

WEIGH IN MOTION REPORT 2014

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EXECUTIVE SUMMARY

Weigh in Motion (WIM) systems are commonly used to collect traffic related information. WIM systems involve the installation of various sensors in the roadway to provide traffic volumes, vehicle types, weights, and speeds. There are six WIM systems installed on Alberta highways at the following sites:

- **Red Deer Site** – 4-lane site located on Highway 2, approximately 7 kilometres south of Red Deer
- **Leduc Vehicle Inspection Station Site** – 4-lane site located on Highway 2, approximately 1 kilometre south of Leduc;
- **Fort Macleod Site** – 4-lane site located on Highway 3, approximately 6 kilometres east of Fort Macleod;
- **Edson Site** – 4-lane site located on Highway 16, approximately 25 kilometres east of Edson;
- **Leduc Site** – 2-lane site located on Highway 2A, approximately 4 kilometres south of Leduc; and
- **Villeneuve Site** – 2-lane site located on Highway 44, approximately 4 kilometres south of Villeneuve.

The WIM systems are periodically tested for accuracy using a process known as calibration verification. During the 2014 calibration verifications, the WIM systems:

- Correctly measured lengths 98.8% of the time;
- Correctly measured speeds 98.7% of the time;
- Correctly recorded axle weights 71.4% of the time;
- Correctly recorded gross vehicle weight 54.7% of the time; and
- Overall, measured and recorded correctly 86.2% of the time.

In 2014, the WIM systems measured average passenger vehicle speeds between 114 km/h to 116 km/h and average commercial vehicle speeds between 105 km/h to 106 km/h at four-lane WIM sites. At two-lane WIM sites, the WIM systems measured average passenger vehicle speeds of 100 km/h to 103 km/h and average commercial vehicle speeds of 96 km/h to 99 km/h. At four-lane sites, over 70% of recorded vehicles were travelling at or over the posted speed limit. At two-lane sites, over 65% of the recorded vehicles were travelling at or over the posted speed limit.

Equivalent Single Axle Loading (ESAL) is a metric used for pavement design and can be calculated using data from WIM systems. Using all of the data recorded in 2014, the average ESAL for single-unit trucks was 0.318 and the average ESAL for tractor-trailer combinations was 2.313. The current department standards use 0.881 for single-unit trucks and 2.073 for tractor-trailer combinations.

An estimate of trucks carrying no load, or empty trucks, can be derived from the WIM data. In 2014, it was estimated that 10% of all FHWA class 9 and 10 trucks were recorded as being empty.

Legal weight limits for axle groups are found in Alberta's Traffic Safety Act. In 2014, it was determined that there were more overweight axle groups during the winter months, while the number of overweight axle groups was lowest during summer months. This is consistent with the fact that a high number of commercial vehicles operate under overweight permits, which allows for increased axle weights during the winter months.

INTRODUCTION

Weigh in Motion (WIM) systems are used by many jurisdictions to collect traffic related information on roads.

WIM systems involve the installation of sensors in a road surface. The sensors detect the pressure that is exerted on the road by the tires of vehicles that drive by. The data that is collected from the sensors can be used to infer the weights, speeds, and types (passenger car, small truck, big truck) of vehicles that drive by. The number of detections can also be used to infer the total volume of traffic.

On Alberta highways, there are 6 WIM sites, which cover 20 lanes of traffic. They are located at the following locations:

- **Red Deer Site** – Four-lane site at Highway 2, approximately 7 kilometres south of Red Deer
- **Leduc Vehicle Inspection Station (VIS) Site** – Four-lane site at Highway 2, approximately 1 kilometre south of Leduc;
- **Fort Macleod Site** – Four-lane site at Highway 3, approximately 6 kilometres east of Fort Macleod;
- **Edson Site** – Four-lane site at Highway 16, approximately 25 kilometres east of Edson;
- **Leduc Site** – Two-lane site at Highway 2A, approximately 4 kilometres south of Leduc; and
- **Villeneuve Site** – Two-lane site at Highway 44, approximately 4 kilometres south of Villeneuve.

This report provides some statistics using the data that was collected by the WIM systems in 2014. This report is focused on providing information to the reader and is not intended to provide an analysis of the statistics.

ACCURACY OF WIM SYSTEMS

The accuracy of each WIM system needs to be periodically tested. A process known as Calibration Verification (CV) is performed at each WIM site every two months to verify that the calibrations of the WIM systems are accurately recording vehicle weights and lengths.

The CV's are conducted using a "test truck", which is a five axle semi-trailer with known axle weights. The test truck is driven multiple times over each site at approximately 100 kilometres per hour. The known vehicle length, weight, and speed of the test truck can then be compared to the recordings of the WIM system to determine the accuracy of the WIM system to measure within acceptable tolerances (e.g. it is acceptable to record a vehicle speed that is within +/- 5% of the "test truck" speedometer reading). Each of the 20 lanes of all 6 WIM sites were tested 50 times, for a total of 1000 test passes in 2014.

During the 2014 CV's, the WIM systems:

- Correctly measured lengths 98.8% of the time;
- Correctly measured speeds 98.7% of the time;
- Correctly recorded axle weights 71.4% of the time;
- Correctly recorded gross vehicle weight 54.7% of the time; and
- Overall, measured and recorded correctly 86.2% of the time.

In addition to the CV's, another check for accuracy is to compare the traffic volumes that are recorded by the WIM systems to the traffic volumes that are recorded by adjacent automated traffic recorders (ATR). In 2014, the WIM sites recorded 99.1% of the traffic that were recorded by the adjacent ATR's.

VEHICLE SPEEDS RECORDED BY WIM SYSTEMS

Of the six WIM sites, four of them are on highway sections that have four lanes of travel (two lanes per direction). The four-lane sites are Red Deer, Leduc VIS, Fort Macleod, and Edson. The Leduc and Villeneuve sites only have two lanes (one lane per direction).

Figure 1 shows the average speed of passenger vehicles in each month of 2014 for the driving (right) lanes, passing (left) lanes, and all lanes combined on four-lane sites. Figure 2 shows the same information, but for commercial vehicles instead of passenger vehicles.

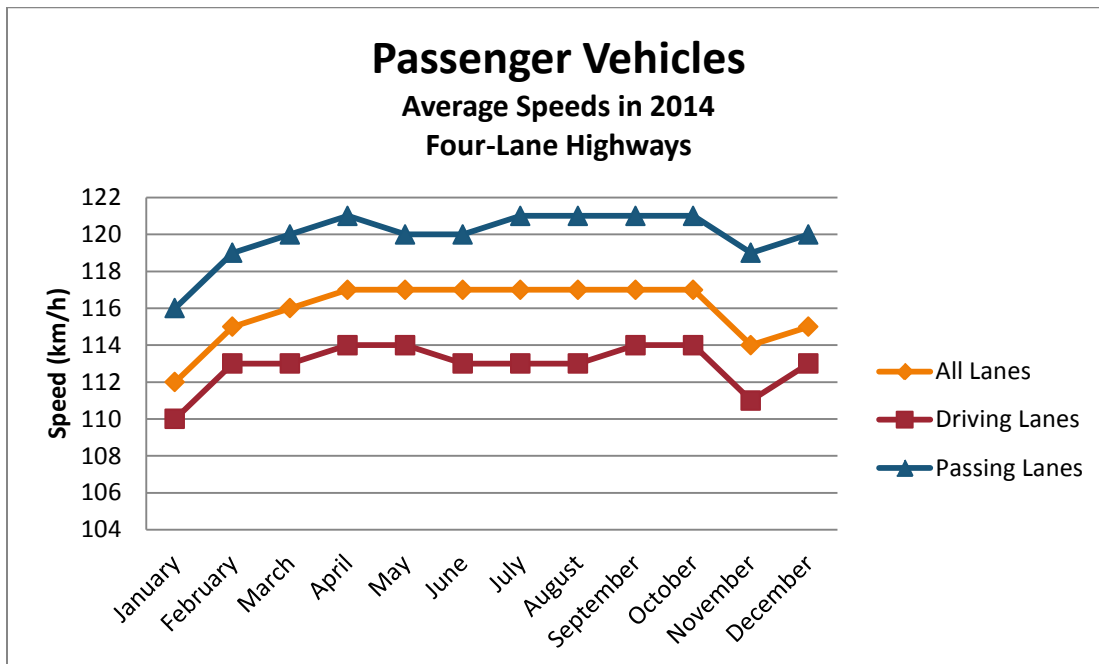


Figure 1: Average Speed of Passenger Vehicles on Four-Lane Highways

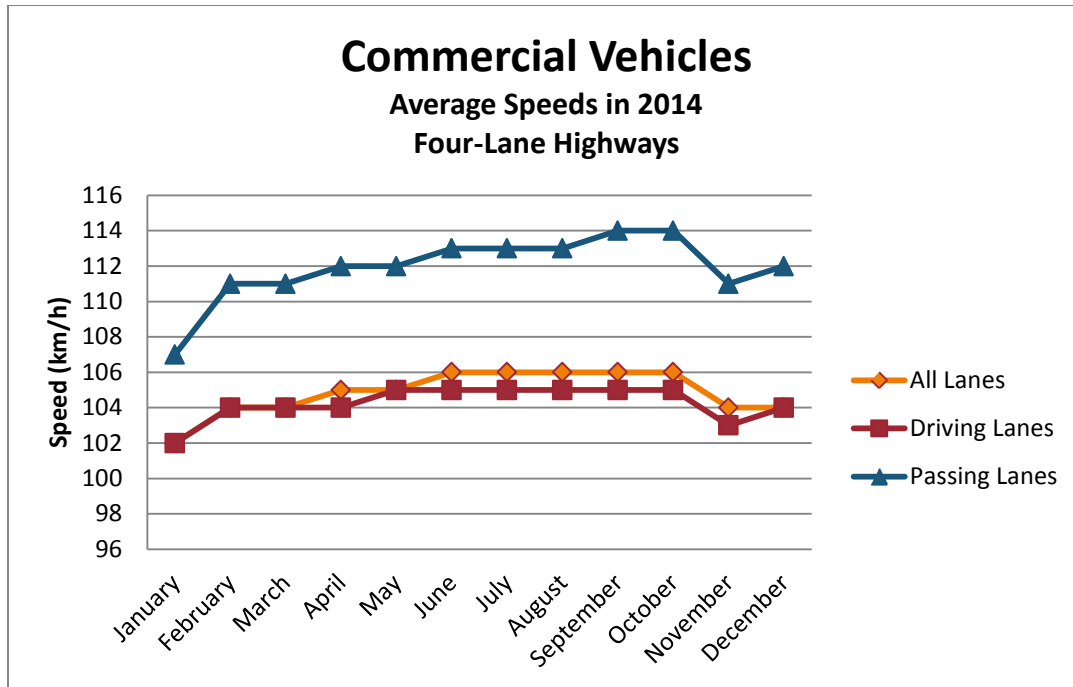


Figure 2: Average Speed of Commercial Vehicles on Four-Lane Highways

Figure 3 shows the average speed of passenger and commercial vehicles in each month of 2014 on the two-lane sites.

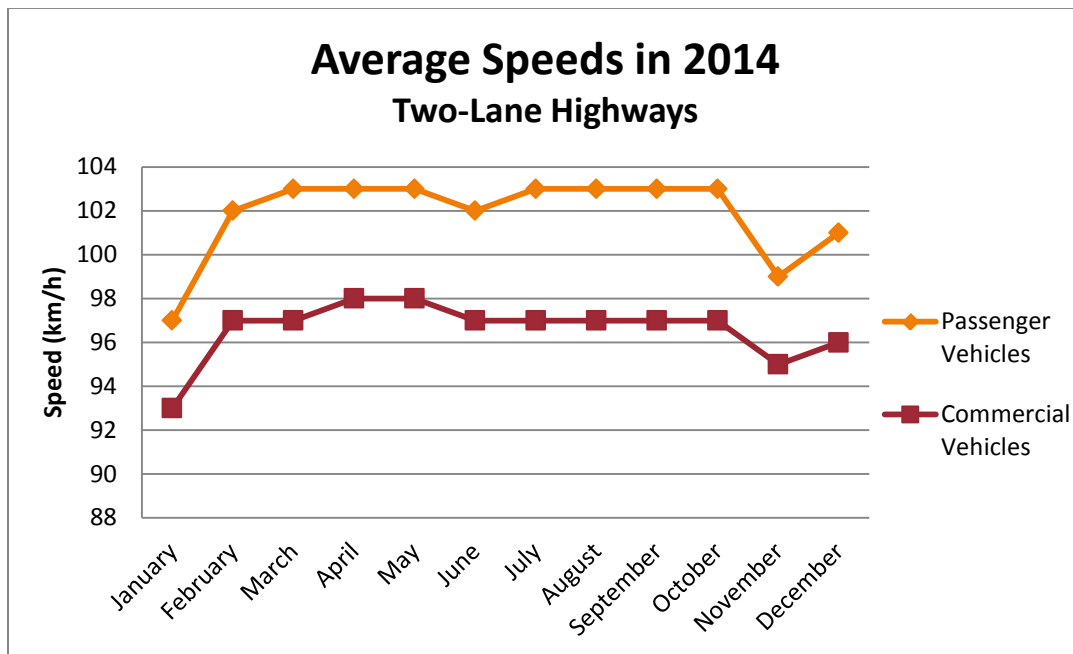


Figure 3: Average Speed of Passenger and Commercial Vehicles on Two-Lane Highways

Table 1 shows the average speed of all vehicles recorded in 2014 at each separate WIM site.

Table 1: Average Speeds at Each Site

	Passenger Vehicles	Commercial Vehicles
Four-Lane Sites		
Red Deer	116 km/h	105 km/h
Leduc VIS	116 km/h	105 km/h
Fort Macleod	114 km/h	105 km/h
Edson	115 km/h	106 km/h
Two-Lane Sites		
Leduc	103 km/h	99 km/h
Villeneuve	100 km/h	96 km/h

Over 70 percent of the vehicles that were recorded at the four-lane sites in 2014 were travelling at speeds of 110 km/h (speed limit) or over. Over 65 percent of the vehicles that were recorded at the two-lane sites in 2014 were travelling at speeds of 100 km/h (speed limit) or over. Figure 4 and Figure 5 show the speed distributions at the four lane sites and the two lane sites.

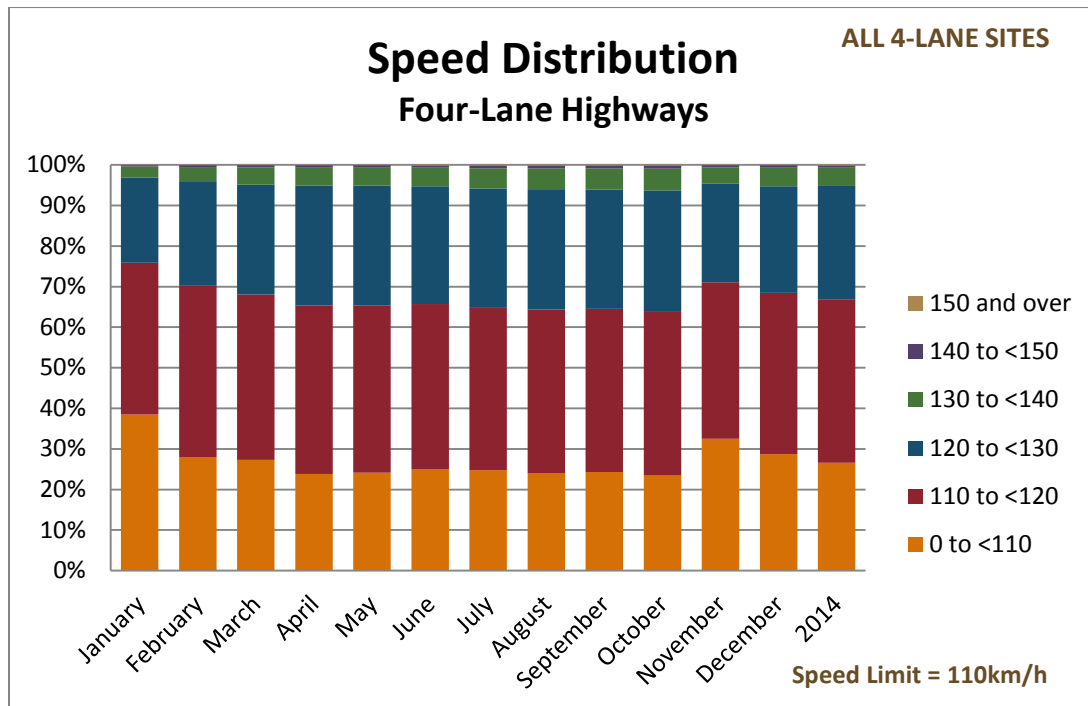


Figure 4: Speed Distribution of Vehicles on Four-Lane Highways

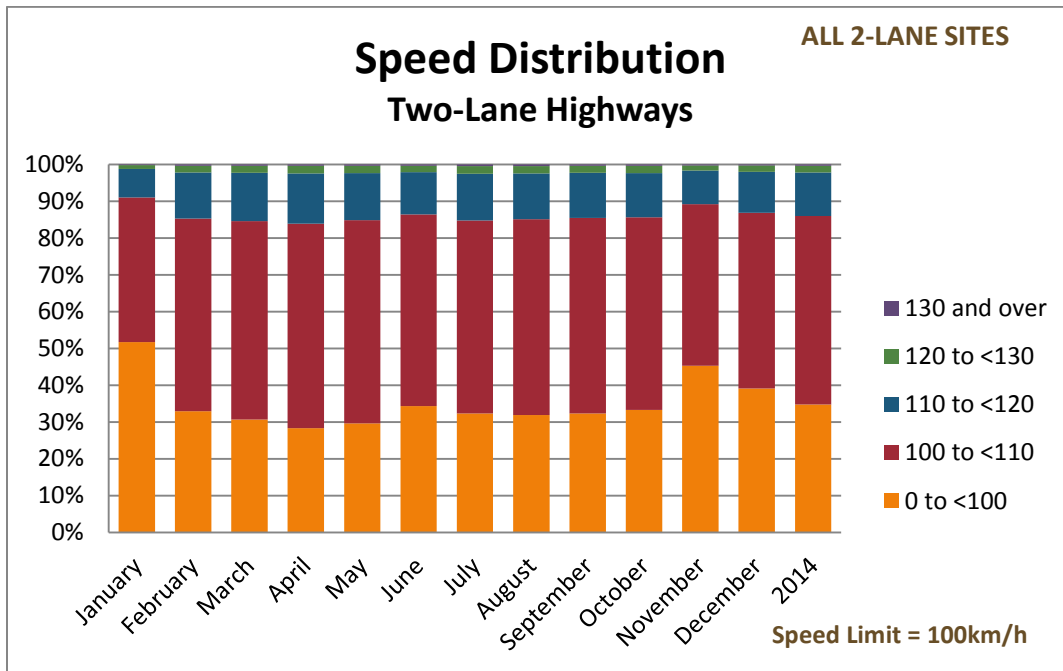


Figure 5: Speed Distribution of Vehicles on Two-Lane Highways

EQUIVALENT SINGLE AXLE LOADINGS

An Equivalent Single Axle Loading (ESAL) is the equivalent number of applications of an 80kN (8100kg) single axle dual tire load onto a road surface. ESALs are calculated to determine the impact different truck types have on road structures. This information is used for pavement designs. More information on ESAL for pavement design can be found at <http://www.transportation.alberta.ca/630.htm>.

Alberta Transportation uses the following equations to determine ESALs, where L equals to axle weight in thousands of pounds:

Single Steering Axles

$$ESAL = \left[\frac{L}{11.5} \right]^{3.30}$$

Tandem Steering Axles

$$ESAL = \left[\frac{L}{28.0} \right]^{3.30}$$

Single Carrying Axles

$$ESAL = \frac{\left[\left(\frac{L}{1,000} \right) + 1 \right]^{4.79}}{1,334,400^{4.33}}$$

Tandem Carrying Axles

$$ESAL = \frac{\left[\left(\frac{L}{1,000}\right) + 2\right]^{4.79}}{2,668,800^{4.33}}$$

Tridem Carrying Axles

$$ESAL = \left[\frac{L}{47.0}\right]^{4.49}$$

The average ESAL for all lanes at all the WIM sites is shown in Table 2 for single-unit trucks and tractor-trailer combinations.

Table 2: Average ESAL at all WIM Sites

Month	Single-Unit	Tractor-Trailer
January	0.353	2.845
February	0.332	2.930
March	0.323	2.767
April	0.308	2.542
May	0.323	2.345
June	0.321	2.240
July	0.322	1.953
August	0.300	1.647
September	0.306	1.991
October	0.319	2.242
November	0.320	2.296
December	0.302	2.360
2014	0.318	2.313

Table 3 shows the average ESAL for all lanes at all WIM sites from the years 2010 to 2014.

Table 3: Annual Average ESAL at all WIM Sites for Last 5 Years

Year	Single Unit	Tractor Trailer
2010	0.650	1.600
2011	0.618	1.717
2012	0.603	1.799
2013	0.650	2.106
2014	0.318	2.313

ESTIMATED TRUCKS CARRYING NO LOAD

This section will present the estimated percentage of trucks that are assumed to be carrying no load (empty trucks). It should be noted that these values are high level estimates due to the fact that, as previously mentioned, in 2014 the WIM systems correctly recorded gross vehicle weight only 54.7% of the time and that tare weight (or empty weight) of trucks can vary between trucks. The statistics in this section are meant to show an overall pattern of the movement of empty trucks on highways.

The Federal Highway Administration (FHWA) recognizes 13 vehicle classifications. The most common truck classifications are FHWA Class 9 and Class 10, which are shown in Figure 6.

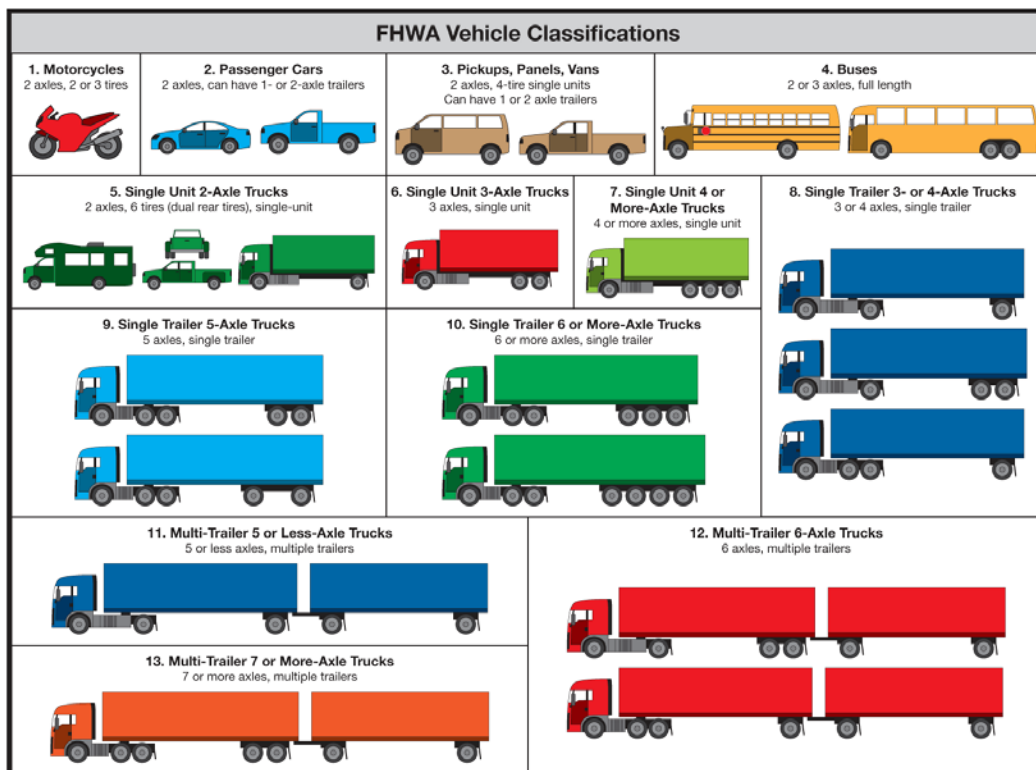


Figure 6: FHWA Vehicle Classifications

Source: http://onlinemanuals.txdot.gov/txdotmanuals/tri/images/FHWA_Classification_Chart_FINAL.png, accessed on June 5, 2015

The statistics below focus on Class 9 and Class 10 trucks that were recorded by the WIM systems in 2014. These classifications were chosen because they are most commonly used to transport goods. The statistics assume a tare weight of 15,000 kg for Class 9 trucks and 17,000 kg for Class 10 trucks, which are consistent with the weights recorded for empty trucks during a commercial vehicle survey in 2013 in Manitoba.

Of all of the Class 9 and 10 trucks that were recorded by the WIM systems in 2014, approximately 10 percent of them were not carrying a load. Table 4 shows the percentage of recorded trucks that were assumed to not be carrying a load at each WIM site in 2014.

Table 4: Percentage of Empty Class 9 and 10 Trucks Recorded at each WIM Site by Direction

WIM Site	EB/NB	WB/SB	Two-Way
Edson	7%	5%	6%
Fort Macleod	7%	16%	11%
Leduc VIS	5%	5%	5%
Red Deer	9%	16%	13%
Leduc	43%	15%	26%
Villeneuve	20%	10%	15%
All Sites			10%

Figure 7 shows the distributions of the Class 9 and 10 trucks amongst each direction of travel at each WIM site, for both total recorded trucks and only empty trucks. It shows that the total number of Class 9 and 10 trucks recorded at each WIM site is almost evenly split amongst each direction of travel. For example, 49 percent of all the recorded Class 9 and 10 trucks were in the eastbound lanes, while 51 percent were in the westbound lane. This near even split is consistent across all six WIM sites. When focusing on the Class 9 and 10 trucks that were assumed to be empty, the distribution amongst the direction of travel at each site is not nearly as even (except for Leduc VIS, where 53 percent of the empty trucks were recorded in the northbound lanes, while 47 percent of the empty trucks were recorded in the southbound lanes). For example, of all of the empty Class 9 and 10 trucks recorded at the Red Deer site, 34 percent of them were northbound, while 66 percent were southbound.

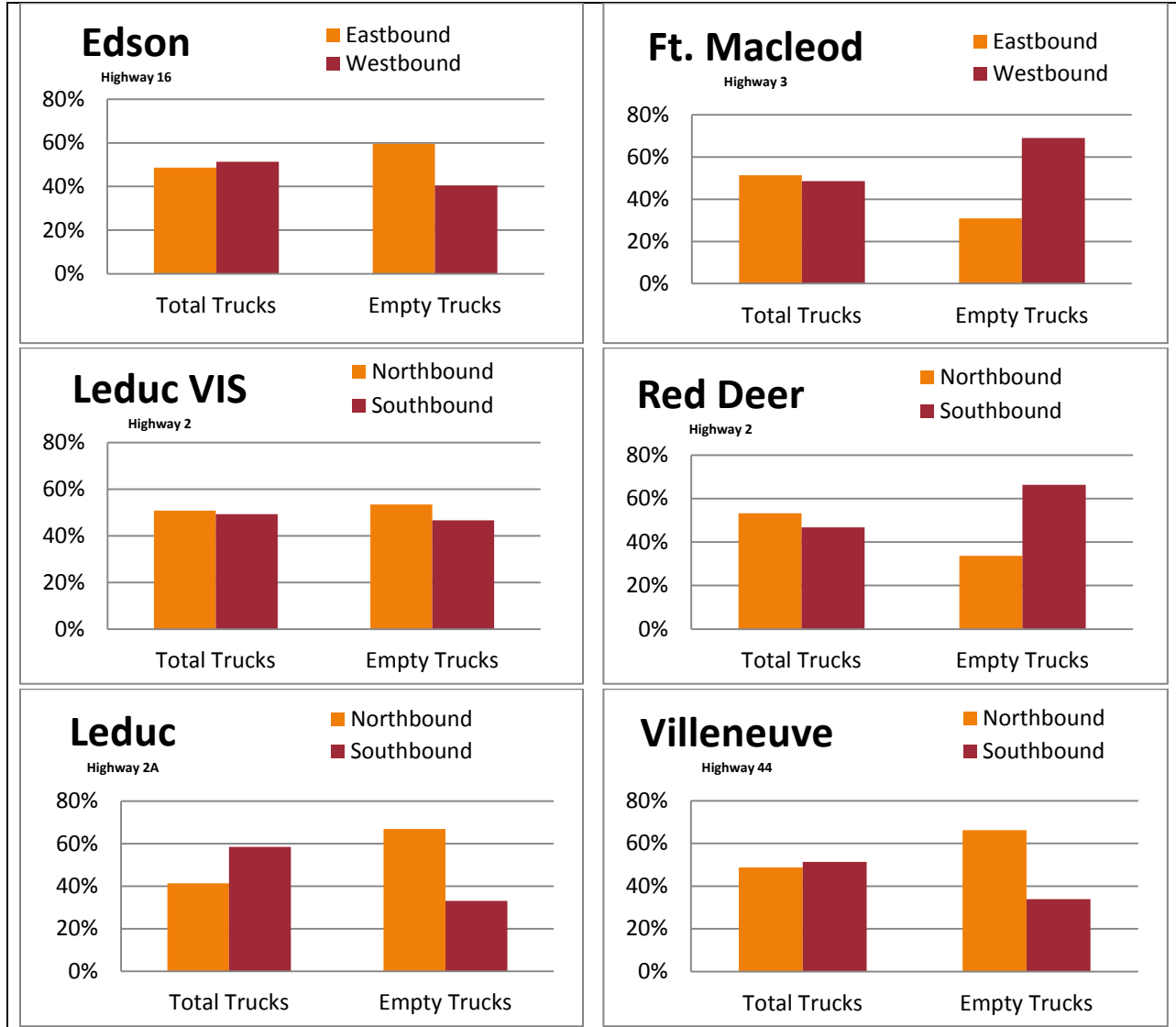


Figure 7: Distribution of Class 9 and 10 Trucks by Direction of Travel at Each WIM Site

OVERWEIGHT AXLE GROUPS

Table 5 shows legal weight limits on each axle group. These limits are found in the Commercial Vehicle Dimension and Weight Regulation of Alberta's *Traffic Safety Act*.

Table 5: Legal Weight Limits on Each Axle Group

Axle Group	Number of tires	Axle spacing [m]	Limit [kg]
Steer	2	-	5,500
Single	4	-	9,100
Tandem	8 or more	1.2-1.85	17,000
Tridem	12 or more	3.0 - 3.7	24,000
Tridem	12 or more	< 3.0	21,000

Although the limits are constant throughout the year, vehicles operating under overweight permits do have different allowable weights for five different seasons in a year. The weight seasons with increasing allowable axle weights include:

- Spring (from thaw to approximately June 14);
- Post-thaw (approximately June 15 to June 30);
- Summer (July 1 to August 31);
- Fall (September 1 to freeze-up); and
- Winter (freeze-up to thaw).

In this report, the WIM data for six sites was compared to the weight limits shown in Table 5 to infer the number of overweight axle groups. Then the percentages of overweight axle groups with respect to all axle groups were calculated. Figures 8 - 13 show the distribution of overweight axle groups in both directions of travel at each WIM site.

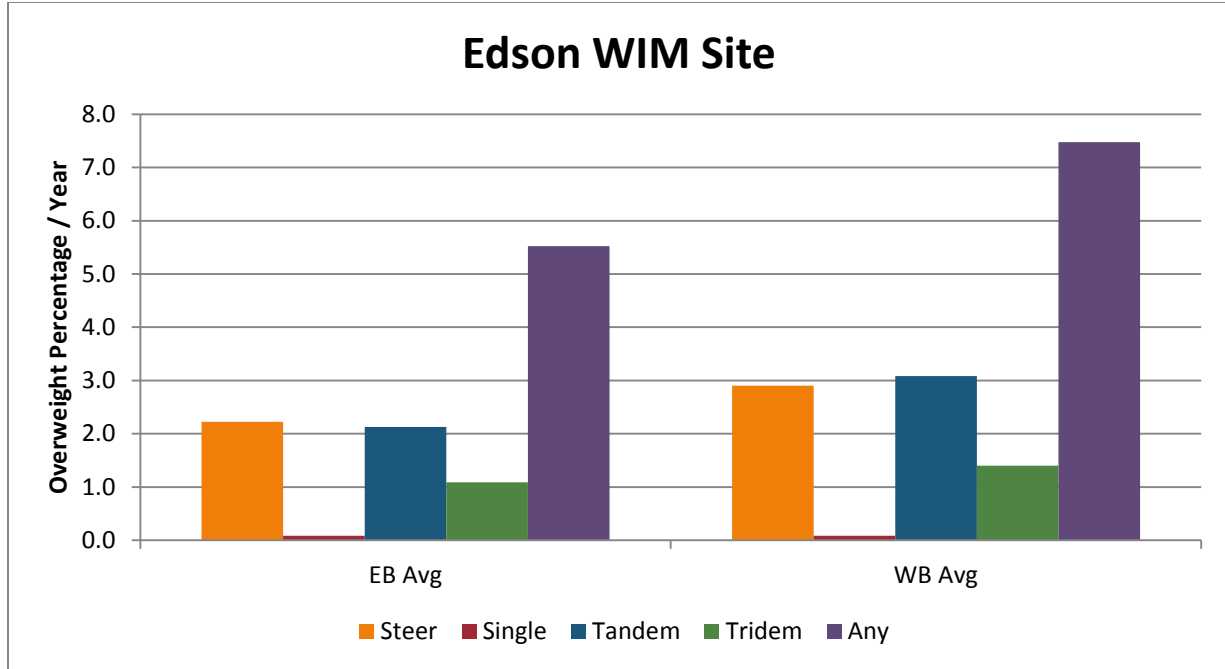


Figure 8: Distribution of Overweight Axle Groups in Both Directions of Travel at Edson WIM Site

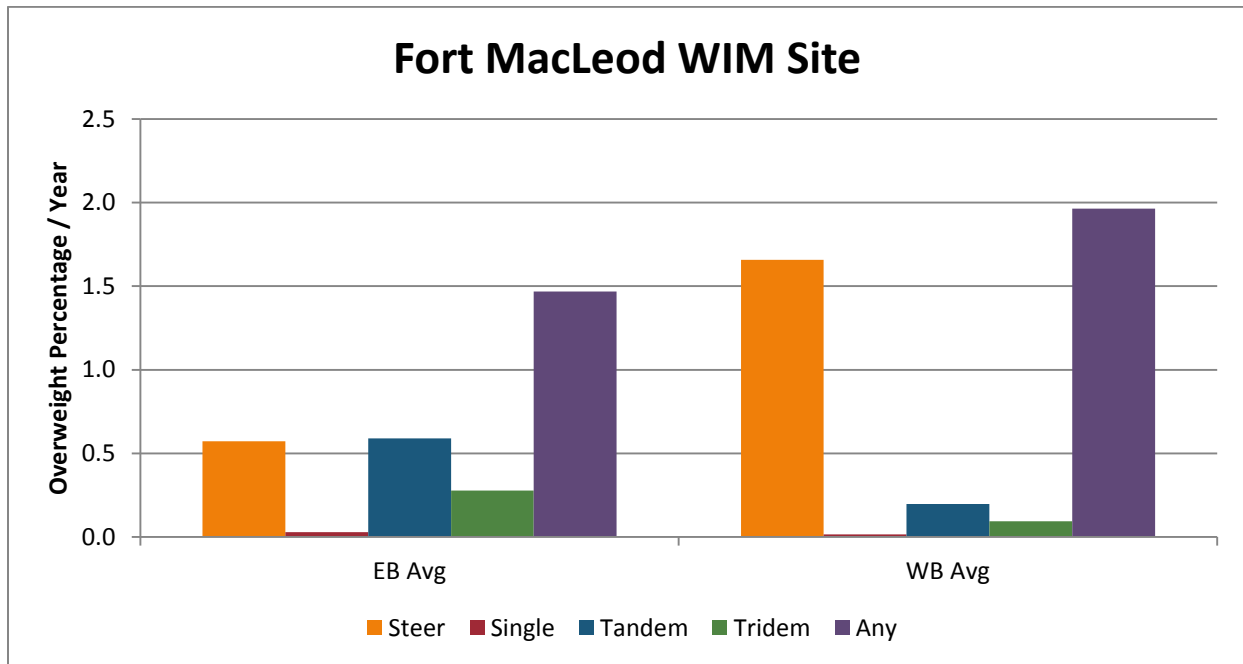


Figure 9: Distribution of Overweight Axle Groups in Both Directions of Travel at Fort MacLeod WIM Site

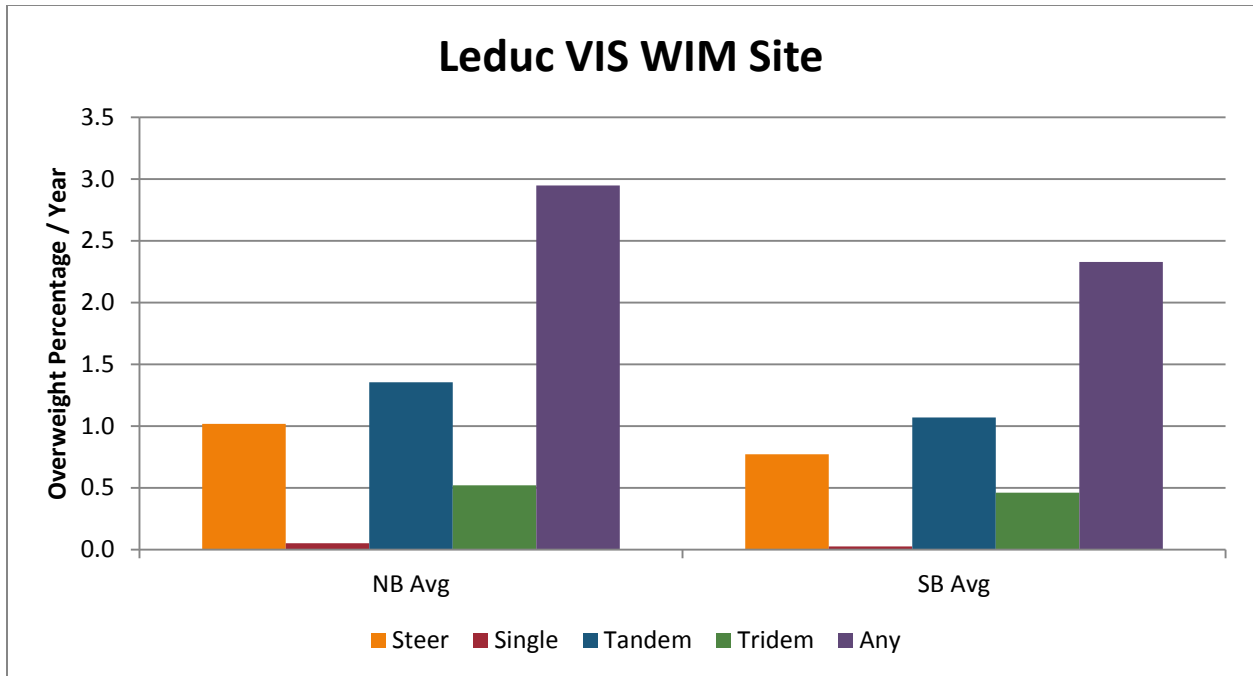


Figure 10: Distribution of Overweight Axle Groups in Both Directions of Travel at Leduc VIS WIM Site

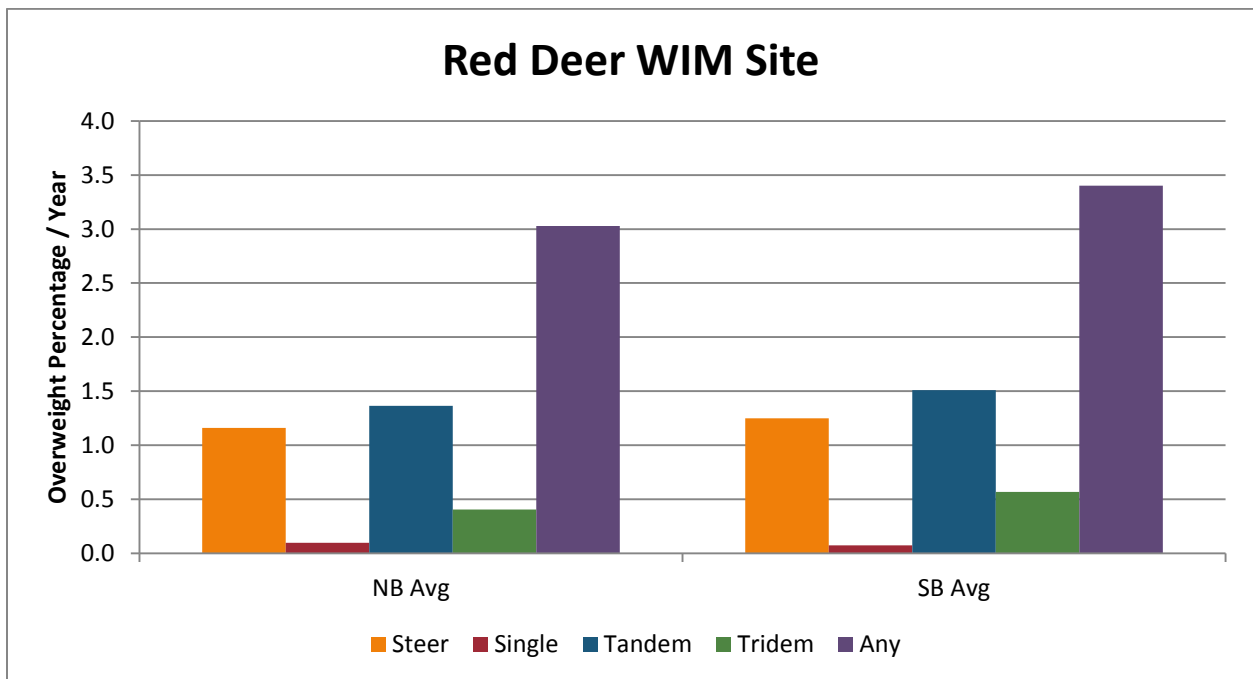


Figure 11: Distribution of Overweight Axle Groups in Both Directions of Travel at Red Deer WIM Site

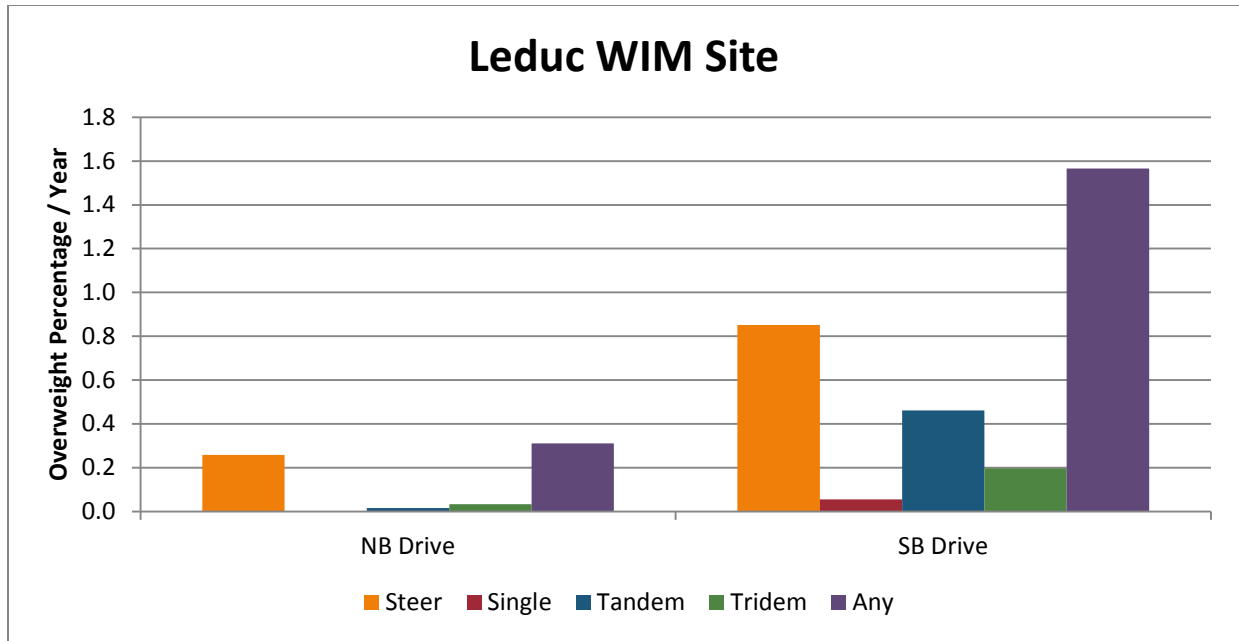


Figure 12: Distribution of Overweight Axle Groups in Both Directions of Travel at Leduc WIM Site

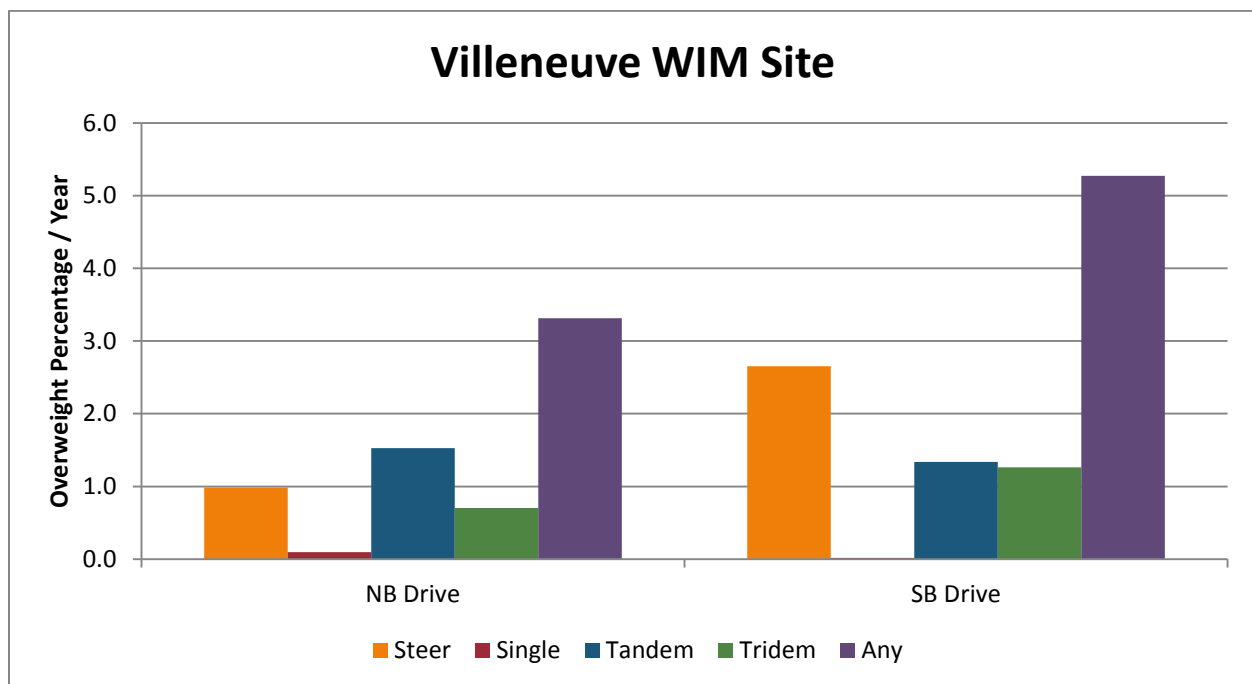


Figure 13: Distribution of Overweight Axle Groups in Both Directions of Travel at Villeneuve WIM Site

Figure 14 shows the monthly trend of percentage of overweight axles with respect to total axles at each WIM site for all types of axle configurations. For Edson WIM site, no data was recorded for Eastbound driving lane for the month of July.

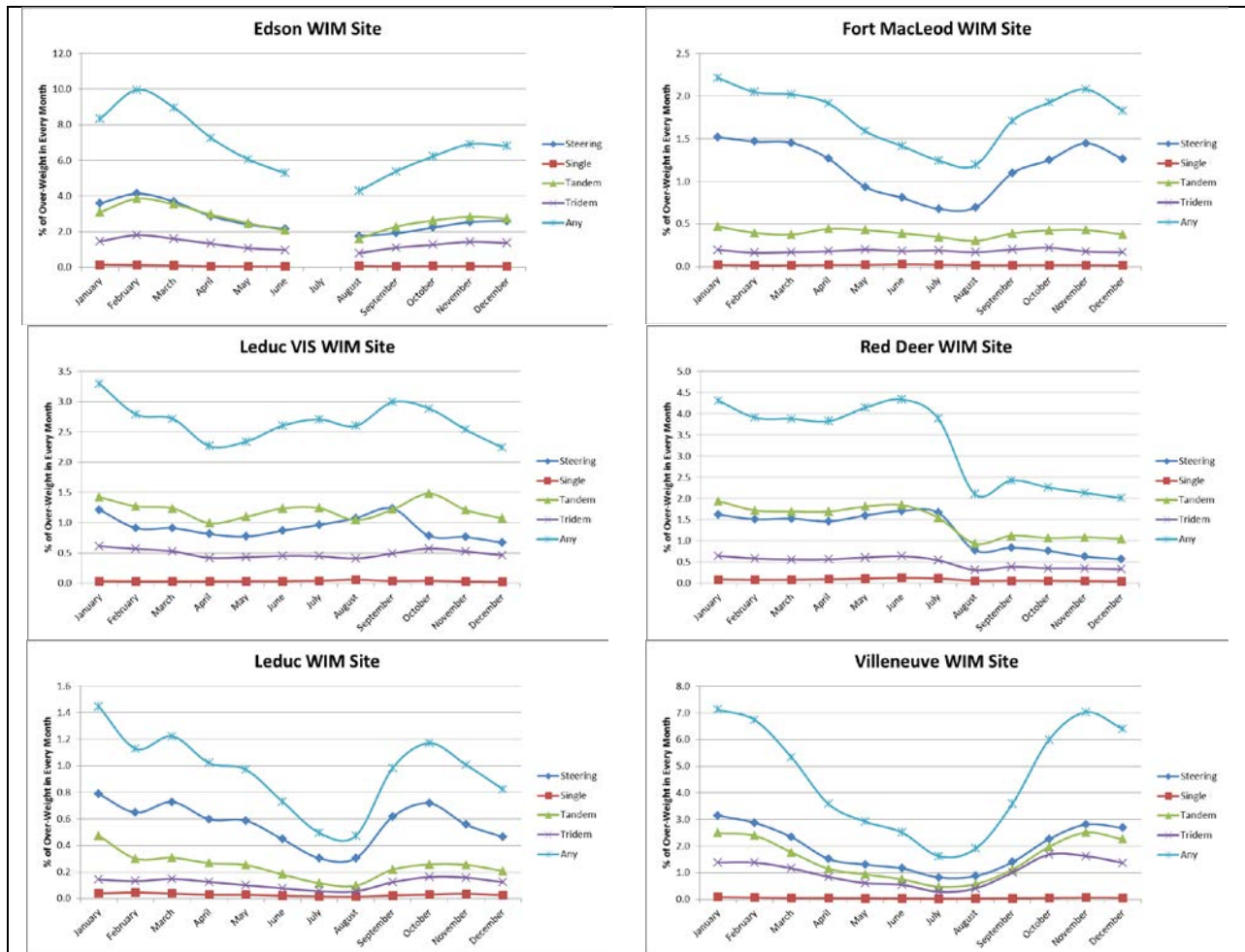


Figure 14: Monthly Trend of Percentage of Overweight Axle Groups With Respect to Total Axle Groups for All Types of Axle Configurations

Figure 15 shows a general trend of recording overweight axle groups at any WIM sites. For example, more overweight axle groups were recorded in Edson WIM site compared to Leduc WIM site throughout the year.

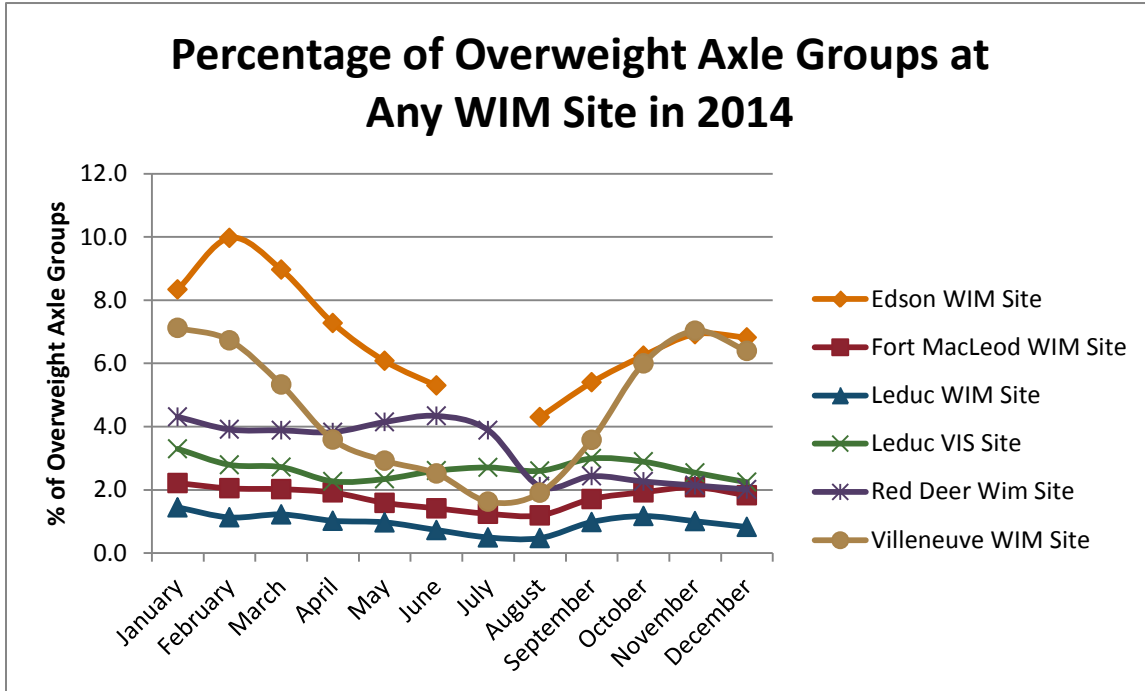


Figure 15: A General Trend of Recording Overweight Axle Groups at Any WIM sites

Figure 16 shows the monthly trend of percentage of overweight axles with respect to total axles for each type of axle configurations at all WIM sites.

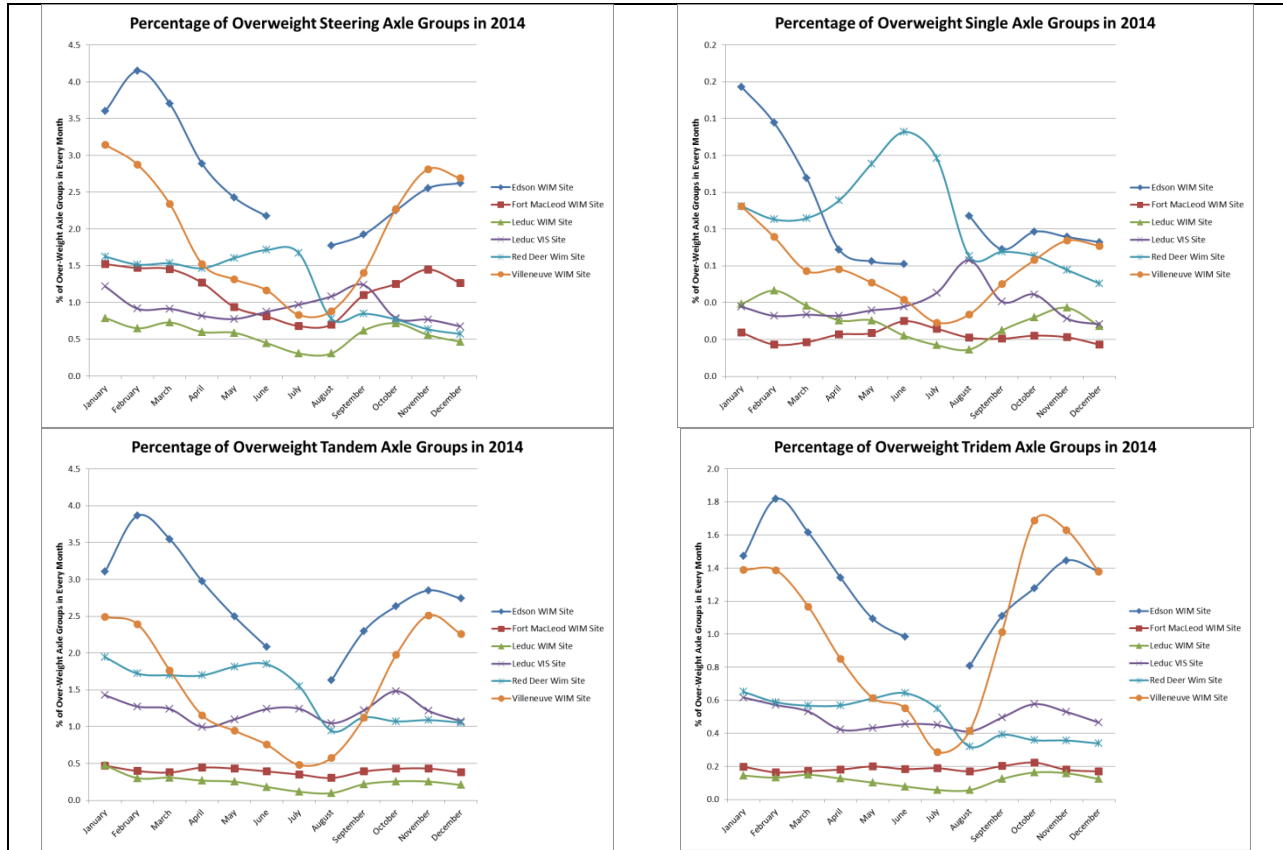


Figure 16: Monthly Trend of Percentage of Overweight Axle Groups with Respect to Total Axle Groups for All WIM sites

A general trend of any axle group being overweight in any month is shown in Figure 17. Steering and tandem axle groups were recorded overweight more times than single and tridem axle groups.

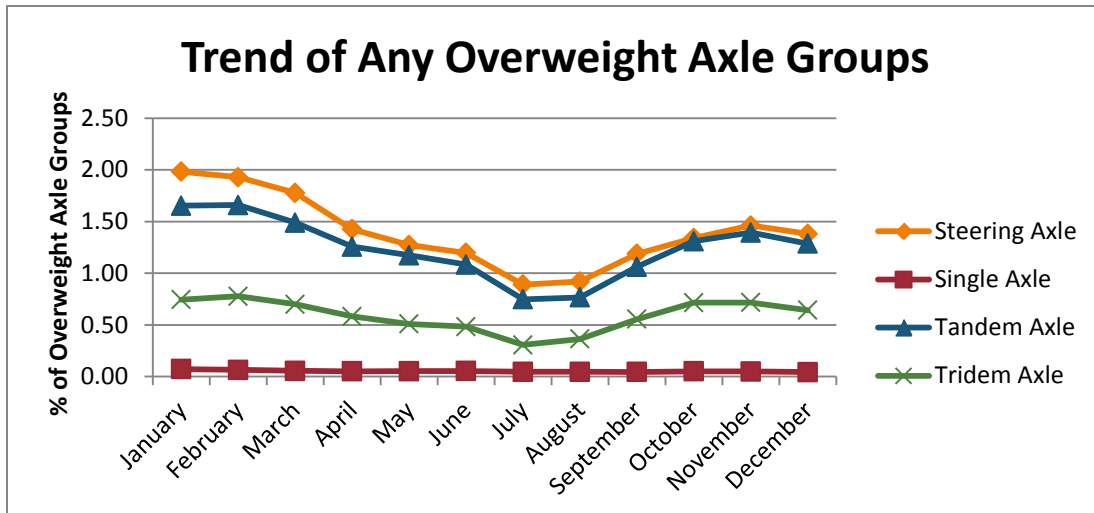


Figure 17: A General Trend of Recording Overweight Axle Groups at Any WIM sites

A general trend of being overweight for any axle group during any quarter of the year is:

(January – March) > (October – December) > (Rest of the Year)

This trend is visually shown Figure 18. However, it should be noted that a fairly high number of vehicles operate under overweight permits in Alberta every year.

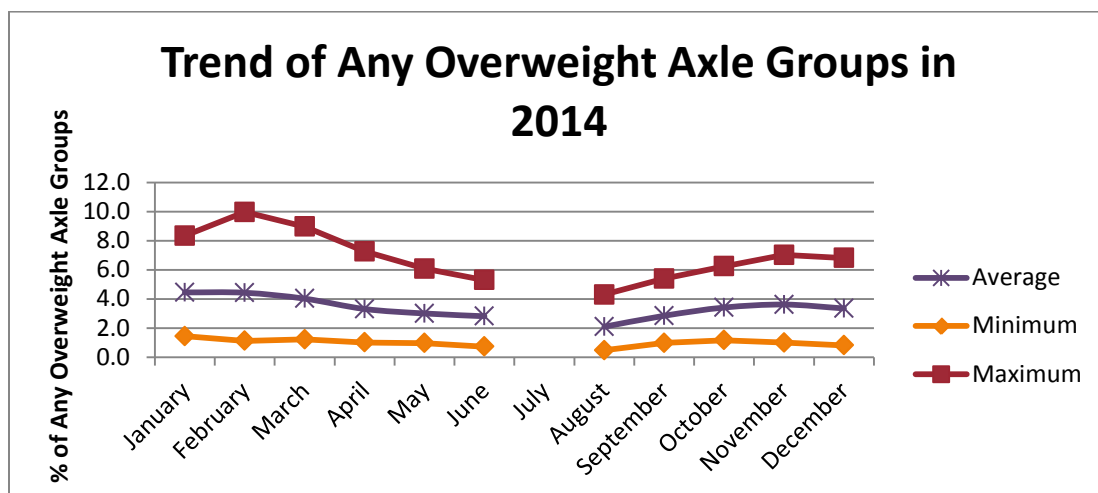


Figure 18: A General Trend of being Overweight for during Any Quarter of the Year

CONCLUSION

The statistics that can be produced from WIM data varies greatly. This report only represented a few examples of statistics that can be derived from the data. There may be other statistics or uses for WIM data that have not yet been explored.

The intentions of this report were to introduce the overall functionality and capabilities of WIM systems, as well as to showcase the potential of WIM systems and the data they collect. It is anticipated that this report will trigger new ideas and dialogue for different uses of WIM data.

APPENDIX



Figure 19: Weigh in Motion Installation on Pavement



Figure 20: Weigh in Motion Cabinet