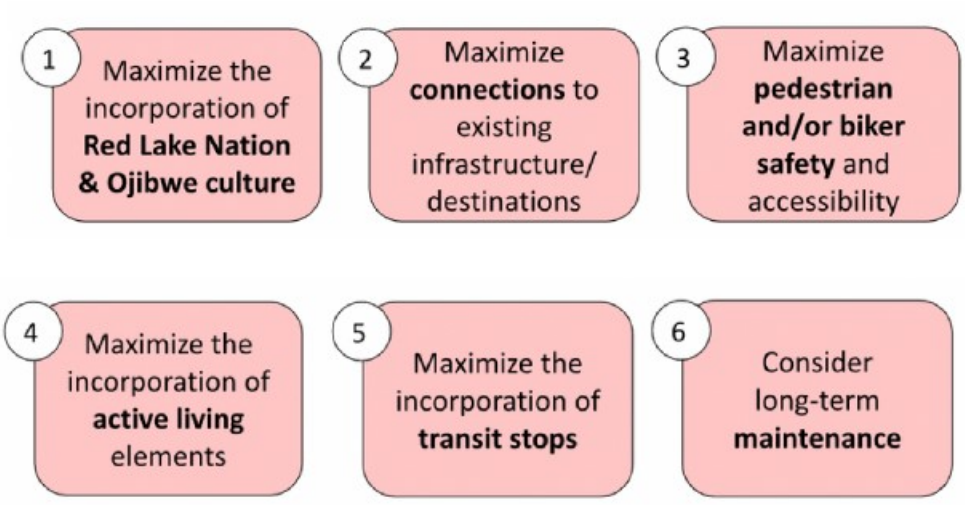


Figure 5.4 Redby Hwy 1 and Central Street: Daily and mean hourly crossing volume

Research Question

What are community preferences for design of trail pocket parks and Copper City community park in Redby?

Design Principles



Trail Pocket Park: Design Sketch

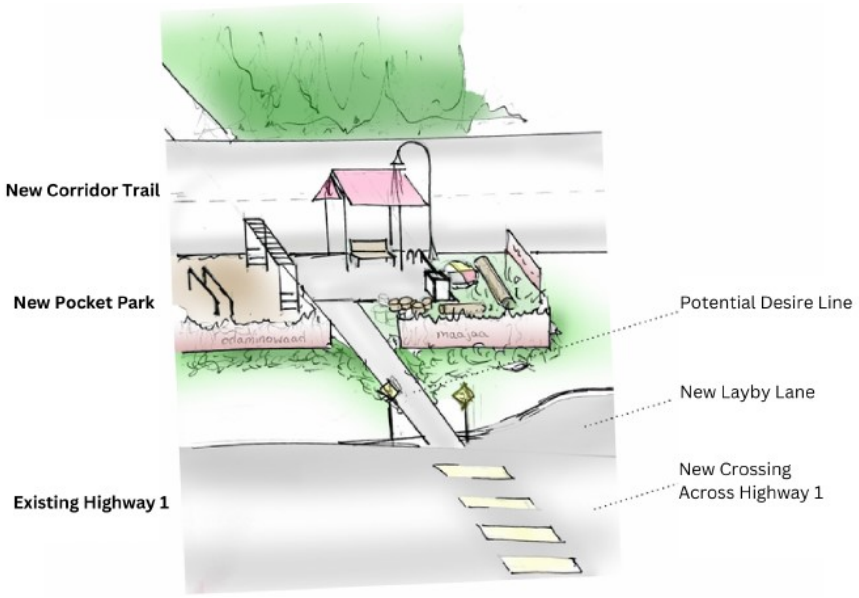
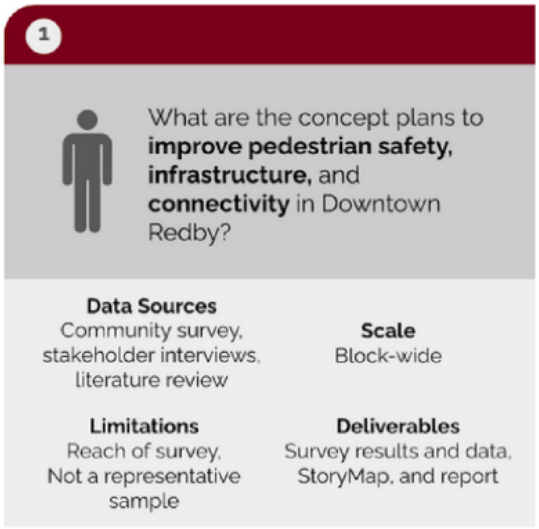


Figure 5.5 Red Lake Reservation: Conceptual design for trail pocket parks along Hwy 1 (Flannery et al. 2023)

Key Research Question and Data Sources



Concept Plan to Reduce Pedestrian Risk and Improve Livability in Redby

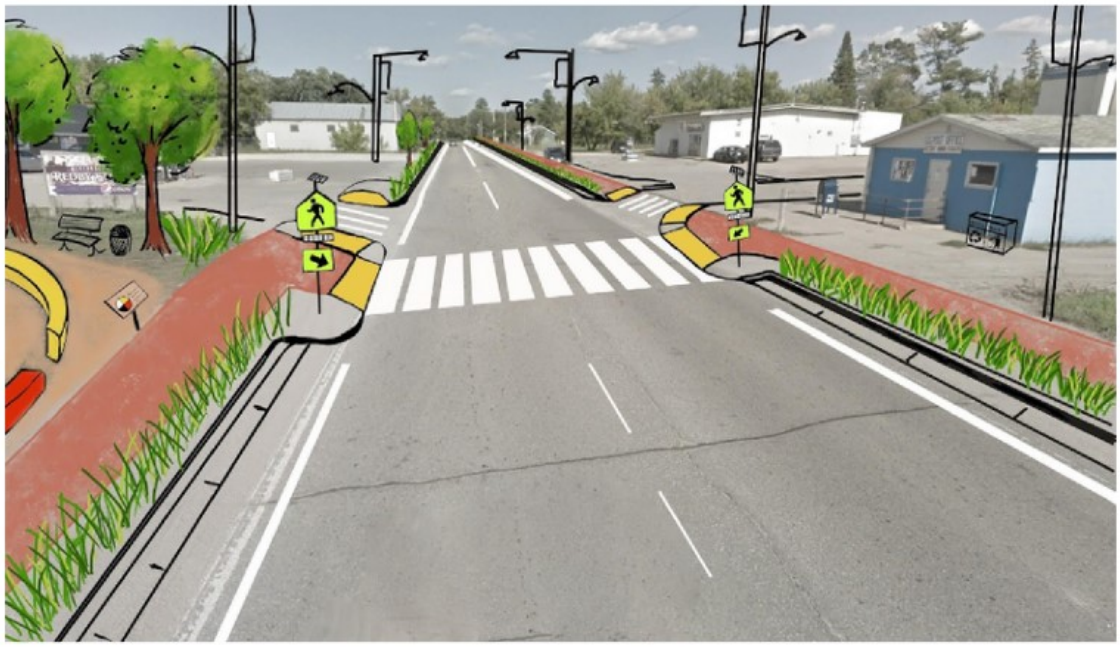


Figure 5.6 Redby: Conceptual design for Hwy 1 pedestrian crossing (Bakken et al. 2023)

Chapter 6: White Earth Reservation Monitoring Results

White Earth Nation transportation leaders identified three unmarked crossing locations along Hwy 59 on the reservation where pedestrians experience the risk of crashes with drivers when crossing the highway for daily activities like walking to school, visiting a convenience store or Tribal institution, or going to other destinations in downtown Mahnomen (Table 6.1, Figure 6.1). Two locations in Mahnomen were between the Hwy 59 intersections with Washington and Monroe-Adams Streets. The third site was in Waubun at the intersection of Hwy 59 and Hwy 113 (Figure 6.2). As noted in Chapter 2, in September 2021, following consultation with Tribal and MnDOT partners, the research team deployed video cameras, observed pedestrians at these two sites, and then analyzed results. Table 6.2 summarizes the dates when cameras were deployed and the roadway context. Cameras were deployed for 13 and 19 days, respectively, at Washington and Monroe-Adams streets (Table 6.2). In Waubun, the camera was deployed for 18 days. Video recorders operated only during daylight hours, so monitoring results are undercounts of actual pedestrian volumes.

6.1 Mahnomen

Tribal leaders specified the main risks at the Mahnomen locations were associated with pedestrians crossing Hwy 59 when going to and from destinations to the east (e.g., the Dollar Store, the White Earth Technical College) and to the west (e.g., downtown Mahnomen). Tribal leaders were concerned that the absence of pedestrian facilities increased the risks of crashes between pedestrians and drivers (Table 6.1).

The project team observed pedestrian crossings at the specified location (Table 6.2, Table 6.3, Figure 6 6.3). At Highway 59 and Washington Street, the mean numbers of pedestrians and crossing events per day were, respectively, 36 and 29 (Table 6.3). Pedestrians interacted with drivers in 39% of the crossing events and yielded to drivers in 90% of the interactions. At Highway 59 and Monroe-Adams Street, the mean numbers of pedestrians and crossing events per day were, respectively, 8 and 7 (Table 6.3). Pedestrians interacted with drivers in 30% of the crossing events and yielded to drivers in 100% of them (Table 6.4).

Tribal transportation managers advised the research team that many pedestrians make midblock crossings of Hwy 59 between Washington and Monoe-Adams Streets. The research team therefore coded origin-destination zones and coded crossings accordingly (Figure 6.3, Table 6.4, Table 6.5)

Tribal representatives and MnDOT engineers and planners discussed the intersections of Hwy 59 with Washington and Monroe-Adams as part of the corridor through Mahnomen. Potential countermeasures include pedestrian crossing signs to bookend the corridor, standard or raised crosswalks, RRFBs, narrowed lanes, a roundabout, and tactical installation of green infrastructure such as rain gardens or

solar gardens to funnel pedestrians away from the rail yards between Washington and Jefferson to intersections, thus reducing mid-block crossings.

6.2 Waubun

Tribal leaders specified that pedestrians in Waubun experience risks of crashes with drivers when crossing Hwy 59 when traveling east along Hwy 113 from a school to a convenience store on the northeast corner of Hwys 59 and 113 (Figure 6.1, Table 6.1,). The project team observed pedestrian crossings at this location (Table 6.2). The mean numbers of pedestrians and crossing events per day were, respectively, 4 and 3 (Table 6.3). Pedestrians interacted with drivers in 50% of the crossing events and yielded to drivers in 95% of the interactions (Table 6.4).

Potential countermeasures identified by Tribal representatives and MnDOT engineers and planners in follow-up meetings to discuss results include safety-related signage (e.g., pedestrian crossing and/or speed limit signs) and crosswalks, possibly as part of a MnDOT resurfacing project planned for 2023-2024. MnDOT subsequently added sidewalks along Hwy 113 to the intersection with Hwy 59, including connection to the Dollar Store on the west side of Hwy 59.

Table 6.1 White Earth Reservation: Pedestrian monitoring, September 2021					
Reservation City / Town	**Monitoring Location**	**Pedestrian Safety Concerns**	**# of Cameras**	**Date Cameras Deployed (number of cameras)**	**Total Complete Days**
Mahnomen	Hwy 59 (3rd St. NE) and E. Washington Ave.	People, students crossing Hwy 59 to reach White Earth Tribal and Community College	1	9.7.2021	13
Mahnomen	Hwy 59 (3rd St. NE) and Monroe-Adams	People, students crossing Hwy 59 to reach White Earth Tribal and Community College	1	9.7.2021	19
Waubun	Hwy 59 and Hwy 113 (Pleasant Ave.)	People, children crossing Hwy 59 to gas station and convenience store	1	9.7.2021	18

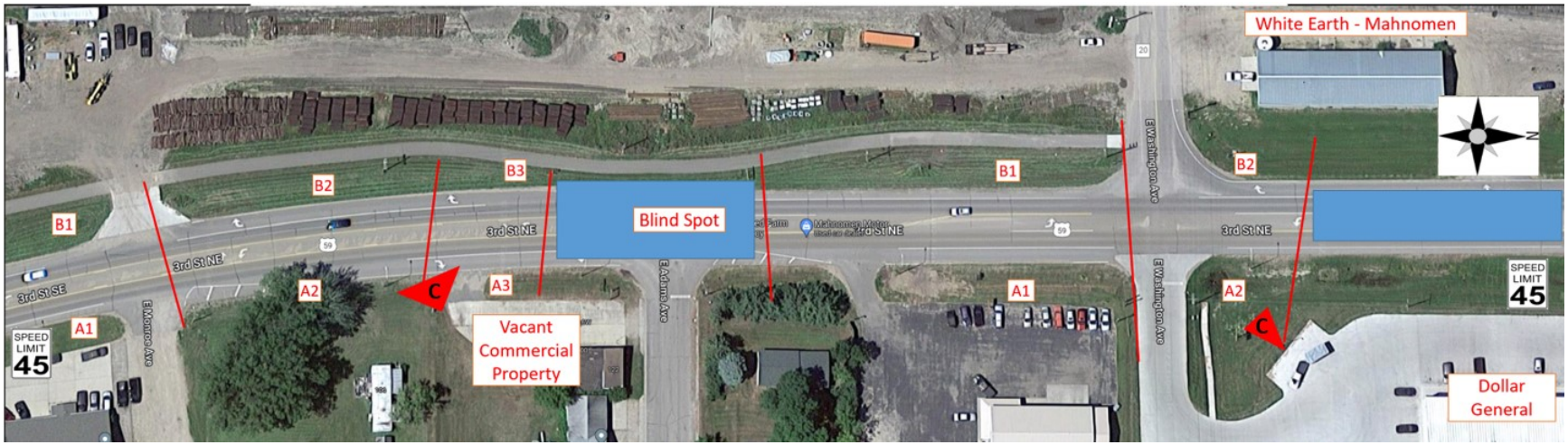


Figure 6.1 Mahnomen: Hwy 59 and Washington and Monroe-Adams Street crossing zones and camera locations

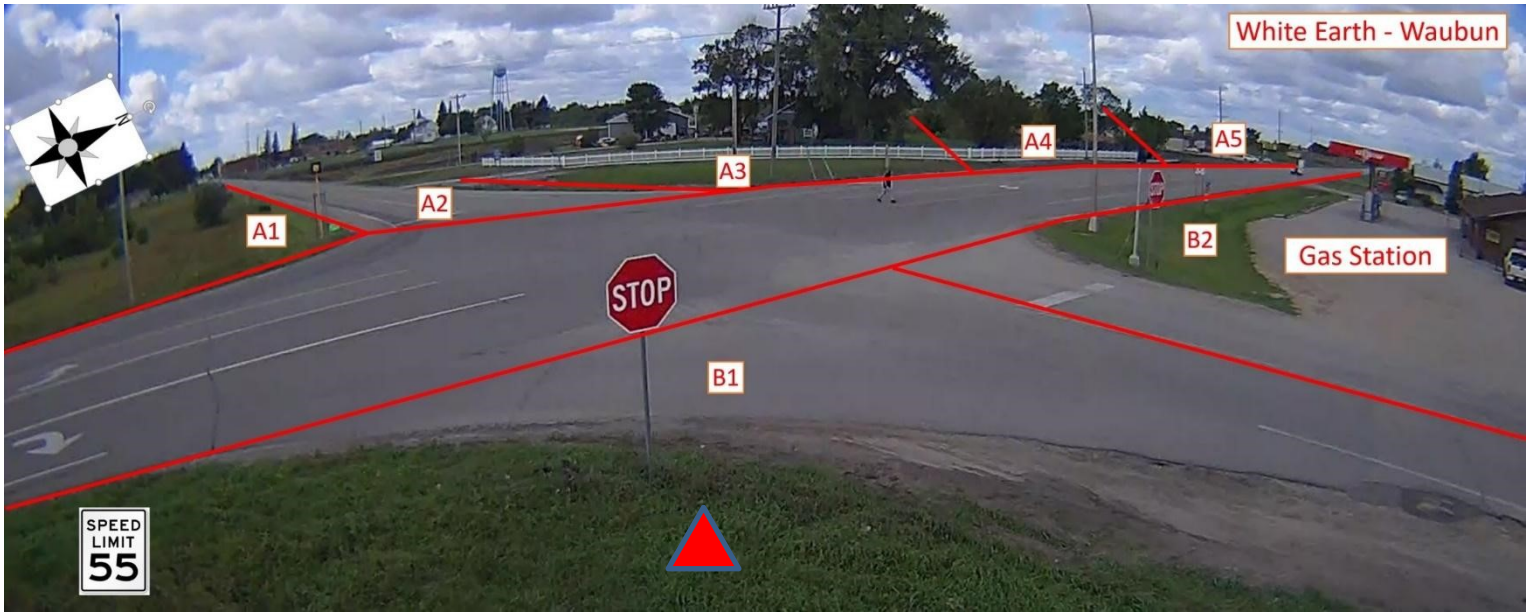


Figure 6.2 Waubun: Hwy 59 and Hwy 113 crossing zones and camera location

Table 6.2 Mahnomen and Waubun: Monitoring days, period, and context

Sites – Camera Views	Total Days of Data	Beginning Date	End Date	Vehicular Travel Lanes	Paved Road Shoulder	Vehicular Speed Limit	Notes
Mahnomen – Hwy 59 and Washington (Dollar Store)	13	9.08.2021	9.20.2021	2 + 2-3 turn lanes	No	45 mph	• Three-lane design with the middle lane being bidirectional turn lanes; right-hand turn lanes also present
Mahnomen – Hwy 59 and Monroe-Adams (Vacant commercial property)	13	9.09.2021	9.24.2021	2 + 2 turn lanes	No	45 mph	• Data not recorded on some days due to battery failure • Pedestrians crossing to and from Adams Street enter railroad property
Waubun – Hwy 59 and Hwy 113 (EZ-1 Stop)	14	9.11.2021	10.03.2021	2 + 1 turn lane (Hwy 59)	No	55 mph	• No pedestrians observed on some days.

Table 6.3 Mahnomen and Waubun: Pedestrians, crossing events, and pedestrian group size

Site	Total Pedestrians Observed	Mean Pedestrians / Day	Crossing Events*	Mean Crossing Events/Day	Mean Pedestrians / Crossing Event	Crossing Group Size = 1 pedestrian	Crossing Group Size = 2 pedestrians	Crossing Group Size = 3 pedestrians	Crossing Group Size ≥ 4 pedestrians
Mahnomen – Hwy 59 and Washington (Dollar Store)	465	36	380	29	1.2	84%	10%	4%	4%
Mahnomen – Hwy 59 and Monroe-Adams (Vacant commercial property)	104	8	94	7	1.1	91%	6%	2%	1%
Waubun – Hwy 59 and Hwy 113 (EZ-1 Stop)	56	4	42	3	1.3	88%	7%	2%	3%

Table 6.4 Mahnomen and Waubun: Crossing events, interactions, and yield rates

Site	Crossing Events	Crossing Events with Interactions	Percent Crossing Events with Interactions	Pedestrian Yield Rate	Driver Yield Rate	Pedestrian and Driver Yield Rate
Mahnomen – Hwy 59 and Washington (Dollar Store)	380	149	39%	90%	9%	1%
Mahnomen – Hwy 59 and Monroe-Adams (Vacant commercial property)	94	38	30%	100%	0%	0%
Waubun – Hwy 59 and Hwy 113 – EZ Stop	42	21	50%	95%	0%	5%

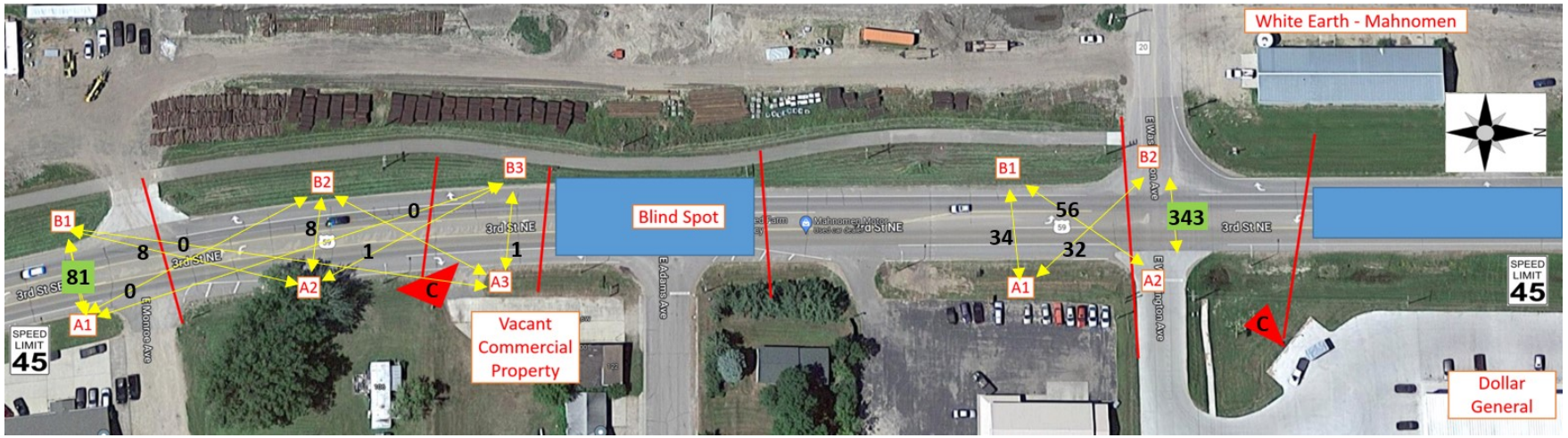
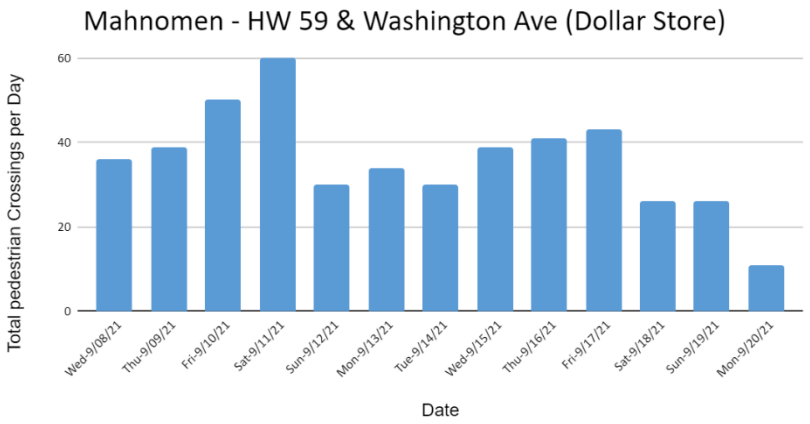


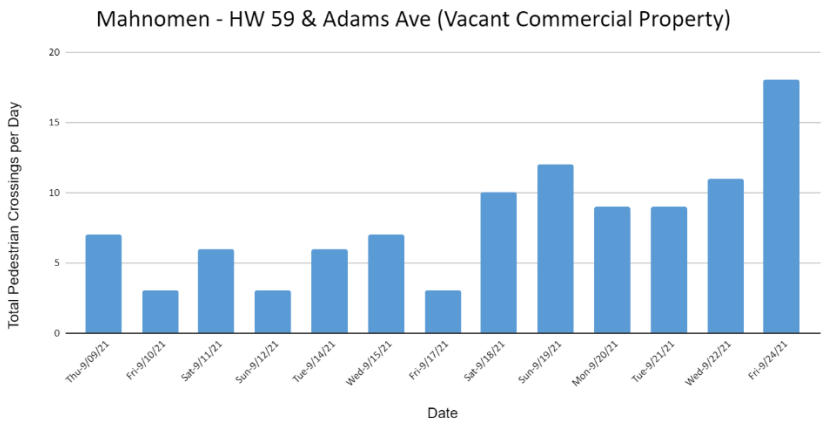
Figure 6.3 Mahnomen: Pedestrian crossing volumes and trajectories.

Table 6.5 Mahnomen: Pedestrian traffic volumes and crossing trajectories between zones

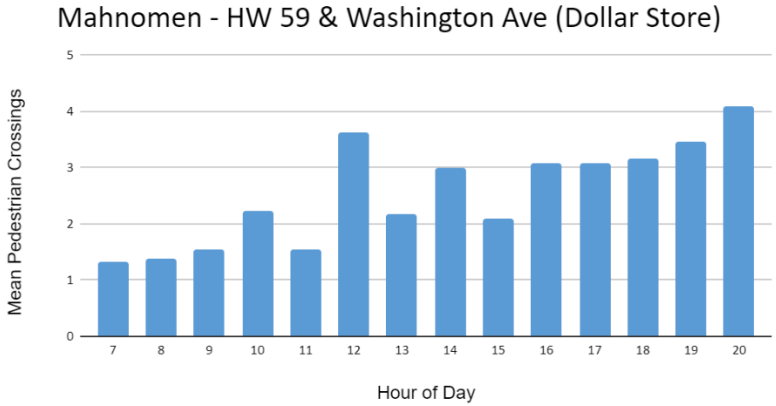
Monitoring Locations	A1-B1	A1-B2	A1-B3	A2-B1	A2-B2	A2-B3	A3-B1	A3-B2	A3-B3	Totals
Hwy 59 and Washington	34	32	--	56	343	--	--	--	--	465
Hwy 59 and Monroe-Adams	81	0	0	8	8	1	0	5	1	104

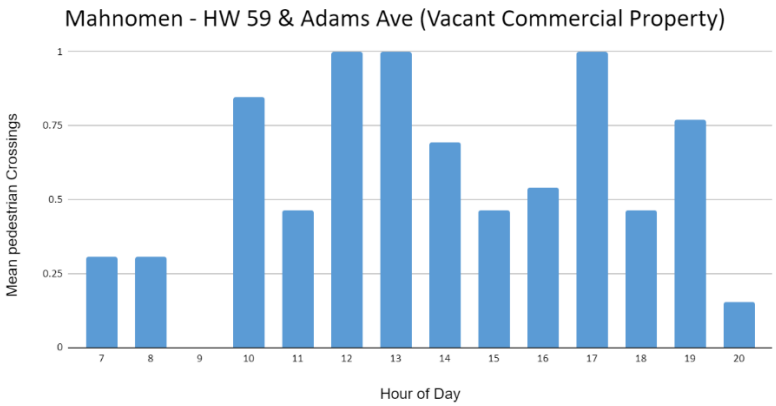
Table 6.6 Mahnomen: Bidirectional pedestrian volumes and crossing trajectories between zones												
Mahnomen – Hwy 59 and Washington St (Dollar Store)		**A1**	**A2**	**B1**	**B2**			**Total Westbound**		**Total Eastbound**		**Total Pedestrians**
	A1	-	-	11	7			18	200	-		465
	A2	-	-	33	149			182		-		
	B1	23	23	-	-			-		46	265	
	B2	25	194	-	-			-		219		
Mahnomen – Hwy 59 and Monroe St (to Adams St and Vacant Commercial Property)		**A1**	**A2**	**A3**	**B1**	**B2**	**B3**	**Total Westbound**		**Total Eastbound**		
	A1	-	-	-	26	0	0	26	38	-		104
	A2	-	-	-	0	6	1	7		-		
	A3	-	-	-	0	5	0	5		-		
	B1	55	8	0	-	-	-	-		63	66	
	B2	0	2	0	-	-	-	-		2		
	B3	0	0	1	-	-	-	-		1		





Total Pedestrians Observed by Day





Mean Hourly Pedestrian Crossings by Hour-of-Day over Monitoring Period

Figure 6.4 Mahnomen: Hwy 59 daily and mean hourly variation in pedestrian crossings

Bar charts of Hwy 59 pedestrian crossing volumes at the intersection with Hwy 113 in Waubun for the monitoring period. Chart in left panel presents daily totals for the monitoring period. Vertical axis is total pedestrian crossings per day. Horizontal axis is the day of year. Chart in right panel presents average hourly traffic between the hours of 7:00 a.m. and 8:00 p.m. for the duration of the monitoring period. Vertical axis is average hourly pedestrian crossings. Horizontal axis is hour of day.

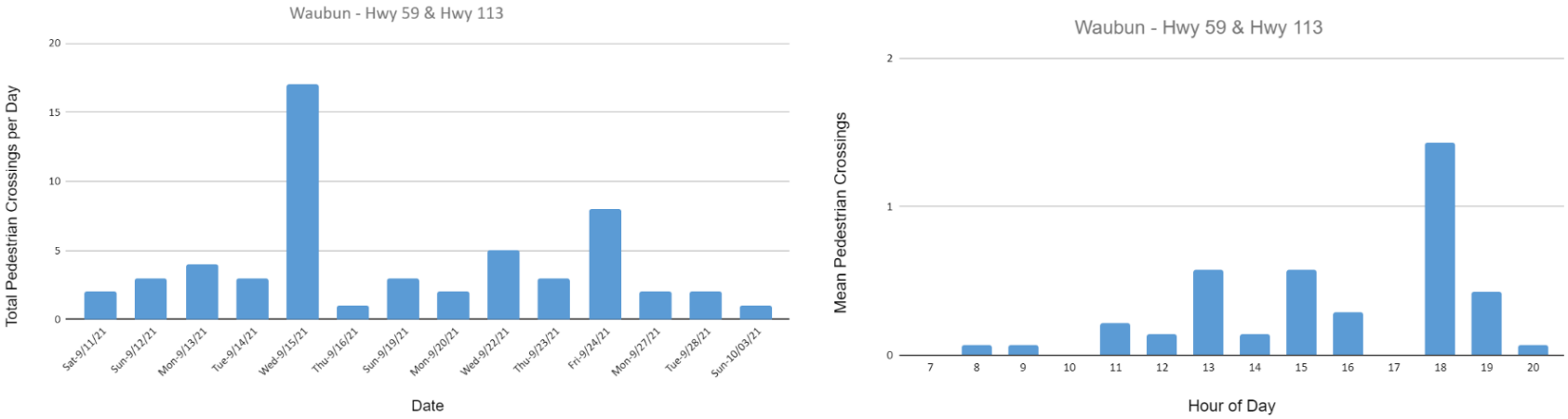


Figure 6.5 Waubun: Hwy 59 daily and mean hourly variation pedestrian crossings

Chapter 7: Fond du Lac Reservation Monitoring Results

The Fond du Lac Band of Lake Superior Chippewa participated in both the Phase 1 and Phase 2 projects. In Phase 1, the Band identified four crossing locations where pedestrians experience crash risk when walking to destinations, three along Big Lake Road in Cloquet and one on Hwy 210 in Sawyer. In 2019, following Phase 1 monitoring in 2017, the Band worked with MnDOT and Carlton County to implement several countermeasures to reduce risks to pedestrians along Big Lake Road and at the Hwy 210 site. Along Big Lake Road in Cloquet, agencies:

- Built a multiuse trail parallel to the roadway in 2019 with Safe Routes to Schools funds
- Reduced posted speed limits to 35 mph
- Marked north-south crosswalks across Big Lake Road with standard pavement markings to facilitate pedestrian crossings
- Installed SRTS Temporary Demonstration Project on Big Lake Road in October 2020 (paint, bollards, signs)

At the Hwy 210 and Mission Road intersection in Sawyer, agencies:

- Reduced the speed limit on Hwy 210 from 60mph to 55mph
- Installed a dynamic speed feedback sign to advise drivers of their speed
- Installed blinking 24/7 advance warning signs on Hwy 210
- Narrowed travel lanes on HwyMN 210 through the Mission Road intersection
- Installed new lighting
- Painted a crosswalk across Hwy 210 on the east side of Mission Road
- Painted a crosswalk across Mission Road on the south side of MN 210
- Installed an ADA curb cut and pad for the planned trail connection to be built in 2025

In Phase 2, the Band requested monitoring to assess pedestrian behaviors at five sites. These sites included three locations previously monitored in 2017 where countermeasures had been installed along Big Lake Road and on Hwy 210 and two new sites of interest to the Band. One site monitored in 2017 was not monitored in Phase 2 based on priorities of the Band.

The objectives of Phase 2 monitoring were to document (1) changes in pedestrian behaviors following installation of countermeasures at the three sites monitored previously in Phase 1 and (2) crossing volumes and safety concerns at the two new sites. The Band requested that monitoring occur in fall (September 2022) when school would be in session (rather than during July and August when the 2017 observations occurred) to capture school-related pedestrian traffic. The five locations monitored in 2022 were:

- Big Lake Road and Trettel Lane (Phase 1 site)

- Big Lake Road and University / Brevator (Phase 1 site)
- Big Lake Road and Mizhakii (new site)
- University Road Crossing (new, RRFB site)
- Hwy 210 and Mission Road, Sawyer (Phase 1 site)

Pedestrian crossings at these sites were monitored for between 7 and 18 days (Table 7.1). As in Phase 1, UMN undergraduate students viewed video recordings, coded total pedestrians, crossing events, group size, interactions with drivers, and pedestrian and driver yield rates. Key results from all sites monitored in both Phase 1 and 2 are summarized in Table 7.2.

Vulnerable user (pedestrian/cyclist) volumes in 2017 and 2022 were comparable, ranging 3 to 31 users per day across sites in 2017 and from 2 to 30 users per day across sites in 2022 (Table 6.2). While the ranges of volumes across sites were similar, pedestrian/cyclist volumes at the Big Lake Road Crossing at Trettel Ln and the HWY 210 crossing at Mission Rd in Sawyer declined from volumes observed in 2017.

Detailed monitoring results are presented by community and site in the following sections. Data analysis focuses on major road crossings (i.e., Big Lake Road, HWY 210), although crossing volumes on crosswalks on some minor roads also are reported. Key observations include:

- Across the five sites monitored in 2022, the percent of crossing events in which vulnerable users interacted with drivers ranged from 14% to 37%. The range of pedestrian-driver interactions observed in 2017 was similar (i.e., 9% to 33%).
- Across sites, vulnerable users yielded between 50% and 91% of interactions in 2017 and 79% to 100% of interactions in 2022.
- Pedestrian use of crosswalks as designed varied across locations.
- Pedestrian crossing patterns appear to reflect access to facilities and destinations.

At the Big Lake Rd and Trettel Lane site, the mean crossing volume was 8 vulnerable users/day (20% pedestrians; 80% cyclists). Fewer people crossed Big Lake Rd at this location during monitoring in September, 2022 than in July-August, 2017. One pedestrian used the crosswalk; most cyclists crossed Big Lake Rd on the roadway on the west side of the intersection. More people crossed Trettel Lane on the new multiuse trail than on any other intersection leg.

At the Big Lake Rd and Brevator Rd site, only 3 vulnerable users/day were observed (35% pedestrians; 65% cyclists). A plurality of pedestrians crossing Big Lake Rd used the crosswalk as designed; the pedestrians tended to disperse across the intersection.

At the Big Lake Rd and Mizhakii location (new in 2022), only 2 vulnerable users per day were observed, all of whom were pedestrians. Most pedestrians crossed Big Lake Rd following the north-south alignment of Mizhakii.

At the University Rd site where an RRFB and a marked crosswalk had been installed to enable pedestrians to warn drivers of their intent to cross, 30 vulnerable users/day were observed (83% pedestrians; 13% cyclists). Despite the presence of RFFB and crosswalk, more people crossed University Rd south of the crosswalk from a parking lot on the east side of University Rd. The lack of sidewalk access to the crosswalk landing on the east side of University Rd may affect use of the existing crosswalk.

At the Hwy 210 and Mission Rd site, 5 vulnerable users/day were observed, 50% pedestrians and 50% cyclists. More pedestrians crossed HWY 210 on the west side of the intersection than on the crosswalk on the east side; only one person was observed crossing Mission Road using the crosswalk on th southern side Hwy 210.

Table 7.1 Fond du Lac Reservation: Phase 2 monitoring at Phase 1 and other sites (2022)

Reservation City / Town	Monitoring Location	Pedestrian Safety Concerns	# of Cameras	Date Deployed (# of cameras)	Total Complete Days
Fond du Lac					
Cloquet	Big Lake Rd crosswalk and Trettel Ln	Pedestrians crossing Big Lake Road along Trettel Ln	1	9..0522 – 9.14.2022	10
Cloquet	Big Lake Rd and crosswalk Brevator Rd	Pedestrians crossing Big Lake Road from Brevator Rd to University Rd	1	9.05.2022 – 9.22.2022	18
Cloquet	Big Lake Rd and Mizhakii Rd (Phase 2 only site)	Pedestrians crossing Big Lake Road going north-south along Mizhakii Rd to T-intersection to school and Tribal buildings	1	9.05.2022 – 9.22.2022	18
Cloquet	University Road crosswalk with RFFB (Phase 2 only site)	Pedestrians crossing east-west across University Road either using crosswalk and RRFB or from parking lot to other Tribal buildings	1	9.06.2022 – 9.25.2022 (excluding 9.21.2022 & 9.23.2022)	18
Sawyer	Hwy 210 crosswalk and Mission Rd crosswalk	Vulnerable users crossing Hwy 210 along Mission Rd to convenience store and US Post Office	1	9.10.2022 – 9.16.2022	7

Table 7.2 Fond du Lac Reservation: Crossing volumes, interactions, and yield rates (2017 and 2022)							
	2017	2017	2017	2022	2022	2022	2022
Monitoring Location	**Vulnerable Users / Day**	**% Users with Interactions**	**Vulnerable User Yielded**	**Vulnerable Users / Day**	**% Crossings with Interactions**	**Vulnerable User Yielded**	**% Bicyclists**
Big Lake Rd and Pinewood	29	29%	50%	Not monitored	Not monitored	Not monitored	Not Monitored
Big Lake Rd and Trettel (CSAH 114)	31	29%	75%	8	22%	100%	80%
Big Lake Rd and Brevator Rd-CSAH 5	3	9%	Not reported, small sample	3	19%	Not reported, small sample	65%
Big Lake Rd and Mizhakii	Not monitored	Not monitored	Not Monitored	2	37%	Not reported, small sample	0%
University Rd -CSAH 5; RFFB site)	Not monitored	Not monitored	Not Monitored	30 (25 groups)	14%	79%	13%
dHwy 210 and Mission Rd (CSAH 112/CSAH 7), Sawyer	12	33%	91%	5	21%	100%	50%

7.1 Cloquet: Big Lake Road and University Road Locations

Big Lake Road and Trettel Lane (CSAH 114)

Vulnerable user crossing volumes and patterns at the intersection of Big Lake Road and Trettel Lane are presented in Figure 7.1. Pedestrian crossing patterns were documented by creating origin and destination zones (e.g., A1, B1, etc.) and then coding the numbers of pedestrians from each zone to all other zones. The mean number of people crossing Big Lake Road was 8 per day; cyclists accounted for 75% of users observed. In general, user crossing patterns were dispersed across the intersection. Only three of 80 vulnerable users completed their entire north-south crossing in the painted crosswalk. Approximately 88% of users walking or cycling east or west along Big Lake Road used the crossing on the south side of Big Lake Road that connects to the multi-use trail.

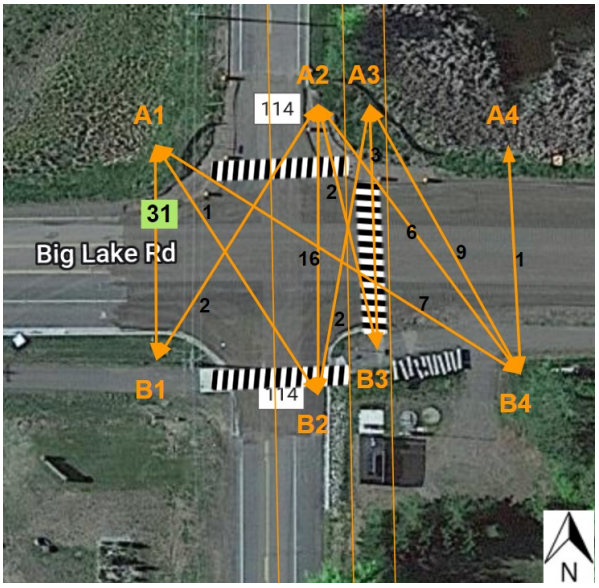
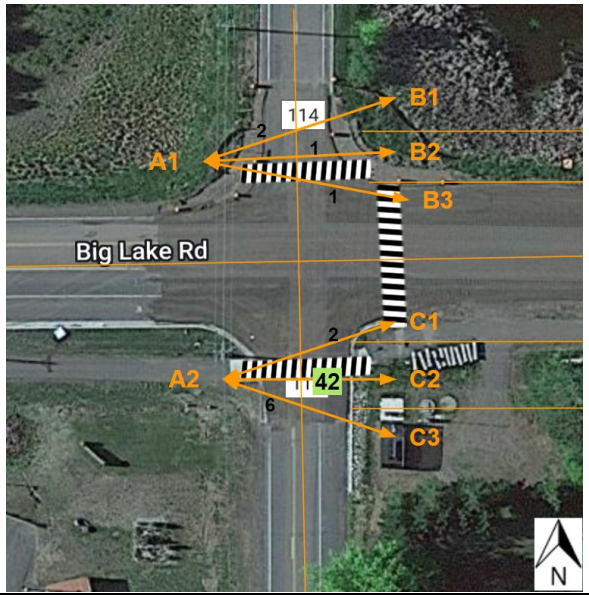
Big Lake Rd All User Crossings (mean = 8/day)	Trettel Ln All User Crossings (mean = 5/day)
	

Figure 7.1 Cloquet: Big Lake Rd and Trettel Ln vulnerable user crossings and trajectories

Figures 7.2 and 7.3, respectively, summarize pedestrian and cyclist crossing patterns at Big Lake Road and Trettel Lane. Cyclist patterns are more dispersed than pedestrian patterns: cyclists appear more likely to cross at diagonals to progress towards their destination. Most pedestrians were observed crossing Trettel Lane in the crosswalk going east-west on the multiuse trail.

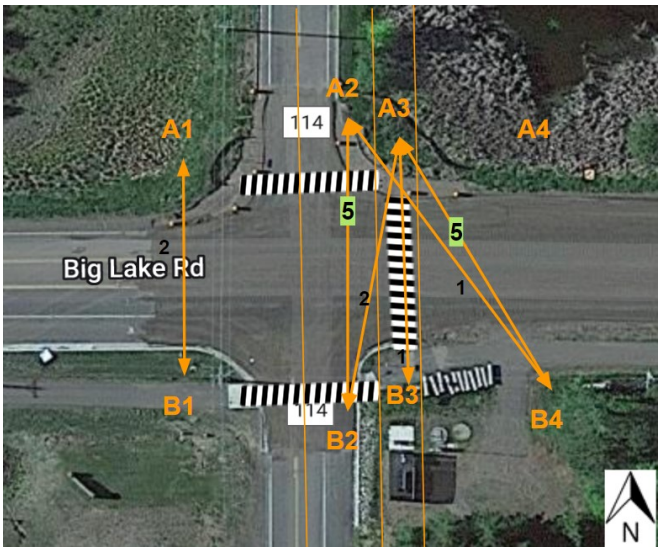
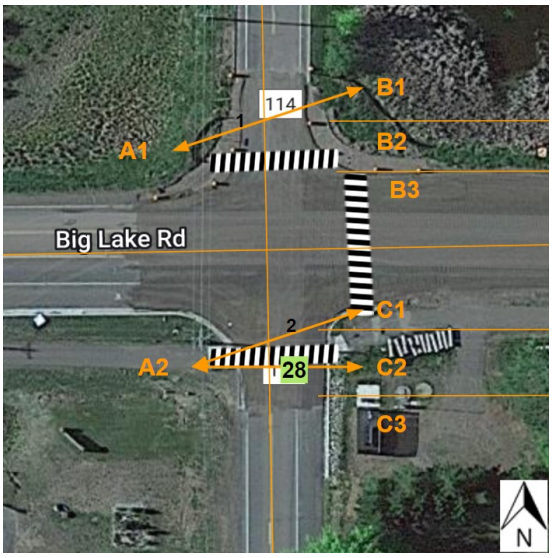
Big Lake Rd Pedestrian Crossings	Trettel lane Pedestrian Crossings
	

Figure 7.2 Cloquet: Big Lake Rd and Trettel Ln pedestrian crossings and trajectories

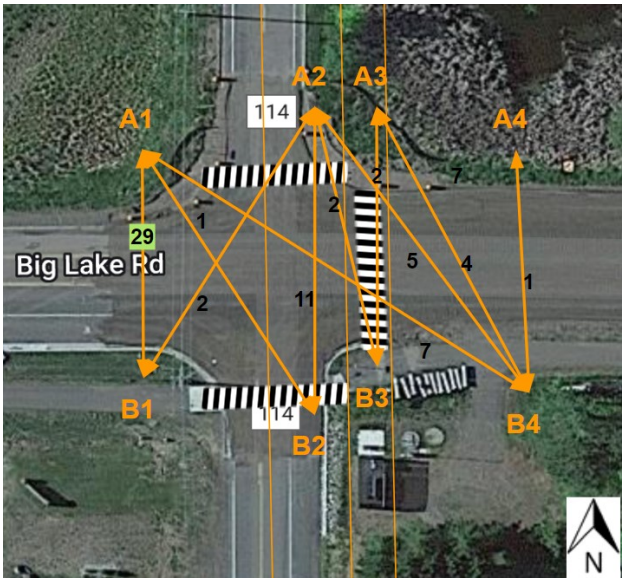
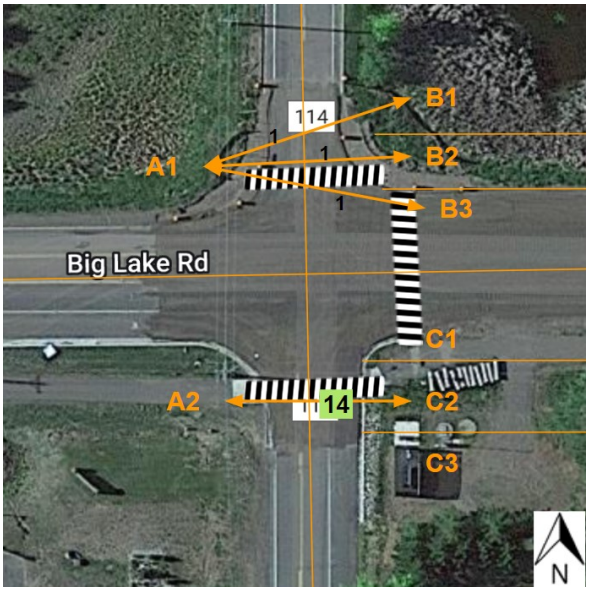
Big Lake Rd Cyclist Crossings	Trettel In Cyclist Crossings
	

Figure 7.3 Cloquet: Big Lake Rd and Trettel Ln cyclist crossings and trajectories

Big Lake Road and Brevator Road (CSAH 5)

Vulnerable user crossing volumes and patterns at the intersection of Big Lake Road and Brevator Road are presented in Figures 7.4 and 7.5. The mean number of people crossing Big Lake Road was 3 per day; cyclists accounted for 65% of users. In general, user crossing patterns were dispersed across the intersection. A plurality of vulnerable users completed their entire north-south crossing in the painted crosswalk on the east side of the intersection (B2-A2).

Figure 7.5 shows pedestrian and cyclist crossing patterns at Big Lake Road and Brevator Road. The patterns are similar: many cyclists and pedestrians cross Big Lake Road diagonally enroute to destinations. A plurality of cyclists, however, use north-south travel lanes on Brevator when crossing Big Lake Road.

Figure 7.4 Cloquet: Big Lake Rd and Brevator Rd vulnerable user crossings and trajectories

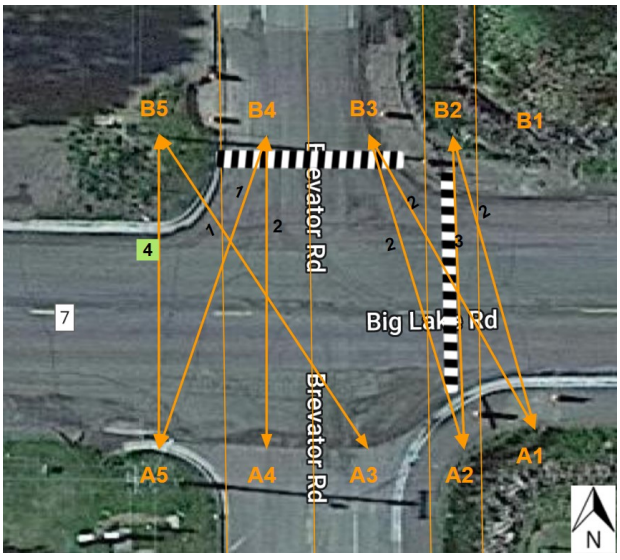
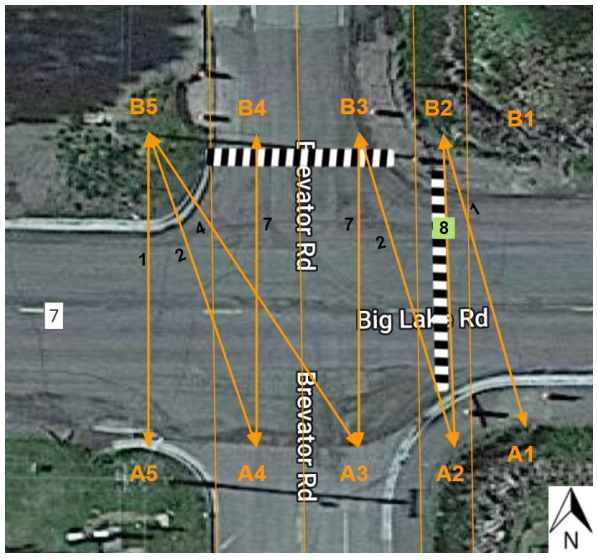
Big Lake Rd Pedestrian Crossings	Big Lake Rd Cyclist Crossings
	

Figure 7.5 Cloquet: Big Lake Rd and Brevator pedestrian and cyclist crossings and trajectories

Big Lake Road and Mizhakii Road

Vulnerable user crossing volumes and patterns at the intersection of Big Lake Road and Mizhakii Road are shown in Figure 7.6. The mean number of people crossing Big Lake Road was 2 per day; all the persons crossing at this location were pedestrians. Most people crossed directly north-south along the roadway trajectory (B2-A2).

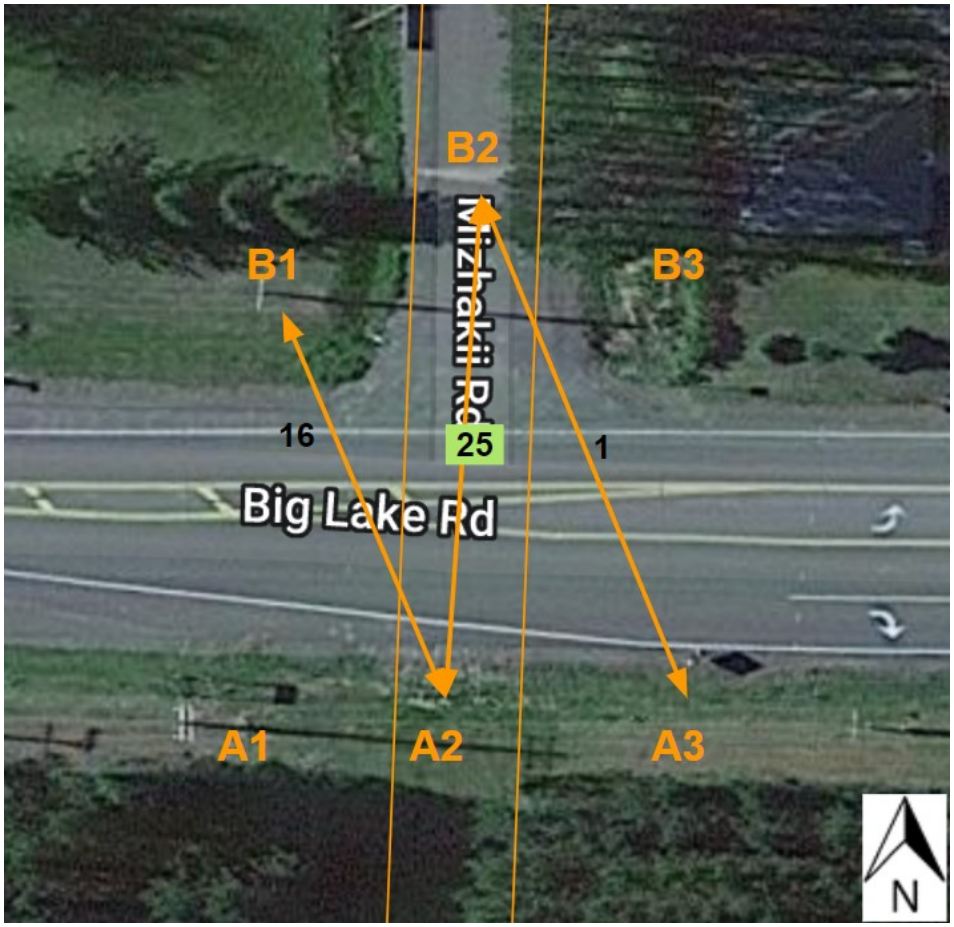


Figure 7.6 Cloquet: Big Lake Rd and Mizhakii Rd vulnerable user crossings and trajectories

University Road (CSAH 5 – RRFB site)

Vulnerable user crossing volumes and patterns at the midblock crossing on University Road where a Rectangular Rapid Flashing Beacon (RRFB) is located are shown in Figure 7.7. The mean number of people crossing Big Lake Road was 30 per day. The number of crossing events was 25; the mean group size was 1.2 persons. More people (279) crossed south of the crosswalk (B3-A3) than on the crosswalk (139, B2-A2). The lack of access to the crossing landing pad (A2) on the east and the preferred route to destinations (B3) from the parking lot may influence observed patterns. Tribal representatives noted that plans exist to construct or pave access to the landing pad from the parking lot.

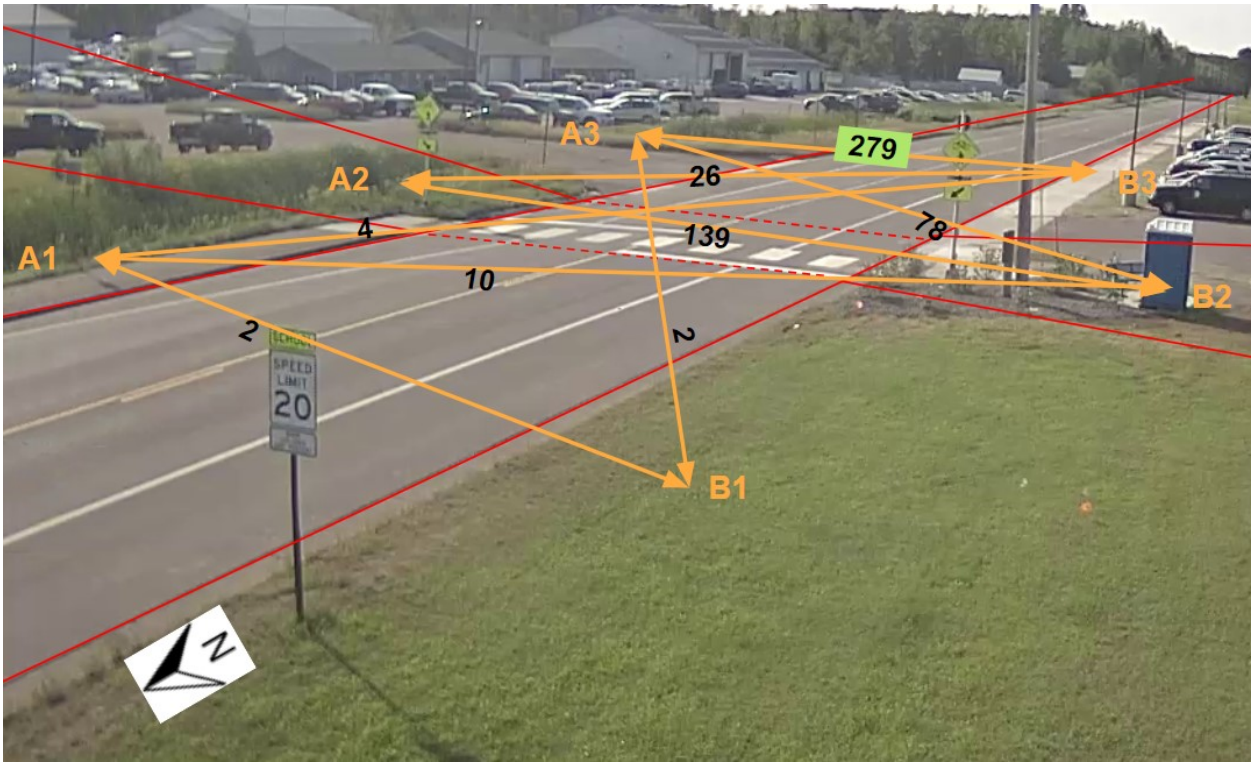


Figure 7.7 Cloquet: University Ave midblock vulnerable user crossings and trajectories

7.2 Sawyer: HWY 210 Site

HWY 210 and Mission Road (CSAH 7), Sawyer

Vulnerable user crossing volumes and patterns at the intersection of Highway 210 and Mission Road in Sawyer are summarized in Figures 7.8 and 7.9. The mean number of people crossing was 5 per day, seven persons per day fewer than in 2017. Half of the users were pedestrians, and half were cyclists. Ten of 17 pedestrians crossed HWY 210 on the west side of Mission Rd. Only one used the crosswalk (A4-B4). Ten of 17 cyclists crossed HWY 210 in Mission Rd travel lanes (A2-B2; A3-B3). One person used Mission Road crosswalk when traveling along Highway 210.

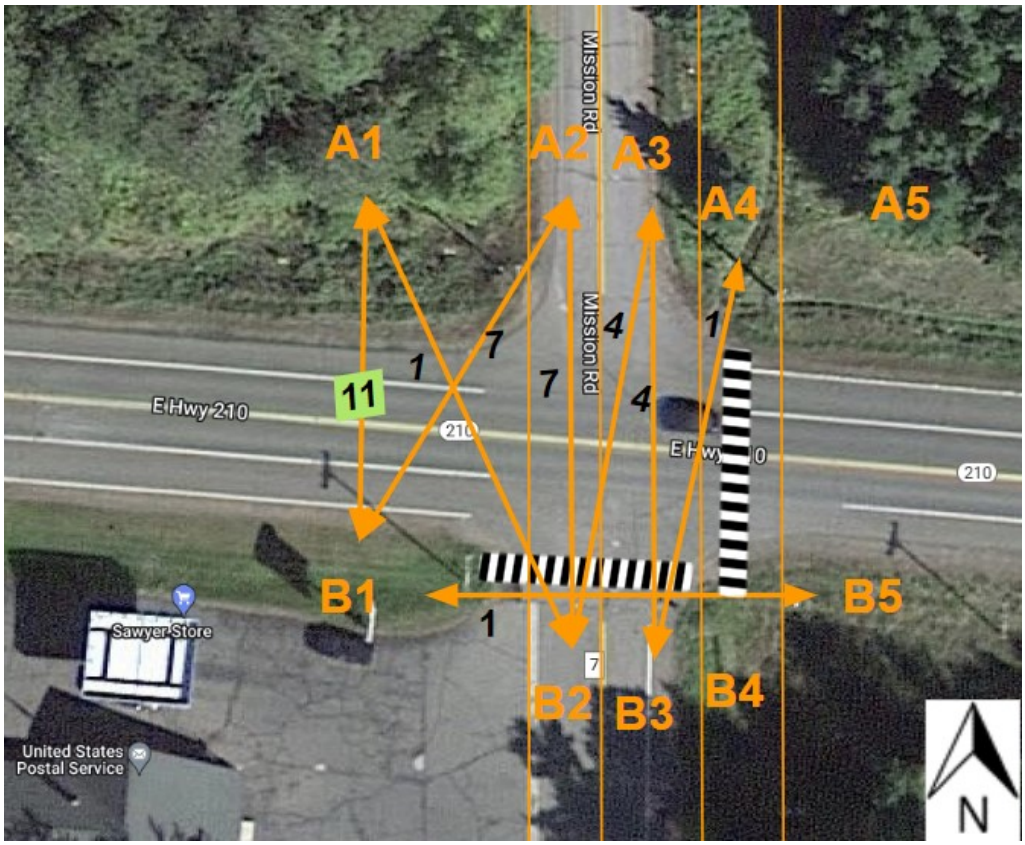


Figure 7.8 Sawyer: Hwy 210 and Mission Rd vulnerable user crossings and trajectories

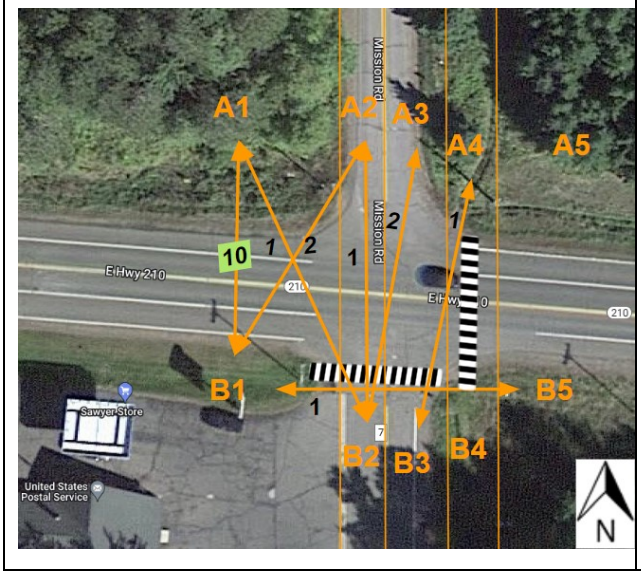
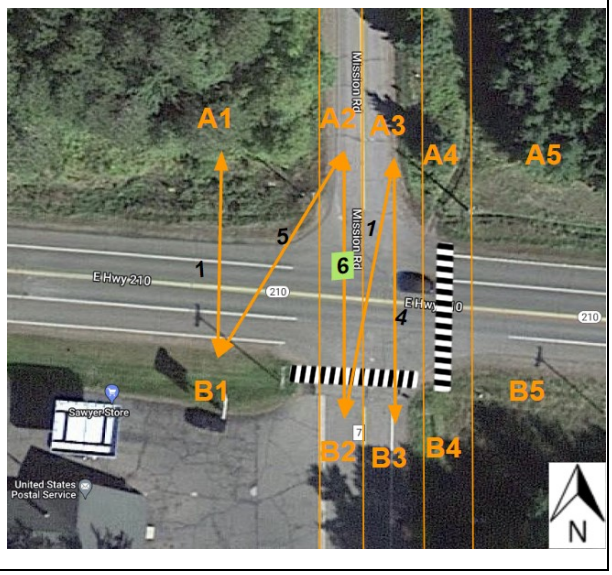
Hwy 210 Pedestrian Crossings	Hwy 210 Cyclist Crossings
	

Figure 7.9 Sawyer: Hwy 210 and Mission Rd pedestrian and cyclist crossings and trajectories

Chapter 8: Grand Portage Reservation Monitoring Results

The Grand Portage Band of Lake Superior Chippewa participated in both the Phase 1 and Phase 2 projects. In Phase 1, the Band identified two crossing locations on Hwy 61 where it bisects the community of Grand Portage and pedestrians experience crash risk when walking from residential locations east of the highway to retail and institutional destinations on the east side. In 2021, following Phase 1 monitoring in 2017, the Band worked with MnDOT to implement countermeasures at both locations as part of a major road improvement and resurfacing project. At the Blaze's Pit, Marina Road crossing near the Trading Post, US Post Office, and casino, MnDOT:

- Added a new crosswalk consisting of 15-foot wide continental block pavement markings
- Installed gate-posted crossing signs (W11-2*) to alert drivers to the possibility of pedestrian crossings
- Built an ADA-accessible sidewalk, steps, and ramp to the crosswalk on the east side of Hwy 61
- Installed guardrails along Highway 61 to encourage use of the crosswalk
- Installed new lighting at the crossing area.

At the Hwy 61-Stevens Road intersection to the north, MnDOT:

- Added a new crosswalk consisting of 15-foot wide continental block pavement markings Installed gate-posted crossing signs (W11-2*)
- Constructed a sidewalk/trail to lead to the crosswalk
- Installed new lighting at the crossing area.

In addition, signs indicating PEDS/BIKES NEXT 1 MILE were posted in the right-of-way along both the northbound and southbound lanes where pedestrians/cyclists previously were observed along the Highway 61 road shoulder,

In Phase 2, the Band requested monitoring to assess pedestrian behaviors at both locations during the annual PowWow held in August of each year. The objectives of monitoring were to document changes in pedestrian behaviors between 2017 and 2022 following installation of countermeasures. Vulnerable user crossings were monitored for 14 days at the Blaze's Pit crossing and 12 days at the Stevens Road crossing (Table 8.1). Data analysis focused on Highway 61 crossings although some pedestrian traffic along Highway 61 also was noted. For each site, crossing zones for documenting patterns were defined. As in Phase 1, UMN undergraduate students viewed video recordings, coded total pedestrians, crossing events, group size, interactions with drivers, and pedestrian and driver yield rates. Crossing patterns by operators of off-road vehicles (ORVs) also were noted.

Phase 2 results for both sites are summarized in Table 8.2. The mean daily crossing volumes at each location were lower in 2022 than in 2017, despite the timing of the observations to include the days of the PowWow. At the Blaze's Pit crossing, the mean daily crossing volumes dropped 50%, from 14 users per day in 2017 to 7 users per day in 2022. At the Stevens Road location, the decline was smaller, from 11 users per day in 2017 to 9 users per day in 2022. While the mean number of crossings per day was higher at Blazes Pit than Stevens Road in 2017, the reverse was observed in 2022 (i.e., more pedestrian traffic at the Stevens Road crossing. At both locations, pedestrian traffic generally was higher on days of the PowWow, indicating that the observed decline in pedestrian and cyclist traffic on days without events may be somewhat greater.

Observed interactions between vulnerable users and drivers and yield rates also are summarized in Table 8.2. The percent of crossing events with interactions with drivers was higher at the Stevens Road intersection than at the Blaze's Pit crossing location. Pedestrians yielded to drivers in 100% of interactions.

Crossing events, interactions, and yield rates for ORVs are summarized in Table 8.3 ORVs were observed crossing Highway 61 at the Stevens Road location 27 times, three times as many as at the Blaze's Pit crossing. The percentage of crossings with interactions with drivers was 22% at Stevens Road and 11% at Blazes Pit. Operators of ORVs yielded to drivers in 83% of the interactions at Stevens Road; in the single interaction between an ORV and a driver at Blazes Pit, the operator of the ORV yielded.

Table 8.1 Grand Portage Reservation: Hwy 61 Pedestrian monitoring, August 2022					
Reservation City / Town	**Monitoring Location**	**Pedestrian Safety Concerns**	**# of Cameras**	**Date Cameras Deployed (number of cameras)**	**Total Complete Days**
Grand Portage	Blazes Pit Rd crosswalk with access stairs and ADA ramp	Vulnerable users crossing Hwy 61 from residential areas west of Hwy 61 to Trading Post, USPO, and casino on east (Lake Superior) side of Hwy 61	1	8.09.2022 – 8.23.2022 `	15
Grand Portage	Stevens Rd crosswalk	Vulnerable users crossing Hwy 61 from residential areas west of Hwy 61 to Grand Portage Tribal Offices and school on east (Lake Superior) side of Hwy 61)	1	8.10.2022 – 8.22.2022 (excluding 8.20.2022) `	12

Table 8.2 Grand Portage Reservation: Hwy 61 Vulnerable user crossing events, interactions, and yield rates						
Crossing Events and Yield Rates						
Site	Crossing Events	Crossing Events with Interactions	Percent Crossing Events with Interactions	Pedestrian Yield Rate	Driver Yield Rate	Pedestrian and Driver Yield Rate
Marina – HW 61 Crossing near Trading Post	93	15	16.1%	100%	0%	0%
Stevens - Hwy 61 Crossing at Stevens Rd	84	18	21.4%	100%	0%	0%

Table 8.3 Grand Portage Reservation: Hwy 61 ORV crossing events, interactions and yield rates						
ORV Crossing Events and Yield Rates*						
Site	Crossing Events	Crossing Events with Interactions	Percent Crossing Events with Interactions	ORV Yield Rate	Road Vehicle Yield Rate	ORV and Road Vehicle Yield Rate
Stevens - Hwy 61 Crossing at Stevens Rd	27	6	22.2%	83.3%	16.7%	0%
Marina – HW 61 Crossing near Trading Post	9	1	11.1%	100%	0%	0%
*ORVs recorded when not acting as a passenger vehicle and are using pedestrian and/or bicycle infrastructure						

Observations revealed that most pedestrians at the Blaze's Pit Road are using the crosswalk and access stairs and ramp as designed and that the countermeasures are successful in orienting behaviors (Table 8.4, Figures 8.1 and 8.2). Most pedestrians (83%) used the stairs from the Trading Post to access the crosswalk to Blazes Pit Road; 6% used the ADA accessible ramp, while 11% did not use the crosswalk and were observed crossing over guardrails or walking further along the road shoulder.

At Stevens Road, observations reveal that a plurality of users are using the new crosswalk but that patterns of use are diverse and reflect trajectories of pedestrians approaching the intersection (Figures 8.3 and 8.4). A minority of users cross diagonally across Highway 61 through the intersection.

Table 8.4 Grand Portage Reservation: Hwy 61 and Blazes's Pit Rd - use of crosswalk and pedestrian facilities				
Access to Crossing	Number of Pedestrians (n=126)	Percentage of Pedestrians	ORVs (n=12)	Percentage of ORVs
Stairs	96	83%	-	-
Ramp	7	6%	6	50%
Embankment	13	11%	6	50%

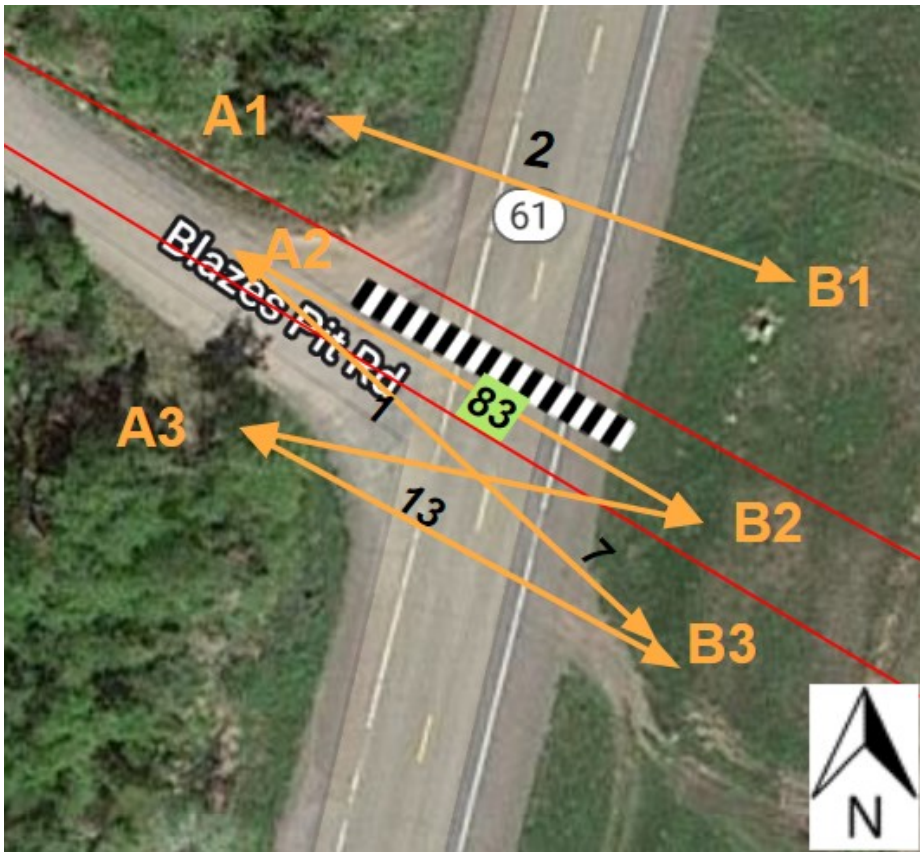


Figure 8.1 Grand Portage Reservation: Hwy 61 and Blazes Pit Rd crossing volumes and trajectories (plan view, 2022)

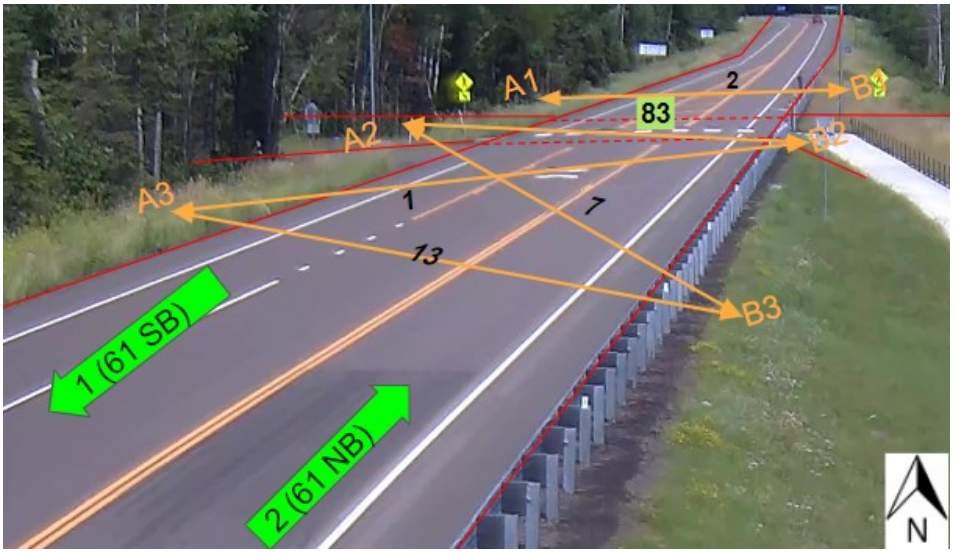


Figure 8.2 Grand Portage Reservation: Hwy 61 and Blazes Pit Rd crossing volumes and trajectories (camera view, 2022)

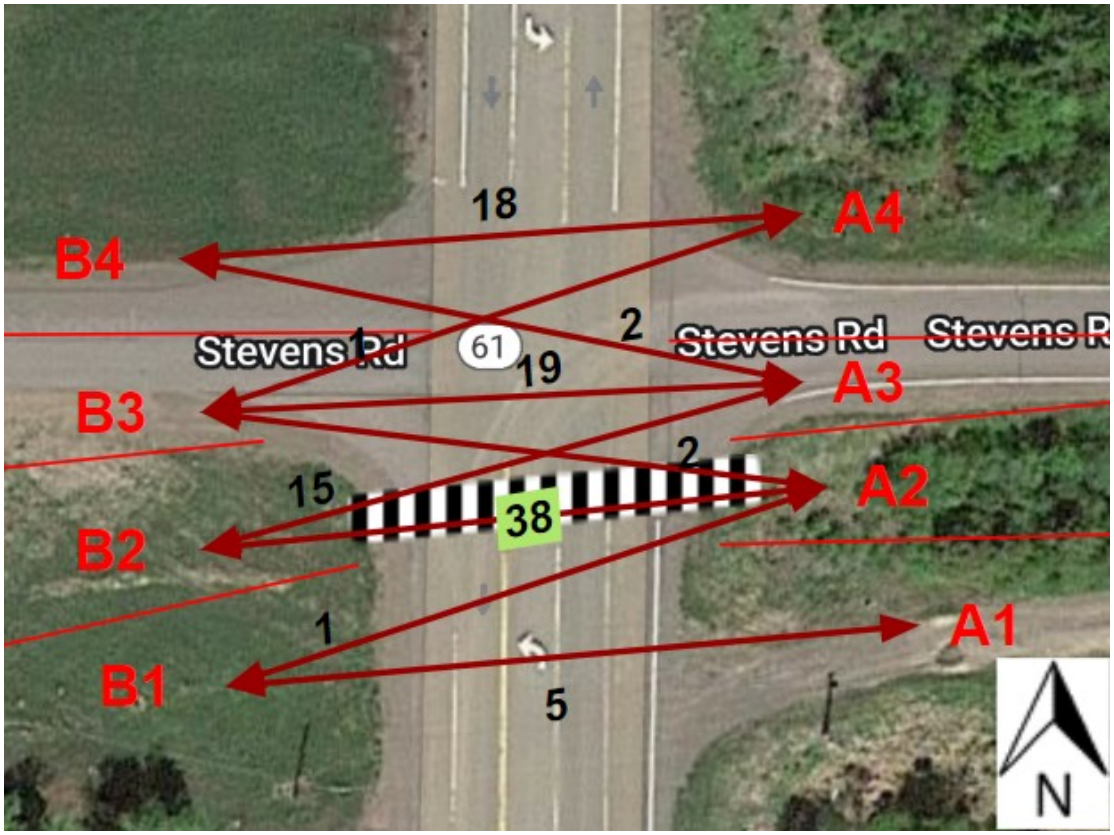


Figure 8.3 Grand Portage Reservation: Hwy 61 and Stevens Rd crossing volumes and trajectories (plan view, 2022)

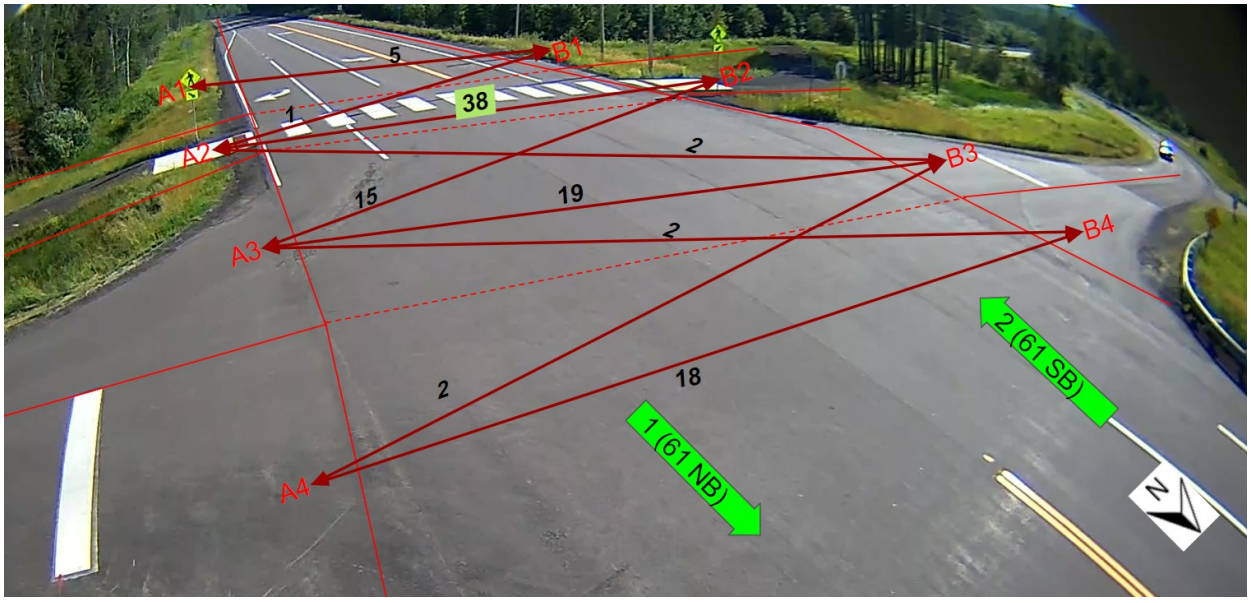


Figure 8.4 Grand Portage Reservation: Hwy 61 and Stevens Rd crossing volumes and trajectories (camera view, 2022)

8.1 Summary of Findings

Observations of vulnerable user crossings on the Grand Portage Reservation were motivated by risks to pedestrians posed by drivers of motor vehicles who may not anticipate crossings in this rural, remote area. Observations revealed that pedestrian traffic at both Blazes Pit and Stevens Road declined from 2017 to 2022. Reasons for this decline are not known. During discussions of results, a representative of the Band hypothesized this could be because of reduced traffic flows across the border into Canada during and immediately after the COVID pandemic.

The 2022 field observations confirmed that the new countermeasures, particularly the crosswalks, are being used. At the Blazes Pit Crossing, the majority of pedestrians is using the new facilities as designed, with substantially more using the stairs than the ADA accessible ramp to access the crosswalk from the parking lot near the Trading Post. The combination of stairs, ramp, crosswalk landing pad, and guardrails appear to be effective in directing most pedestrian traffic to the crosswalk.

A plurality of pedestrians is using the crosswalk as designed at the Stevens Rd crossing, but the crossing patterns are more dispersed. Pedestrians were observed yielding to drivers in most interactions observed in both the pre- and post-installation observation period. None of the interactions between vulnerable users involved close calls. While pedestrian behaviors appear more predictable, risk associated with unanticipated crossings remains, particularly with children or groups of children crossing to destinations near both intersections.

Chapter 9: Mille Lacs Reservation Monitoring Results

The Mille Lacs Band of Ojibwe participated in both the Phase 1 and Phase 2 projects. The focus of Phase 1 in 2017 was an informal crossing used by people to cross Hwy 169 when traveling to and from residential and other areas east of Hwy 169 to destinations west of the highway. Following Phase 1 monitoring, in response to the risks that were identified, the Mille Lacs Band obtained funding for pedestrian hybrid beacon (PHB). The Band and MnDOT completed installation of the HAWK in 2021. Phase 2 monitoring to assess use of the new HAWK signal was completed in 2021.

9.1 Phase 1 Monitoring Results

In Phase 1, the Band identified two crossing locations on Hwy 169 that subsequently were monitored (Lindsey et al. 2020). The first, which was the Band's main concern, was an informal, unmarked crossing about one-half mile north of the Grand Casino where pedestrians were crossing Hwy 169 through a break in a chain-link fence along a frontage road on the east side of the highway to access a large commercial and institutional area on the west side that includes a supermarket, a movie theater, a hotel, and the casino. The second was a signalized intersection about one-half mile to the south at the entrance to the Grand Casino. This location was monitored primarily to assess use relative to the informal crossing. The Band had long been concerned about risk to pedestrians at the informal crossing, had developed plans for alternatives to address risk (e.g., PHB and a pedestrian bridge), but had been unable to secure funding to implement any of the alternatives. Part of the rationale for monitoring crossings in 2017 was the need for evidence of the severity of risk to pedestrians and drivers at the site.

Phase 1 monitoring in 2017 showed 30 times more people crossing at the informal site than at the signalized crossing to the south (Lindsey et al. 2020, Figure 9.1). At the signalized crossing at the entrance to the casino, only 4 pedestrians per day were observed. During two different sampling periods at the informal crossing, averages of 136 (May) and 125 (July) vulnerable users crossed Highway 169 daily (Table 9.1). Forty-three percent and 54% of those crossing, respectively, interacted with drivers. Pedestrians yielded 93%-96% of the interactions, while drivers yielded 4%-7% of the time.

Tribal transportation managers used these results along with other historical evidence to seek funding for a specific type of pedestrian hybrid beacon known as a HAWK (High-Intensity Activated crosswalk) signal (Mille Lacs Band of Ojibwe 2018). Pedestrians can activate HAWK signals to stop traffic to facilitate safe crossings. The Band received Transportation Alternatives Program funding through MnDOT for the HAWK signal and installed it in 2020. At the time of installation, the Band also conducted outreach to residents of the reservation, including release of a You Tube video in which Band leaders illustrated how to use the HAWK signal to stop traffic and cross safely.

Figure 9.1 Mille Lacs Reservation: Hwy 169 pedestrian crossings at informal and signalized crossings (2017)

Table 9.1 Mille Lacs Reservation: Hwy 169 pedestrian crossings and interactions						
Monitoring Period	**Days of Counting**	**Total Vulnerable Users Observed**	**Average Vulnerable Users / Day**	**Maximum Vulnerable Users / Day**	**Crossing Events (full, both road directions)**	**Crossings with Driver Interactions**
Post-HAWK Installation (August 2021)	8.5	867	102	134	666	55%
Pre-HAWK Installation (May 2017)	20	2728	136	210	2728	43%
Pre- HAWK Installation (July 2018)	3	375	125	155	375*	54%
*crossing events = total pedestrians: crossing events not adjusted for groups						

9.2 Phase 2 Monitoring Results

Phase 2 monitoring to evaluate use of the HAWK signal and changes in risk to vulnerable users was completed in August 2021. Prior to monitoring, MnDOT convened a meeting to develop the evaluation plan with Tribal Transportation Managers, MnDOT personnel from both the District and the Central Office, and the UMN research team. The general research plan involved a pre-post design with the collection of several different measures:

- Pedestrian volumes and crossing events
- Crossing behaviors
- Activations of HAWK signal
- Interactions with drivers

- Yield rates (pedestrians and drivers)
- Driver behaviors (responses to HAWK signals)
- HAWK signal timing

Figure 9.2 is a picture of the new countermeasures on Highway 169, including the HAWK signal, the new crosswalk, and new landings and sidewalks both east and west sides of the highway. The letters (A, B, C) signify entry or waiting locations for the crossing and were used to code crossing events. Students viewed video recordings and then coded and summarized data to produce the measures in the evaluation plan.

Figure 9.2 Mille Lacs Reservation: HAWK signal on Hwy 169

An understanding of the HAWK operations, the timing of the signal, and the sources of risk during different phases of the signal is important to assessing changes in risk associated with the signal. Figure 9.3 is a graphic illustration of the operations of a HAWK signal. Pedestrians wishing to cross can push a button to activate the signal. Following activation, a flashing yellow warning light warns approaching drivers that a pedestrian will be crossing. The flashing yellow then turns to solid yellow, which is followed by a solid red light, and then a flashing red, known as the crossing countdown.

Pedestrians are supposed to wait until the red light is on before walking; drivers are supposed to stop during solid red. The timing is designed to permit pedestrians to complete the crossing to the median prior to the termination of the flashing red light. While the timing can be adjusted, engineering guidelines apply. As shown in Figure 9.3, a complete cycle of the signal requires about 50 seconds (this

estimate is based on video observation of the signal). The nature of risk associated with different pedestrian and driver behaviors varies with the signal phase.

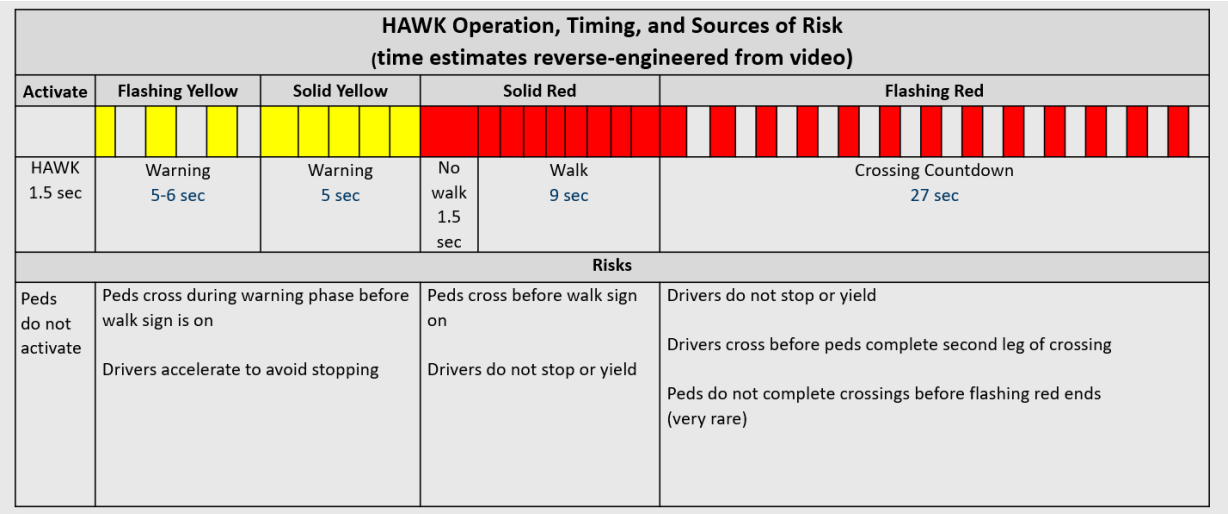


Figure 9.3 Mille Lacs Reservation: HAWK operation, timing, and sources of risk

The research team observed 666 crossing events in 2021 following installation of the HAWK signal (Table 9.2). Pedestrians activated the HAWK in 28% of the crossing events; they did not activate the signal in 72% of the crossing events. The rate of activation was higher – 37% – when pedestrians were crossing and interacting with drivers, but even during interactions with drivers, a majority (63%) of pedestrians did not activate the signal. Pedestrians also activated the HAWK both when interacting with drivers and when they did not interact with drivers. In total, pedestrians activated the HAWK 189 times (Table 9.2). approximately 70% of the activations occurred when pedestrians were interacting with drivers; 30% occurred when no vehicles were present. The rate of activation was similar for both eastbound and westbound crossings. Just over 98% of people crossing remained in the crosswalk for the entire crossing.

The mean number of seconds of waiting time to begin crossing for all crossing events was 6.5 seconds (Table 9.3). When pedestrians activated the signal, the mean waiting time was 12 seconds. The mean time it took individuals who activated the signal to complete the crossing was nearly 31 seconds; the mean crossing time for pedestrians who did not activate the signal was about 22 seconds.

Approximately 54% of those pedestrians (n=189) who activated the signal crossed before the walk sign was on (Table 9.4). The proportion of pedestrians who waited for the walk sign was higher for those interacting with vehicles (65%) than those who were not interacting with vehicles (2%; Table 9.4).

Table 9.2 Hwy 169: Pedestrian activation of HAWK signal					
Crossing Events	**Total**	**Activated HAWK**		**Did Not Activate HAWK**	
Both road directions (7 in median island)	666	189	28%	477	72%
West (Casino) to East	313	86	28%	227	72%
East (frontage road) to West	346	103	30%	243	70%
Crossing events with interactions	364	133	37%	231	63%
Crossing events with no interactions	302	56	19%	246	81%
Activations and Interactions	**Total**	**With Interactions**		**No Interactions**	
Total	189	133	70%	56	30%

Table 9.3 Hwy 169: Pedestrian waiting and crossing times with and without signal activation		
	Waiting Time to Begin Crossing (seconds)	
Crossings and Activation	Mean	Standard Deviation
All crossings, both directions (n=666)*	6.5	8.3
West (Casino) to East (n=333)	7.1	8.3
East (Frontage Rd) to West (n=349)	5.8	8.3
Activated HAWK (both directions; n=189)	12	8.3
Did Not Activate HAWK (both directions; n=477)	4.3	7.4
	Time to Complete Crossing (seconds)	
Activated HAWK (both directions; n=189)	30.8 sec	9.2 sec
Did Not Activate HAWK (both directions; n=477)	21.6 sec	12.7 sec
*7 pedestrians on median did not complete full crossings		

Table 9.4 Hwy 169 HAWK: Pedestrian behaviors: waiting for WALK sign following activation

Crossing Events		Activated HAWK 1.5 sec	Crossed before WALK sign on	
			Flashing Yellow Warning 5-6 sec	Solid Yellow Warning 5 Sec
Total	666	189 (28%)	103 (54%)	
With interactions	354	133 (37%)	47 (35%)	
Without interactions	302	56 (19%)	55 (98%)	

Pedestrians yielded to drivers in 76% of the crossing events from their origin to the island between the northbound and southbound travel lanes (Table 9.5). The percentage was lower (49%) when crossing from the islands to the destination. When the signal was activated, the pedestrian yield rate dropped to 58% and 14%, respectively, indicating that activation of the signal is associated with driver yielding. Conversely, when pedestrians did not activate the signals, pedestrian yielding rates increased to 86% from original to island and to 74% from island to destination. Driver yield rates decreased proportionately when pedestrians did not activate the signals during an interaction. Analysis of pedestrian group size during crossing events with interactions indicate that larger groups of pedestrians were more likely to activate the signal and that driver yield rates were higher with larger groups (Table 9.6).

Driver noncompliance rates following pedestrian activation of the HAWK signal are summarized in Table 9.7 for both the east and west side crossings. Because drivers can fail to comply in multiple ways during a single event, the total number of violations is larger than the number of activations. Of the 189 times pedestrians activated the signal, most drivers complied with the solid red light indicating they should stop: the rates were 89% of drivers on the west (southbound) side of Highway 169 and 88% on the east (northbound) side. Only 11% and 12%, respectively, were not in compliance with the solid red lights. Driver noncompliance rates were higher for the flashing red lights: 43% and 50%, respectively on the west and east sides.

Table 9.5 Hwy 169 HAWK: Pedestrian and driver yield rates when crossing with interactions												
	All Crossing Events with Interactions				**HAWK Activated**				**HAWK Not Activated**			
	Origin to Island		Island to Destination		Origin to Island		Island to Destination		Origin to Island		Island to Destination	
Yielding Behaviors	Events	%	Events	%	Events	%	Events	%	Events	%	Events	%
Half-crossings	218	100 %	224	100 %	77	100 %	93	100 %	141	100 %	131	100 %
Pedestrian yielded	166	76 %	110	49 %	45	58 %	13	14 %	121	86 %	97	74 %
Driver yielded	48	22 %	105	47 %	32	42 %	80	86 %	14	10 %	25	19 %
Both yielded	6	3%	9	4%	0	0%	0	0%	6	4%	9	7%

Table 9.6 Hwy 169 HAWK: Pedestrians per crossing event with and without activation												
	All Crossing Events with Interactions				**HAWK Activated**				**HAWK Not Activated**			
	Origin to Island		Island to Destination		Origin to Island		Island to Destination		Origin to Island		Island to Destination	
	Peds	Peds / Event	Peds	Peds / Event	Peds	Peds / Event	Peds	Peds / Event	Peds	Peds / Event	Peds	Peds / Event
Total half-crossings	308	1.4	307	1.4	136	1.8	153	1.6	172	1.2	154	1.2
Total pedestrians yielded	217	1.3	125	1.1	72	1.6	16	1.2	145	1.2	109	1.1
Total when driver yielded	81	1.7	168	1.6	64	2.0	137	1.7	17	1.2	31	1.2
Total when both yielded	10	1.7	14	1.6	0	NA	0	NA	10	1.7	14	1.6

Table 9.7 Hwy 169 HAWK: Driver noncompliance following HAWK activation								
Activations	**West Side (Casino) Origin (n=86)**				**East Side (frontage road) Origin) (n=103)**			
	Solid Red Violations	% of all Activations (n=189)	Flashing Red Violations*	% of all Activations (n=189)	Solid Red Violations	% of all Activations (n=189)	Flashing Red Violations*	% of all Activations (n=189)
Total events with violations	21	11%	81	43%	22	12%	94	50%
Turn lane (nearest)	7	4%	7	4%	16	8%	12	6%
Near lane (southbound right lane)	11	6%	17	9%	17	9%	18	10%
Far lane same side (southbound left lane)	12	6%	15	8%	0	0%	14	7%
Far lane opposite side (northbound left lane)	1	1%	10	5%	0	0%	24	13%
Farthest lane (northbound right lane)	1	1%	13	7%	0	0%	11	6%
*Driver passed ahead of pedestrian(s)								

9.2.1 Summary of Findings

Overall, the 2021 monitoring results indicate that both pedestrians and drivers have changed behaviors in response to installation of the HAWK signal. The volume of vulnerable users observed in 2021 was somewhat smaller than volumes observed previously – approximately 120 persons per day, compared to 125 to 136 in 2017. The mean group size per crossing event in 2021 was 1.3. The crossing volumes

were highest between 3:00 p.m. and 5:00 p.m. Pedestrians crossing Highway 169 had similar rates of interactions with vehicles in 2017 and 2021, about 55%.

The rates of activation of the HAWK signal were relatively low: pedestrians activated the signal for 28% of all crossings and 37% of crossings with interactions with drivers. The average waiting time for pedestrians to begin crossing following activation was 12 seconds; without activation the mean time was 4.3 seconds. Approximately 54% of pedestrians who activated the signal crossed before the WALK sign came on. This proportion dropped to 35% during crossings with interactions.

Finally, analyses show that activation reduces pedestrian yield rates and increases driver yielding. While pedestrians yielded 95% of the time when interacting with drivers in 2017, this percentage dropped to 78% in 2021 for the origin to island crossing events and to 49% for the island to destination events. The rates of pedestrian yielding were lower with signal activation (i.e., 58% from origin to island and 14% from island to destination). Analyses also show frequent driver violations of red lights, though some are technical violations and do not present risk because they occurred after pedestrians have passed by in front of vehicles. Driver noncompliance during solid red lights was approximately 20% and was higher during flashing red lights.

Following release of these results, MnDOT convened a meeting with the Mille Lacs Band, District Engineers, and the UMN to discuss options to address risks indicated by them. These options included the following:

- Engineering: Review and change signal timing, and plan and implement demonstration project(s) to see how lane narrowing or reduction affects all traffic through the area
- Education: Community outreach about use of HAWK
- Enforcement: Address violations of red lights
- Research: Assess changes in signal timing and effectiveness of outreach and enforcement.

Chapter 10: Observations and Conclusions

Between 2016 and 2024, MnDOT, ACTT, and the 7 federally recognized Anishinaabe Bands in Minnesota collaborated with the University of Minnesota and the Minnesota Traffic Observatory in two phases of a continuing project to produce evidence on pedestrian risks on reservations. In addition to the knowledge produced in each project about pedestrian behavior and crash risk on reservations, the outcomes of each phase have included new funding to implement countermeasures on six reservations, safety studies on the seventh reservation, and new collaborations that likely will lead to additional investments in safety countermeasures in the future. Phase 1 of the project (2016-2020) included observations of pedestrian crossings at 10 sites on four reservations that led to implementation of countermeasures on six locations on three reservations, plus safety studies on the fourth. In the final Phase 1 report, the project team drew five lessons for the future (Lindsey et al. 2020):

1. *Mission, vision, and policies matter.* As summarized in Chapter 2 of this report, MnDOT's vision, mission, policies related to equity, and plans related to pedestrian travel and safety constitute the institutional framework for these projects. MnDOT's "Government-to-Government" policy that calls for "consultation, coordination, and cooperation" with Minnesota's sovereign Tribal nations provided the foundation for both Phase 1 and Phase 2 activities that resulted in substantial resources to address pedestrian safety on Anishinaabe reservations. Without these institutional commitments and policies, it is doubtful that these Phase 1 and 2 projects would have been prioritized and funded.

2. *Evidence is essential.* The principal objectives of both Phases 1 and 2 were to document pedestrian crossing behaviors on state and local highways on the seven reservations. Project partners were unanimous that subsequent investments in countermeasures to reduce pedestrian risks would not have been made without the evidence produced by these field studies. This evidence — pedestrian volumes, pedestrian-driver interactions and yield rates, and pictures of vulnerable users interacting with drivers — directly informed the funding and design of new countermeasures.

3. *Risks are relative, but real.* Following collection and analysis of pedestrian crossing volumes, project partners acknowledged the numbers of pedestrians crossing roadways on reservations was small relative to crossing volumes frequently measured on urban roadways, but project partners also agreed the risks were real and potentially life-threatening to those individuals experiencing them. For example, all partners readily agreed that drivers on trunk highways did not expect to see youth crossing high-speed highways in remote, wooded rural areas where no homes were visible. With policies like Vision Zero — the goal of which is to eliminate deaths from crashes — it is incumbent on MnDOT to take actions to reduce crashes and deaths regardless of roadway and vulnerable road user volumes.

4. *Equity, as well as efficiency, is important*. MnDOT has acknowledged its "*decisions* have *underserved, excluded, harmed, and overburdened"* Tribal communities and that equity *"requires ensuring underserved communities, especially Black, Indigenous and People of Color, share in the power of decision making."* Within this policy framework, it is important that equity, in addition to utilitarian metrics like the benefit-cost criterion of net present benefits, be used in project evaluation. Use of equity as a decision criterion can begin to redress disparities in access to transportation resources that stem from historical equities.

5. *Engagement of collaborators is critical.* As noted in Chapter 2, MnDOT's Tribal relation policies call for "consultation, coordination, and cooperation" with the sovereign Tribes recognized in Minnesota (MnDOT AD005). MnDOT's approach in both Phase 1 and Phase 2 epitomized the spirit of these policies. MnDOT asked ACTT for collaborators; asked Tribal transportation managers where risk was of most concern; asked Tribal leaders if the UMN could monitor pedestrian crossing patterns and approve monitoring designs; asked Tribal partners to participate in data interpretation; asked collaborators about preferred countermeasures to reduce risk; and supported Tribal partners in efforts to fund countermeasures. Project partners agreed countermeasures would not have been implemented without this degree of collaboration.

Each of these lessons was applied in Phase 2 when the Leech Lake Band, Red Lake Nation, and White Earth Nation joined the partnership and new investigations were undertaken. Their relevance and validity was demonstrated again when countermeasures at Phase 2 sites were implemented during the project. But beyond replication of Phase 1 activities, Phase 2 also included evaluation of countermeasures implemented in response to Phase 1 monitoring at six locations. These new evaluations also have led to lessons important for achieving Vision Zero and other policy objectives.

6. *Engineer with people, not for them*. Post-implementation monitoring at six Phase 1 sites confirmed that countermeasures change pedestrian and driver behaviors and that not all pedestrians or drivers use countermeasures as designed. For example, on the Mille Lacs reservation, only 37% of pedestrians actuated the HAWK signal when beginning to cross Hwy 169 and interacting with vehicles; 63% crossed without actuating the signal. Among pedestrians who actuated the signal, many walked before the walk sign was on. Many drivers also did not remain stopped for the duration of the HAWK's red lights. In Grand Portage, while a new guardrail was successful in orienting pedestrians to a new crosswalk at a previously unmarked, informal crossing on Hwy 61, some people nevertheless walked along the highway, hopped over the guardrail, and did not use the crosswalk. In Fond du Lac, many people crossed mid-block, proceeding across University Road from a parking lot driveway rather than use a crosswalk with an RRFB immediately to the north, possibly because there was no sidewalk to the crosswalk landing pad. The point of these examples is that people choose whether and how to use

countermeasures ostensibly designed to protect them, whether or not their behaviors are those intended and expected by the designers. Consultation with potential users may increase use of facilities as designed.

7. *Subjective, value-based judgments are inevitable and should be acknowledged.* Engineers are trained and work hard to achieve objectivity and eliminate subjective bias from analyses and project-related decisions. The commitment to objectivity is grounded in commitments to fairness, equity, and quality control. The systematic approach to prioritizing investments in countermeasures to reduce crash risk, for example, epitomizes this approach. In the systematic approach, analysts analyze historical crashes, identify and assess factors that have contributed to crashes, and estimate safety performance functions to estimate crash risk indices or other measures to inform decisions such as allocation resources. In other objective approaches, signal warrants are used to prioritize sites for investigation for traffic signals such as pedestrian actuated beacons. In Phases 1 and 2, however, these types of quantitative ranking procedures were not used to select study sites. Instead, Tribes used knowledge and experience informed through interactions with Tribal members to choose sites. Similarly, rather than evaluating alternative potential countermeasures using methods like benefit-cost analysis, project engineers used professional judgment to determine whether countermeasures could be incorporated into existing project budgets, thereby avoiding the need for additional technical analyses. These examples of the use of professional judgment to further a public agency's mission and priorities are not anomalies; professional judgment is central to practices of policy-making and engineering, particularly in situations where value-based objectives such as remedying historical disparities are relevant. Recognizing and being transparent about the role of professional judgment in reducing crash risk and increasing pedestrian safety is essential to address equity, safety, and other objectives.

8. *Risks can be reduced but not eliminated*. The Phase 1 and 2 evaluations of countermeasures confirm not only that implementation of countermeasures may change risk factors and reduce risks, but also that risks cannot be eliminated and will remain after countermeasures have been implemented. Continuous, collaborative efforts among Tribal, state, and local transportation planners and engineers are essential to reducing crash risk and increasing pedestrian safety over the long term.

References

Grossman, D. C., Sugarman, J. R., Fox, C., & Moran, J. (1997). Motor-Vehicle Crash-Injury Risk Factors Among American Indians. *Accident Analysis and Prevention*, *29*(3), 313–319.

Hilton, J. (2006). *Race and Ethnicity: Factors in Fatal Motor Vehicle Traffic Crashes 1999–2004* (Report DOT HS 809 956). Washington, DC: NHTSA, U.S. Department of Transportation.

Iragavarapu, V., Carlson, P., & Schertz, G. (2015). Review of Tribal Transportation Safety. *Transportation Research Record*, *2531*(1), 153–160.

Kozak, J., & White, M. E. (2003). Building on Common Desire for Better Tribal–State Governmental Relationships: 2002 Four Corners Institute for Tribal-State Relations. *Transportation Research Record*, *1848*(1), 114–117. doi.org/10.3141/1848-16

LaValley, J., Crandall, C. S. Sklar, D. P., & Banks, L. (2004). *Pedestrian Safety in Indian Country* (FHWA-SA-04-007 2). Washington, DC: Federal Highway Administration, Office of Safety Research. https://www.pedbikeinfo.org/cms/downloads/Ped_Safety_in_Native_America.pdf

Lindsey, G., Hourdos, J., Dirks, P., Duhn, M., Qi, Y., Singer-Berk, L., & Petesch, M. (2020). *Pedestrian Safety on Four Anishinaabe Reservations in Minnesota* (MN 2020-29). St. Paul: Minnesota Dept. of Transportation. http://mndot.gov/research/reports/2020/202029.pdf

Martinez, R. M., Migliaccio, G. C., Albert, D., & Holley, T. (2009). Review of Strategies for Enabling Collaboration between Transportation Agencies and Native American Tribes. *Transportation Research Record*, *2119*(1), 113–119. doi.org/10.3141/2119-14

Mickleson, R., & Corbett, E. (2007). *Building Tribal Traffic Safety Capacity* (SPR 592). InterTribal Council of Arizona, Inc. Washington, DC: FHWA, U.S. Department of Transportation. Retrieved from https://apps.azdot.gov/ADOTLibrary/publications/project_reports/PDF/AZ592.pdf

Mille Lacs Band of Ojibwe. (2018). *HAWK Pedestrian Crossing Project* (Greater Minnesota Transportation Alternatives Application 2017-2018). Submitted to Minnesota Department of Transportation, Transportation Alternatives Program, St. Paul, MN.

MN.gov/EO-13-10. (2013). Affirming the Government-to-Government Relationship Between the State of Minnesota and the Minnesota Tribal Nations: Providing for Consultation, Coordination, and Cooperation.

MN.gov/EO-19-24; Rescinding Executive Order 13-10. (2019). Affirming the Government-to-Government Relationship Between the State of Minnesota and the Minnesota Tribal Nations: Providing for Consultation, Coordination, and Cooperation.

MnDOT Policy AD005. (n.d.) Minnesota Tribal Nations Government-to-Government Relationship with MnDOT. Retrieved from https://www.dot.state.mn.us/policy/admin/ad005.html.

Minn Stat. 10-65. (2021). Government-to-Government Relationship with Tribal Governments.

MnDOT. (2024a). About MnDOT. Retrieved from https://www.dot.state.mn.us/about/strategic-plan.html

MnDOT. (2024b). Family of Plans. Minnesota GO 50-Year Vision for Transportation. Retrieved from https://www.dot.state.mn.us/minnesotago/vision.html

MnDOT. (2024c). Advancing Transportation Equity Initiative. Retrieved from https://www.dot.state.mn.us/planning/program/advancing-transportation-equity/

MnDOT & Minnesota Dept. of Health. (2017). Minnesota Walks. Retrieved from http://www.dot.state.mn.us/peds/documents/planning-research/minnesota-walks-2017-final.pdf

Nazneen, S., Terrill, T. L., & Ksaibati, K. (2018). Developing a Toolkit to Improve Transportation Safety on Indian Reservations. *Transportation Research Record*, *2672*(7), 69–81. doi.org/10.1177/0361198118791863

Quick, K. S., Larsen, A., & Narváez Guillermo, E. (2019). Tribal Transportation Specialists' Priorities for Reservation Roadway Safety: Results of a National Survey. *Transportation Research Record*, *2673(7),* 652–661. doi.org/10.1177/0361198119844979

Shinstine, D. S., & Ksaibati, K. (2013). Indian Reservation Safety Improvement Program: A Methodology and Case Study. *Transportation Research Record*, *2364*(1), 80–89. doi.org/10.3141/2364-10

Shinstine, D. S., Ksaibati, K., & Gross, F. (2015). Strategic Safety Management Plan for Wind River Indian Reservation. *Transportation Research Record*, *2472*(1), 75–82. doi.org/10.3141/2472-09

Shinstine, D. S., & Ksaibati, K. (2015). Road Safety Improvement Program on Indian Reservations in North Dakota and South Dakota. *Transportation Research Record, 2531,* 146–152. doi.org/10.3141/2531-17

Subramanian, R. (2005). *Motor Vehicle Traffic Crashes as a Leading Cause of Death in the United States, 2002: A Demographic Perspective* (Report DOT HS 809 843). Washington, DC: NHTSA, U.S. Department of Transportation.

Terrill, T. L., & Ksaibati, K. (2018). Developing a Toolkit to Improve Transportation Safety on Indian Reservations. *Transportation Research Record*, *2672*(7), 69–81. doi.org/10.1177/0361198118791863

Wemple, E., & Colling, T. (2014). Improving Safety on Rural Local and Tribal Roads-Safety Toolkit. Washington, DC: U.S. Department of Transportation, Federal Highway Administration. Retrieved from https://safety.fhwa.dot.gov/local_rural/training/fhwasa14072/isrltrst.pdf

West, B. A., & Naumann, R. B. (2011). Motor Vehicle-Related Deaths—United States, 2003–2007. *Morbidity and Mortality Weekly Report, Supplement 60*, 52–55. Retrieved from http://www.cdc.gov/mmwr/pdf/other/su6001.pdf