Saskatchewan Ministry of Highways and Infrastructure

NOVEMBER 2018

# HIGHWAY 35 AND HIGHWAY 335 INTERSECTION

## IN-SERVICE ROAD SAFETY REVIEW


McElhanney

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# Highway 35 & Highway 335 Intersection

# Intersection Safety Review

**November 2018**

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CERTIFICATE OF AUTHORIZATION

**McElhanney Consulting Services Ltd.**

Number 20663

Permission to Consult held by:

| Discipline | Sk. Reg. No. | Signature |
|---|---|---|
| CIVIL | 22616 | |

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# 1. Introduction

## 1.1 Study Background

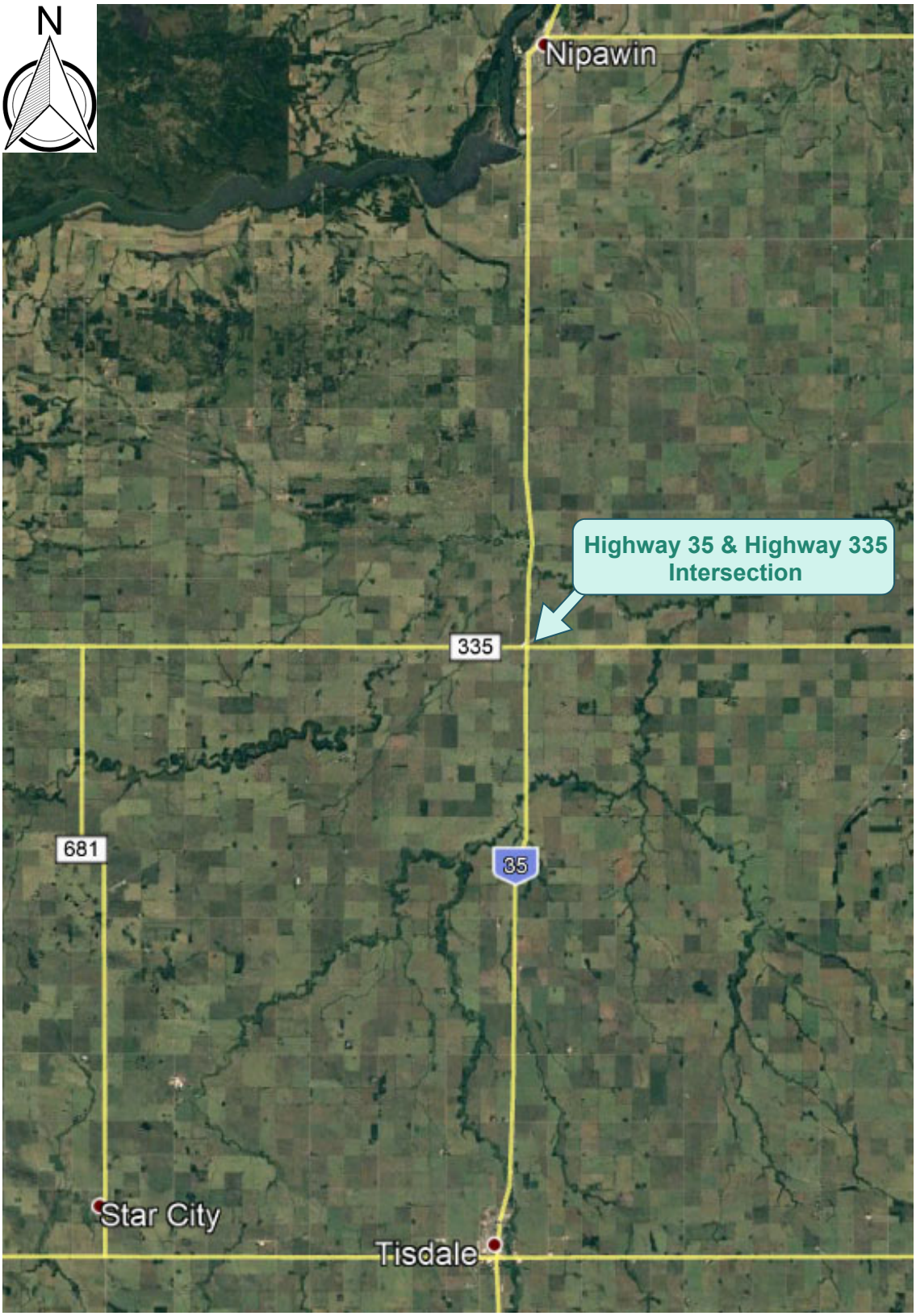
On April 6, 2018, a fatal collision occurred at the intersection of Highway 35 and Highway 335. The collision involved a tractor-trailer and a bus, which was transporting the Humboldt Broncos hockey team. The collision resulted in sixteen (16) fatalities and thirteen (13) injuries.

Given the severity of the incident, the Saskatchewan Ministry of Justice has commissioned McElhanney Consulting Services Ltd. (McElhanney) to conduct a safety review of the intersection.

The purpose of this study was to review the geometric, collision, traffic, and human factor characteristics of the intersection and identify any deficiencies or potential safety issues that could be increasing the risk (frequency and severity) of collisions at the intersection and to recommend mitigation strategies to reduce these risks.

## 1.2 Study Location

The intersection of Highway 35 and Highway 335 is located 30 kilometres north of Tisdale and 30 kilometres south of Nipawin, Saskatchewan as shown in Figure 1-1




*Source: Google Earth*

Figure 1-1: Location of Study Intersection

## 1.3 Methodology

This study was carried out following the methodology outlined in the Transportation Association of Canada's (TAC) *The Canadian Guide to In-Service Road Safety Reviews* (2004). The project methodology consisted of the following steps:

1. Collect relevant data from Ministry of Highways and Infrastructure (MHI), including traffic volumes, drawings, and collision data.
2. Visit the project site to gain an understanding of the physical characteristics and to collect photos, videos, and measurements.
3. Conduct 3D mobile scan of the site to obtain 360-degree photos and dimensions.
4. Analyze the physical, traffic, collision, and human factor characteristics of the intersection.
5. Conduct stakeholder interviews.
6. Identify potential safety issues and recommend improvement options.
7. Develop an implementation strategy using high level benefit-cost- analyses.

## 1.4 3D Mobile Scan

McElhanney conducted engineering-grade mobile mapping of the intersection which collected high-density, high-accuracy 3D point data, along with accurately georeferenced digital photography. Laser-based point cloud data was collected while moving by a module installed on top of a truck. Four specially-calibrated cameras mounted on the module capture photography at specified intervals and allowed for point colorization and asset identification.

## 1.5 Site Visits

The purpose of the site visit included observing vehicular operations within and adjacent to the intersection, documenting physical characteristics and geometric elements (including measurements), collecting an inventory of site photographs and videos, and assessing the conditions, placement and adequacy of signage in the study area.

Site visits were conducted during the following times:

- Thursday, August 30:
    - Daytime: 12:00pm and 7:00pm
    - Nighttime: 9:00pm and 10:30pm
- Friday August 31, 2018
    - Daytime: 9:00am and 12:00pm

Weather conditions included a mix of sunny and rainy conditions with a high temperature of 16°C.

# 2. Stakeholder Consultation

Several stakeholders were contacted to get feedback and information regarding the study intersection. A summary of these conversations is provided below:

## 2.1 RCMP Nipawin Detachment

The local RCMP Nipawin detachment was contacted to get feedback on their enforcement experience with the intersection, such as any history with speeding, stop control compliance, collisions, or other driver behaviours that should be considered as a part of this review.

The RCMP noted that there has been an increase in public complaints regarding stop sign violations at the intersection since the April 6, 2018 collision. No other driver behaviour concerns were identified.

## 2.2 RCMP Major Crimes Unit

The RCMP Major Crimes Unit was contacted as they are overseeing the investigation of the Humboldt Broncos Collision. Since the investigation is currently open, the unit was unable to provide any commentary regarding the collision or the intersection.

## 2.3 RCMP Traffic Services Unit

The Traffic Services Unit was contacted as they were responsible for conducting the collision reconstruction investigation for the Humboldt Broncos Collision. Similar to the Major Crimes Unit, they were not able to provide any commentary regarding the collision or the intersection due to the ongoing investigation.

## 2.4 Rural Municipality of Connaught

The RCMP Rural Municipality of Connaught was contacted to identify any concerns or recommended improvements that they, or their constituents, have identified. They noted that the most prevalent comments included:

- Improve signage;
- Install transverse rumble strips on Highway 335;
- Install a roundabout at the intersection; and,
- Install a 4-Way stop at the intersection.

# 3. Collision Analysis

Historical collision data at the intersection for the years between 1990 to 2017 (28 years) was provided by MHI. The data included collisions occurring within 500m of the intersection on both Highway 35 and Highway 335.

The collision data was reviewed to identify trends in the collision type, severity, time, vehicle type, direction, contributing factors, and road surface and lighting conditions. The analysis is separated into two categories:

- Intersection Collisions (Section 3.1): Collisions within the intersection.
- Non-Intersection Collisions (Section 3.2): Collisions close to the intersection, but unrelated to the intersection itself.

Detailed collision information is provided in Appendix A and a summary is provided in the following sections. The collision dataset does not include the fatal Humboldt Broncos collision as it occurred in 2018, beyond the data set limits. This collision is discussed separately in Section 3.3.

## 3.1 Intersection Collisions

### 3.1.1 Collision Frequency, Rate and Severity

A total of six (6) intersection related collisions occurred at the study intersection between 1990 and 2017, resulting in an average collision frequency of 0.21 collisions per year. A look at the more recent collision trends revealed:

- Last ten (10) years (2008 to 2017): 3 collisions, average of 0.3 collisions per year.
- Last five (5) years (2013 to 2017): 2 collisions, average of 0.4 collisions per year.

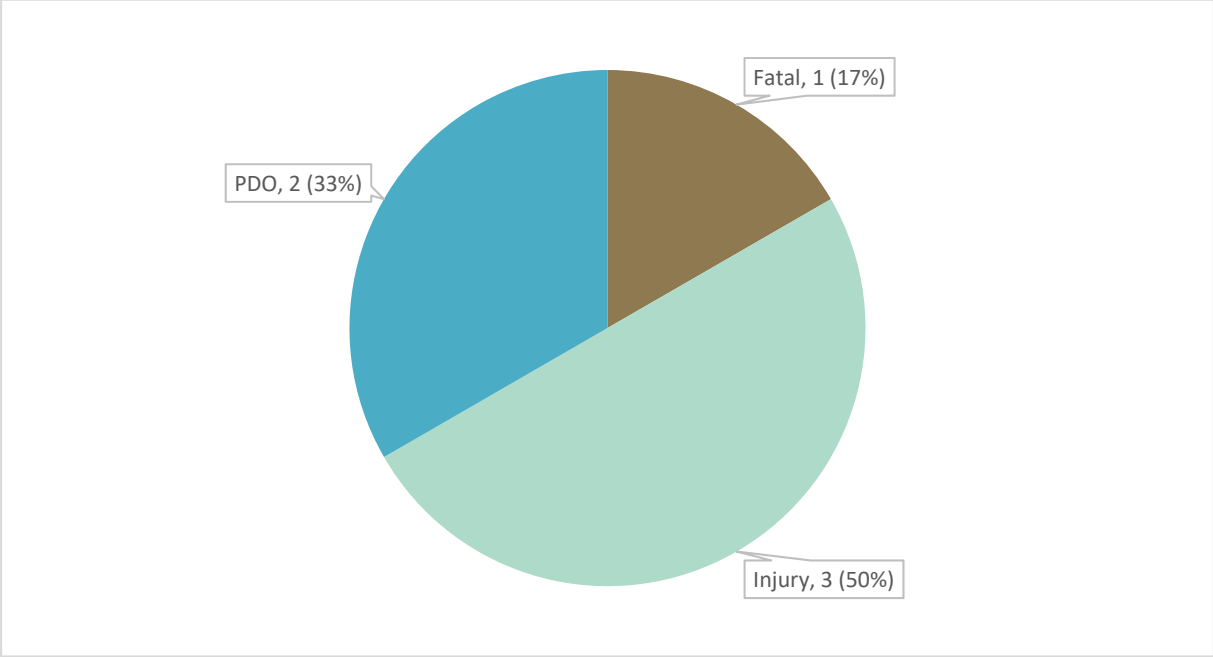
Compared to the overall 28-year analysis period, average annual collision frequency has been increasing, but is still very low.

The collision rate over the 28-year analysis period equates to 0.34 collisions per million vehicles entering the intersection. A look at the more recent collision trends revealed:

- Last ten (10) years (2008 to 2017): 0.46 collisions per million vehicles entering the intersection.
- Last five (5) years (2013 to 2017): 0.61 collisions per million vehicles entering the intersection.

Compared to the overall 28-year analysis period, collision rates have been increasing. Provincial average intersection collision rates were not found for comparison purposes.

- The distribution of intersection collisions by severity over the analysis period is provided in Figure 3-1.




*PDO = Property Damage Only*

Figure 3-1: Distribution of Intersection Collisions by Severity (1990 – 2017)

- Although the frequency of collisions at the intersection is low, the severity of the collisions is high with 50% resulting in injury and 17% resulting in fatality.
- The fatal collision occurred in 1997 and involved an eastbound vehicle colliding with a southbound vehicle at a right angle. Media reports indicate that the eastbound vehicle failed to stop at the stop-control and travelled into the path of the oncoming southbound vehicle. The collision resulted in six (6) fatalities in the eastbound pickup truck. The driver of the southbound tractor-trailer was not seriously injured.

### 3.1.2 Spatial Distribution

- A breakdown of travel directions for vehicles involved in intersection collisions is provided in Figure 3-2.

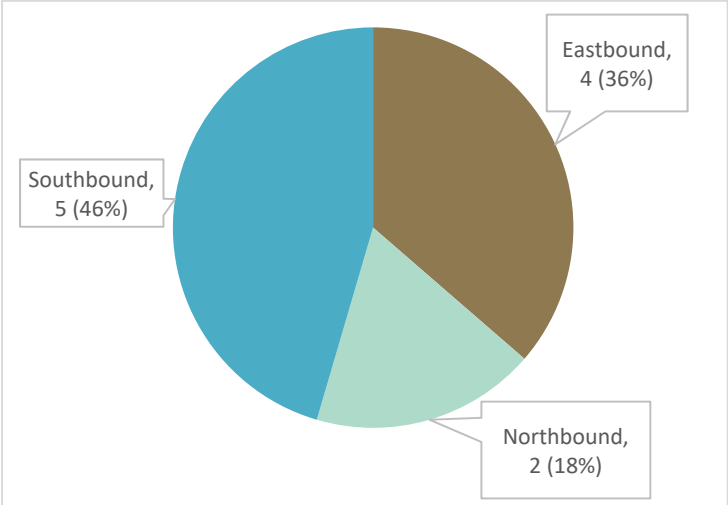



Figure 3-2: Distribution of Intersection Collision Travel Directions (1990 – 2017)

- The majority of vehicles (64%) were travelling on Highway 35, with 36% travelling eastbound on Highway 335. No intersection collisions involving westbound vehicles were recorded in the 28-year analysis period.

### 3.1.3 Temporal Distribution

- There were no annual trends with no year experiencing more than one collision. The six collisions occurred in 1994, 1997, 2000, 2011, 2016 and 2017.

- June had the highest collision frequency (2 collisions). The distribution of collisions by month is provided in Figure 3-3.

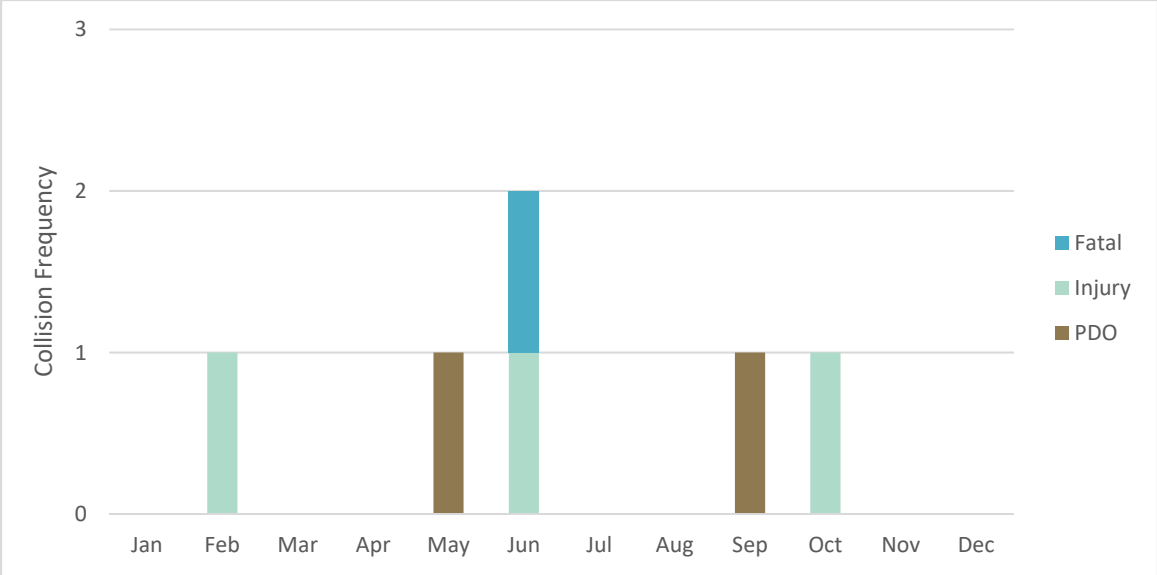



Figure 3-3: Distribution of Intersection Collisions by Month (1990 – 2017)

- The distribution of collisions by time of day is provided in Figure 3-4. The majority of collisions occurred during daylight (5 incidents) with the remaining one occurring at dawn. The collision at dawn involved struck wildlife.

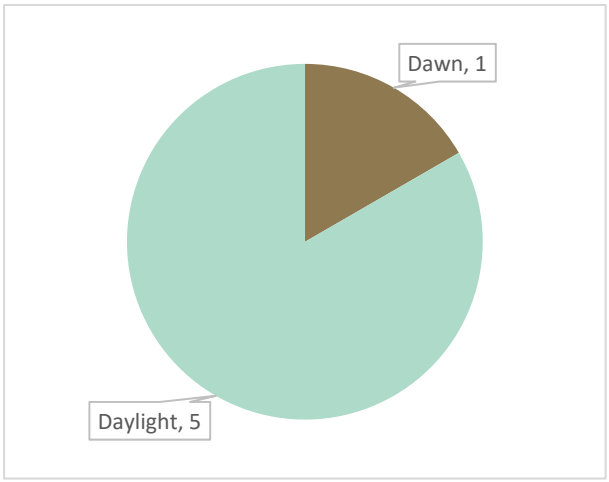



Figure 3-4: Distribution of Intersection Collisions by Time of Day (1990 – 2017)

- All six (6) intersection collisions occurred during dry road surface conditions.

### 3.1.4 Collision Type

- The distribution of collisions by type is provided in Figure 3-5. Right angle collisions were the most frequent (2 incidents). The collision type of two collisions was not specified.

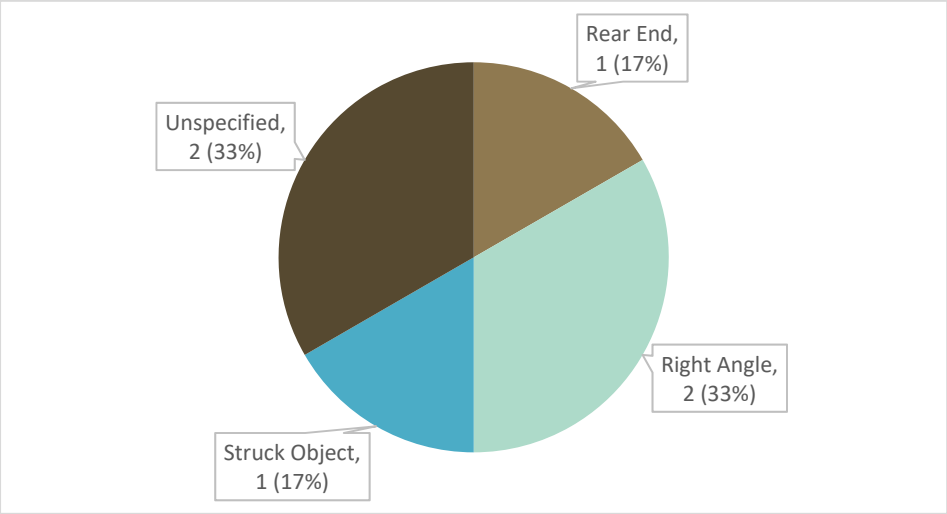
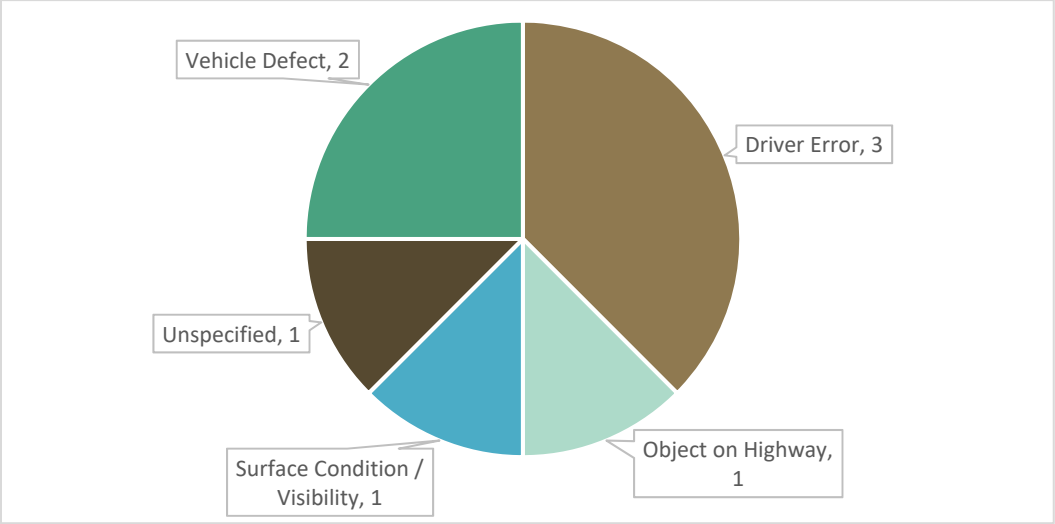



Figure 3-5: Distribution of Collisions by Type (1990 – 2017)

- Of the two right angle collisions, one involved an eastbound and northbound vehicle, while the other involved an eastbound and a southbound vehicle, which resulted in multiple fatalities. Driver error was a contributing factor for both collisions, while surface condition and/or visibility was a contributing factor to the collision involving the eastbound and southbound vehicle.
- One of the collisions was a struck object collision that involved a struck animal.
- One of the collisions was a rear-end that involved southbound vehicles travelling through the intersection.
- Two of the collisions were not categorized according to type. One of these collisions involved multiple vehicles.
- The distribution of collisions by contributing factor is provided in Figure 3-6. Driver error was a contributing factor in three (3) collisions, while vehicle defect was a contributing factor in two (2) of the collisions.




*Note: The total count exceeds the total number of collisions as some collisions have multiple contributing factors.*

Figure 3-6: Distribution of Contributing Factors for Intersection Collisions (1990 – 2017)

### 3.1.5 Vehicle Type

- A breakdown of the classification of vehicles involved in collisions is provided in Figure 3-7. Trucks were involved in 54% of collisions. Considering that trucks represent on average 19% of vehicles passing through the intersection, the proportion of trucks involved in collisions is high.

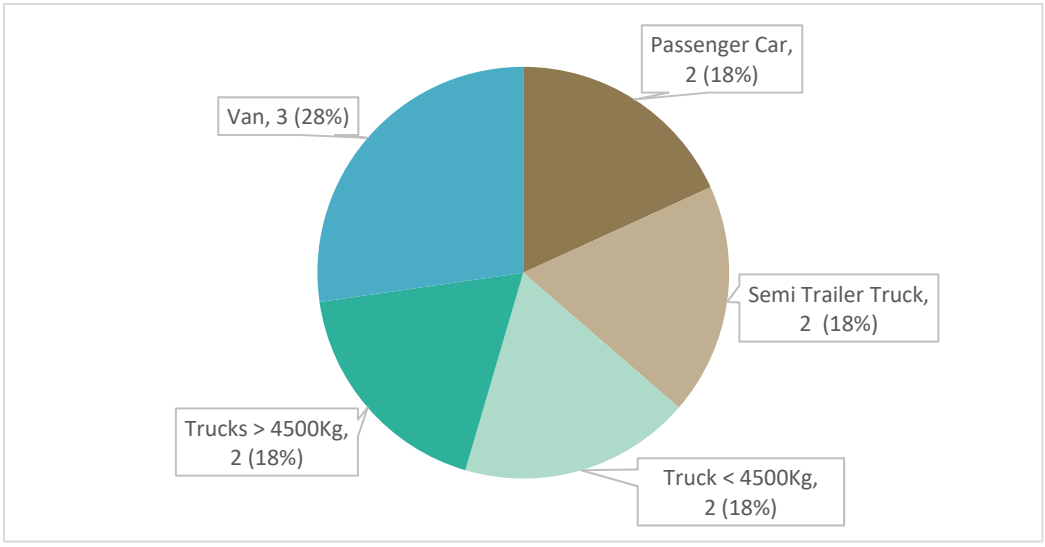



Figure 3-7: Classification of Vehicles Involved in Collisions (1990 – 2017)

## 3.2 Non-Intersection Collisions

### 3.2.1 Collision Frequency, Rate and Severity

A total of 14 non-intersection collisions occurred between 1990 and 2017, resulting in an average collision frequency of 0.5 collisions per year. A look at the more recent collision trends revealed:

- Last ten (10) years (2008 to 2017): 5 collisions, average of 0.5 collisions per year.
- Last five (5) years (2013 to 2017): 2 collisions, average of 0.4 collisions per year.

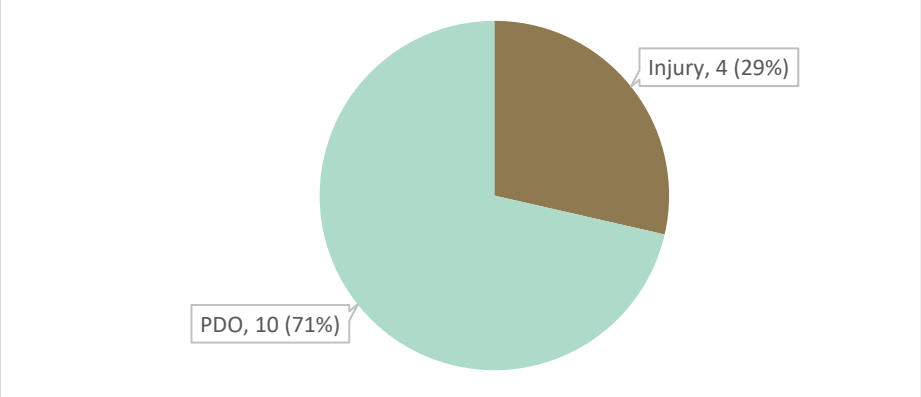
Compared to the overall 28-year analysis period, average annual collision frequencies have remained consistent in recent years.

The collision rate over the 28-year analysis period equates to approximately 0.8 collisions per million vehicle kilometers. A look at the more recent collision trends revealed:

- Last ten (10) years (2008 to 2017): 0.77 collisions per million vehicle kilometers.
- Last five (5) years (2013 to 2017): 0.61 collisions per million vehicle kilometers.

Compared to the overall 28-year analysis period, collision rates have been decreasing.

- The distribution of collisions by severity over the analysis period is provided in Figure 3-8. Injury and PDO collisions account for 29% and 71%, respectively.




*PDO = Property Damage Only*

Figure 3-8: Distribution of Non-Intersection Collisions by Severity (1990 – 2017)

### 3.2.2 Spatial Distribution

- Collisions occurring adjacent to the intersection had the following spatial distribution:
    - Eleven (11) on the north leg (8 northbound, 2 southbound, 1 unspecified);
    - Two (2) on the south leg (both southbound); and,
    - One (1) on the west leg (westbound).

- A breakdown of vehicle travel directions is provided in Figure 3-9.

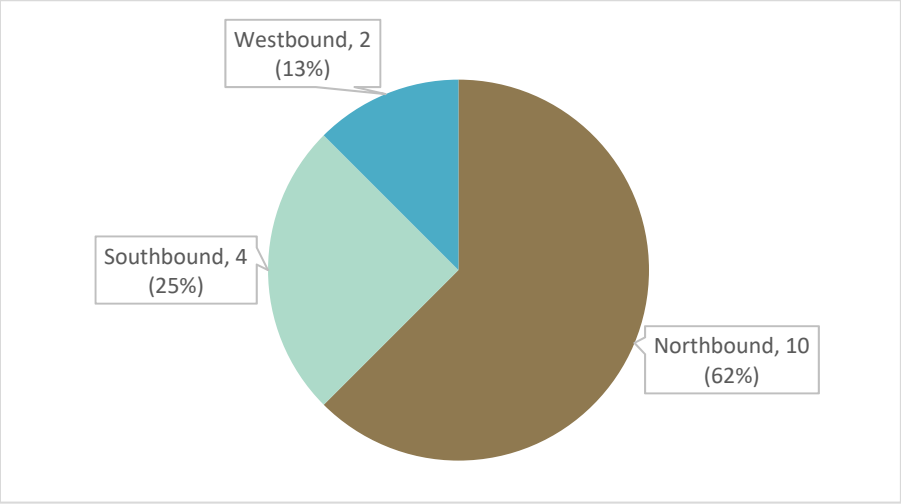



Figure 3-9: Distribution of Non-Intersection Collision Travel Directions (1990 – 2017)

- The majority of vehicles (87%) were travelling on Highway 35, with 13% travelling westbound on Highway 335. There were no non-intersection collisions involving eastbound vehicles within the 28-year analysis period.

### 3.2.3 Temporal Distribution

- Within the review period, the highest number of collisions were observed in 2009 and 2016 (2 incidents each). No trends in the yearly distribution of collisions could be discerned due to the relatively low frequency of collisions. The distribution of collisions by year is provided in Figure 3-10.

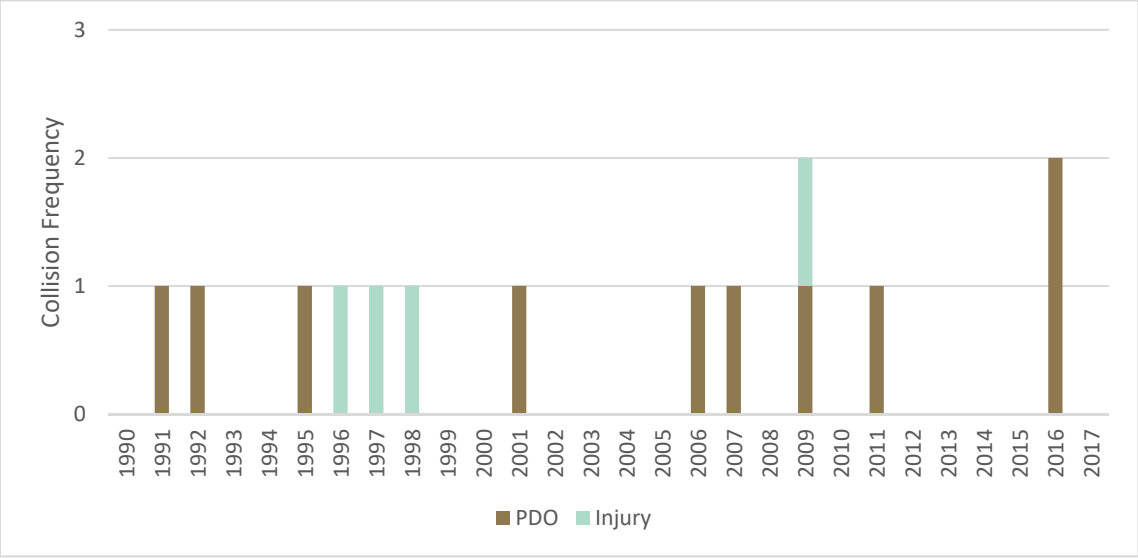



Figure 3-10: Distribution of Non-Intersection Collisions by Year (1990 – 2017)

- The distribution of collisions by month is provided in Figure 3-11. February, August, September and October had the highest number of collisions per month (2 incidents each).

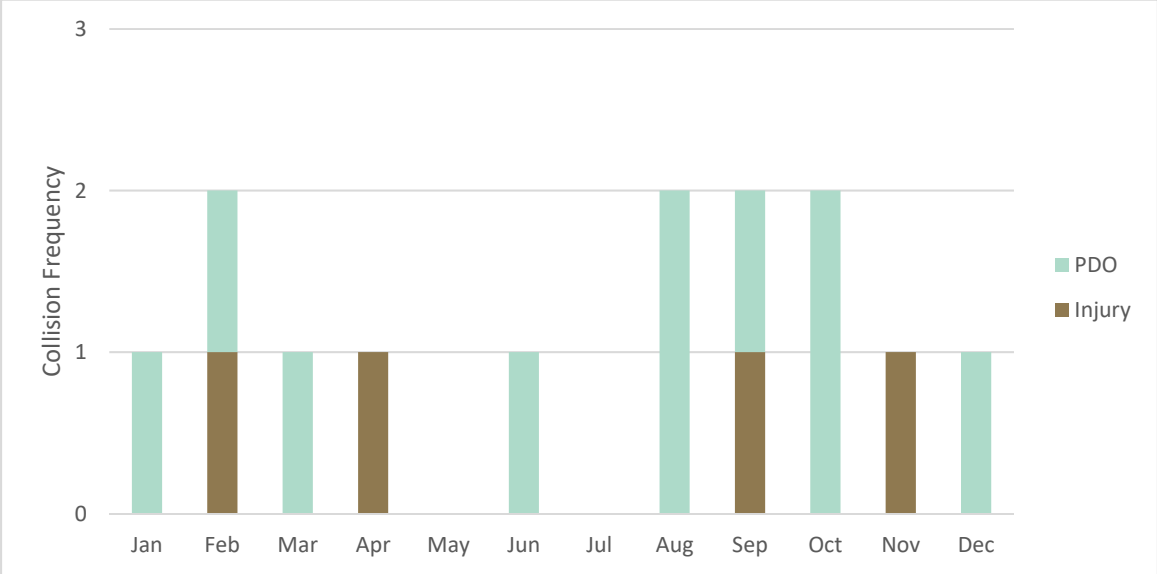



Figure 3-11: Distribution of Non-Intersection Collisions by Month (1990 – 2017)

- The distribution of collisions by time of day is provided in Figure 3-12. 72% of the collisions occurred during darkness (10 incidents), followed by 21% of collisions occurring during daylight (3 incidents). Given the lower traffic volumes at night, collisions occurring during dark conditions are overrepresented. A review of the nighttime collisions revealed four of the collisions were run-off-road right and three were struck object. Four of the ten nighttime collisions included objects on the highway, including two collisions with wildlife and one involving debris on the highway.

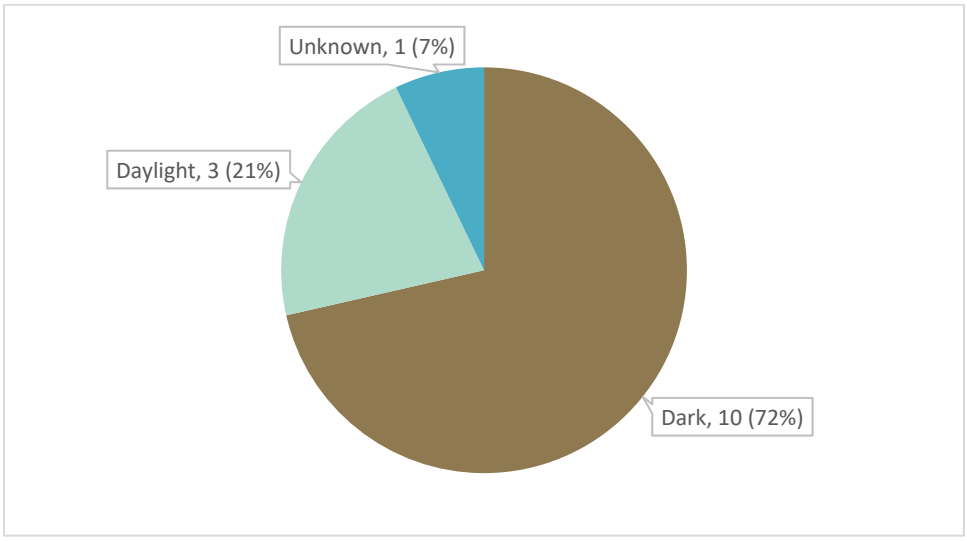



Figure 3-12: Distribution of Non-Intersection Collisions by Time of Day (1990 – 2017)

- The distribution of collisions by surface condition is provided in Figure 3-13. Snowy and icy surface conditions were present in 22% of the collisions (3 incidents), while wet conditions were present in 7% of collisions (1 incident).

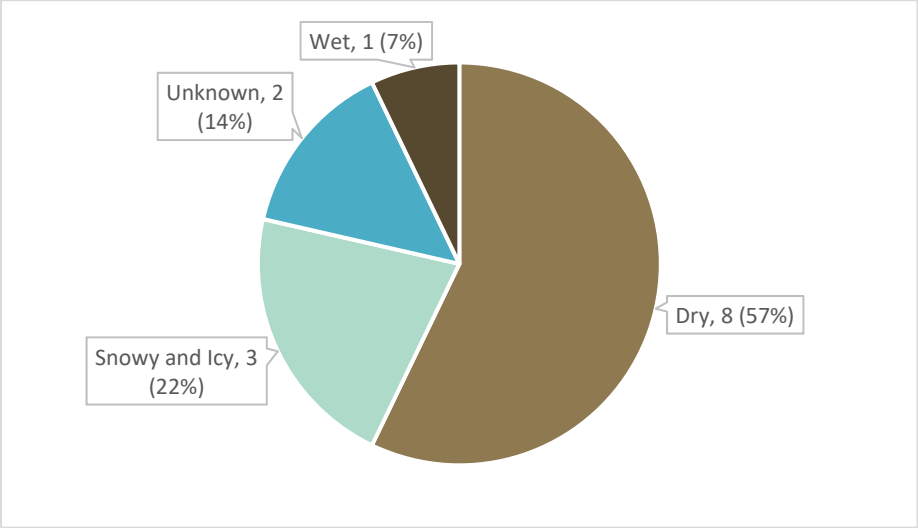



Figure 3-13: Distribution of Non-Intersection Collision Road Surface Conditions (1990 – 2017)

### 3.2.4 Collision Type

- The distribution of collisions by type is provided in Figure 3-14. Run-off road collisions were the most frequent (5 incidents) followed by struck object collisions (4 incidents). The collision type of four collisions was not specified.

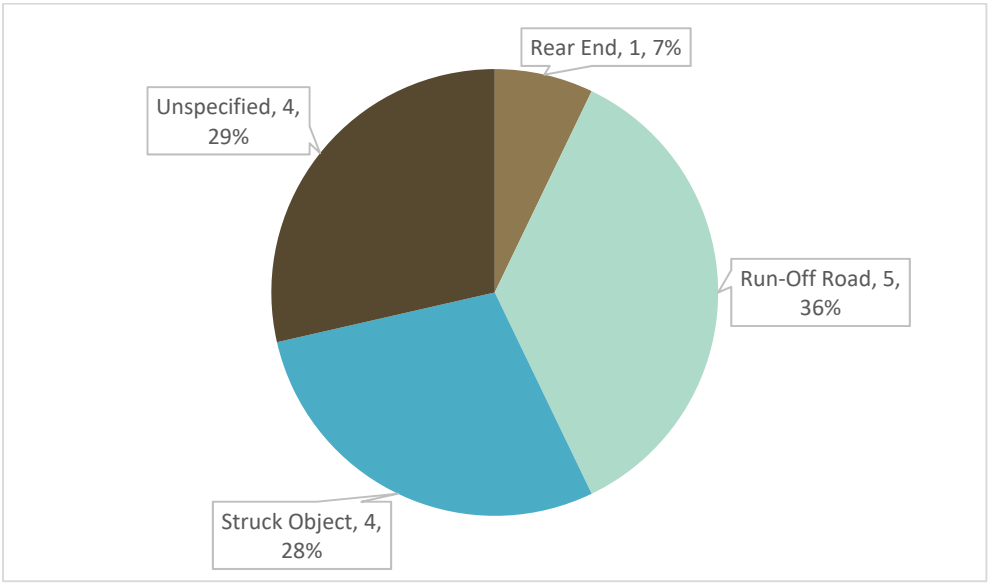
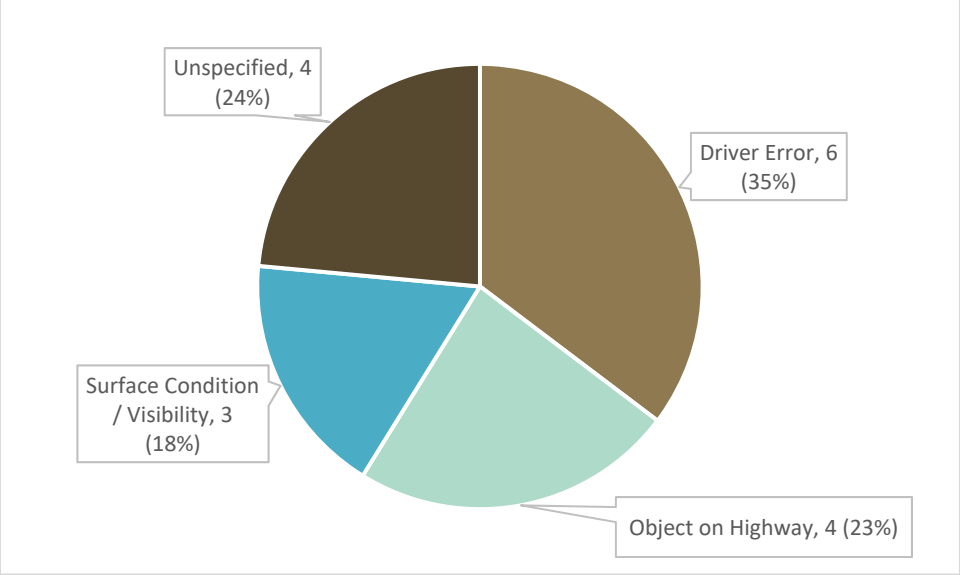



Figure 3-14: Distribution of Collisions by Type (1990 – 2017)

- Five of the collisions were run-off-road collisions. One occurred during daylight, while four occurred during darkness.
- Of the four struck objects collisions, one involved a struck animal, one involved debris on the highway, one involved a struck railway warning signal and one involved a struck tree. Three of the collisions occurred during darkness with the remaining collision occurring at an unspecified time of day.
- One collision was a rear-end collision involving southbound vehicles north of the intersection.
- Four of the collisions were not categorized according to type. One collision involved multiple vehicles while another involved a jack-knifed truck.
- The distribution of collisions by contributing factor is provided in Figure 3-15. Driver error was a contributing factor in 35% of collisions (6 incidents), while object on the highway was a contributing factor in 23% of collisions (4 incidents).




*Note: The total count exceeds the total number of collisions as some collisions have multiple contributing factors.*

Figure 3-15: Distribution of Contributing Factors for Collisions (1990 – 2017)

### 3.2.5 Vehicle Type

- A breakdown of the classification of vehicles involved in collisions is provided in Figure 3-16. Trucks were involved in 50% of collisions. Considering that trucks represent on average 19% of vehicles travelling along Highway 35 and Highway 335, the proportion of trucks involved in collisions is high.

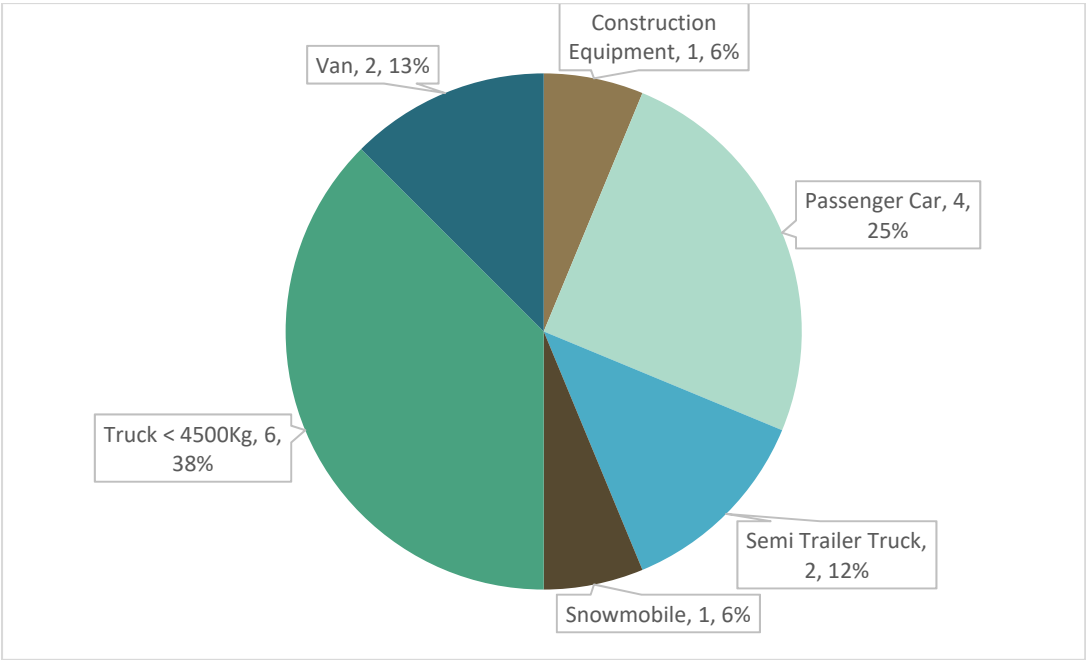



Figure 3-16: Classification of Vehicles Involved in Collisions (1990 – 2017)

## 3.3 April 6, 2018 Fatal Collision

Although the full collision dataset for 2018 is not yet available, there was a fatal collision on April 6, 2018. The incident occurred at approximately 5:00pm and was a right-angle collision between a northbound bus and a westbound tractor-trailer. The collision resulted in sixteen (16) fatalities and thirteen (13) injuries amongst the bus passengers and minor injuries to the driver of the tractor-trailer.

## 3.4 Conflict Analysis

Traffic video footage from approximately 4:00 PM to 5:30 PM on Thursday, August 30, 2018 and from 9:45AM to 10:30 AM on Friday, August 31, 2018 was reviewed to identify vehicle conflicts and driving infractions at the intersection to identify near miss incidents or other characteristics that may help identify potential safety issues. The following conflicts/infractions were identified within the review period:

- Two (2) eastbound vehicles and one (1) westbound vehicle performed a “rolling stop”.
- An eastbound left-turn vehicle failed to yield the right of way to a westbound vehicle after both had stopped at the stop signs.

There were no observed collisions at the intersection during the review period. Majority of the observed eastbound and westbound vehicles obeyed the stop signs and came to a complete stop before entering the intersection.

# 4. Highway Characteristics

## 4.1 Highway 35

In the vicinity of the intersection, Highway 35 is a two-lane major arterial highway with a functional classification of U120-7420. As such, the highway has a design speed of 120 km/h and a posted speed limit of 100 km/h.

Highway 35 is oriented in a predominantly north-south direction in east Saskatchewan extending from north of Nipawin to the Canada / U.S.A. border.

Based on traffic volumes provided by MHI, the 2016 Annual Average Daily Traffic (AADT) was 1,320 vehicles north of Highway 335 and 1,100 vehicles to the south. Additional traffic volume information is provided in Section 5.

## 4.2 Highway 335

In the vicinity of the intersection, Highway 335 is a collector highway with a functional classification of U110-7020. As such, the highway has a design speed of 110 km/h and a posted speed limit of 100 km/h.

Highway 335 is oriented in a predominantly east-west direction in central Saskatchewan extending from Gronlid in the west to Aborfield in the east.

Based on traffic volumes provided by MHI, the 2016 AADT was 560 vehicles east of Highway 35 and 510 vehicles to the west. Additional traffic volume information is provided in Section 5.

## 4.3 Surrounding Land Use

The land use near the intersection includes a mix of farmland, rural residences, and grain elevators. There are two grain elevators close to the intersection, including Cargill, which is located 100 m north of the intersection and the Bunge Parkland Terminal, which is located 1.4 kilometres to the west.

There is a gravel roadway / parking area located in the northwest corner of the intersection, which can be accessed via both Highway 35 and Highway 335. The parking area was present prior to the April 6, 2018 collision, but has since become the location of a roadside memorial. During the site visit, the memorial was observed to attract numerous visitors throughout the day. Furthermore, it appears that the parking area is regularly used by locals, possibly as a place to leave a vehicle when meeting and travelling with others. One or two vehicles were typically parked in the area during the daytime site visits.

# 5. Traffic Operations

## 5.1 Traffic Volumes

The estimated historical Average Annual Daily Traffic (AADT) and Truck Average Annual Daily Traffic (TAADT) along Highway 35 and Highway 335 were obtained from MHI using short-term 24 hour or 48 hour counts along the highway, inclusive of traffic in both directions. The estimated AADT and TAADT on Highway 35 and Highway 335 adjacent to the intersection are provided below in Figure 5-1 and Figure 5-2 respectively.

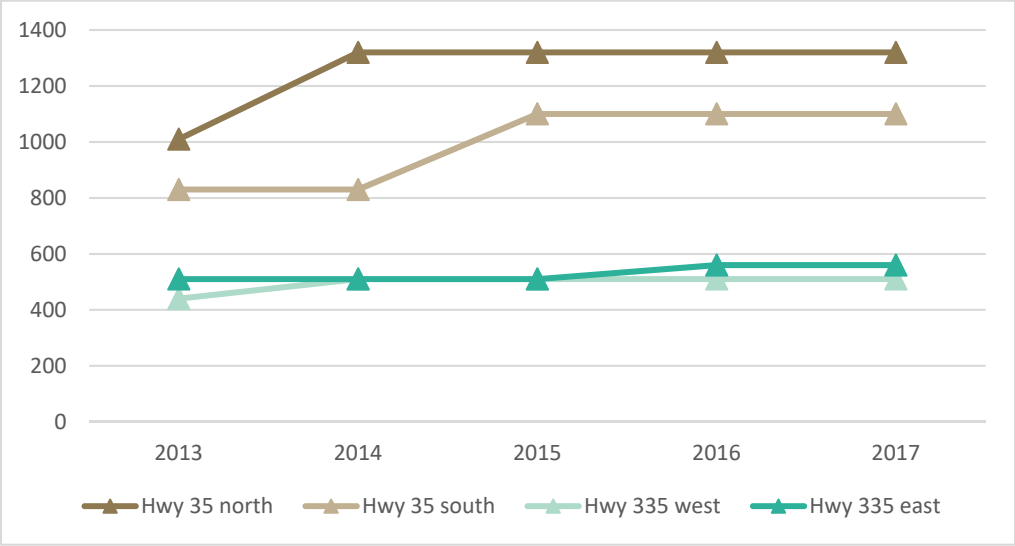



Figure 5-1: Estimated Average Annual Daily Traffic Volumes

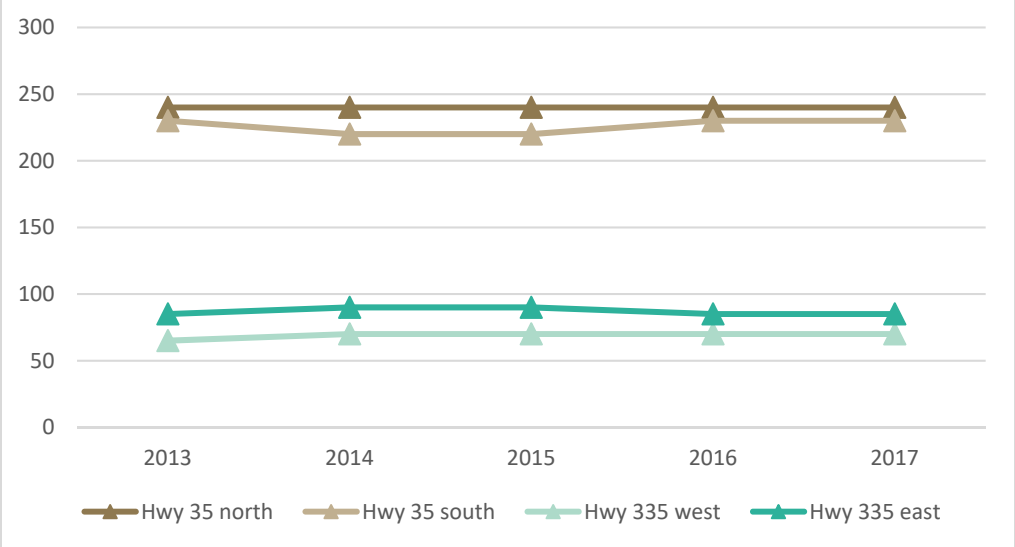



Figure 5-2: Estimated Truck Average Annual Daily Traffic Volumes

The following trends regarding the estimated AADT and TAADT were identified:

- AADT and TAADT estimates have remained generally constant in the last five years. The notable exception was an increase in AADT on Highway 35 in the years 2014 and 2015.
- AADT and TAADT on Highway 35 are approximately double of those on Highway 335.
- The percentage of truck traffic as part of the overall traffic stream is estimated at between 18 - 28% along Highway 35 and 14 -18% along Highway 335.

Average hourly traffic volumes on Highway 35 and Highway 335 were collected for a continuous 48 hour period between May 24 – 26, 2016 and a continuous 24 hour period between June 2 – 3, 2016. A summary of the average hourly volumes is provided in Figure 5-3 and the hourly truck volumes are provided in Figure 5-4.

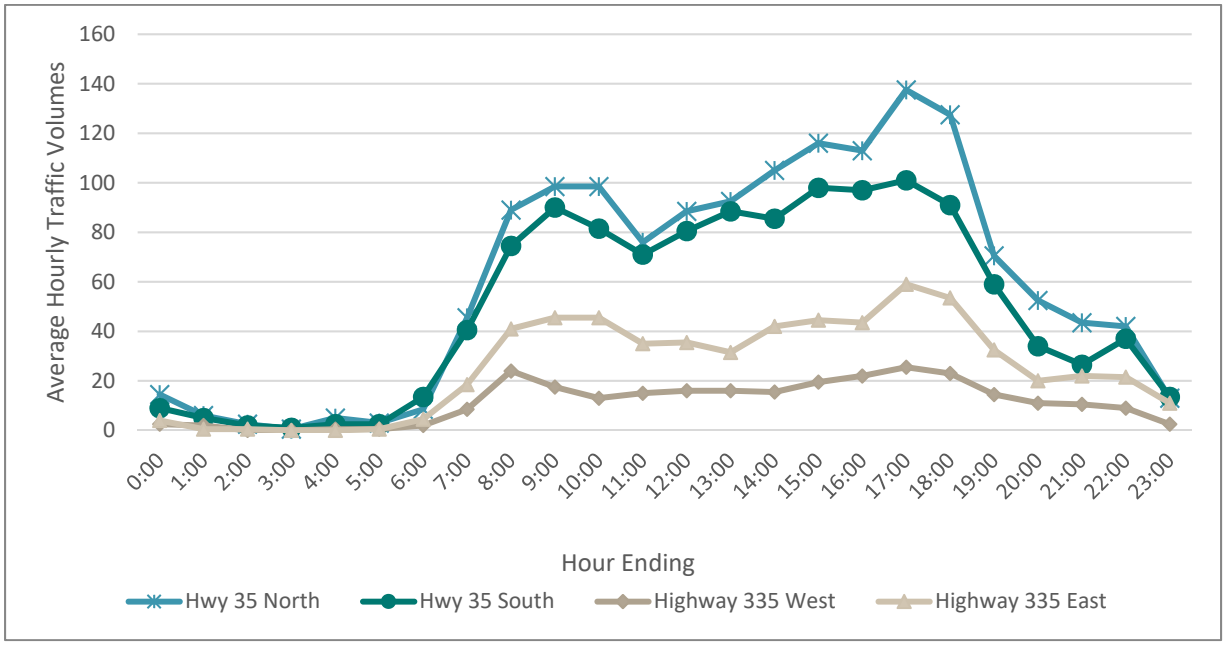



Figure 5-3: Average Hourly Traffic Volumes

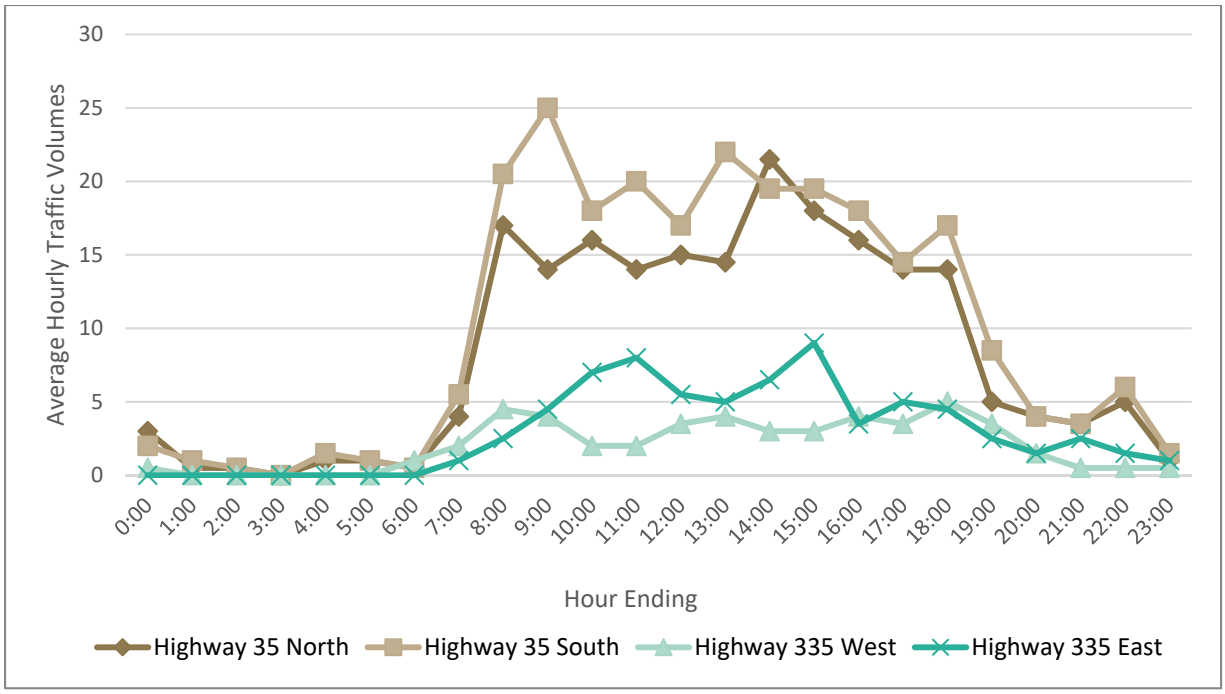



Figure 5-4: Average Truck Hourly Traffic Volumes

The following trends regarding the average hourly traffic volumes were identified:

- Average hourly traffic volumes are generally highest in the morning between 8:00am – 10:00am and between 4:00pm – 5:00pm in the afternoon.
- Truck volumes peak in the morning between 8:00am – 9:00am.
- The distribution of hourly volumes on both Highway 35 and Highway 335 are generally consistent with the overall trend on rural Saskatchewan highways, according to MHI's *Travel on Saskatchewan Highway 2016*.

## 5.2 Intersection Turning Movement Volumes

Intersection turning movement volumes were obtained from MHI. The volumes were recorded over a 12-hour period on October 30, 2018. The AM peak hour was determined to be 7:30 to 8:30 AM while the PM peak hour was determined to be 4:30 to 5:30 PM. Detailed traffic count data is provided in Appendix B. The AM and PM peak hour volume are summarized in Figure 5-5.

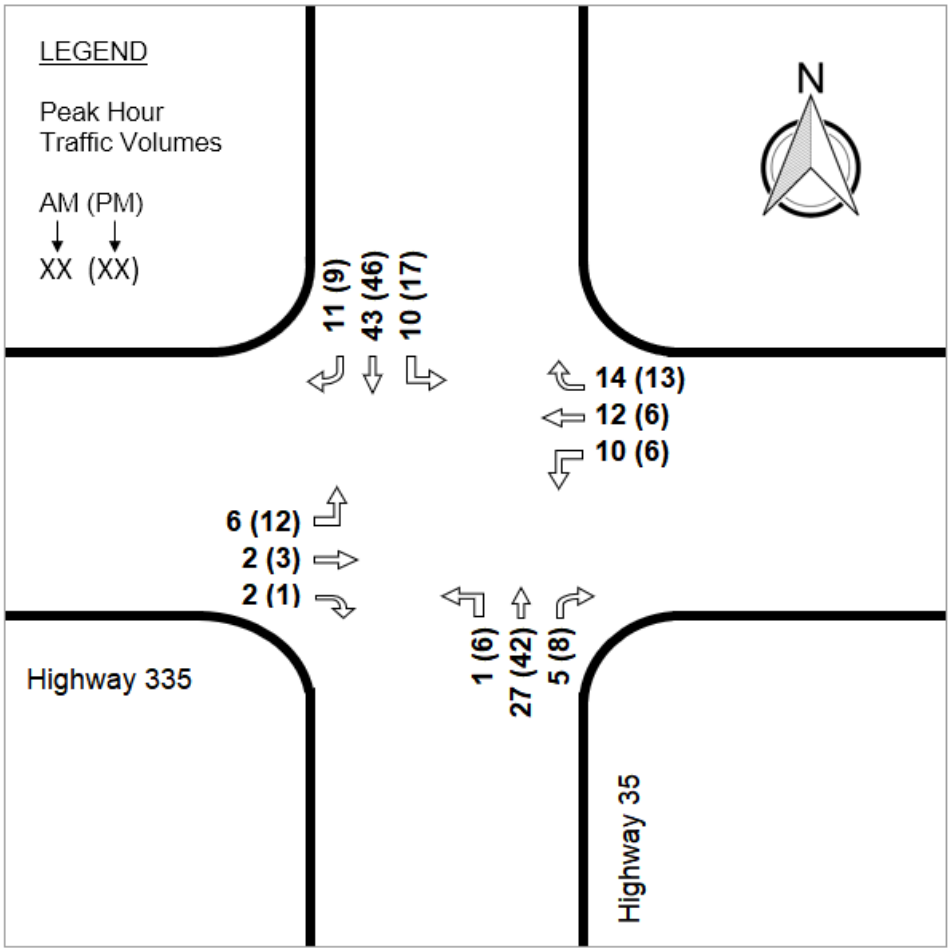



Figure 5-5: Peak Hour Turning Movement Volumes

The following trends regarding the peak hour intersection turning movement volumes were identified:

- The PM peak hour has generally higher volumes than the AM peak hour.
- The majority of vehicles on Highway 335 turned onto Highway 35 rather than travelling through the intersection while the majority of Highway 35 traffic was through traffic.

The peak hour turning movement volumes were analyzed using the Synchro 9 software to assess Level of Service (LOS) for the intersection in addition to the LOS of individual movements. LOS is a measure of performance based on a scale of LOS A to LOS F with LOS A representing little delay and LOS representing failing conditions.

The LOS of the intersection and all approaches was LOS A, with the exception of the eastbound approach, which is LOS B. The results indicate that there are no operational concerns (e.g. delay, congestion) at the intersection. Detailed analysis of intersection turning movement volumes are provided in Appendix B.

## 5.3 Growth Factor

The 15-year growth factor for traffic along Highway 35 and Highway 335 were provided by MHI. The growth factor for Highway 35 north of the intersection is 1.2, which indicates a growth of 20% over a 15-year period. The growth factor for Highway 35 south of the intersection is 1, which indicates no growth after a 15-year period. Similarly, the growth rate for Highway 335 east of the intersection is 1. The growth factor for Highway 335 west of the intersection is 1.05, which indicates a growth of 5% over a 15-year period.

# 6. Geometric Design Characteristics

The physical and geometric characteristics of the intersection were reviewed to gain insight into the key road elements that may be contributing to the safety and operational performance of the intersection. The review was based on information obtained from MHI, mobile scanning data, and site visits conducted by McElhanney.

## 6.1 Applicable Guidelines and Design Manuals

In order to assess the geometric characteristics of the highways and intersection, the existing conditions were established and compared to those recommended in the relevant design guidelines. For the purpose of this review, the following documents were used:

- Saskatchewan Ministry of Highways and Infrastructure's *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (September 6, 2018):
    - As outlined in the guide, the Ministry's former *Design Manual* was consolidated with the Transportation Association of Canada's (TAC) *Geometric Design Guide for Canadian Roads* to become the basis for the Ministry's geometric design guidance. The old *Design Manual* is now considered obsolete. However, it is noted that the guide does cross-reference several of the old Standard Plans.
    - MHI's *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads* shall take precedence over the TAC *Geometric Design Guide for Canadian Roads*. If a topic is not covered in the Saskatchewan Supplement, then the recommendations in the TAC guide should be used.
- Transportation Association of Canada's *Geometric Design Guide for Canadian Roads:*
    - It should be noted that the Saskatchewan Supplement references the 1999 version of the TAC geometric design guide. Since this time, an update version of the TAC guide was produced in 2017. For completeness, both versions of the TAC guide were reviewed to identify any potential differences in the recommendations and the findings are presented where required.
- Saskatchewan Ministry of Highways and Infrastructure's *Design Manual Part 1*, (February 2009) and *Design Manual Part 2*, (June 2011):
    - These manuals were used any time a topic was not covered in the above documents and was often cross-referenced by the Saskatchewan Supplement. Manual also provides guidance on pavement markings.
- Saskatchewan Ministry of Highways and Infrastructure's *Traffic Control Devices Manual* (2007):
    - Used for the review of traffic control devices, including signs.

- Saskatchewan Ministry of Highways and Infrastructure's *Roadside Management Manual* (1999):
  - Used for the review of intersection spacing.

## 6.2 Posted Speed Limit

The posted speed limit is 100 km/h on both Highway 35 and Highway 335. Based on the function and geometric design of both highways, the posted speed limit is appropriate.

A temporary speed limit reduction to 60 km/h is currently in place on both highways in the vicinity of the intersection due to safety concerns related to increased traffic volumes and pedestrians at the intersection due to the presence of the roadside memorial. Although not permanent, some recommendations regarding the temporary signage is provided in Section 6.15.

## 6.3 Horizontal and Vertical Alignment

Both Highway 35 and Highway 335 have straight horizontal alignments in the vicinity of the intersection and intersect at a ninety-degree angle. Highway 335 is oriented due east/west. As a result, sun glare can be an issue when looking east during sunrise and west during sunset.

The vertical alignment of both highways is predominately flat through and approaching the intersection. Due to the flat alignment, the surround vegetation can obstruct the visibility of the road surface of the cross street. Cross street visibility can help motorists identify the intersection.

## 6.4 Pavement Condition

Highway 35 is an asphalt concrete pavement while Highway 335 is a single seal granular surface. No pavement surface deficiencies were identified on site that would impact road safety.

## 6.5 Side Slopes

A summary of the side slopes provided and recommended is provided in Table 6-1.

Table 6-1: Side Slopes

| Highway | Recommended Side Slope | Provided Side Slope |
|---|---|---|
| Highway 35 | 4:1 (1) | 6:1 or flatter |
| Highway 335 | 4:1 (1) | 6:1 or flatter |

1) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (August 7, 2009), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 3.1.4-B.9. Refers to Standard Plans 21030 & 21050.

Based on the review, existing side slopes are adequate on both Highway 35 and Highway 335.

## 6.6 Through Lane and Shoulder Widths

A summary of the lane and shoulder widths provided and recommended is provided in Table 6-2. In this table, and all subsequent tables, elements that meet recommended requirements are highlighted green while elements that are less than recommended are highlighted yellow.

Table 6-2: Lane and Shoulder Widths

| Highway | Leg | Through Lane Width | | Shoulder Width | |
|---|---|---|---|---|---|
| | | Recommended | Provided | Recommended | Provided |
| Highway 35 | North | 3.7m (1)(2) | 3.7m (SB)<br>3.7m (NB) | 2.0m (1)(3) | 1.6m (SB)<br>1.5m (NB) |
| | South | 3.7m (1)(2) | 3.7m (SB)<br>3.7m (NB) | 2.0m (1)(3) | 1.9m (SB)<br>1.9m (NB) |
| Highway 335 | North | 3.5m (1)(2) | 3.5m (WB)<br>3.5m (EB) | 2.0m (1)(3) | 1.5m (WB)<br>1.5m (EB) |
| | South | 3.5m (1)(2) | 3.6m (WB)<br>3.5m (EB) | 2.0m (1)(3) | 1.5m (WB)<br>1.5m (EB) |

1) Based on highway functional classification:

   Highway 35: 7.4m travelled way (3.7m travel lanes) and 2.0m shoulders

   Highway 335: 7.0m travelled way (3.5m travel lanes) and 2.0m shoulders

2) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (August 7, 2009), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 2.2.2-B.5.

3) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (August 7, 2009), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 2.2.4-A.6. Refers to Standard Plan 20020.

Based on the review of lane widths, the existing travel lanes are adequate. The shoulder widths on both highways are narrower than recommended based on the highway classification.

## 6.7 Clear Zone

A summary of the clear zones provided and recommended is provided in Table 6-3.

Table 6-3: Clear Zones

| Highway | Recommended Clear Zone | Closest Object(s) | Lateral Offset |
|---|---|---|---|
| Highway 35 | 7.5 – 8.0m (1) | Light Standard | 10.8m (NE Corner)<br>9.5m (SW Corner) |
| | | Railway Crossing Signs (170m north of Highway 335) | 2.5m (east)<br>1.6m (west) |
| Highway 335 | 5.5 – 6.0m (2) | Light Standard | 4.8m (NE Corner) |
| | | | 6.3m (SW Corner) |

1) *Geometric Design Guide for Canadian Roads*, (2017), Transportation Association of Canada, Table 7.3.1 (Design Speed ≥ 110 km/h, ADT 750 – 1,500, Fill Slope 6:1 or flatter). Same recommendation as 1999 Guide.

2) *Geometric Design Guide for Canadian Roads*, (2017), Transportation Association of Canada, Table 7.3.1 (Design Speed ≥ 110 km/h, ADT under 750, Fill Slope 6:1 or flatter). Same recommendation as 1999 Guide.

Based on the clear zone review, the railway crossing signs north of Highway 335 are located within the clear zone. It is unclear if the sign bases are break-away. If not, they represent a fixed object collision risk.

The light pole in the NE corner of the intersection is within the Highway 335 clear zone. However, since the pole is located at the stop sign. Operating speeds should be close to 0 km/h, significantly less than the design speed. Therefore, the pole is only a hazard in the event of a stop sign violation.

There are also several signs located within the clear zone. More discussion on this is provided in Section 6.15.

## 6.8 Intersection Layout

As shown in Figure 6-1, the intersection has a flared treatment with the northbound and southbound through lanes being shared through/left-turn lanes, shared through/right-turn lanes develop through the intersection, including a transition lane downstream of the intersection. Highway 335, is stop controlled with single lane approaches in both directions.

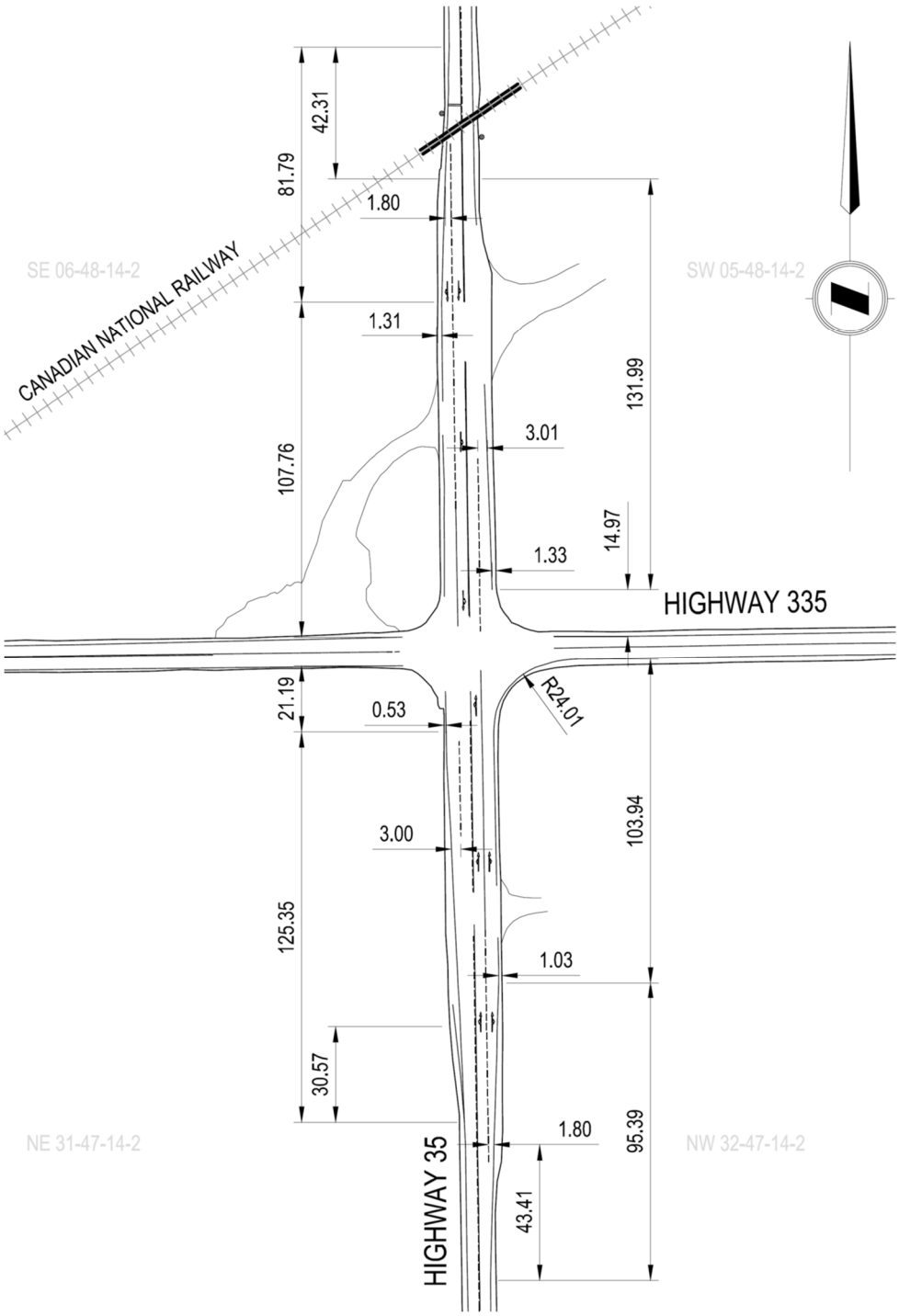



Figure 6-1: Highway 35 and Highway 335 Intersection Layout

MHI's Standard Plan for flared intersection treatments is reproduce in Figure 6-2.

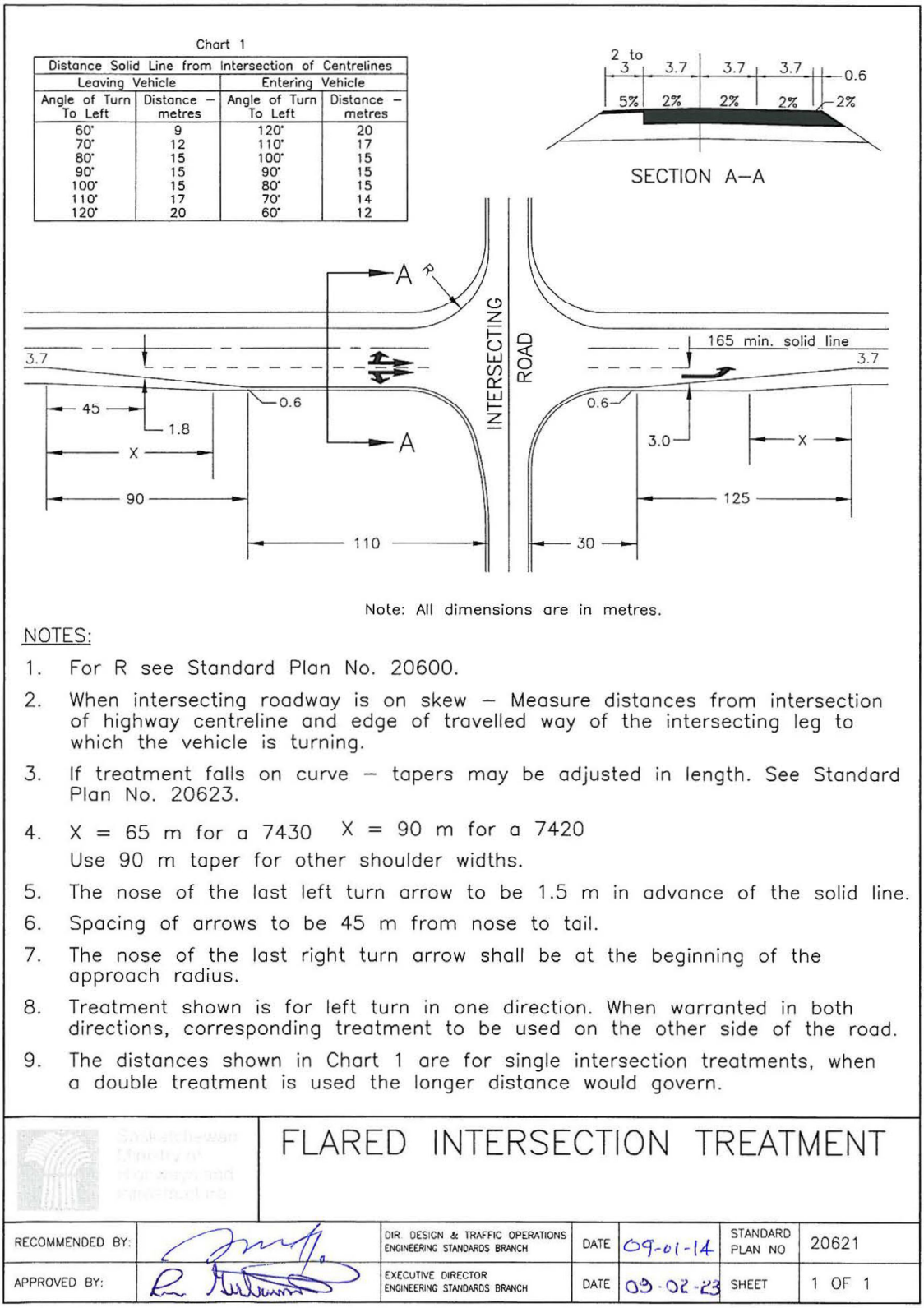



Figure 6-2: Highway 35 and Highway 335 Intersection Layout

The existing intersection dimensions were compared to the recommended dimensions and the findings are summarized in Table 6-4.

Table 6-4: Intersection Dimensions

| Intersection Characteristic | Recommended [1] (m) | Provided (m) | |
|---|---|---|---|
| | | Northbound | Southbound |
| Painted Deceleration Taper | 90 | 95 | 82 |
| Pavement Deceleration Taper | 90 | 95 | 82 |
| Deceleration Lane | 110 | 104 | 108 |
| Transition Lane | 30 | 15 | 22 |
| Painted Transition Taper | 125 | 132 | 125 |
| Pavement Transition Taper | 90 | 132 | 31 |

1) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (August 7, 2009), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 2.3.5-D.3. References Standard Plan 20621.

Although the table indicates that some of the dimensions are shorter than recommended, the combined lengths are only marginally different.

In the northbound direction, the deceleration lane length is shorter than recommended. However, the combined deceleration lane/taper length is adequate, so the taper has just been painted a little longer than recommended. Similarly, the combined northbound transition lane/taper is only about 8m short of recommended, which is understandable given the close proximity of the railway crossing to the north.

In the southbound direction, the combined deceleration lane/taper is 10m shorter than recommended and the combined transition lane/taper is 8m shorter than recommended.

The deficiencies noted above are not significant enough to have a noticeable impact on traffic operations or safety.

## 6.9 Adjacent Intersections

The closest adjacent intersection on each approach is summarized in Table 6-5.

Table 6-5: Adjacent Intersections

| Highway | Leg | Side | Access Type | Distance from Intersection | |
|---|---|---|---|---|---|
| | | | | Recommended (m) | Provided (m) |
| Highway 35 | North | West | Roadside Pullout | 40 (1) | 72 |
| | | East | Grain Elevator | 300 minimum (1)<br>400 desirable (1) | 100 |
| | South | West | Residential | 40 (1) | 900 |
| | | East | Residential | 40 (1) | 80 |
| Highway 335 | West | North | Roadside Pullout | 40 (2) | 40 |
| | | South | Field Access | 40 (2) | 190 |
| | East | North | Field Access | 40 (2) | 190 |
| | | South | Gravel Road | N/A | 1,600 |

1) *Roadside Management Manual*, (July 1999), Saskatchewan Ministry of Highways and Infrastructure, Section RSMM 430-30, R-4 Access Management Level:

2) *Roadside Management Manual*, (July 1999), Saskatchewan Ministry of Highways and Infrastructure, Section RSMM 430-30, R-5 Access Management Level:

As identified above, the access to the grain elevator north of Highway 335 does not meet the recommended minimum intersection spacing from the study intersection.

The roadside pullouts meet the minimum separation requirements for a Type II access. However, given the recent increase in traffic volumes due to the creation of a memorial within the roadside pullout, it could be argued that these approaches should now be considered Type I and that the separation distance is now inadequate.

## 6.10 Stopping Sight Distance

The stopping sight distances (SSD) available and recommended on each approach are summarized in Table 6-6.

Table 6-6: Stopping Sight Distances

| Approach | Recommended Stopping Sight Distance (m) | Available Sight Distance (m) |
|---|---|---|
| Highway 35 Northbound | 265 (1) | 550 |
| Highway 35 Southbound | | 550 |
| Highway 335 Westbound | 230 (2) | 400 |
| Highway 335 Eastbound | | 580 |

1) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (September 2018), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 1.2.5-A, Table SKS 1.2.5-A.1, 120 km/h design speed.

2) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (September 2018), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 1.2.5-A, Table SKS 1.2.5-A.1, 110 km/h design speed.

Based on the SSD review, the available SSD is adequate on all approaches.

## 6.11 Approaching Sight Distance

The approaching sight distances available and recommended on each approach are summarized in Table 6-7.

Table 6-7: Approaching Sight Distances

| Approach | Recommended Approach Sight Distance (m) | Available Sight Distance (m) |
|---|---|---|
| Highway 35 Northbound | 200 (1) | 375 |
| Highway 35 Southbound | 200 (1) | 375 |
| Highway 335 Westbound | 340 (2) | 400 |
| Highway 335 Eastbound | 340 (2) | 580 |

1) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (August 7, 2009), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 2.3.3-C.4. References Standard Plan 20635

2) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (August 7, 2009), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 2.3.3-D, Table SKS 2.3.3-D.1, 110 km/h design speed.

Based on the review of approach sight distances, no deficiencies were identified on any of the approaches.

## 6.12 Departure Sight Distance

The departure sight distances (DSD) available and recommended on each approach are summarized in Table 6-8.

Table 6-8: Departure Sight Distances

| Highway 335 Approach | Looking | Departure Sight Distance (m) | | | | Available Departure Sight Distance (m) |
|---|---|---|---|---|---|---|
| | | Recommended Minimum | Desirable Minimum | Truck (WB-15) Minimum | Manual Calculation | |
| Westbound | North | 240 (1) | 370 (1) | 465 (2) | 590 (3) | 735 |
| | South | | | | | 800 |
| Eastbound | North | | | | | 2,500 |
| | South | | | | | 800 |

1) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (August 7, 2009), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 2.3..3-B.5. References Standard Plan 20630

2) *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads*, (August 7, 2009), Saskatchewan Ministry of Highways and Infrastructure, Section SKS 2.3..3-B.5. References Standard Plan 20632

3) Calculation based on *Alberta Transportation's Highway Geometric Design Guide*, Section D.4.2.2.2, Manual Calculation (Design Speed = 120 km/h, Crossing Distance = 54m, Design Vehicle = Tractor-Trailer)

The manual calculation provided in Table 6-8 was provided to account for the fact the turning distance is longer than assumed in the references (1) and (2) as they do not account for the extra lane at a flared intersection. Even with this additional factor of safety, the available DSD is adequate on both Highway 335 approaches.

Although the roadway geometry provides adequate DSD. It was noted that the DSD is interrupted in the northwest, northeast, and southeast corners due to roadside signs on Highway 35 obstructing sight lines (See Section 8.6).

## 6.13 Sight Triangles

Saskatchewan's recommended sight triangle dimensions are detailed in Standard Plan No. 20640, which is reproduced in Figure 6-3.

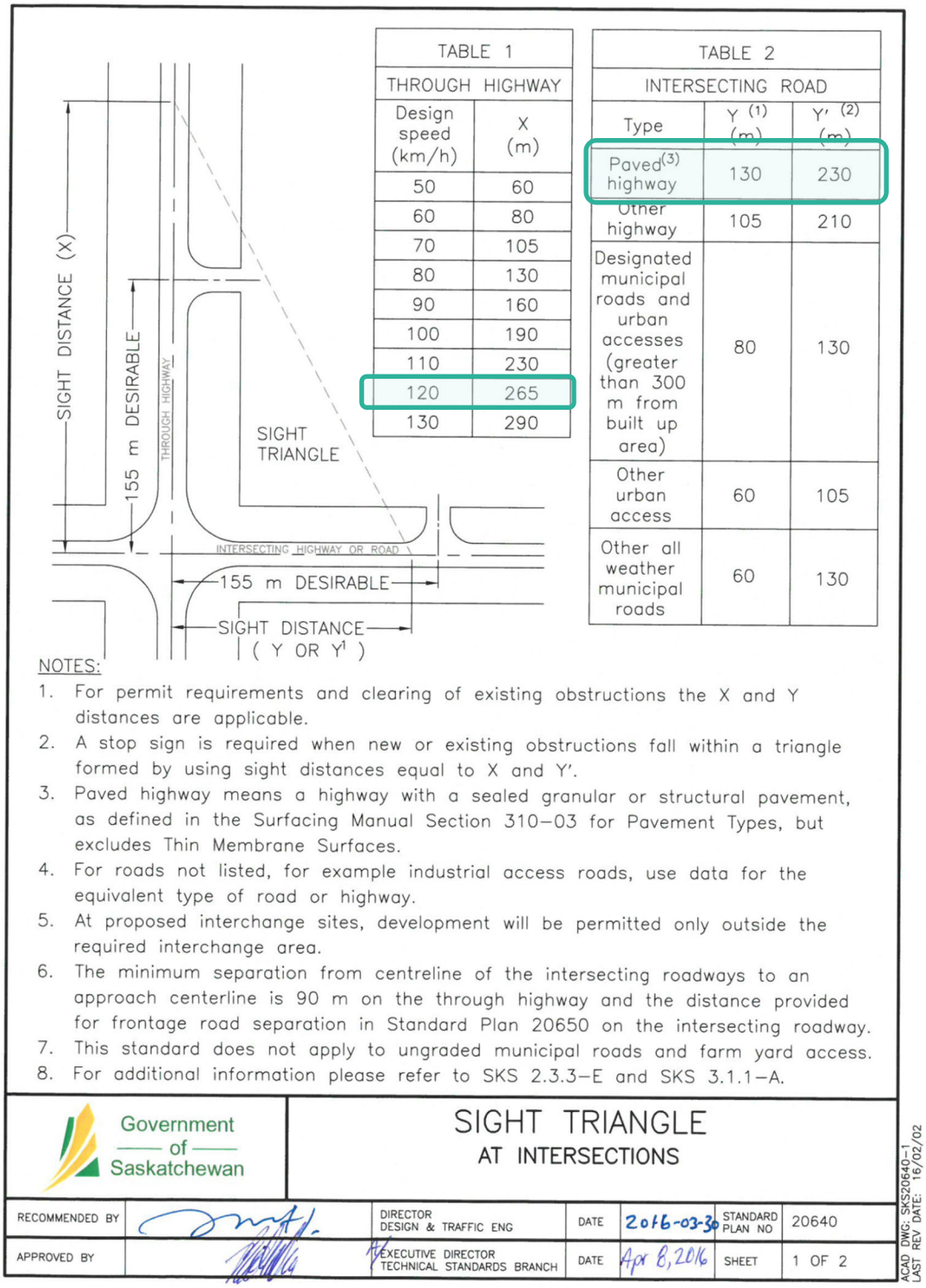



Figure 6-3: MHI Sight Triangle at Intersections (Page 1 of 2)

At the time of the August 2018 site visit, the sight triangles available are illustrated in Figure 6-4 along with the recommended sight triangles.

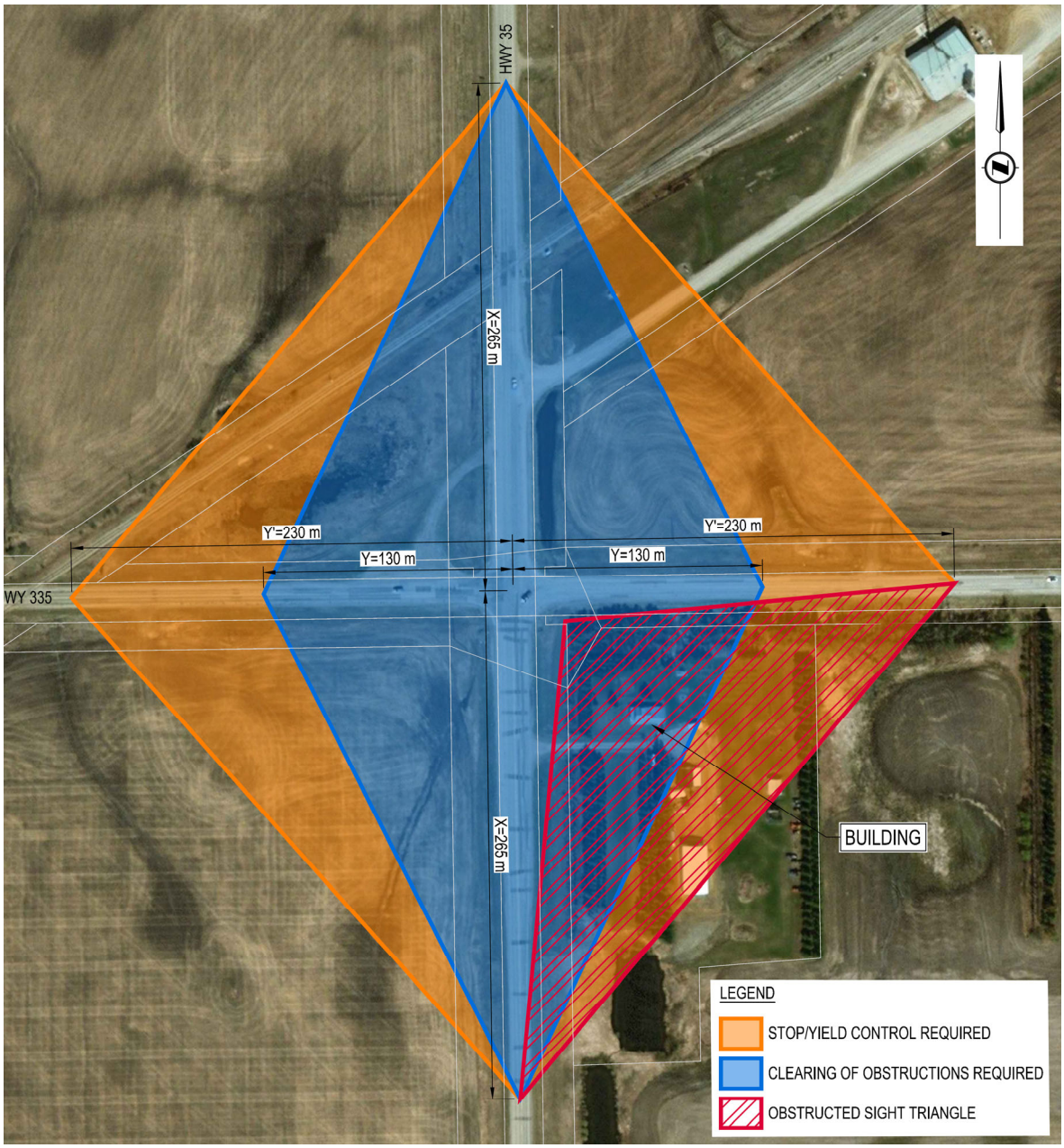



Figure 6-4: Intersection Sight Triangles (August 2018)

Based on the sight triangle review there are adequate sight triangles in the northeast, northwest, and southwest quadrants.

The recommended sight triangle in the southeast quadrant was obstructed by trees and a building. This includes the area that should be free of all obstructions (Y = 130m) and the area that requires stop/yield control (Y' = 230m). Since the intersection is already stop controlled, Y=130m is the governing factor. The area in Figure 6-4 that is both shaded blue and hatched red is the area requiring clearing to achieve the recommended sight triangle.

Standard Plan No. 20640 goes on to specify the limits of expenditures to apply in obtaining the recommended sight triangle (see Figure 6-5).

TABLE 3

| Through highway | INTERSECTING ROAD | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Grid | Municipal |
| 1 | $94,000 | $56,000 | $51,000 | $46,000 | $36,000 | $10,000 |
| 2 | | $51,000 | $46,000 | $42,000 | $31,000 | $5100 |
| 3 | | | $42,000 | $42,000 | $25,000 | $5100 |
| 4 | | | $42,000 | $42,000 | $25,000 | $5100 |

NOTES:

1. Table 3 shows limits of expenditure to apply in obtaining the sight triangle subject to 1, 2, 3 and 4.
2. For one leg apply one–half value.
3. Subject to acceptability of necessary property arrangements.
4. Applicable to normal construction and new building construction only, unless identified as an accident prone location.
5. The classes of highway corresponding to the numbers in the table are:

   Number 1 – D 130–7430
   U 130–7430

   Number 2 – U 120–7420
   U 120–7415

   Number 3 – U 110–7010 (DS/SS/M/G)

   Number 4 – U 100–7010 (G)
6. The above values have been adjusted from their original 1988 values to 2013 values using Statistics Canada's Consumer Price Index for December 2013.

Government of Saskatchewan

SIGHT TRIANGLE
AT INTERSECTIONS

| | | | | | | |
|---|---|---|---|---|---|---|
| RECOMMENDED BY | | DIRECTOR DESIGN & TRAFFIC ENG | DATE | 2016-03-30 | STANDARD PLAN NO | 20640 |
| APPROVED BY | | EXECUTIVE DIRECTOR TECHNICAL STANDARDS BRANCH | DATE | Apr 8, 2016 | SHEET | 2 OF 2 |

ACAD DWG: SKS20640-2
LAST REV DATE: 16/02/02

Figure 6-5: MHI Sight Triangle at Intersections (Page 2 of 2)

Based on the above figure, up to $23,000 could have been spent to mitigate the sight triangle obstruction. Although the exact cost of clearing the sight triangle at the time of construction cannot be verified, the cost of removing all trees within the sight triangle is estimated at $20,000 in today's dollars. The majority of these trees are on private property and there was also a private building within the site triangle. Based on the property impacts and costs, it is unlikely that the cost of clearing the site triangle was less than the expenditure limit.

The $20,000 for tree removal includes $5,000 for trees within the MHI right-of-way and $15,000 for trees on private property (not including property costs). In October 2018, MHI cleared the trees within their right-of-way. It was also identified at this time that the building in the southeast corner was removed or relocated outside of the sight triangle. An update sight triangle diagram is provided in Figure 6-6.

Approximately 400m$^2$ of trees were removed in the southeast corner of the intersection. The removal of the trees within the MHI right-of-way only marginally improves the sight triangle. On the northbound Highway 35 approach, it provides an additional 9.5m of visibility to the east at X=265m. On westbound Highway 335, an additional 7.1m of visibility to the south is provided at Y=130m.

The trees still remain on the private property in the southeast corner. However, the recent removal of the building in the southeast corner means that only trees would need to be removed in order to achieve the sight triangle, which would be significantly less expensive, but would still require negotiation with the land owner.

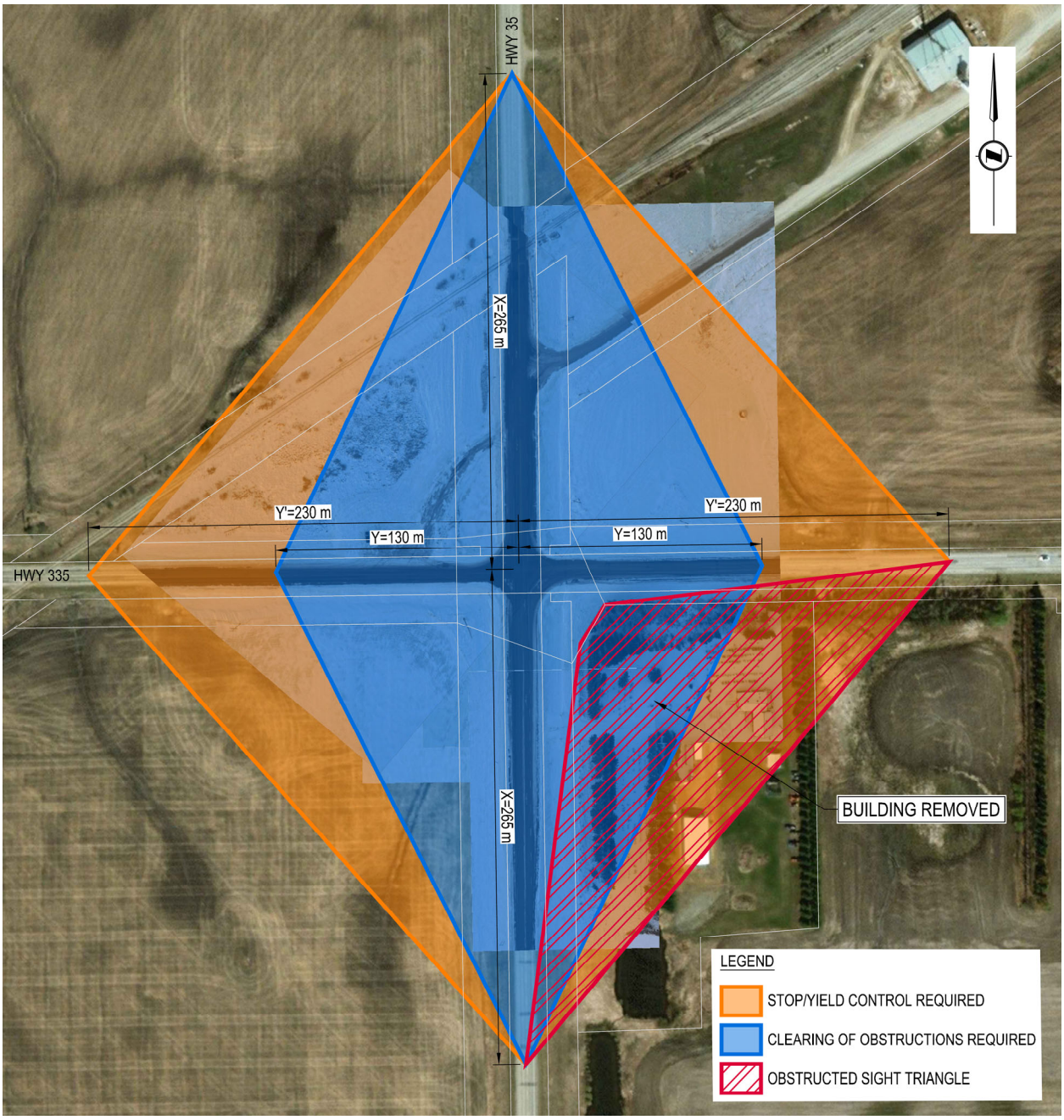



Figure 6-6: Intersection Sight Triangles (November 2018)

## 6.14 Illumination

As per the Saskatchewan Ministry of Highways and Infrastructure's Design Manual, Section DM 2621-1, All provincial highway to highway intersections qualify for intersection delineation lighting.

The intersection of Highway 35 and Highway 335 has delineation lighting as shown in Figure 6-7 and the lighting is consistent with Standard Plan 2621-1-1 (Figure 6-8). Based on MHI's *Traffic Control Devices Manual* (2007), Section TCDM 1102, the light standards should have break-away bases. Visual inspection could not confirm if the bases were break-away and should be confirmed by MHI.


Figure 6-7: Highway 35 and Highway 335 Intersection Illumination

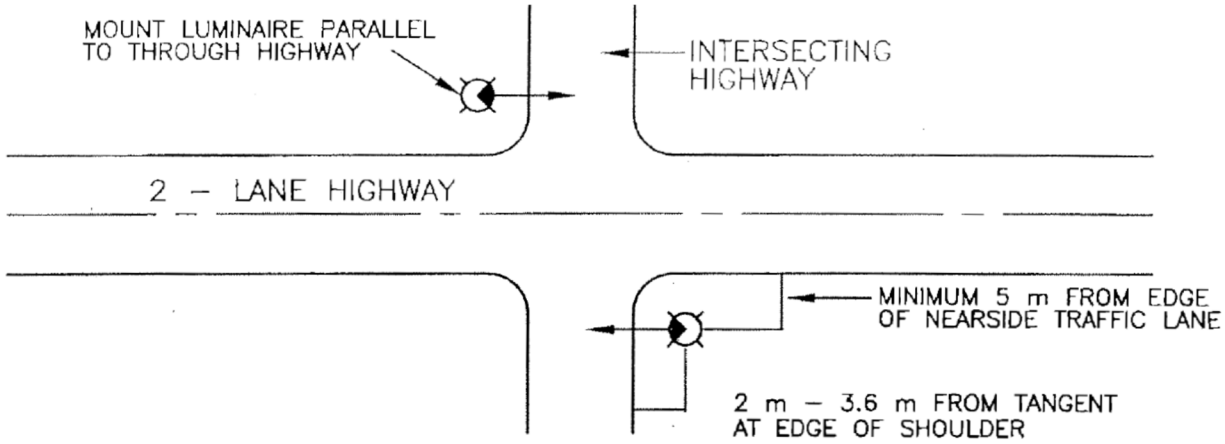



Figure 6-8: Delineation Lighting (MHI Standard Plan 2621-1-1)

## 6.15 Signage

An inventory of signage (drawing and spreadsheet) at the intersection was created and is provided in Appendix C. All signage was reviewed based on the following criteria and deficiencies are noted in the appendix.

### 6.15.1 Horizontal and Vertical Placement

The height and lateral offset of signs were reviewed based on Saskatchewan Highways and Transportation's *Traffic Control Devices Manual* (2007), which recommends the offsets shown in Figure 6-9.

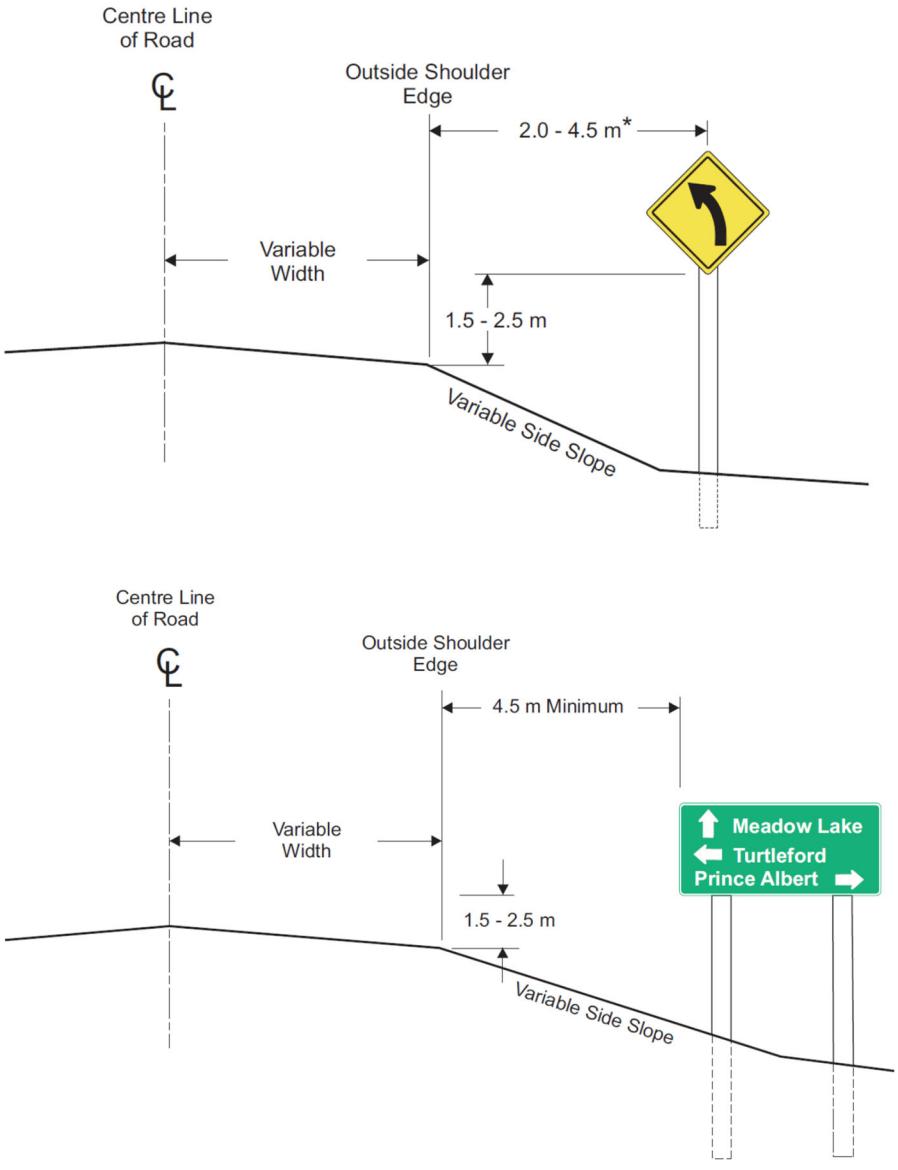



Figure 6-9: Recommended Lateral and Vertical Placement of Signs

### 6.15.2 Break-Away Posts

All roadside signs are located within the clear zone as they must be close enough to the roadway for motorists to see. As a result, signs end up being a fixed object collision hazard.

Saskatchewan's sign post requirements are outlined in Section TCDM 201 of the Saskatchewan Ministry of Highways and Infrastructure's *Traffic Control Devices Manual* (2007), which requires 10 cm x 15 cm wooden posts. All existing signs meet these requirements.

In some other jurisdictions, there is a requirement that all signs within the clear zone must be on break-away posts. The *Traffic Control Devices Manual* does not require break-away posts with the following exception:

- Section TCDM 206: *"May use an I-beam post with a break-away base once the area of the sign exceeds 72 square feet. Policy is under review."*

There are no signs at the intersection that are 72 square feet or larger. MHI indicated that they consider the 10 cm x 15 cm wooden posts to be break-away and that increasing the frangibility of the signs any further could reduce the signs ability to withstand snow plough operations, and damaged/missing signs is seen as a bigger risk to motorists.

### 6.15.3 Longitudinal Placement

The longitudinal placement of signs was reviewed based on recommendations and typical plans provided in Saskatchewan Ministry of Highways and Infrastructure's *Traffic Control Devices Manual* (2007). All deficiencies are noted in the inventory in Appendix C.

### 6.15.4 Condition

The condition of each sign was reviewed in the field to determine if damage/deterioration is affecting the signs performance.

### 6.15.5 Retroreflectivity

The retroreflectivity of each sign was also visually inspected in the field to assess their effectiveness during dark conditions. Any night time visibility concerns are noted in the inventory.

## 6.16 Stop Control Enhancements

Highway 335 is stop controlled in both directions because of the road classification and it is a lower volume road compared to Highway 35.

As noted in Appendix C, both stop signs are located within the recommended horizontal and vertical offsets. However, the eastbound sign is close to the upper end of the range and could benefit from relocation closer to the highway.

There are additional enhancements that can be considered to increase the effectiveness of a stop control and these are discussed in the following subsections.

### 6.16.1 Oversized Stop Signs

Based on MHI's *Design Manual Part 2*, Section DM 2931-1, the standard size of a stop sign in Saskatchewan is 75 x 75cm. Oversized stop signs measuring 90 x 90cm or 120 x 120cm may be used:

- where more attention is required;
- where an ambient condition is distracting;
- when a flashing red light is used.

The first and last bullets above apply to the study intersection and 120 x 120cm stop signs are in place on both approaches.

### 6.16.2 Stop Bars

Stop bars are painted transversely across an approach when it is important to indicate the point where a vehicle must stop in compliance with a stop sign. Stop signs and stop bars are usually directly in line with each other. MHI recommends a stop bar width of 60cm.

Stop bars are provided on both Highway 335 approaches. They are in line with the stop signs and are 60cm wide.

### 6.16.3 Stop Ahead Signs

MHI's *Design Manual Part 2*, notes that:

> *"if the approaching visibility of the stop sign is limited, a Stop Ahead Sign (WA-1) will be installed in advance of the Stop sign. The stop ahead sign shall be installed on only the right-hand side of the traffic lane to which it applies."*

As per Section 6.15, the signs should be installed at an offset of 2.0 – 4.5m from the outside shoulder edge and 1.5 – 2.5 metres above the road surface. Based on MHI's *Traffic Control Devices Manual*, stop ahead signs are typically installed 300m in advance of the stop sign.

Stop ahead signs are provided on both Highway 335 approaches. The longitudinal placement is consistent with the above requirements. Both the eastbound and westbound signs have a lateral offset greater than 4.5m (5.15m westbound and 5.91m eastbound) and the westbound sign is posted at a height of 1.19m, which is lower than recommended.

### 6.16.4 Transverse Rumble Strips

MHI's Policy and Guidelines for the implementation of transverse rumble strips is provided in the *Design Manual Part 2*, Section DM 2980:

> *Rumble strips can be used where a non-visual warning is required to increase the level of awareness due to an unexpected condition such as a long tangent section approaching an intersection.*
>
> *For a stop condition, rumble strips may be used when the following condition exists:*
>
> - *supplements flashing red over the stop sign*
> - *approach speed is 80 km/h or greater*
> - *accident history indicates drivers are failing to stop for the stop sign*

Although the collision frequency at the intersection is low, the collision history, conflict analysis and stakeholder interviews identified stop sign violations as an issue. Therefore, all three conditions exist at the study intersection. However, rumble strips are not provided on either Highway 335 approach. Although not explicitly stated in any of the design guidelines, MHI indicated that rumble strips are not typically installed on granular road surfaces, such as Highway 335, as the seal is too thin and the structural strength too low to sustain rumble strips under traffic loading.

### 6.16.5 Flashing Red Lights

Flashing red lights are currently provided on Highway 335 above the stop signs in both directions. The following MHI guidelines discuss flashing red lights at intersections:

*Design Manual Part 2*, Section DM 2540-1 (1):

*"Flashing lights should be considered at intersections which have stop control and where any of the following accident conditions exist:*

- *a total of four or more preventable accidents occur in the most recent year;*
- *a total of six or more preventable accidents occur in the most recent three year period; or*
- *an average of three or more preventable accidents per year occur over a five year period."*

The above conditions are not met at the study intersection due to the low collision frequency.

*"When flashing lights are warranted at an intersection use:*

- *Red flashing lights over the stop sign if motorists are not stopping for the stop sign. This has the highest potential for accident reduction and can be used alone.*
- *Advance amber flashing lights, for the through traffic may be considered, with red flashing lights on the stop sign if motorists are stopping, and then proceeding into the path of the through motorist. The amber flashing light is to indicate a hazardous situation and is a warning for motorists to reduce speed or be more vigilant. The flashing amber should be installed with an appropriate advance warning sign.*

Based on the collision review and good departure sight distances at the intersection, it is expected that failure to stop collisions are a higher risk than collisions associated with poor gap acceptance. Therefore, the provision of flashing red lights on Highway 335, and not the provision of advanced amber lights on Highway 35, is recommended and is consistent with what is currently in place at the intersection.

- *… an overhead flashing red light at the intersection should only be installed as a supplement to flashing red lights over the stop sign.*

*Overhead flashing lights at the intersection should only be considered under special circumstances where additional warning for the motorist is required"*

Given the accident conditions are not met, the provision of an overhead flashing light is not warranted.

*Design Manual Part 2*, Section DM 2540-1 (2) states:

*"Flashing red lights above the stop sign can be considered at intersections meeting both the following criteria:*

- *a highway intersection where the through road AADT is >I,000 and the stop road AADT is >750; and*
- *the speed limit on the through highway is 100 km/h."*

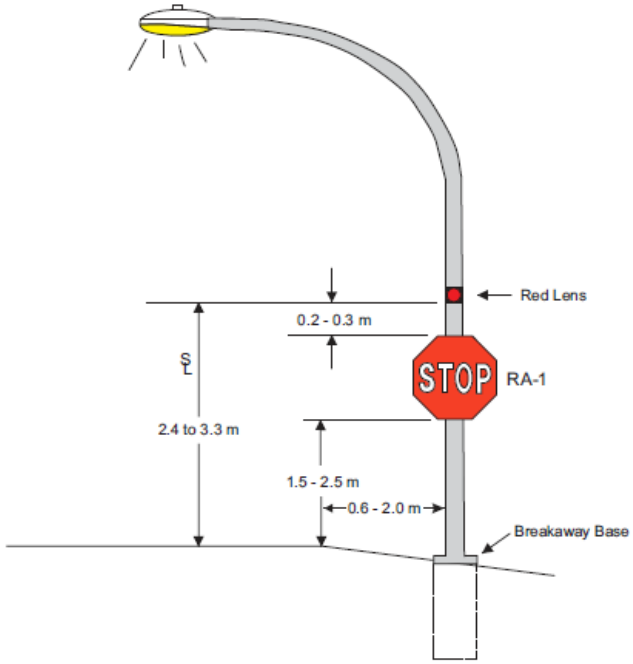
The AADT on Highway 35 meets the requirement, but the Highway 335 volume is less than 750. The speed limit on Highway 35 is 100 km/h.

*Design Manual Part 2*, Section DM 2931-1 states:

*"A flashing red light may be used to supplement or compliment a stop sign when there is an indication that such reinforcement will increase visibility, attention and compliance, thereby reducing accidents."*

A flashing light would increase visibility, attention and compliance.

The recommended vertical and lateral placement of the flashing light is provided in Figure 6-10.




Source: *Traffic Control Devices Manual,* (2007), Saskatchewan Ministry of Highways and Infrastructure, Section TCDM 1102

Figure 6-10: Intersection Flashing Warning Lights – Light Standard Mounted

The westbound flashing light is mounted 3.7m above the road surface and 800mm above the stop sign. The light is therefore posted too high and should be lowered to be within 200 – 300mm of the stop sign. The eastbound sign is posted at the correct height, but the lateral offset is 4.4m.

### 6.16.6 Supplementary Left-Side Stop Sign

MHI's *Design Manual Part 2*, Section DM 2931-1 states:

> *"At an intersection with large radius flares on the signed approach, an additional sign may be installed on the left side of the approach road."*

The intersection does have large radius flares so supplementary signs on the left side of the road could be considered. Placing a stop sign on the left side of the road is not expected to provide a significant benefit. Placing a stop sign on the centreline could be a consideration, but is likely not practical given the frequency of oversized vehicles that could strike the sign (see Section 8.11).

### 6.16.7 Alternative Stop Control Enhancements

The intersection currently has the highest level of stop control enhancements used by MHI. Consideration could be given to additional measures used in other jurisdictions. Examples are provided below and recommendations are provided in Section 8.11.

### *"Stop" and/or "Stop Ahead" Pavement Messages*

MHI does not currently implement painted messages on the approaches to stop-controlled intersections. In the Province of Alberta, "Stop" and "Stop Ahead" pavement messages are often painted on the highway as a stop control enhancement. Based on Alberta Transportation's *Highway Pavement Marking Guide* (2003):

> *"In general, STOP word markings may be installed at intersections where all of the following conditions are present:*
>
> - *The intersection has a history of at least three Failing to Stop type incidents or collisions over the period of five years* (This condition is not met at the study intersection).
> - *Traffic volumes on an approach exceeds 500 vehicles per day* (This condition is met at the study intersection).
> - *Other safety measures such as oversize STOP sign and STOP AHEAD sign have already been provided and have not been effective in eliminating Failing to Stop type of collisions* (This condition is met at the study intersection).
>
> "Stop Ahead" word markings may be installed at intersections when "Stop" word markings are used and "Stop Ahead" warning sign is present." The message should be placed next to the stop ahead warning sign.

### *Oversized Stop Sign*

The existing stop signs on Highway 335 are 120 x 120cm, which is the largest stop sign that MHI currently uses. Other jurisdictions, such as Alberta, also use even larger 150 x 150cm signs in some situations. As per Alberta Transportation's *Stop Sign Recommended Practices* (2012):

- *"Normally, a 1500 mm x 1500 mm Stop sign should only be reserved for major junctions of the provincial highways with complex geometry, high traffic volumes and high running speeds."* (The intersection geometry is not complex and traffic volumes are low. The running speeds are high. MHI does not consider this a major junction)
- *"Installed only as an enhancement when other measures have failed. A 1500 mm x 1500 mm sign should only be reserved for higher classes, high speed roadways."* (There have been some collisions since the other stop control enhancements were installed, but the frequency is low. Highway 335 is not considered a higher class roadway)

### *Oversized Stop Ahead Warning Signs*

Alberta Transportation also uses oversize 120 x 120cm stop ahead warning signs, to increase their conspicuity in some situations. Oversize stop ahead warning signs are not currently implemented by MHI.

## 6.17 Pavement Markings

A summary of the pavement markings provided at the intersection is as follows:

*Highway 35 South Leg:*

- Yellow dashed centreline, solid centreline northbound starts 200m south of Highway 335, gap in centreline at residential driveway;
- Solid white shoulder lines;
- Dashed/solid white dividing line between left/through and through/right lanes;
- Three sets of left/through and through/right pavement marking arrows;
- Single merge arrow in right southbound lane.

*Highway 35 North Leg:*

- Double solid yellow centreline extending 165m north from intersection, gap in centreline at gravel roadway and grain elevator, dashed line northbound starting at railway crossing, the southbound no-passing zone continues 150m north of the railway;
- Solid white shoulder lines;
- Dashed/solid white dividing line between left/through and through/right lanes;
- Three sets of left/through and through/right pavement marking arrows;
- Single merge arrow in right northbound lane;
- Double stop lines on both railway crossing approaches.

*Highway 335 West Leg:*

- Yellow dashed centreline, solid centreline eastbound starts 400m west of Highway 35, double solid centreline between Highway 35 and first railway crossing (gap at gravel roadway);
- Solid white shoulder lines;
- Stop bar at intersection;
- Double stop bars on all railway approaches.

*Highway 335 East Leg:*

- Yellow dashed centreline, solid centreline westbound starts 175m east of Highway 35, passing permitted eastbound immediately east of Highway 35;
- Solid white shoulder lines;
- Stop bar at intersection;

The markings were reviewed based on the recommendations of MHI's *Design Manual Part 2* and no deficiencies were identified.

## 6.18 Shoulder and Centreline Rumble Strips

There are currently no shoulder or centreline rumble strips along Highway 35 or Highway 335.

The *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads* states that "*rumble strips shall be installed on all highways having paved asphalt concrete shoulders that exceed 1.8m in width and an AADT greater than 1800 vpd*" (Section SKS 2.2.4-B.1).

Neither highway currently meets the AADT threshold and therefore don't warrant rumble strips.

## 6.19 Railway Crossings

There are three at-grade railway crossings in close proximity to the intersection:

- Highway 35: 170m to the north
- Highway 335: 250m to the west
- Highway 335: 800m to the west

Although a formal railway crossing safety assessment was not conducted, the crossings are located on the intersection approaches and were reviewed from a signage and pavement marking perspective. The following comments are noted:

- Railway crossing signs are provided on both sides of the highway at all three crossings. Retroreflective strips are provided on the back of all signs with the exception of the west sign on Highway 35.
- Saskatchewan Ministry of Highways and Infrastructure's *Traffic Control Devices Manual* (2007) recommends that railway crossing ahead warning signs should be located 200m in advance of a crossing:
    - The northbound sign is located 155m in advance. However, due to the proximity of Highway 335, the sign is located at the most practical location.
    - The westbound sign meets the 200m requirement, but this places the sign within 15m of the Highway 35 intersection. As a result, motorists may not see the sign due to sight lines and high mental workload.
- The bump warning signs provided below the northbound and southbound railway crossing ahead warning signs are redundant and could be removed.
- Railway sight triangles are generally good. A few potential conflicts were noted and should be confirmed (train speed information required):
    - Eastbound Highway 335, crossing 170m west of Highway 35, bushes obstruct sight lines of southbound trains.
    - Westbound Highway 335, crossing 800m west of Highway 35, trees obstruct sight lines of northbound trains.

# 7. Human Factor Characteristics

The study intersection, including all approaches, was reviewed from a human factors perspective to identify any characteristics that might contribute to driver related errors such as distraction, confusion, impatience or fatigue. A summary of some potential human factors characteristics that may contribute to collisions is discussed in the following subsections.

## 7.1 Motorists Might Assume Highway 335 is Uncontrolled

Highway 335 is the stop-controlled roadway at the intersection with Highway 35. However, for a significant distance both east and west of the intersection, Highway 335 is the major roadway and is uncontrolled. As a result, motorists may become complacent and assume that Highway 335 is uncontrolled at all intersections. This factor, in combination with other issues, such as the tunnel vision discussed below and large lateral offset of signs, increases the risk that a motorist will overlook the stop control and fail to stop.

## 7.2 Westbound Tunnel Vision

There are some elements along westbound Highway 335 that could lead to tunnel vision. This includes the road alignment, horizon, trees, and power poles. As shown in Figure 7-1, this could focus motorist's attention to the centre of Highway 335 further west, which may result in motorist's overlooking Highway 35 and the stop sign. The illusion was observed to be even more pronounced during wet and/or sun glare conditions.

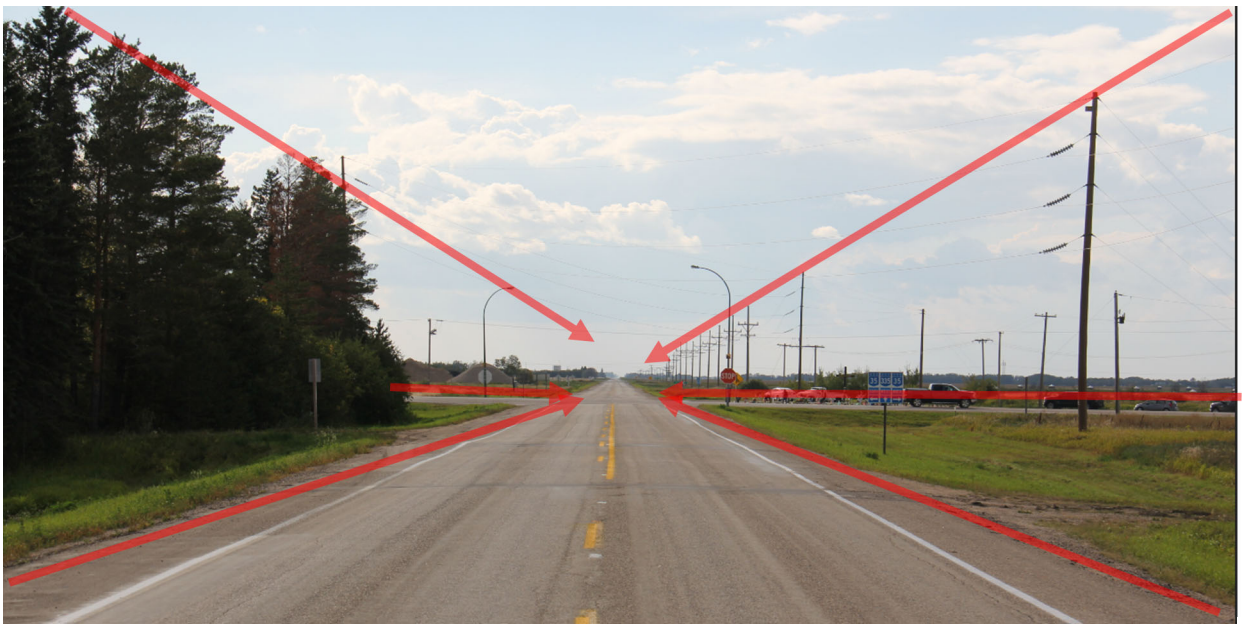


Figure 7-1: Tunnel Vision on Westbound Highway 335

## 7.3 High Mental Workload on Highway 35

There are a number of factors that increase the mental workload required of motorists travelling on Highway 35:

- The Highway 335 intersection is a major intersection with a flared intersection treatment and numerous signs.
- There is a railway crossing with associated signs located in close proximity to the Highway 335 intersection.
- There are offset intersections between the railway crossing and Highway 335, both within the flared intersection treatment:
    - The east leg is well used as it provides access to a grain elevator.
    - The west leg would have been low volume, but with the presence of the roadside memorial, volumes have increased at this access.
- The roadside memorial in the northwest quadrant of the intersection could also add to distraction and workload at the intersection.

Due to the factors above, there is a higher potential for driver error at and approaching the intersection.

## 7.4 Driver Fatigue and Alertness

The intersection is located in a rather remote location in rural northeast Saskatchewan. The location increases the chance that motorists travelling through the intersection have been travelling long distances and could be suffering from fatigue. The intersection is the most major intersection within 30 kilometres to the north and south and 20 kilometres to the east and west. The high proportion of tractor-trailers traversing the intersection could also be an indicator of long-haul trips through the intersection. Higher levels of fatigue can result in reduced alertness and increase reaction time, thus increasing the potential for errors or in some cases result in motorists falling asleep at the wheel.

## 7.5 Overhead Power Line Clutter

As noted, intersections are high mental workload locations. It was noted that the overhead power lines that diagonally cross the intersection add to the visual clutter and could divert motorists gaze away from the roadway.

# 8. Potential Safety Issues and Improvements

Potential safety issues have been identified based on the site inspection, a review of physical characteristics, analysis of historic collision records, and a human factors review. A summary of the potential safety issues is included in the following sections along with improvement suggestions to reduce the frequency and severity of collisions.

## 8.1 Narrow Shoulders

**Issue Description**

The shoulder widths on both Highway 35 and Highway 335 are narrower than recommended. The shoulder widths are as narrow as 1.5m, where the recommended width is 2.0m.

Shoulders provide a recovery area for errant vehicles and a refuge for stopped or disabled vehicles. Narrow shoulders decrease the effectiveness of the shoulders to achieve the above objectives.

Five collisions over the past 28 years involved a run-off-road right movement.

**Issue Photo**

**Improvement Suggestions**

Mitigating this risk would require widening of the highway(s) to increase shoulder width.

**Improvement Costs**

The cost of implementation depends on the extent of the widening since this issue is not isolated to the intersection itself. The cost of shoulder widening is estimated at $200,000 per kilometre per shoulder.

## 8.2 Sight Triangle Obstructions

**Issue Description**

As discussed in Section 6.13, the sight triangle is obstructed by trees in the southeast corner of the intersection which blocks sight lines between northbound and westbound traffic. There also used to be a building within this sight triangle, but the land owner removed the building in the Fall of 2018.

Providing adequate sight triangles allows motorists to see a potentially conflicting vehicle approaching on the cross street and to take evasive action if required. In the case of a stop-controlled intersection, such as Highway 35 and Highway 335, it provides opportunity for traffic on the through road (Highway 35) to assess if traffic on the stop-controlled roadway (Highway 335) is likely to stop.

A review of the available collision data revealed no collisions between northbound and westbound vehicles between 1990 and 2017. The fatal Humboldt Broncos collision, which occurred in 2018, involved a northbound vehicle and a westbound vehicle.

**Issue Photo**


*Highway 35 Northbound Approach (August 2018)*

**Improvement Suggestions**

The most desirable mitigation for this issue would be the removal of the trees within the obstructed sight triangle. The trees located within MHI's right-of-way were removed in October 2018. The trees that are remaining are located on private property and would require negotiation with the land owner to remove.

If the sight triangle obstructions cannot be removed, the mitigation strategy would be to provide additional stop control enhancement on westbound Highway 335 (see Section 8.11).

Consideration was given to the installation of a concealed road warning sign (WA-11). As per the TAC *MUTCDC:*

> *"concealed road signs are installed on major roads in advance of crossroads where the vision triangle is inadequate…to the extent that a driver on the major road would not be adequately prepared for turning movements or cross traffic."*

The WA-11 sign is intended for locations where the intersection itself is concealed and is not intended to mitigate failure to stop collisions. In the case of northbound Highway 35, even if the sign was present, there would be inadequate time to react in the event of a westbound failure to stop. Implementing signage in a way other than intended is not recommended as it could increase motorist confusion with the sign's purpose.

**Improvement Costs**

The sight triangle as identified in Figure 6-6, should ideally be cleared of obstructions. The cost is estimated at $15,000 (4,000 $m^2$). It is acknowledged that the costs associated with tree removal on private property may be cost prohibitive. Furthermore, there has only been one documented collision in over 28 years, which does not indicate a trend of collisions related to this issue. If clearing the obstructions within the triangle is not practical, stop control enhancements should be considered, the costs of which are discussed in Section 8.11.

## 8.3 Grain Elevator Access in Close Proximity to Intersection

### Issue Description

The access to the Cargill Grain Elevator is located 100m north of Highway 335 on the east side of the highway. The close proximity to Highway 35 creates the following risks:

- Westbound motorists departing Highway 335 might assume that northbound traffic destined for the grain elevator are turning right at Highway 335, as they may be entering the right lane and signalling to turn. This could result in right angle collisions between northbound and westbound traffic.
- Westbound traffic turning northbound on Highway 35 would be accelerating at the same location as traffic decelerating to turn at the grain elevator. This creates the risk of speed differentials and rear-end collisions.
- The northbound transition taper ends prior to the grain elevator access. Vehicles destined for the grain elevator may enter the right lane to turn. However, the lane terminates prior to the access, which would require them to re-enter the left (through) lane. These movements may be sudden and sporadic, which could result in sideswipe or rear-end collisions.

The collision review did not identify any collisions involving turning movements at the intersection.

### Issue Photo

*Highway 35 Northbound at Cargill Grain Elevator Access*

### Improvement Suggestions

Due to the presence of the railway crossing north of the intersection, there are no better alternatives for intersection placement on Highway 35. It would be desirable to relocate the access south onto Highway 335 as there is no railway crossing which increases separation from the study intersection. Also, traffic volumes are significantly less than Highway 35.

### Improvement Costs

Realign grain elevator access road to Highway 335 (approximately 275m): $250,000

Given the road is located on private property, relocation would require negotiations with the land owner.

## 8.4 Railway Crossing Signs Within Clear Zone

### Issue Description

The railway crossing signals on Highway 35 are located 2.5m and 1.6m from the travel lanes, which is within the clear zone for the highway. As a result, they are a fixed object hazard. It is unclear if the bases are break-away and the concrete bases stick up more than the 100mm recommended by Transport Canada.

Four collisions in the available collision dataset occurred at the railway crossing on Highway 35 north of the intersection. The signal mast was struck in at least two of these instances.

### Issue Photos

*Railway Crossing Signals Within Clear Zone on Highway 35*

### Improvement Suggestions

Transport Canada's *Canadian Railway-Roadway Grade Crossing Standards* (2014), Section 8.1.5, recommends the signs be placed 2.0 - 4.5m from the edge of the travel lane. It is suggested that both signs be located 4.5m from the travel lane on break-away bases, with no more than 100mm of the concrete base protruding from the ground. It should be confirmed if the bases are break-away prior to modification (railway signals are typically under the jurisdiction of the railway company and any modifications would likely be at their discretion). The street light bases at the intersection should also be reviewed to determine if they are break-away.

### Improvement Costs

Install railway signals on break-away bases: $3,000 per signal

Provide break-away street light bases: $2,000 per street light

## 8.5 Roadside Pullout Access in Close Proximity to Intersection

**Issue Description**

There is a gravel roadway connecting Highway 35 and Highway 335 in the northwest corner of the intersection. Based on discussions with MHI, the roadway used to provide access to a gas station, which has since been decommissioned. The gravel roadway has become the location of a large roadside memorial that has developed in memory of the Humboldt Broncos bus crash.

Both highway access points are located close to the study intersection (72m to the north and 40m to the west). The close proximity of the intersections creates risks including, but not limited to:

- Motorists may not anticipate turning or braking maneuvers in such close proximity to a preceding intersection;
- Motorists may not be aware of an intersection's presence (and potential conflicts) due to high mental workload and poor sight lines at the previous intersection;
- Motorists may be unsure which intersection a signaling vehicle is intending to turn at;
- Reduces the delineation of the highways; and,
- Creates difficulties in signing the intersections due to space constraints.

The collision data review did not identify any collisions occurring at either access road intersection.

**Issue Photos**


*Gravel Road in Northwest Corner of Study Intersection*

## Improvement Suggestions

Prior to the Humboldt Bronco's collision, the recommendation would have been to remove the gravel road as it does not appear to serve a purpose. However, since the crash, the gravel road has become the location of a roadside memorial. The memorial attracts quite a lot of traffic, which further exacerbates the risks above. Furthermore, it increases the volume of pedestrians in close proximity to the highways and creates a distraction for motorists.

It is expected that the memorial will continue to draw visitors for decades to come. It is recommended that a more permanent installation be considered at a safer location. Ideally the memorial should be set back far enough from the highways to protect pedestrians and access should be provided via an access road that meets minimum setback requirements.

## Improvement Costs

Remove gravel roadway (approximately 1,000$m^2$): $20,000

Construct new roadside memorial and access road: Cost is dependant on design and funding.

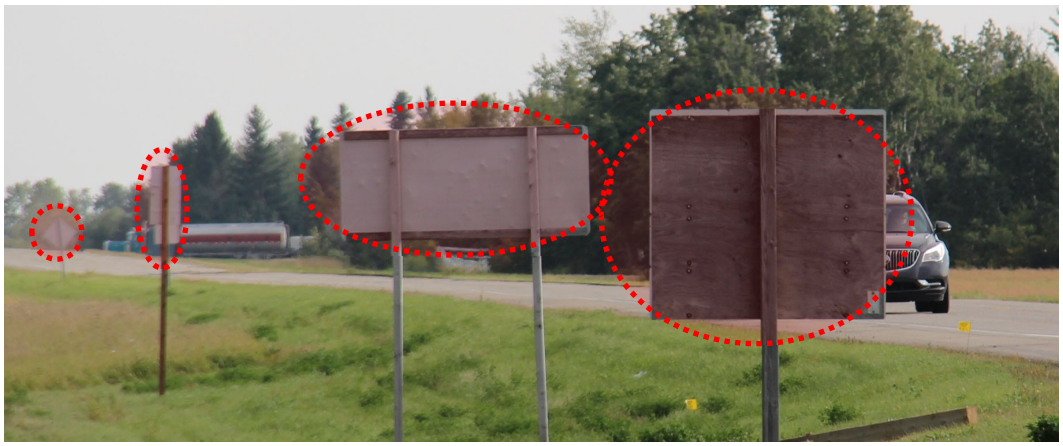
## 8.6 Highway 35 Signs Obstruct Departure Sight Distance

### Issue Description

On both the westbound (looking north and south) and eastbound (looking north) approaches of Highway 335, there are signs on Highway 35 that obstruct the visibility of oncoming through traffic. As a result, there is the potential that motorists entering the intersection from Highway 335 will not see an oncoming vehicle and enter the intersection using an inadequate gap traffic. This increases the risk of high-speed right-angle collisions.

The fatal collision that occurred in 1997 involved a southbound vehicle and an eastbound vehicle that failed to stop. The fatal Humboldt Broncos collision involved a northbound vehicle and a westbound vehicle.

### Issue Photos



*Highway 335 Westbound Approach Looking South*

### Improvement Suggestions

Increasing the height of signs obstructing the view of approaching vehicles would mitigate this risk. Signs that could benefit from an increase in height have been identified in the sign inventory in Appendix C.

### Improvement Costs

Costs are included in Section 8.9.

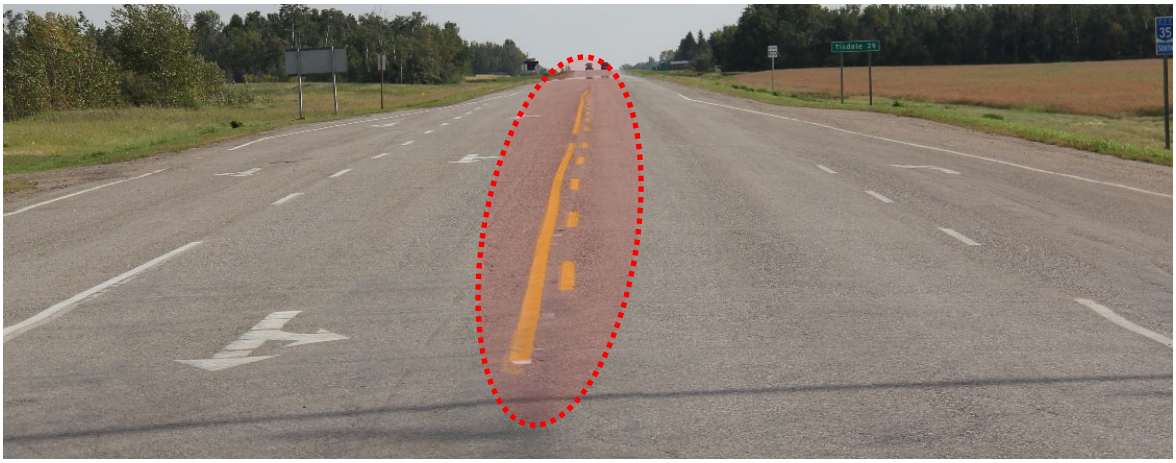
## 8.7 Eastbound and Southbound Passing in Close Proximity to Intersection

### Issue Description

Passing is permitted in the eastbound and southbound direction starting immediately after the intersection. In the case of the southbound direction, passing is permitted within the flared intersection treatment. Intersections are high workload areas, and adding an additional conflict, such as passing, increases the risk of collisions.

It is noted that this design is consistent with the Saskatchewan Ministry of Highways and Infrastructure's *Design Manual Part 2*, (June 2011), Figure 2320-9. There have also been no collisions identified related to this risk.

### Issue Photos



*Highway 35 Looking South from Highway 335 Intersection*

### Improvement Suggestions

It is recommended that passing not be permitted in close proximity of the intersection in either direction. On Highway 35, this would include the area within the flared intersection treatment.

### Improvement Costs

Paint solid centre line on Highway 35 southbound and Highway 335 eastbound (175m each): $1,500

## 8.8 Sun Glare

### Issue Description

Highway 335 is oriented in an east-west direction. As a result, sun glare can be an issue looking east during sunrise and west during sunset, creating the following risks:

- Glare and/or prolonged eye strain can impair vision; and,
- Road alignment, roadside hazards, and traffic control can be silhouetted (as shown in photo below).

One collision in the available collision dataset occurred during dawn and involved wildlife being struck on the highway by an eastbound vehicle. Sun glare may have reduced the visibility of wildlife on the highway at the time of the collision. The Humboldt Broncos collision on April 6, 2018 occurred close at 4:50pm and sunset that day was approximately 7:38pm.

### Issue Photo(s)

*Westbound Highway 335 Sunset Glare Silhouettes Stop Sign (August 30, 2018, 6:15pm)*

### Improvement Suggestions

Sun glare can be a challenging issue to mitigate. Although the glare cannot be removed, improvements can help increase the visibility of information important to motorists. Recommendations to improve sign placement (see Section 8.9) and enhance the stop controls (see Section 8.11) could help motorists during glare conditions.

### Improvement Costs

See Section 8.9 and Section 8.11

## 8.9 Various Sign Related Issues

**Issue Description**

All signs in the vicinity of the intersection were reviewed to identify deficiencies. A detailed summary is provided in Appendix C. A summary of the issues is provided below:

- Incorrect sign placement: Several signs were located at too large a lateral offset or positioned at too low a height. This placement makes the signs less conspicuous, which could result in them being overlooked by motorists.

- "Slow Down" and "60 km/h Maximum" signs have recently been added on all approaches since the Humboldt Broncos collision. The slow down message does not convey what the hazard is nor the appropriate speed. The 60 km/h signs are either orange or yellow, neither of which are a regulatory sign.


- Some signs are positioned too close to the intersection. Intersections are high mental workload areas, which could result in the signs being overlooked. They may also be outside the sight lines of turning motorists.

- "Bump" warning signs have been installed in conjunction with railway crossing ahead warning signs. The message is redundant and unnecessarily increases sign clutter and mental workload.

**Improvement Suggestions**

Improvement recommendations have been provided for each sign (when required) in the sign inventory provided in Appendix C.

**Improvement Costs**

The estimated cost to mitigate all sign issues as noted is $15,000 – 18,000.

## 8.10 Overhead Power Line Clutter

### Issue Description

Overhead power lines run parallel to Highway 335 along the north side of the roadway. The lines criss-cross over Highway 335 (to the south) at the intersection. Based on discussions with MHI, the lines may cross to the south because they were avoiding a conflict with the service station that used to be located in the northwest corner of the intersection.

A total of eleven (11) lines cross over Highway 335, which adds to the visual clutter on the westbound and eastbound approaches. This increases driver workload and could divert motorists' attention away from the road surface or traffic control devices, which could increase the risk of driver error.

### Issue Photos


*Westbound Highway 335 Approach*

### Improvement Suggestions

If the lines were aligned to avoid the service station, there may be opportunity to realign the lines to continue due east/west instead of crossing to the south.

### Improvement Costs

Unknown. Dependant on third party utility relocation costs.

## 8.11 Stop Control Enhancement

### Issue Description

The frequency of right-angle collisions at the intersection is very low with only two collisions occurring over the 28-year review period. However, these collisions did result in multiple fatalities, so opportunities to further increase stop control enhancement were investigated.

As discussed in Section 6.16, Highway 335 has all of the stop control enhancements recommended by MHI with the exception of transverse rumble strips. Although the level of stop control enhancement is high, there are some additional enhancements that could be considered at the intersection.

### Issue Photo

*Westbound Highway 335 Approach*

### Improvement Suggestions

Rumble strips could be installed on both the eastbound and westbound approaches. However, the cost would be higher than usual as the approaches would need to be paved in order to provide a deep enough surface to mill. Consideration would also have to be given to the noise it would generate in close proximity to a residence in the southeast corner.

Additional stop-control enhancements that could be implemented include:

- “Stop” and “Stop Ahead” pavement messages on the stop-controlled approaches. These are not standard MHI enhancements but could be considered for trial.
- Larger sized Stop and Stop Ahead signs (150 x 150cm and 120 x 120cm respectively). These are not standard MHI enhancements but could be considered for trial.
- Median stop signs: Could be installed on the centreline to increase visibility of the stop control and address some of the human factors identified. However, given the frequency of large farming equipment, such a sign would likely be obtrusive and frequently damaged.

Two other options were considered to address failure to stop collisions, but are not recommended:

**Roundabout**

Roundabouts have been proven to significantly reduce the potential for high severity right-angle and head-on collisions. Studies have indicated that the implementation of roundabouts can result in a 90% reduction in fatalities, 80% reduction in injuries and a 40% reduction in the total number of collisions when implemented correctly.

However, roundabouts may not be suitable at highway intersections where the preservation of a high speed through highway is both desirable and feasible. The interaction with nearby railway crossings, in which there are two adjacent to the study intersection, is also an important safety consideration. Although there have been two high profile multiple-fatality collisions at the intersection, the collision frequency at the intersection is actually very low over the last 28 years.

Considering the volume imbalance between the highways, low volume of left-turn movements, proximity of railway crossings, and low collision history, the intersection is not an ideal candidate for a roundabout at this time. The costs associated with the implementation of a roundabout could be better used on other mitigations or at locations suffering from a higher collision frequency/rate.

**4-Way Stop**

Stop signs are implemented as a means of clearly assigning right-of-way between vehicles approaching an intersection. Four-way stop controls are used at intersections to optimize operations by reducing delays and providing adequate gaps in traffic for all movements to complete their maneuvers. They should not be used as speed control measures or as a method of introducing traffic calming. Because the intersection of Highway 35 and Highway 335 does not experience traffic delays, the intersection does not warrant introduction of a four-way stop control.

Four-way stops are typically used when traffic volumes on the intersecting roadways are generally equal to reduce delays to side-street movements. Given that the AADT volumes on Highway 35 are almost double Highway 335, a four-way stop control would not be suitable.

Rear-end collisions on Highway 35 would likely increase with the implementation of a four-way stop controlled high speed junction. Given that Highway 35 is a major highway and typically has the right-of-way as a free-flow movement through other intersections, the introduction of stop controls along this roadway may not be expected by motorists. The risks associated with the implementation of a four-way stop control are expected to be higher than existing.

**Improvement Costs**

Milled rumble strips in advance of the intersection (both approaches): $150,000

Install “Stop” and “Stop Ahead” pavement messages: $1,500

Install larger sized Stop and Stop Ahead signs: $3,000

## 8.12 Potentially Obstructed Railway Sight Triangles on Highway 335

**Issue Description**

Conducting a detailed review of the railway sight triangles was not in the scope of this study. However, it was noted that two sight triangles that may be less than required:

- Eastbound Highway 335, crossing 170m west of Highway 35, bushes obstruct sight lines of southbound trains.
- Westbound Highway 335, crossing 800m west of Highway 35, trees obstruct sight lines of northbound trains.

The actual sight triangles would need to be confirmed on sight during a train crossing as it is difficult to assess visibility without a train present. Train speeds would also need to be confirmed.

**Issue Photos**

*Eastbound Highway 335 Railway Approach*

**Improvement Suggestions**

Clear sight obstructions within railway sight triangles if required.

**Improvement Costs**

To Be Confirmed

# 9. Benefit-Cost Analysis

The estimated improvement costs, as discussed previously, are summarized in Table 9-1. The relative benefit-cost for each improvement is also estimated for each improvement. The relative benefit-cost reflects how cost effective an improvement is expected to be. A high relative benefit-cost indicates a high collision cost reduction compared to the cost of construction. A low relative benefit-cost indicates a low collision cost reduction compared to the cost of construction.

Table 9-1 Benefit-Cost Analysis

| Improvement | | Estimated Cost | Relative Benefit-Cost |
|---|---|---|---|
| 8.1 | Widen Shoulders | $200,000 / km per side | Low |
| 8.2 | Tree removal on private property | $15,000* | High* |
| 8.3 | Realign Grain Elevator Access to Highway 335 | $250,000 | Low |
| 8.4 | Relocate railway signals (on break-away bases if required) | $6,000 | Medium |
| | Install light standards on break-away bases (if required) | $4,000 | Medium |
| 8.5 | Remove gravel roadway | $20,000 | High |
| | Construct new roadside memorial and access road | Dependant on design / funding. | |
| 8.6 | Highway 35 Signs Obstruct Departure Sight Distance | See 8.9 | |
| 8.7 | Paint solid centreline on Highway 35 and Highway 335 | $1,500 | Low |
| 8.8 | Sun Glare Mitigations | See 8.10 and 8.12 | |
| 8.9 | Various Sign Related Enhancements | $15,000 – 18,000 | High |
| 8.10 | Realign Overhead Power Lines | Unknown | Low |
| 8.11 | Mill rumble strips on Highway 335 approaches | $150,000 | Medium |
| | Install “Stop” and “Stop Ahead” pavement messages | $1,500 | High |
| | Install larger sized Stop and Stop Ahead signs | $3,000 | Low |

**Cost does not include any land owner negotiation / compensation if required. If costs are high, the benefit-cost ratio will be reduced.*

# 10. Implementation Strategy

The relative benefit-cost was used to develop an implementation strategy. The purpose of the implementation strategy is to prioritize the improvements with the goal of reducing the collision risk as quickly and efficiently as possible. Table 10-1 provides the prioritized list of improvements based on the safety analysis. Prioritization considered several factors when developing the rankings, such as:

- Improvements with a high benefit-cost are given higher priority.
- Improvements that can be implemented quickly are given higher priority. Low cost improvements are typically quicker to implement such that benefits can be obtained sooner.
- Improvements of a similar nature, such as sign improvements, are sometimes grouped together as there are cost and time savings for completing them concurrently.
- Longer-term, higher cost improvements are given lower priority such that lower cost improvements can be implemented and evaluated. If they are effective, higher cost improvements may not be required.

Table 10-1 Implementation Strategy

| Priority | Improvement | | Estimated Cost | Relative Benefit-Cost | Time Frame** |
|---|---|---|---|---|---|
| 1 | 8.9 | Various Sign Related Enhancements | $15,000–18,000 | High | Short |
| 2 | 8.11 | Install “Stop” and “Stop Ahead” pavement messages | $1,500 | High | Short |
| 3 | 8.2 | Tree removal on private property | $15,000* | High* | Medium |
| 4 | 8.5 | Construct new roadside memorial and access road | Dependant on design / funding. | | Medium |
| 5 | | Remove gravel roadway | $20,000 | High | Medium |
| 6 | 8.4 | Install railway signals on break-away bases (if required) | $6,000 | Medium | Short |
| 7 | 8.4 | Install light standards on break-away bases (if required) | $4,000 | Medium | Short |
| 8 | 8.11 | Mill rumble strips on Highway 335 approaches | $150,000 | Medium | Short |
| 9 | 8.11 | Install larger sized Stop and Stop Ahead signs | $3,000 | Low | Short |
| 10 | 8.7 | Paint solid centreline on Highway 35 and Highway 335 | $1,500 | Low | Short |
| 11 | 8.3 | Realign Grain Elevator Access to Highway 335 | $250,000 | Low | Long |
| 12 | 8.1 | Widen Shoulders | $200,000 / km per side | Low | Long |
| 13 | 8.10 | Realign Overhead Power Lines | Unknown | Low | Long |

** Cost does not include any land owner negotiation / compensation if required.*

*** Approximate time frames: Short-Term (0 – 2 years), Medium-Term (2 – 10 years), Long-Term ( >10 years)*

# 11. Conclusion

The purpose of this study was to identify potential safety issues that may be increasing the collision risk at the study intersection. Potential safety issues were identified based on discussions with stakeholders and a review of the physical, traffic, collision and human factors characteristics of the study intersection. Improvement options to mitigate these risks were identified along with cost estimates.

Although there have been two multiple fatality collisions at the intersection, the location does not have a high overall frequency of collisions, including high severity collisions. No significant collision trends were identified at the intersection. However, the geometric design review did identify some potential safety issues that could be mitigated to further reduce the collision risk at the intersection.

Removing the trees within the sight triangle in the southeast corner is desirable. MHI removed the trees within their right-of-way in October 2018. Removing the trees on private property would be dependant on land owner negotiations and cost.

In order to mitigate the sight triangle limitations in the southeast corner, MHI has installed numerous stop control enhancements on the westbound approach. Similar enhancements have also been provided on the eastbound approach in response to a fatal eastbound collision that occurred in 1997. Although there have only been two right-angle collisions at the intersection in close to 29 years, the collisions did result in multiple-fatalities. Additional stop-control enhancements have been proposed to further mitigate the risk of future failure to stop collisions.

There are several adjacent intersections located in close proximity to the intersection, which can create some operational and safety challenges. Closure or relocation of the access points has been recommended. Ideally the roadside memorial in the northwest corner of the intersection should be relocated to a safer location in the future.

# Appendix A

# Collision Data

| CASENO | ACCDATE | CTRLSECT | ATKM | LATITUDE | LONGITUDE | ACCSITE | NOVEH | NOKILLED | NOINJ | VEHNO | CONFIG | ROADCOND | ROADSURF | WEATHER | NATLIGHT | ARTLIGHT | PEDACT | PEDMCF1 | PEDMCF2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1545978 | 21-Jan-07 | 3350200 MUA | 0 | | | Non-Intersection | 1 | 0 | 0 | 1 | Other | Normal/Good | Dry | Clear | Dark | 1 | | | |
| 1866446 | 21-Feb-17 | 3350200 MUA | 0 | | | Int With Highway | 1 | 0 | 1 | 1 | Fixed/Movable Object | Normal/Good | Dry | Clear | Dawn | 1 | | | |
| 974174 | 27-Dec-06 | 0351500 MUA | 29.56 | | | Non-Intersection | 1 | 0 | 0 | 1 | Fixed/Movable Object | Normal/Good | Dry | Clear | Dark | 1 | | | |
| 4031571 | 26-Jun-09 | 0351500 MUA | 29.56 | | | Non-Intersection | 1 | 0 | 0 | 1 | Other | | | | Daylight | 1 | | | |
| 4142517 | 2-May-16 | 0351500 MUA | 29.56 | | | Int With Highway | 1 | 0 | 0 | 1 | Other | | Dry | | Daylight | 1 | | | |
| 1669592 | 23-Jun-11 | 0351600 MUA | 0 | | | Int With Highway | 2 | 0 | 1 | 1 | Other | Normal/Good | Dry | Clear | Daylight | 1 | | | |
| 1669592 | 23-Jun-11 | 0351600 MUA | 0 | | | Int With Highway | 2 | 0 | 1 | 2 | Other | Normal/Good | Dry | Clear | Daylight | 1 | | | |
| 1642807 | 8-Nov-09 | 0351600 MUA | 0.16 | | | Railroad Level Crossing | 1 | 0 | 1 | 1 | Lost Control - Right Ditch | Normal/Good | | Clear | Dark | | | | |
| 1642771 | 14-Oct-11 | 0351600 MUA | 0.16 | | | Railroad Level Crossing | 2 | 0 | 0 | 1 | Other | Normal/Good | Dry | Clear | Dark | 1 | | | |
| 1642771 | 14-Oct-11 | 0351600 MUA | 0.16 | | | Railroad Level Crossing | 2 | 0 | 0 | 2 | Other | Normal/Good | Dry | Clear | Dark | 1 | | | |

| CASENO | HOR | VERT | CONTROLS | MCF1 | MCF2 | MCF3 | MCF4 | PRECOLL | SEQ1 | SEQ2 | SEQ3 | DIRECT | LANE | VIDENT | TAISACCDESC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1545978 | Straight | Level or Near Level | No Control Present | Did not cause/contribute to the collision | | | | Going Straight Ahead | Skidding/ Sliding/Spinning | | | West | 1 | 3 | |
| 1866446 | Straight | Level or Near Level | No Control Present | Animal (wild) | | | | Going Straight Ahead | Animal | | | East | 1 | 1 | |
| 974174 | Straight | Level or Near Level | No Control Present | Animal (wild) | | | | Going Straight Ahead | Animal | | | North | 1 | 1 | |
| 4031571 | Straight | Level or Near Level | No Control Present | Jackknife/ trailer swing | | | | Going Straight Ahead | Jack-knife/Trailer Swing | | | North | 2 | 2 | |
| 4142517 | Straight | Level or Near Level | No Control Present | Defective tires/tires blowout | | | | Going Straight Ahead | Other Non-Collision Event | | | North | 1 | 5 | |
| 1669592 | Straight | Level or Near Level | Stop Sign | Did not cause/contribute to the collision | | | | Going Straight Ahead | Another Road Vehicle | | | East | 1 | 3 | |
| 1669592 | Straight | Level or Near Level | No Control Present | Other human action | | | | Going Straight Ahead | Another Road Vehicle | | | South | 1 | 4 | |
| 1642807 | Straight | Level or Near Level | Rail Road Crossing - With No Automatic Controls | Distracted | Taking evasive action | Animal (domestic) | | Going Straight Ahead | Ran off Road | Sign Post | Overturned | North | 1 | 1 | |
| 1642771 | Straight | Level or Near Level | Rail Road Crossing - With Automatic Controls | Did not cause/contribute to the collision | | | | Going Straight Ahead | Debris on Roadway | | | North | 1 | 2 | |
| 1642771 | Straight | Level or Near Level | Rail Road Crossing - With Automatic Controls | Did not cause/contribute to the collision | | | | Going Straight Ahead | Debris on Roadway | | | South | 1 | 2 | |

| CASENO | ACCDATE | CTRLSECT | ATKM | LATITUDE | LONGITUDE | ACCSITE | NOVEH | NOKILLED | NOINJ | VEHNO | CONFIG | ROADCOND | ROADSURF | WEATHER | NATLIGHT | ARTLIGHT | PEDACT | PEDMCF1 | PEDMCF2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1915177 | 24-Oct-16 | 0351600 MUA | 0.3 | | | Railroad Level Crossing | 1 | 0 | 0 | 1 | Lost Control - Right Ditch | Normal/Good | Dry | Cloudy | Dark | 2 | | | |
| 1881749 | 7-Mar-16 | 0351600 MUA | 0.5 | | | Non-Intersection | 1 | 0 | 0 | 1 | Lost Control - Right Ditch | Normal/Good | Packed Snow/Ice | Strong Winds | Dark | 1 | | | |
| 820488 | 4-Aug-91 | 351600 | 0 | | | Non-Intersection | 1 | 0 | 0 | 1 | Fixed/Movable Object | Normal/Good | Dry | Clear | Dark | 1 | | | |
| 985649 | 17-Jun-97 | 351600 | 0 | | | Int With Highway | 2 | 6 | 1 | 1 | Right Angle | Normal/Good | Dry | Cloudy | Daylight | 2 | | | |
| 985649 | 17-Jun-97 | 351600 | 0 | | | Int With Highway | 2 | 6 | 1 | 2 | Right Angle | Normal/Good | Dry | Cloudy | Daylight | 2 | | | |
| 1282634 | 25-Oct-00 | 351600 | 0 | | | Int With Highway | 3 | 0 | 1 | 2 | Rear End | Normal/Good | Dry | Clear | Daylight | 1 | | | |
| 1282634 | 25-Oct-00 | 351600 | 0 | | | Int With Highway | 3 | 0 | 1 | 3 | Rear End | Normal/Good | Dry | Clear | Daylight | 1 | | | |
| 1282634 | 25-Oct-00 | 351600 | 0 | | | Int With Highway | 3 | 0 | 1 | 1 | Rear End | Normal/Good | Dry | Clear | Daylight | 1 | | | |
| 1262912 | 13-Feb-01 | 351600 | 0 | | | Railroad Level Crossing | 1 | 0 | 0 | 1 | Fixed/Movable Object | Normal/Good | Dry | Clear | | 1 | | | |

| CASENO | HOR | VERT | CONTROLS | MCF1 | MCF2 | MCF3 | MCF4 | PRECOLL | SEQ1 | SEQ2 | SEQ3 | DIRECT | LANE | VIDENT | TAISACCDESC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1915177 | Curved | Level or Near Level | Rail Road Crossing - With Automatic Controls | Distracted | Exceeding speed limit | Careless driving/stunting | | Going Straight Ahead | Lamp Support (Traffic Signals, Street Light) | Ditch Bottom/Back Slope | Overturned | South | | 1 | |
| 1881749 | Straight | Level or Near Level | No Control Present | Snow drift | | | | Going Straight Ahead | Snow Bank/Drift | Overturned | | South | 1 | 1 | |
| 820488 | Straight | Level or Near Level | No Control Present | Obstruction/debris on roadway | | | | Going Straight Ahead | Other Movable Object | | | North | 1 | 3 | |
| 985649 | Straight | Level or Near Level | | Inattentive | View obstruction/limited outside the vehicle | | | Going Straight Ahead | Another Road Vehicle | | | South | 1 | 5 | |
| 985649 | Straight | Level or Near Level | Stop Sign | Inattentive | View obstruction/limited outside the vehicle | Other human action | | Going Straight Ahead | Another Road Vehicle | | | East | 1 | 2 | |
| 1282634 | Straight | Level or Near Level | No Control Present | Did not cause/contribute to the collision | | | | Slowing or Stopping | Another Road Vehicle | | | South | 1 | 4 | |
| 1282634 | Straight | Level or Near Level | No Passing Zone | Inattentive | Defective brakes | | | Going Straight Ahead | Another Road Vehicle | | | South | 1 | 2 | |
| 1282634 | Straight | Level or Near Level | No Passing Zone | Did not cause/contribute to the collision | | | | Slowing or Stopping | Another Road Vehicle | | | South | 1 | 3 | |
| 1262912 | | Level or Near Level | Rail Road Crossing - With No Automatic Controls | Other human action | | | | Reversing | Lamp Support (Traffic Signals, Street Light) | | | North | 1 | 16 | |

| CASENO | ACCDATE | CTRLSECT | ATKM | LATITUDE | LONGITUDE | ACCSITE | NOVEH | NOKILLED | NOINJ | VEHNO | CONFIG | ROADCOND | ROADSURF | WEATHER | NATLIGHT | ARTLIGHT | PEDACT | PEDMCF1 | PEDMCF2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 926864 | 1-Sep-92 | 351600 | 0.4 | | | Non-Intersection | 1 | 0 | 0 | 1 | Lost Control - Right Ditch | Normal/Good | Dry | Cloudy | Daylight | 1 | | | |
| 1068614 | 2-Feb-98 | 351600 | 0.4 | | | Off Roadway | 1 | 0 | 1 | 1 | Lost Control - Right Ditch | Normal/Good | Loose Snow | Clear | Dark | 1 | | | |
| 966446 | 11-Sep-94 | 351600 | 0.5 | | | Int With Highway | 2 | 0 | 0 | 1 | Right Angle | Normal/Good | Dry | Clear | Daylight | 1 | | | |
| 966446 | 11-Sep-94 | 351600 | 0.5 | | | Int With Highway | 2 | 0 | 0 | 2 | Right Angle | Normal/Good | Dry | Clear | Daylight | 1 | | | |
| 985507 | 2-Aug-95 | 351600 | 0.5 | | | Non-Intersection | 1 | 0 | 0 | 1 | Fixed/Movable Object | Normal/Good | Dry | Clear | Dark | 1 | | | |
| 942027 | 2-Apr-96 | 351600 | 0.5 | | | Non-Intersection | 2 | 0 | 2 | 1 | Rear End | Normal/Good | Loose Snow | Drifting Snow/Dust | Daylight | 1 | | | |
| 942027 | 2-Apr-96 | 351600 | 0.5 | | | Non-Intersection | 2 | 0 | 2 | 2 | Rear End | Normal/Good | Loose Snow | Drifting Snow/Dust | Daylight | 1 | | | |
| 985730 | 16-Sep-97 | 351600 | 0.5 | | | Non-Intersection | 1 | 0 | 1 | 1 | Other | Normal/Good | Wet | Cloudy | Dark | 1 | | | |

| CASENO | HOR | VERT | CONTROLS | MCF1 | MCF2 | MCF3 | MCF4 | PRECOLL | SEQ1 | SEQ2 | SEQ3 | DIRECT | LANE | VIDENT | TAISACCDESC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 926864 | Straight | Level or Near Level | No Control Present | Inattentive | | | | Going Straight Ahead | Ditch Bottom/Back Slope | Overturned | Load Spill | North | 1 | 5 | |
| 1068614 | Straight | Level or Near Level | No Control Present | Driver Inexperience/Confusion | Snow drift | | | Going Straight Ahead | Approach | Snow Bank/Drift | Overturned | North | | 15 | |
| 966446 | Straight | Level or Near Level | Stop Sign | Inattentive | Fail to yield the right-of-way | | | Going Straight Ahead | Another Road Vehicle | Skidding/Sliding/Spinning | | East | 1 | 1 | |
| 966446 | Straight | Level or Near Level | No Control Present | Did not cause/contribute to the collision | | | | Going Straight Ahead | Another Road Vehicle | Skidding/Sliding/Spinning | | North | 1 | 3 | |
| 985507 | Curved | Level or Near Level | No Control Present | Inattentive | Had Been Drinking | | | Going Straight Ahead | Skidding/Sliding/Spinning | Tree/Bush | | West | 1 | 2 | |
| 942027 | Straight | Level or Near Level | No Control Present | Weather conditions | | | | Slowing or Stopping | Another Road Vehicle | | | South | 1 | 5 | |
| 942027 | Straight | Level or Near Level | No Control Present | View obstruction/limited outside the vehicle | Weather conditions | Driver Inexperience/Confusion | | Going Straight Ahead | Skidding/Sliding/Spinning | Another Road Vehicle | | South | 1 | 2 | |
| 985730 | Straight | Level or Near Level | No Control Present | Did not cause/contribute to the collision | Other human action | | | Going Straight Ahead | Other Non-Collision Event | | | North | 1 | 2 | |

## Intersection Collision Rates - Calculations

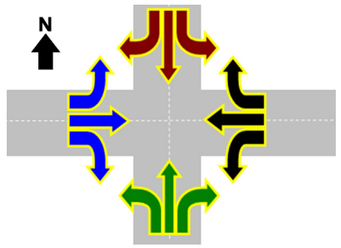
| Field Notation | Field | Value | | | Formula |
|---|---|---|---|---|---|
| A | Analysis period | 28 YEARS (1990 to 2017) | 10 YEARS (2008 to 2017) | 5 YEARS (2013 to 2017) | |
| B | Number of Collisions (Frequency) | 6 | 3 | 2 | |
| C | Average Number of Collisions Per Year | 0.21 | 0.30 | 0.40 | C = B / A |
| D | Average AADT of Vehicles Entering Intersection over Analysis Period | 1713 | 1775 | 1788 | Based on MHI Data |
| E | Average Number Vehicles Entering Intersection In a Year (Million Veh.) | 0.63 | 0.65 | 0.65 | E = D * 365 / 1,000,000 |
| F | Collision Rate (Frequency / Million Veh. Km) | 0.34 | 0.46 | 0.61 | F = C / E |

## Non-Intersection Collision Rates - Calculations

| Field Notation | Field | Value | | | Formula |
|---|---|---|---|---|---|
| A | Analysis period | 28 YEARS (1990 to 2017) | 10 YEARS (2008 to 2017) | 5 YEARS (2013 to 2017) | |
| B | Number of Collisions (Frequency) | 14 | 5 | 2 | |
| C | Average Number of Collisions Per Year | 0.50 | 0.50 | 0.40 | C = B / A |
| D | Average AADT of Highway Over Analysis Period | 1713 | 1775 | 1788 | Based on MHI Data |
| E | Average Vehicle Kilometers  (Million Veh. Km) | 0.63 | 0.65 | 0.65 | E = D * 365 / 1,000,000 * (0.5km + 0.5km) |
| F | Collision Rate (Frequency / Million Veh. Km) | 0.80 | 0.77 | 0.61 | F = C / E |

# Appendix B

# Intersection Turning Movement Volume Data and Analysis




# Data Entry Sheet

**The other category is to include all buses, RV's and miscellaneous vehicles.**

**After entering data, calculations and summaries without passenger-car-equivalents can be found in the "15 Min Totals" and "1 Hour Totals" Sheets. The "Summary Diagrams" sheet graphically represents key calculated data for analysis. The "Diagrams-For Printing" sheet contains graphics of data most useful for supervisors in a quick printing format. The values required for the system warrant calculations can be found in the "System Warrant values" sheet. For passenger-car-equivalents calculations and summaries, see "15 Min Totals PCE's" & "1 Hour Totals PCE's" sheets. The diagrams pertaining to calculated values using PCE's are found in the "PCE's Summary Diagrams" and "PCE's Diagrams for Printing" sheets. The system warrant calculations including PCE's can be found in the "PCE System Warrant Values" sheet.**

| | | Eastbound | | | | | | | | | Southbound | | | | | | | | | Westbound | | | | | | | | | Northbound | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other | Passenger | Trucks | Other |
| Start | End | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7:00:00 | 7:15:00 | | | | 1 | | | 1 | | | 2 | | | | 1 | | | | | | | | | 1 | 1 | | 1 | | | 3 | 1 | | | | | | |
| 7:15:00 | 7:30:00 | | | | | | | 1 | | | 1 | | | 4 | | | 5 | | | 5 | | | | 1 | | | | | | 1 | 2 | | 2 | | | | |
| 7:30:00 | 7:45:00 | | 1 | | 1 | | | | | | 4 | | | 7 | 5 | | | 2 | | 3 | 1 | | 2 | | | 7 | | | | | | 6 | 2 | | 1 | | |
| 7:45:00 | 8:00:00 | 1 | | | | | | | | | 3 | | | 9 | 8 | | 1 | 1 | | 3 | | | 4 | | | 2 | | | | | | 5 | 1 | | 3 | | |
| 8:00:00 | 8:15:00 | 2 | 1 | | 1 | | | 1 | | | 2 | | | 5 | | | 3 | 1 | | 6 | | | 3 | | | | | | 1 | | | 8 | 1 | | 1 | | |
| 8:15:00 | 8:30:00 | | 1 | | | | | 1 | | | | 1 | | 7 | 2 | | 3 | | | 1 | | | 3 | | | 1 | | | | | | 2 | 2 | | | | |
| 8:30:00 | 8:45:00 | 4 | | | | | | 1 | 1 | | | | | 12 | | | 4 | | | 1 | 1 | | 4 | | | 2 | | | | | | 3 | 1 | | 1 | | |
| 8:45:00 | 9:00:00 | 2 | | | 1 | 1 | | 3 | 1 | | 1 | | | 7 | | | 4 | 1 | | 2 | 2 | | | 1 | | 1 | | | 1 | | | 5 | 4 | | 1 | | |
| 9:00:00 | 9:15:00 | 2 | 1 | | | | | | | | 1 | 1 | | 5 | 2 | | | | | 1 | | | 2 | | | 4 | | | | | | 1 | 2 | | 1 | | |
| 9:15:00 | 9:30:00 | | 1 | | | | | | 1 | | 1 | | | 1 | 1 | | 1 | 2 | | 3 | | | 1 | | | 3 | 1 | | 1 | | | 2 | 1 | | 2 | | |
| 9:30:00 | 9:45:00 | 2 | | | 1 | | | | | | 2 | 2 | | 3 | 5 | | 1 | 2 | | 2 | | | 1 | | | 1 | | | | | | 1 | 1 | | 1 | | |
| 9:45:00 | 10:00:00 | 1 | | | 1 | 1 | | 2 | | | | 1 | | 3 | | | 6 | | | 2 | | | 1 | | | 3 | | | | | | 4 | 3 | | 1 | | |
| 10:00:00 | 10:15:00 | 1 | 1 | | | | | 2 | | | | 1 | | 8 | 3 | | 2 | 1 | | | | | | | | 3 | | | | | | 4 | 4 | | | | |
| 10:15:00 | 10:30:00 | | | | | | | 1 | | | 1 | 1 | | 5 | 2 | | 2 | 1 | | 2 | | | 1 | | | 3 | 1 | | | | | 4 | 3 | | 1 | 2 | |
| 10:30:00 | 10:45:00 | 2 | | | 2 | 2 | | | | | 1 | 1 | | 9 | 1 | | 4 | | | | | | | | | 3 | | | 1 | | | 4 | 4 | | | | |
| 10:45:00 | 11:00:00 | 1 | 1 | | | 1 | | 1 | | | | | | 5 | 2 | | 3 | | | 1 | 1 | | 1 | | | 2 | | | | | | 3 | 8 | | 1 | | |
| 11:00:00 | 11:15:00 | 1 | 1 | | | 1 | | | | | 1 | | | 5 | 3 | | 2 | | | 1 | | | 2 | 2 | | 2 | 2 | | 2 | | | 3 | 5 | | 1 | | |
| 11:15:00 | 11:30:00 | 1 | | | | 1 | | 1 | | | 4 | | | 4 | 4 | | 2 | | | 3 | | | | | | 1 | | | | 1 | | 6 | 2 | | 1 | 1 | |
| 11:30:00 | 11:45:00 | 2 | 1 | | 2 | | | 2 | | | 2 | | | 5 | 5 | | | 2 | | 1 | 1 | | | | | 1 | | | | | | 6 | 2 | | 3 | | |
| 11:45:00 | 12:00:00 | 1 | 2 | | | | | | | | 1 | 1 | | 6 | 2 | | 2 | | | 1 | 1 | | | | | | | | 1 | | | 1 | 6 | | 1 | | |
| 12:00:00 | 12:15:00 | 2 | | | | | | | | | 1 | | | 3 | | | 3 | | | 1 | 2 | | 2 | | | 2 | 1 | | | | | 3 | 3 | | | | |
| 12:15:00 | 12:30:00 | 3 | | | 1 | | | 1 | | | | | | 3 | 4 | | 1 | | | 1 | | | 1 | 1 | | | | | 2 | | | 11 | 1 | | 4 | 1 | |
| 12:30:00 | 12:45:00 | 2 | | | 1 | | | | 1 | | | | | 7 | 3 | | | | | 5 | 1 | | 1 | 2 | | | 1 | | | | | | 8 | | | | |
| 12:45:00 | 13:00:00 | 5 | 1 | | 1 | | | | | | | | | 5 | 2 | | 1 | 2 | | | | | 2 | | | 2 | 2 | | 2 | 1 | | 11 | 4 | | | | |
| 13:00:00 | 13:15:00 | 3 | | | | | | | | | 4 | 2 | | | 2 | | 7 | 3 | | 2 | 1 | | | 1 | | 5 | | | 1 | | | 7 | 5 | | 2 | | |
| 13:15:00 | 13:30:00 | 3 | | | 1 | | | | | | 1 | 1 | | 10 | | | | 1 | | 1 | 1 | | | | | 2 | | | | | | 3 | 4 | | 1 | 1 | |
| 13:30:00 | 13:45:00 | 1 | | | | 2 | | | | | 2 | 1 | | 5 | 3 | | 2 | 3 | | | | | | | | 1 | 1 | | 1 | | | 9 | 4 | | | 1 | |
| 13:45:00 | 14:00:00 | 3 | | | | | | | 1 | | 1 | | | 5 | 3 | | 1 | | | 7 | 2 | | | | | | | | | | | 8 | 1 | | | | |
| 14:00:00 | 14:15:00 | 4 | | | | | | | | | 4 | 1 | | 8 | 3 | | 3 | | | 1 | 1 | | 2 | | | 1 | 3 | | 1 | | | 2 | 2 | | 3 | 1 | |
| 14:15:00 | 14:30:00 | 1 | 1 | | | | | 1 | | | 2 | 1 | | 7 | 7 | | | 1 | | 2 | | | | | | 1 | | | | 1 | | 6 | 2 | | 3 | | |
| 14:30:00 | 14:45:00 | | | | | | | 1 | | | 1 | | | 5 | 2 | | 1 | 1 | | 1 | 1 | | | 1 | | 2 | | | 2 | | | 2 | 1 | | | | |
| 14:45:00 | 15:00:00 | 5 | 2 | | | | | | 1 | | 1 | | | 3 | | | 1 | 1 | | 7 | | | | 1 | | 2 | | | | 1 | | 6 | 1 | | 3 | 1 | |
| 15:00:00 | 15:15:00 | 7 | 1 | | | 1 | | | | | 3 | 1 | | 7 | 4 | | 6 | | | 1 | | | | | | 3 | | | 1 | | | 6 | | | 1 | 1 | |
| 15:15:00 | 15:30:00 | 1 | 1 | | | | | | 1 | | 4 | | | 4 | 1 | | 3 | | | 3 | 2 | | | | | 2 | | | | | | 7 | 2 | | 3 | 1 | |
| 15:30:00 | 15:45:00 | 2 | | | | | | | 1 | | 3 | | | 3 | 1 | | 4 | 1 | | 5 | | | 2 | | | 1 | 1 | | 1 | | | 7 | 1 | | 4 | | |
| 15:45:00 | 16:00:00 | 4 | | | 2 | | | 1 | | | | | | 8 | 5 | | | 2 | | 7 | 1 | | | | | 1 | | | | 1 | | 8 | 1 | | | | |
| 16:00:00 | 16:15:00 | 5 | 1 | | | | | 1 | 1 | | 2 | | | 7 | 2 | | 2 | 1 | | 3 | | | 1 | 1 | | 2 | | | | | | 9 | 4 | | | | |
| 16:15:00 | 16:30:00 | 2 | | | 3 | | | | | | 1 | | | 9 | 1 | | 2 | | | 3 | 1 | | 1 | | | | 1 | | | | | 6 | 2 | | 1 | 2 | |
| 16:30:00 | 16:45:00 | 1 | 1 | | 1 | | | | | | 3 | 1 | | 10 | 6 | | | | | 4 | | | 2 | 1 | | 2 | | | | | | 9 | 1 | | 1 | | |
| 16:45:00 | 17:00:00 | 2 | | | 1 | | | 1 | | | 2 | | | 7 | 3 | | 2 | 1 | | | | | | 1 | | | 1 | | | | | 9 | 2 | | 2 | 1 | |
| 17:00:00 | 17:15:00 | 2 | | | | | | | | | 4 | | | 8 | 4 | | 3 | | | 3 | 1 | | 1 | 1 | | 1 | 1 | | | | | 7 | 1 | | 2 | | |
| 17:15:00 | 17:30:00 | 5 | 1 | | | 1 | | | | | 7 | | | 7 | 1 | | 2 | 1 | | 5 | | | | | | 2 | | | 4 | 1 | | 12 | 1 | | 2 | | |
| 17:30:00 | 17:45:00 | 3 | | | | | | 2 | 1 | | 3 | | | 2 | 2 | | 2 | | | 2 | 1 | | 1 | | | | 1 | | | | | 9 | | | 3 | | |
| 17:45:00 | 18:00:00 | 5 | | | 2 | | | 1 | | | | | | 3 | 1 | | 2 | | | 1 | | | | | | | 1 | | 1 | | | 10 | 1 | | 5 | | |
| 18:00:00 | 18:15:00 | | | | 2 | | | | 1 | | 2 | | | 2 | | | | | | 1 | | | 1 | | | 1 | | | 7 | | | 11 | 4 | | 1 | | |
| 18:15:00 | 18:30:00 | 2 | | | | | | 2 | | | 1 | | | 5 | 1 | | 1 | 1 | | | | | 1 | | | 1 | | | | | | 6 | | | 1 | | |
| 18:30:00 | 18:45:00 | 3 | | | | | | | | | 1 | | | 1 | | | 2 | | | | | | 1 | | | 2 | | | 3 | | | 5 | | | | | |
| 18:45:00 | 19:00:00 | | | | 1 | | | | | | | | | 2 | | | 2 | | | | | | | 1 | | 1 | | | 2 | | | 4 | | | | | |
| Totals | | 99 | 20 | 0 | 26 | 11 | 0 | 28 | 11 | 0 | 80 | 17 | 0 | 256 | 107 | 0 | 98 | 32 | 0 | 104 | 22 | 0 | 44 | 15 | 0 | 77 | 18 | 0 | 37 | 6 | 0 | 265 | 111 | 0 | 64 | 13 | 0 |

# 15 Minute Traffic Count Totals

Note: This summary sheet does not take into account passenger-car equivalents. For the 15 minute totals, including passenger-car equivalents, see "15 Min Totals PCE's" sheet.

| Time Begins | Time Ends | Eastbound | | | | Westbound | | | | Total East West | Northbound | | | | Southbound | | | | Total North South | Total 15 Min. Vol | Time Begins | Time Ends | East-West Directional Split | North-South Directional Split |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Left | Straight | Right | Total | Left | Straight | Right | Total | | Left | Straight | Right | Total | Left | Straight | Right | Total | | | | | | |
| 7:00:00 | 7:15:00 | 0 | 1 | 1 | 2 | 2 | 0 | 0 | 2 | 4 | 1 | 4 | 0 | 5 | 2 | 1 | 0 | 3 | 8 | 12 | 7:00:00 | 7:15:00 | 50/50 | 63/38 |
| 7:15:00 | 7:30:00 | 0 | 0 | 1 | 1 | 0 | 1 | 5 | 6 | 7 | 0 | 3 | 2 | 5 | 1 | 4 | 5 | 10 | 15 | 22 | 7:15:00 | 7:30:00 | 14/86 | 33/67 |
| 7:30:00 | 7:45:00 | 1 | 1 | 0 | 2 | 7 | 2 | 4 | 13 | 15 | 0 | 8 | 1 | 9 | 4 | 12 | 2 | 18 | 27 | 42 | 7:30:00 | 7:45:00 | 13/87 | 33/67 |
| 7:45:00 | 8:00:00 | 1 | 0 | 0 | 1 | 2 | 4 | 3 | 9 | 10 | 0 | 6 | 3 | 9 | 3 | 17 | 2 | 22 | 31 | 41 | 7:45:00 | 8:00:00 | 10/90 | 29/71 |
| 8:00:00 | 8:15:00 | 3 | 1 | 1 | 5 | 0 | 3 | 6 | 9 | 14 | 1 | 9 | 1 | 11 | 2 | 5 | 4 | 11 | 22 | 36 | 8:00:00 | 8:15:00 | 36/64 | 50/50 |
| 8:15:00 | 8:30:00 | 1 | 0 | 1 | 2 | 1 | 3 | 1 | 5 | 7 | 0 | 4 | 0 | 4 | 1 | 9 | 3 | 13 | 17 | 24 | 8:15:00 | 8:30:00 | 29/71 | 24/76 |
| 8:30:00 | 8:45:00 | 4 | 0 | 2 | 6 | 2 | 4 | 2 | 8 | 14 | 0 | 4 | 1 | 5 | 0 | 12 | 4 | 16 | 21 | 35 | 8:30:00 | 8:45:00 | 43/57 | 24/76 |
| 8:45:00 | 9:00:00 | 2 | 2 | 4 | 8 | 1 | 1 | 4 | 6 | 14 | 1 | 9 | 1 | 11 | 1 | 7 | 5 | 13 | 24 | 38 | 8:45:00 | 9:00:00 | 57/43 | 46/54 |
| 9:00:00 | 9:15:00 | 3 | 0 | 0 | 3 | 4 | 2 | 1 | 7 | 10 | 0 | 3 | 1 | 4 | 2 | 7 | 0 | 9 | 13 | 23 | 9:00:00 | 9:15:00 | 30/70 | 31/69 |
| 9:15:00 | 9:30:00 | 1 | 0 | 1 | 2 | 4 | 1 | 3 | 8 | 10 | 1 | 3 | 2 | 6 | 1 | 2 | 3 | 6 | 12 | 22 | 9:15:00 | 9:30:00 | 20/80 | 50/50 |
| 9:30:00 | 9:45:00 | 2 | 1 | 0 | 3 | 1 | 1 | 2 | 4 | 7 | 0 | 2 | 1 | 3 | 4 | 8 | 3 | 15 | 18 | 25 | 9:30:00 | 9:45:00 | 43/57 | 17/83 |
| 9:45:00 | 10:00:00 | 1 | 2 | 2 | 5 | 3 | 1 | 2 | 6 | 11 | 0 | 7 | 1 | 8 | 1 | 3 | 6 | 10 | 18 | 29 | 9:45:00 | 10:00:00 | 45/55 | 44/56 |
| 10:00:00 | 10:15:00 | 2 | 0 | 2 | 4 | 3 | 0 | 0 | 3 | 7 | 0 | 8 | 0 | 8 | 1 | 11 | 3 | 15 | 23 | 30 | 10:00:00 | 10:15:00 | 57/43 | 35/65 |
| 10:15:00 | 10:30:00 | 0 | 0 | 1 | 1 | 4 | 1 | 2 | 7 | 8 | 0 | 7 | 3 | 10 | 2 | 7 | 3 | 12 | 22 | 30 | 10:15:00 | 10:30:00 | 13/88 | 45/55 |
| 10:30:00 | 10:45:00 | 2 | 4 | 0 | 6 | 3 | 0 | 0 | 3 | 9 | 1 | 8 | 0 | 9 | 2 | 10 | 4 | 16 | 25 | 34 | 10:30:00 | 10:45:00 | 67/33 | 36/64 |
| 10:45:00 | 11:00:00 | 2 | 1 | 1 | 4 | 2 | 1 | 2 | 5 | 9 | 0 | 11 | 1 | 12 | 0 | 7 | 3 | 10 | 22 | 31 | 10:45:00 | 11:00:00 | 44/56 | 55/45 |
| 11:00:00 | 11:15:00 | 2 | 1 | 0 | 3 | 4 | 4 | 1 | 9 | 12 | 2 | 8 | 1 | 11 | 1 | 8 | 2 | 11 | 22 | 34 | 11:00:00 | 11:15:00 | 25/75 | 50/50 |
| 11:15:00 | 11:30:00 | 1 | 1 | 1 | 3 | 1 | 0 | 3 | 4 | 7 | 1 | 8 | 2 | 11 | 4 | 8 | 2 | 14 | 25 | 32 | 11:15:00 | 11:30:00 | 43/57 | 44/56 |
| 11:30:00 | 11:45:00 | 3 | 2 | 2 | 7 | 1 | 0 | 2 | 3 | 10 | 0 | 8 | 3 | 11 | 2 | 10 | 2 | 14 | 25 | 35 | 11:30:00 | 11:45:00 | 70/30 | 44/56 |
| 11:45:00 | 12:00:00 | 3 | 0 | 0 | 3 | 0 | 0 | 2 | 2 | 5 | 1 | 7 | 1 | 9 | 2 | 8 | 2 | 12 | 21 | 26 | 11:45:00 | 12:00:00 | 60/40 | 43/57 |
| 12:00:00 | 12:15:00 | 2 | 0 | 0 | 2 | 3 | 2 | 3 | 8 | 10 | 0 | 6 | 0 | 6 | 1 | 3 | 3 | 7 | 13 | 23 | 12:00:00 | 12:15:00 | 20/80 | 46/54 |
| 12:15:00 | 12:30:00 | 3 | 1 | 1 | 5 | 0 | 2 | 1 | 3 | 8 | 2 | 12 | 5 | 19 | 0 | 7 | 1 | 8 | 27 | 35 | 12:15:00 | 12:30:00 | 63/38 | 70/30 |
| 12:30:00 | 12:45:00 | 2 | 1 | 1 | 4 | 1 | 3 | 6 | 10 | 14 | 0 | 8 | 0 | 8 | 0 | 10 | 0 | 10 | 18 | 32 | 12:30:00 | 12:45:00 | 29/71 | 44/56 |
| 12:45:00 | 13:00:00 | 6 | 1 | 0 | 7 | 4 | 2 | 0 | 6 | 13 | 3 | 15 | 0 | 18 | 0 | 7 | 3 | 10 | 28 | 41 | 12:45:00 | 13:00:00 | 54/46 | 64/36 |
| 13:00:00 | 13:15:00 | 3 | 0 | 0 | 3 | 5 | 1 | 3 | 9 | 12 | 1 | 12 | 2 | 15 | 6 | 2 | 10 | 18 | 33 | 45 | 13:00:00 | 13:15:00 | 25/75 | 45/55 |
| 13:15:00 | 13:30:00 | 3 | 1 | 0 | 4 | 2 | 0 | 2 | 4 | 8 | 0 | 7 | 2 | 9 | 2 | 10 | 1 | 13 | 22 | 30 | 13:15:00 | 13:30:00 | 50/50 | 41/59 |
| 13:30:00 | 13:45:00 | 1 | 2 | 0 | 3 | 2 | 0 | 0 | 2 | 5 | 1 | 13 | 1 | 15 | 3 | 8 | 5 | 16 | 31 | 36 | 13:30:00 | 13:45:00 | 60/40 | 48/52 |
| 13:45:00 | 14:00:00 | 3 | 0 | 1 | 4 | 0 | 0 | 9 | 9 | 13 | 0 | 9 | 0 | 9 | 1 | 8 | 1 | 10 | 19 | 32 | 13:45:00 | 14:00:00 | 31/69 | 47/53 |
| 14:00:00 | 14:15:00 | 4 | 0 | 0 | 4 | 4 | 2 | 2 | 8 | 12 | 1 | 4 | 4 | 9 | 5 | 11 | 3 | 19 | 28 | 40 | 14:00:00 | 14:15:00 | 33/67 | 32/68 |
| 14:15:00 | 14:30:00 | 2 | 0 | 1 | 3 | 1 | 0 | 2 | 3 | 6 | 1 | 8 | 3 | 12 | 3 | 14 | 1 | 18 | 30 | 36 | 14:15:00 | 14:30:00 | 50/50 | 40/60 |
| 14:30:00 | 14:45:00 | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 5 | 6 | 2 | 3 | 0 | 5 | 1 | 7 | 2 | 10 | 15 | 21 | 14:30:00 | 14:45:00 | 17/83 | 33/67 |
| 14:45:00 | 15:00:00 | 7 | 0 | 1 | 8 | 2 | 1 | 7 | 10 | 18 | 1 | 7 | 4 | 12 | 1 | 3 | 2 | 6 | 18 | 36 | 14:45:00 | 15:00:00 | 44/56 | 67/33 |
| 15:00:00 | 15:15:00 | 8 | 1 | 0 | 9 | 3 | 0 | 1 | 4 | 13 | 1 | 6 | 2 | 9 | 4 | 11 | 6 | 21 | 30 | 43 | 15:00:00 | 15:15:00 | 69/31 | 30/70 |
| 15:15:00 | 15:30:00 | 2 | 0 | 1 | 3 | 2 | 0 | 5 | 7 | 10 | 0 | 9 | 4 | 13 | 4 | 5 | 3 | 12 | 25 | 35 | 15:15:00 | 15:30:00 | 30/70 | 52/48 |
| 15:30:00 | 15:45:00 | 2 | 0 | 1 | 3 | 2 | 2 | 5 | 9 | 12 | 1 | 8 | 4 | 13 | 3 | 4 | 5 | 12 | 25 | 37 | 15:30:00 | 15:45:00 | 25/75 | 52/48 |
| 15:45:00 | 16:00:00 | 4 | 2 | 1 | 7 | 1 | 0 | 8 | 9 | 16 | 1 | 9 | 0 | 10 | 0 | 13 | 2 | 15 | 25 | 41 | 15:45:00 | 16:00:00 | 44/56 | 40/60 |
| 16:00:00 | 16:15:00 | 6 | 0 | 2 | 8 | 2 | 2 | 3 | 7 | 15 | 0 | 13 | 0 | 13 | 2 | 9 | 3 | 14 | 27 | 42 | 16:00:00 | 16:15:00 | 53/47 | 48/52 |
| 16:15:00 | 16:30:00 | 2 | 3 | 0 | 5 | 1 | 1 | 4 | 6 | 11 | 0 | 8 | 3 | 11 | 1 | 10 | 2 | 13 | 24 | 35 | 16:15:00 | 16:30:00 | 45/55 | 46/54 |
| 16:30:00 | 16:45:00 | 2 | 1 | 0 | 3 | 2 | 3 | 4 | 9 | 12 | 0 | 10 | 1 | 11 | 4 | 16 | 0 | 20 | 31 | 43 | 16:30:00 | 16:45:00 | 25/75 | 35/65 |
| 16:45:00 | 17:00:00 | 2 | 1 | 1 | 4 | 0 | 1 | 0 | 1 | 5 | 1 | 11 | 3 | 15 | 2 | 10 | 3 | 15 | 30 | 35 | 16:45:00 | 17:00:00 | 80/20 | 50/50 |
| 17:00:00 | 17:15:00 | 2 | 0 | 0 | 2 | 2 | 2 | 4 | 8 | 10 | 0 | 8 | 2 | 10 | 4 | 12 | 3 | 19 | 29 | 39 | 17:00:00 | 17:15:00 | 20/80 | 34/66 |
| 17:15:00 | 17:30:00 | 6 | 1 | 0 | 7 | 2 | 0 | 5 | 7 | 14 | 5 | 13 | 2 | 20 | 7 | 8 | 3 | 18 | 38 | 52 | 17:15:00 | 17:30:00 | 50/50 | 53/47 |
| 17:30:00 | 17:45:00 | 3 | 0 | 3 | 6 | 1 | 1 | 3 | 5 | 11 | 0 | 9 | 3 | 12 | 3 | 4 | 2 | 9 | 21 | 32 | 17:30:00 | 17:45:00 | 55/45 | 57/43 |
| 17:45:00 | 18:00:00 | 5 | 2 | 1 | 8 | 1 | 0 | 1 | 2 | 10 | 1 | 11 | 5 | 17 | 0 | 4 | 2 | 6 | 23 | 33 | 17:45:00 | 18:00:00 | 80/20 | 74/26 |
| 18:00:00 | 18:15:00 | 0 | 2 | 1 | 3 | 1 | 1 | 1 | 3 | 6 | 7 | 15 | 1 | 23 | 2 | 2 | 0 | 4 | 27 | 33 | 18:00:00 | 18:15:00 | 50/50 | 85/15 |
| 18:15:00 | 18:30:00 | 2 | 0 | 2 | 4 | 1 | 1 | 0 | 2 | 6 | 0 | 6 | 1 | 7 | 1 | 6 | 2 | 9 | 16 | 22 | 18:15:00 | 18:30:00 | 67/33 | 44/56 |
| 18:30:00 | 18:45:00 | 3 | 0 | 0 | 3 | 2 | 1 | 0 | 3 | 6 | 3 | 5 | 0 | 8 | 1 | 1 | 2 | 4 | 12 | 18 | 18:30:00 | 18:45:00 | 50/50 | 67/33 |
| 18:45:00 | 19:00:00 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 2 | 3 | 2 | 4 | 0 | 6 | 0 | 2 | 2 | 4 | 10 | 13 | 18:45:00 | 19:00:00 | 33/67 | 60/40 |
| Totals | | 119 | 37 | 39 | 195 | 95 | 59 | 126 | 280 | 475 | 43 | 376 | 77 | 496 | 97 | 363 | 130 | 590 | 1086 | 1561 | | | 41/59 | 46/54 |

| | Intersection Max 15 Min Total | | |
|---|---|---|---|
| | Total | AM Peak | PM Peak |
| Maximum | 52 | 42 | 52 |
| Start Time | 17:15:00 | 7:30:00 | 17:15:00 |
| | Eastbound Max 15 Min Total | | |
| | Total | AM Peak | PM Peak |
| Maximum | 9 | 8 | 9 |
| Start Time | 15:00:00 | 8:45:00 | 15:00:00 |
| | Westbound Max 15 Min Total | | |
| | Total | AM Peak | PM Peak |
| Maximum | 13 | 13 | 10 |
| Start Time | 7:30:00 | 7:30:00 | 12:30:00 |
| | Northbound Max 15 Min Total | | |
| | Total | AM Peak | PM Peak |
| Maximum | 23 | 12 | 23 |
| Start Time | 18:00:00 | 10:45:00 | 18:00:00 |
| | Southbound Max 15 Min Total | | |
| | Total | AM Peak | PM Peak |
| Maximum | 22 | 22 | 21 |
| Start Time | 7:45:00 | 7:45:00 | 15:00:00 |

# 1 Hour Traffic Count Totals

Note: This summary sheet does not take into account passenger-car equivalents. For the 1 hour totals, including passenger-car equivalents, see "1 hour Totals PCE's" sheet.

| Time Begins | Time End | Eastbound | | | | Westbound | | | | Total East West | Northbound | | | | Southbound | | | | Total North South | Total 1 Hour Volume | Time Begins | Time Ends | East-West Directional Split | North-South Directional Split | A.M. or P.M. | | Peak Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Left | Straight | Right | Total | Left | Straight | Right | Total | | Left | Straight | Right | Total | Left | Straight | Right | Total | | | | | | | | | |
| 7:00:00 | 8:00:00 | 2 | 2 | 2 | 6 | 11 | 7 | 12 | 30 | 36 | 1 | 21 | 6 | 28 | 10 | 34 | 9 | 53 | 81 | 117 | 7:00:00 | 8:00:00 | 17/83 | 35/65 | A.M. | 13 | FALSE |
| 7:15:00 | 8:15:00 | 5 | 2 | 2 | 9 | 9 | 10 | 18 | 37 | 46 | 1 | 26 | 7 | 34 | 10 | 38 | 13 | 61 | 95 | 141 | 7:15:00 | 8:15:00 | 20/80 | 36/64 | A.M. | 14 | FALSE |
| 7:30:00 | 8:30:00 | 6 | 2 | 2 | 10 | 10 | 12 | 14 | 36 | 46 | 1 | 27 | 5 | 33 | 10 | 43 | 11 | 64 | 97 | 143 | 7:30:00 | 8:30:00 | 22/78 | 34/66 | A.M. | 15 | FALSE |
| 7:45:00 | 8:45:00 | 9 | 1 | 4 | 14 | 5 | 14 | 12 | 31 | 45 | 1 | 23 | 5 | 29 | 6 | 43 | 13 | 62 | 91 | 136 | 7:45:00 | 8:45:00 | 31/69 | 32/68 | A.M. | 16 | FALSE |
| 8:00:00 | 9:00:00 | 10 | 3 | 8 | 21 | 4 | 11 | 13 | 28 | 49 | 2 | 26 | 3 | 31 | 4 | 33 | 16 | 53 | 84 | 133 | 8:00:00 | 9:00:00 | 43/57 | 37/63 | A.M. | 17 | FALSE |
| 8:15:00 | 9:15:00 | 10 | 2 | 7 | 19 | 8 | 10 | 8 | 26 | 45 | 1 | 20 | 3 | 24 | 4 | 35 | 12 | 51 | 75 | 120 | 8:15:00 | 9:15:00 | 42/58 | 32/68 | A.M. | 18 | FALSE |
| 8:30:00 | 9:30:00 | 10 | 2 | 7 | 19 | 11 | 8 | 10 | 29 | 48 | 2 | 19 | 5 | 26 | 4 | 28 | 12 | 44 | 70 | 118 | 8:30:00 | 9:30:00 | 40/60 | 37/63 | A.M. | 19 | FALSE |
| 8:45:00 | 9:45:00 | 8 | 3 | 5 | 16 | 10 | 5 | 10 | 25 | 41 | 2 | 17 | 5 | 24 | 8 | 24 | 11 | 43 | 67 | 108 | 8:45:00 | 9:45:00 | 39/61 | 36/64 | A.M. | 20 | FALSE |
| 9:00:00 | 10:00:00 | 7 | 3 | 3 | 13 | 12 | 5 | 8 | 25 | 38 | 1 | 15 | 5 | 21 | 8 | 20 | 12 | 40 | 61 | 99 | 9:00:00 | 10:00:00 | 34/66 | 34/66 | A.M. | 21 | FALSE |
| 9:15:00 | 10:15:00 | 6 | 3 | 5 | 14 | 11 | 3 | 7 | 21 | 35 | 1 | 20 | 4 | 25 | 7 | 24 | 15 | 46 | 71 | 106 | 9:15:00 | 10:15:00 | 40/60 | 35/65 | A.M. | 22 | FALSE |
| 9:30:00 | 10:30:00 | 5 | 3 | 5 | 13 | 11 | 3 | 6 | 20 | 33 | 0 | 24 | 5 | 29 | 8 | 29 | 15 | 52 | 81 | 114 | 9:30:00 | 10:30:00 | 39/61 | 36/64 | A.M. | 23 | FALSE |
| 9:45:00 | 10:45:00 | 5 | 6 | 5 | 16 | 13 | 2 | 4 | 19 | 35 | 1 | 30 | 4 | 35 | 6 | 31 | 16 | 53 | 88 | 123 | 9:45:00 | 10:45:00 | 46/54 | 40/60 | A.M. | 24 | FALSE |
| 10:00:00 | 11:00:00 | 6 | 5 | 4 | 15 | 12 | 2 | 4 | 18 | 33 | 1 | 34 | 4 | 39 | 5 | 35 | 13 | 53 | 92 | 125 | 10:00:00 | 11:00:00 | 45/55 | 42/58 | A.M. | 25 | FALSE |
| 10:15:00 | 11:15:00 | 6 | 6 | 2 | 14 | 13 | 6 | 5 | 24 | 38 | 3 | 34 | 5 | 42 | 5 | 32 | 12 | 49 | 91 | 129 | 10:15:00 | 11:15:00 | 37/63 | 46/54 | A.M. | 26 | FALSE |
| 10:30:00 | 11:30:00 | 7 | 7 | 2 | 16 | 10 | 5 | 6 | 21 | 37 | 4 | 35 | 4 | 43 | 7 | 33 | 11 | 51 | 94 | 131 | 10:30:00 | 11:30:00 | 43/57 | 46/54 | A.M. | 27 | FALSE |
| 10:45:00 | 11:45:00 | 8 | 5 | 4 | 17 | 8 | 5 | 8 | 21 | 38 | 3 | 35 | 7 | 45 | 7 | 33 | 9 | 49 | 94 | 132 | 10:45:00 | 11:45:00 | 45/55 | 48/52 | A.M. | 28 | FALSE |
| 11:00:00 | 12:00:00 | 9 | 4 | 3 | 16 | 6 | 4 | 8 | 18 | 34 | 4 | 31 | 7 | 42 | 9 | 34 | 8 | 51 | 93 | 127 | 11:00:00 | 12:00:00 | 47/53 | 45/55 | A.M. | 29 | FALSE |
| 11:15:00 | 12:15:00 | 9 | 3 | 3 | 15 | 5 | 2 | 10 | 17 | 32 | 2 | 29 | 6 | 37 | 9 | 29 | 9 | 47 | 84 | 116 | 11:15:00 | 12:15:00 | 47/53 | 44/56 | A.M. | 30 | FALSE |
| 11:30:00 | 12:30:00 | 11 | 3 | 3 | 17 | 4 | 4 | 8 | 16 | 33 | 3 | 33 | 9 | 45 | 5 | 28 | 8 | 41 | 86 | 119 | 11:30:00 | 12:30:00 | 52/48 | 52/48 | A.M. | 31 | FALSE |
| 11:45:00 | 12:45:00 | 10 | 2 | 2 | 14 | 4 | 7 | 12 | 23 | 37 | 3 | 33 | 6 | 42 | 3 | 28 | 6 | 37 | 79 | 116 | 11:45:00 | 12:45:00 | 38/62 | 53/47 | A.M. | 32 | FALSE |
| 12:00:00 | 13:00:00 | 13 | 3 | 2 | 18 | 8 | 9 | 10 | 27 | 45 | 5 | 41 | 5 | 51 | 1 | 27 | 7 | 35 | 86 | 131 | 12:00:00 | 13:00:00 | 40/60 | 59/41 | P.M. | 33 | FALSE |
| 12:15:00 | 13:15:00 | 14 | 3 | 2 | 19 | 10 | 8 | 10 | 28 | 47 | 6 | 47 | 7 | 60 | 6 | 26 | 14 | 46 | 106 | 153 | 12:15:00 | 13:15:00 | 40/60 | 57/43 | P.M. | 34 | FALSE |
| 12:30:00 | 13:30:00 | 14 | 3 | 1 | 18 | 12 | 6 | 11 | 29 | 47 | 4 | 42 | 4 | 50 | 8 | 29 | 14 | 51 | 101 | 148 | 12:30:00 | 13:30:00 | 38/62 | 50/50 | P.M. | 35 | FALSE |
| 12:45:00 | 13:45:00 | 13 | 4 | 0 | 17 | 13 | 3 | 5 | 21 | 38 | 5 | 47 | 5 | 57 | 11 | 27 | 19 | 57 | 114 | 152 | 12:45:00 | 13:45:00 | 45/55 | 50/50 | P.M. | 36 | FALSE |
| 13:00:00 | 14:00:00 | 10 | 3 | 1 | 14 | 9 | 1 | 14 | 24 | 38 | 2 | 41 | 5 | 48 | 12 | 28 | 17 | 57 | 105 | 143 | 13:00:00 | 14:00:00 | 37/63 | 46/54 | P.M. | 37 | FALSE |
| 13:15:00 | 14:15:00 | 11 | 3 | 1 | 15 | 8 | 2 | 13 | 23 | 38 | 2 | 33 | 7 | 42 | 11 | 37 | 10 | 58 | 100 | 138 | 13:15:00 | 14:15:00 | 39/61 | 42/58 | P.M. | 38 | FALSE |
| 13:30:00 | 14:30:00 | 10 | 2 | 2 | 14 | 7 | 2 | 13 | 22 | 36 | 3 | 34 | 8 | 45 | 12 | 41 | 10 | 63 | 108 | 144 | 13:30:00 | 14:30:00 | 39/61 | 42/58 | P.M. | 39 | FALSE |
| 13:45:00 | 14:45:00 | 9 | 0 | 3 | 12 | 7 | 3 | 15 | 25 | 37 | 4 | 24 | 7 | 35 | 10 | 40 | 7 | 57 | 92 | 129 | 13:45:00 | 14:45:00 | 32/68 | 38/62 | P.M. | 40 | FALSE |
| 14:00:00 | 15:00:00 | 13 | 0 | 3 | 16 | 9 | 4 | 13 | 26 | 42 | 5 | 22 | 11 | 38 | 10 | 35 | 8 | 53 | 91 | 133 | 14:00:00 | 15:00:00 | 38/62 | 42/58 | P.M. | 41 | FALSE |
| 14:15:00 | 15:15:00 | 17 | 1 | 3 | 21 | 8 | 2 | 12 | 22 | 43 | 5 | 24 | 9 | 38 | 9 | 35 | 11 | 55 | 93 | 136 | 14:15:00 | 15:15:00 | 49/51 | 41/59 | P.M. | 42 | FALSE |
| 14:30:00 | 15:30:00 | 17 | 1 | 3 | 21 | 9 | 2 | 15 | 26 | 47 | 4 | 25 | 10 | 39 | 10 | 26 | 13 | 49 | 88 | 135 | 14:30:00 | 15:30:00 | 45/55 | 44/56 | P.M. | 43 | FALSE |
| 14:45:00 | 15:45:00 | 19 | 1 | 3 | 23 | 9 | 3 | 18 | 30 | 53 | 3 | 30 | 14 | 47 | 12 | 23 | 16 | 51 | 98 | 151 | 14:45:00 | 15:45:00 | 43/57 | 48/52 | P.M. | 44 | FALSE |
| 15:00:00 | 16:00:00 | 16 | 3 | 3 | 22 | 8 | 2 | 19 | 29 | 51 | 3 | 32 | 10 | 45 | 11 | 33 | 16 | 60 | 105 | 156 | 15:00:00 | 16:00:00 | 43/57 | 43/57 | P.M. | 45 | FALSE |
| 15:15:00 | 16:15:00 | 14 | 2 | 5 | 21 | 7 | 4 | 21 | 32 | 53 | 2 | 39 | 8 | 49 | 9 | 31 | 13 | 53 | 102 | 155 | 15:15:00 | 16:15:00 | 40/60 | 48/52 | P.M. | 46 | FALSE |
| 15:30:00 | 16:30:00 | 14 | 5 | 4 | 23 | 6 | 5 | 20 | 31 | 54 | 2 | 38 | 7 | 47 | 6 | 36 | 12 | 54 | 101 | 155 | 15:30:00 | 16:30:00 | 43/57 | 47/53 | P.M. | 47 | FALSE |
| 15:45:00 | 16:45:00 | 14 | 6 | 3 | 23 | 6 | 6 | 19 | 31 | 54 | 1 | 40 | 4 | 45 | 7 | 48 | 7 | 62 | 107 | 161 | 15:45:00 | 16:45:00 | 43/57 | 42/58 | P.M. | 48 | FALSE |
| 16:00:00 | 17:00:00 | 12 | 5 | 3 | 20 | 5 | 7 | 11 | 23 | 43 | 1 | 42 | 7 | 50 | 9 | 45 | 8 | 62 | 112 | 155 | 16:00:00 | 17:00:00 | 47/53 | 45/55 | P.M. | 49 | FALSE |
| 16:15:00 | 17:15:00 | 8 | 5 | 1 | 14 | 5 | 7 | 12 | 24 | 38 | 1 | 37 | 9 | 47 | 11 | 48 | 8 | 67 | 114 | 152 | 16:15:00 | 17:15:00 | 37/63 | 41/59 | P.M. | 50 | FALSE |
| 16:30:00 | 17:30:00 | 12 | 3 | 1 | 16 | 6 | 6 | 13 | 25 | 41 | 6 | 42 | 8 | 56 | 17 | 46 | 9 | 72 | 128 | 169 | 16:30:00 | 17:30:00 | 39/61 | 44/56 | P.M. | 51 | TRUE |
| 16:45:00 | 17:45:00 | 13 | 2 | 4 | 19 | 5 | 4 | 12 | 21 | 40 | 6 | 41 | 10 | 57 | 16 | 34 | 11 | 61 | 118 | 158 | 16:45:00 | 17:45:00 | 48/53 | 48/52 | P.M. | 52 | FALSE |
| 17:00:00 | 18:00:00 | 16 | 3 | 4 | 23 | 6 | 3 | 13 | 22 | 45 | 6 | 41 | 12 | 59 | 14 | 28 | 10 | 52 | 111 | 156 | 17:00:00 | 18:00:00 | 51/49 | 53/47 | P.M. | 53 | FALSE |
| 17:15:00 | 18:15:00 | 14 | 5 | 5 | 24 | 5 | 2 | 10 | 17 | 41 | 13 | 48 | 11 | 72 | 12 | 18 | 7 | 37 | 109 | 150 | 17:15:00 | 18:15:00 | 59/41 | 66/34 | P.M. | 54 | FALSE |
| 17:30:00 | 18:30:00 | 10 | 4 | 7 | 21 | 4 | 3 | 5 | 12 | 33 | 8 | 41 | 10 | 59 | 6 | 16 | 6 | 28 | 87 | 120 | 17:30:00 | 18:30:00 | 64/36 | 68/32 | P.M. | 55 | FALSE |
| 17:45:00 | 18:45:00 | 10 | 4 | 4 | 18 | 5 | 3 | 2 | 10 | 28 | 11 | 37 | 7 | 55 | 4 | 13 | 6 | 23 | 78 | 106 | 17:45:00 | 18:45:00 | 64/36 | 71/29 | P.M. | 56 | FALSE |
| 18:00:00 | 19:00:00 | 5 | 3 | 3 | 11 | 5 | 4 | 1 | 10 | 21 | 12 | 30 | 2 | 44 | 4 | 11 | 6 | 21 | 65 | 86 | 18:00:00 | 19:00:00 | 52/48 | 68/32 | P.M. | 57 | FALSE |

| | Intersection Max 1 Hour Total | | |
|---|---|---|---|
| | Total | AM Peak | PM Peak |
| Maximum | 169 | 143 | 169 |
| Start Time | 16:30:00 | 7:30:00 | 16:30:00 |
| | Eastbound Max 1 Hour Total | | |
| | Total | AM Peak | PM Peak |
| Maximum | 24 | 21 | 24 |
| Start Time | 17:15:00 | 8:00:00 | 17:15:00 |
| | Westbound Max 1 Hour Total | | |
| | Total | AM Peak | PM Peak |
| Maximum | 37 | 37 | 32 |
| Start Time | 7:15:00 | 7:15:00 | 15:15:00 |
| | Northbound Max 1 Hour Total | | |
| | Total | AM Peak | PM Peak |
| Maximum | 72 | 45 | 72 |
| Start Time | 17:15:00 | 10:45:00 | 17:15:00 |
| | Southbound Max 1 Hour Total | | |
| | Total | AM Peak | PM Peak |
| Maximum | 72 | 64 | 72 |
| Start Time | 16:30:00 | 7:30:00 | 16:30:00 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 6 | 2 | 2 | 10 | 12 | 14 | 1 | 27 | 5 | 10 | 43 | 11 |
| Future Volume (Veh/h) | 6 | 2 | 2 | 10 | 12 | 14 | 1 | 27 | 5 | 10 | 43 | 11 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Hourly flow rate (vph) | 8 | 3 | 3 | 13 | 15 | 18 | 1 | 34 | 6 | 13 | 54 | 14 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 132 | 129 | 34 | 96 | 133 | 20 | 68 | | | 40 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 132 | 129 | 34 | 96 | 133 | 20 | 68 | | | 40 | | |
| tC, single (s) | 7.9 | 6.9 | 7.3 | 7.9 | 6.9 | 7.3 | 4.4 | | | 4.6 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.7 | 4.2 | 3.5 | 3.7 | 4.2 | 3.5 | 2.3 | | | 2.5 | | |
| p0 queue free % | 99 | 100 | 100 | 98 | 98 | 98 | 100 | | | 99 | | |
| cM capacity (veh/h) | 747 | 714 | 976 | 816 | 710 | 997 | 1454 | | | 1415 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|
| Volume Total | 14 | 46 | 18 | 23 | 40 | 41 |
| Volume Left | 8 | 13 | 1 | 0 | 13 | 0 |
| Volume Right | 3 | 18 | 0 | 6 | 0 | 14 |
| cSH | 779 | 835 | 1454 | 1700 | 1415 | 1700 |
| Volume to Capacity | 0.02 | 0.06 | 0.00 | 0.01 | 0.01 | 0.02 |
| Queue Length 95th (ft) | 1 | 4 | 0 | 0 | 1 | 0 |
| Control Delay (s) | 9.7 | 9.6 | 0.4 | 0.0 | 2.5 | 0.0 |
| Lane LOS | A | A | A | | A | |
| Approach Delay (s) | 9.7 | 9.6 | 0.2 | | 1.2 | |
| Approach LOS | A | A | | | | |

| Intersection Summary | | | | |
|---|---|---|---|---|
| Average Delay | 3.8 | | | |
| Intersection Capacity Utilization | 17.2% | ICU Level of Service | A | |
| Analysis Period (min) | 15 | | | |

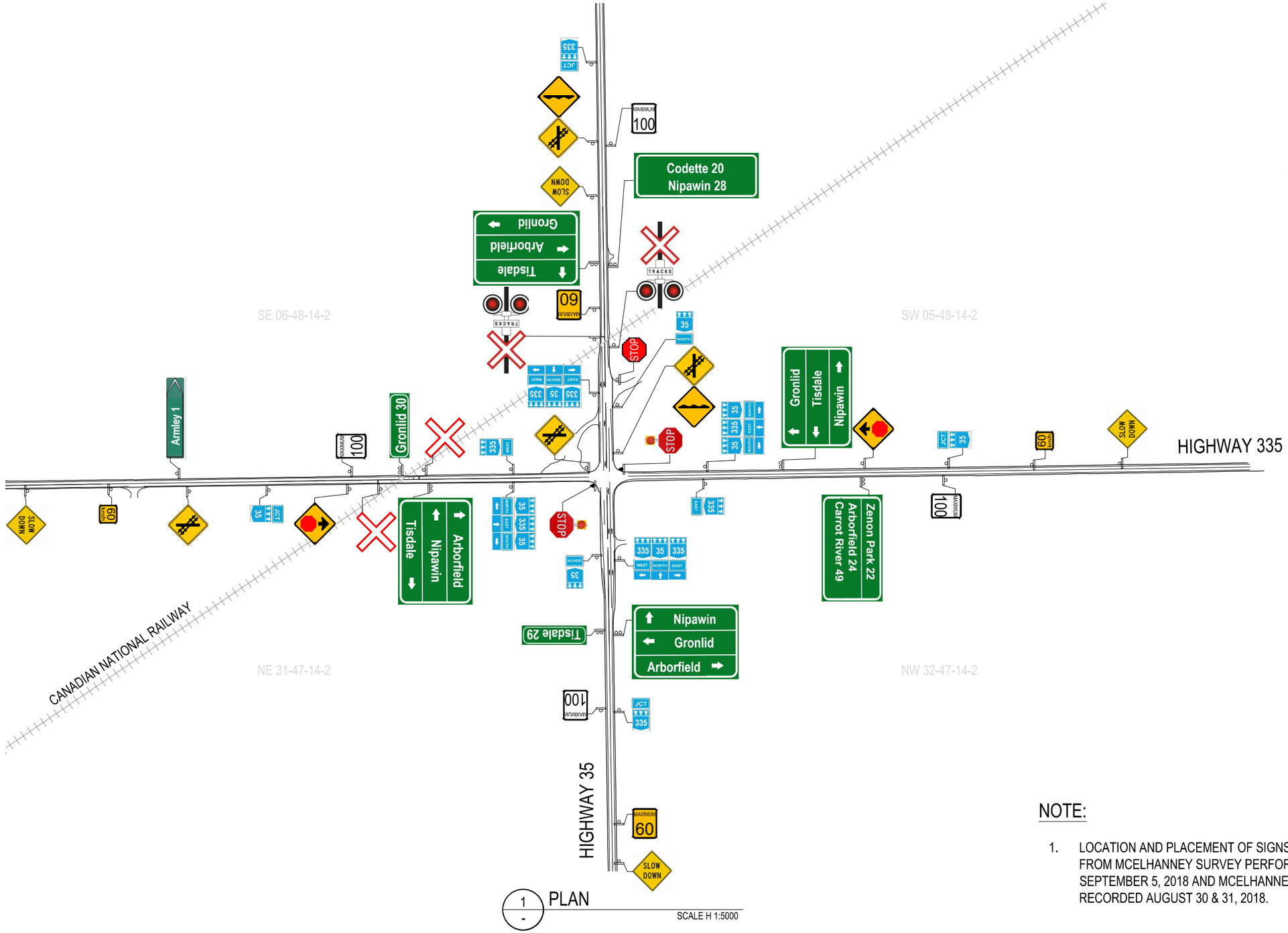
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 12 | 3 | 1 | 6 | 6 | 13 | 6 | 42 | 8 | 17 | 46 | 9 |
| Future Volume (Veh/h) | 12 | 3 | 1 | 6 | 6 | 13 | 6 | 42 | 8 | 17 | 46 | 9 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Hourly flow rate (vph) | 15 | 4 | 1 | 8 | 8 | 16 | 8 | 53 | 10 | 21 | 58 | 11 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 168 | 184 | 34 | 148 | 185 | 32 | 69 | | | 63 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 168 | 184 | 34 | 148 | 185 | 32 | 69 | | | 63 | | |
| tC, single (s) | 7.9 | 6.9 | 7.3 | 7.9 | 6.9 | 7.3 | 4.4 | | | 4.6 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.7 | 4.2 | 3.5 | 3.7 | 4.2 | 3.5 | 2.3 | | | 2.5 | | |
| p0 queue free % | 98 | 99 | 100 | 99 | 99 | 98 | 99 | | | 98 | | |
| cM capacity (veh/h) | 703 | 655 | 975 | 742 | 655 | 980 | 1453 | | | 1385 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|
| Volume Total | 20 | 32 | 34 | 36 | 50 | 40 |
| Volume Left | 15 | 8 | 8 | 0 | 21 | 0 |
| Volume Right | 1 | 16 | 0 | 10 | 0 | 11 |
| cSH | 702 | 814 | 1453 | 1700 | 1385 | 1700 |
| Volume to Capacity | 0.03 | 0.04 | 0.01 | 0.02 | 0.02 | 0.02 |
| Queue Length 95th (ft) | 2 | 3 | 0 | 0 | 1 | 0 |
| Control Delay (s) | 10.3 | 9.6 | 1.8 | 0.0 | 3.3 | 0.0 |
| Lane LOS | B | A | A | | A | |
| Approach Delay (s) | 10.3 | 9.6 | 0.9 | | 1.8 | |
| Approach LOS | B | A | | | | |

| Intersection Summary | | | | |
|---|---|---|---|---|
| Average Delay | 3.5 | | | |
| Intersection Capacity Utilization | 17.6% | ICU Level of Service | A | |
| Analysis Period (min) | 15 | | | |

# Appendix C

## Sign Inventory and Recommendations




1 / - PLAN

SCALE H 1:5000

## NOTE:

1. LOCATION AND PLACEMENT OF SIGNS ARE TAKEN FROM MCELHANNEY SURVEY PERFORMED ON SEPTEMBER 5, 2018 AND MCELHANNEY VIDEO RECORDED AUGUST 30 & 31, 2018.

| Rev | Date | Description | Drawn | Design | App'd |
|---|---|---|---|---|---|
| A | 2018-10-15 | ISSUED FOR REVIEW | VR | MW | CW |



0 1:5,000 250

ORIGINAL DWG SIZE: ANSI B (11" x 17")

McElhanney
McElhanney Resource Services Ltd.
2215A Emmett Hall Road
Regina SK
Canada S4N 2Y3
Tel 306 993 2450

MINISTRY OF HIGHWAYS AND INFRASTRUCTURE
1855 VICTORIA AVE., REGINA, SK., S4P 3T2

HWY 35 & 335 INTERSECTION
EXISTING SIGNAGE

Drawing No.
FIGURE B-1

Project Number 2711-18013
Rev. A

## Sign Inventory and Assessment - Northbound Highway 35

| Distance from Intersection | Sign Type | Sign Code (MUTCDC) | Sign Code (MHI) | Height (m) | Lateral Offset (m) | Manufacture Date | MHI Date | Size | Condition | Retroreflectivity | Comments | Recommendation | Improvement Cost | Photograph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 530m South | "Slow Down" warning sign | N/A | WS-38 | Sign Not Present During Survey | | Jun-15 | | Standard | Fair (minor scratch and dents) | Acceptable | The "slow down" message does not convey to motorists what the hazard is or what the appropriate speed is. | These signs are intended to reduce speeds in response to increased traffic at the memorial site. There are two recommended options:<br><br>1) Provide a safer location/access for the memorial and remove these signs.<br><br>2) Monitor traffic volumes. If a reduced speed is required, install a proper speed reduction (RB-1 & RB-5 regulatory speed limit signs) with a 80 km/h transition zone. If traffic volumes have reduced, the warning signs could be removed. | $100 - $500 |  |
| 430m South | "Maximum 60" speed limit construction sign | TC-23 | N/A | Sign Not Present During Survey | | Mar-08 | | Standard | Fair (minor scratch and dents) | Acceptable | The orange color is intended for work zones and could mislead motorists. | | $100 - $500 |  |
| 280m South | "JCT 335" Highway Junction Route Marker | IB-3<br>IB-2 | IB-3<br>IB-2A | 1.34 | 5.57 | November 2012 (Top Panel)<br><br>June 2014 (Bottom Panel) | August 21, 2018 | Standard | Good | Acceptable | Sign height is low<br><br>Lateral offset too large | Reposition sign at correct height and offset<br><br>Increase height beyond minimum requirement to improve departure sight distance on westbound approach. | $200 |  |
| 180m South | Guide Sign "Nipawin, Gronlid, Arborfield" | IA-3 | GS-26 | 1.34 | 5.08 | | November 7, 2007 | Standard | Fair (minor scratch and dents) | Acceptable | Sign height is low | Increase sign height<br><br>Increase height beyond minimum requirement to improve departure sight distance on westbound approach. | $300 |  |
| 90m South | "335 West, 35 North, 335 East" Route Markers | IB-2 (3x)<br>IS-13/10/11<br>IS-8L/7/8R | IB-2 (3x)<br>IB-13/10/11 | 1.08 | 5.67 | | October 21, 2008 | Standard | Good | Acceptable | Sign height is low<br><br>Lateral offset too large | Reposition sign at correct height and offset<br><br>Increase height beyond minimum requirement to improve departure sight distance on westbound approach. | $200 |  |
| 25m North | Railing Crossing Ahead & Bump | WA-18L<br>WA-22 | WA-18L WA-22 | 0.79 | 5.88 | | February 2001<br>May 2009 | Standard | Good | Acceptable | Sign height is low<br>Lateral offset too large<br>Too close to Hwy 335<br>Bump sign is redundant | Relocate sign (at correct offsets) to be 50m north of intersection. Remove bump warning sign. | $200 |  |
| 115m North | "35 North" Highway Route Identification Sign | IB-2<br>IS-10 | IB-2A<br>IB-10 | 1.7 | 6.09 | | October 16, 2008 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway<br><br>Increase height beyond minimum requirement to improve departure sight distance on westbound approach. | $200 |  |
| 160m North | Railway Crossing Sign | RA-6 | N/A | 3.07 | 1.09 | | | Standard | Good | Acceptable | Sign/signal base within clear zone | Confirm if sign base is breakaway and provide breakaway base if required. | Covered Separately in Report |  |
| 260m North | Guide Sign "Codette 20, Nipawin 29" | IA-4 | GS-22 | 1.53 | 5.64 | | November 7, 2007 | Standard | Fair (minor scratch and dents) | Acceptable | | Increase height beyond minimum requirement to improve departure sight distance on westbound approach. | $200 |  |
| 410m North | "Maximum 100" speed limit sign | RB-1 | RB-1 | 1.7 | 5.9 | | August 16, 2017 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |  |

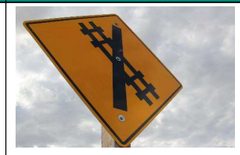
## Sign Inventory and Assessment - Southbound Highway 35

| Distance from Intersection | Sign Type | Sign Code (MUTCDC) | Sign Code (MHI) | Height (m) | Lateral Offset (m) | Manufacture Date | MHI Date | Size | Condition | Retroreflectivity | Comments | Recommendations | Improvement Cost | Photograph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 505m North | "JCT 335" Highway Junction Route Marker | IB-3 IB-2 | IB-3 IB-2A | 1.7 | 6.39 | | October 16, 2008 | Standard | Fair (minor discoloration and scratches) | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |   |
| 410m North | Railway Crossing Ahead & Bump warning signs | WA-18L WA-22 | WA-18L WA-22 | 0.41 | 6.32 | | April 10, 2001 (top sign)<br>November 25, 2009 (bottom sign) | Standard | Fair (minor dents and scratches) | Acceptable | Lateral offset too large<br>Bump warning sign is redundant | Relocate closer to roadway<br>Remove bump warning sign | $200 |  |
| 320m North | "Slow Down" warning sign | N/A | WS-38 | Sign Not Present During Survey | | Jun-15 | | Standard | Good | Acceptable | The "slow down" message does not convey to motorists what the hazard is or what the appropriate speed is. | See Note 1) below | $100 - $500 |   |
| 255m North | Guide Sign "Tisdale, Arborfield, Gronlid" | IA-3 | GS-26 | 1.53 | 5.29 | | November 7, 2007 | Standard | Fair (minor dents and scratches) | Acceptable | | Although height meets minimum requirements. Increasing sign height would improve departure sight distance on eastbound approach. | $300 |   |
| 210m North | "Maximum 60" speed limit construction sign | TC-23 | N/A | Sign Not Present During Survey | | | March 2008 | Standard | Good | Acceptable | The orange color is intended for work zones and could mislead motorists.<br>Sign height is low. | Note 1) These signs are intended to reduce speeds in response to increased traffic at the memorial site. There are two recommended options:<br>1) Provide a safer location/access for the memorial and remove these signs.<br>2) Monitor traffic volumes. If a reduced speed is required, install a proper speed reduction (RB-1 & RB-5 regulatory speed limit signs) with a 80 km/h transition zone. If traffic volumes have reduced, the warning signs could be removed. | $100 - $500 |   |
| 160m North | Railway Crossing Sign | RA-6 | N/A | 3.12 | 1.07 | | | Standard | Good | Acceptable | Sign/signal base within clear zone.<br>Missing retroreflective strips on back of sign. | Confirm if sign base is breakaway and provide breakaway base if required.<br>Relocate to 2.5m from travel lane.<br>Provide retroreflective strip on back of sign. | Covered Separately in Report |  |
| 95m North | "335 East, 35 South, 335 West" Route Markers | IB-2 (3x) IS-11/12/13 IS-8L/7/8R | IB-2A (3x) IB-11/12/13 | 1.67 | 4.82 | | August 19, 2014 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway<br>Although height meets minimum requirements. Increasing sign height would improve departure sight distance on eastbound approach. | $200 |   |
| 90m South | "35 South" Route Marker | IB-2 IS-12 | IB-2A IB-12 | 1.58 | 5.22 | | October 15, 2008 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |   |
| 185m South | Guide Sign "Tisdale 29" | IA-4 | GS-41 | 1.67 | 5.06 | | June 14, 2018 | Standard | Good | Acceptable | | | |   |
| 280m South | "Maximum 100" Speed Limit Sign | RB-1 | RB-1 | 1.58 | 5.96 | | October 15, 2008 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |   |

## Sign Inventory and Assessment - Westbound Highway 335

| Distance from Intersection | Sign Type | Sign Code (MUTCDC) | Sign Code (MHI) | Height (m) | Lateral Offset (m) | Manufacture Date | MHI Date | Size | Condition | Retroreflectivity | Comments | Recommendations | Improvement Cost | Photograph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 630m East | "Slow Down" warning sign | N/A | WS-38 | Sign Not Present During Survey | | May 2018 | | Standard | Good, but surface may be bent slightly | Acceptable | The "slow down" message does not convey to motorists what the hazard is or what the appropriate speed is. | These signs are intended to reduce speeds in response to increased traffic at the memorial site. There are two recommended options:<br><br>1) Provide a safer location/access for the memorial and remove these signs.<br><br>2) Monitor traffic volumes. If a reduced speed is required, install a proper speed reduction (RB-1 & RB-5 regulatory speed limit signs) with a 80 km/h transition zone. If traffic volumes have reduced, the warning signs could be removed. | $100 - $500 |  |
| 515m East | 60 km/h Advisory Speed Warning Sign | N/A | WA-7 | Sign Not Present During Survey | | March 2011 | | Standard | Good | Acceptable | An advisory speed is not a regulatory speed limit and can't be enforced.<br><br>Advisory speeds should only be used in conjunction with an associated warning sign. | | $100 - $500 |  |
| 410m East | "JCT 35" Highway Junction Route Marker | IB-3 IB-2 | IB-3 IB-2A | 1.67 | 4.95 | June 2014 | October 28, 2014 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |  |
| 300m East | Stop Sign Ahead warning sign | WB-1 | WB-1 | 1.19 | 5.15 | August 1998 | December 16, 1999 | Standard | Poor<br><br>(holes, scratches and a bent surface) | Reduced | Sign height is low<br><br>Lateral offset too large<br><br>Sign condition is poor | Reposition sign at correct height and offset.<br><br>Replace sign panel. | $500 |  |
| 200m East | "Gronlid, Tisdale, Nipawin" Destination Direction Sign | IA-3 | GS-26 | 1.21 | 5.12 | | November 7, 2007 | Standard | Fair (minor dents and scratches) | Acceptable | Sign height is low | Increase sign height | $300 |  |
| 110m East | "35 South, 335 West, 35 North" Route Markers | IB-2 (3x) IS-12/13/10 IS-8L/7/8R | IB-2A (3x) IB-12/13/10 | 1.1 | 5.42 | | August 19, 2014 | Standard | Good | Brighter inside panel makes outside panels hard to see | Sign height is low<br><br>Lateral offset too large | Reposition sign at correct height and offset<br><br>Upgrade retroreflectivity of outside panels | $500 |  |
| 4m East | Stop sign with flashing red beacon | RA-1 | RA-1 | 1.78 | 2.58 | September 2007 | April 23, 2008 | Oversized | Poor<br><br>(holes, scratches and a bent surface) | Acceptable | Sign is in relatively poor condition<br><br>Flashing beacon is mounted too high | Replace sign panel<br><br>Reduce height of flashing beacon to be 200 - 300mm above sign. | $1,500 |  |

## Sign Inventory and Assessment - Westbound Highway 335

| Distance from Intersection | Sign Type | Sign Code (MUTCDC) | Sign Code (MHI) | Height (m) | Lateral Offset (m) | Manufacture Date | MHI Date | Size | Condition | Retroreflectivity | Comments | Recommendations | Improvement Cost | Photograph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7m West | Railway Crossing Ahead Sign | WA-18R | WA-18R | 1.66 | 5.39 | | May 1, 2018 | Standard | Good | Acceptable | Lateral offset too large<br><br>Too close to Hwy 35 | Given the importance of this sign, it is recommended that it be relocated further west. Given the sign clutter, it is suggested that the route marker discussed below be relocated further west as it is less important to motorist safety. | $200 |  |
| 105m West | "335 West" Route Marker | IB-2<br>IS-13 | IB-2A<br>IB-13 | 1.63 | 5.87 | | | Standard | Good | Acceptable | Lateral offset too large | As per above, it is suggested that this sign be relocated west of the railway crossing. | $200 |  |
| 215m West | Railway Crossing | RA-6 | N/A | 1.59 | 6.31 | June 2018 | | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |  |
| 240m West | "Gronlid 30" Guide Sign | IA-4 | GS-41 | 1.43 | 5.21 | | November 7, 2007 | Standard | Good | Acceptable | Sign height is low | Increase sign height | $200 |  |
| 300m West | "Maximum 100" speed limit sign | RB-1 | RB-1 | 1.77 | 5.79 | August 2013 | April 23, 2015 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |  |

## Sign Inventory and Assessment - Eastbound Highway 335

| Distance from Intersection | Sign Type | Sign Code (MUTCDC) | Sign Code (MHI) | Height (m) | Lateral Offset (m) | Manufacture Date | MHI Date | Size | Condition | Retroreflectivity | Comments | Recommendations | Improvement Cost | Photograph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 710m West | Slow Down warning sign | N/A | WS-38 | Sign Not Present During Survey | | June 2015 | | Standard | Good | Acceptable | The "slow down" message does not convey to motorists what the hazard is or what the appropriate speed is. | These signs are intended to reduce speeds in response to increased traffic at the memorial site. There are two recommended options:<br><br>1) Provide a safer location/access for the memorial and remove these signs.<br><br>2) Monitor traffic volumes. If a reduced speed is required, install a proper speed reduction (RB-1 & RB-5 regulatory speed limit signs) with a 80 km/h transition zone. If traffic volumes have reduced, the warning signs could be removed. | $100 - $500 |  |
| 605m West | 60 km/h Advisory Speed Warning Sign | N/A | WA-7 | Sign Not Present During Survey | | | | Standard | Good | Reduced | An advisory speed is not a regulatory speed limit and can't be enforced.<br><br>Advisory speeds should only be used in conjunction with an associated warning sign. | | $100 - $500 |  |
| 505m West | Railway Crossing Ahead Sign | WA-18R | WA-18R | 1.59 | 6.5 | February 2001 | April 18, 2001 | Standard | Poor<br>(holes and dents) | Reduced | Lateral offset too large<br><br>Sign condition is poor | Relocate closer to roadway<br><br>Replace sign panel | $500 |  |
| 410m West | "JCT 35" Highway Junction Route Marker | IB-3<br>IB-2 | IB-3<br>IB-2A | 1.67 | 6.18 | June 2013 | August 6, 2014 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |  |
| 305m West | Stop Sign Ahead warning sign | WB-1 | WB-1 | 1.67 | 5.91 | December 2013 | July 7, 2014 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |  |
| 265m West | Railway Crossing Sign | RA-6 | N/A | 1.51 | 4.06 | February 2012 | | Standard | Fair (minor scratches and dents) | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |  |
| 205m West | Guide Sign "Arborfield, Nipawin, Tisdale" | IA-3 | GS-26 | 1.72 | 5.11 | | November 8, 2007 | Standard | Good | Acceptable | | | |  |
| 105m West | "35 North, 335 East, 35 South" Route Markers | IB-2 (3x)<br>IS-10/11/12<br>IS-8L/7/8R | IB-2A (3x)<br>IB-10/11/12 | 1.58 | 5.52 | | July 7, 2014 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |  |

## Sign Inventory and Assessment - Eastbound Highway 335

| Distance from Intersection | Sign Type | Sign Code (MUTCDC) | Sign Code (MHI) | Height (m) | Lateral Offset (m) | Manufacture Date | MHI Date | Size | Condition | Retroreflectivity | Comments | Recommendations | Improvement Cost | Photograph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3m West | Stop Sign with flashing red beacon | RA-1 | RA-1 | 1.5 | 4.37 | | | Oversized | Good | Acceptable | Although the lateral offset meets recommendations, it is close to maximum. Given the importance of the sign it should be located closer to the highway. | Install stop sign and beacon on their own post closer to the roadway. | $4,000 |   |
| 110m East | "335 East" Route Marker | IB-2 IS-11 | IB-2A IB-11 | 1.65 | 5.51 | | August 19, 2014 | Standard | Good | Acceptable | | | |   |
| 305m East | Guide Sign "Zenon Park, Arborfield, Carrot River" | IA-4 | GS-22 | 1.36 | 5.37 | | October 16, 2002 | Standard | Poor (scratched and dented) | Poor | Sign height is low<br>Sign condition is poor | Increase sign height<br>Replace sign panel | $1,500 |   |
| 405m East | "Maximum 100" speed limit sign | RB-1 | RB-1 | 1.85 | 5.65 | | May 28, 2015 | Standard | Good | Acceptable | Lateral offset too large | Relocate closer to roadway | $200 |   |