Reducing Traffic Collisions on South Gammon Road

Turner Entenmann

December 2020

1 Introduction

The objective of this report is to reduce the number of traffic related deaths, injures and collisions in the city. To do so I have analyzed a data set of all traffic collisions since 1994 and made suggestions that can be implemented quickly, easily and economically. These suggestions are tailored specifically to South Gammon Road[1] and three of its intersections with the hope that if the changes have an appreciable positive impact, studies and changes in the same vein can be carried out for other sections of our streets.

This report will focus on a few key questions about traffic collisions in Madison. These questions and their answers will help us understand what actions we can take to reduce traffic fatalities, injuries and collisions in our city. Across the city, are there certain times of day or year when collisions are more likely to result in injury or death (Section 2)? If so, what can be done to change this? In general, does reducing drunk driving related collisions have an appreciable effect on the total number of traffic collisions (Section 3.1)? On what road should changes be made first (Section 4)? Which intersections of South Gammon Road are preforming well, which are in need of change, and what changes should be made (Sections 5 and 6)?

Students in previous semesters have done great work to develop a general understanding of when and how collisions happen in Madison. However, many of their suggested changes were reflective of their scope and difficult to implement and evaluate. This report will build on their work and provide a deeper understanding of a narrower slice of the problem.

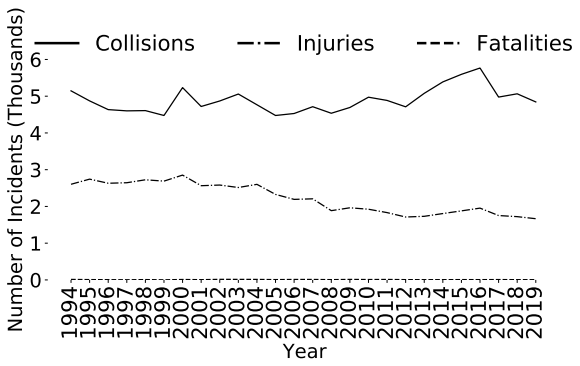

Figure 1: Crashes per Year Chronologically

2 Overview of Traffic Collisions in Madison

2.1 Year to Year Patterns

Since data became available in 1994 there have been over 127,000 recorded traffic collisions in Madison including 57,703 injuries and 254 fatalities. Figure 1 shows the total number of traffic collisions, injuries and fatalities per year since 1994 (2020 is omitted because the data is only complete up to August of that year). We can see that the number of collisions varies between 4,475 and 5,767 per year without a significant trend upwards or downwards over the time period. On the other hand, injuries show a clear downwards trend since 2000 from 2,853 to 1,666. This is most likely the result of improving car safety which while welcome, is outside city control. Fatalities are so infrequent[2] compared to collisions and injuries that no meaningful trend can be observed.

Because the number of collisions is independent of year, it is not prudent to look at previous year-year changes in the city's roads and policies to find ways to decrease the number of collisions in the future. Similarly there are no drastic year-year changes in the trend in the number of injuries so looking to the

[1] For the purposes of this paper, McKinney Boulevard is part of and referred to as South Gammon Road.

[2] Less than 0.2 percent of all collisions result in a fatality.

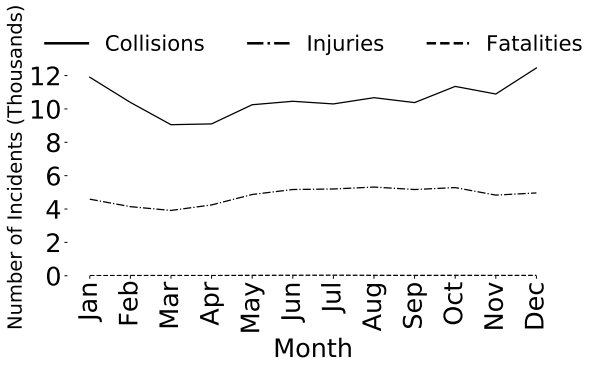

Figure 2: Crashes per Month Chronologically

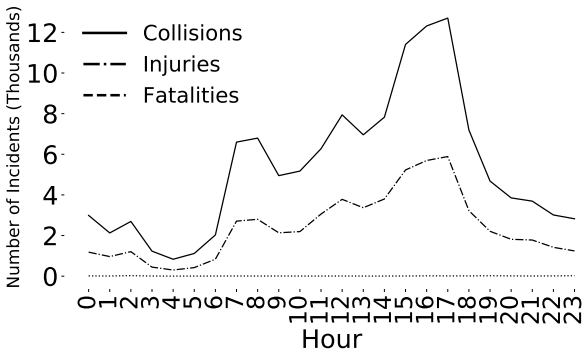

Figure 3: Crashes, Injuries, Fatalities and Injury Rate Chronologically

past to find solutions for the future is unlikely to yield results.

2.2 Month to Month Patterns

Figure 2 shows the total number of collisions, injuries and fatalities per month since 1994. We can see that collisions increase moderately during the winter months but injuries decrease slightly. Fatalities are again, so infrequent that no discernable pattern can be found.

The differences between the number of collisions during the winter and the number of collisions during the summer implies that something about the roads makes them safer during the summer. Snow and freezing rain are most likely the cause of the increased frequency of collisions during the winter. However the fact that the number of injuries decreases during this time implies that these collisions are less dangerous than those during the summer. Therefore improving snow plowing and salting is not an efficient solution to reducing the number of dangerous collisions which result in injuries and deaths.

2.3 Hour to Hour Patterns

Figure 3 shows the total number of collisions, injuries and deaths by hour since 1994. Unsurprisingly there are peaks during the morning and afternoon rush hours and a clear difference between day and night. However, the number of injuries per crash changes very little across the day.[3]

The fact that the injury rate is near constant combined with the fact that the number of collisions follow normal traffic patterns implies that drivers do not

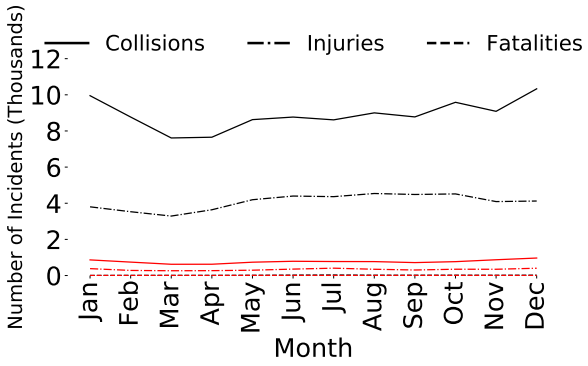

Figure 4: Collisions, Injuries and Fatalities For Intersections (Black) and Non-Intersections (Red) by Month

have problems seeing and avoiding pedestrians during the night[4] so the city's daily streetlight schedule and placement are working as intended and do not need altering.

2.4 Intersection Patterns

Comparing Figure 4 to Figure 2 we can see that the vast majority of traffic collisions, injuries and fatalities occur at intersections rather than on non-intersection sections of roads. This pattern is retained when comparing Figures 3 and 5. This is not surprising because intersections have vehicles crossing the paths of others and require drivers to interact and coordinate with others.

Clearly, intersections are where most collisions and injuries occur. Therefore intersections should be the focus of programs seeking to reduce traffic collisions and injuries.

[3]The maximum injury rate is 49 percent occurring at 11:00 AM while the minimum injury rate is 36 percent occurring at 3:00 AM and the standard deviation is 0.04.

[4]Detao et al.[2] show that pedestrians are at significant risk of injury during a collision

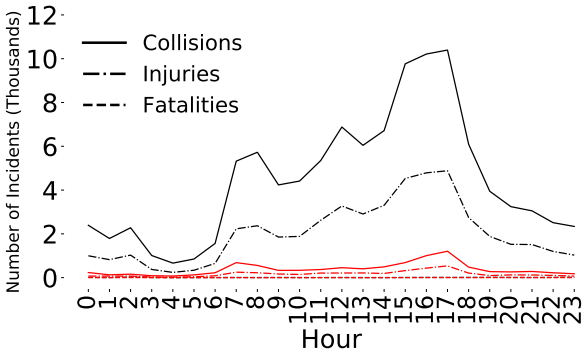

Figure 5: Collisions, Injuries and Fatalities For Intersections (Black) and Non-Intersections (Red) by Hour

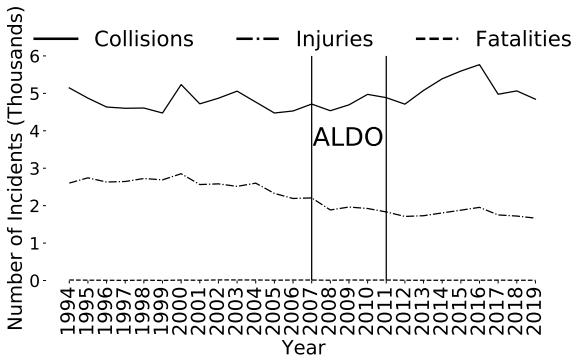

Figure 6: Crashes per Year Chronologically Annotated

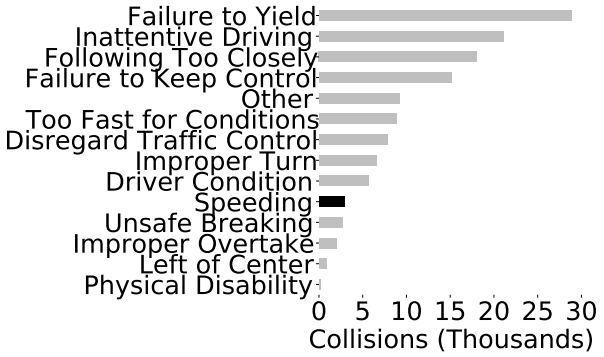

Figure 7: Number of Collisions Caused by Tracked Driver Factors (Shading to Highlight Those Caused by Speeding)

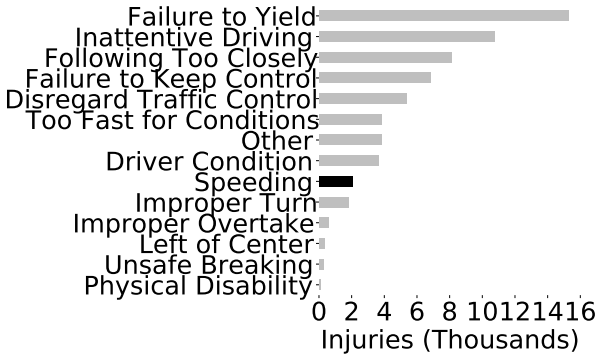

Figure 8: Number of Injuries Caused by Tracked Driver Factors (Shading to Highlight Those Caused by Speeding)

3 Analyzing Related Work

3.1 Traffic Collisions, Drunk Driving and ALDO

A previous analysis of collision data[1] suggested reimplementing ALDO[5] or a similar ordinance to reduce the number of traffic collisions. The reasoning was that collisions involving drunk drivers were less frequent during and after ALDO was in effect. However, Figure 6 shows that the total number of collisions actually increased over the time that ALDO was in place. Injuries have been trending downwards across the entire time that data is available and no significant change to this trend occurs during nor after ALDO was in effect. Either collisions that would have involved a drunk driver were replaced by collisions without drunk drivers during the time ALDO was in effect or the number of drunk driver related collisions is so small that any change caused by ALDO is irrelevant compared to normal year-year variation. In either case, reducing traffic collisions and injuries by targeting drunk driving is not an efficient method. Traffic related deaths are so infrequent relative to collisions and injuries that no meaningful conclusions can be made about the impact on fatalities by ALDO.

3.2 Traffic Collisions and Speeding

Another analysis[2] of collision data found speeding to be a cause of many collisions and so suggested an increase of speed cameras and harsher punishments for speeders. Figures 7, 8 and 9 show that although the plurality of fatal collisions involve speeders, it is far from the only cause. In addition, other factors including 'Failure to Yield'[6] contribute to many more collisions and injury-causing collisions than speeding. Therefore, while speeding should be an aspect of

[5]The ALDO ordinance reduced the number of new liquor licences given to businesses downtown and was in effect from 2007-2011.

[6]See Section 5 for details.

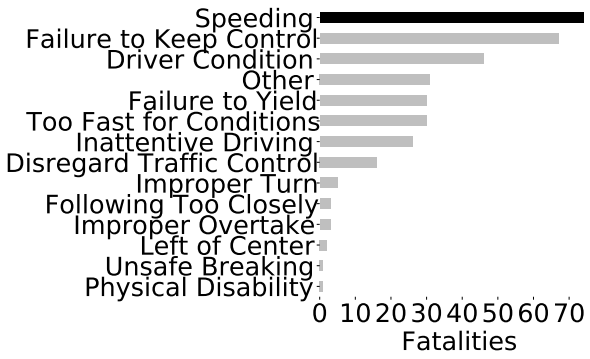

Figure 9: Number of Fatalities Caused by Tracked Driver Factors (Shading to Highlight Those Caused by Speeding)

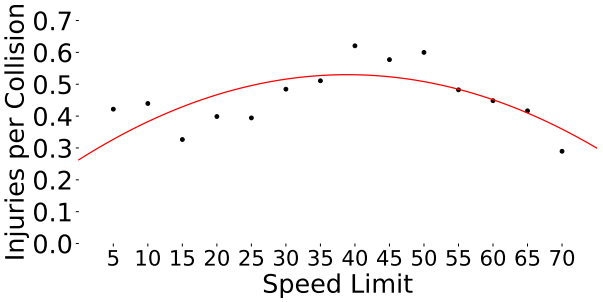

Figure 10: Injuries per Collision as a Function of the Posted Speed Limit

plans to reduce traffic fatalities, injuries and collisions it must not be the only component.

On December 7, 2020 the speed limit was reduced from 35 mph to 30 mph as a part of Madison's Vision Zero initiative. The reason behind this change is that a lower speed limit will result in fewer fatalities, injuries and collisions. Figure 10 shows a curious[7] relationship between the speed limit and how often injuries occur as a result of a collision and is a promising area of future study. However, based on the injury rate on roads with speed limits of 35 mph and 30 mph and the average number of collisions on South Gammon Road this change will prevent around four injuries per year. From the fatality rate of 35 mph and 30 mph roads in Figure 11 and the average number of collisions on South Gammon Road, this change will prevent much fewer than one fatality per year.[8]

[7]I expected injuries to increase strictly with the speed limit not peak in the middle of the speed limit range.

[8]This is because there have been so few fatalities on South Gammon Road to begin with.

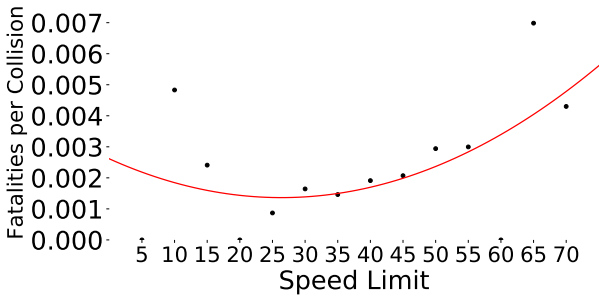

Figure 11: Fatalities per Collision as a Function of the Posted Speed Limit

3.3 Traffic Collisions, Winter and Salt

Detao Yu et al.[2] found that traffic collisions were more frequent during the winter months and suggested increased salting of the roads. Indeed, Figure 2 shows that there are more collisions during the snowy months of December through March and in theory it is possible to increase salting and plowing to the extent that snow becomes a non-issue on Madison's roads. However, the city currently spends well over six million dollars per year on salting and snow plowing and Section 2.2 shows that targeting collisions in winter is not an efficient method of preventing dangerous collisions so an increase in snow removal efforts is unlikely to have a significant effect on traffic fatalities, injuries and collisions.

4 South Gammon Road

4.1 Overview of South Gammon and its Intersections

South Gammon Road runs north to south from Colony Drive to Raymond Road on Madison's Westside. It connects a handful of residential neighborhoods to Elver Park, Madison Memorial High School, Jefferson Middle School, the Beltline, West Towne Mall and to other commercial areas. The road is mostly four lanes (two each way), widening to six near the Beltline. The speed limit was 35 mph during the time the data was collected but was reduced to 30 mph on December 7, 2020 as a part of the Vision Zero initiative.

4.2 Why To Prioritize South Gammon Road

Focusing on a single road in Madison allows for a more detailed analysis than addressing the city as a whole. Figure 12 shows that South Gammon Road

Figure 12: Total Collisions, Injuries and Fatalities for Madison's Seven Most Dangerous Roads

is the fifth-most dangerous road in Madison behind East Washington Avenue, Mineral Point Road, University Avenue and South Park Street. However, all of these roads are at least in part highways whereas no part of South Gammon Road is, and each of the others is much longer than South Gammon Road. Therefore, due to the nature of South Gammon Road and the frequency of collisions on the road, it is an ideal target for study and change. There have been 3839 total collisions on South Gammon Rd since 1994, these have resulted in 1842 total injuries and two deaths. This accounts for about 3 percent of total collisions and injuries and one percent of total traffic deaths in the city since 1994.

5 South Gammon Intersections

The Mineral Point Road, Watts Road and Odana Road intersections of South Gammon Road are very close to each other geographically and service comparable traffic loads but differ in safety. 'Failure to Yield' and 'Following too Closely' are the two most common causes of collisions on intersections of South Gammon Road. 'Following too Closely' is largely up to the driver and is very difficult to design and legislate against. 'Failure to Yield' is often the result of drivers not following proper right of way or behaving in a predictable manner in intersections. Therefore, traffic engineers have much more control over this type of collision especially relative to those caused by 'Following too Closely'. Interestingly, the rates of collisions caused by 'Failing to Yield' are not uniform across all of the intersections. Specifically the Watts Road and Mineral Point Road intersections have many more collisions caused by 'Failing to Yield' than the Odana Road Intersection. However, the number of collisions caused by other driver factors are relatively similar across the three intersections. This implies that the Odana Road intersection is designed in a way that is safer for drivers but the Mineral Point Road and Watts Road intersections are not.

5.1 Watts Road

The intersection of South Gammon Road and Watts Road is just south of the Beltline and connects a residential neighborhood to its south-west to the highway and a number of commercial buildings. Since 1994 there have been 662 total collisions at this intersection and 304 injuries. This accounts for over 19 percent of total collisions on South Gammon Road and over 18 percent of the total injuries.

5.2 Mineral Point Road

The intersection of South Gammon Road and Mineral Point Road is north of the Beltline and connects Memorial High School to its northeast to the highway and a number of commercial buildings. Since 1994 there have been 496 total collisions and 253 total injuries. This accounts for over 14 percent of the total collisions on South Gammon Road and over 15 percent of the total injuries.

5.3 Odana Road

The intersection of South Gammon Road and Odana Road is just north of the Beltline and just south of the Mineral Point Road intersection. It serves to connect Beltline traffic to the West Towne Mall and the neighborhoods to the north including Jefferson Middle School and Memorial High School. Since 1994 there have been 405 total collisions, and 196 total injuries. This accounts for over 11 percent of both total collisions and injuries.

6 How to Fix Problem Intersections

6.1 Fixing the Watts Road Intersection

The South Gammon Road / Watts Road intersection is very comparable to that of South Gammon Road and Odana Road because of location, traffic flow and layout. However the lanes heading into the Odana Road intersection are distinct in their purpose while those heading into Watts Road are multipurpose. Making those lanes single purpose will increase predictability for drivers in the intersection which in turn will make right of way easier to calculate and

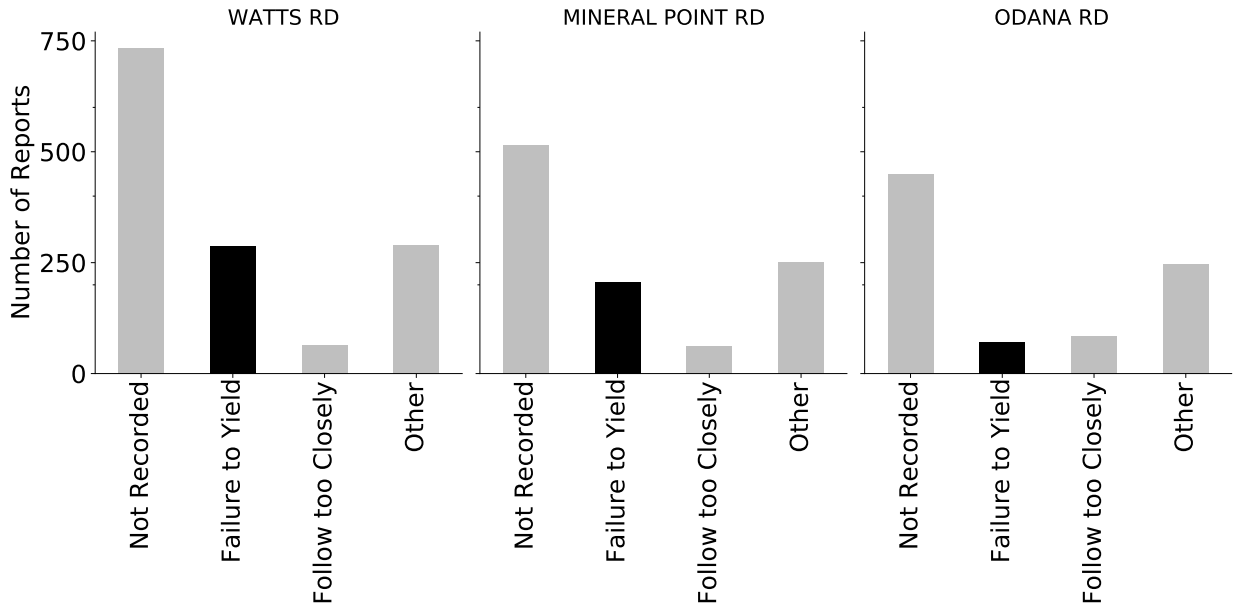

Figure 13: Contributing Factors to Collisions on the Intersections of South Gammon Road and Watts Road, Mineral Point Road and Odana Road ('Failure to Yield' Highlighted)

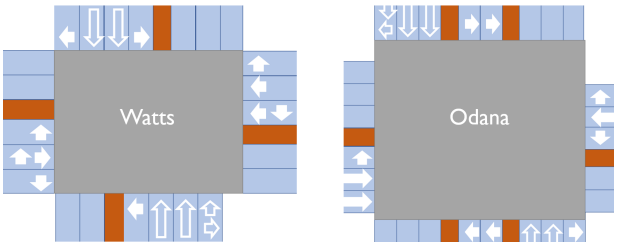

Figure 14: Intersection of South Gammon Road (vertical) and Watts Road (horizontal) Compared to that of South Gammon Road and Odana Road. Traffic Lanes in Light Blue, Medians in Orange, Shaded Arrows Indicate Explicit Traffic Instructions, Outlined Arrows Indicate Implied Traffic Instructions

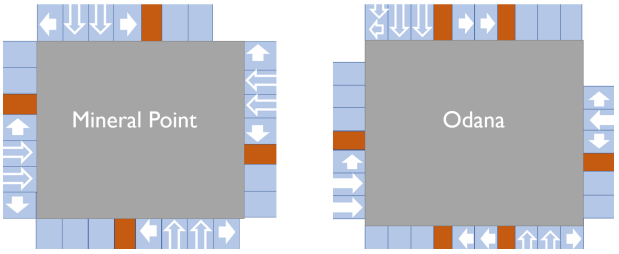

Figure 15: Intersection of South Gammon Road (vertical) and Mineral Point Road (horizontal) Compared to that of South Gammon Road and Odana Road. Traffic Lanes in Light Blue, Medians in Orange, Shaded Arrows Indicate Explicit Traffic Instructions, Outlined Arrows Indicate Implied Traffic Instructions

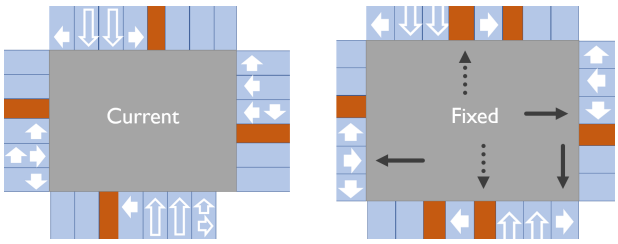

Figure 16: Proposed Changes to the Watts Road Intersection.

hence reduce 'Failure to Yield' collisions. If time and budget allow, rebuilding the intersection to include multiple left turn lanes separated by a median will make the intersection even safer. The left turn lane layout of the Odana Road intersection allows it to have dedicated left turn light cycles which greatly decreases the number of times a left turning vehicle crosses oncoming traffic.If the South Gammon Road / Watts Road performed as well as the South Gammon Road / Odana Road intersection, there would have been 215 fewer collisions and 108 fewer injuries since 1994. This translates to about 8 fewer collisions per year and about 4 fewer injuries per year. Figure 16 highlights the proposed changes.

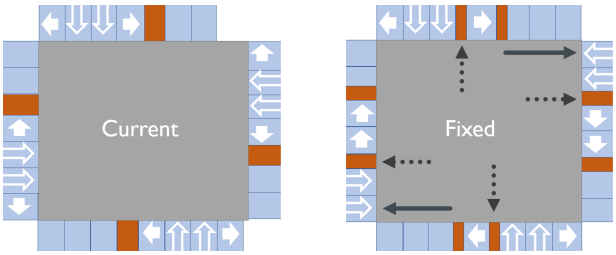

Figure 17: Proposed Changes to the Mineral Point Road Intersection

6.2 Fixing the Mineral Point Road Intersection

The South Gammon Road / Mineral Point Road intersection is very similar in terms of traffic load and location to that of the South Gammon Road / Watts Road intersection so many of the conclusions and suggestions made above apply here as well. An inexpensive, easy and quick change is to label each lane and add intra-intersection markings like those in the Odana Rd intersection. If this does not have the desired effect, separating the left turn lanes from the straight lanes with a median similar to how the lanes are separated in the Odana Road intersection is another, more invasive solution. Finally, when making a right turn at a red light, many drivers turn into the center lane which should be exclusive to vehicles traveling straight through the intersection. Drivers are supposed to fill the nearest lane when making such a turn but this requires a much sharper turn than filling the middle lane, which for any number of reasons is enough prevent drivers from following proper procedure. Moving the right turn lane outside of the intersection similar to the south side of the Odana Road intersection and making it a merging lane prevents this problem as drivers are much more aware of which lane to join and reduces confusion over right of way. If the South Gammon Road / Mineral Point Road performed as well as the South Gammon Road / Odana Road intersection, there would have been 135 fewer collisions and 57 fewer injuries since 1994. This translates to about five fewer collisions per year and about two fewer injuries per year. Figure 17 highlights the proposed changes.

7 Evaluating Changes

It is worth noting that the Mineral Point Road intersection has the single use lanes that are suggested for the Watts Road intersection. This is reflected in Figure 13 as the Mineral Point Road intersection has 80 fewer 'Failure to Yield' collisions than the Watts Road intersection. This translates to about a five percent reduction or three fewer collisions per year, which while not monumental is a measurable improvement and as the change is so simple, is easily achievable. If such a change were to happen to the intersection and collisions did drop the predicted amount it would prove the effectiveness of this method and similar changes could take place across the city. Figure 18 shows the predicted number of injuries prevented with a five percent reduction across South Gammon Road.

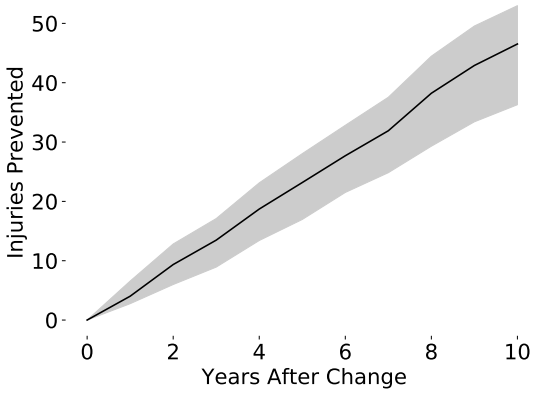

Figure 18: Injuries Prevented with a 5 Percent Reduction of Collisions on South Gammon Road (5th to 95th Percentile Shaded, Median Highlighted)

8 Conclusion

Revisiting the questions asked in Section 1: are there certain times of day or year when collisions are more likely to result in injury or death? If so what can be done to change this? By analyzing the relationship between collisions and time in Figures 1 I found that while collisions have remained somewhat constant from year to year, the number of injuries has seen a steady decline since 2000. This implies that previous traffic safety programs have not been as effective as desired. Figure 2 shows that while collisions do increase in winter, injuries do not, so further investment into snow removal is not an effective method of reducing dangerous collisions. Figure 3 shows that while the number of collisions does vary from hour to hour following predictable traffic patterns, the rate of injury-causing collisions does not. Therefore collisions during the night are not inherently more dangerous than during the day so the city's streetlight

system is working as desired.

Does reducing drunk driving related collisions have an appreciable effect on the total number of traffic collisions? Although ALDO did reduce collisions involving drunk drivers by roughly one third over the time it was in place, figure 6 shows us that this did very little to the overall number of traffic collisions and injuries in Madison over that time. Therefore re-implementing ALDO or similar policies is not an efficient way of reducing collisions, including those that cause serious injury or death.

What are some intersections where collisions are more frequent and what can be done to improve their performance? Finally Figure 13 allows us to compare three intersections of South Gammon Road and see that it is possible to make some intersections much safer than they are right now. Specifically, there are a number of changes that can be made to the intersections of Mineral Point Road and Watts Road to make them significantly safer. Figure 18 shows that even a five percent reduction in collisions only on South Gammon Road will prevent a significant number of injuries.

References

[1] Zhixin Wang, Yijing Gong, Haowen Hu, Alex Radicia *Crashes in the City of Madison* `https://wisc-ds-projects.github.io/f20/past/summer19-crash.pdf`

[2] Detao Yu, Jing Huang, Boyu Shen *Vision Zero Madison: No more Traffic Deaths* `https://wisc-ds-projects.github.io/f20/past/f19/detao-jing-boyu.pdf`

[3] Tongkai Yang, Siyuan Ji, Clarence Kuo *Vision Zero Madison* `https://wisc-ds-projects.github.io/f20/past/f19/tongkai-siyuan-clarence.pdf`

[4] Wisconsin Department of Civil and Environmental Engineering *Wisconsin Traffic Operations and Safety Laboratory Crash Data (2020)*