

SEPTEMBER 2018



**WIM #45
CSAH 14, MP
10.1
BLAINE, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #45 is located on CSAH 14 near Blaine in Anoka county.

System Operation

WIM #45 was operational for the entire month of September 2018. Volume was computed using all monthly data.

System Calibration

WIM #45 was most recently calibrated on 2016-01-19. Table 1 summarizes the front axle weights of class 9s by lane ¹. Table 1 indicates that the class 9 front axle weights were all within +/- 9% of baseline calibration values for all lanes. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation ². Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 419706 | Passenger Vehicles: 407143 | Heavy Commercial Vehicles: 12563

Monthly Average Daily Traffic (MADT): 13990 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 419

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. EB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays. WB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), EB PVs generally reached peak volume levels between 07 AM and 05 PM. Similarly, WB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 07 AM and 05 PM, while volume going WB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 5's and Class 6's.

Overweight HCVs

Volume trends. Of a total of 12563 HCVs, 737 of them were overweight³. These overweight HCVs contributed to 0.2% of total monthly volume, and 5.9% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Wednesdays, with lowest volumes reported on Saturdays. See Figure 3 . The top two overweight violators by class were the class 6 and class 9 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 51.1% of all overweight vehicles traveling WB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in June.

WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report⁴.

Using normal load limits ,44 EB vehicles exceeded 88,000 pounds (22 vehicles were Class 10's; 18 vehicles were Class 13's). Of vehicles traveling WB,

38 EB vehicles exceeded 88,000 pounds (21 vehicles were Class 13's; 11 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from September 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in September 2018. Data suggests that there were greater numbers of empty Class 9's than fully_loaded Class 9's traveling EB, while there were more fully_loaded Class 9's than empty traveling WB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the EB direction. In the WB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 72735 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (52.1%) than WB (47.9%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 02051 (a prestressed concrete beam span) is approximately 2.8 miles west of WIM #45 on CSAH 14, and Bridge No. 02006 (a prestressed concrete beam span) is approximately 5.2 miles east of WIM #45 on CSAH 14. WIM #45 recorded a total of 419706 vehicles with a combined GVW of 2137326 kips (1 kip = 1,000 pounds = 0.5 tons) in September 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 5619 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 51.2% of all ESALs were recorded EB while 48.8% was observed WB. In particular, 26% of all ESALs were generated by the Class 5's (Class 5's

were also responsible for generating 6% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

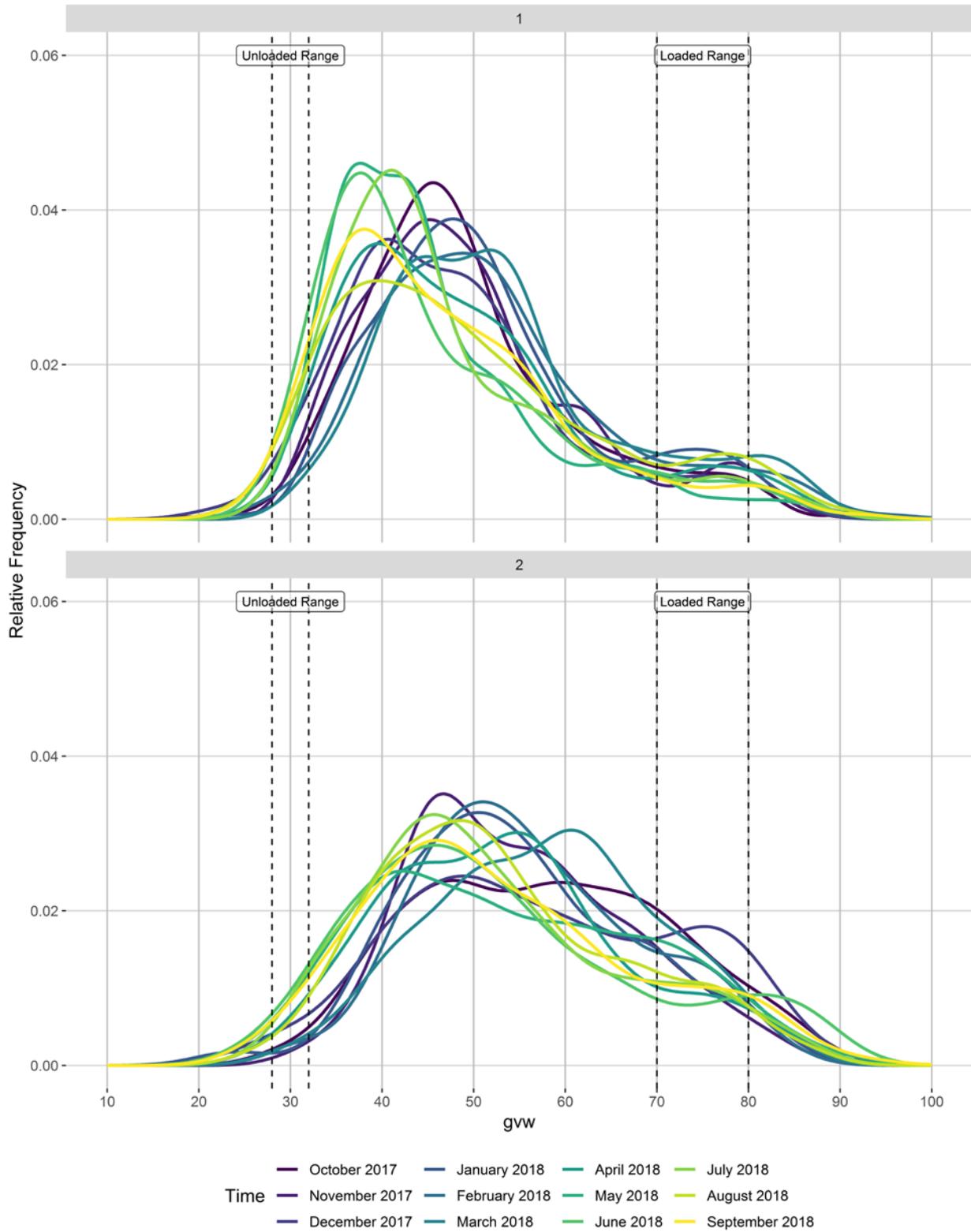
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at: <http://www.dot.state.mn.us/traffic/data/data-products.html#weight>

- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ±9% of baseline calibration values
- ² Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.
- ³ An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp
- ⁴ For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

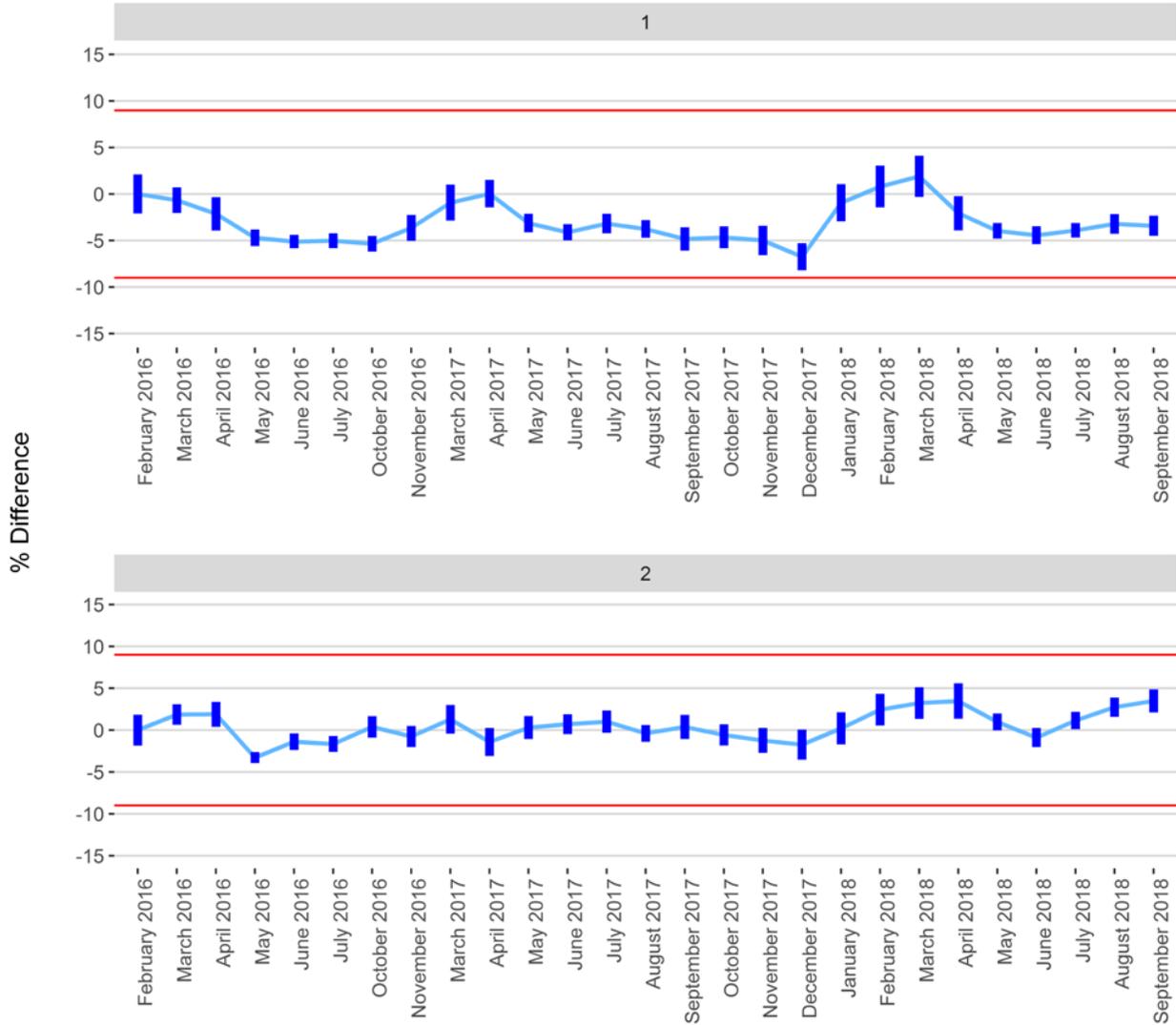
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume vs. Day of the Week

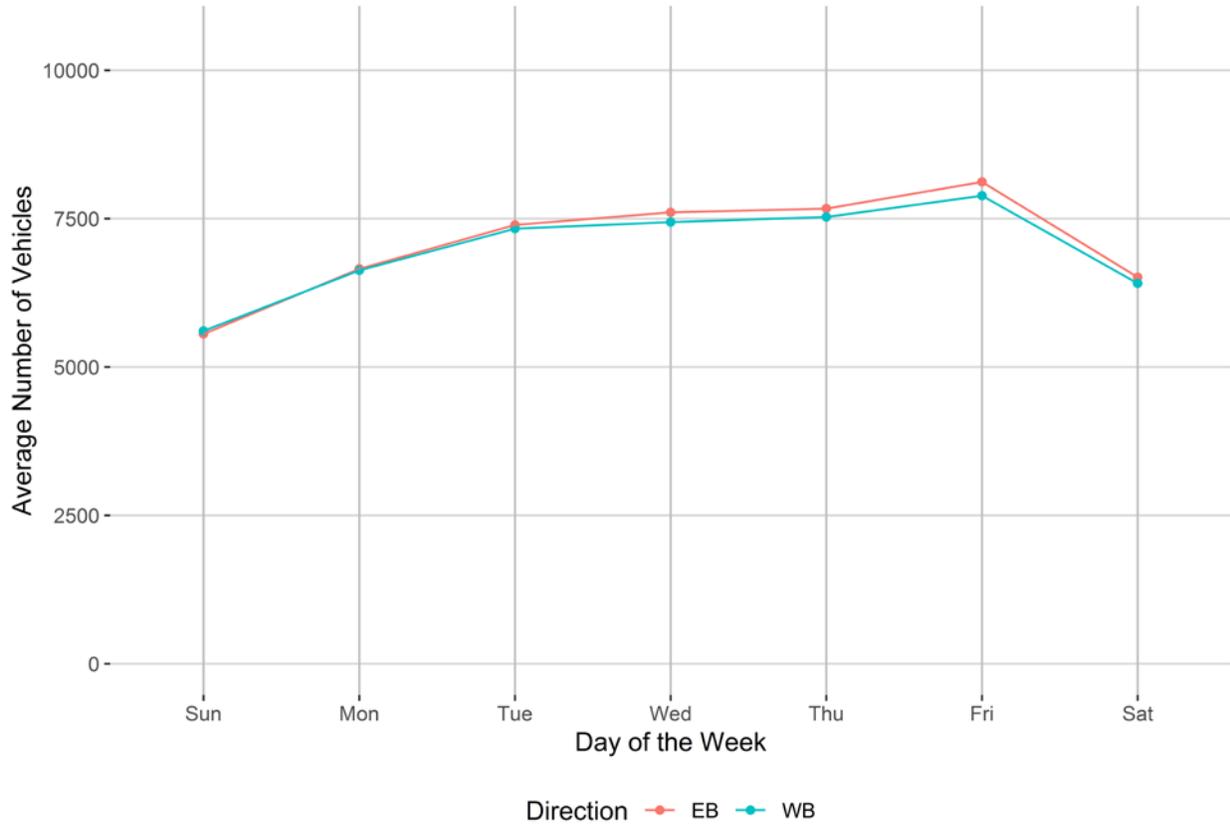


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

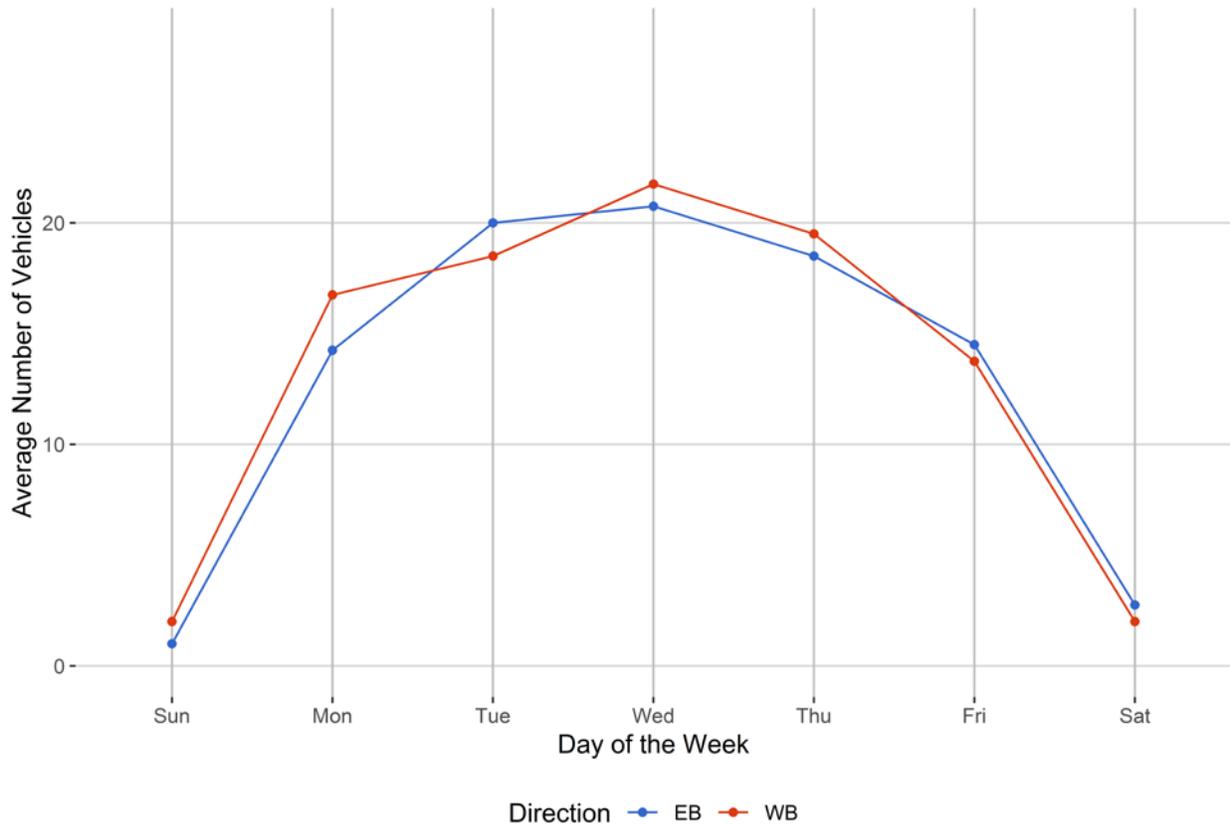


Figure 4 - Passenger Vehicles vs. Hour of the Day

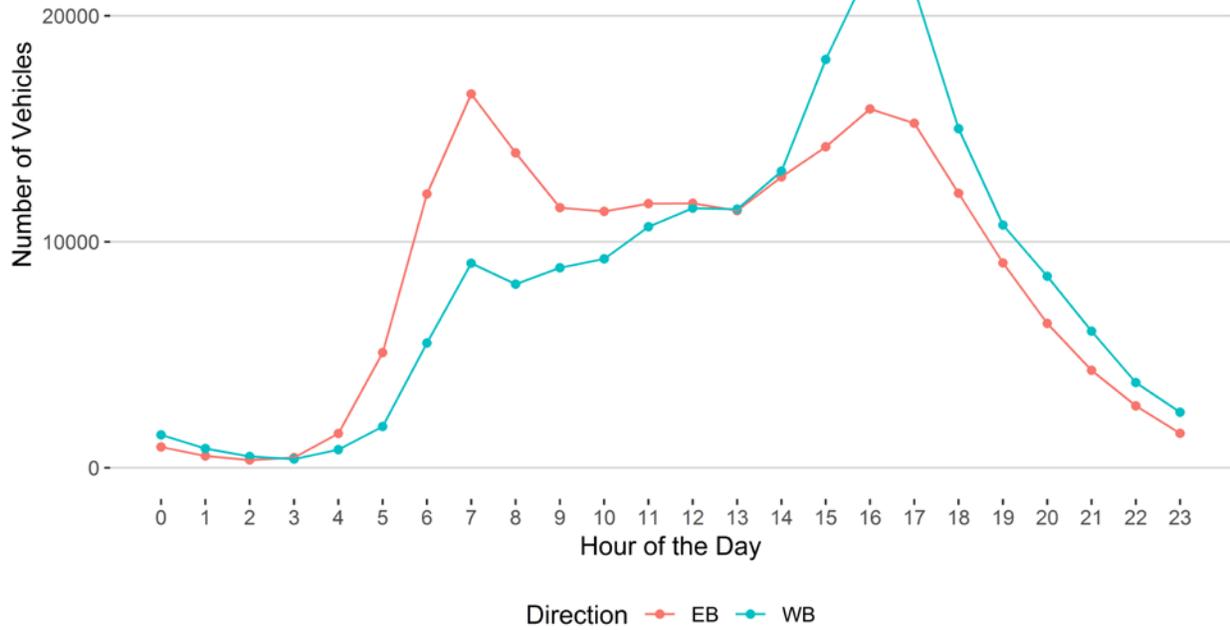


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

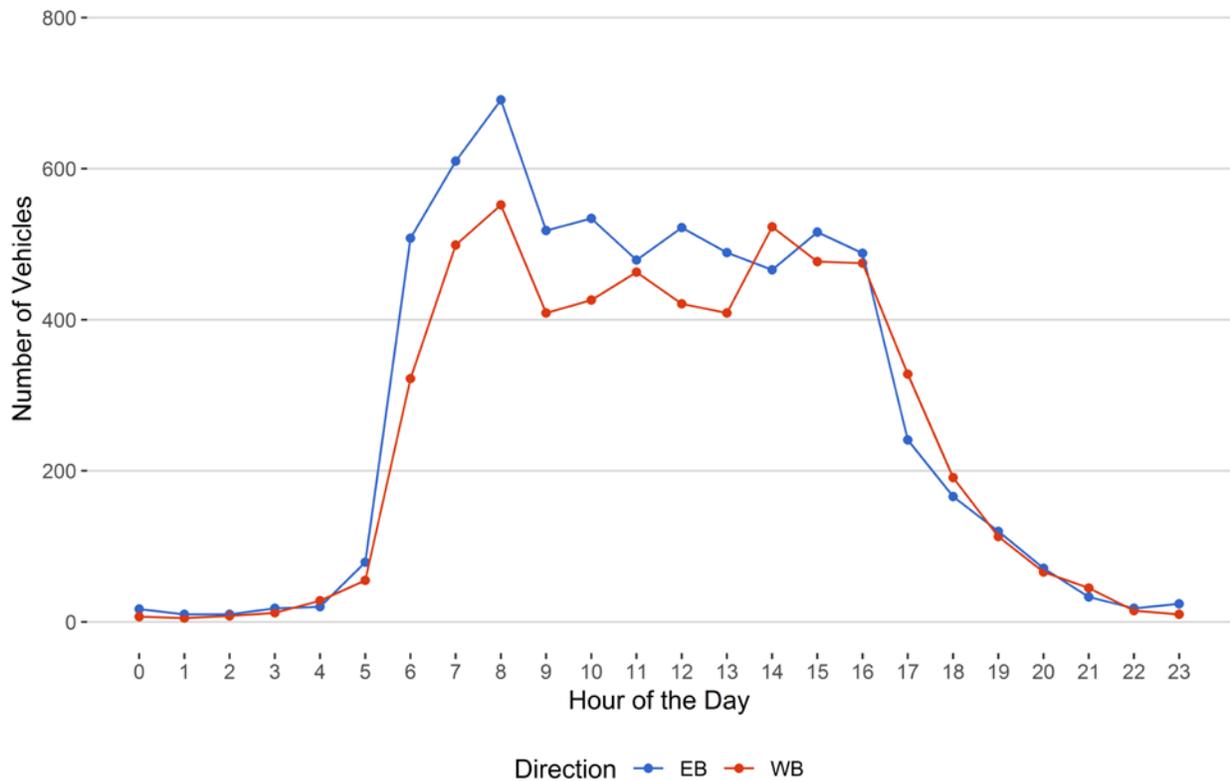


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

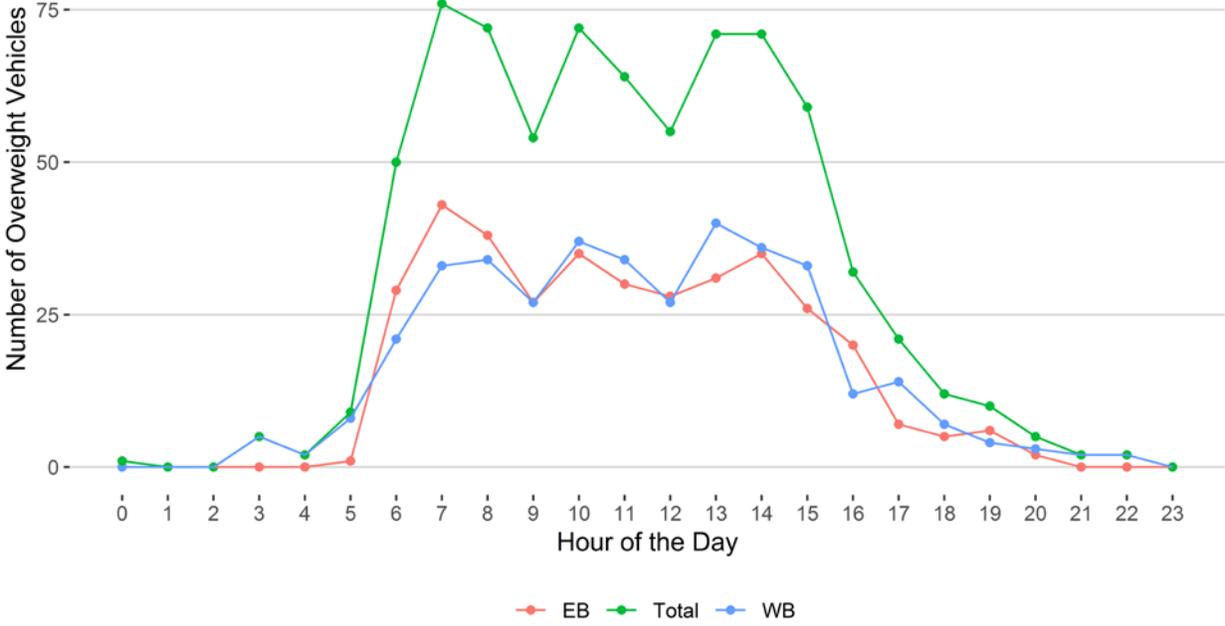
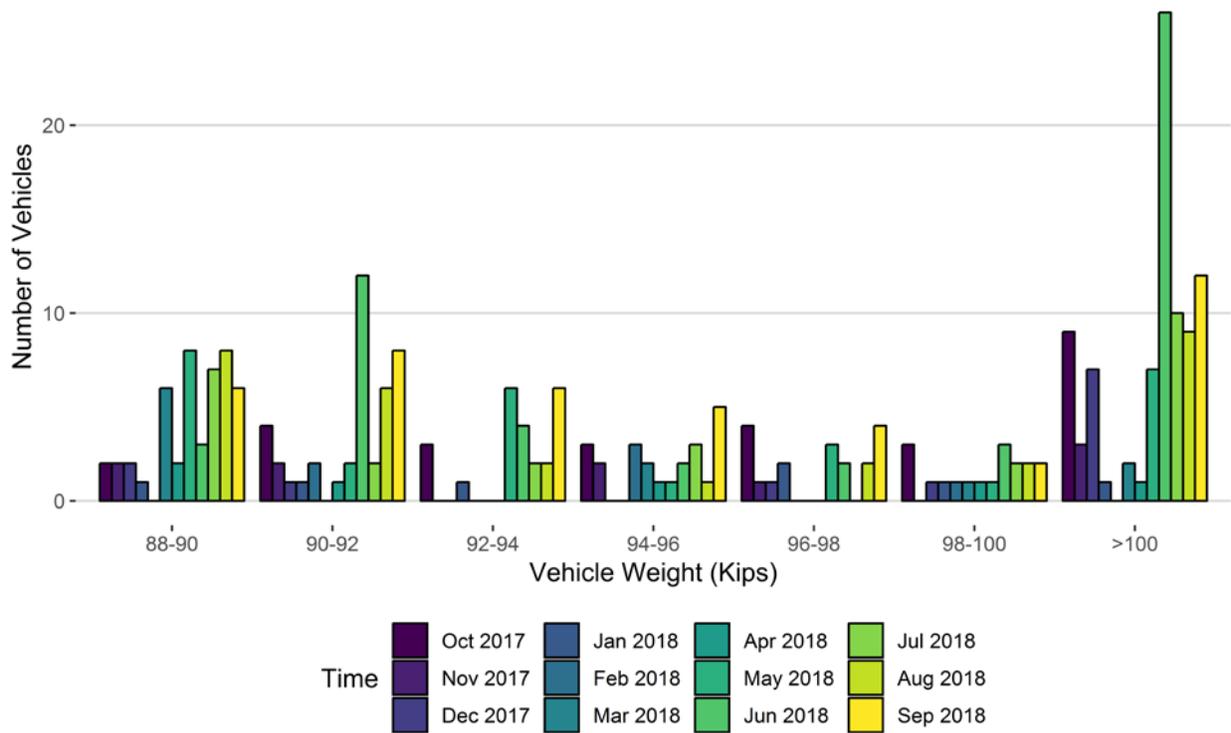
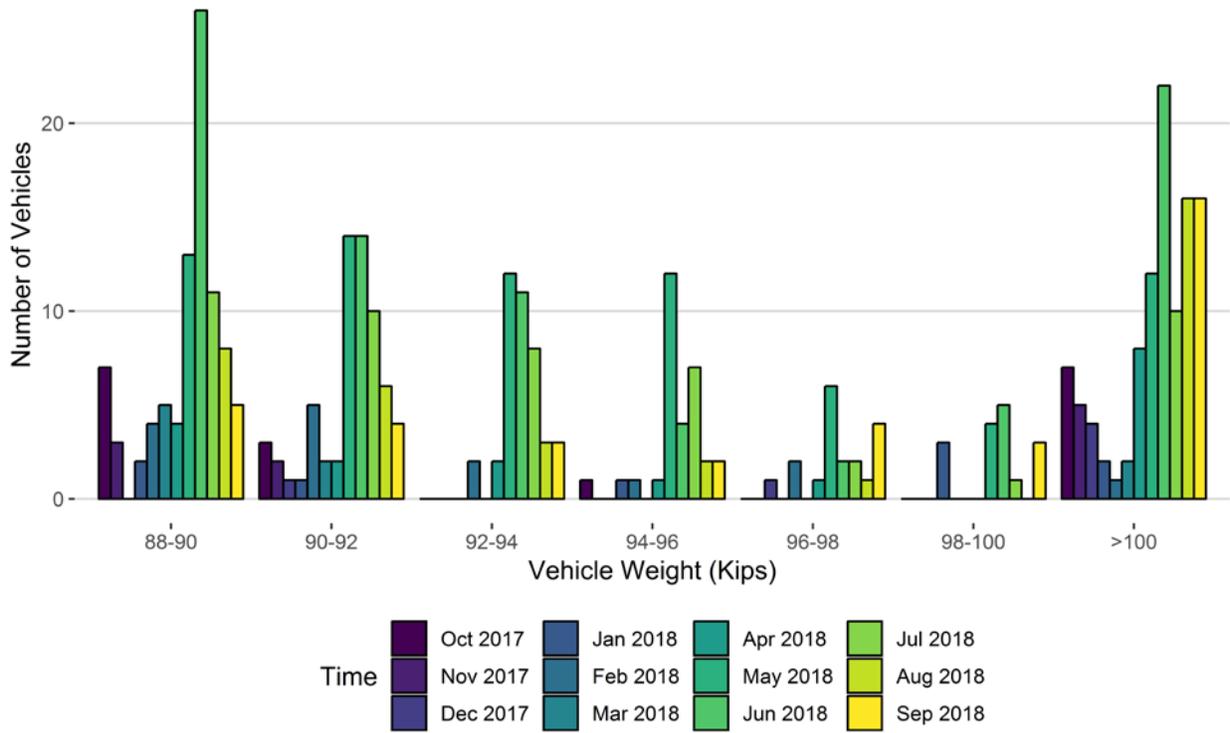


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018
88-90	2	2	2	1	0	6	2	8	3	7	8	6
90-92	4	2	1	1	2	0	1	2	12	2	6	8
92-94	3	0	0	1	0	0	0	6	4	2	2	6
94-96	3	2	0	0	3	2	1	1	2	3	1	5
96-98	4	1	1	2	0	0	0	3	2	0	2	4
98-100	3	0	1	1	1	1	1	1	3	2	2	2
>100	9	3	7	1	0	2	1	7	26	10	9	12
Total	28	10	12	7	6	11	6	28	52	26	30	43

Figure 8 - Histogram of WB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018
88-90	7	3	0	2	4	5	4	13	26	11	8	5
90-92	3	2	1	1	5	2	2	14	14	10	6	4
92-94	0	0	0	0	2	0	2	12	11	8	3	3
94-96	1	0	0	1	1	0	1	12	4	7	2	2
96-98	0	0	1	0	2	0	1	6	2	2	1	4
98-100	0	0	0	3	0	0	0	4	5	1	0	3
>100	7	5	4	2	1	2	8	12	22	10	16	16
Total	18	10	6	9	15	9	18	73	84	49	36	37

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

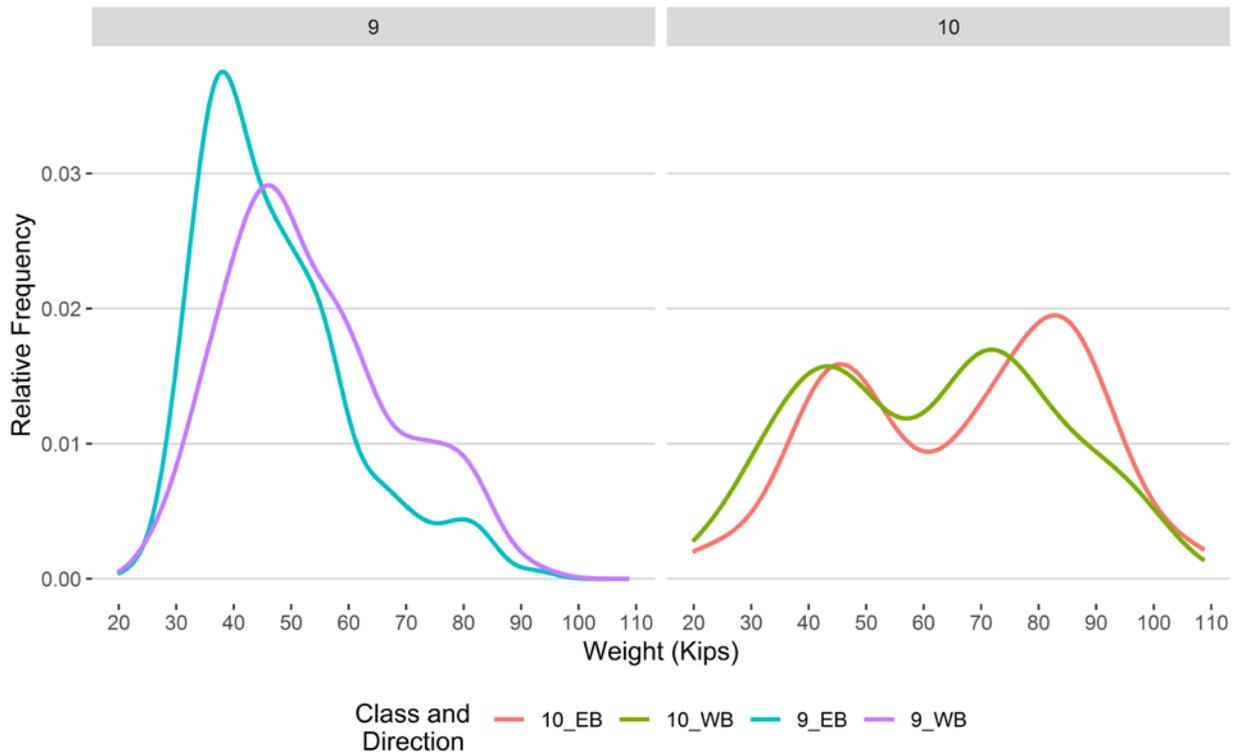


Figure 9 - Freight Percentage by Direction and Class

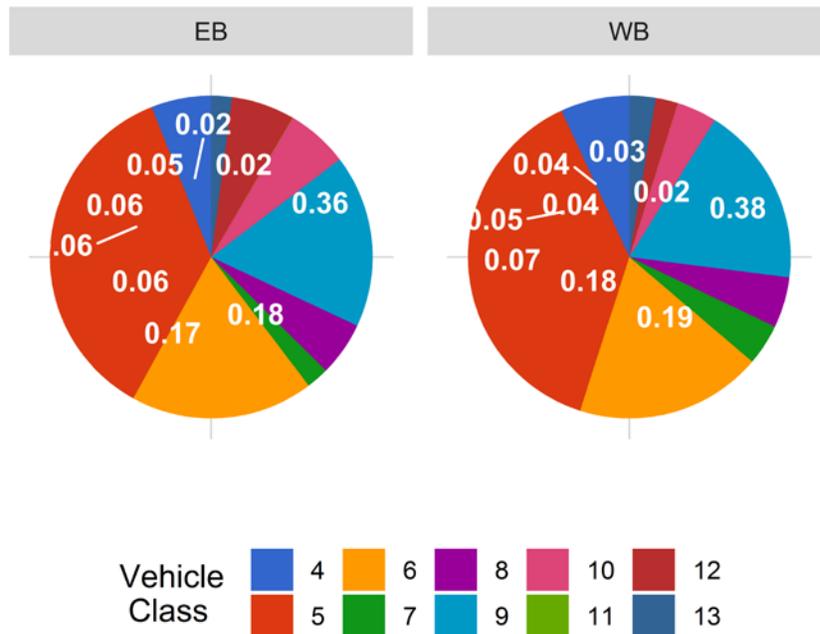


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

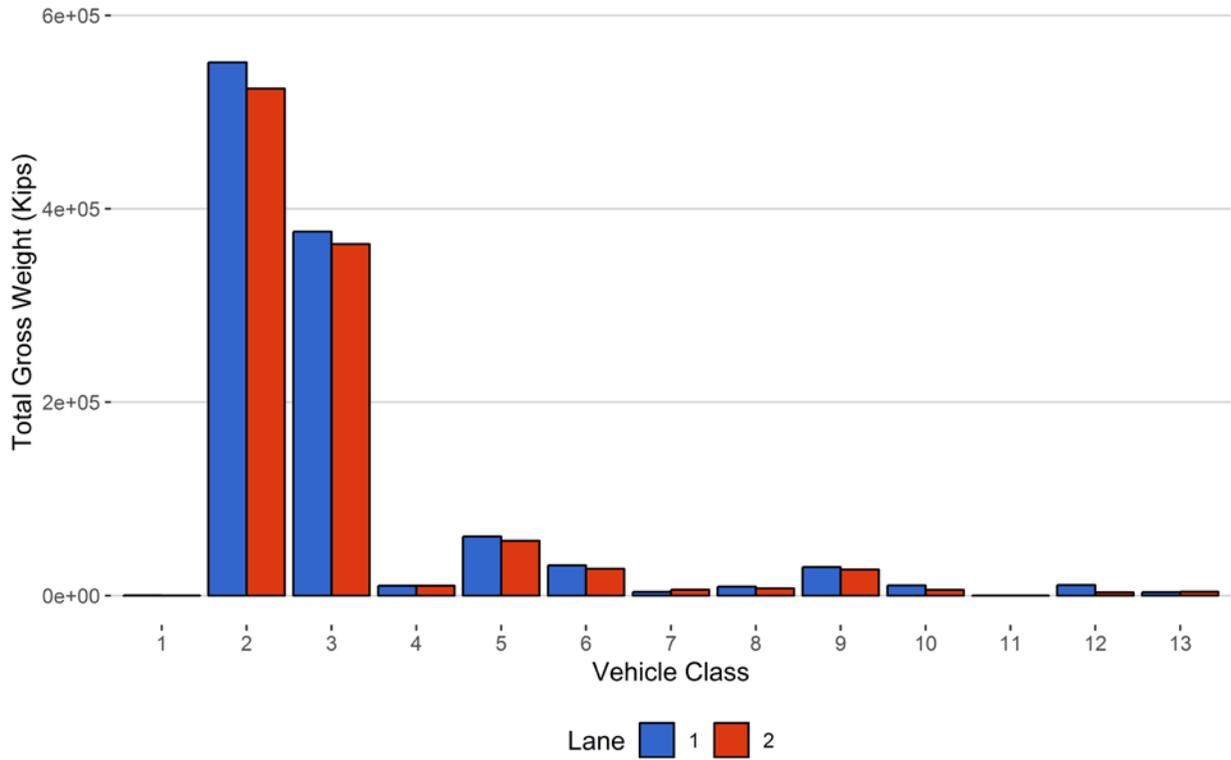


Figure 11 - Total Gross Vehicle Weight t

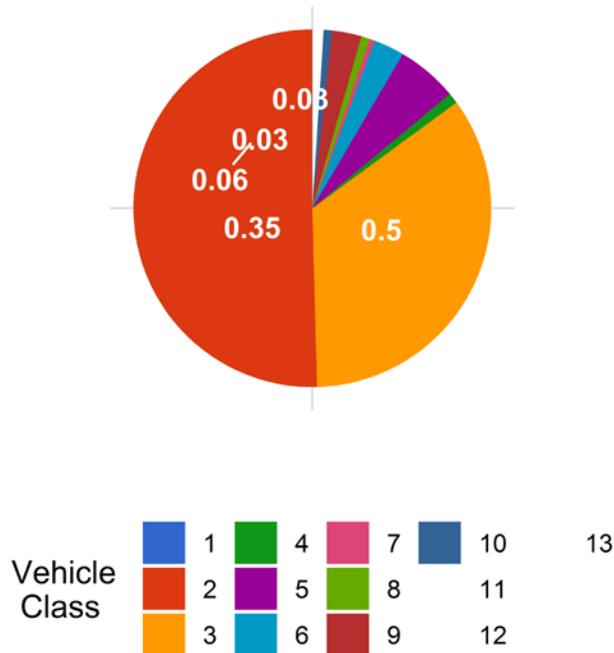


Figure 12 - Total ESALs by Class and Lane

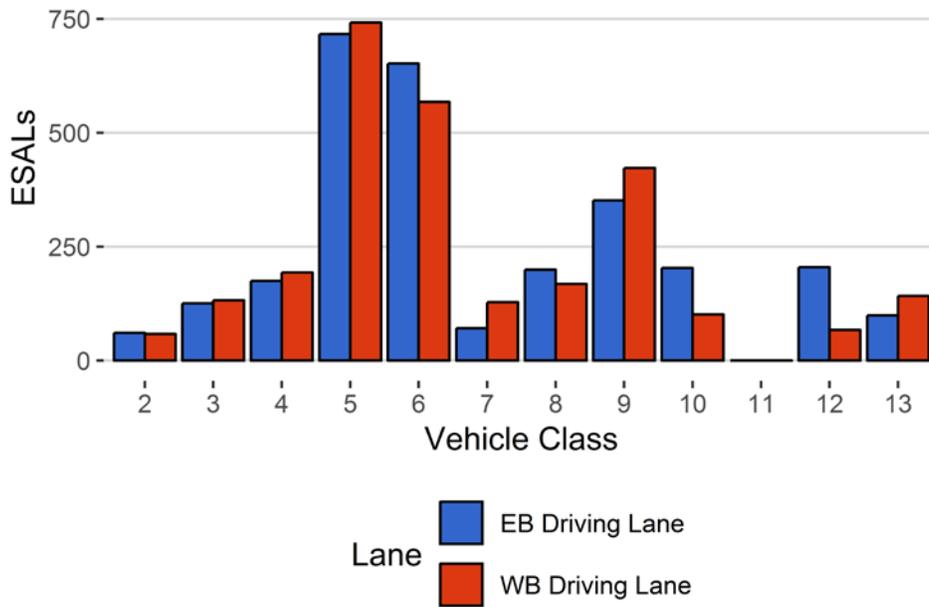


Figure 13 - ESALs by Class

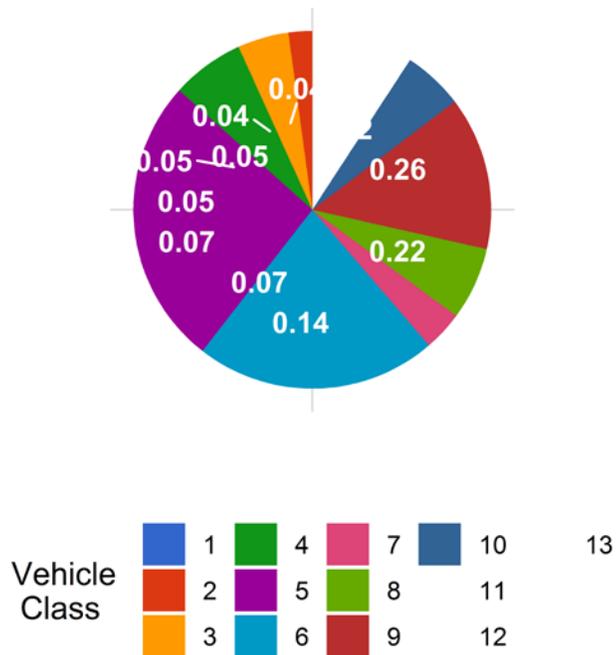


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
February 2016	11.29	0.00	10.54	0.00
March 2016	11.21	-0.66	10.73	1.86
April 2016	11.05	-2.13	10.74	1.89
May 2016	10.75	-4.71	10.19	-3.28
June 2016	10.71	-5.12	10.39	-1.38
July 2016	10.72	-5.02	10.36	-1.66
October 2016	10.68	-5.35	10.58	0.39
November 2016	10.87	-3.64	10.46	-0.76
March 2017	11.18	-0.93	10.67	1.29
April 2017	11.29	0.03	10.39	-1.41
May 2017	10.93	-3.13	10.57	0.31
June 2017	10.82	-4.11	10.61	0.71
July 2017	10.93	-3.18	10.65	1.01
August 2017	10.86	-3.76	10.50	-0.39
September 2017	10.74	-4.83	10.58	0.39
October 2017	10.76	-4.66	10.48	-0.58
November 2017	10.72	-5.00	10.41	-1.23
December 2017	10.53	-6.74	10.36	-1.74
January 2018	11.18	-0.95	10.56	0.22
February 2018	11.38	0.81	10.80	2.44
March 2018	11.50	1.90	10.88	3.23
April 2018	11.05	-2.07	10.90	3.47
May 2018	10.84	-3.96	10.64	0.98
June 2018	10.79	-4.43	10.44	-0.89
July 2018	10.84	-3.91	10.66	1.15
August 2018	10.92	-3.22	10.83	2.74
September 2018	10.90	-3.41	10.91	3.49

Table 2 Vehicle Classification Data

<i>Vehicle Class</i>	<i>Monthly Average Daily Volume</i>	<i>Monthly Total Volume</i>	<i>Monthly Total Volume Percentage</i>	<i>Monthly Total Overweight Vehicles</i>	<i>Monthly Total Overweight Percentage</i>
1	13	380	0.1	0	0
2	9401	282025	67.2	0	0
3	4158	124738	29.7	0	0
4	22	672	0.2	34	4.6
5	263	7892	1.9	80	10.9
6	55	1648	0.4	145	19.7
7	5	155	0	79	10.7
8	18	531	0.1	50	6.8
9	38	1137	0.3	114	15.5
10	9	257	0.1	91	12.3
11	0	4	0	0	0
12	6	189	0	98	13.3
13	3	77	0	46	6.2
TOTAL	13990	419706	100	737	100

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

<i>Date</i>	<i>Day of Week</i>	<i>Time</i>	<i>Vehicle Class</i>	<i>Direction</i>	<i>Lane</i>	<i>GVW (lbs)</i>
2018-09-20	Thursday	15:00:21	10	EB	1	108.84
2018-09-04	Tuesday	15:54:09	10	EB	1	106.91
2018-09-20	Thursday	08:00:07	10	EB	1	106.67
2018-09-24	Monday	19:39:40	10	EB	1	104.75
2018-09-19	Wednesday	15:04:47	10	EB	1	103.65
2018-09-21	Friday	20:16:07	10	WB	2	99.81
2018-09-24	Monday	14:43:36	10	WB	2	98.43
2018-09-10	Monday	06:41:38	10	WB	2	97.8
2018-09-14	Friday	06:12:22	10	WB	2	97.25
2018-09-24	Monday	18:55:46	10	WB	2	96.54

Table 4 Freight Summary

<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	EB	15	343	47	13.7	9599	633	2580
5	EB	8	4107	370	9	58568	2610	14336
6	EB	19	884	24	2.7	30799	423	7230
7	EB	11.5	62	0	0	3847	0	1567
8	EB	31	278	130	46.8	6865	2354	1138
9	EB	33	627	60	9.6	27667	1827	4478
10	EB	33.5	159	7	4.4	10399	175	2653
11	EB	36.5	3	3	100	0	60	0
12	EB	36.5	145	0	0	10791	0	2749
13	EB	31.5	40	0	0	3519	0	1129
TOTAL	****	****	6648	641	****	162055	****	37861
<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	WB	15	326	39	12	9741	511	2718
5	WB	8	3750	249	6.6	54829	1747	13410
6	WB	19	757	10	1.3	27605	163	6706
7	WB	11.5	92	0	0	6114	0	2528
8	WB	31	251	140	55.8	4910	2628	735
9	WB	33	505	26	5.1	26129	768	5161
10	WB	33.5	97	8	8.2	5728	227	1373
11	WB	36.5	1	1	100	0	21	0
12	WB	36.5	43	0	0	3291	0	861
13	WB	31.5	37	1	2.7	3898	14	1382
TOTAL	****	****	5859	474	****	142245	****	34874
GRAND TOTAL	****	****	12507	1115	378	304300	14160	72735

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>EB</i>	<i>WB</i>	<i>Total</i>	<i>Percentage</i>
1	222	170	393	0
2	551463	524373	1075836	50.4
3	376389	363469	739858	34.7
4	10232	10252	20484	1
5	61178	56576	117754	5.5
6	31222	27768	58990	2.8
7	3847	6114	9961	0.5
8	9218	7538	16756	0.8
9	29495	26897	56391	2.6
10	10573	5955	16529	0.8
11	60	21	81	0
12	10791	3291	14082	0.7
13	3519	3912	7431	0.3
TOTAL	1098210	1036337	2134548	100
GVW/LANE	51.45	48.55	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>EB</i>	<i>WB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.0026
2	61	58	119	2.1	9e-04
3	126	132	258	4.6	0.0042
4	175	193	368	6.6	1.11
5	717	742	1459	26.1	0.38
6	652	568	1220	21.8	1.5
7	71	128	199	3.6	2.54
8	200	168	368	6.6	1.4
9	352	423	774	13.9	1.38
10	203	101	305	5.5	2.35
11	0	0	0	0	0.74
12	205	68	272	4.9	2.81
13	99	142	241	4.3	5.56
TOTAL	2861	2723	5584	100	20
ESALS/LANE	51.2	48.8	100	-	-

Table 7 Site Summary: Volume and Vehicle Class

<i>Month</i>	<i>Total Volume</i>	<i>Monthly ADT</i>	<i>Monthly HCADT</i>	<i>Passenger Vehicles</i>	<i>Passenger Vehicles %</i>	<i>Heavy Commercial Vehicles</i>	<i>Heavy Commercial Vehicles %</i>
Oct 2017	431651	13924	387	419648	97.2	12002.7	2.8
Nov 2017	386452	12882	329	376587	97.4	9865.3	2.6
Dec 2017	376429	12143	262	368302	97.8	8127.3	2.2
Jan 2018	355465	11467	261	347380	97.7	8085	2.3
Feb 2018	325130	11612	263	317772	97.7	7358.3	2.3
Mar 2018	372037	12001	262	363916	97.8	8121	2.2
Apr 2018	380697	12690	315	371242	97.5	9455.4	2.5
May 2018	474991	15322	486	459934	96.8	15057	3.2
Jun 2018	450683	15023	471	436568	96.9	14115.2	3.1
Jul 2018	438254	14137	398	425930	97.2	12323.7	2.8
Aug 2018	446876	14415	414	434052	97.1	12824.4	2.9
Sep 2018	419706	13990	419	407143	97	12563.1	3
TOTAL	4858371	-	-	4728474	-	129898	-
AVERAGE	404864	13301	356	394040	97	10825	3

ESALS

<i>Month</i>	<i>ESALS EB Driving Lane</i>	<i>ESALS WB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Oct 2017	2635	2471	5106	5
Nov 2017	2032	1968	4000	1.9
Dec 2017	3283	1617	4900	0.8
Jan 2018	1757	1548	3305	1
Feb 2018	1598	1410	3008	1.6
Mar 2018	1922	1690	3612	2.3
Apr 2018	2022	1838	3860	0.9
May 2018	3365	3799	7164	6.9
Jun 2018	3507	3885	7392	9.5
Jul 2018	2794	3073	5867	4.8
Aug 2018	3256	2967	6222	3.4
Sep 2018	2874	2745	5619	4.4
TOTAL	31044	-	-	-
AVERAGE	2587	2418	5004	4

Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Oct 2017	863971	774480	1638451
Nov 2017	794931	697417	1492348
Dec 2017	906278	785702	1691980
Jan 2018	951084	865467	1816551
Feb 2018	1258909	1200368	2459277
Mar 2018	1209273	1130898	2340171
Apr 2018	1148174	1088707	2236882
May 2018	1207538	1132967	2340504
Jun 2018	1098955	1038371	2137326
Jul 2018	1075078	966463	2041541
Aug 2018	936552	846652	1783204
Sep 2018	888219	819015	1707234
TOTAL	12338962	11346508	23685470
AVERAGE	1028247	945542	1973789

Overweight Vehicles

<i>Month</i>	<i>Total Number of Overweight Vehicles</i>	<i>Overweight / Total Volume</i>	<i>Overweight / Heavy Commercial Volume</i>	<i>Number Over 88,000 lbs</i>	<i>Number Over 98,000 lbs</i>
Oct 2017	701	0.2	4.4	46	19
Nov 2017	526	0.1	3.8	21	8
Dec 2017	413	0.1	3.6	23	17
Jan 2018	363	0.1	3.1	16	7
Feb 2018	348	0.1	3.2	21	2
Mar 2018	412	0.1	3.2	20	5
Apr 2018	427	0.1	3.6	24	10
May 2018	1095	0.2	7.1	101	24
Jun 2018	1168	0.3	8.1	138	57
Jul 2018	870	0.2	6.9	77	25
Aug 2018	911	0.2	6.8	66	27
Sep 2018	745	0.2	5.8	82	35
TOTAL	7979	-	-	635	236
AVERAGE	664.9	0.2	5	52.9	19.7

Freight

<i>Month</i>	<i>EB Freight Tons</i>	<i>WB Freight Tons</i>	<i>Total Freight</i>	<i>EB Freight %</i>	<i>WB Freight %</i>
Oct 2017	35932	34011	69943	51.4	48.6
Nov 2017	27530	27260	54790	50.2	49.8
Dec 2017	21124	21090	42214	50	50
Jan 2018	21619	19888	41507	52.1	47.9
Feb 2018	19893	18452	38345	51.9	48.1
Mar 2018	23367	21391	44757	52.2	47.8
Apr 2018	25949	23798	49747	52.2	47.8
May 2018	43173	51851	95024	45.4	54.6
Jun 2018	43944	48196	92140	47.7	52.3
Jul 2018	35591	37365	72955	48.8	51.2
Aug 2018	40646	36410	77056	52.7	47.3
Sep 2018	37861	34874	72735	52.1	47.9
TOTAL	376628	374587	751215	-	-
AVERAGE	31385.7	31215.6	62601.2	50.6	49.4