

Development of a Traffic Safety Action Plan for the City of Saskatoon

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ABSTRACT

A “Traffic Safety Action Plan” (TSAP) is currently being developed for the City of Saskatoon. A TSAP is defined as a scientific, data-driven, four to five year comprehensive safety document that is designed to identify a jurisdiction’s areas of safety concern known as “emphasis areas”, establish target collision reduction goal(s), provide network screening results, and general countermeasures and strategies for each chosen emphasis area. This TSAP will help the City of Saskatoon allocate their limited resources to a manageable number of emphasis areas to maximize the benefits for safety investment and generate the greatest safety improvement.

The objective of the paper is to describe the development of a municipal-level TSAP for the City of Saskatoon. The study starts with the selection of emphasis areas using the most recent ten years of collision data (2001-2010). The results of the stakeholder workshop and the chosen emphasis areas (i.e., Intersections, Aggressive Driving, Distracted Driving, Vulnerable Road Users, Impaired Driving, Young Drivers and Older Drivers) will then be discussed. Preliminary network screening of the chosen emphasis areas will be presented, and will be followed by the selection of countermeasures/strategies and target goals in the future.

INTRODUCTION

A jurisdiction's "Traffic Safety Action Plan" (TSAP) is a high-level traffic safety policy that provides a scientific, data-driven, four to five year comprehensive safety document for the jurisdiction. Many jurisdictions in Canada have already developed TSAPs or an equivalent document (e.g., "Canada's Road Safety Strategy 2015" [1], the "Alberta Traffic Safety Plan" [2] and the "Hamilton Strategic Road Safety Program" [3]). Although there are variations in titles, the primary purposes of TSAPs are to identify a manageable number of safety focus areas known as "emphasis areas", establish target collision reduction goal(s) for each chosen emphasis area, and provide high-level action plans such as network screening and/or general safety improvement strategies for the chosen emphasis areas.

SASKATOON'S STRATEGIC TRAFFIC SAFETY ACTION PLAN

A TSAP is being developed to assist the City of Saskatoon to allocate its limited budget in the most efficient way to identify and improve areas of safety concern in Saskatoon. The following stakeholders are currently involved: City of Saskatoon, Saskatchewan Government Insurance (SGI), Saskatoon Health Region and Saskatoon Police Service.

The study requires: identifying emphasis areas; developing target goals for each emphasis area; providing network screening results for each emphasis area; and providing high-level safety improvement strategies for each emphasis area.

SELECTION OF EMPHASIS AREAS

Potential Emphasis Area Selection Process

"Emphasis areas" are areas of safety concern. Hundreds of different safety concerning areas can be selected as emphasis areas for a jurisdiction. Emphasis areas in existing TSAPs were reviewed in order to suggest potential emphasis areas for the City of Saskatoon. Federal-level TSAPs (Canadian Council of Motor Transport Administrators (CCMTA) [1]), provincial-level TSAPs (Alberta [2], British Columbia [4], Saskatchewan [5]), municipal-level TSAPs (Burlington [6], Edmonton [7], Grande Prairie [8], Hamilton [3], New Westminster [9], Ottawa [10], Red Deer [11], Strathcona County [12] and North Vancouver [13]) and the American Association of State Highway and Transportation Officials' (AASHTO's) TSAP (AASHTO [14]) were reviewed. A frequency table was created in order to determine the number of cities that chose each emphasis area. The emphasis areas were divided into the CCMTA's [1] six target groups (e.g., young drivers, medically-at-risk drivers etc.) and four contributing factors (e.g., impaired driving, speed and aggressive driving etc.) categories. The emphasis areas considered were those that were chosen by one or more cities. The second step was considering the data available in the SGI's collision database.

Table 1 lists 33 potential emphasis areas screened on the basis of the literature review. Ten of the 33 potential emphasis areas (highlighted in grey) were discarded due to various reasons including the lack of available collision data linked to these emphasis areas. For example, there is no collision record relating to emergency medical services (EMS). Seven of the ten potential emphasis areas (numbers 25 to 29 under Data Management/Public Education and

numbers 32 and 33 under Others) were also discarded because they are countermeasures rather than areas of safety concern. For instance, Driver Education could be used to reduce the number of collisions for certain emphasis areas (e.g., Impaired Driving, Seatbelts) rather than being an emphasis area. After discarding the ten potential emphasis areas, the remaining 23 potential emphasis areas were retained as potential emphasis areas for the City of Saskatoon.

Collision Comparison between Potential Emphasis Areas

Figure 1 shows the frequency and percentage of collisions during the ten-year study period (2001-2010) for total collisions. The 23 potential emphasis areas are ranked in descending order by number and percentage of collisions. If we ignore the ten potential emphasis areas that account for less than 2% of total collisions (i.e., Medically-at-risk Driving, Winter Driving, Wildlife, Seatbelts, At-Grade Crossings, Fatigued Driving, Work Zones, School Zones, Pavement Markings and Commercial Vehicles), 13 potential emphasis areas remain. The ranking for total collisions (by percentage) is:

- 1) Intersections (60%),
- 2) Young Drivers (46%),
- 3) Distracted Driving (28%),
- 4) Rear End Collisions (27%),
- 5) Aggressive Driving (21%),
- 6) Turning Movement Collisions (15%),
- 7) Angle Collisions (12%),
- 8) Older Drivers (10%),
- 9) Road Condition (9%),
- 10) Lane Departure Collisions (6%),
- 11) Horizontal Curves (5%),
- 12) Vulnerable Road Users (4%), and
- 13) Impaired Driving (3%).

Two different types of costs, direct and societal costs, were used to estimate collision costs. Direct costs are costs associated with a collision. They include property damage, medical expenses, travel expense to and from appointments, and income replacement after seven consecutive days of work missed [15]. Societal costs are the costs that a society is willing to pay to prevent or reduce the risks associated with a collision that involves a serious injury and/or death. Societal costs involve an individual's willingness to trade between wealth or income and the potential for physical risk and harm [16]. Note that the societal cost (not the direct cost) is used in the decision making process (e.g., benefit/cost analysis for safety initiatives) when considering the introduction of a certain safety initiative.

Table 2 summarizes the direct and societal costs by collision severity. The direct costs were taken from the SGI's [15] 2005 to 2009 collision costs. The 2007 dollar values used for direct costs are based on the average of the 2005 to 2009 costs. Societal costs were taken from the Capital Region Intersection Safety Partnership's (CRISP's) [16] collision cost study which reported 2007 dollar values. (The costs used in this study have not been inflated.)

Figure 2(a) presents the direct cost of total collisions for each of the 23 potential emphasis areas. For example, intersection collisions (the top ranked emphasis area) resulted in a direct cost of \$380.52 million for total collisions over the ten-year study period (2001-2010). Figure 2(b) presents the total societal cost of total collisions for each of the 23 potential emphasis areas. Intersection collisions resulted in a societal cost of \$1.78 billion, approximately 4.7 times higher than the direct cost of intersection collisions.

The 13 potential emphasis areas can be grouped under three headings (drivers, environmental conditions and special road users):

Drivers

- 1) Aggressive Driving (21%)
- 2) Distracted Driving (28%)
- 3) Impaired Driving (3%)
- 4) Older Drivers (10%)
- 5) Young Drivers (46%)

Environmental Conditions

- 6) Angle Collisions (12%)
- 7) Horizontal Curves (5%)
- 8) Intersections (60%)
- 9) Lane Departure Collisions (6%)
- 10) Rear End Collisions (27%)
- 11) Road Condition (9%)
- 12) Turning Movement Collisions (15%)

Special Road Users

- 13) Vulnerable Road Users (4%).

Detailed collision statistics for the 13 potential emphasis areas were created. Charts based on total number of collisions and total number of fatal or injury collisions showing collision trends (i.e., annual, monthly, daily and hourly), collision costs (i.e., direct and societal costs), collisions per road configuration (i.e., road classification, collision configuration) and collisions by driver group (i.e., age group and gender) were developed. Figures 3 to 8 show a sample of collision charts for the Young Driver potential emphasis area.

Figure 3(a) shows the annual trend in the total number of young driver collisions over the study period. Figure 3(b) shows the annual trend in the total number of fatal or injury young driver collisions. Figures 4(a) and 4(b) shows the total number of young driver collisions and fatal or injury young driver collisions by season [Spring (March, April and May), Summer (June, July and August), Fall (September, October and November) and Winter (December, January and February)], respectively.

Figure 5 is a 3D diagram known as a clockplot. These figures show the number of young driver collisions by hour and day of the week. Clockplots are used to compare a variable, in this case day of the week, with the hours of the day. The first hour, for example, consists of circles that represent young driver collisions that occurred between 12 am and 1 am. The legend located

on the top right hand corner shows the range of collisions categorized by the size and colour of the circle in the clockplot. For example, Figure 5(a) shows that the largest number of young driver collisions occurred at 4 pm to 5 pm with the large red circle representing 652 collisions. The size and value of the circles were divided into quarterly sections based on the largest number of young driver collisions (i.e., 326 collisions is half of 652 collisions). The colour of the circles represents the number of young driver collisions from largest (red) to smallest (green).

Figure 6 shows the total direct and societal costs of young driver collisions (direct costs on the left y axis and the societal costs on the right y axis) in 2007 dollar values. Figure 7 shows young driver collision by road configuration (i.e., intersection, segment and unknown) and Figure 8 shows young driver collisions by gender.

Stakeholder Workshop Results

A stakeholder workshop was held on November 26th, 2012. The collision statistics for the 13 potential emphasis areas were presented and a questionnaire was circulated. Based on the questionnaire results and intensive discussions amongst the City Engineers, Police Service and Traffic Safety Committee members, which included a school board and SGI representative, the 13 potential emphasis areas were reduced to seven emphasis areas. They are:

- Intersections;
- Aggressive Driving;
- Distracted Driving;
- Vulnerable Road Users;
- Impaired Driving;
- Young Drivers; and
- Older Drivers.

Various factors led to the inclusion of an emphasis area in the final seven. For instance, angle and turning movement collisions were excluded as chosen emphasis areas because angle collisions mainly occur at unsignalized intersections whilst turning movement collisions occur mostly at signalized intersections. Instead, intersection collisions were retained as one of the chosen emphasis areas not only because intersections are where the majority of city collision occurs, but also because the emphasis area includes both intersection configurations. Aggressive Driving was retained as an emphasis area. The committee members considered that Saskatoon will experience a higher level of congestion (Saskatoon is known as one of the fast growing cities in western Canada), and thus a higher number of aggressive driving collisions. As new communication technologies, such as handset devices, are also a growing problem in Saskatoon, Distracted Driving was chosen. Although the number of vulnerable road user collisions may be relatively small, Vulnerable Road Users was included because the consequences are often severe. Impaired Driving was retained as an emphasis area mainly due to public demand and support. Young Drivers are a target area of concern because they are the most collision involved age group and generated very high proportions of collisions. Older Drivers was included because Saskatoon's demography is becoming older rapidly.

Road Condition (e.g., icy surface conditions) was not chosen as an emphasis area because it is related to weather conditions which are not easily controllable. Rear End Collisions,

Horizontal Curves and Lane Departure Collisions were also excluded because they were ranked lower (i.e., rank 11, 12 and 13, respectively) based on the questionnaire.

SELECTION OF TARGET GOALS

Target goals represent a jurisdiction's safety improvement vision. Elvik and Vaa [17] reported that the adoption of quantitative target goals can result in better safety programs and initiatives, more effective allocation of scarce resources, and a more efficient achievement of a system-wide safety improvement for a jurisdiction. Federal Highway Safety Administration (FHWA) [18] also indicates that target goals are necessary in a TSAP as target goals indicate what the TSAP is intended to accomplish.

Target goals in a TSAP may be ambitious, but they need to be realistic. If the target goals for the emphasis areas are unrealistically ambitious, requiring a very aggressive program and a degree of progress that exceeds what is affordable and achievable with a reasonable amount of time and effort, officials and the public may perceive the targets as out of reach and may not accept them. If the target goals in a TSAP are too easily achievable, a major opportunity for saving lives may have been lost as once the goals are achieved, support for the safety programs/initiatives may wane.

In Canada, the most frequently used TSAP target goal is a percentage reduction in, for example, the number of fatal and/or injury collisions, the number of fatalities and/or injuries and/or the fatal and/or injury rate over a given time frame (e.g., within the next five years or by 2020). Unfortunately, no set of target goals and safety measures applies to every jurisdiction. The CCMTA [1], for instance, did not produce any specific numbers or safety measures that can be regarded as nation-wide safety target goals and safety measures. Instead, CCMTA encourages individual jurisdictions to select their own target goals and safety measures for each jurisdiction's TSAP.

FHWA [18] explained underlying approaches that can be useful when selecting target goals for emphasis areas in a jurisdiction's TSAP. For example, one approach links a jurisdiction's target goals to the national and/or partnering agencies' safety target goals so that multiple agencies can coordinate and unify the safety target goals in a complementary manner.

When it comes to specific targets, targets and the safety measure that assesses the target vary. SGI [5], for instance, selected a 30% reduction in the total number of fatalities and a 10% reduction in the total number of injuries during the five-year time frame from 2011 to 2015. Alberta [2] also chose the number of fatalities and injuries as their safety measure, but their target goals vary for each emphasis area (from 20% to 40% reductions). Alberta did not clearly specify the time period for achieving the target goals for each emphasis area. Two Ontario cities (City of Hamilton [3] and City of Ottawa [10]) used the number of fatal or injury collisions (as opposed to the number of fatalities and injuries) as a safety measure for their TSAPs and both cities selected 10% as a common goal for all their emphasis areas. The City of Edmonton [7] selected different safety measures and target goals for their emphasis areas. For instance, Edmonton's targets included a 20% reduction in the number of intersection-related collisions for the "Intersection" emphasis area and a 95% seatbelt wearing rate for the "Seatbelt" emphasis area during the five-year time period from 2006 to 2010. Some emphasis areas in Edmonton's

TSAP lacked specified target goals (e.g., Impaired Driving and speed-related collisions had no specific target goals).

The City of Saskatoon's committee members decided to choose the specific target goals for the chosen emphasis areas after developing high-level strategies for safety improvement. The high-level strategies will be developed later in 2013.

NETWORK SCREENING RESULTS

Preliminary network screening results for the seven chosen emphasis areas have been conducted. The network screening results can be used to select locations that will target more than one emphasis area at the same time. The collision maps for each emphasis area will provide useful supplementary information for City staff to allocate their limited safety budgets to the right locations, and to reduce the number of collisions more rapidly.

Methodology

The Observed Equivalent Property Damage Only (EPDO) Average Crash Frequency method was used to identify the riskiest locations for each of the seven emphasis areas. This method is simple and straightforward. The method considers crash severity by assigning weighting factors to collisions by severity to produce a single combined frequency and severity score for each location [19]. The weighting factors are calculated relative to PDO collisions. Societal collision costs are used to calculate the EPDO weights. Table 2 summarizes the societal costs used in this project for each collision severity [16].

EPDO weights for fatal collisions are calculated as shown in the following example (i.e., the cost of a fatal collision is divided by the cost of a PDO collision).

$$\text{Fatal Weight} = \frac{\$5,543,800}{\$10,900} = 509 \quad (1)$$

Table 3 summarizes the estimated weighting factors for all collision severities. The EPDO weights are multiplied by the corresponding number of fatal, injury and PDO collisions for each location. (Note that the frequency of fatal and injury collisions is based on the number of collisions, not the number of fatalities or injuries per collision.) In the case of the Young Drivers emphasis area, the EPDO weight calculated at intersection SKL9-18 located at Preston Avenue South and 8th Street East is shown as follows.

$$\text{Total EPDO} = (1 \text{ Fatal Collision} \times 509) + (35 \text{ Injury Collisions} \times 12) + (102 \text{ PDO Collision} \times 1) = 1031 \quad (2)$$

When screening the network, locations are ranked by EPDO score from the highest to the lowest, and a list of the riskiest locations is determined. The riskiest locations can then be shown on the collision maps.

DEVELOPMENT OF COLLISION MAPS FOR EACH EMPHASIS AREA

The City of Saskatoon currently uses a Geographic Information System (GIS) to manage, analyze and display various surface and underground infrastructure data. About 80% of the municipal data are spatial in nature and can be presented visually [20]. The city's GIS also

contains a transportation model. This model stores transportation-related spatial information such as road classification, types of traffic control, roadway geometry, road structure, etc. [21]. All of the UGRIDs (i.e., the common location identifiers) are listed in the City of Saskatoon's [22] Grid Codes document.

The SGI's collision database was linked to the city's GIS base maps using the UGRID location codes. Records for individual vehicles involved in specific collisions were related to the collision locations using common case numbers (caseno). The UGRID locations were then displayed in a collision map using their X,Y coordinates and the most recent five-year collision data (2006-2010).

Selection of Riskiest Locations for Each Emphasis Area

The collision maps produced include the 10 riskiest locations for each emphasis area. Some collision maps, however, show more than 10 locations because multiple locations can contain identical Observed EPDO values. Some collision maps show less than 10 locations because identical Observed EPDO values result in too many locations.

During the process of identifying the riskiest locations, some locations had to be excluded. Reasons for excluding a location included: intersection configurations updated after 2010; the realignment of Circle Drive and Highway 16 due to the Circle Drive South Bridge Project; and lack of information on the location of a UGRID (some UGRIDs could not be found in the City of Saskatoon's GIS base map or the City of Saskatoon's [22] Grid Codes document). Two types of collision maps were produced for each of the seven emphasis areas: the total number of collisions and the peak time of the collisions.

Collision Maps based on Total Number of Collisions

The first type of collision map shows the total number of collisions. This type of map can be used, for example, when considering the implementation of countermeasures/strategies that require 24 hours of collision data as an input (e.g., roadway surface infrastructure improvement). An example of a collision map based on total number of collisions is shown in Figure 9. The Preston Avenue South and 8th Street East intersection is ranked the most risky location in terms of total young driver collisions as seen in the figure.

Collision Maps based on Peak Time of Collisions

The second type of collision map considered only collisions that occurred during the peak time for the collisions. This type of map may be useful, for example, for police enforcement strategies as police officers usually apply enforcement only for a limited time of day rather than 24 hours.

The peak time of collisions for a particular emphasis area is determined through a series of clockplot analyses. For example, Figure 5(a) clearly shows that most young driver collisions occurred from 3pm to 6pm. The collision map for young driver collisions for the peak time of collisions is therefore based on young driver collisions that occurred from 3pm to 6pm. An example of a collision map based on peak time of collisions is shown in Figure 10. The figure shows that the most risky location for young driver collisions from 3pm to 6pm is the intersection of Taylor Street East and Boychuk Drive.

FUTURE WORK

Several TSAPs (e.g., those of Hamilton [3] and Ottawa [10]) included additional information such as the safety countermeasures, initiatives and programs that can be useful in reducing collisions in a particular emphasis area. The City of Saskatoon project will consult the NCHRP 500 series (www.trb.org/main/blurbs/152868.aspx) to suggest safety strategies for Saskatoon's emphasis areas. The specific target goal for each emphasis area will also be included in the final safety plan.

ACKNOWLEDGMENTS

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Table 1. Potential Emphasis Areas

<u>Drivers</u> <ol style="list-style-type: none"> 1. Aggressive Driving 2. Distracted Driving 3. Fatigued Driving 4. Impaired Driving 5. Medically-at-risk Driving 6. Older Drivers 7. Seatbelts 8. Young Drivers <u>Environmental Conditions</u> <ol style="list-style-type: none"> 9. Angle Collisions 10. At-Grade Crossings 11. Horizontal Curves 12. Intersections 13. Lane Departure Collisions 14. Pavement Markings 15. Rear End Collisions 16. Road Condition 17. Roadway Configuration 18. Rural Roadways 19. Signage 20. School Zones 	<ol style="list-style-type: none"> 21. Turning Movement Collisions 22. Wildlife 23. Winter Driving 24. Work Zones <u>Data Management/Public Education</u> <ol style="list-style-type: none"> 25. Data Collection/Record/Analysis Improvement 26. Driver Education 27. Municipal Road Network Improvement 28. Public Information 29. Roadway and Roadside Design and Operation Improvement <u>Special Road Users</u> <ol style="list-style-type: none"> 30. Commercial Vehicles (Public Transit and Heavy Trucks) 31. Vulnerable Road Users (Bicycles/Motorcycles/Pedestrians) <u>Others</u> <ol style="list-style-type: none"> 32. Emergency Medical Services (EMS) 33. Traffic Safety Legislation
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Table 2. Direct and Societal Costs by Severity

	Direct Costs (2007 \$)	Societal Costs (2007 \$)
Fatal	251,973	5,543,800
Injury	25,204	134,600
PDO	4,365	10,900

Table 3. EPDO Weights by Severity

Severity	Weight
Fatal	509
Injury	12
PDO	1

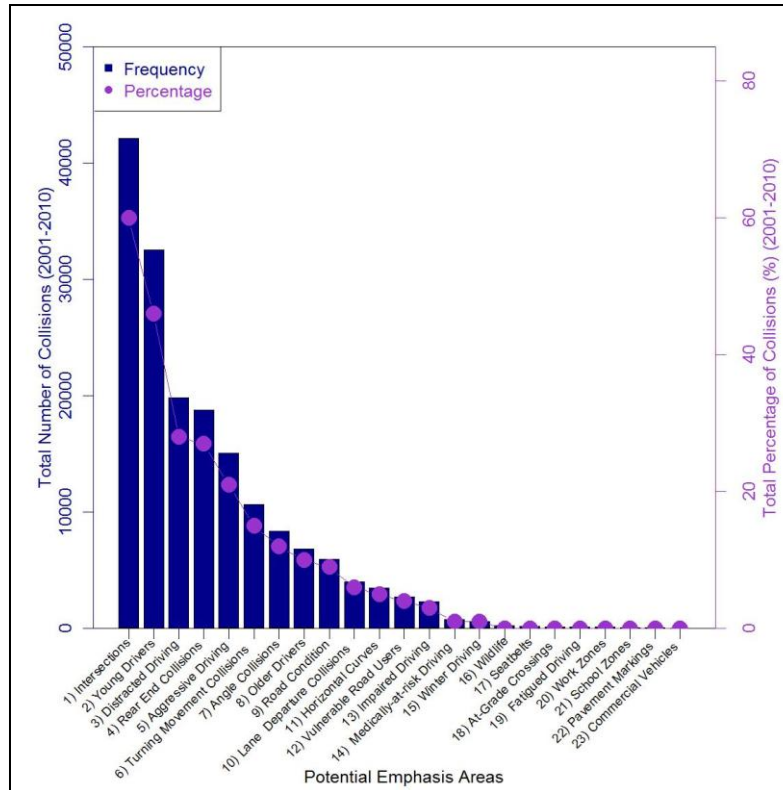
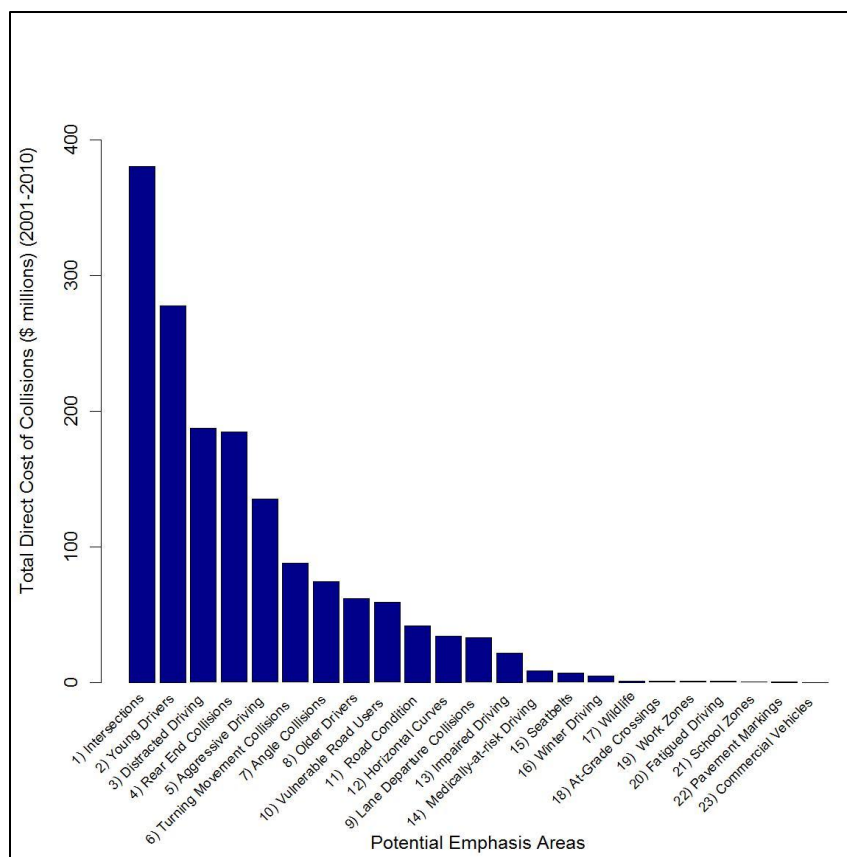
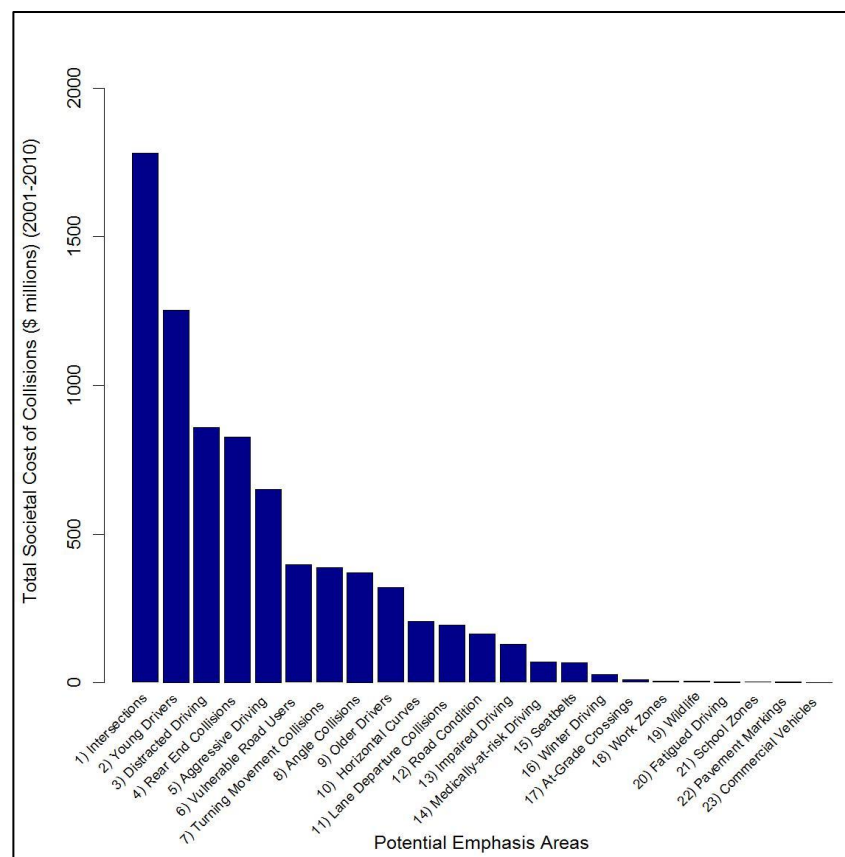


Figure 1. Number of Collisions by Potential Emphasis Areas, 2001-2010

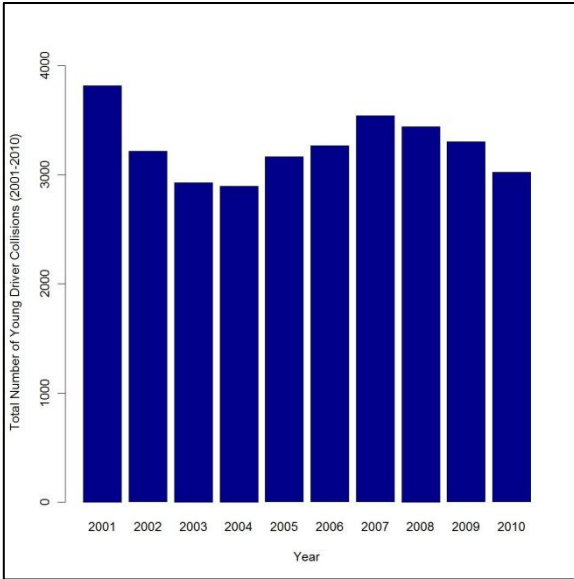


(a) Direct

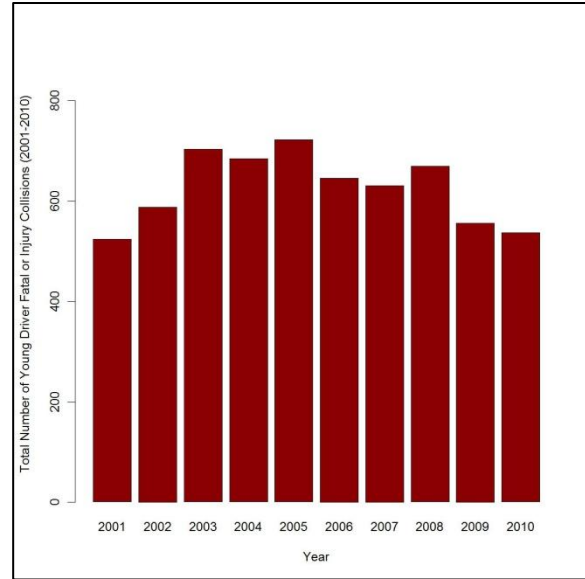


(b) Societal

Figure 2. Total Cost of Collisions by Potential Emphasis Areas (2007 \$ millions), 2001-2010

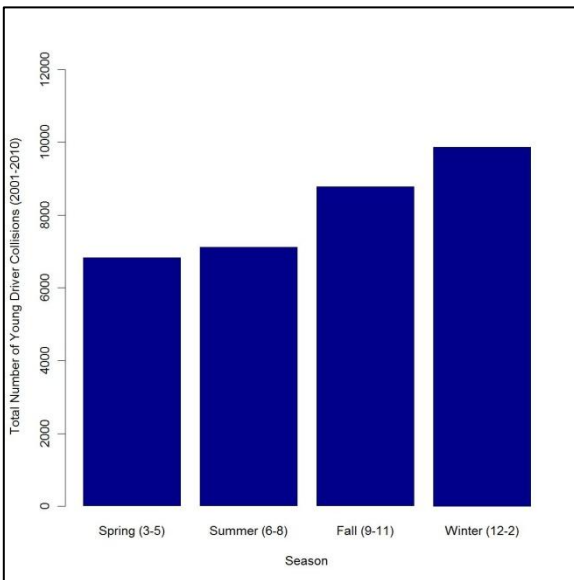


(a) Total

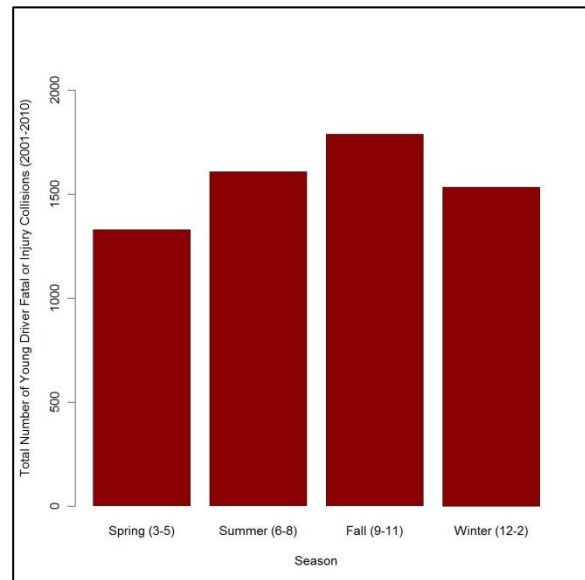


(b) Fatal or Injury

Figure 3. Number of Young Driver Collisions by Year, 2001-2010

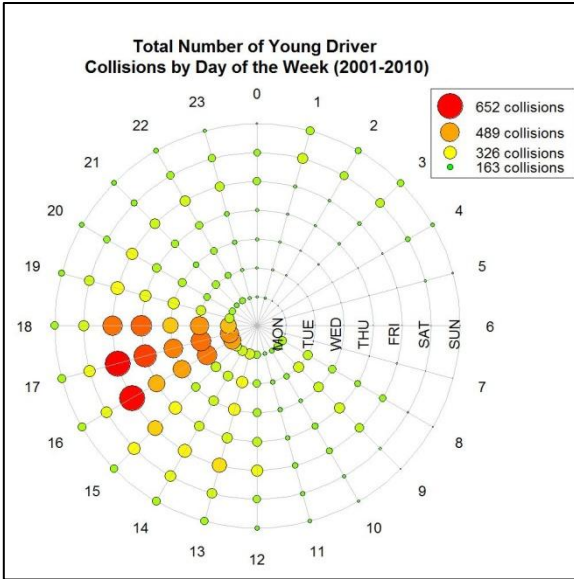


(a) Total

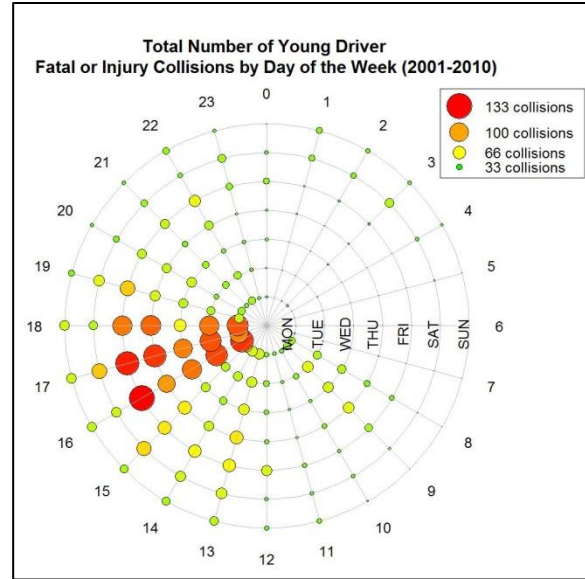


(b) Fatal or Injury

Figure 4. Number of Young Driver Collisions by Season, 2001-2010

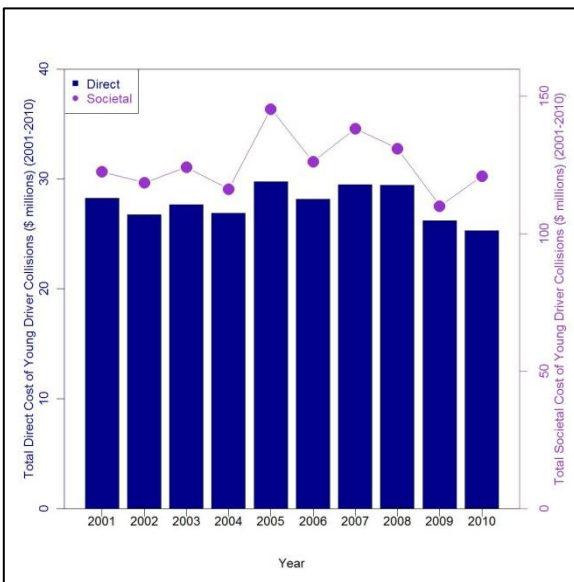


(a) Total

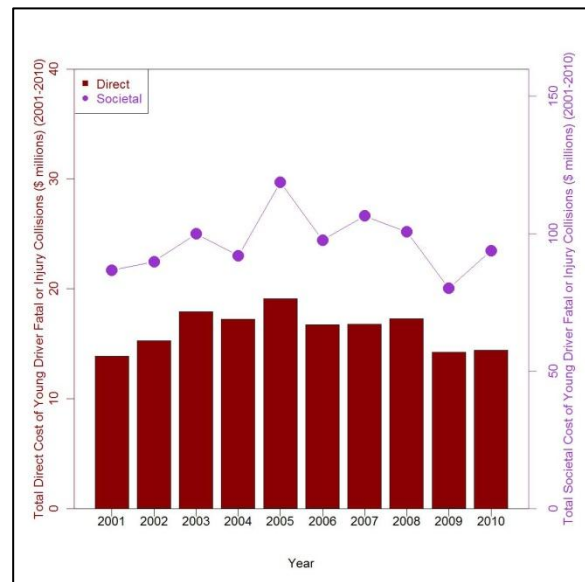


(b) Fatal or Injury

Figure 5. Number of Young Driver Collisions by Hour and Day of the Week, 2001-2010

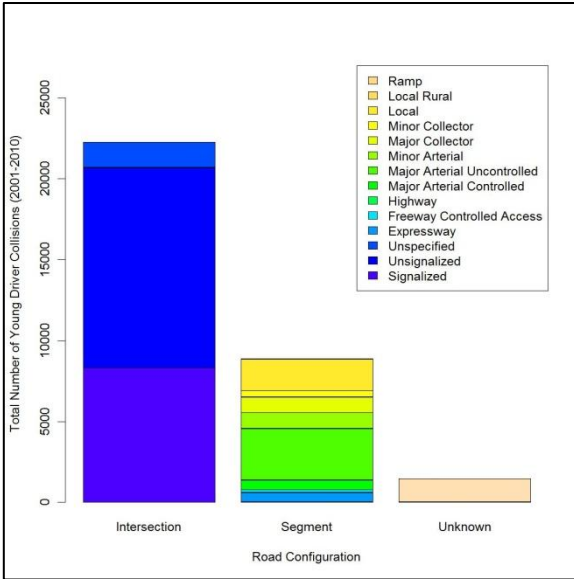


(a) Total

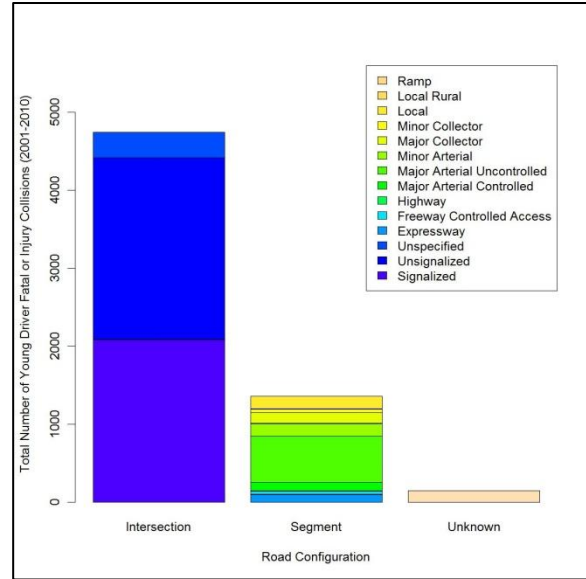


(b) Fatal or Injury

Figure 6. Direct and Societal Cost of Young Driver Collisions by Year (2007 \$ millions), 2001-2010

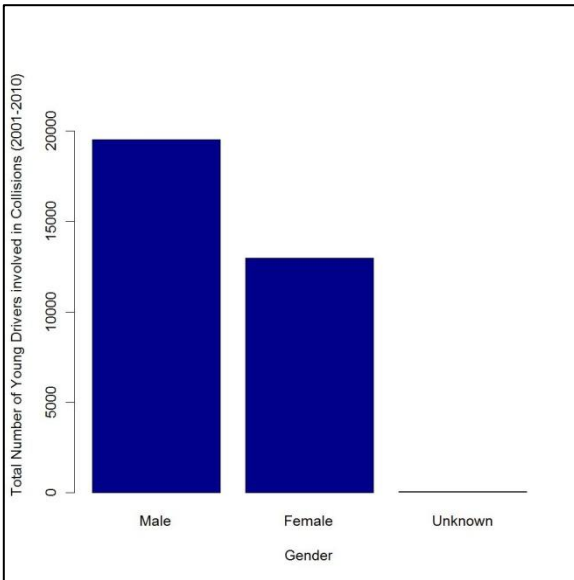


(a) Total

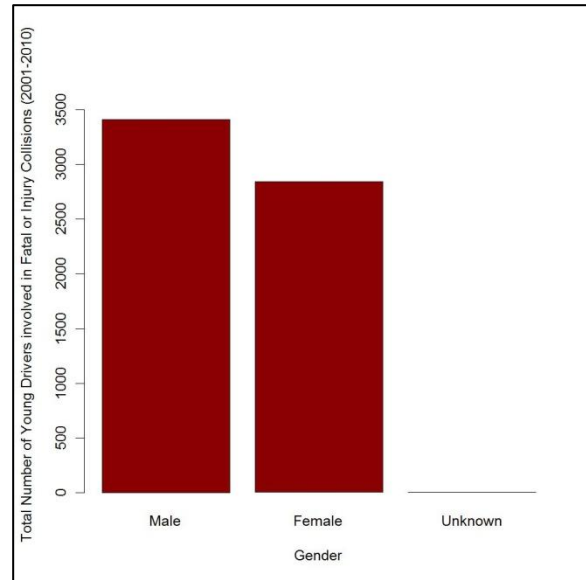


(b) Fatal or Injury

Figure 7. Number of Young Driver Collisions by Road Configuration and Road Classification, 2001-2010



(a) Total



(b) Fatal or Injury

Figure 8. Number of Young Drivers involved in Collisions by Gender, 2001-2010

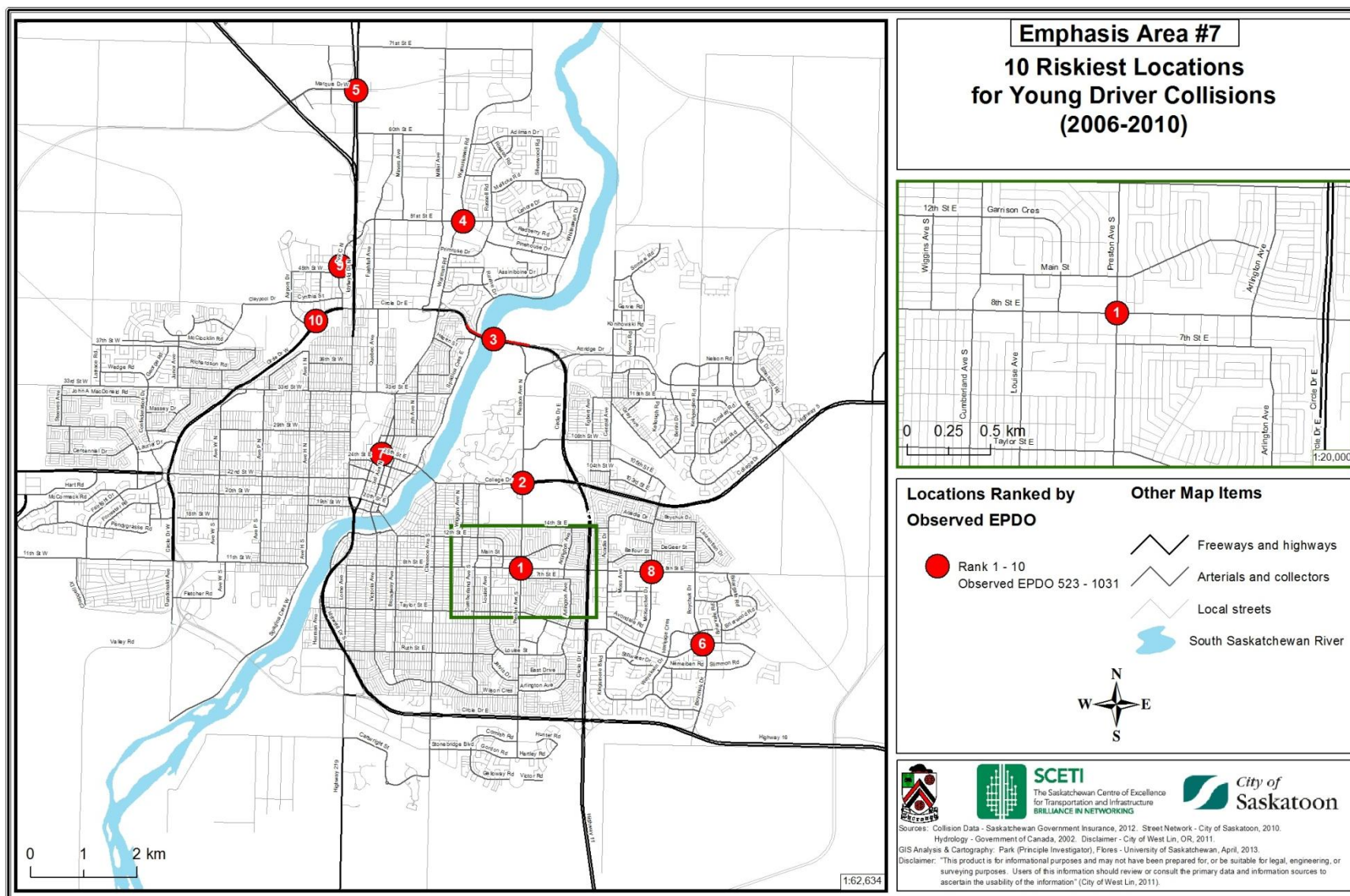


Figure 9. Young Driver Hotspots in Saskatoon

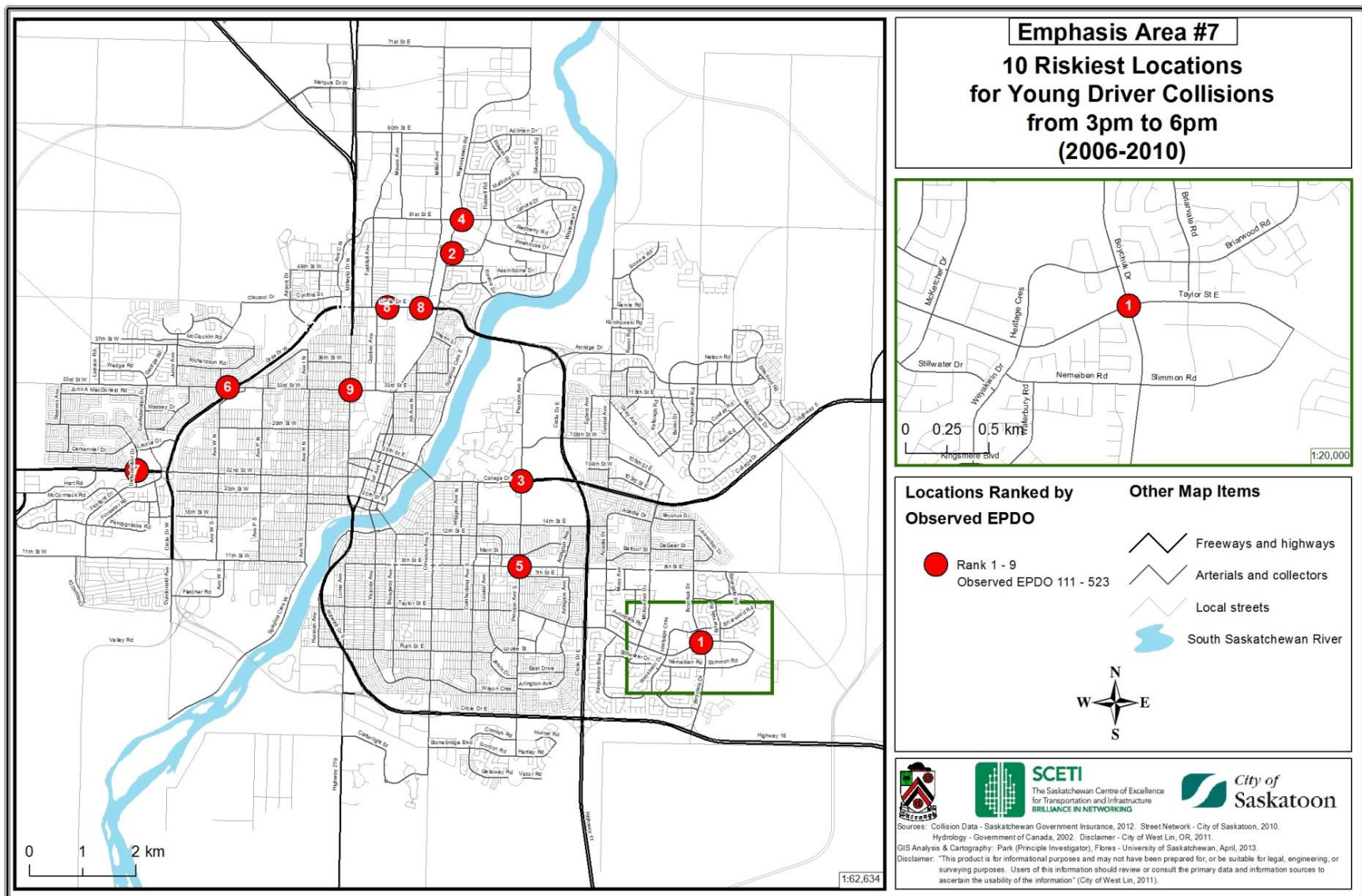


Figure 10. Young Driver Hotspots from 3pm to 6pm in Saskatoon