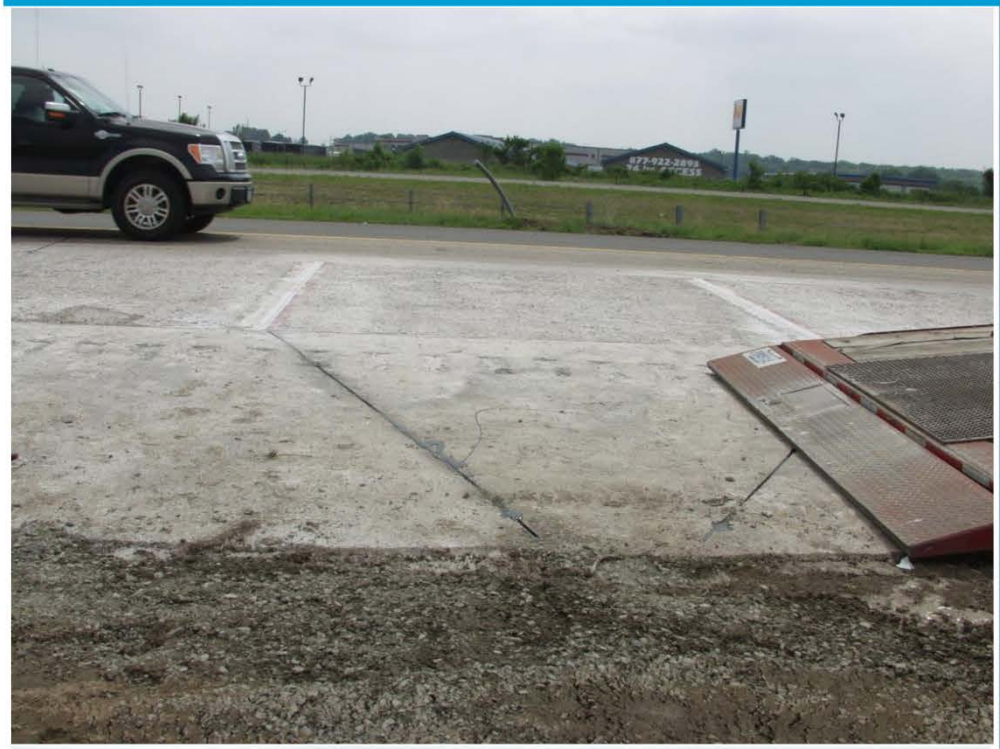
JUNE 2019



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 June 2019. 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]. 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: 1087979 | Passenger Vehicles: 951857 | Heavy Commercial Vehicles: 136122

Monthly Average Daily Traffic (MADT): 36266 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 4537

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 Tuesdays (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 14's.

Overweight HCVs

Volume trends. Of a total of 136122 HCVs, 8227 of them were overweight [3]. These overweight HCVs contributed to 0.8% of total monthly volume, and 6.4% 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 4 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 ,1437 WB vehicles exceeded 88,000 pounds (490 vehicles were Class 9's; 309 vehicles were Class 14's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from June 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9's and 10's in June 2019. 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 1069888 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 1087979 vehicles with a combined GVW of 10135201 kips (1 kip = 1,000 pounds = 0.5 tons) in June 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 95497 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 67% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 41% 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

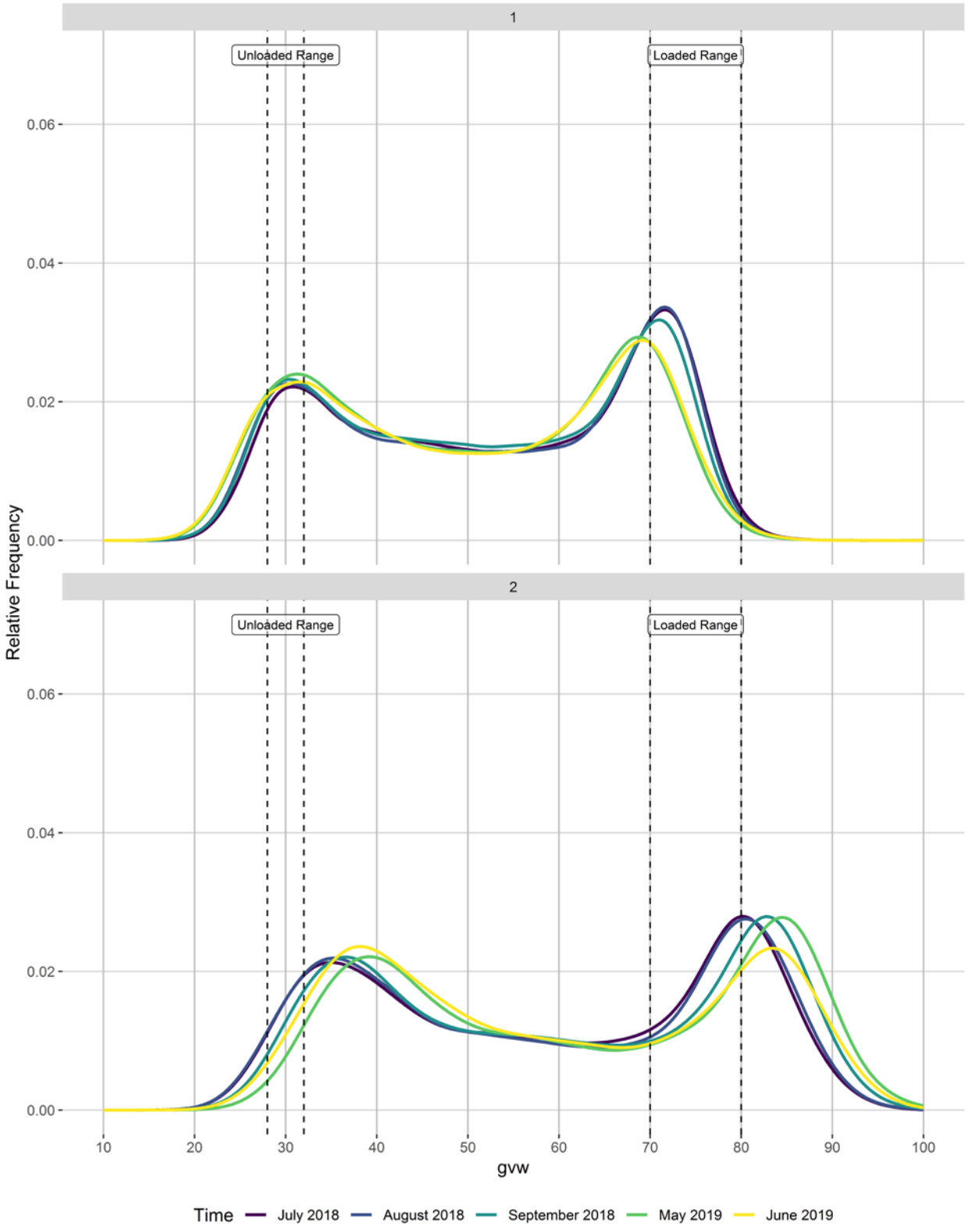
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of +/-9% of baseline calibration values

- [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

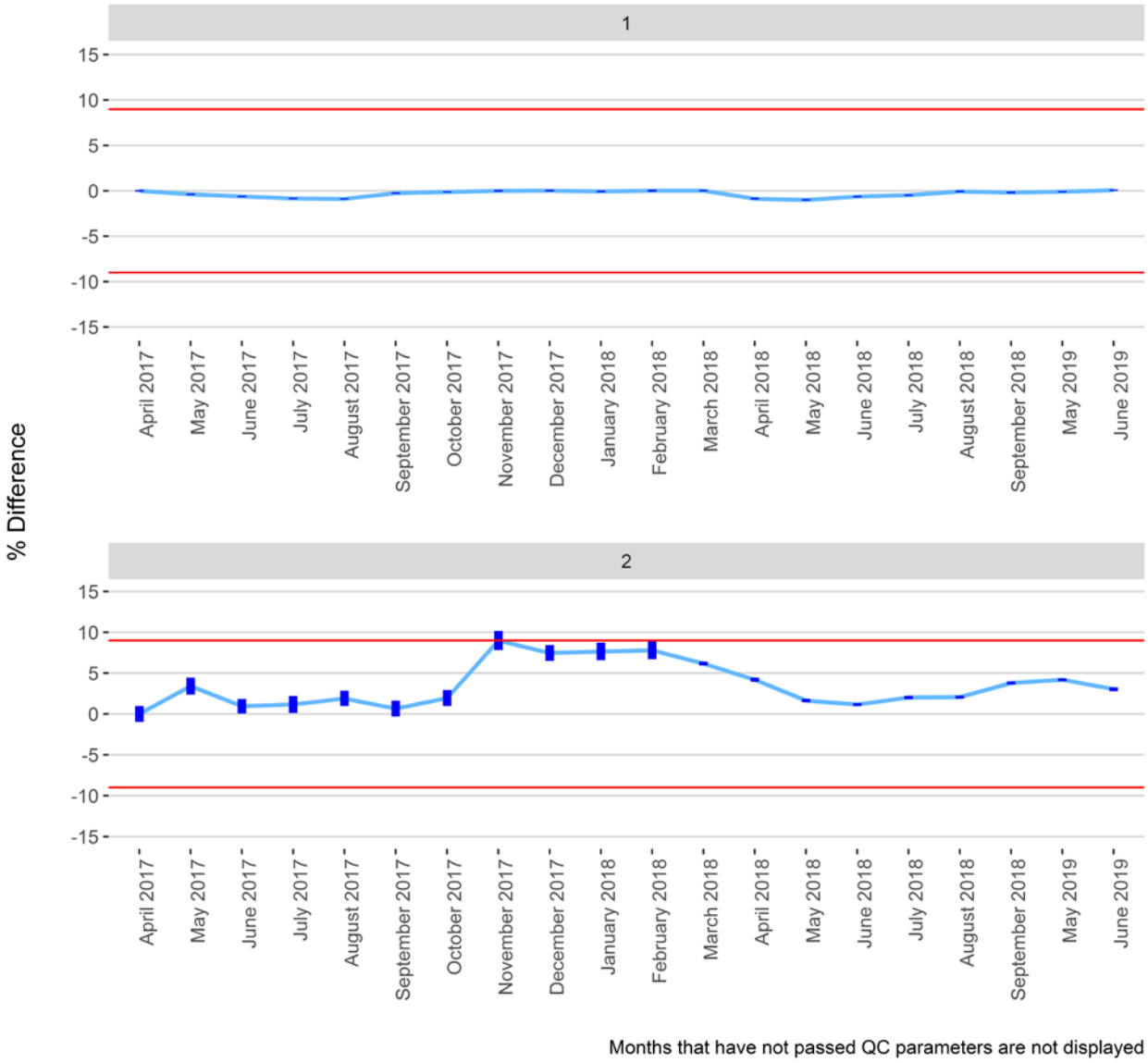
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened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

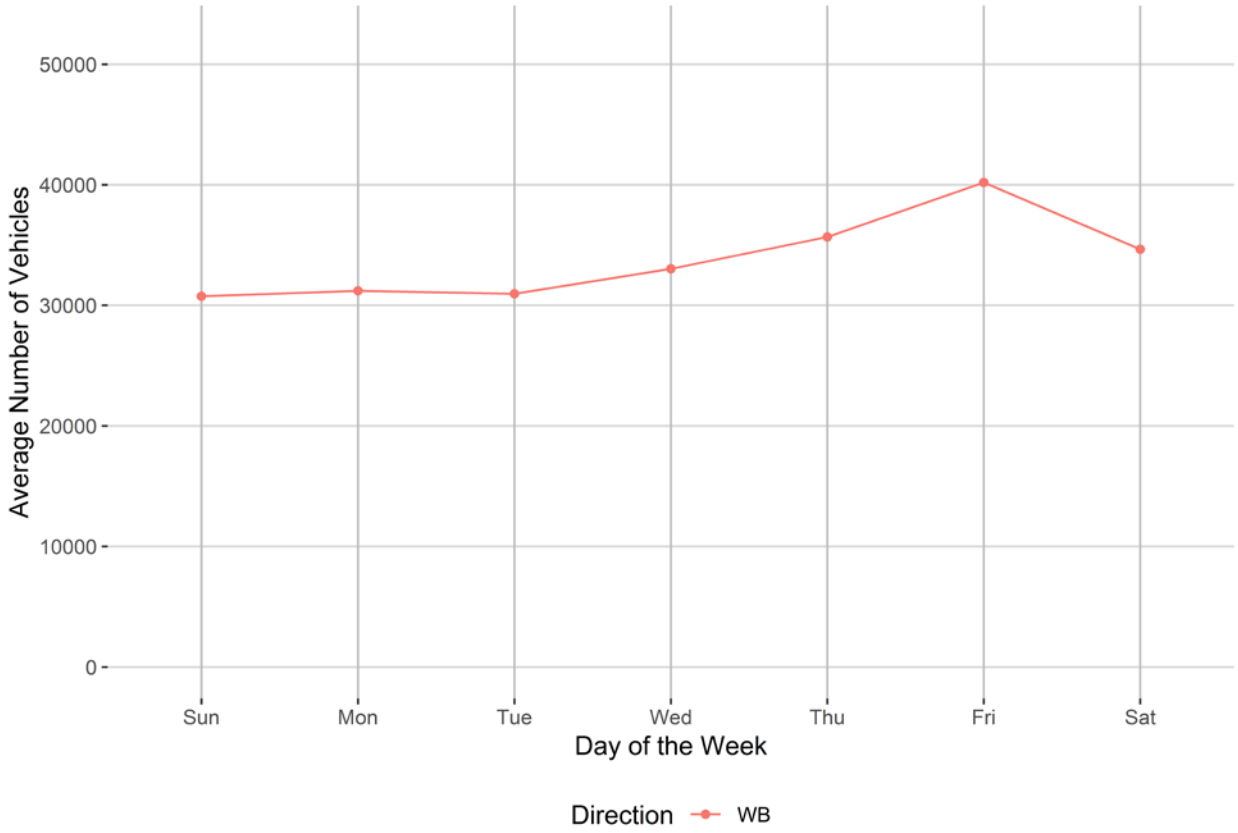


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

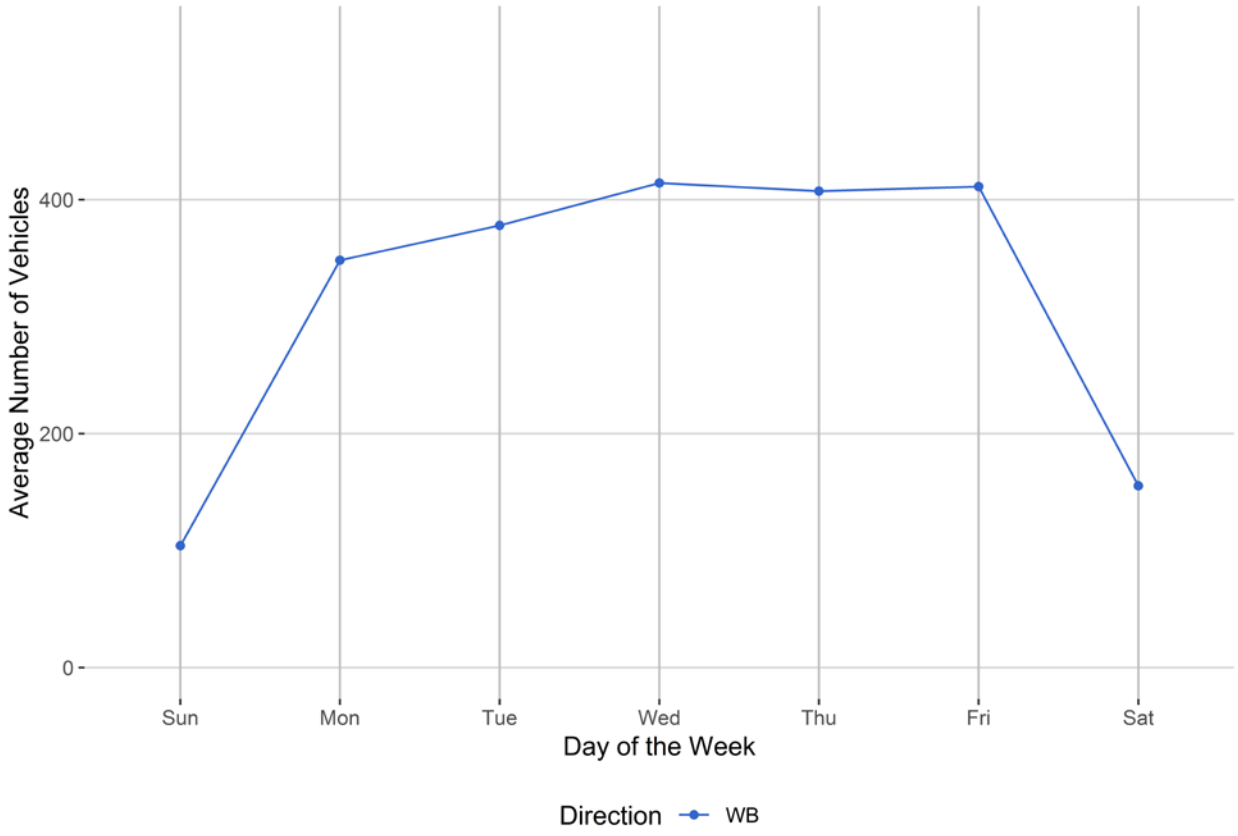


Figure 4 - Passenger Vehicles vs. Hour of the Day

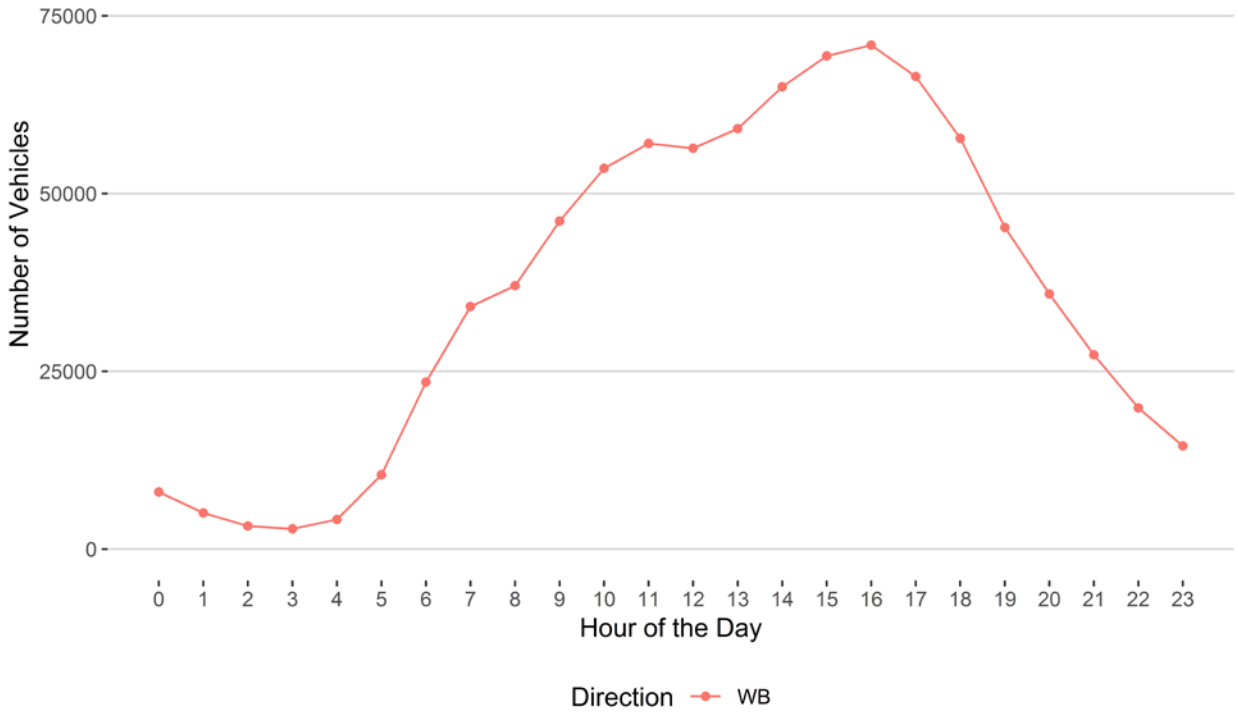


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

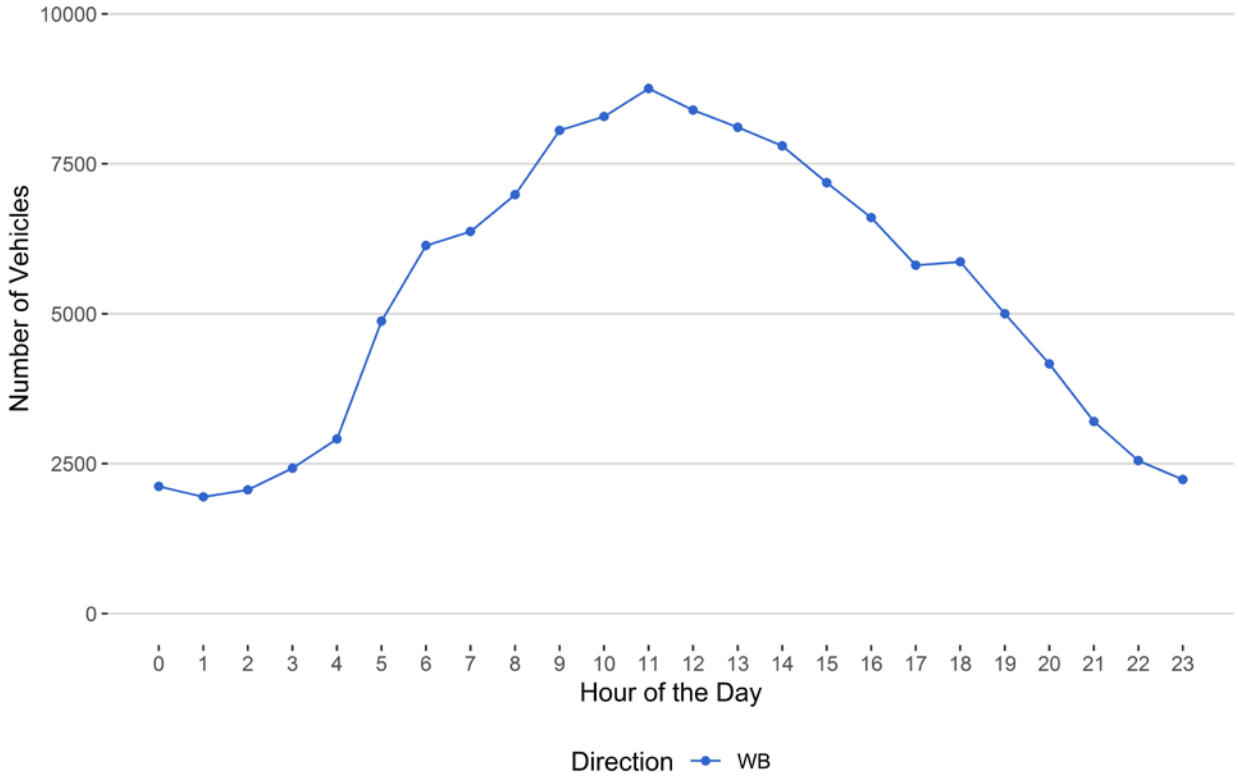


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

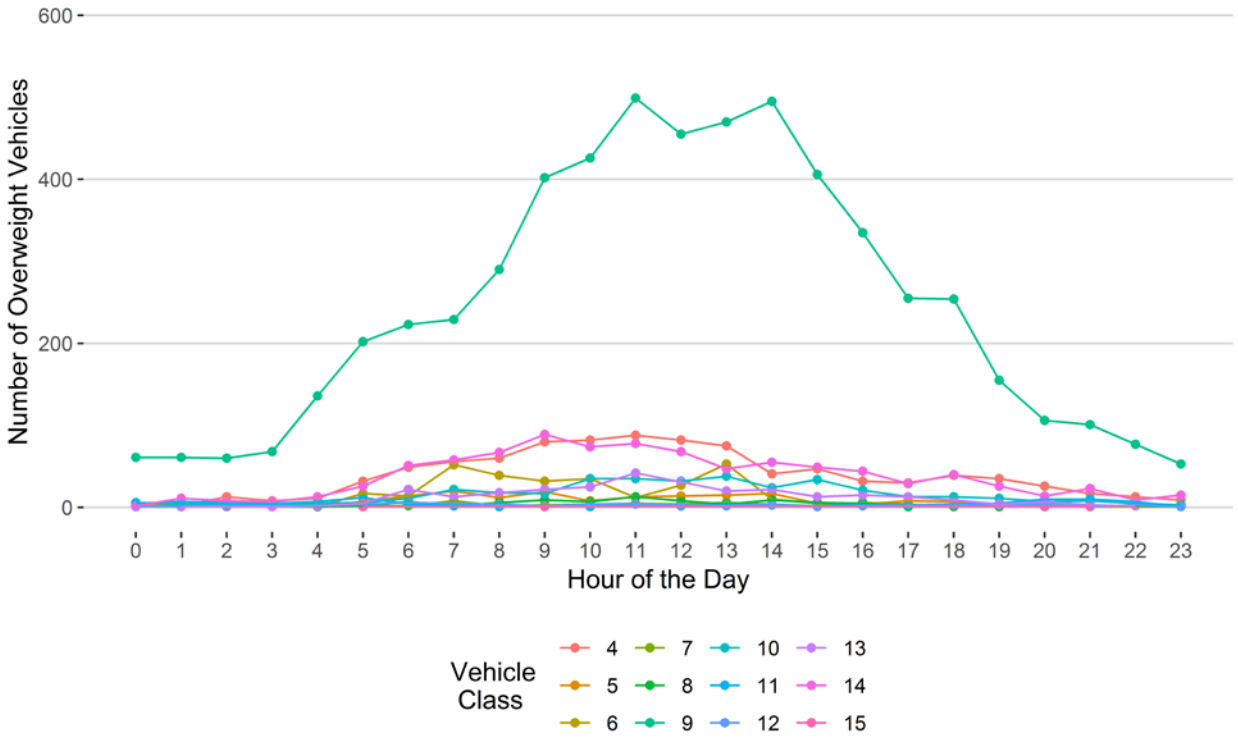


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

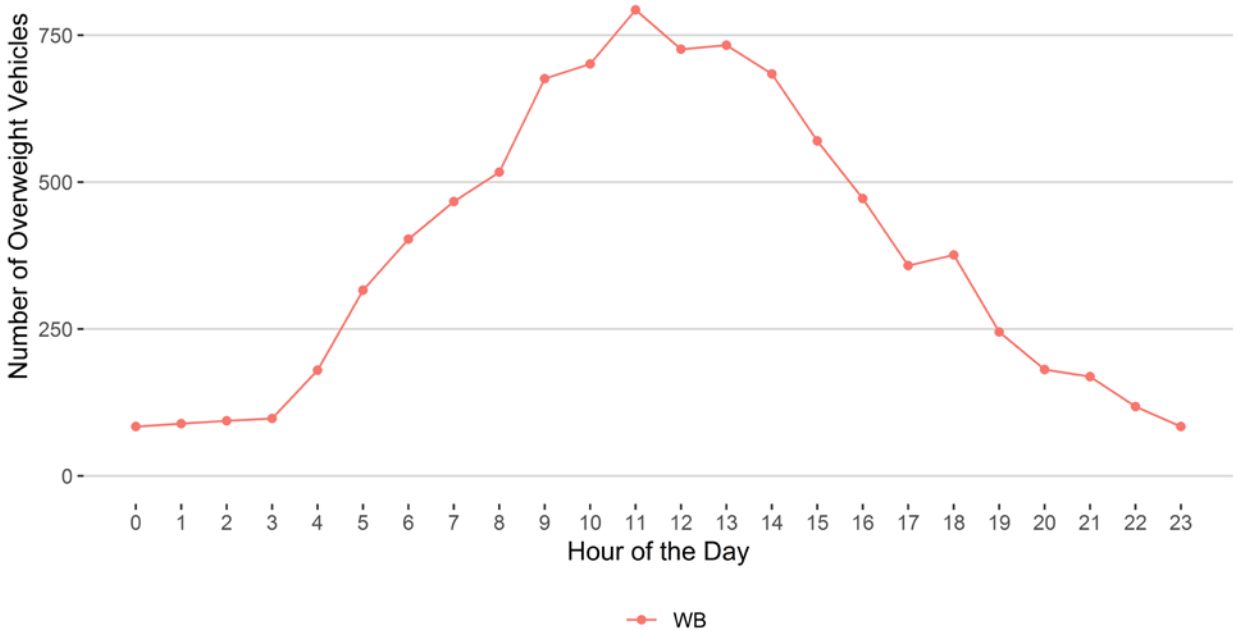
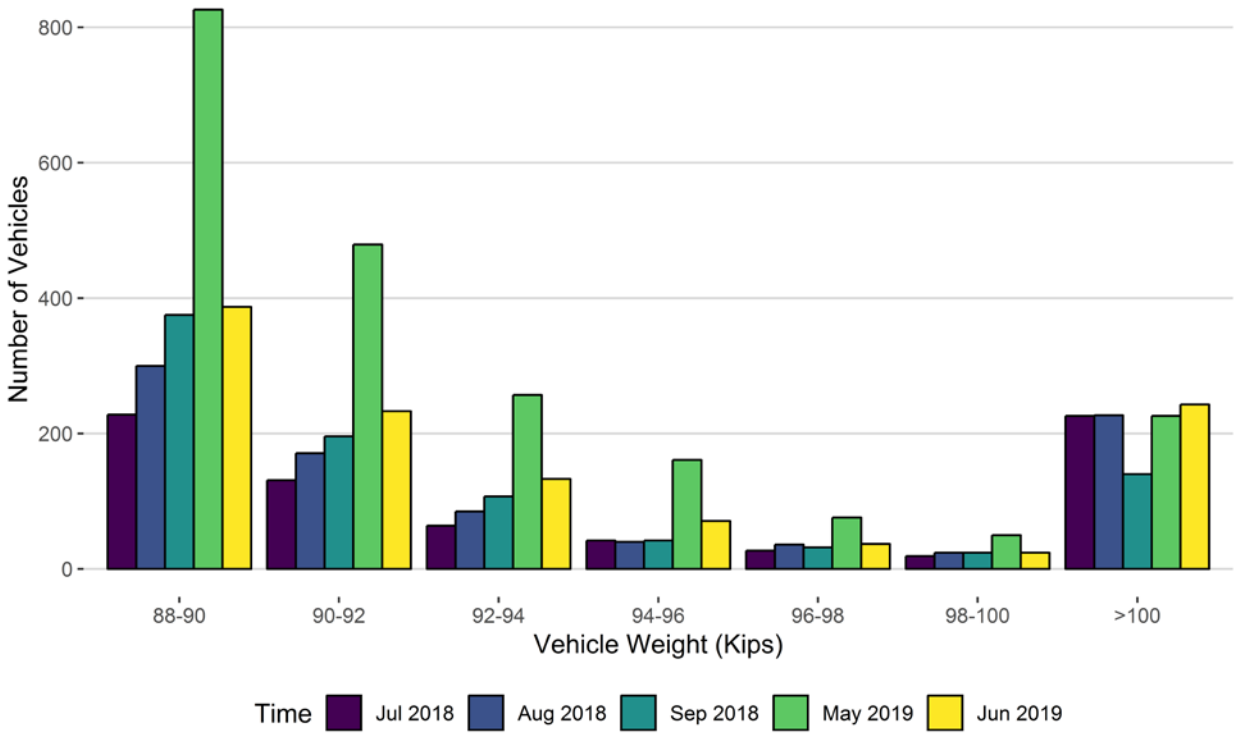


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Jul 2018*	*Aug 2018*	*Sep 2018*	*May 2019*	*Jun 2019*
88-90	228	300	375	826	387
90-92	131	171	196	479	233
92-94	64	85	107	257	133
94-96	42	40	42	161	71
96-98	27	36	32	76	37
98-100	19	24	24	50	24
>100	226	227	140	226	243
Total	737	883	916	2075	1128

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

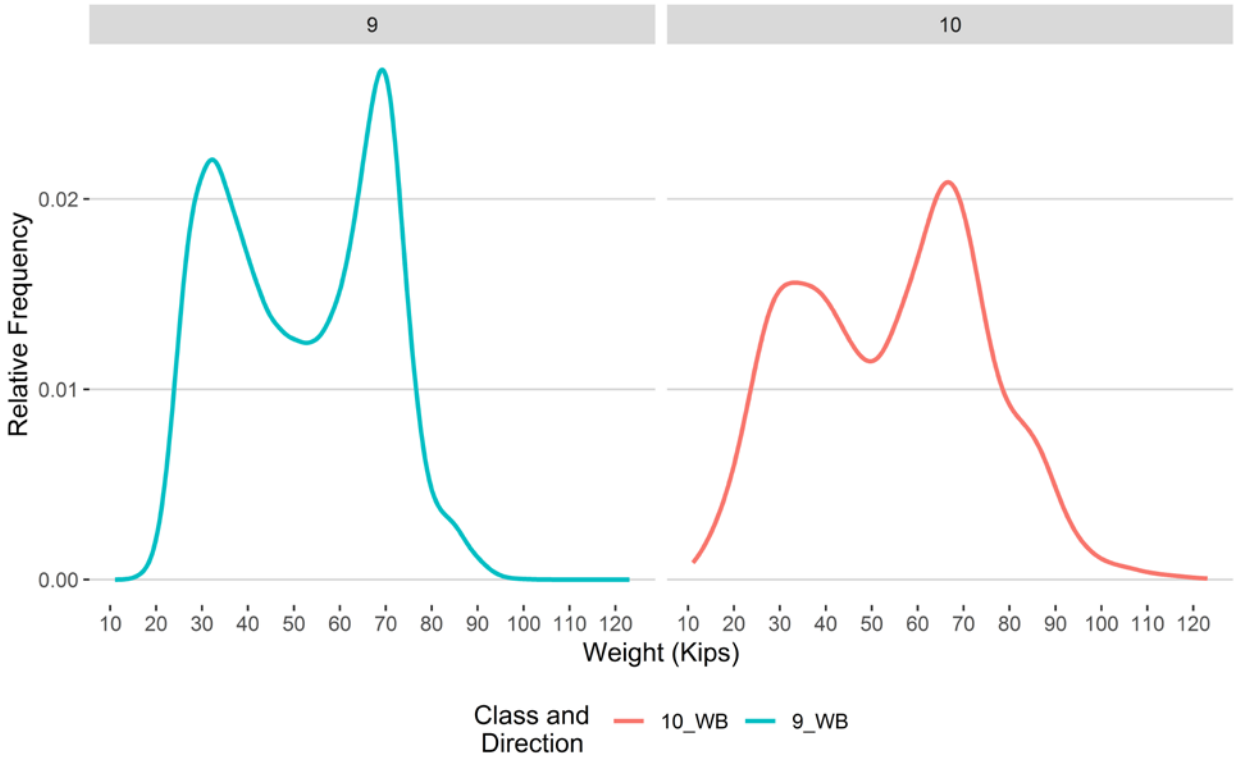


Figure 9 - Freight Percentage by Direction and Class

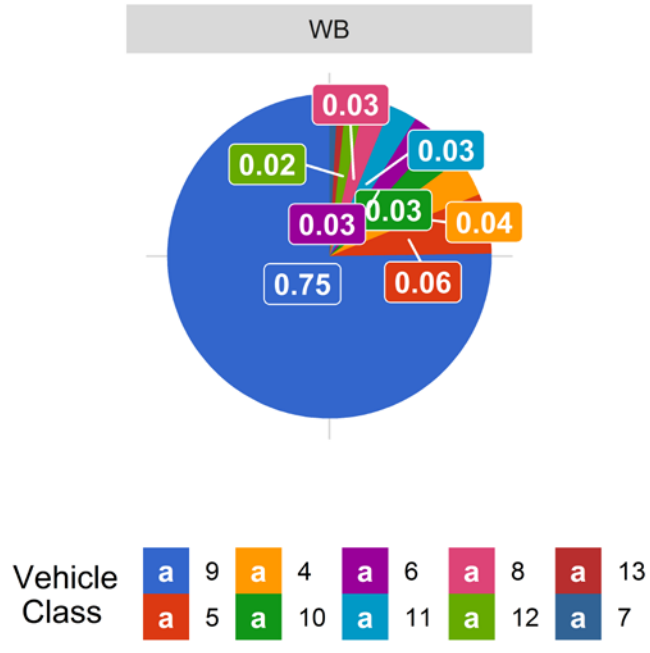


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

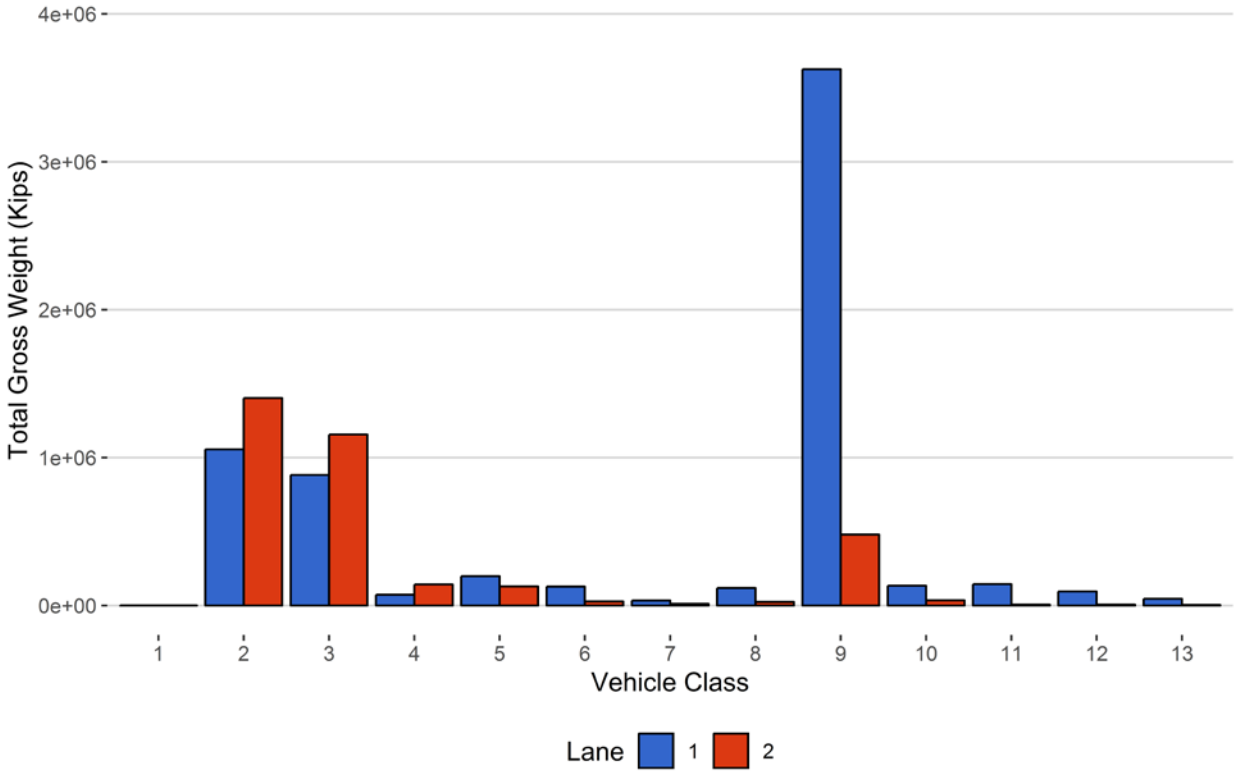


Figure 11 - Total Gross Vehicle Weight b

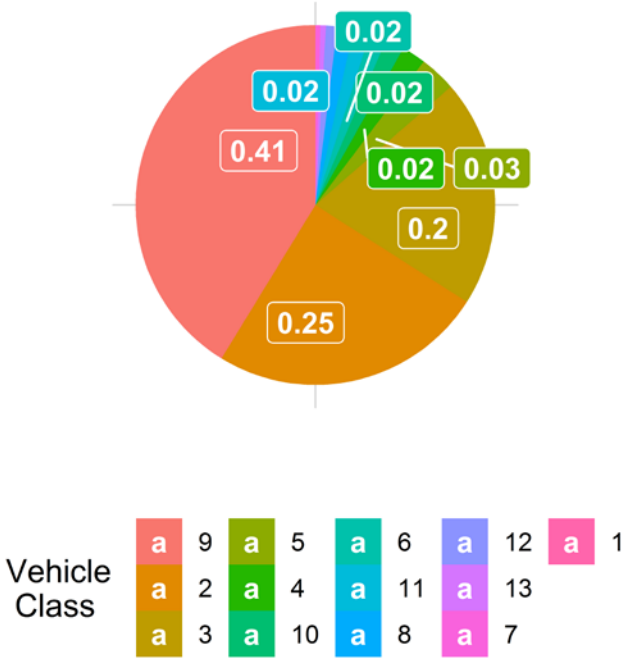


Figure 12 - Total ESALs by Class and Lane

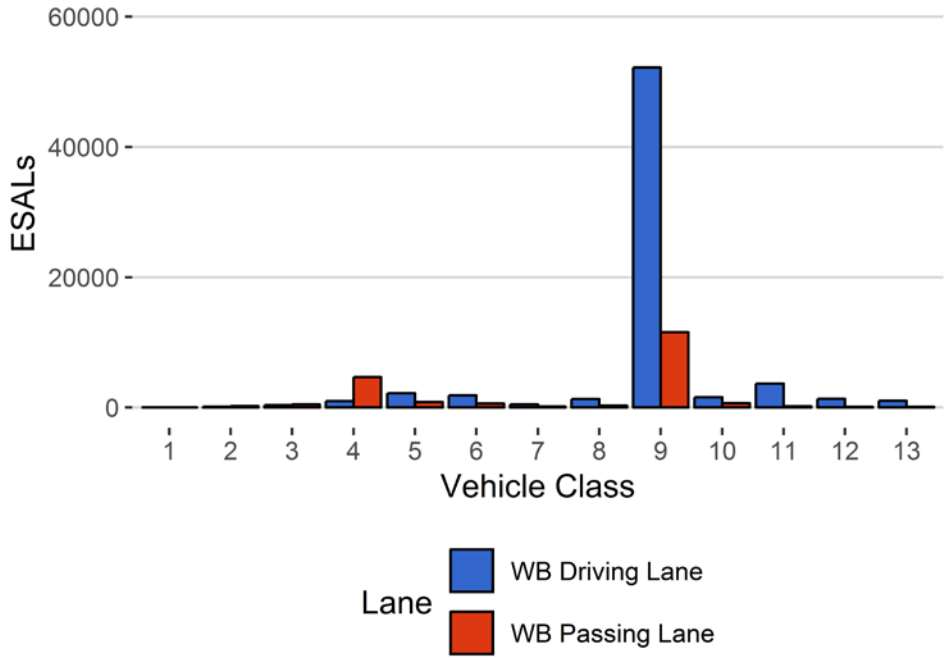


Figure 13 - ESALs by Class

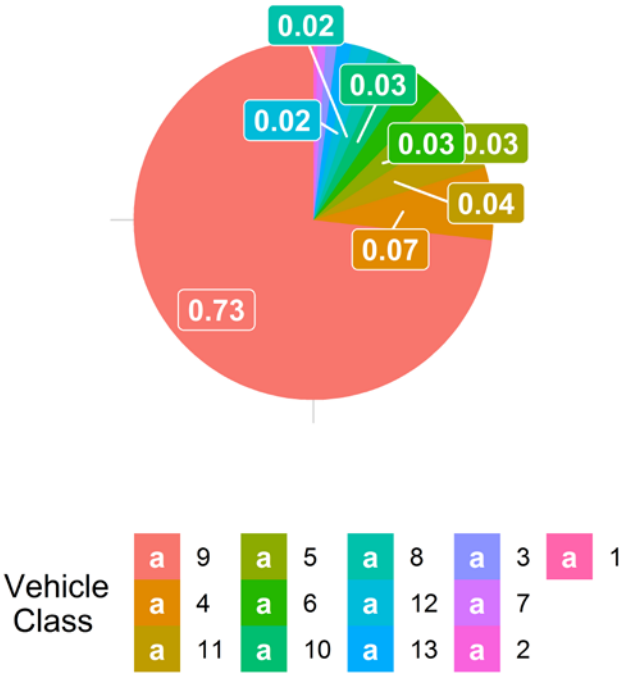


Table 1 Class 9 Front Axle Weight by Lane

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
February 2018	10.55	0.02	12.70	7.79
March 2018	10.55	0.02	12.51	6.17
April 2018	10.45	-0.87	12.28	4.20
May 2018	10.44	-0.99	11.98	1.65
June 2018	10.48	-0.64	11.92	1.16
July 2018	10.49	-0.48	12.02	2.01
August 2018	10.54	-0.07	12.03	2.06
September 2018	10.52	-0.18	12.23	3.79
May 2019	10.53	-0.10	12.28	4.19
June 2019	10.55	0.07	12.14	3.04

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*
1	8	251	0	0	0
2	21081	632443	58.1	0	0
3	10639	319162	29.3	0	0
4	202	6071	0.6	932	11.3
5	855	25636	2.4	179	2.2
6	179	5356	0.5	314	3.8
7	38	1134	0.1	57	0.7
8	177	5306	0.5	91	1.1
9	2814	84418	7.8	5819	70.7
10	110	3291	0.3	375	4.6
11	86	2586	0.2	107	1.3
12	58	1743	0.2	63	0.8
13	19	581	0.1	290	3.5
TOTAL	**36266**	**1087979**	**100**	**8227**	**100**

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

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-06-14	Friday	19:02:24	10	WB	1	123.07
2019-06-08	Saturday	13:51:50	10	WB	2	117.32
2019-06-14	Friday	19:02:17	10	WB	1	116.11
2019-06-08	Saturday	15:09:27	10	WB	1	115.87
2019-06-26	Wednesday	10:02:31	10	WB	1	114.7
2019-06-15	Saturday	00:14:41	10	WB	1	111.93
2019-06-11	Tuesday	22:40:19	10	WB	2	111.3
2019-06-17	Monday	12:55:02	10	WB	1	110.82
2019-06-22	Saturday	00:58:36	10	WB	1	110.36
2019-06-16	Sunday	01:27:47	9	WB	1	110.21

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	5703	569	10	206644	7462	64817
5	WB	8	24081	1828	7.6	313706	13081	67841
6	WB	19	5031	375	7.5	147440	6484	29488
7	WB	11.5	1065	16	1.5	44336	171	16136
8	WB	31	4984	2966	59.5	77702	64870	7572
9	WB	33	79296	15426	19.5	3670633	434664	781462
10	WB	33.5	3091	610	19.7	152350	16228	34618
11	WB	36.5	2429	78	3.2	148794	1750	31491
12	WB	36.5	1637	22	1.3	100005	552	20529
13	WB	31.5	546	1	0.2	49036	22	15934
TOTAL	****	****	**127863**	**21891**	****	**4910645**	****	**1069888**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*WB Driving Lane*	*WB Passing Lane*	*Total*	*Percentage*
1	103	207	310	0
2	1055614	1401761	2457375	24.7
3	881925	1155535	2037460	20.5
4	72439	141667	214106	2.2
5	198099	128688	326788	3.3
6	127319	26605	153924	1.5
7	33514	10993	44507	0.4
8	118302	24270	142572	1.4
9	3626084	479214	4105298	41.3
10	133815	34763	168578	1.7
11	144576	5968	150544	1.5
12	94607	5949	100556	1
13	45156	3902	49058	0.5
TOTAL	**6531552**	**3419523**	**9951075**	**100**
GVW/LANE	**65.64**	**34.36**	**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*
1	0	0	0	0	0.0042
2	130	206	337	0.4	0.0012
3	372	497	869	1	0.0058
4	999	4691	5690	6.5	2
5	2189	838	3027	3.5	0.25
6	1887	614	2501	2.9	0.99
7	492	154	647	0.7	1.21
8	1317	272	1588	1.8	0.64
9	52208	11559	63767	73.2	1.61
10	1586	654	2240	2.6	1.45
11	3665	187	3852	4.4	3.16
12	1354	103	1457	1.7	1.78
13	1035	95	1130	1.3	4.07
TOTAL	**67235**	**19871**	**87106**	**100**	**17**
ESALS/LANE	**77.2**	**22.8**	**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 %*
Jul 2018	1072651	34602	4186	942884	87.9	129767	12.1
Aug 2018	1122311	36204	4092	995460	88.7	126851.1	11.3
Sep 2018	762407	31767	2952	673849	88.4	88558.1	11.6
May 2019	1067629	34440	4742	920637	86.2	146992	13.8
Jun 2019	1087979	36266	4537	951857	87.5	136122.2	12.5
TOTAL	**5112977**	**–**	**–**	**4484687**	**–**	**628290**	**–**
AVERAGE	**1022595**	**34656**	**4102**	**896937**	**88**	**125658**	**12**

ESALs

Month	*ESALS WB Driving Lane*	*ESALS WB Passing Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Jul 2018	70515	25002	95518	1.3
Aug 2018	62410	29879	92289	1
Sep 2018	39826	23509	63334	1.2
May 2019	68732	35483	104215	0.8
Jun 2019	67408	28036	95444	1.3
TOTAL	**308891**	**–**	**–**	**–**
AVERAGE	**61778**	**28382**	**90160**	**1**

Gross Vehicle Weight

Month	*GVW WB Driving Lane*	*GVW WB Passing Lane*	*Total GVW Kips*
Jul 2018	6660185	4283216	10943402
Aug 2018	6540614	3595908	10136522
Sep 2018	6501613	3913029	10414641
May 2019	6040668	4371275	10411943
Jun 2019	3908977	3125851	7034828
TOTAL	**29652057**	**19289280**	**48941336**
AVERAGE	**5930411**	**3857856**	**9788267**

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*
Jul 2018	9377	0.9	7.3	744	247
Aug 2018	9894	0.9	7.9	888	253
Sep 2018	7285	1	8.6	920	165
May 2019	11556	1.1	8	2156	290
Jun 2019	9130	0.9	6.6	1437	294
TOTAL	**47242**	**–**	**–**	**6145**	**1249**
AVERAGE	**9448.4**	**1**	**7.7**	**1229**	**249.8**

Freight

Month	*WB Freight Tons*
Jul 2018	1158446
Aug 2018	1105836
Sep 2018	748630
May 2019	1230391
Jun 2019	1069888
TOTAL	**5313192**
AVERAGE	**1062638.3**