

DECEMBER 2019



**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 December 2019. 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. 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: 395504 | Passenger Vehicles: 385468 | Heavy Commercial Vehicles: 10036

Monthly Average Daily Traffic (MADT): 12834 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 324

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 04 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 04 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 9's.

Overweight HCVs

Volume trends. Of a total of 10036 HCVs, 646 of them were overweight ³. These overweight HCVs contributed to 0.2% of total monthly volume, and 6.5% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Saturdays. WB overweight vehicles tended to reach highest volumes on Fridays, with lowest volumes reported on Sundays. See Figure 3 .

The top two overweight violators by class were the class 9 and class 6 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 56% of all overweight vehicles traveling EB 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 report ⁴.

Using normal load limits ,34 EB vehicles exceeded 88,000 pounds (21 vehicles were Class 9's; 7 vehicles were Class 10's). Of vehicles traveling WB,

19 EB vehicles exceeded 88,000 pounds (8 vehicles were Class 13's; 5 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from December 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in December 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty 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 56641 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (53.5%) than WB (46.5%). 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 395504 vehicles with a combined GVW of 1986471 kips (1 kip = 1,000 pounds = 0.5 tons) in December 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 4773 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 52.8% of all ESALs were recorded EB while 47.2% was observed WB. In particular, 34% 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).

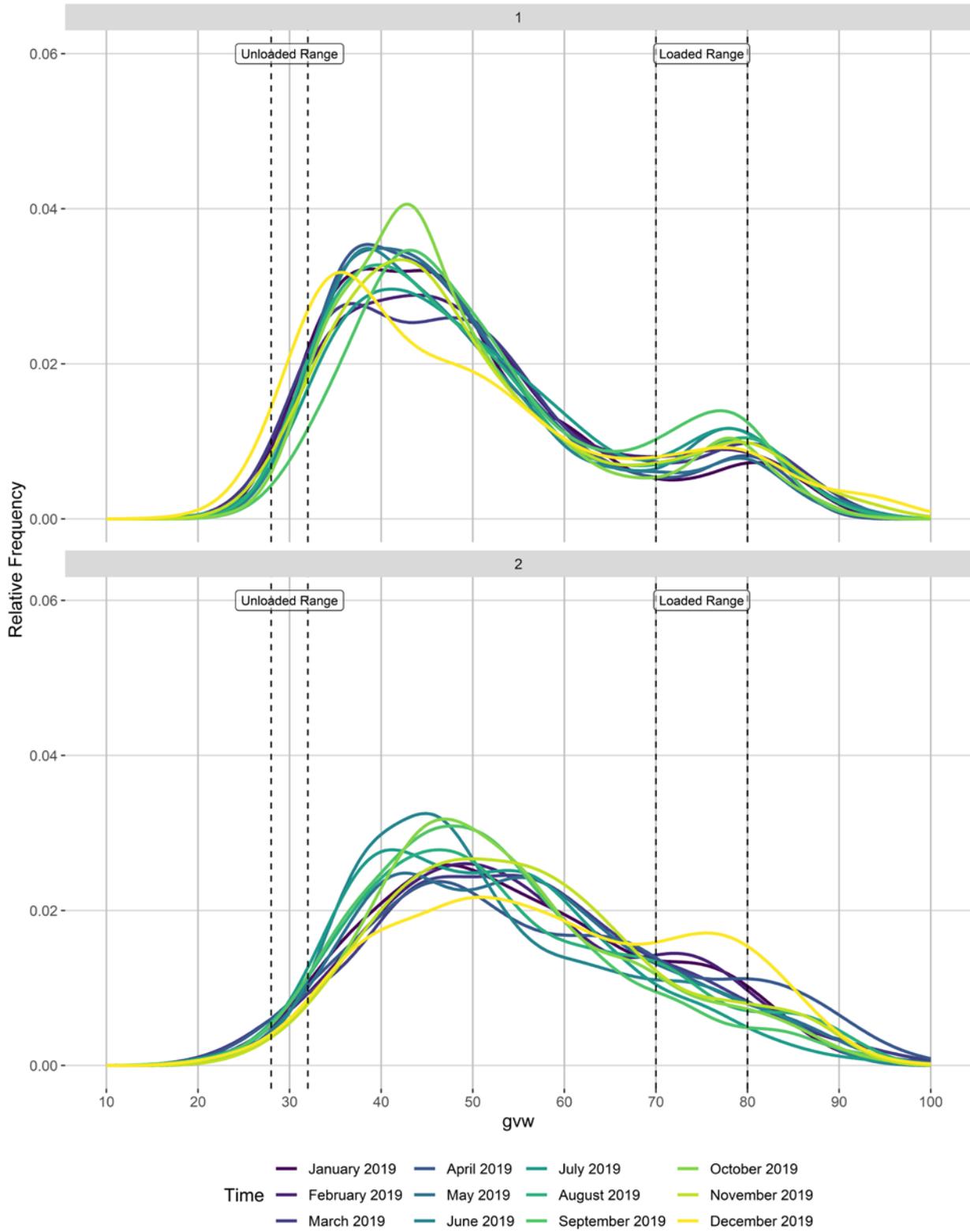
#####WIM monthly reports can be found at:

<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.

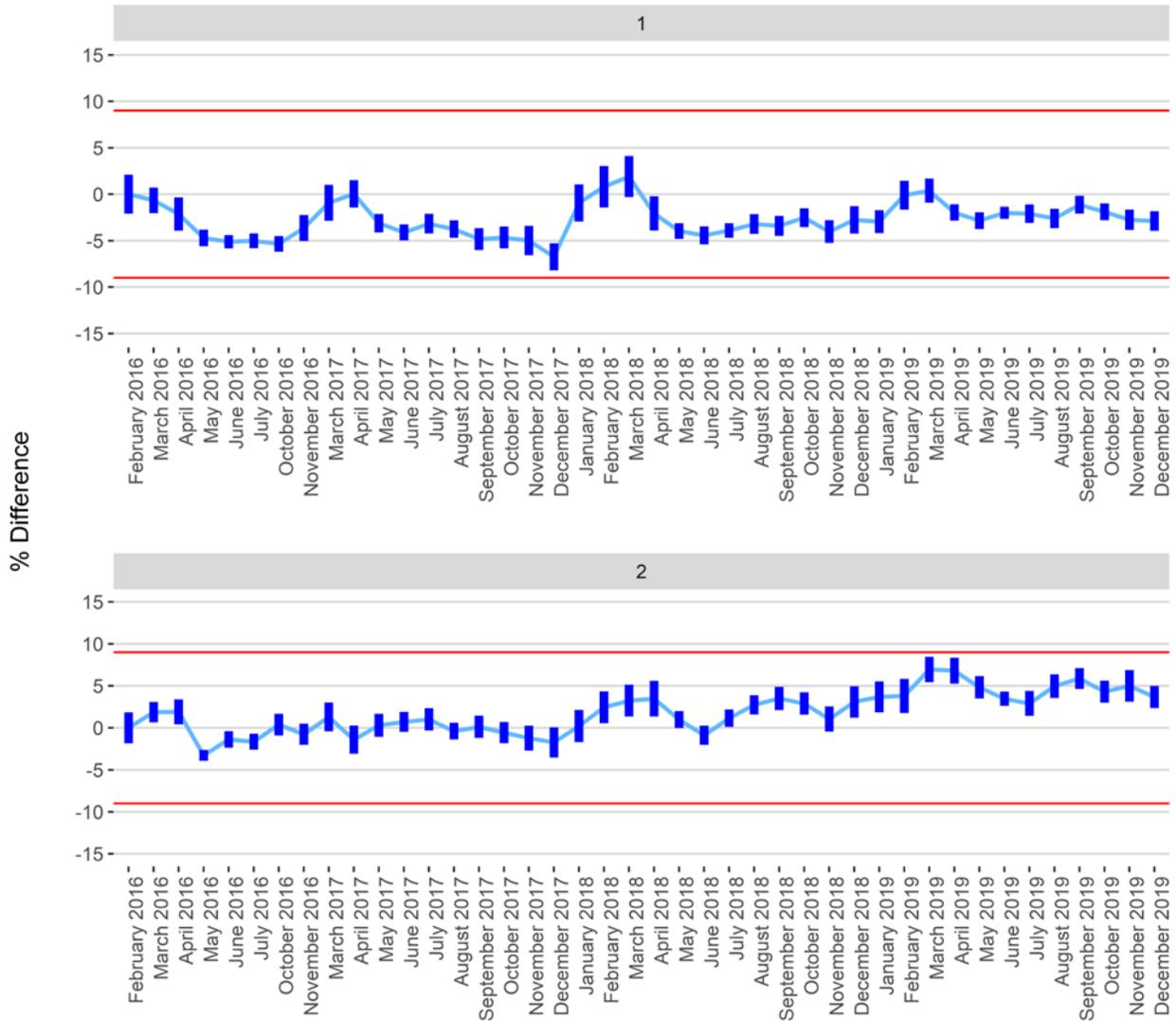
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Figure 1 - Monthly Class 9 GVW Histogram



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

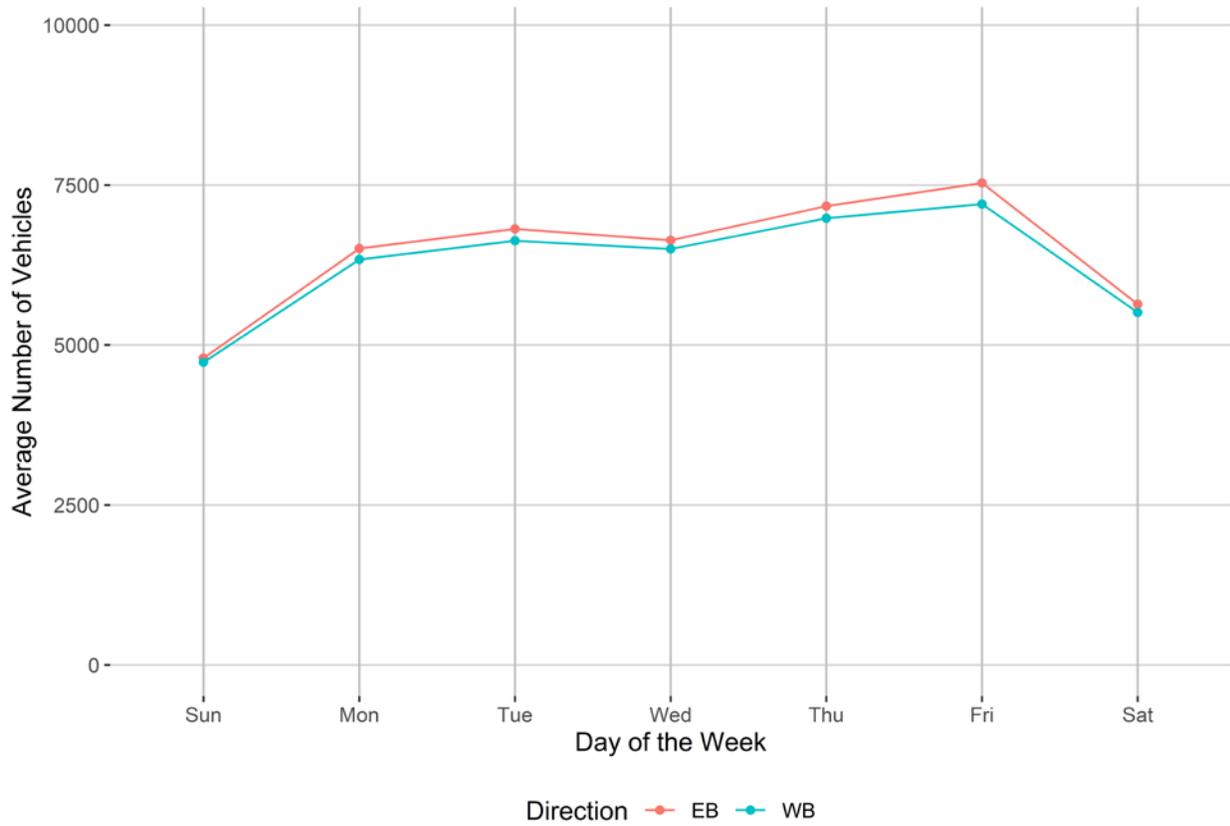


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

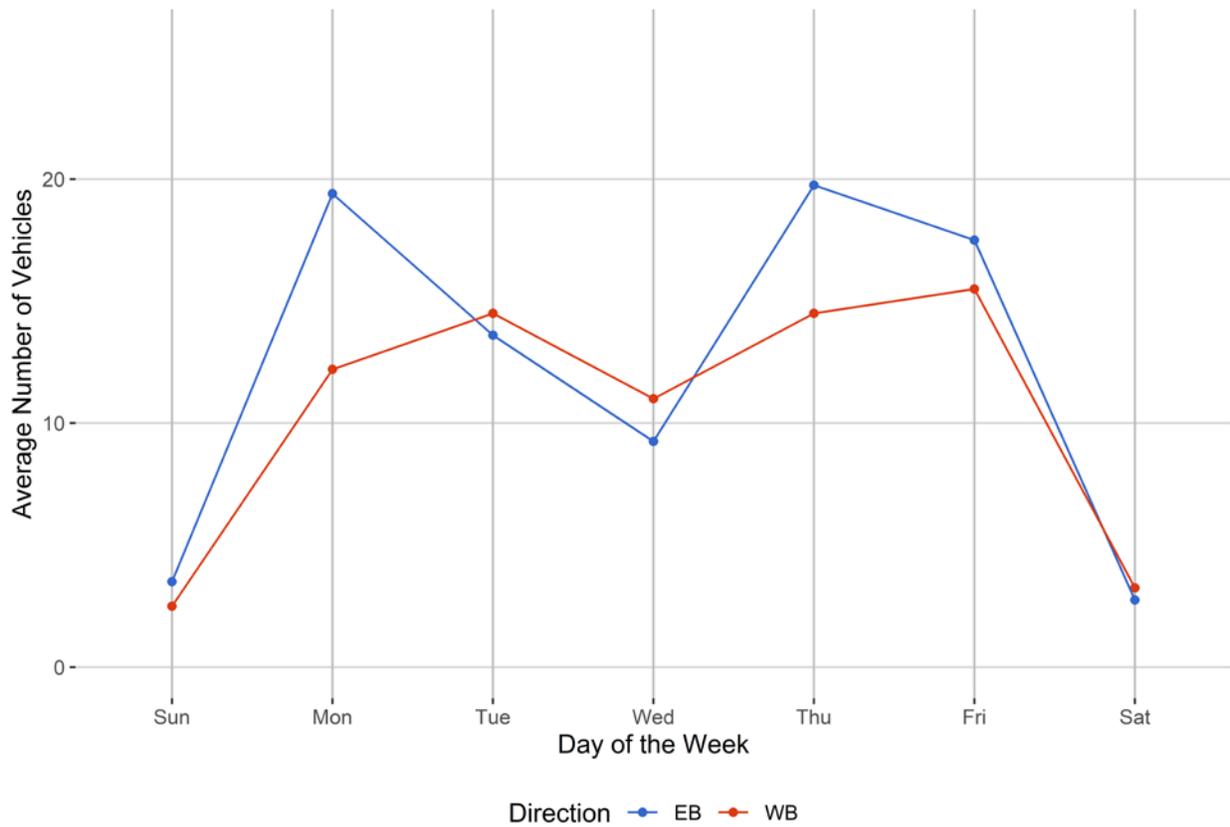


Figure 4 - Passenger Vehicles vs. Hour of the Day

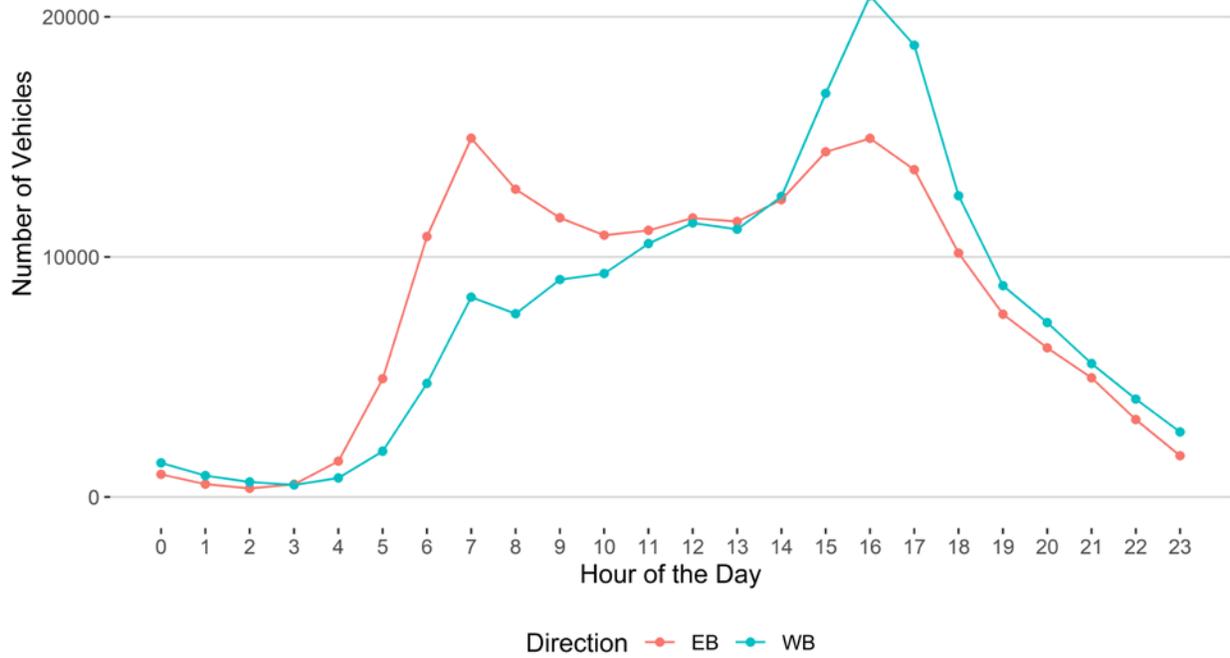


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

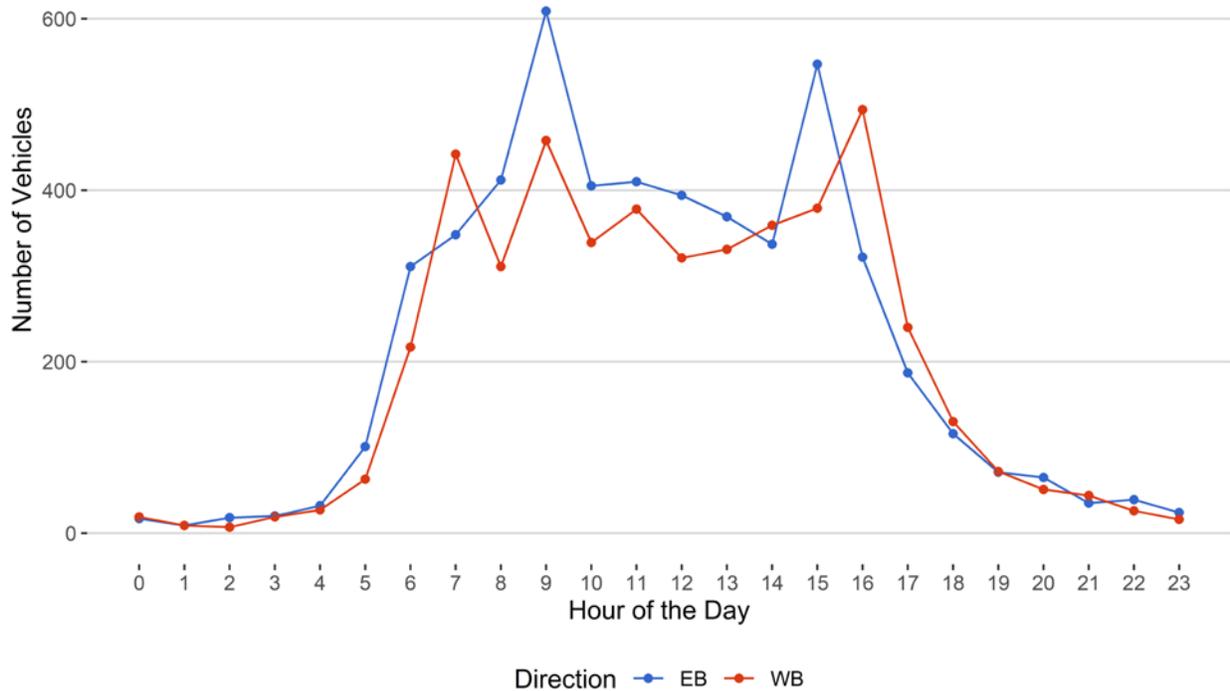


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

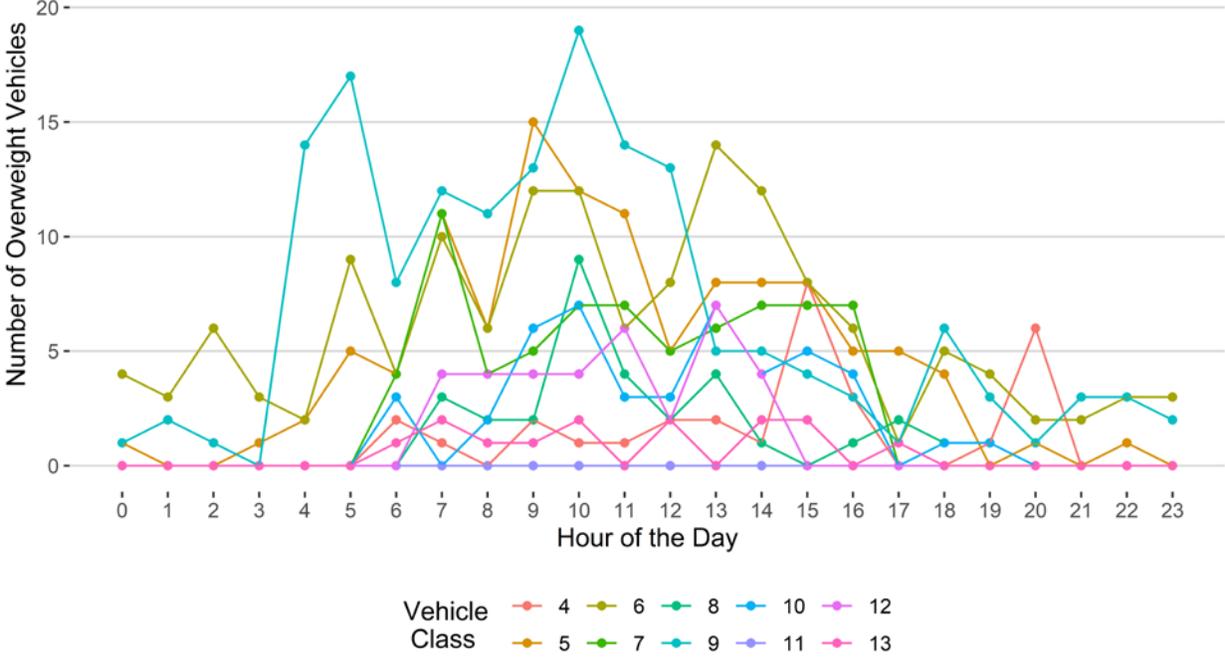


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

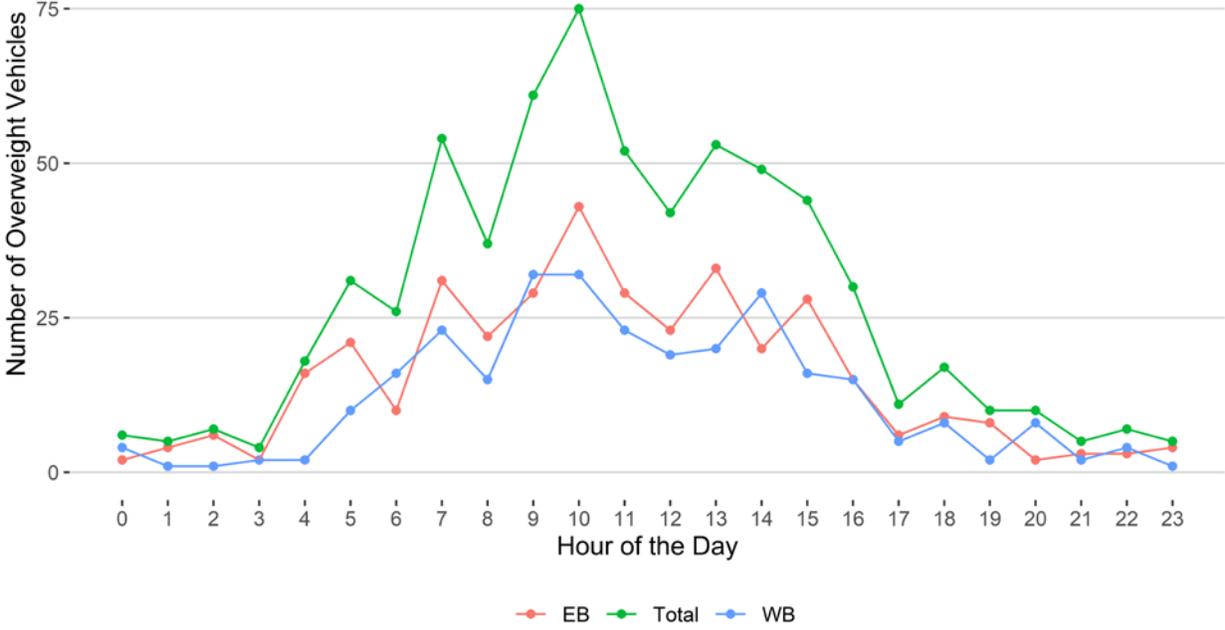
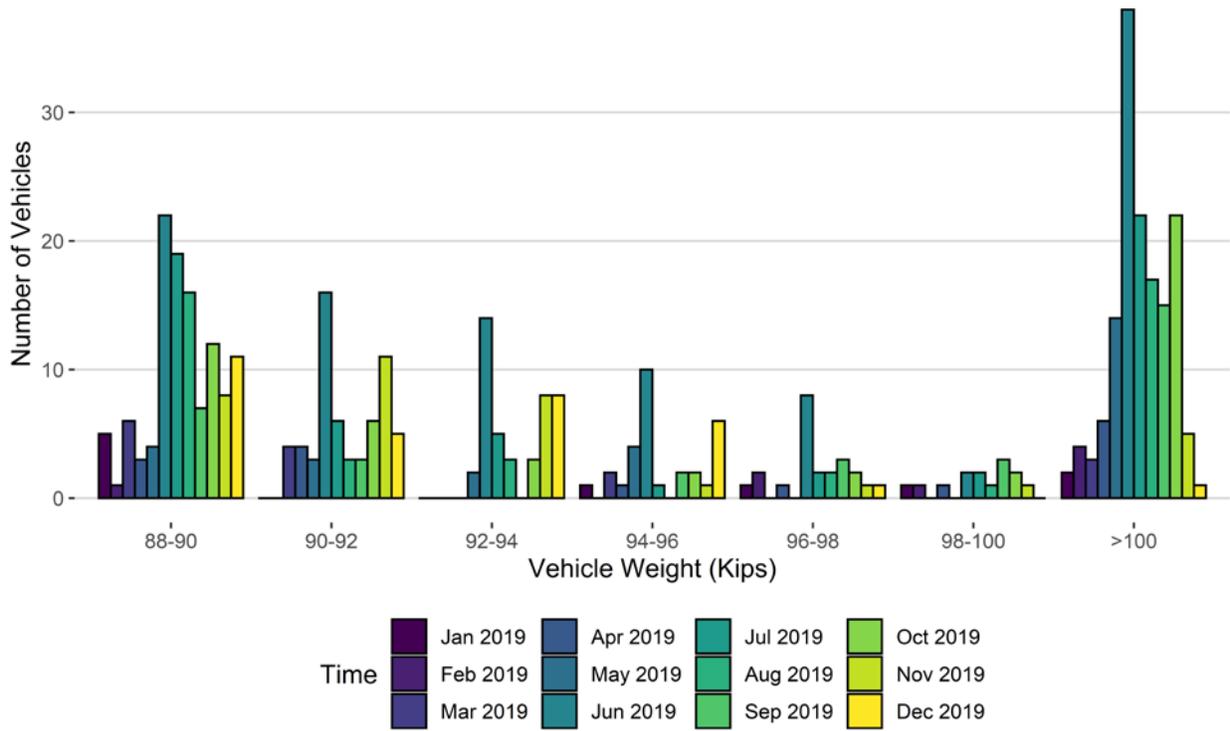
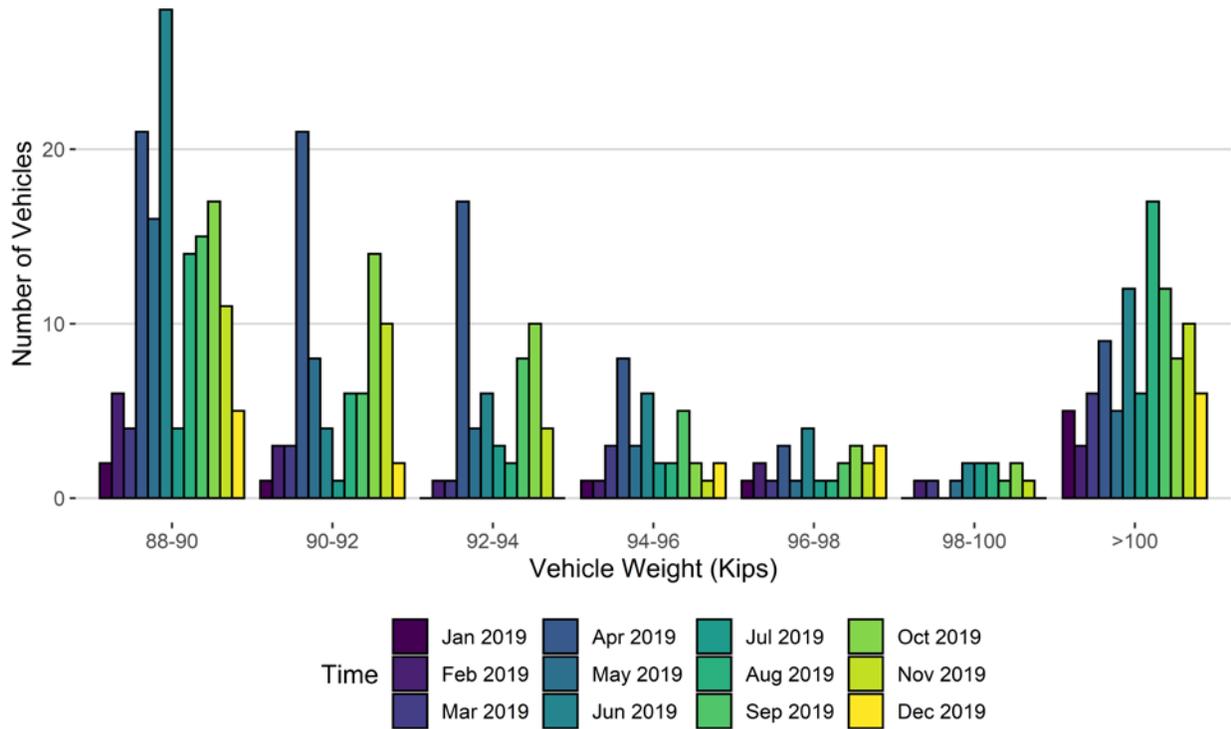


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	5	1	6	3	4	22	19	16	7	12	8	11
90-92	0	0	4	4	3	16	6	3	3	6	11	5
92-94	0	0	0	0	2	14	5	3	0	3	8	8
94-96	1	0	2	1	4	10	1	0	2	2	1	6
96-98	1	2	0	1	0	8	2	2	3	2	1	1
98-100	1	1	0	1	0	2	2	1	3	2	1	0
>100	2	4	3	6	14	38	22	17	15	22	5	1
Total	10	8	15	16	27	110	57	42	33	49	35	32

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



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	2	6	4	21	16	28	4	14	15	17	11	5
90-92	1	3	3	21	8	4	1	6	6	14	10	2
92-94	0	1	1	17	4	6	3	2	8	10	4	0
94-96	1	1	3	8	3	6	2	2	5	2	1	2
96-98	1	2	1	3	1	4	1	1	2	3	2	3
98-100	0	1	1	0	1	2	2	2	1	2	1	0
>100	5	3	6	9	5	12	6	17	12	8	10	6
Total	10	17	19	79	38	62	19	44	49	56	39	18

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

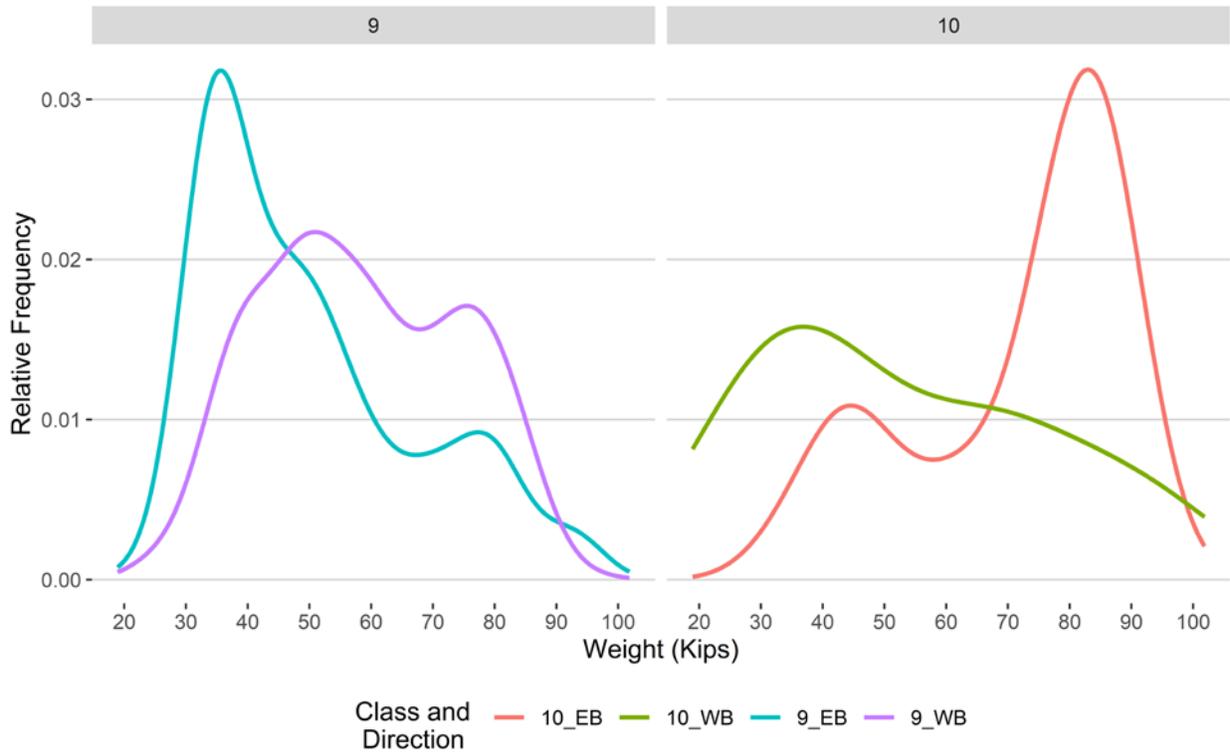


Figure 9 - Freight Percentage by Direction and Class

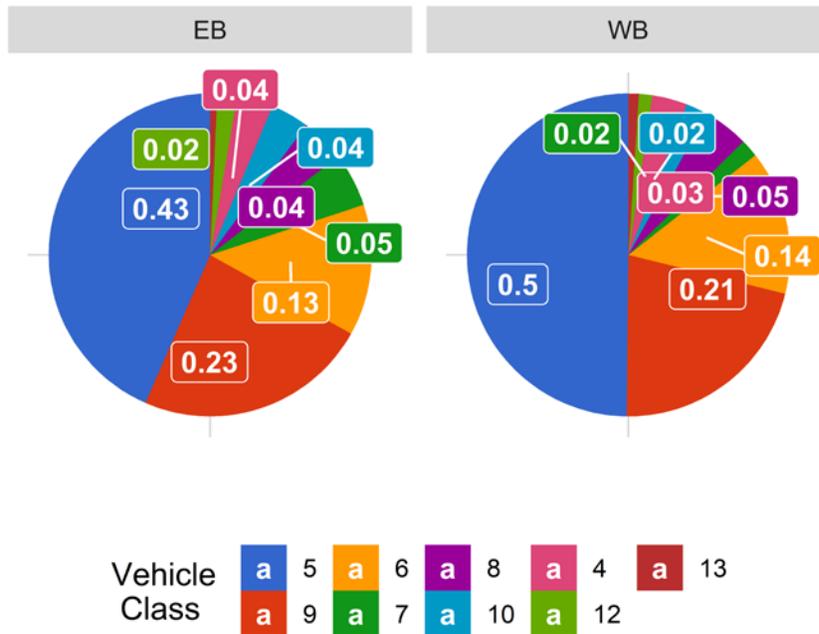


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

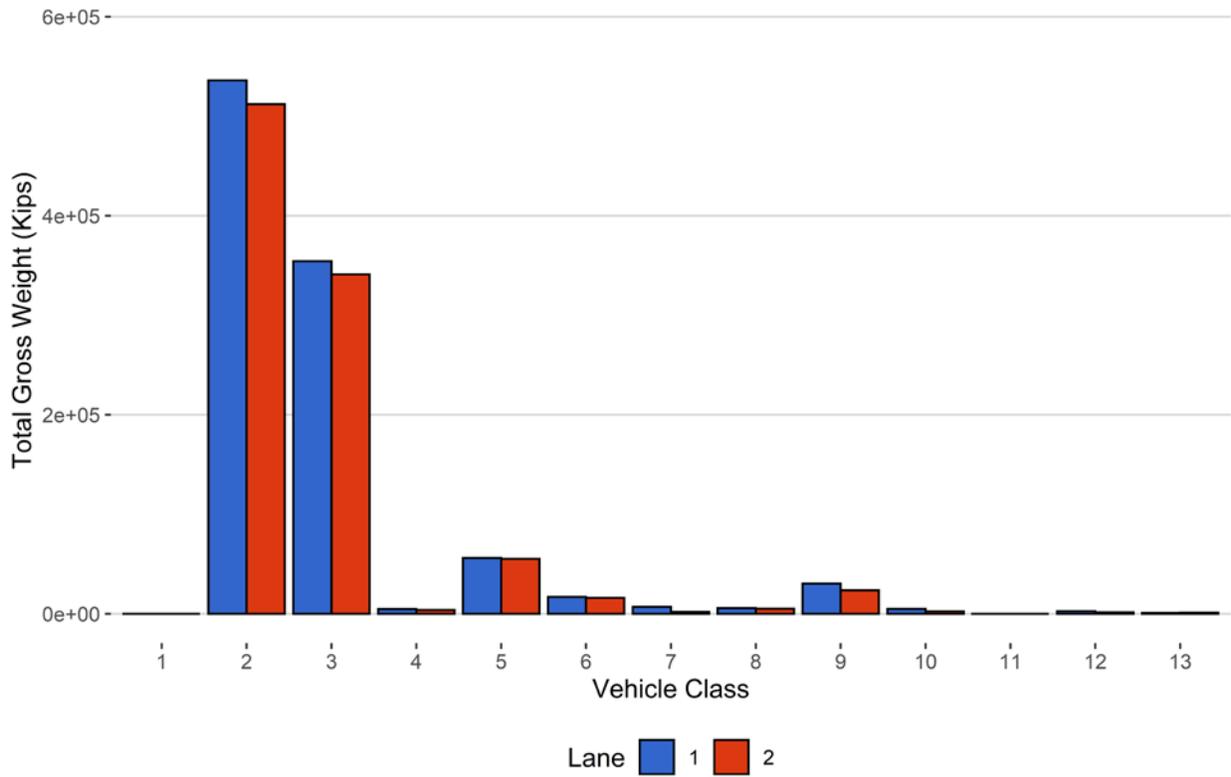


Figure 11 - Total Gross Vehicle Weight t

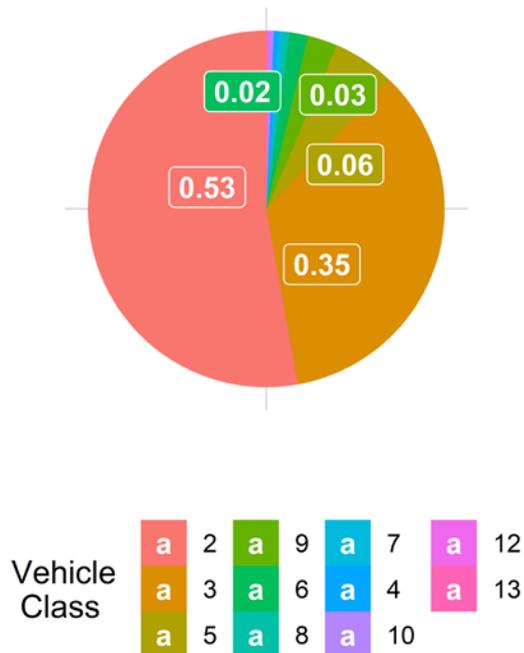


Figure 12 - Total ESALs by Class and Lane

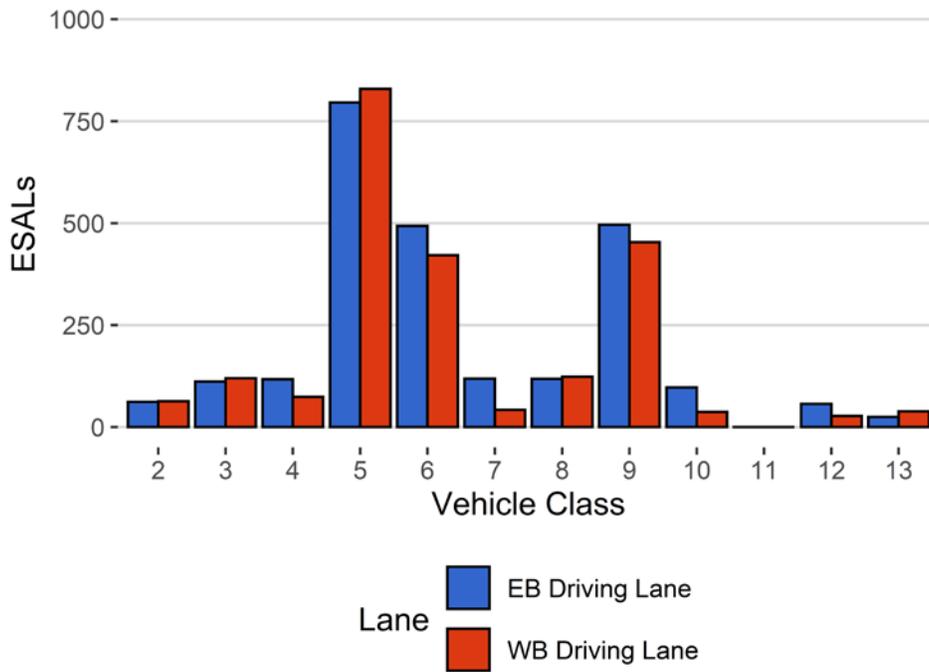


Figure 13 - ESALs by Class

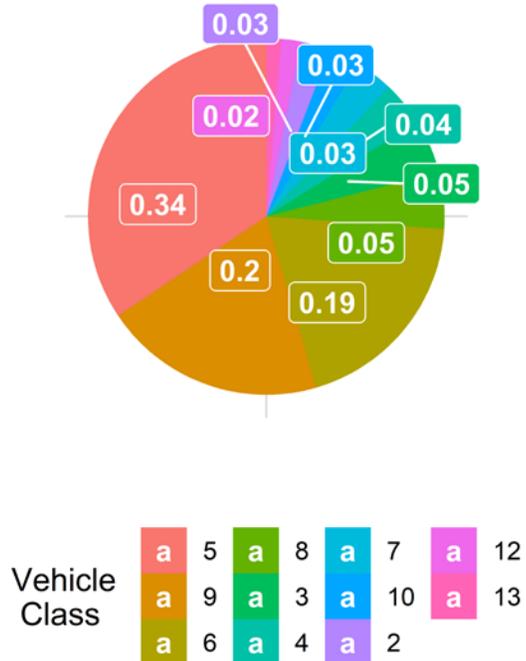


Table 1 Class 9 Front Axle Weight by Lane

<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	-4.84	10.55	0.11
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
October 2018	11.00	-2.54	10.84	2.90
November 2018	10.83	-4.03	10.65	1.04
December 2018	10.97	-2.76	10.86	3.08
January 2019	10.95	-2.96	10.93	3.69
February 2019	11.27	-0.11	10.94	3.80
March 2019	11.33	0.37	11.27	6.95
April 2019	11.06	-1.97	11.26	6.80
May 2019	10.96	-2.85	11.05	4.82
June 2019	11.06	-2.00	10.90	3.46
July 2019	11.05	-2.10	10.84	2.90
August 2019	10.99	-2.62	11.06	4.96
September 2019	11.16	-1.14	11.16	5.87

October 2019	11.07	-1.90	10.99	4.30
November 2019	10.97	-2.76	11.07	4.99
December 2019	10.96	-2.89	10.93	3.67

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	0	0	0	0	0
2	8586	266154	67.3	0	0
3	3849	119314	30.2	0	0
4	9	267	0.1	30	4.6
5	233	7227	1.8	113	17.5
6	28	860	0.2	145	22.4
7	5	143	0	70	10.8
8	11	327	0.1	32	5
9	33	1021	0.3	161	24.9
10	4	115	0	46	7.1
11	0	0	0	0	0
12	2	53	0	35	5.4
13	1	22	0	14	2.2
TOTAL	12758	395504	100	646	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>
2019-12-04	Wednesday	06:41:34	10	WB	2	101.84
2019-12-03	Tuesday	15:48:05	10	WB	2	97.97
2019-12-11	Wednesday	16:51:15	10	WB	2	97.42
2019-12-25	Wednesday	12:46:04	9	EB	1	96.29
2019-12-24	Tuesday	22:05:56	9	EB	1	95.95
2019-12-10	Tuesday	18:04:21	9	WB	2	95.83
2019-12-24	Tuesday	18:17:30	9	EB	1	95.79
2019-12-27	Friday	19:46:57	9	EB	1	95.63
2019-12-31	Tuesday	07:10:13	10	WB	2	94.73
2019-12-24	Tuesday	01:46:34	9	EB	1	94.7

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	140	11	7.9	4546	144	1306
5	EB	8	3626	313	8.6	53827	2253	13662
6	EB	19	437	7	1.6	16824	124	4327
7	EB	11.5	111	0	0	6983	0	2853
8	EB	31	164	60	36.6	4495	1209	635
9	EB	33	607	78	12.9	27903	2379	5223
10	EB	33.5	69	1	1.4	4915	33	1319
12	EB	36.5	34	0	0	2556	0	658
13	EB	31.5	10	0	0	912	0	299
TOTAL	****	****	5198	470	****	122961	****	30280
<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	125	10	8	3747	129	1011
5	WB	8	3539	237	6.7	53532	1656	13558
6	WB	19	416	6	1.4	15942	94	4076
7	WB	11.5	31	0	0	1980	0	812
8	WB	31	160	82	51.2	3407	1633	494
9	WB	33	405	14	3.5	23181	410	5139
10	WB	33.5	45	11	24.4	2121	292	491
12	WB	36.5	19	0	0	1491	0	399
13	WB	31.5	12	0	0	1141	0	382
TOTAL	****	****	4752	360	****	106541	****	26361
GRAND TOTAL	****	****	9950	830	164	229502	10354	56641

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>
2	535969	512098	1048067	52.8
3	354277	341081	695358	35.1
4	4690	3876	8566	0.4
5	56080	55188	111268	5.6
6	16948	16036	32984	1.7
7	6983	1980	8962	0.5
8	5703	5039	10743	0.5
9	30281	23591	53872	2.7
10	4948	2413	7361	0.4
12	2556	1491	4047	0.2
13	912	1141	2054	0.1
TOTAL	1019349	963933	1983281	100
GVW/LANE	51.4	48.6	100	0.01

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>
2	62	64	126	2.7	0.001
3	112	120	232	4.9	0.004
4	117	74	192	4.1	1.46
5	796	829	1625	34.4	0.46
6	493	421	915	19.4	2.16
7	119	43	161	3.4	2.24
8	118	123	242	5.1	1.5
9	496	454	950	20.1	1.89
10	97	37	134	2.8	2.27
12	57	28	84	1.8	2.81
13	25	38	64	1.3	4.04
TOTAL	2493	2231	4723	100	19
ESALS/LANE	52.8	47.2	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>
Jan 2019	367731	11862	300	358419	97.5	9311.5	2.5
Feb 2019	343809	12279	328	334638	97.3	9170.8	2.7
Mar 2019	385777	12444	286	376903	97.7	8874.2	2.3
Apr 2019	420217	14007	355	409564	97.5	10653.3	2.5
May 2019	484371	15469	467	469906	97	14465.4	3
Jun 2019	447421	14914	380	436036	97.5	11385.3	2.5
Jul 2019	404321	12901	335	393924	97.4	10396.9	2.6
Aug 2019	416566	13437	356	405520	97.3	11045.9	2.7
Sep 2019	445533	15002	464	431613	96.9	13919.9	3.1
Oct 2019	470635	15082	500	455121	96.7	15513.7	3.3
Nov 2019	407686	13603	378	396342	97.2	11343.9	2.8
Dec 2019	395504	12834	324	385468	97.5	10036	2.5
TOTAL	4989571	-	-	4853454	-	136117	-
AVERAGE	415798	13653	373	404454	97	11343	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>
Jan 2019	2057	1877	3933	1.3
Feb 2019	2201	2100	4301	1.1
Mar 2019	2197	1698	3894	2.1
Apr 2019	2374	2514	4888	15.4
May 2019	3494	3224	6717	4.3
Jun 2019	6067	4480	10547	6.4
Jul 2019	3071	1861	4932	4
Aug 2019	2786	2746	5532	3.7
Sep 2019	3726	2987	6713	2.1
Oct 2019	3822	3710	7531	2.9
Nov 2019	2924	2500	5424	4.9
Dec 2019	2519	2255	4773	6.2
TOTAL	37236	-	-	-
AVERAGE	3103	2662	5766	4

###Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Jan 19	928842	879765	1808607
Feb 19	893522	831150	1724672

Mar 19	1002496	848116	1850612
Apr 19	1090589	993366	2083955
May 19	1300770	1199019	2499789
Jun 19	2470166	2048533	4518699
Jul 19	1170043	874938	2044980
Aug 19	1057506	1074847	2132353
Sep 19	1190943	1137172	2328115
Oct 19	1254288	1226776	2481064
Nov 19	1065576	1008461	2074037
Dec 19	1020195	966276	1986471
TOTAL	14444938	13088418	27533355
AVERAGE	1203745	1090701	2294446

###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>
Jan 2019	492	0.1	5.2	20	8
Feb 2019	553	0.2	5.9	27	11
Mar 2019	470	0.1	5.1	34	10
Apr 2019	638	0.2	5.8	95	16
May 2019	999	0.2	6.8	66	20
Jun 2019	1566	0.2	6.8	172	54
Jul 2019	761	0.2	7.2	76	32
Aug 2019	939	0.2	8.4	86	37
Sep 2019	974	0.2	6.9	85	32
Oct 2019	1158	0.2	7.4	105	34
Nov 2019	774	0.2	6.7	74	17
Dec 2019	659	0.2	6.4	53	7
TOTAL	9983	-	-	893	278
AVERAGE	831.9	0.2	6.5	74.4	23.2

###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>
Jan 2019	25566	23173	48739	52.5	47.5
Feb 2019	25807	22634	48441	53.3	46.7
Mar 2019	26399	20405	46803	56.4	43.6
Apr 2019	30513	29739	60251	50.6	49.4
May 2019	45606	43096	88702	51.4	48.6
Jun 2019	76795	58724	135519	56.7	43.3

Jul 2019	39281	23158	62440	62.9	37.1
Aug 2019	35223	33847	69070	51	49
Sep 2019	48501	38842	87342	55.5	44.5
Oct 2019	49038	49561	98598	49.7	50.3
Nov 2019	36445	31407	67852	53.7	46.3
Dec 2019	30280	26361	56641	53.5	46.5
TOTAL	469454	400945	870399	-	-
AVERAGE	39121.1	33412.1	72533.2	53.9	46.1
