Technical Memo

Date:	Monday, December 28, 2020
Project:	Watertown Master Transportation Plan
To:	Study Advisory Team
From:	HDR
Subject:	Crash History Review

Introduction

The purpose of this memorandum is to present and assess the crash history throughout the City of Watertown. Crashes on all roads within the city limits were examined on a high-level perspective. The focus of this review is on state highways, urban arterial and collector roadways, and study corridors, with a cursory examination of other roadways within city limits. The following sections summarize findings from a city-wide perspective, intersections and corridors with specific safety concerns, pedestrian and bicycle crashes, and railroad crossing crashes. This review will ultimately help identify the safety needs on the city road network and support the development of the Watertown Master Transportation Plan.

Crash History Review

Crash data was obtained from the South Dakota Department of Transportation (SDDOT) for reportable crashes on public roadways within the City of Watertown. This review looked at the five most recent, complete calendar years of crash data, 2015-2019. The data includes all motor vehicle crashes, including motor vehicle crashes with pedestrians and bicyclists. For the purpose of this analysis, several variables were identified based on safety performance measures, which are detailed below. The analysis consists of three elements:

1. Crash Frequency: total number of crashes occurring at intersections within Watertown city limits
2. Crash Rates: the number of crashes occurring at intersections per million entering vehicles
3. 2019 South Dakota Strategic Highway Safety Plan (SHSP) Emphasis Areas[1]: crash attribute focal points that guide future South Dakota safety investments

Throughout the review, crashes were reported by two main crash fields, injury severity and manner of collision. Injury severity is delineated into:

- **Fatal Injury:** An injury resulting in death, or an injury caused death occurring within 30 days of the crash.
- **Incapacitating Injury:** Any injury, other than fatal, that prevents the injured person from walking, driving, or continuing the activities they were capable of performing prior to the crash.
- **Non-Incapacitating Injury:** Any injury, other than a fatal or incapacitating injury, that is evident to observers at the crash scene.

- **Possible Injury:** Any injury reported that is not a fatal injury, incapacitating injury, or non-incapacitating injury.
- **Property Damage Only:** A reported crash with no injuries.

Manner of collision is the identification of the manner in which two motor vehicles in transport initially came together without regard to the direction of force. Manner of collision is delineated into **Angle Crashes**, **Rear-end Crashes**, **Head-on**, and **Sideswipe Crashes**.

City-wide Summary

A total of 2,013 crashes were reported within Watertown city limits, between 2015 and 2019. Location of these crashes, in terms of crash severity, is depicted in **Figure 1**.

The following tables present a summary of crash characteristics for the 2,013 crashes, aligning with several of the SDDOT's 2019 Strategic Highway Safety Plan emphasis areas:

- **Table 1:** Crash Severity
- **Table 2:** Manner of Collision
- **Table 3:** Light Condition
- **Table 4:** Pavement Condition
- **Table 5:** Crashes by Month
- **Table 6:** 2019 SHSP Emphasis Area Crash Characteristics[1]

495 of the 2,013 crashes (nearly 25 percent) resulted in a fatality, injury, or possible injury (**Table 1**). Five crashes resulted in a fatality and 29 resulted in an incapacitating injury. Locations of these severe crashes are shown in **Figure 2**. The following provides additional characteristics of the 5 fatal crashes:

- 3 occurred on US 212
- 1 occurred on SD 20
- 3 occurred at an intersection
  - 2 angle crashes
- 4 occurred during dry road conditions
- 4 involved an unbelted vehicle occupant
- 3 involved speeding
- 2 involved a motorcycle
- 2 involved alcohol use
- 1 involved drug use
- 1 involved a pedestrian

Table 1: Crash Severity

Crash Severity	Total # Crashes[2]	
Fatal Injury	5	<1%
Incapacitating Injury	29	1%
Non-Incapacitating Injury	139	7%
Possible Injury	322	16%
No Injury	1,456	72%
Wild Animal Hit	62	3%
Total Crashes	**2,013**	

Table 2: Manner of Collision

Manner of Collision	Total # Crashes[2]	
Single Vehicle	606	30%
Rear-end	383	19%
Angle	933	46%
Sideswipe	83	4%
Head-on	8	<1%

Table 3: Light Condition

Light Condition	Total # Crashes[2]	
Dark – Lighted Roadway	307	15%
Dark – Roadway not Lighted	87	4%
Dark – Unknown Roadway Lighting	25	1%
Dawn	17	<1%
Daylight	1,528	76%
Dusk	34	2%
Unknown/Other	15	<1%

[1] South Dakota Strategic Highway Safety Plan (SHSP), August 2019. https://dot.sd.gov/media/documents/SHSP_FINAL_Reduced.pdf

[2] Total number of crashes includes all crashes within Watertown city limits. Crash Source: SDDOT Crash Database

In addition to crash location maps classified by severity, crash density maps were developed to better indicate where greater frequencies of crashes are occurring. These are shown for total crashes and severe crashes in **Figure 3** and **Figure 4** respectively.

1,407 of the 2,013 crashes (nearly 70 percent) involved two or more vehicles, while 606 crashes involved a single vehicle (about 30 percent) (**Table 2**). In order of frequency, multi-vehicle crashes included 933 angle crashes, 383 rear-end crashes, 83 sideswipe crashes, and 8 head-on crashes. A majority of crashes (1,528) occurred during daylight hours (76 percent), which is typically during the higher volume periods of the day (**Table 3**). 307 crashes occurred on a dark, lighted roadway (15 percent) and 87 crashes occurred on a dark, not lighted roadway (4 percent).

1,261 of the 2,013 study area crashes occurred on dry surface roads (**Table 4**). In comparing dry and weather-impacted roads, 63% of crashes occurred on dry surface roads while 37% of crashes occurred on roads with frost, ice, slush, snow, or wet surfaces. Specifically, 351 crashes occurred on snow surface roads (17 percent), 203 crashes occurred on ice surface roads (10 percent), and 203 crashes on wet surface roads (8 percent).

Crash frequency was notably higher from November to February (**Table 5**). January exhibited the most crashes with 244, followed by December with 216 crashes. Monthly total crash trends exhibit typical trends for cities in this region, with peak total crashes occurring in winter months.

Table 6 lists crash characteristics of the 2,013 crashes city-wide to support emphasis areas identified in the 2019 SDDOT Strategic Highway Safety Plan[1].

Table 4: Pavement Condition

Pavement Condition	Total # Crashes[2]	
Dry	1,261	63%
Frost	10	<1%
Ice	203	10%
Slush	15	<1%
Snow	351	17%
Wet	152	8%
Sand/Mud/Dirt/Gravel	3	<1%
Unknown/Other	18	<1%

Table 5: Crashes by Month

Month	Total # Crashes[2]	
January	244	12%
February	193	10%
March	162	8%
April	148	7%
May	107	5%
June	150	7%
July	128	6%
August	155	8%
September	155	8%
October	167	8%
November	188	9%
December	216	11%

Table 6: 2019 SHSP Emphasis Area Crash Characteristics[1]

Crash Characteristic	Total # Crashes[2]	
Alcohol/Drugs	161	8%
Intersections	1,105	55%
Lane Departures	184	9%
Unbuckled Vehicle Occupants	88	4%
Motorcycles	42	2%
Distracted Driving	126	6%
Speeding/Aggressive Driving	294	15%

[1] South Dakota Strategic Highway Safety Plan (SHSP), August 2019. https://dot.sd.gov/media/documents/SHSP_FINAL_Reduced.pdf

[2] Total number of crashes includes all crashes within Watertown city limits. Crash Source: SDDOT Crash Database

The following are expanded summaries of each 2019 SDDOT SHSP Emphasis Area crash type:

- Alcohol/drug use
  - 161 total crashes
  - 9 involved fatal or incapacitating injuries
  - 28 were angle crashes

- Intersections
  - 1,105 total crashes
  - 15 involved fatal or incapacitating injuries
  - 711 were classified as angle crashes
  - 362 occurred at signalized intersections
  - 328 occurred at stop-controlled intersections
  - 26 occurred at yield sign-controlled intersections

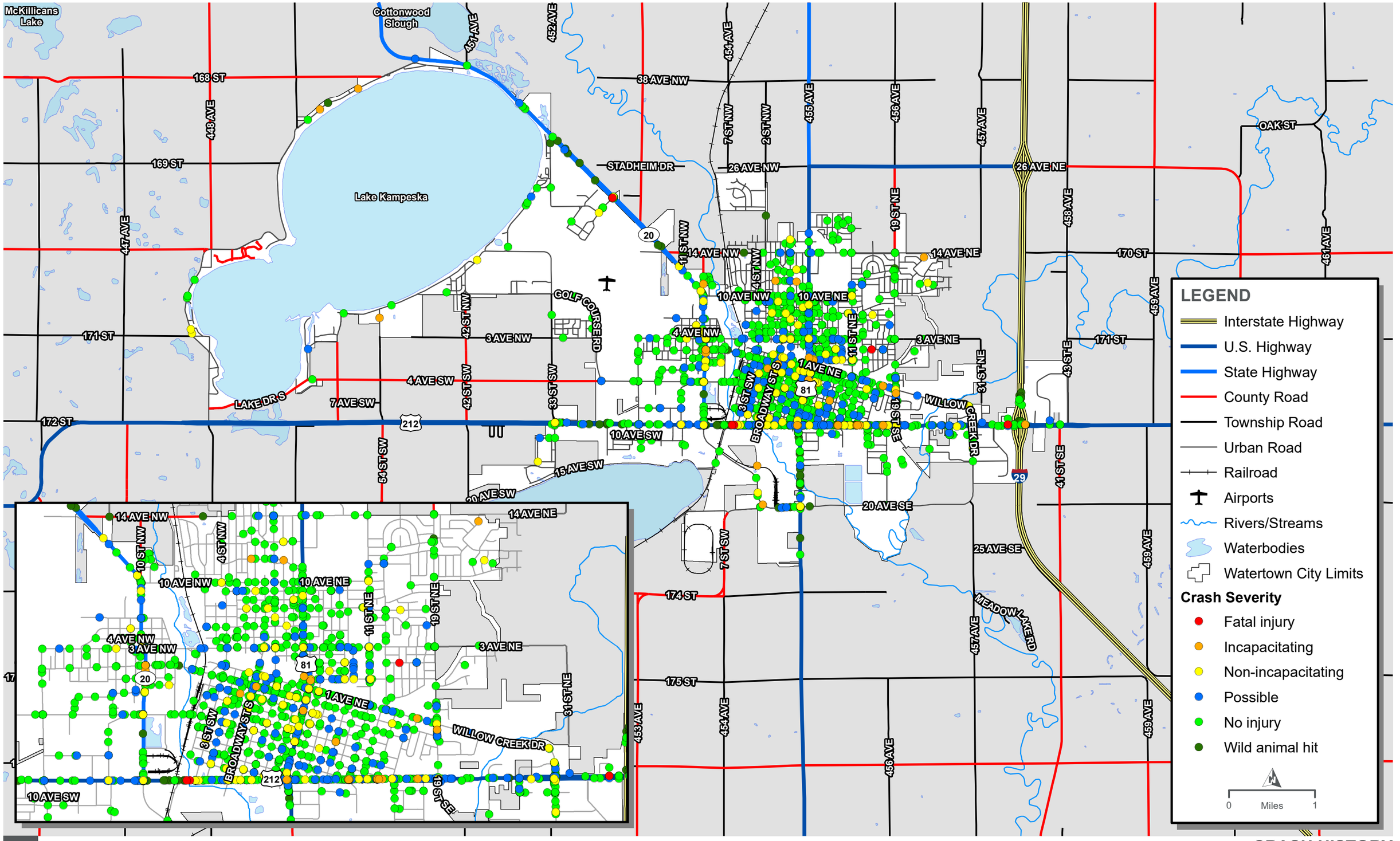
- Lane Departures
  - 184 total crashes
  - 1 incapacitating crashes
  - 50 sideswipe crashes

- Unbuckled Vehicle Occupants
  - 88 total crashes
  - 10 fatal or incapacitating injuries
  - 18 angle crashes

- Motorcycles
  - 42 total crashes
  - 11 involved fatal or incapacitating injuries
  - 15 angle crashes

- Distracted Driving
  - 126 total crashes
  - 1 involved an incapacitating injury
  - 55 rear-end crashes

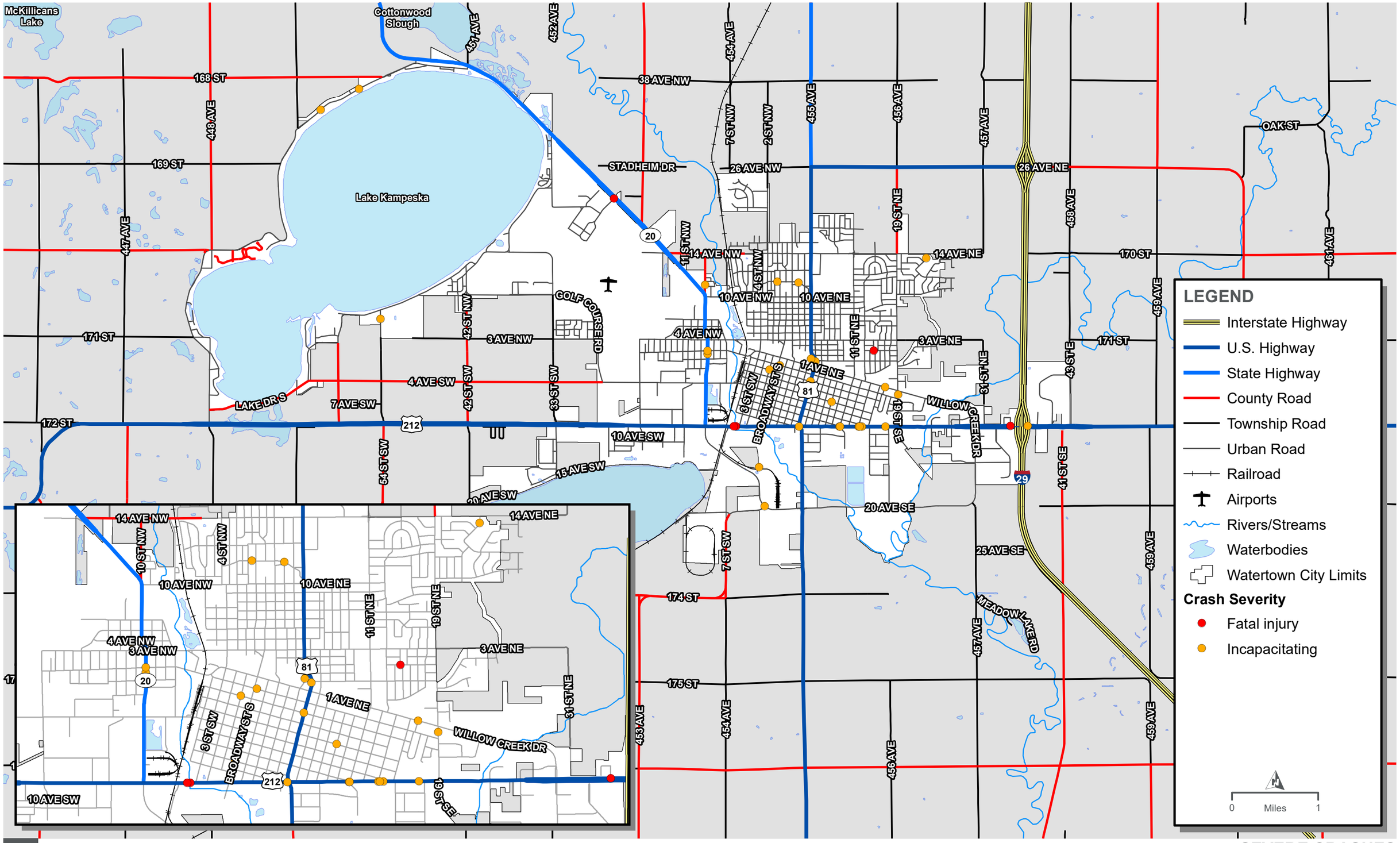
- Speeding/Aggressive Driving
  - 294 total crashes
  - 7 involved a fatal or incapacitating injury
  - 104 angle crashes



CRASH HISTORY

(2015-2019)

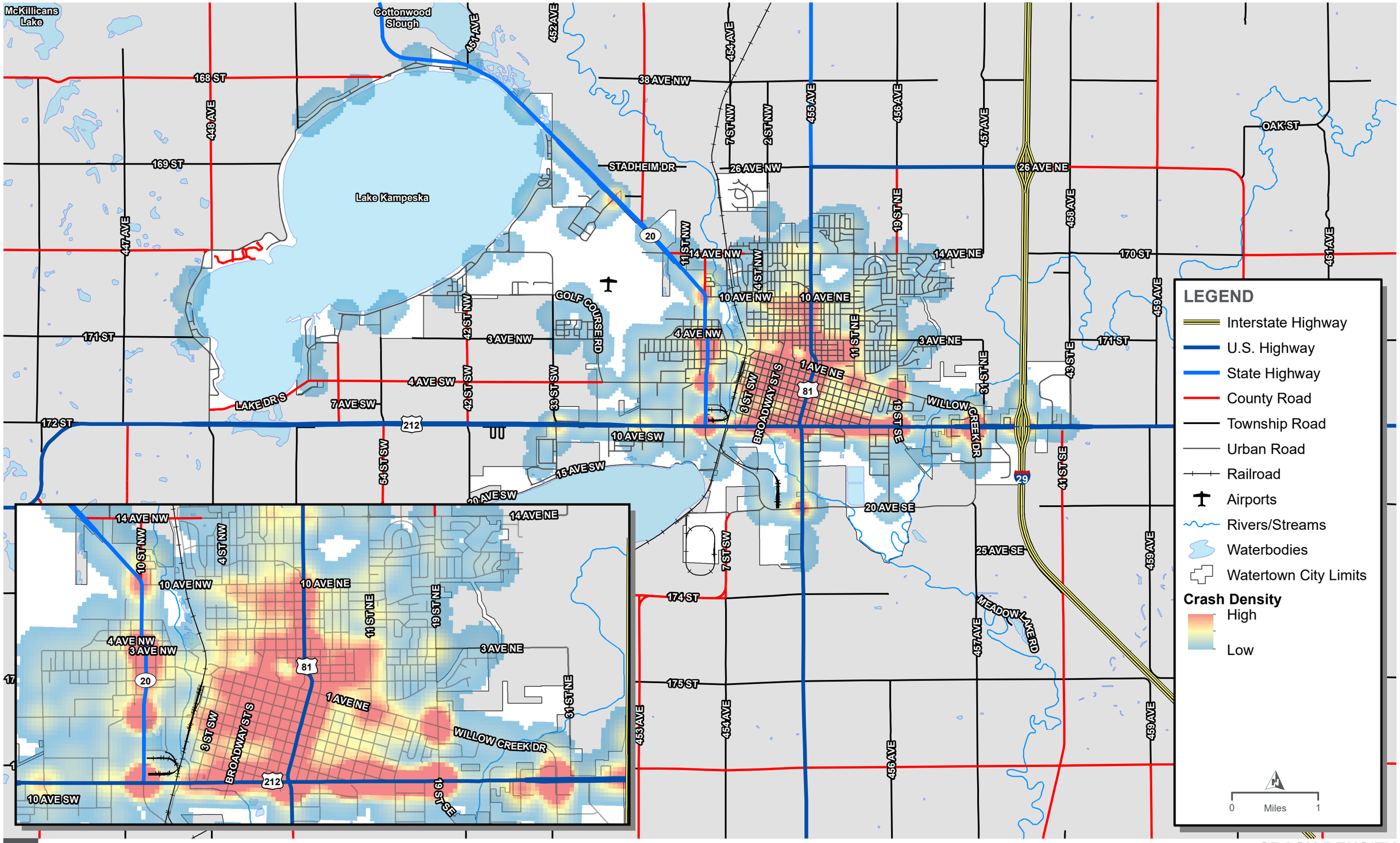
FIGURE 1



SEVERE CRASHES

(2015-2019)

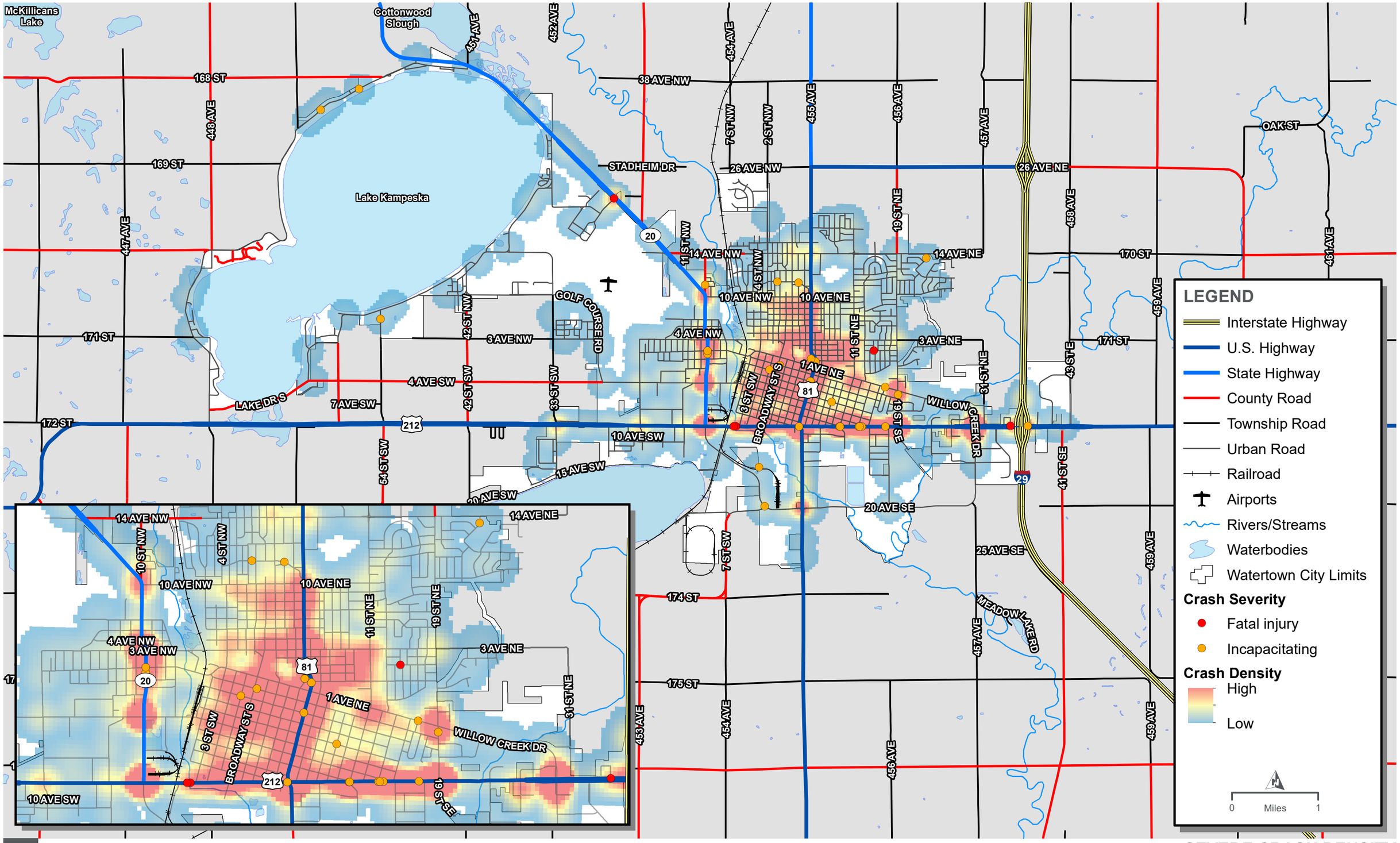
FIGURE 2



CRASH DENSITY

(2015-2019)

FIGURE 3



SEVERE CRASH DENSITY

(2015-2019)

FIGURE 4

Intersections

Crashes occurring within a 250-foot radius of an intersection in the GIS crash database were categorized as an intersection crash for this analysis. 1,105 of 2,013 crashes met this criterion. Intersections were analyzed and ranked based on the twenty highest crash frequencies and the twenty highest crash rates.

CRASH FREQUENCY

Crash frequency is defined as the total number of crashes that occurred at an intersection. Crash frequency is important as it indicates locations that record frequent crash events, but it does not consider traffic exposure which can lead to an under-emphasis of intersections with lower volumes and an overemphasis of intersections with higher traffic volumes. The twenty highest ranked crash frequency intersections are presented in **Figure 5**, **Table 7** (in terms of injury severity), and **Table 8** (in terms of manner of collision).

In terms of crash frequency, the following was found to have occurred on the major corridors within Watertown:

- **US 212:** 1st, 2nd, and 3rd highest crash frequency intersections (8 of 20 total)
- **US 81:** 1st and 4th highest crash frequency intersection (5 of 20 total)
- **SD 20:** 5th highest crash frequency intersections (6 of 20 total)

Overall, the US 212 and US 81 intersection exhibited the greatest number of crashes with 54. This intersection is signalized with 2 through lanes, a left-turn lane, and a channelized right-turn lane at each approach. While no fatal or incapacitating injury crashes were observed, 3 crashes were non-incapacitating injury crashes. 29 of these crashes were rear-end crashes, 22 were angle crashes, and 3 were sideswipe crashes. The US 212 intersections with 19th St SE and Willow Creek Drive had the next highest crash frequency, with 42 and 34 crashes respectively.

Table 7: Watertown Intersection Crash Frequency Rankings – Injury Severity (2015-2019)[2]

Rank	Intersection Name	Crashes (5 years)						Daily Entering Volume	Crash Rate (Crashes / MEV**)
		Total	Fatal Injury	*Major Injury	*Minor Injury	Possible Injury	Property Damage Only		
1	US 212 and US 81	54	0	0	3	14	37	25,398	1.17
2	US 212 and 19th St SE	42	0	0	2	13	27	20,499	1.12
3	US 212 and Willow Creek Dr	34	0	0	1	4	29	11,453	1.63
4	US 81 and 1st Ave NE	27	0	0	2	7	18	16,807	0.88
5	US 212 and SD 20	26	0	0	1	7	18	21,701	0.66
6	US 212 and 11th St SE	24	0	2	3	5	14	19,421	0.68
7	US 81 and 3rd Ave NE	22	0	0	1	3	18	13,588	0.89
8	SD 20 and 4th Ave SW	20	0	0	2	5	13	15,759	0.70
9	SD 20 and 3rd Ave NW	17	0	0	3	5	9	15,962	0.58
10	US 212 and 13th St SE	16	0	1	2	2	11	21,580	0.41
11	US 81 and 4th Ave SE	15	0	0	3	4	8	11,662	0.70
12	US 81 and E Kemp Ave	14	0	0	1	1	12	12,516	0.61
13	19th St SE and Willow Creek Dr	13	0	0	2	4	7	12,157	0.59
14	US 212 and I-29 NB	12	0	1	1	3	7	6,371	1.03
15	US 212 and Broadway St	12	0	0	3	1	8	18,244	0.36
16	SD 20 and Airport Dr	11	1	0	3	3	4	5,084	1.19
17	11th St NE and 3rd Ave NE	10	0	0	1	3	6	5,756	0.95
18	SD 20 and 10th Ave NW	10	0	0	0	0	10	9,530	0.57
19	SD 20 and W Kemp Ave	9	0	1	0	1	7	13,109	0.38
20	N Maple St & 3rd Ave NE	9	0	0	1	1	7	5,764	0.86

*Incapacitating injuries are referred to as Major Injury, non-incapacitating injuries are referred to as Minor Injury
**MEV: Million Entering Vehicles

[2] Total number of crashes includes all crashes within Watertown city limits.
Crash Source: SDDOT Crash Database

Table 8: Watertown Intersection Crash Frequency Rankings – Manner of Collision (2015-2019)[2]

Rank	Intersection Name	Crashes (5 years)						Daily Entering Volume	Crash Rate (Crashes / MEV**)
		Total	Angle	Rear-end	Head-on	Sideswipe	No Collision		
1	US 212 and US 81	54	22	29	0	3	0	25,398	1.17
2	US 212 and 19th St SE	42	19	19	0	1	3	20,499	1.12
3	US 212 and Willow Creek Dr	34	20	11	0	3	0	11,453	1.63
4	US 81 and 1st Ave NE	27	19	7	0	1	0	16,807	0.88
5	US 212 and SD 20	26	12	11	1	2	0	21,701	0.66
6	US 212 and 11th St SE	24	9	14	0	1	0	19,421	0.68
7	US 81 and 3rd Ave NE	22	10	10	0	1	1	13,588	0.89
8	SD 20 and 4th Ave SW	20	16	3	1	0	0	15,759	0.70
9	SD 20 and 3rd Ave NW	17	10	5	0	0	2	15,962	0.58
10	US 212 and 13th St SE	16	8	6	0	0	2	21,580	0.41
11	US 81 and 4th Ave SE	15	14	1	0	0	0	11,662	0.70
12	US 81 and E Kemp Ave	14	7	5	0	1	1	12,516	0.61
13	19th St SE and Willow Creek Dr	13	10	1	0	0	2	12,157	0.59
14	US 212 and I-29 NB	12	8	4	0	0	0	6,371	1.03
15	US 212 and Broadway St	12	4	6	0	0	2	18,244	0.36
16	SD 20 and Airport Dr	11	8	2	0	0	1	5,084	1.19
17	11th St NE and 3rd Ave NE	10	4	4	0	0	2	5,756	0.95
18	SD 20 and 10th Ave NW	10	7	2	0	0	1	9,530	0.57
19	SD 20 and W Kemp Ave	9	7	1	0	0	1	13,109	0.38
20	N Maple St & 3rd Ave NE	9	7	1	0	0	1	5,764	0.86

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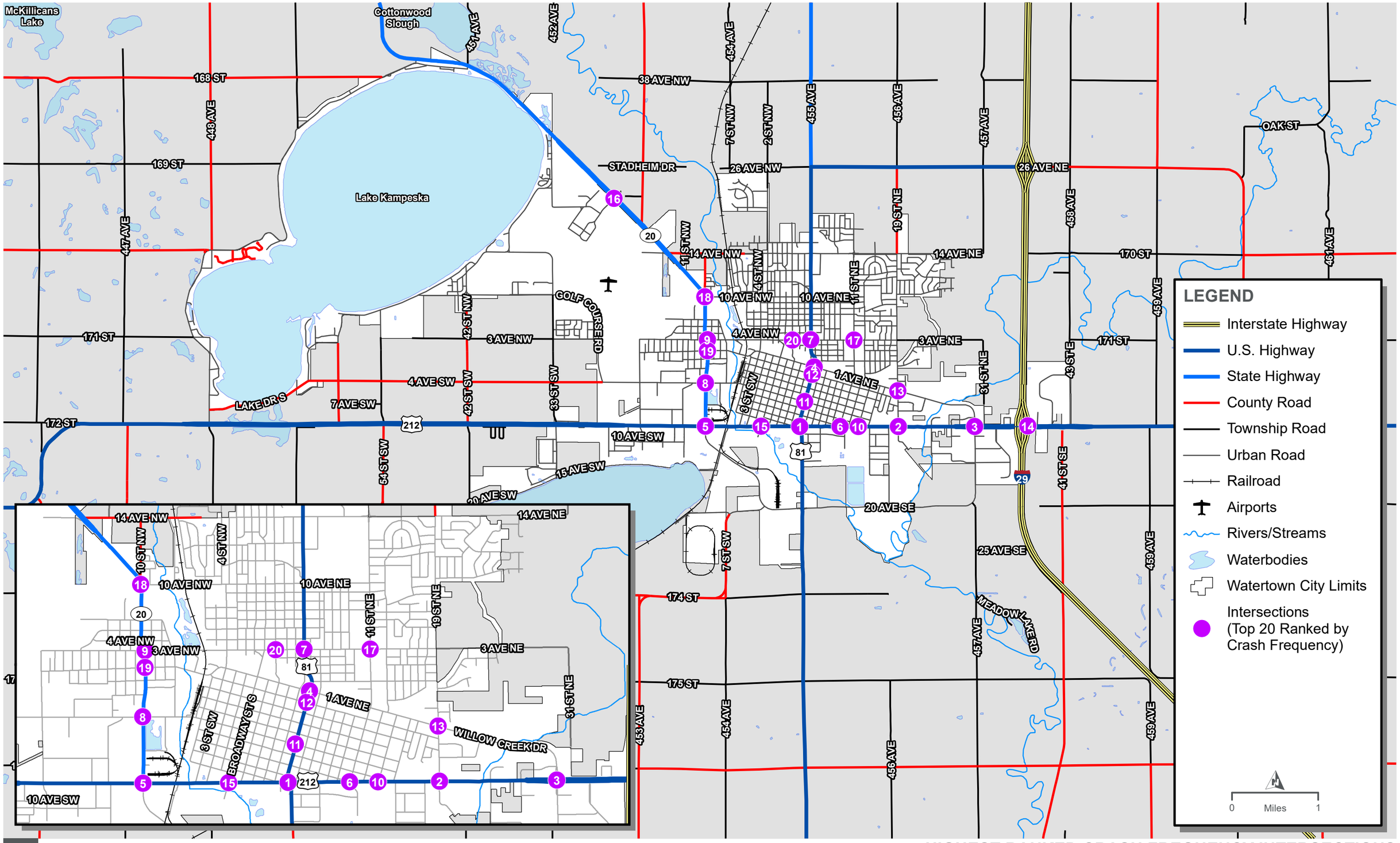


HIGHEST RANKED CRASH FREQUENCY INTERSECTIONS

(2015-2019)

FIGURE 5

CRASH RATES

Crash rates were calculated to further assess traffic safety conditions within Watertown city limits. A **crash rate** is the calculation of the number of vehicular crashes per million entering vehicles (MEV) and normalizes crash frequencies based on traffic exposure. The method used for calculating crash rates utilized crash and traffic count data sourced from SDDOT. For intersections without available traffic counts, daily traffic volumes were estimated to be 1,500 ADT. The highest ranked crash rate intersections are presented in **Figure 6**.

Crash rates are based on the daily entering volumes at each intersection, which were estimated based on the data discussed above. The daily entering volumes that were calculated give insight into roadway usage and specifically the average number of vehicles using an intersection during typical weekday travel. This high-level overview provides a snapshot of traffic safety and its relationship with roadway usage throughout Watertown city limits in normal conditions.

In addition to crash rates, critical crash rates and critical index ratios were calculated for each of the twenty intersections. Critical crash rates are the comparison of a site crash rate to an average crash rate of a reference group, which in this case was intersections that observed 8 or more crashes. If a crash rate exceeds the critical crash rate, shown in the Critical Index Ratio, there is likely a safety issue.

The highest crash rate intersections are presented in terms of injury severity and manner of collision in **Table 9** and **Table 10**, respectively.

Regarding the critical index ratio, five intersections had crash rates that exceeded the critical crash rate:

- US 212 and Willow Creek Drive (1.63 crashes/MEV, 1.5 ratio)
- SD 20 and Airport Drive (1.19 crashes/MEV, 1.3 ratio)
- US 212 and US 81 (1.17 crashes/MEV, 1.2 ratio)
- US 212 and 19th Street SE (1.12 crashes/MEV, 1.1 ratio)
- N Maple Street and 3rd Avenue NE (1.03 crashes/MEV, 1.0 ratio)

ROUNDABOUTS

During the observed 5-year period, two roundabout intersections were constructed at US 81 and 20th Avenue SE (constructed between April and August 2018) and 11th Street NE and 14th Avenue NE (completed in July 2015). While direct crash data comparisons to other study area intersections cannot be made due to these major geometric changes, crash data was examined for any indications of changes in safety trends. For this examination, SDDOT crash data from 2014 was employed in order to have at least one full year of data prior to the construction of the roundabout at 11th Street NE and 14th Avenue NE. Crash data from these intersections is shown in **Table 11**.

Table 9: Watertown Intersection Crash Rates Rankings – Injury Severity (2015-2019)[2]

Rank	Intersection Name	Crashes (5 years)						Daily Entering Volume	Crash Rate (Crashes / MEV**)	Critical Crash Rate	Critical Index Ratio
		Total	Fatal Injury	*Major Injury	*Minor Injury	Possible Injury	Property Damage Only				
1	US 212 and Willow Creek Dr	34	0	0	1	4	29	11,453	1.63	1.11	**1.5**
2	SD 20 and Airport Dr	11	1	0	3	3	4	5,084	1.19	0.91	**1.3**
3	US 212 and US 81	54	0	0	3	14	37	25,398	1.17	0.99	**1.2**
4	US 212 and 19th St SE	42	0	0	2	13	27	20,499	1.12	1.02	**1.1**
5	US 212 and I-29 NB	12	0	1	1	3	7	6,371	1.03	1.24	0.8
6	11th St NE and 3rd Ave NE	10	0	0	1	3	6	5,756	0.95	1.26	0.8
7	US 81 and 3rd Ave NE	22	0	0	1	3	18	13,588	0.89	1.08	0.8
8	US 81 and 1st Ave NE	27	0	0	2	7	18	16,807	0.88	1.05	0.8
9	N Maple St and 3rd Ave NE	9	0	0	1	1	7	5,764	0.86	0.88	**1.0**
10	Broadway St and 4th Ave SW	8	0	0	0	1	7	6,198	0.71	1.24	0.6
11	SD 20 and 4th Ave SW	20	0	0	2	5	13	15,759	0.70	1.06	0.7
12	US 81 and 4th Ave SE	15	0	0	3	4	8	11,662	0.70	1.11	0.6
13	US 212 and 11th St SE	24	0	2	3	5	14	19,421	0.68	1.03	0.7
14	29th St SE and 26th St SE	8	0	0	0	0	8	6,600	0.66	0.85	0.8
15	US 212 and SD 20	26	0	0	1	7	18	21,701	0.66	1.01	0.6
16	US 81 and E Kemp Ave	14	0	0	1	1	12	12,516	0.61	1.09	0.6
17	11th St NE and 1st Ave NE	8	0	0	0	1	7	7,218	0.61	0.83	0.7
18	19th St SE and Willow Creek Dr	13	0	0	2	4	7	12,157	0.59	1.10	0.5
19	6th St NE and 1st Ave NE	8	0	0	1	4	3	7,599	0.58	0.82	0.7
20	SD 20 and 3rd Ave NW	17	0	0	3	5	9	15,962	0.58	1.05	0.6

*Incapacitating injuries are referred to as Major Injury, non-incapacitating injuries are referred to as Minor Injury
**MEV: Million Entering Vehicles

[2] Total number of crashes includes all crashes within Watertown city limits.
Crash Source: SDDOT Crash Database

Table 10: Watertown Intersection Crash Rate Rankings – Manner of Collision (2015-2019)[2]

Rank	Intersection Name	Crashes (5 years)						Daily Entering Volume	Crash Rate (Crashes / MEV**)	Critical Crash Rate	Critical Index Ratio
		Total	Angle	Rear-end	Head-on	Sideswipe	No Collision				
1	US 212 and Willow Creek Dr	34	20	11	0	3	0	11,453	1.63	1.11	**1.5**
2	SD 20 and Airport Dr	11	8	2	0	0	1	5,084	1.19	0.91	**1.3**
3	US 212 and US 81	54	22	29	0	3	0	25,398	1.17	0.99	**1.2**
4	US 212 and 19th St SE	42	19	19	0	1	3	20,499	1.12	1.02	**1.1**
5	US 212 and I-29 NB	12	8	4	0	0	0	6,371	1.03	1.24	0.8
6	11th St NE and 3rd Ave NE	10	4	4	0	0	2	5,756	0.95	1.26	0.8
7	US 81 and 3rd Ave NE	22	10	10	0	1	1	13,588	0.89	1.08	0.8
8	US 81 and 1st Ave NE	27	19	7	0	1	0	16,807	0.88	1.05	0.8
9	N Maple St and 3rd Ave NE	9	7	1	0	0	1	5,764	0.86	0.88	**1.0**
10	Broadway St and 4th Ave SW	8	5	3	0	0	0	6,198	0.71	1.24	0.6
11	SD 20 and 4th Ave SW	20	16	3	1	0	0	15,759	0.70	1.06	0.7
12	US 81 and 4th Ave SE	15	14	1	0	0	0	11,662	0.70	1.11	0.6
13	US 212 and 11th St SE	24	9	14	0	1	0	19,421	0.68	1.03	0.7
14	29th St SE and 26th St SE	8	8	0	0	0	0	6,600	0.66	0.85	0.8
15	US 212 and SD 20	26	12	11	1	2	0	21,701	0.66	1.01	0.6
16	US 81 and E Kemp Ave	14	7	5	0	1	1	12,516	0.61	1.09	0.6
17	11th St NE and 1st Ave NE	8	5	3	0	0	0	7,218	0.61	0.83	0.7
18	19th St SE and Willow Creek Dr	13	10	1	0	0	2	12,157	0.59	1.10	0.5
19	6th St NE and 1st Ave NE	8	5	2	0	0	1	7,599	0.58	0.82	0.7
20	SD 20 and 3rd Ave NW	17	10	5	0	0	2	15,962	0.58	1.05	0.6

*Incapacitating injuries are referred to as Major Injury, non-incapacitating injuries are referred to as Minor Injury
**MEV: Million Entering Vehicles

[2] Total number of crashes includes all crashes within Watertown city limits.
Crash Source: SDDOT Crash Database

Table 11: Roundabout Intersections (2014-2019)[2]

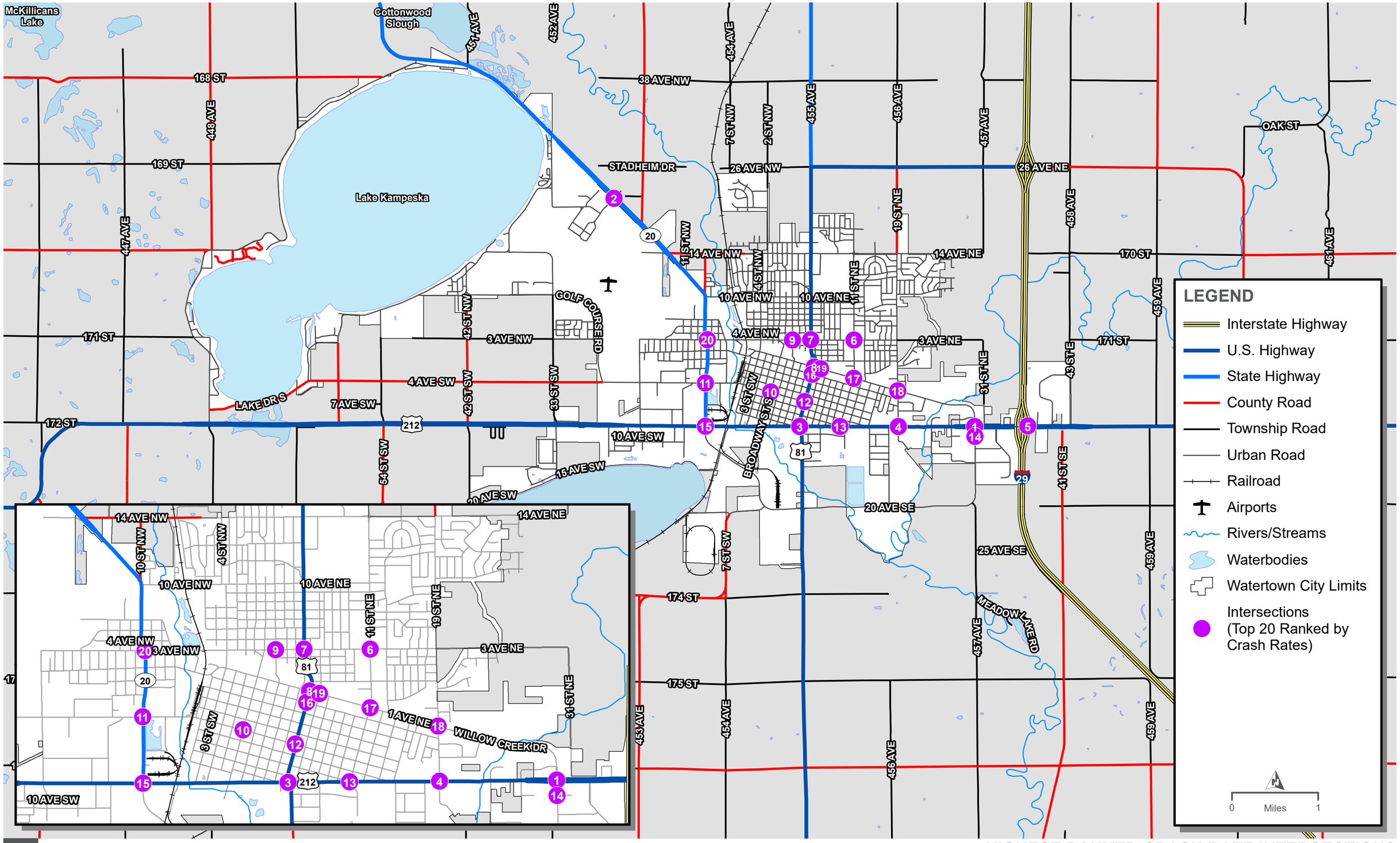
Intersection Name	Crashes (6 years)							Crashes Before Roundabout Construction	Crashes After Roundabout Construction
	Total	2014	2015	2016	2017	2018	2019		
US 81 and 20th Avenue SE*	**16**	5	3	6	0	0	2	**14 Crashes (4 years)** **Injury Severity** • 6 non-incapacitating injury crashes • 3 possible injury crashes • 5 no injury crashes **Manner of Collision** • 12 angle crashes • 2 rear-end crashes	**2 Crashes (1 year)** **Injury Severity** • 1 possible injury crash • 1 no injury crash **Manner of Collision** • 1 angle crash
11th Street NE and 14th Avenue NE**	**2**	0	1	0	0	0	1	**1 Crash (1 year)** **Injury Severity** • 1 no injury crash **Manner of Collision** • 1 rear-end crash	**1 Crash (4 years)** **Injury Severity** • 1 no injury crash **Manner of Collision** • 1 rear-end crash

*Roundabout was constructed in between April 2018 and August 2018. 2018 crashes at this intersection occurred during construction and are not considered in the before and after crash totals.

**Roundabout construction was completed by July 2015. The one 2015 crash observed occurred on January 20th of that year and thus was included in the before total.

Color Code: Gray – crashes occurred before roundabout construction, Yellow – crashes occurred during roundabout construction year, Green – crashes occurred after roundabout construction

[2] Total number of crashes includes all crashes within Watertown city limits.
Crash Source: SDDOT Crash Database



HIGHEST RANKED CRASH RATE INTERSECTIONS

(2015-2019)

FIGURE 6

Corridor Segments

Fourteen corridors, including the three study corridors, were evaluated for segment crash rates. These segments are identified in **Figure 7** and segment crash densities are shown in **Figure 8**. Corridor segment crash rates were calculated in terms of crashes per million vehicle miles traveled (MVMT) using 2015-2019 reported crashes and traffic volumes from the most recently available daily traffic counts. The corridor crash totals and rates include only segment crashes with the respective study corridor (intersection crashes are excluded). In addition, critical crash rates were calculated based on the average segment crash rate. The crash rates and critical crash rates were compared to determine if a safety concern. Corridor segment crash rates are shown in **Table 12**, **Table 13**, and **Table 14**, categorized by functional classification.

Table 12: Interstate Corridor Segment Crash Rates (2015-2019)[2]

Corridor No.	Roadway Corridor	Limits	Length (miles)	Crash Rate (Crashes / MVMT)	Critical Crash Rate	Critical Index Ratio
1	Interstate 29 (NB)	US 212 Interchange Area	0.91	1.77	2.51	0.7
		US 212 Off Ramp (Exit 177)	0.31	0.00	3.75	0.0
		US 212 On Ramp (Exit 177)	0.29	2.67	4.51	0.6
2	Interstate 29 (SB)	US 212 Interchange Area	0.90	0.89	2.00	0.4
		US 212 Off Ramp (Exit 177)	0.32	3.54	4.29	0.8
		US 212 On Ramp (Exit 177)	0.30	0.86	3.81	0.2

Table 13: U.S. and State Highway Corridor Segment Crash Rates (2015-2019)[2]

Corridor No.	Roadway Corridor	Limits	Length (miles)	Crash Rate (Crashes / MVMT)	Critical Crash Rate	Critical Index Ratio
3	US 212	Willow Creek Dr to 43rd St E	1.11	0.34	1.91	0.2
		19th St SE to Willow Creek Dr	0.89	0.80	1.84	0.4
		11th St NE to 19th St SE	0.68	2.00	1.74	**1.1**
		US 81 to 11th St NE	0.47	1.74	1.83	0.9
		Broadway St to US 81	0.45	1.70	1.86	0.9
		SD 20 to Broadway St	0.65	1.43	1.79	0.8
		21st St SW to SD 20	0.76	0.86	1.79	0.5
		33rd St SW to 21st St SW	0.98	1.63	2.02	0.8
4	US 81	10th Ave NE to 18th Ave NE	0.80	0.33	2.00	0.2
		3rd Ave NE to 10th Ave NE	0.50	1.03	2.06	0.5
		1st Ave NE to 3rd Ave NE	0.33	1.37	2.13	0.6
		4th Ave SE to 1st Ave NE	0.42	1.46	2.04	0.7
		US 212 to 4th Ave SE	0.30	2.04	2.28	0.9
		20th Ave SE to US 212	0.95	2.22	1.93	**1.1**
5	SD 20	Airport Dr to N Lake Dr	2.90	0.73	1.80	0.4
		14th Ave NW to Airport Dr	0.89	1.00	2.05	0.5
		10th Ave NW to 14th Ave NW	0.67	0.42	1.99	0.2
		3rd Ave NW to 10th Ave NW	0.51	1.21	2.00	0.6
		4th Ave SW to 3rd Ave NW	0.50	0.49	1.96	0.3
		US 212 to 4th Ave SW	0.50	1.30	2.00	0.7

[2] Total number of crashes includes all crashes within Watertown city limits.
Crash Source: SDDOT Crash Database

Table 14: Urban Arterial and Collector Corridor Segment Crash Rates (2015-2019)[2]

Corridor No.	Roadway Corridor	Limits	Length (miles)	Crash Rate (Crashes / MVMT)	Critical Crash Rate	Critical Index Ratio
6	Broadway Street	3rd Ave NW to 10th Ave NW	0.50	2.78	3.01	0.9
		1st Ave NW to 3rd Ave NW	0.21	2.89	3.66	0.8
		4th Ave SW to 1st Ave NW	0.42	6.22	2.65	2.3
		US 212 to 4th Ave SW	0.41	0.92	2.83	0.3
7	11th Street	10th Ave NE to 14th Ave NE	0.50	0.64	3.15	0.2
		3rd Ave NE to 10th Ave NE	0.50	0.00	2.80	0.0
		1st Ave NE to 3rd Ave NE	0.44	3.08	2.80	**1.1**
		4th Ave SE to 1st Ave NE	0.42	0.88	2.79	0.3
		US 212 to 4th Ave SE	0.17	2.43	4.01	0.6
8	19th Street	3rd Ave NE to 14th Ave NE	1.00	0.21	1.98	0.1
		1st Ave NE to 3rd Ave NE	0.58	0.87	2.05	0.4
		US 212 to 1st Ave NE	0.42	1.49	2.30	0.6
9	4th Avenue S	US 81 to 14th St SE	0.79	0.00	4.13	0.0
		Broadway St to US 81	0.41	2.24	2.39	0.9
		3rd St SW to Broadway St	0.25	2.16	2.31	0.9
		SD 20 to 3rd St SW	0.52	1.66	2.23	0.7
		21st St SW to SD 20	0.76	0.53	2.97	0.2
10	1st Avenue N	11th St NE to 19th St NE	0.54	2.24	2.39	0.9
		US 81 to 11th St NE	0.48	2.16	2.31	0.9
		Broadway St to US 81	0.41	1.66	2.23	0.7
		3rd St NW to Broadway St	0.25	0.53	2.97	0.2
11	3rd Avenue N	11th St NE to 19th St NE	0.50	1.30	2.78	0.5
		US 81 to 11th St NE	0.50	2.87	2.55	**1.1**
		Broadway St to US 81	0.30	0.86	2.78	0.3
		3rd St NW to Broadway St	0.29	1.35	2.81	0.5
		SD 20 to 3rd St NW	0.62	1.12	2.16	0.5
		21st St SW to SD 20	0.79	1.55	2.41	0.6
12	10th Avenue N*	US 81 to 13th St NE	0.62	0.52	2.93	0.2
		Broadway St to US 81	0.21	0.60	3.09	0.2
		Skyline Dr to Broadway St	0.46	0.50	2.39	0.2
		SD 20 to Skyline Dr	0.49	0.00	2.54	0.0
13	14th Avenue N*	11th St NE to 19th St	0.50	0.00	2.38	0.0
		US 81 to 11th St NE	0.50	0.83	2.46	0.3
		Maple St N to US 81	0.22	0.00	2.76	0.0
		2nd St NW to Maple St N*	0.28	0.36	2.64	0.1
		SD 20 to 2nd St NW	1.15	0.35	2.03	0.2
14	16th Avenue N*	2nd St NW to Maple St N*	0.28	1.30	2.78	0.5

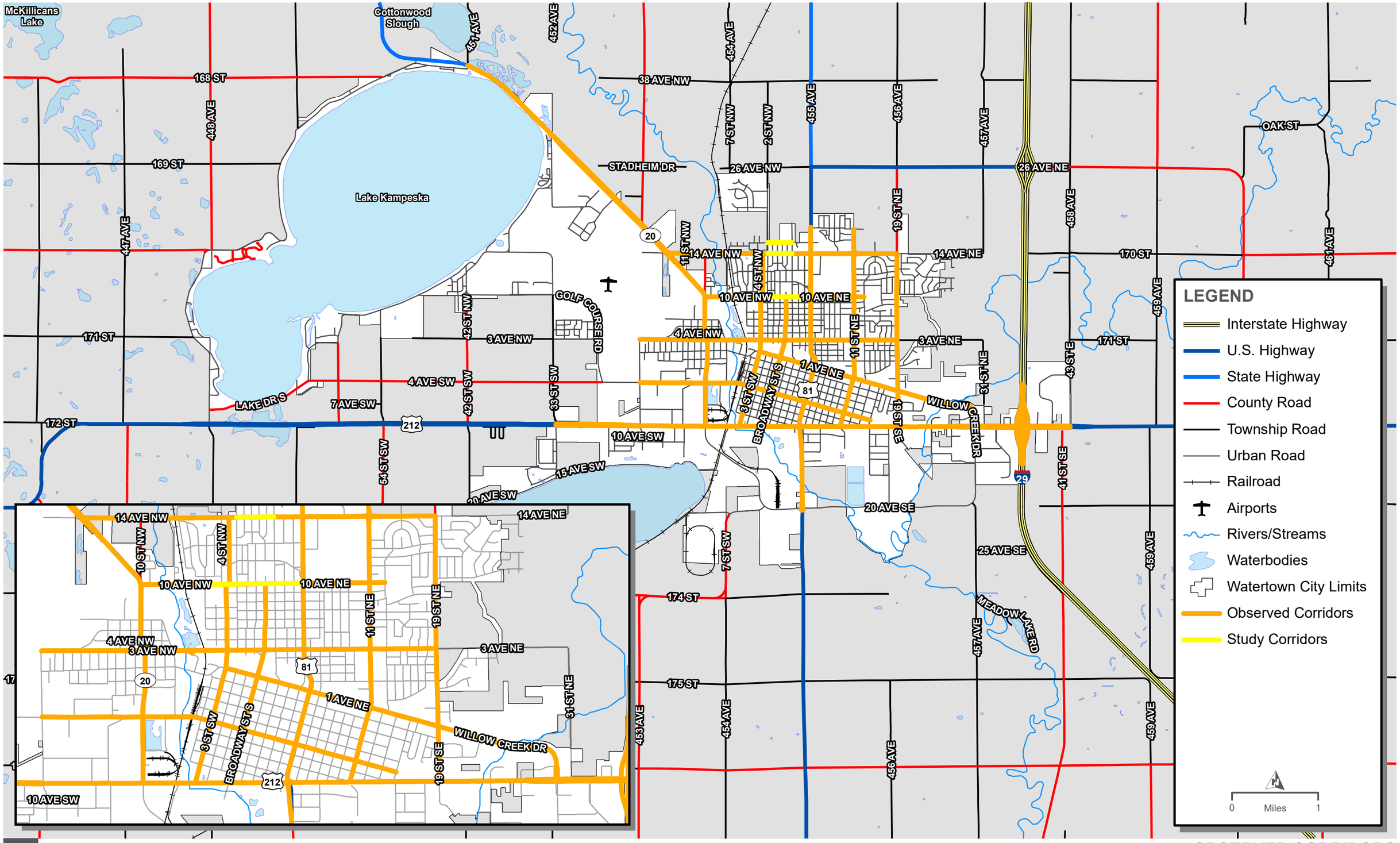
[2] Total number of crashes includes all crashes within Watertown city limits.
Crash Source: SDDOT Crash Database

Overall, only four corridor segments exceeded the critical index ratio. These segments were along portions of US 212, US 81, 11th Street, and 3rd Avenue N. The following attributes were present among these corridor segments:

- US 212: 11th Street SE to 19th Street SE
  - 45 total crashes
  - 3 Incapacitating crashes
  - 4 Non-Incapacitating crashes
  - 22 angle crashes
  - 16 rear-end crashes
  - 5 sideswipe crashes
- US 81: 20th Avenue SE to US 212
  - 25 total crashes
  - 3 Possible injury crashes
  - 9 angle crashes
  - 11 wild animal hit crashes
- 11th Street: 1st Avenue NE to 3rd Avenue NE
  - 7 total crashes
  - 2 angle crashes
- 3rd Avenue N: US 81 to 11th Street NE
  - 9 total crashes
  - 5 rear-end crashes

For segments within the three study corridors, few crashes and no significant safety trends were found. Crash totals for study segments are as follows:

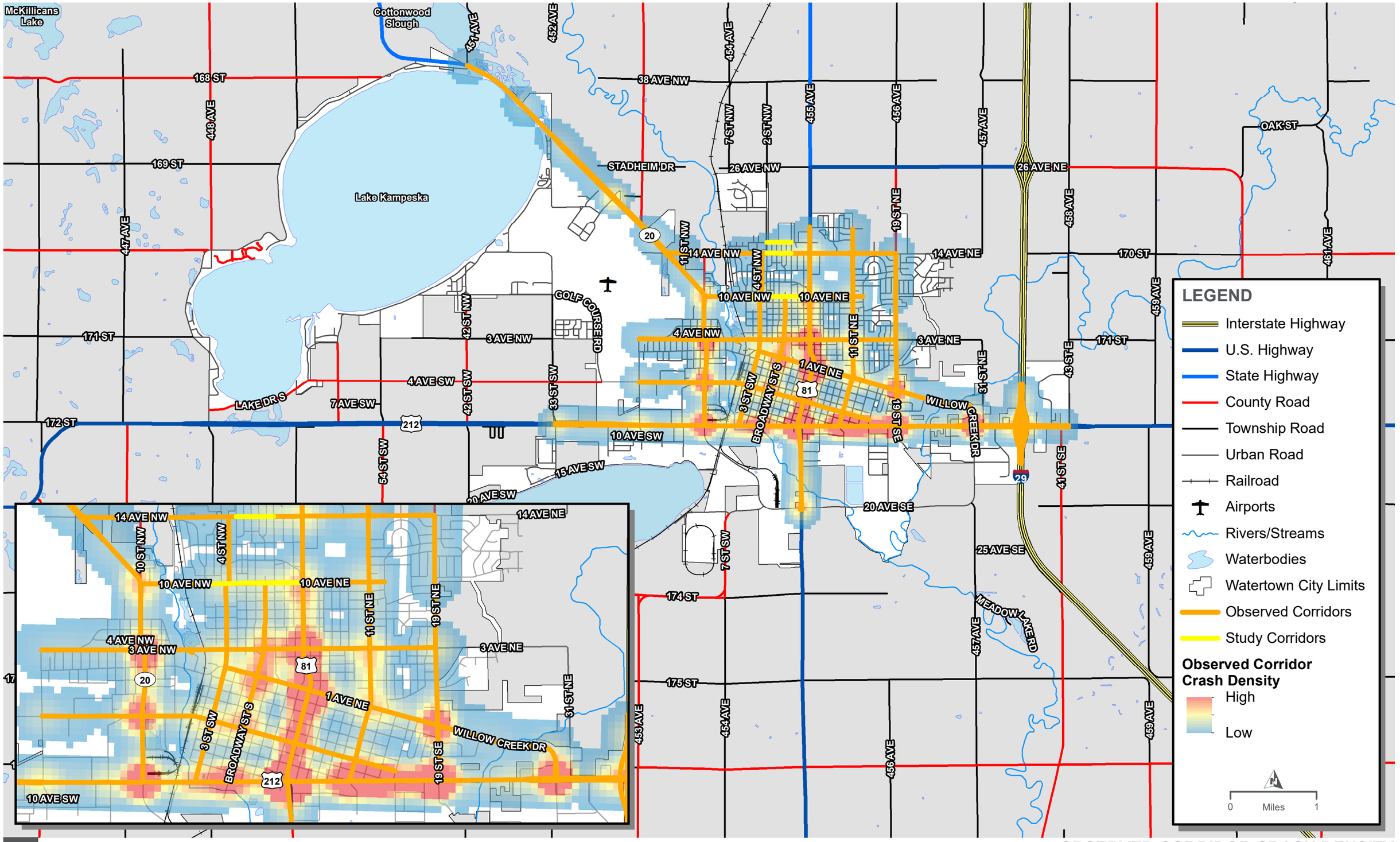
- 10th Avenue N: Broadway Street to US 81
  - 1 total crash
- 10th Avenue N: Skyline Drive to Broadway Street
  - 2 total crashes
- 14th Avenue N: 2nd Street NW to Maple Street N
  - 1 total crash
- 16th Avenue N: 2nd Street NW to Maple Street N
  - No crashes



OBSERVED CORRIDORS

(2015-2019)

FIGURE 7



OBSERVED CORRIDOR CRASH DENSITY

(2015-2019)

FIGURE 8

Bicycles and Pedestrians

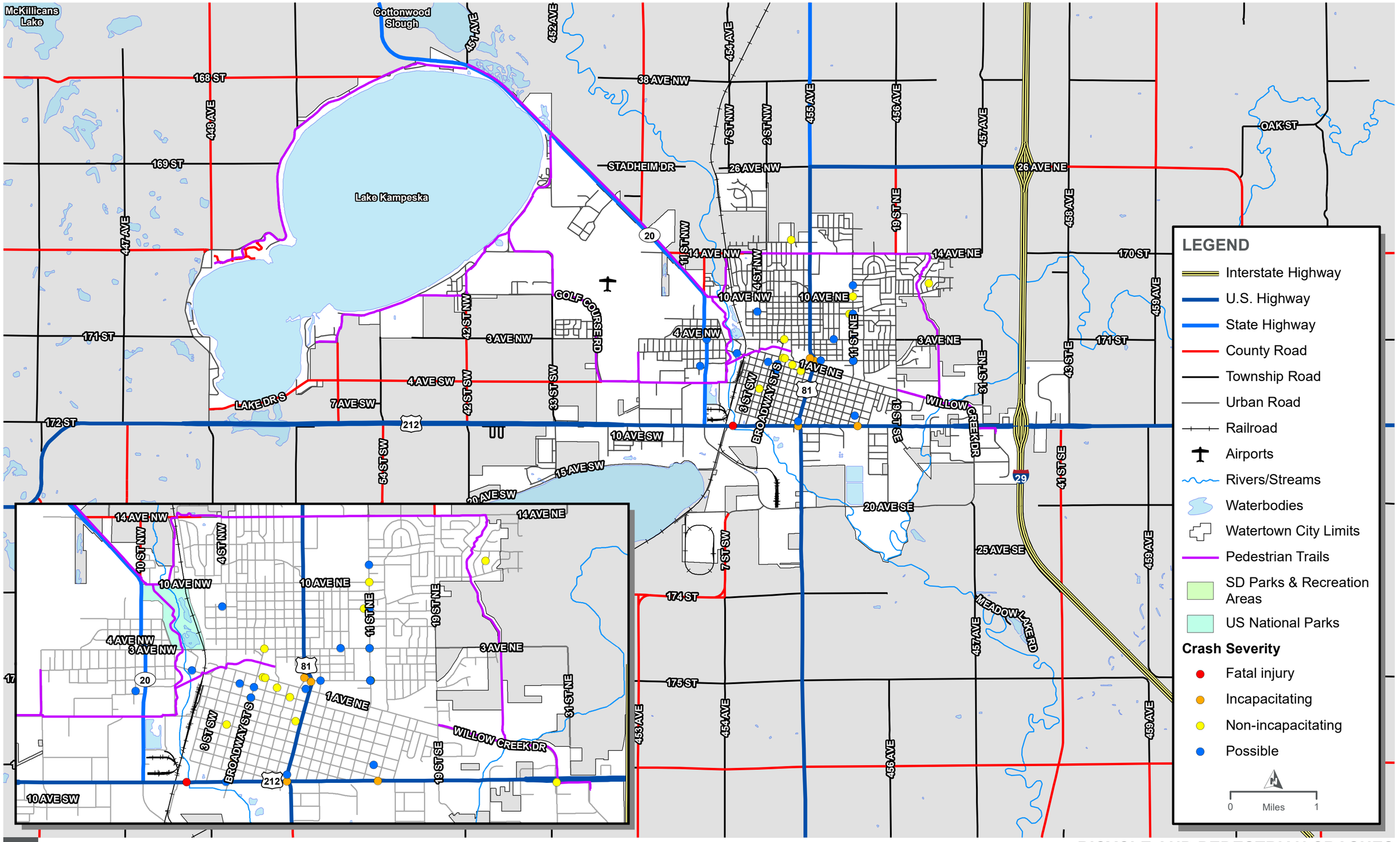
Table 15 presents the number of bicycle and pedestrian crashes by injury severity for the 5-year period of 2015-2019. In total, forty bicycle or pedestrian-related crashes occurred with sixteen bicycle crashes and twenty-four pedestrian crashes. All crashes resulted in an injury and seven of the forty crashes (18 percent) resulted in a fatal or serious injury. The one fatal injury occurred in 2018 on US 212, west of 3rd Street SW. **Figure 9** below displays the locations of all bicycle and pedestrian crashes.

Table 15: Bicycle and Pedestrian Crashes by Injury Severity[2]

Year	Fatal Injury	*Major Injury	*Minor Injury	Possible Injury	No Injury	Unknown	Total
2015	0	1	7	6	0	0	14
2016	0	0	0	5	0	0	5
2017	0	1	2	3	0	0	6
2018	1	3	2	2	0	0	8
2019	0	1	4	2	0	0	7
Total	**1**	**6**	**15**	**18**	**0**	**0**	**40**

*Incapacitating injuries are referred to as Major Injury, non-incapacitating injuries are referred to as Minor Injury

[2] Total number of crashes includes all crashes within Watertown city limits.
Crash Source: SDDOT Crash Database



BICYCLE AND PEDESTRIAN CRASHES

(2015-2019)

FIGURE 9

Railroad Crossings

Rail lines cross through Watertown in the north/south direction on the western-central side of the city. This line is owned and operated by BNSF Railway and is part of a connection between Huron, SD and Benson, MN. There is one 54-car loading facility in Watertown. An ethanol plant is located northwest of the intersection of US 81 and 20th Avenue SE.

The Federal Railroad Administration (FRA) maintains an inventory of rail crossings throughout the United States. Their inventory indicates 10 public and private highway/rail crossings within Watertown city limits.

The crash history at highway/rail crossings was reviewed between 2015 and 2019. Twelve reported crashes occurred at or were related to a rail crossing, which are summarized in **Table 16** and shown in **Figure 10**.

Table 16: Rail Crossing Crashes (2015-2019)[2, 3]

Roadway Corridor	Crossing Location	Crossing Number	Railroad	Total Crashes	Trains/ Day	Crossing Control
3rd Avenue NW	West of Skyline Drive	075499N	BNSF	2	2	Active – flashing lights (mast mounted)
W Kemp Avenue	East of 6th Street NW	075502U	BNSF	2	2	Active – flashing lights (mast and cantilever mounted)
4th Avenue SW	West of 5th Street SW	075503B	BNSF	4#	1 per week	Active – flashing lights (mast and cantilever mounted) and gate arms
US 212	West of 3rd Street SW	075504H	BNSF	3#	1 per week	Active – flashing lights (mast and cantilever mounted)
10th Street SW	West of Fish Road	929051F	BNSF	1	1 per week	Passive – ENS sign

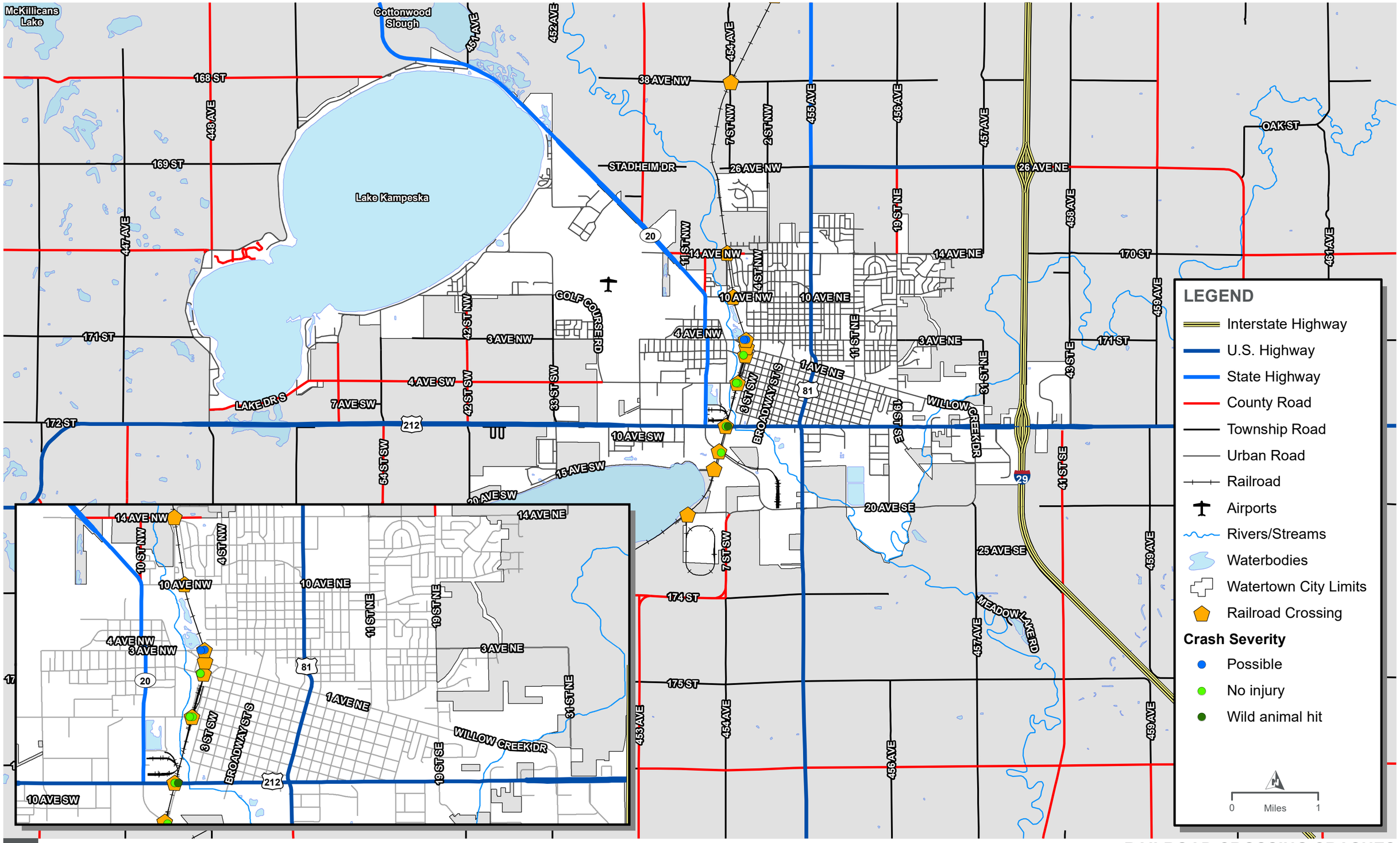
Includes a vehicle-train crash

Crashes were largely dispersed across the five crossing locations with observed crashes. The most, four crashes, were reported at the BNSF crossing on 4th Avenue SW just west of 5th Street SW. Other than half of these crashes being labeled as rear-end crashes, no discernable trends appeared for the crashes at this crossing.

There were two vehicle-train collisions reported in the 5-year analysis period. One occurred at the 4th Avenue SW crossing and the other occurred at the US 212 crossing just west of 3rd Street SW. Both crashes resulted in no injury.

Overall, the dispersion of crashes across five crossing locations illustrate the random nature of crossing crashes, even in urban areas with higher volumes. It is important to continually improve crossings through a systematic process of identifying and addressing potential issues of vehicle-train, vehicle-pedestrian, and vehicle-vehicle conflicts as well as single-vehicle roadway departure risks.

[2] Total number of crashes includes all crashes within Watertown city limits.
Crash Source: SDDOT Crash Database
[3] Federal Railroad Administration (FRA) GIS Database
https://fragis.fra.dot.gov/GISFRASafety/



RAILROAD CROSSING CRASHES

(2015-2019)

FIGURE 10

General Findings

The following are the main trends and general findings derived from the crash history review:

City-wide Summary

- A total of 2,013 crashes occurred within City limits between 2015 and 2019.
- 34 severe crashes (4 fatal injury crashes and 29 incapacitating injury crashes) occurred.
- 63 percent of crashes occurred on dry pavement conditions.
- December, January, and February were the 3 highest crash frequency months.

Intersections

- The US 212 and US 81 intersection had the highest crash frequency with 54 crashes.
- 6 study intersections were amongst the top twenty highest crash frequency intersections.
- 5 study intersections were amongst the top twenty highest crash rate intersections.
- Five intersections had crash rates that exceeded the critical crash rate:
    - US 212 and Willow Creek Drive (1.63 crashes/MEV, 1.5 ratio)
    - SD 20 and Airport Drive (1.19 crashes/MEV, 1.3 ratio)
    - US 212 and US 81 (1.17 crashes/MEV, 1.2 ratio)
    - US 212 and 19th Street SE (1.12 crashes/MEV, 1.1 ratio)
    - N Maple Street and 3rd Avenue NE (1.03 crashes/MEV, 1.0 ratio)
- Recently installed roundabouts at the US 81 and 20th Avenue SE intersection and 11th Street NE and 14th Avenue NE intersection were analyzed for early safety trends. Due to either a lack of post-installation data or minimal crash occurrences, no notable safety trends can be deduced at this time.

Corridor Segments

- The following 4 corridor segments exceeded the critical index ratio:
    - US 212 from 11th Street SE to 19th Street SE
    - US 81 from 20th Avenue SE to US 212
    - 11th Street from 1st Avenue NE to 3rd Avenue NE
    - 3rd Avenue N from US 81 to 11th Street NE
- Few crashes and no significant safety trends were found on the 3 study corridor segments.

Bicycle and Pedestrian-Related Crashes

- 40 total bicycle/pedestrian-related crashes occurred with 16 bicycle crashes and 24 pedestrian crashes.
- All bicycle/pedestrian-related crashes resulted in an injury. 7 bicycle or pedestrian-related crashes resulted in a fatal or serious injury.
- 1 fatal injury bicycle/pedestrian-related crash occurred on US 212, west of 3rd Street SW.

Railroad Crossing-Related Crashes

- 12 total crashes occurred at or were related to a railroad crossing.
- The railroad crossing on 4th Avenue SW observed the most crashes (4).
- Railroad crossing-related crashes were largely dispersed across 5 crossing locations. These crashes had no notable trends and were random in nature.