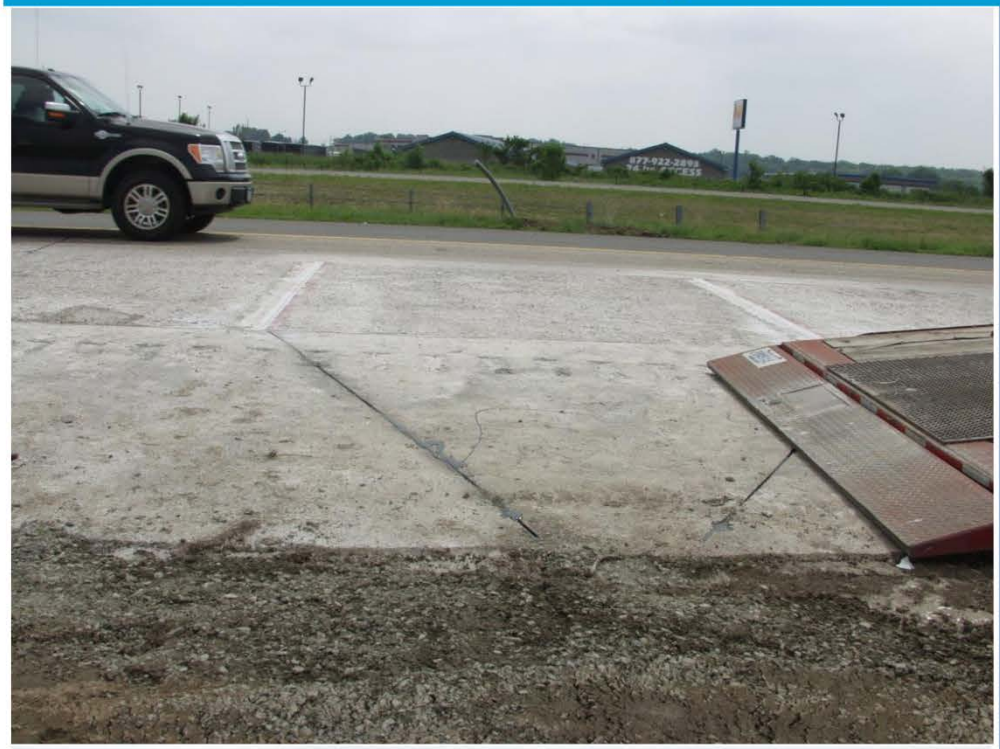
JANUARY 2018



WIM #37
I-94, MP 200.1
OTSEGO, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #37 is located on I-94 near Otsego in Wright county. The WIM is located only on the westbound (WB) side of I-94, meaning that all data mentioned in this report pertains to WB traffic only (Lanes 1 and 2).

System Operation

WIM #37 was operational for the entire month of January 2018. Volume was computed using all monthly data.

System Calibration

WIM #37 was most recently calibrated on 2017-03-23. 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 the Class 9s at this site for the last 12 months [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: 786355 | Passenger Vehicles: 696926 | Heavy Commercial Vehicles: 89429

Monthly Average Daily Traffic (MADT): 25366 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 2885

See Table 2 for vehicle class breakdown

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

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

Passenger Vehicles (PVs)

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

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling WB typically reached peak volume levels between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 15's.

Overweight HCVs

Volume trends. Of a total of 89429 HCVs, 4248 of them were overweight [3]. These overweight HCVs contributed to 0.6% of total monthly volume, and 4.9% of total monthly

HCV volume. WB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Sundays See Figure 3 .
The top two overweight violators by class were the class 9 and class 14 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours (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 May.
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 ,344 WB vehicles exceeded 88,000 pounds (122 vehicles were Class 13's; 106 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from January 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9's and 10's in January 2018. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling WB Data also suggests that there were more NA Class 10's than NA traveling in the WB direction.

Freight Totals. A total of 745526 tons of freight was recorded to have crossed the WIM. See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 86817 is approximately 1.2 miles east of WIM #37 and Bridge No. 86813 is approximately 4.7 miles west of WIM #37. WIM #37 recorded a total of 786355 vehicles with a combined GVW of 7036943 kips (1 kip = 1,000 pounds = 0.5 tons) in January 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 78221 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 59% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 43% 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

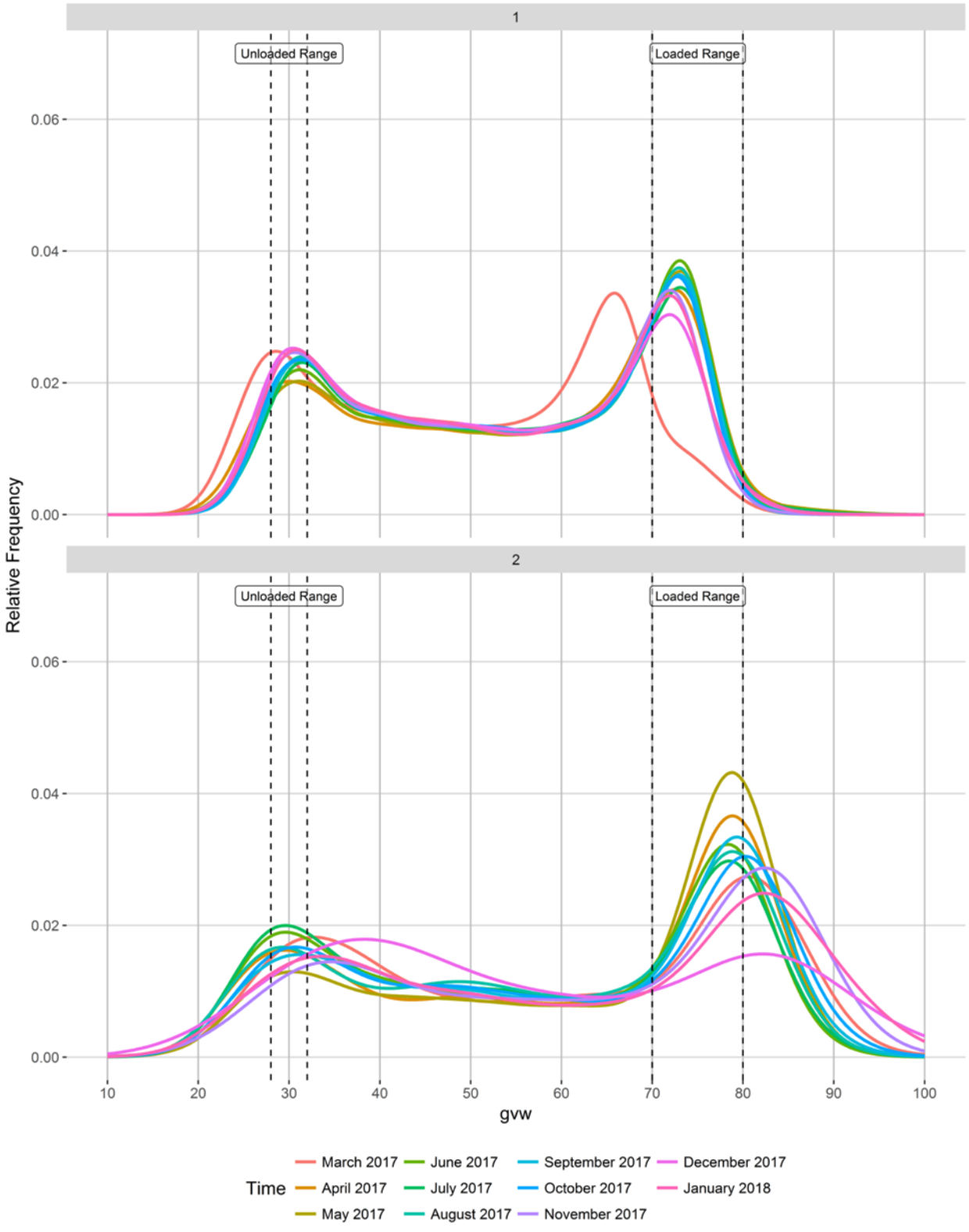
have each individual axle weight stay within a range of +/-9% of baseline calibration values

- [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

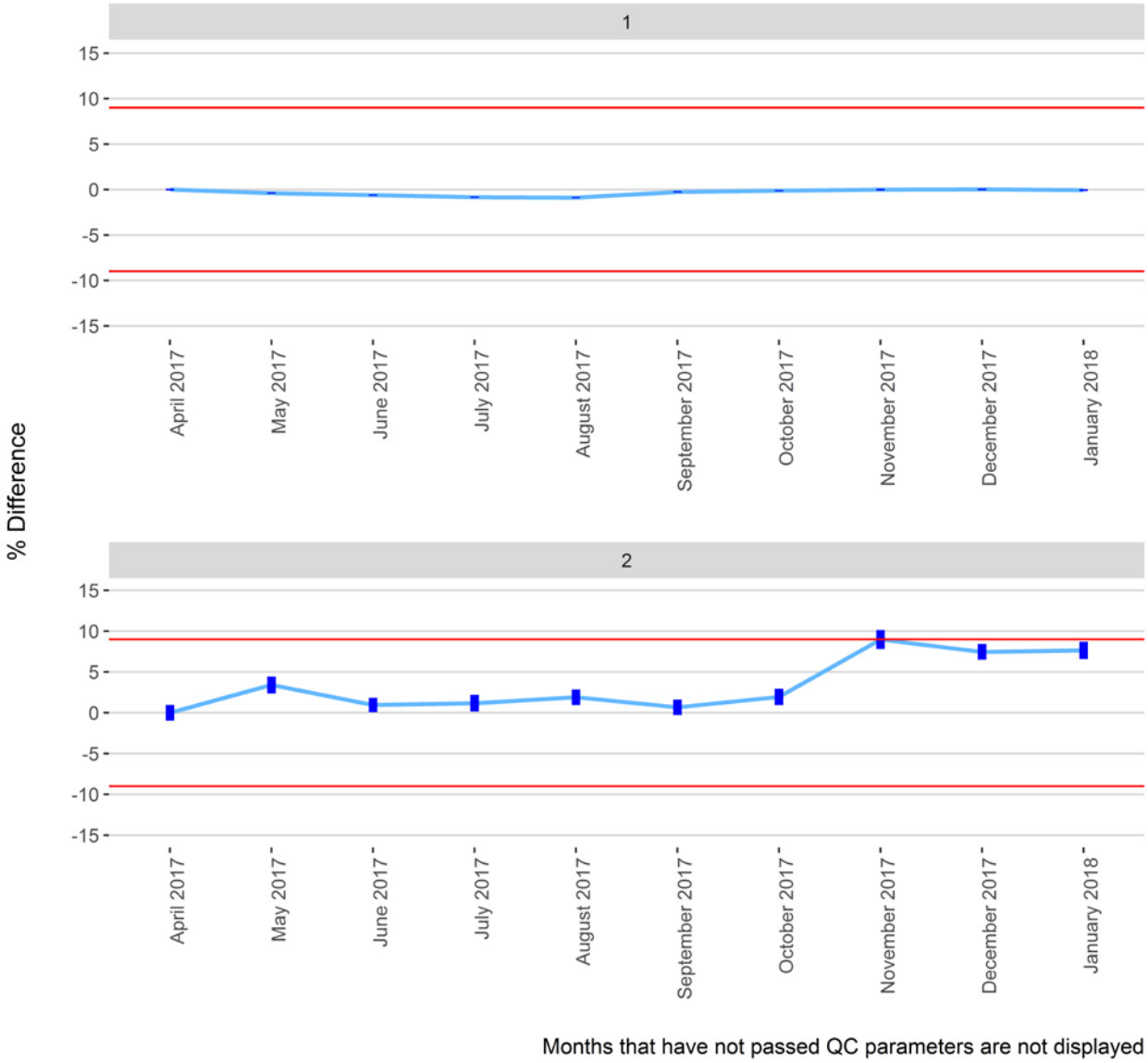
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

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

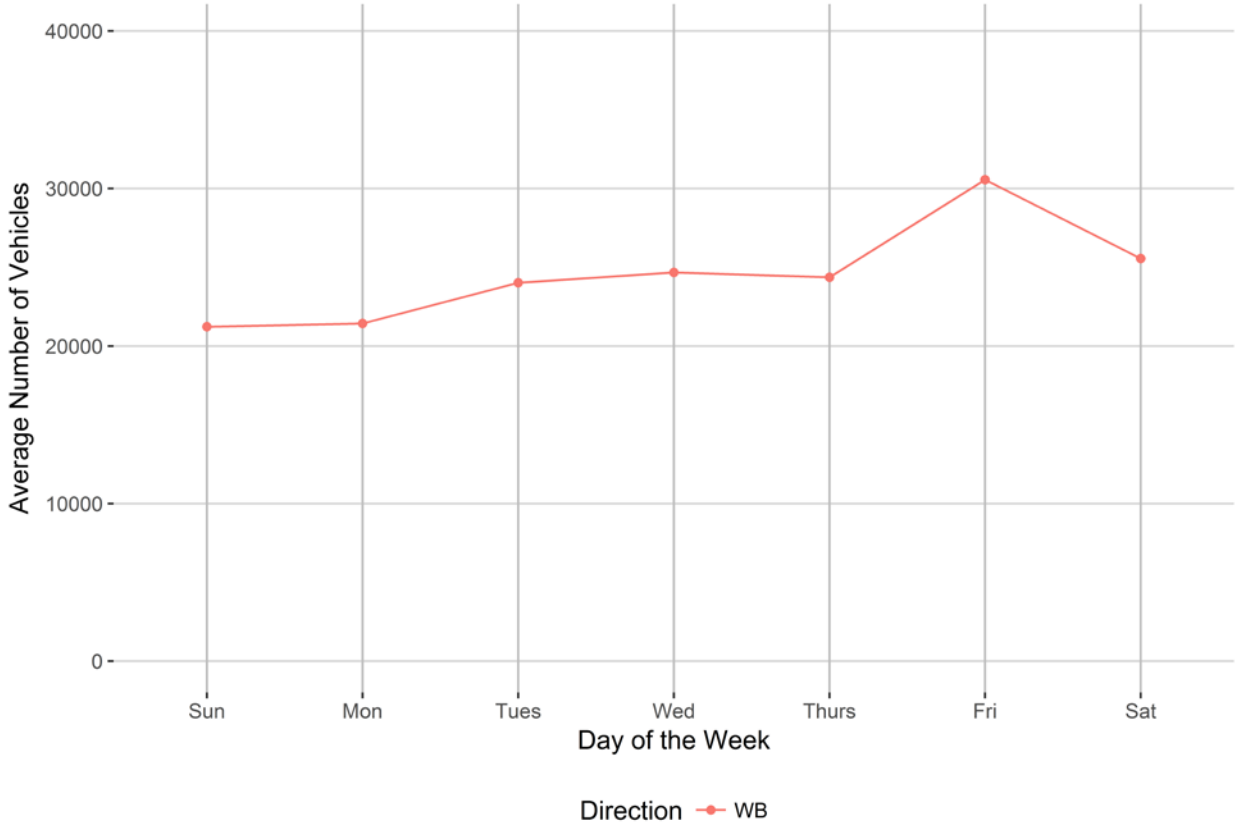


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

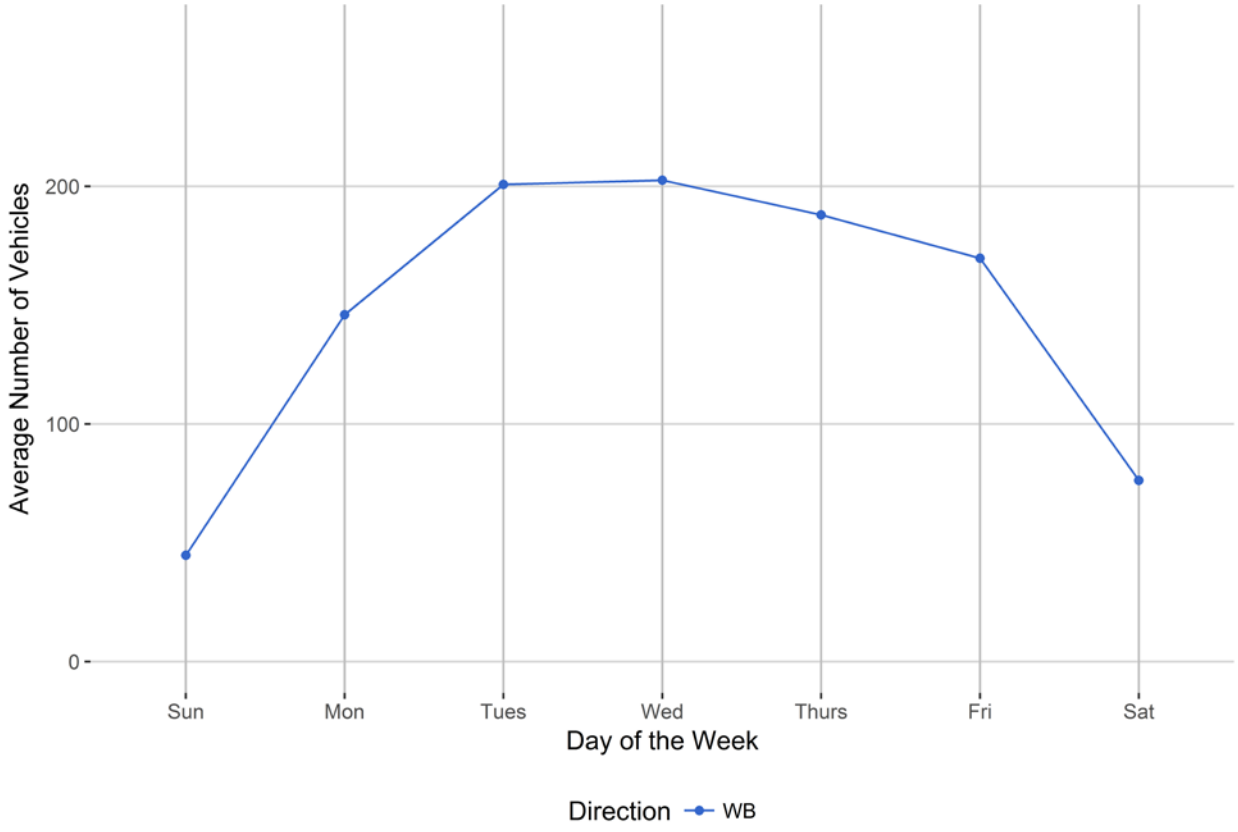


Figure 4 - Passenger Vehicles vs. Hour of the Day

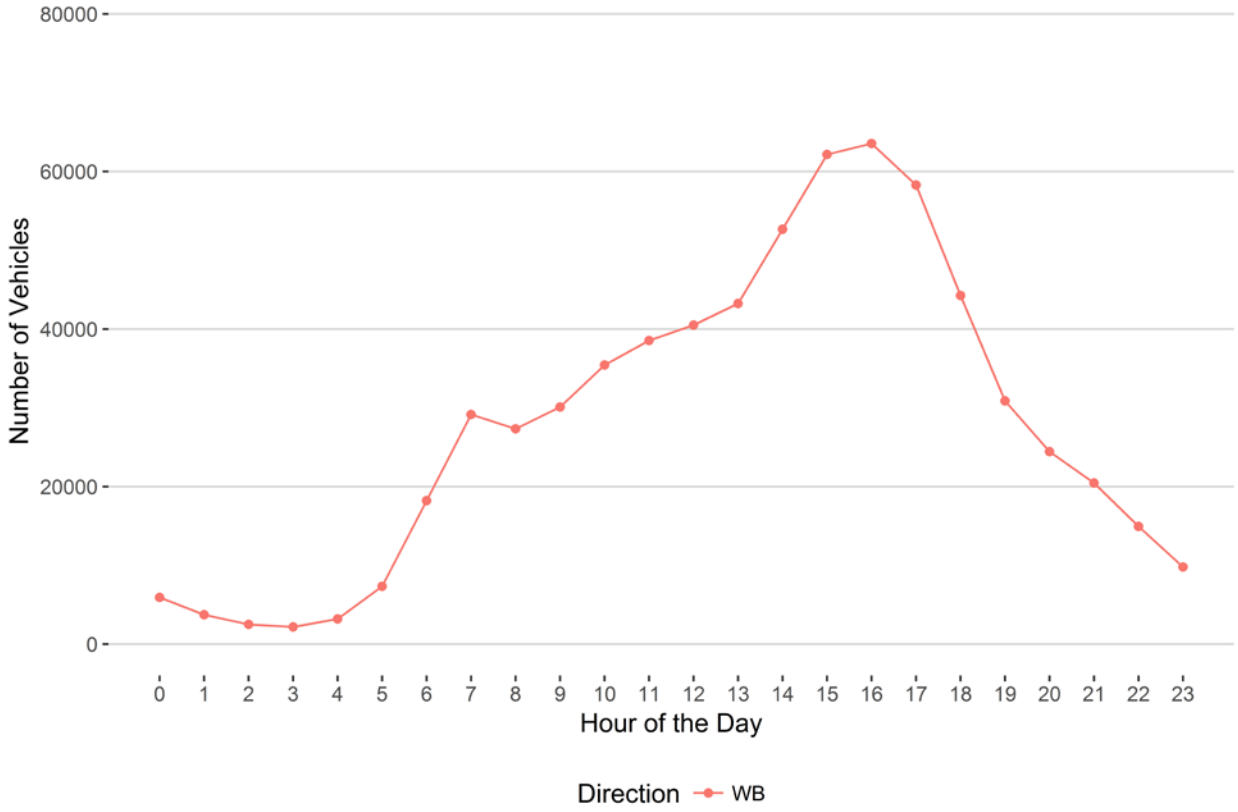


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

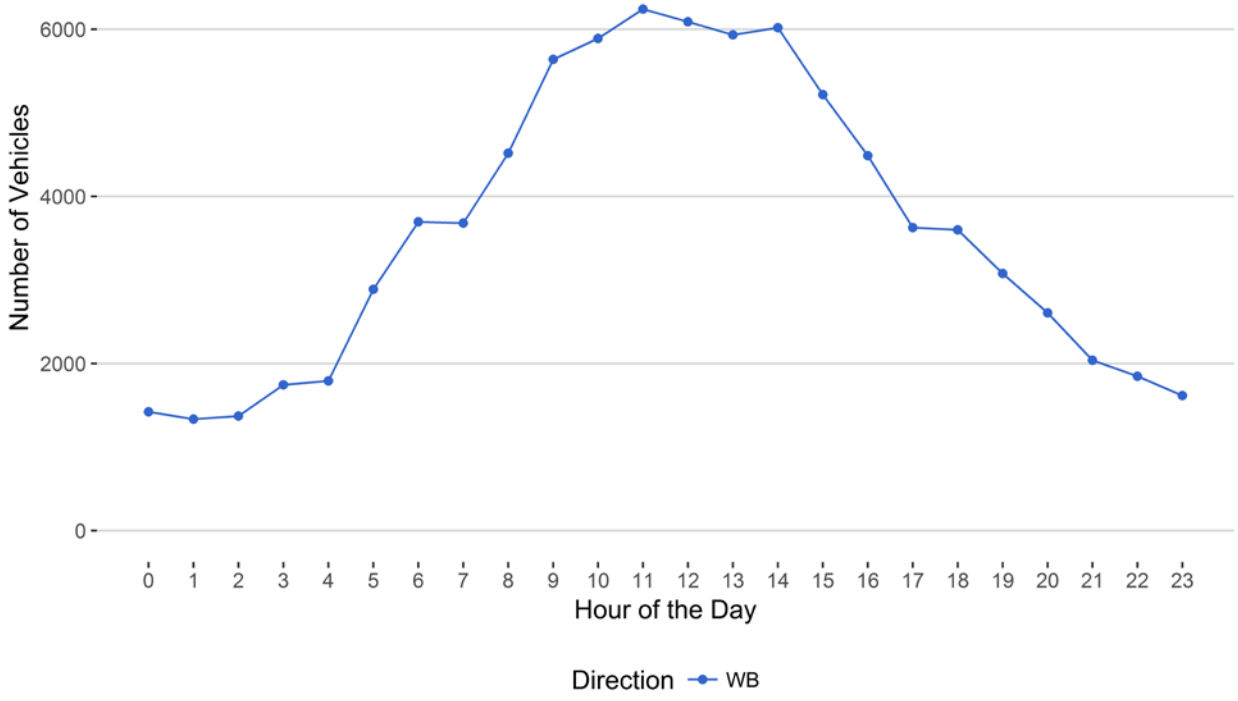


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

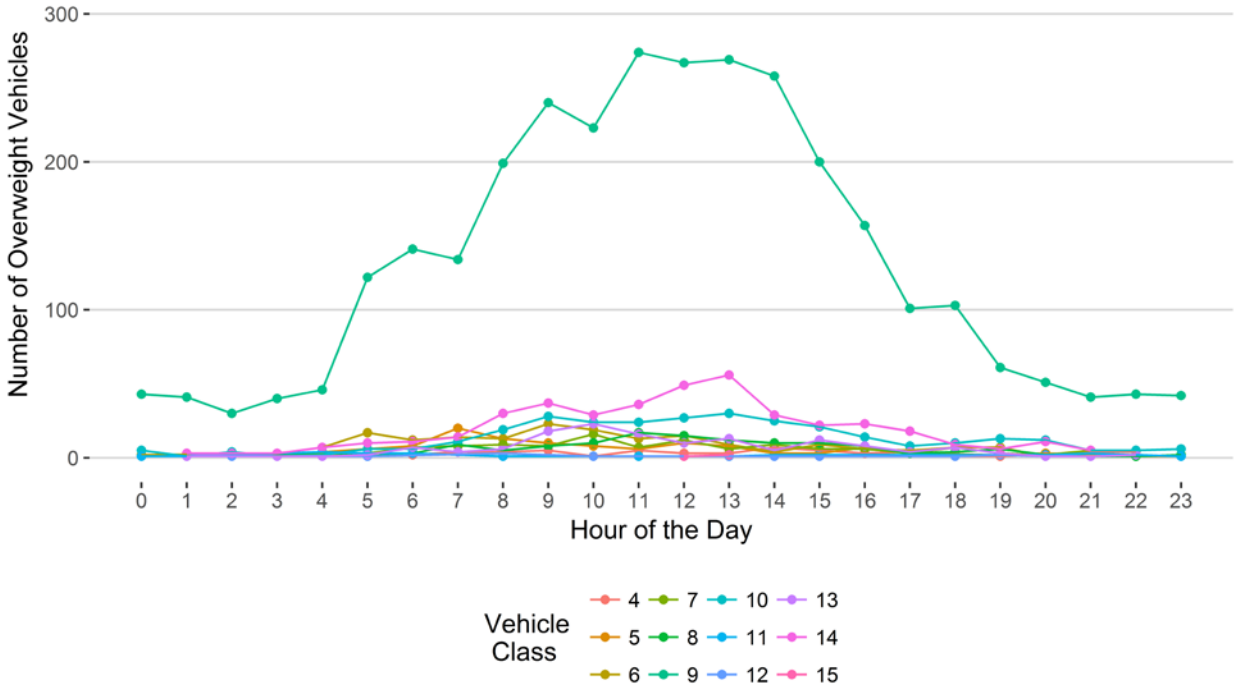


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

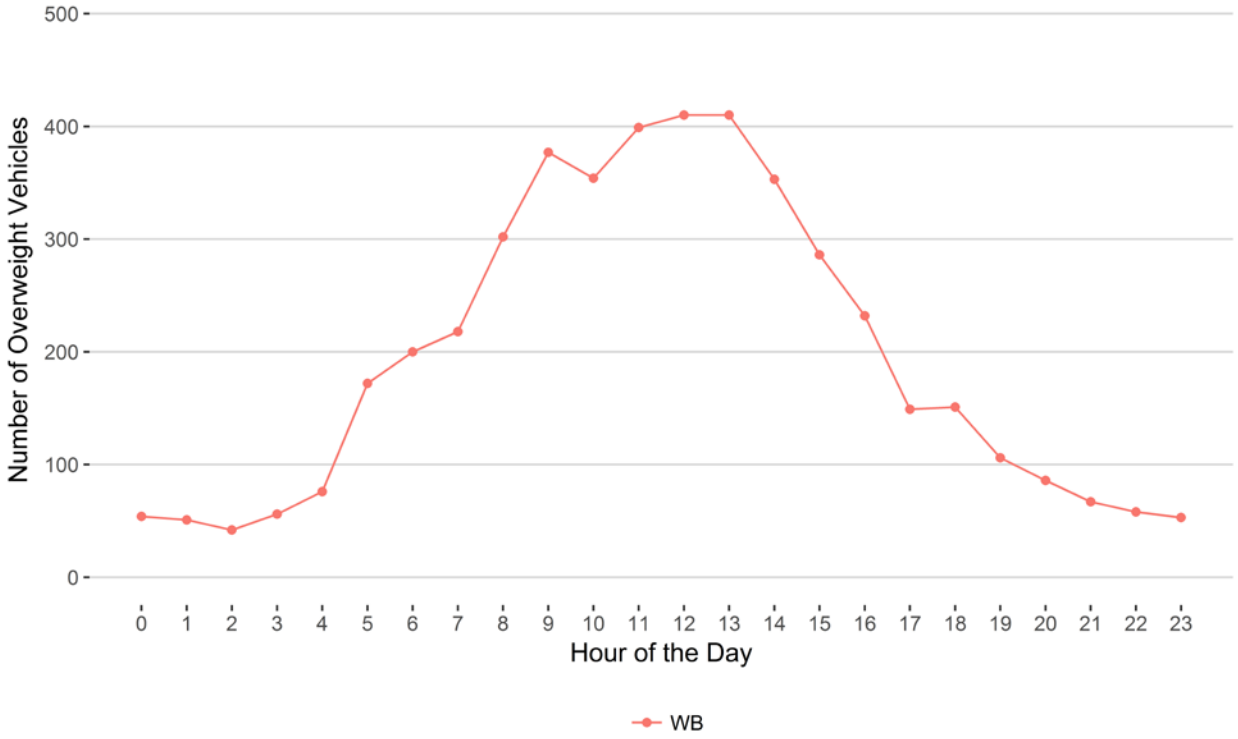
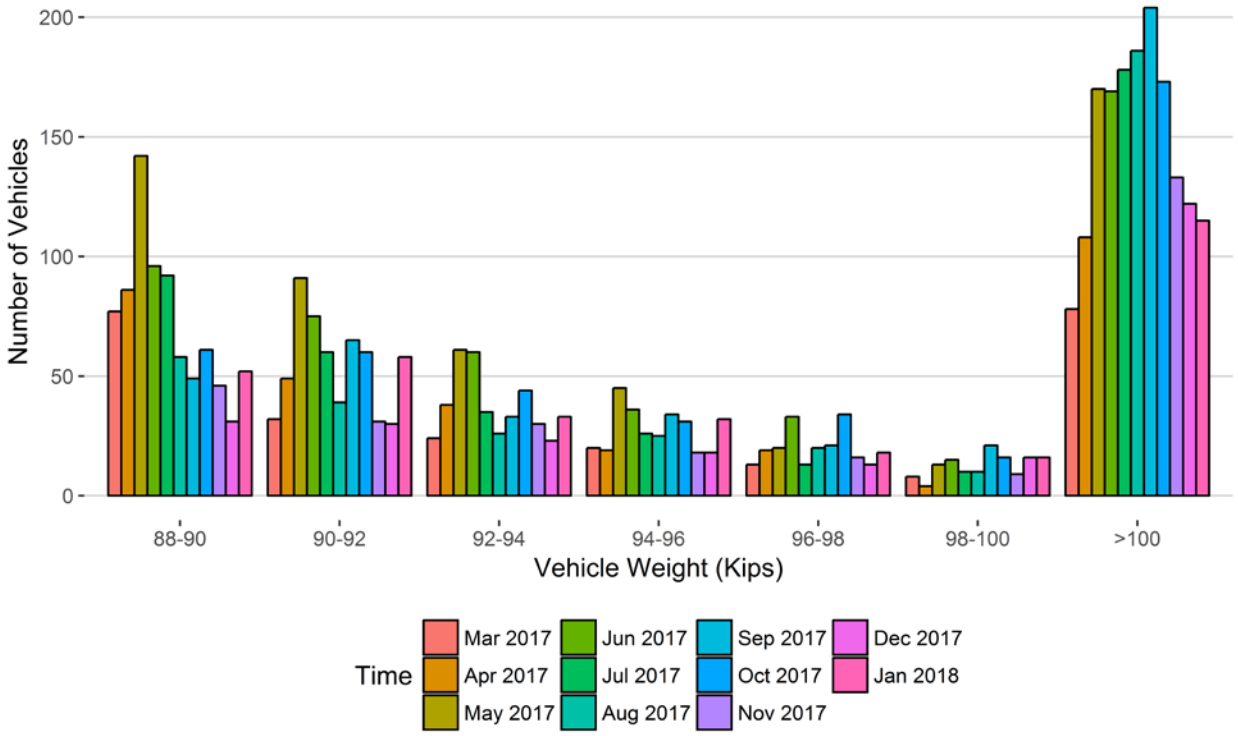


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Mar 2017*	*Apr 2017*	*May 2017*	*Jun 2017*	*Jul 2017*	*Aug 2017*	*Sep 2017*	*Oct 2017*	*Nov 2017*	*Dec 2017*	*Jan 2018*
88-90	77	86	142	96	92	58	49	61	46	31	52
90-92	32	49	91	75	60	39	65	60	31	30	58
92-94	24	38	61	60	35	26	33	44	30	23	33
94-96	20	19	45	36	26	25	34	31	18	18	32
96-98	13	19	20	33	13	20	21	34	16	13	18
98-100	8	4	13	15	10	10	21	16	9	16	16
>100	78	108	170	169	178	186	204	173	133	122	115
Total	252	323	542	484	414	364	427	419	283	253	324

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

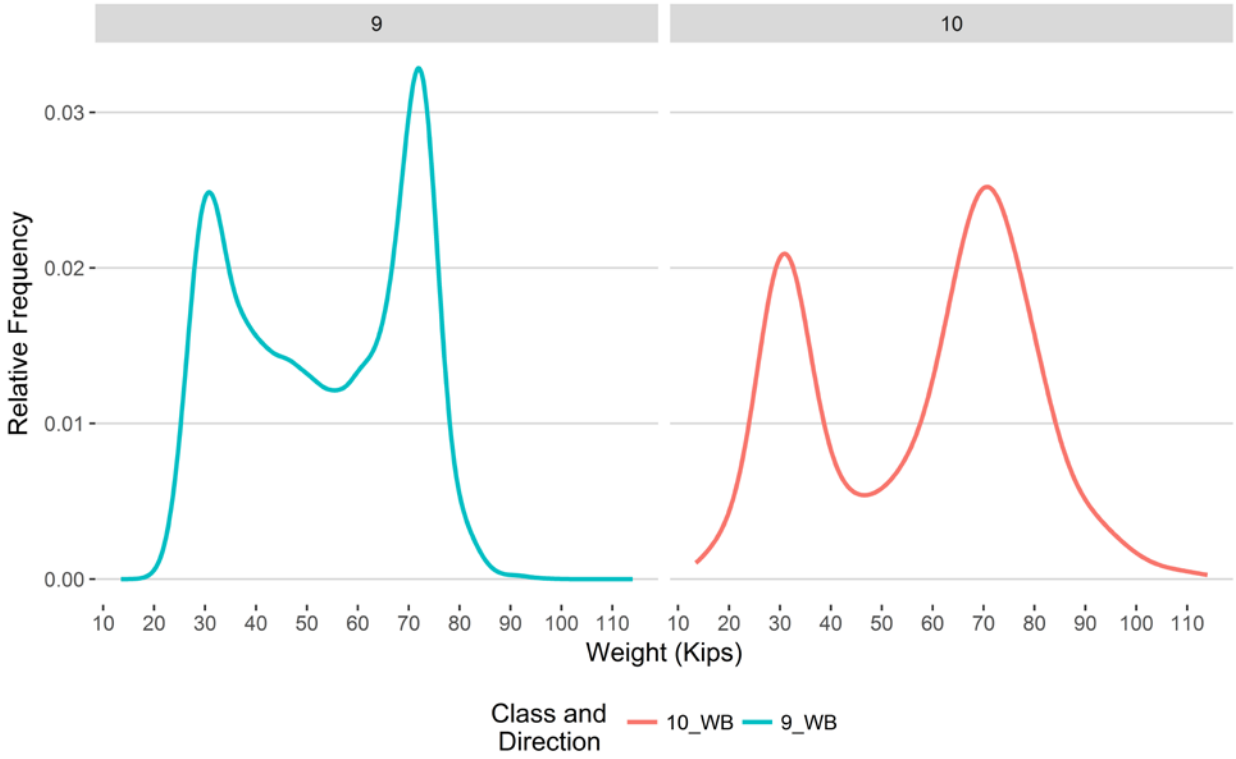


Figure 9 - Freight Percentage by Direction and Class

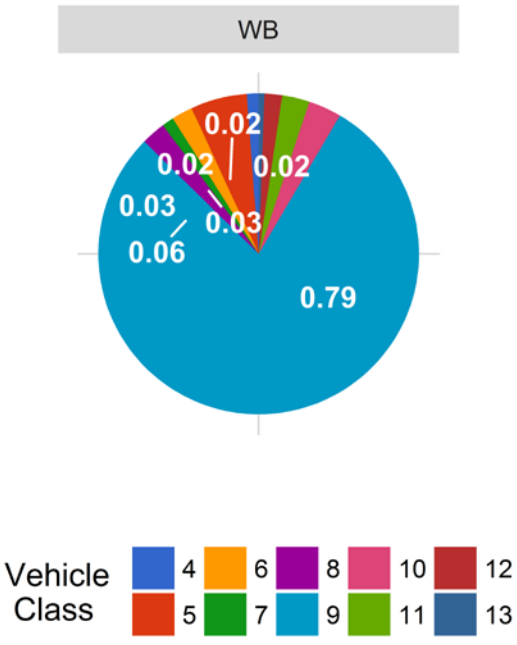


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

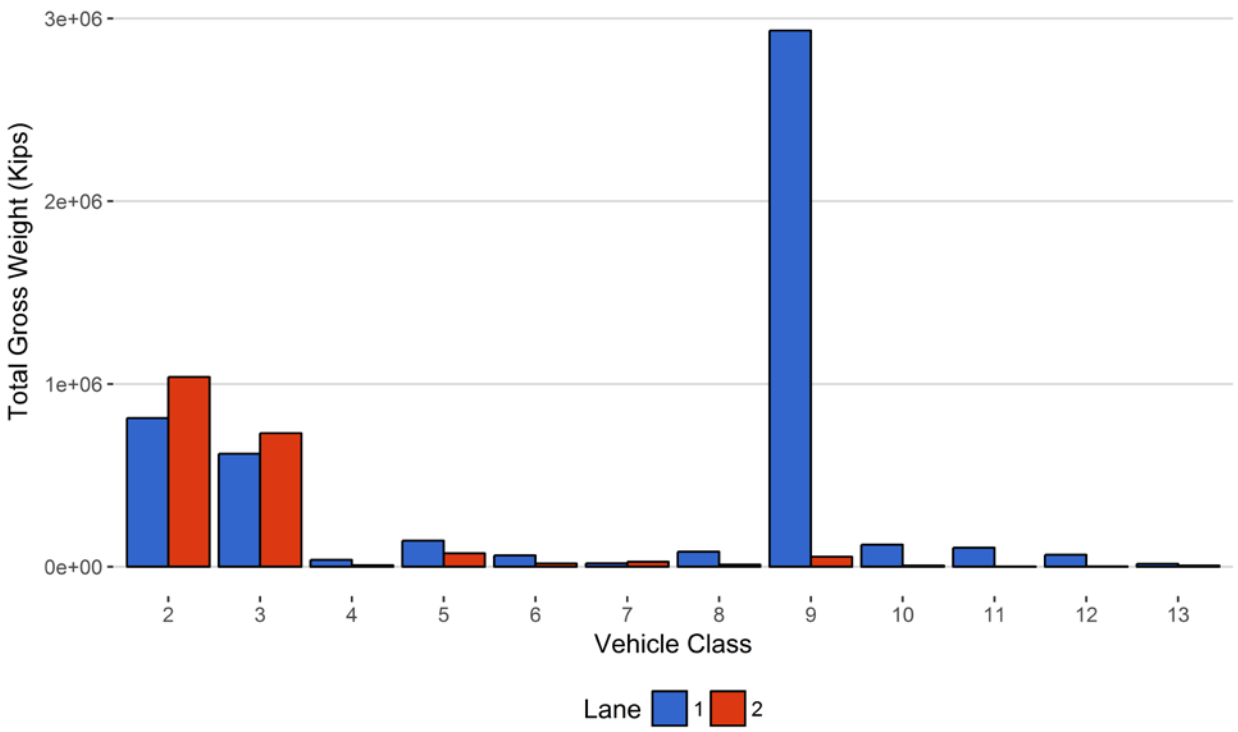


Figure 11 - Total Gross Vehicle Weight I

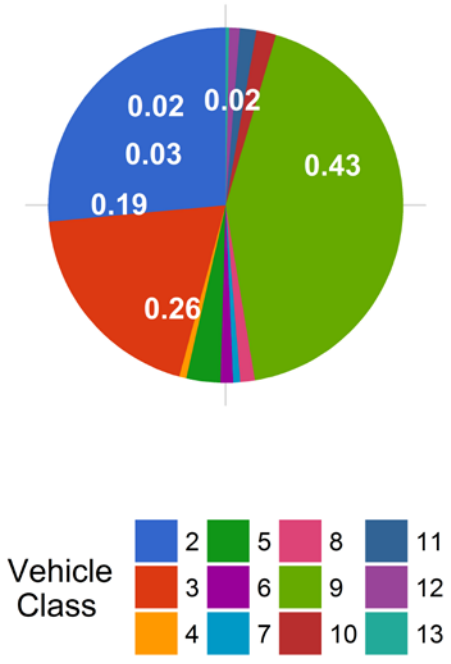


Figure 12 - Total ESALs by Class and Lane

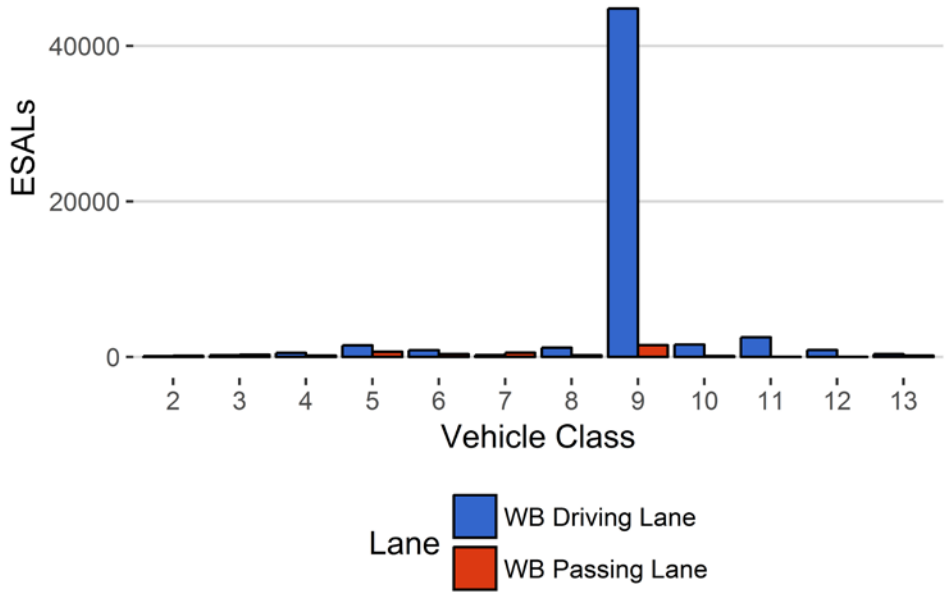


Figure 13 - ESALs by Class

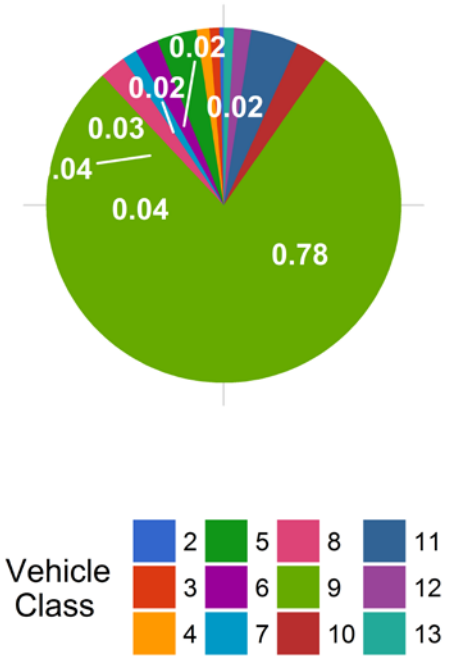


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
April 2017	10.54	0.00	11.79	0.00
May 2017	10.50	-0.39	12.19	3.41
June 2017	10.48	-0.62	11.90	0.95
July 2017	10.45	-0.84	11.92	1.16
August 2017	10.45	-0.89	12.01	1.90
September 2017	10.52	-0.26	11.86	0.67
October 2017	10.53	-0.12	12.02	1.94
November 2017	10.54	0.00	12.84	8.98
December 2017	10.55	0.02	12.67	7.46
January 2018	10.54	-0.06	12.69	7.65

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
2	15453	479042	60.9	0	0
3	7029	217884	27.7	0	0
4	58	1807	0.2	52	1.2
5	530	16442	2.1	123	2.9
6	91	2806	0.4	191	4.5
7	43	1333	0.2	118	2.8
8	106	3295	0.4	136	3.2
9	1883	58366	7.4	3126	73.6
10	73	2259	0.3	307	7.2
11	57	1768	0.2	32	0.8
12	35	1098	0.1	18	0.4
13	8	255	0	145	3.4
TOTAL	**25366**	**786355**	**100**	**4248**	**100**

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

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2018-01-12	Friday	12:03:47	9	WB	2	164.89
2018-01-24	Wednesday	06:39:35	10	WB	2	161.86
2018-01-14	Sunday	15:32:55	9	WB	2	153.36
2018-01-23	Tuesday	07:59:25	9	WB	2	153.32
2018-01-23	Tuesday	11:50:22	9	WB	2	150.63
2018-01-05	Friday	11:45:47	10	WB	2	148.47
2018-01-31	Wednesday	11:11:23	9	WB	2	146.34
2018-01-31	Wednesday	10:00:05	9	WB	2	143.91
2018-01-23	Tuesday	09:01:55	9	WB	2	143.13
2018-01-11	Thursday	10:19:55	9	WB	2	137.33

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	WB	15	1745	299	17.1	41101	3911	9705
5	WB	8	15882	1624	10.2	204311	11719	45124
6	WB	19	2710	422	15.6	72785	7364	14657
7	WB	11.5	1288	16	1.2	45118	171	15245
8	WB	31	3183	1835	57.7	52691	39983	5452
9	WB	33	56377	10441	18.5	2685316	304085	584714
10	WB	33.5	2182	520	23.8	111354	14875	27839
11	WB	36.5	1708	18	1.1	104625	580	21470
12	WB	36.5	1061	2	0.2	67000	46	14173
13	WB	31.5	246	5	2	21886	130	7147
TOTAL	****	****	**86382**	**15182**	****	**3406188**	****	**745526**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*WB Driving Lane*	*WB Passing Lane*	*Total*	*Percentage*
2	813767	1037986	1851754	26.5
3	618095	730386	1348482	19.3
4	37743	7269	45012	0.6
5	142702	73328	216030	3.1
6	62506	17643	80149	1.1
7	18461	26828	45289	0.6
8	81814	10861	92675	1.3
9	2934732	54670	2989402	42.8
10	120530	5699	126229	1.8
11	104208	997	105205	1.5
12	65917	1128	67046	1
13	16371	5646	22017	0.3
TOTAL	**5016848**	**1972440**	**6989288**	**100**
GVW/LANE	**71.78**	**28.22**	**100**	**0**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*WB Driving Lane*	*WB Passing Lane*	*Total*	*Percentage*	*Flexible ESAL Factor*
2	93	143	236	0.4	0.001
3	232	297	529	0.9	0.005
4	515	168	683	1.2	0.78
5	1482	678	2160	3.6	0.27
6	868	386	1254	2.1	0.93
7	253	542	795	1.3	1.23
8	1206	221	1427	2.4	0.9
9	44778	1515	46293	78.3	1.64
10	1595	128	1723	2.9	1.58
11	2524	24	2549	4.3	2.97
12	909	19	929	1.6	1.74
13	375	174	549	0.9	4.29
TOTAL	**54830**	**4296**	**59126**	**100**	**16**
ESALS/LANE	**92.7**	**7.3**	**100**	**--**	**--**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*
Mar 2017	851374	27464	3226	751357	88.3	100017.1	11.7
Apr 2017	914072	30469	3503	808983	88.5	105088.6	11.5
May 2017	980832	31640	3814	862596	87.9	118235.9	12.1
Jun 2017	1035311	34510	4042	914057	88.3	121254	11.7
Jul 2017	1042528	33630	3684	928333	89	114195.2	11
Aug 2017	1085741	35024	3979	962396	88.6	123345.5	11.4
Sep 2017	971749	32392	3802	857703	88.3	114045.8	11.7
Oct 2017	964314	31107	3898	843483	87.5	120831.4	12.5
Nov 2017	870827	29028	2971	781684	89.8	89143	10.2
Dec 2017	861735	27798	2856	773186	89.7	88548.6	10.3
Jan 2018	786355	25366	2885	696926	88.6	89429.4	11.4
TOTAL	**10364838**	**--**	**--**	**9180704**	**--**	**1184135**	**--**
AVERAGE	**942258**	**30766**	**3515**	**834609**	**89**	**107649**	**11**

ESALs

Month	*ESALS WB Driving Lane*	*ESALS WB Passing Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Mar 2017	49274	23275	72549	0.7
Apr 2017	68500	9043	77543	1.4
May 2017	79233	11675	90908	2.4
Jun 2017	78317	11346	89663	2.1
Jul 2017	72545	11473	84018	1.6
Aug 2017	78120	17210	95329	1.2
Sep 2017	71448	17904	89353	1.1
Oct 2017	74092	13806	87898	1
Nov 2017	52468	12005	64473	1.7
Dec 2017	56619	5356	61975	1.9
Jan 2018	68067	10039	78106	1.2
TOTAL	**748683**	**--**	**--**	**--**
AVERAGE	**68062**	**13012**	**81074**	**2**

Gross Vehicle Weight

Month	*GVW WB Driving Lane*	*GVW WB Passing Lane*	*Total GVW Kips*
Mar 2017	5022577	2017371	7039948
Apr 2017	5235330	2442326	7677655
May 2017	5828012	2490336	8318348
Jun 2017	6519459	2682815	9202274
Jul 2017	6656768	2984914	9641682
Aug 2017	6419065	2950979	9370045
Sep 2017	6869439	3007734	9877174
Oct 2017	6264517	2813582	9078098
Nov 2017	6472379	2845191	9317570
Dec 2017	5031471	2309308	7340779
Jan 2018	5296388	2102076	7398464
TOTAL	**65615405**	**28646633**	**94262038**
AVERAGE	**5965037**	**2604239**	**8569276**

Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
Mar 2017	3694	0.4	3.5	264	92
Apr 2017	6274	0.7	5.9	329	113
May 2017	7310	0.8	6.2	553	188
Jun 2017	6542	0.7	5.3	491	186
Jul 2017	6484	0.6	5.6	420	190
Aug 2017	6125	0.6	4.9	366	198
Sep 2017	6376	0.7	5.5	435	229
Oct 2017	6672	0.7	5.4	423	189
Nov 2017	4048	0.5	4.6	286	142
Dec 2017	3927	0.5	4.5	254	139
Jan 2018	4659	0.6	5.3	344	141
TOTAL	**62111**	**--**	**--**	**4165**	**1807**
AVERAGE	**5646.5**	**0.6**	**5.2**	**378.6**	**164.3**

Freight

Month	*WB Freight Tons*
Mar 2017	779000
Apr 2017	939132
May 2017	1081072
Jun 2017	1087451
Jul 2017	1008664
Aug 2017	1076902
Sep 2017	1013502
Oct 2017	1063947
Nov 2017	728121
Dec 2017	735210
Jan 2018	745526
TOTAL	**10258528**
AVERAGE	**932593.4**