APRIL 2019

WIM #47
MN 36, MP 202.9
OAK PARK HEIGHTS, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #47 is located on MN 36 near Oak Park Heights in Washington county. The WIM is located only on the westbound (WB) side of MN 36, meaning that all data mentioned in this report pertains to WB traffic only (Lanes 1 and 2).

System Operation

WIM #47 was operational for the entire month of April 2019. Volume was computed using all monthly data.

System Calibration

WIM #47 was most recently calibrated on 2018-11-20. 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: 550362 | Passenger Vehicles: 528132 | Heavy Commercial Vehicles: 22230

Monthly Average Daily Traffic (MADT): 18345 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 741

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 Sundays (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 07 AM and 04 PM.

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling WB typically reached peak volume levels between 07 AM and 04 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 22230 HCVs, 1237 of them were overweight [3]. These overweight HCVs contributed to 0.2% of total monthly volume, and 5.7% of total monthly HCV volume. WB overweight vehicles typically reached highest numbers on Mondays, with lowest volumes reported on Sundays See Figure 3 .

The top two overweight violators by class were the class 9 and class 10 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 November.
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 ,60 WB vehicles exceeded 88,000 pounds (25 vehicles were Class 13's; 19 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from April 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9's and 10's in April 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 164005 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. 82045 (an extradosed cable stayed) is approximately 1 mile east of WIM #47. WIM #47 recorded a total of 550362 vehicles with a combined GVW of 3096120 kips (1 kip = 1,000 pounds = 0.5 tons) in April 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 12823 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 53% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 13% 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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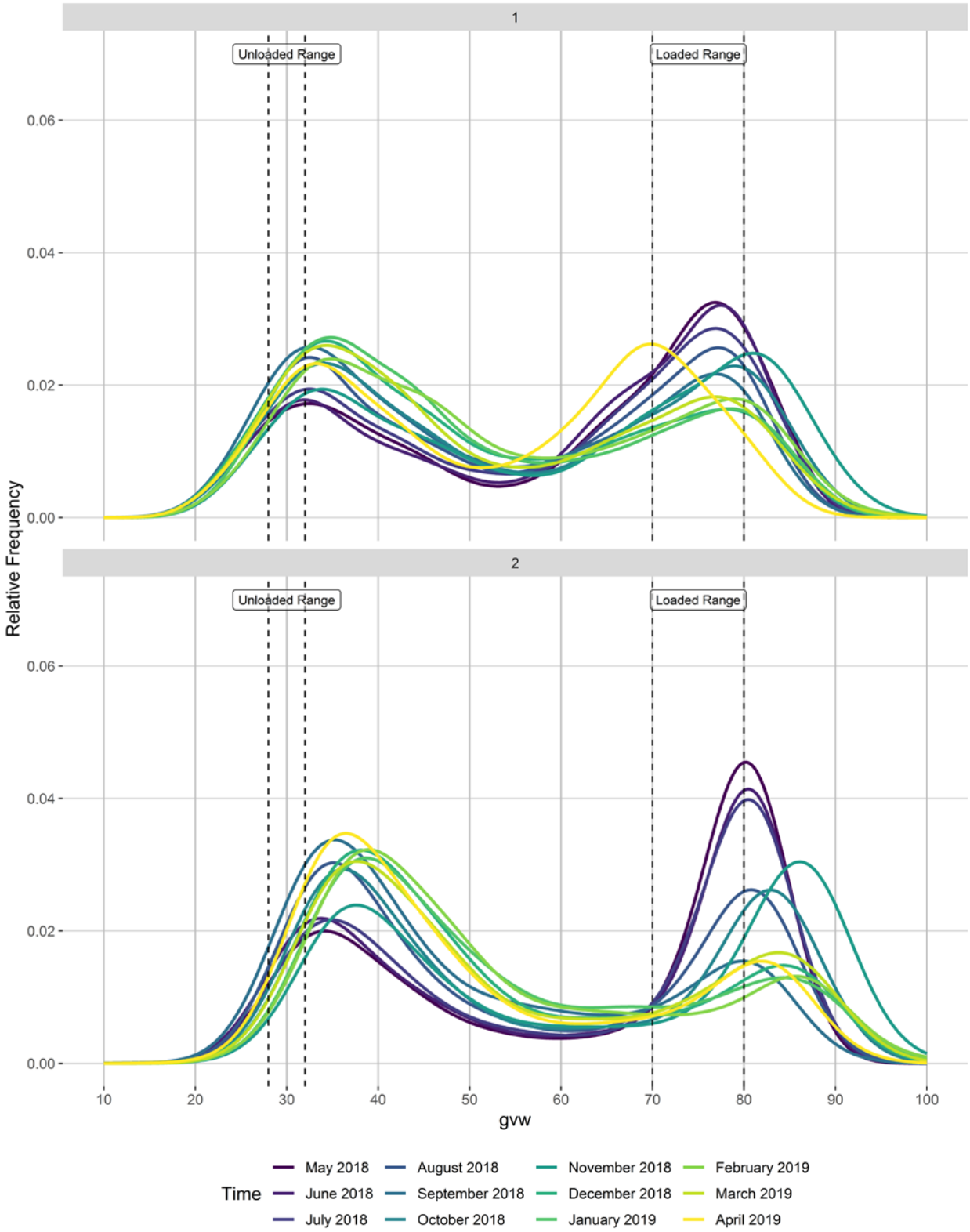
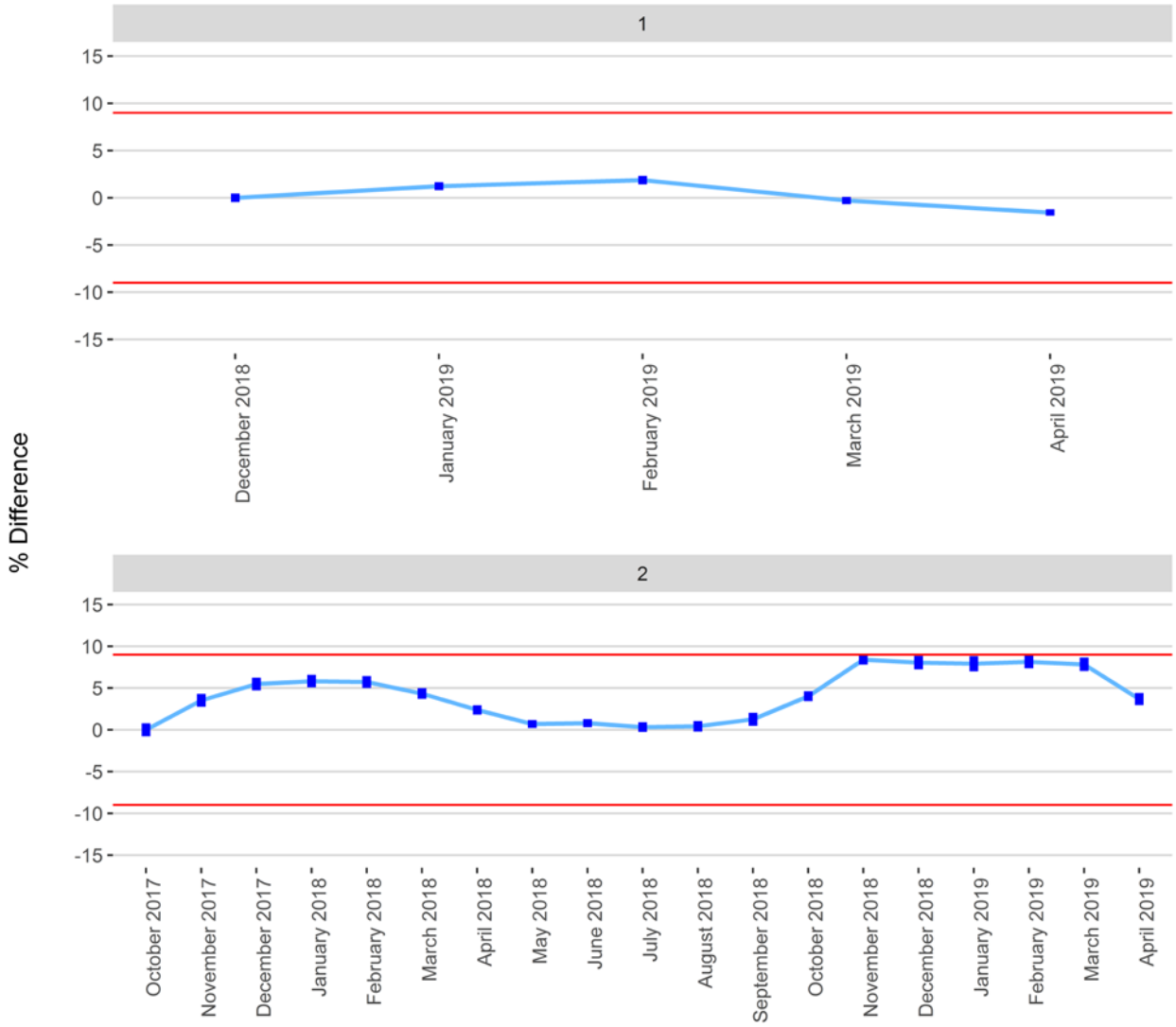
Figure 1 - Monthly Class 9 GVW Histogram



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

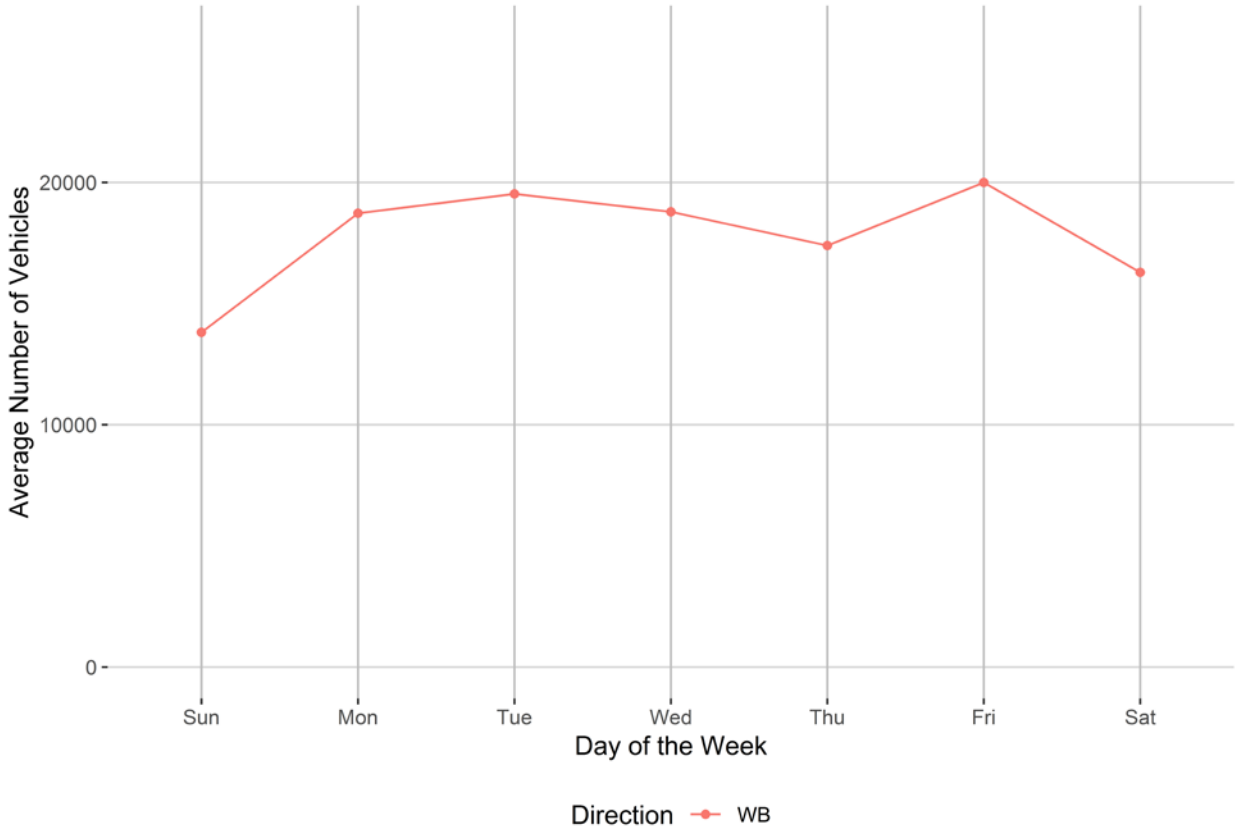


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

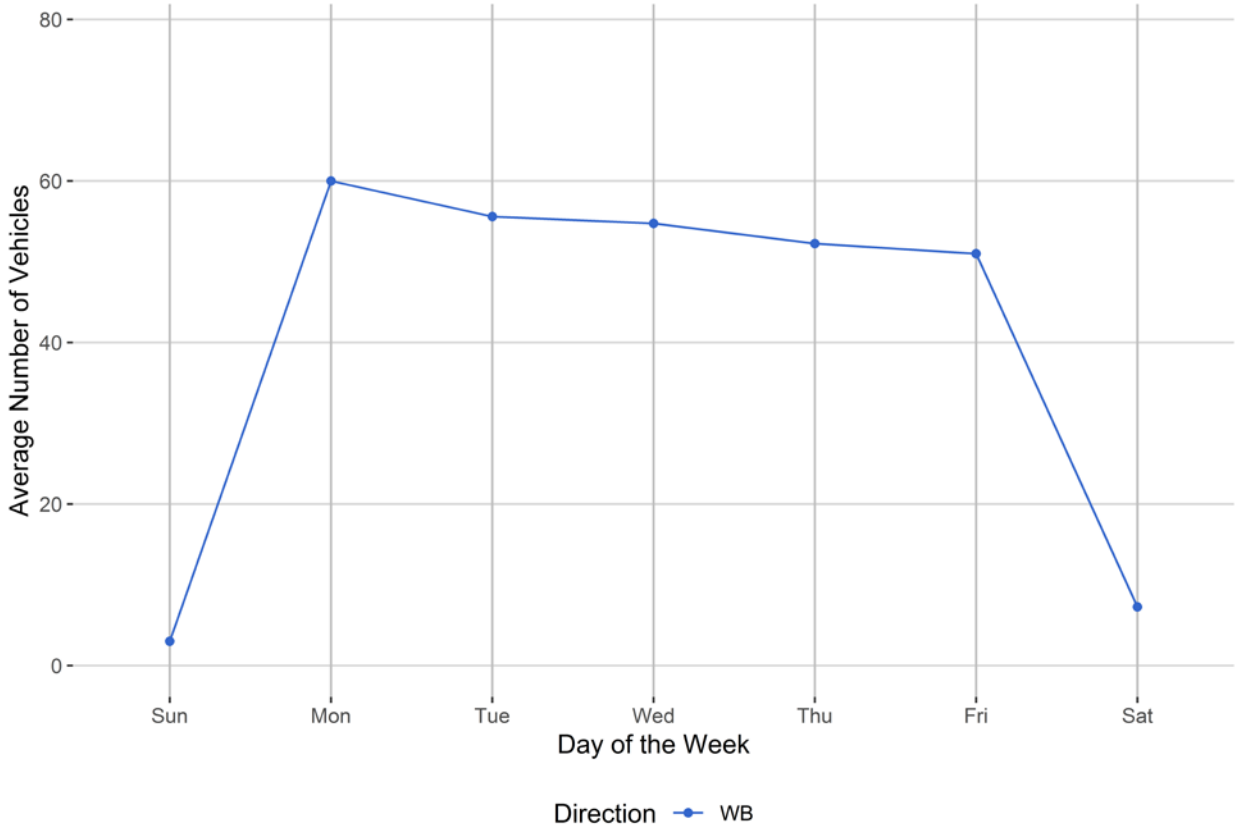


Figure 4 - Passenger Vehicles vs. Hour of the Day

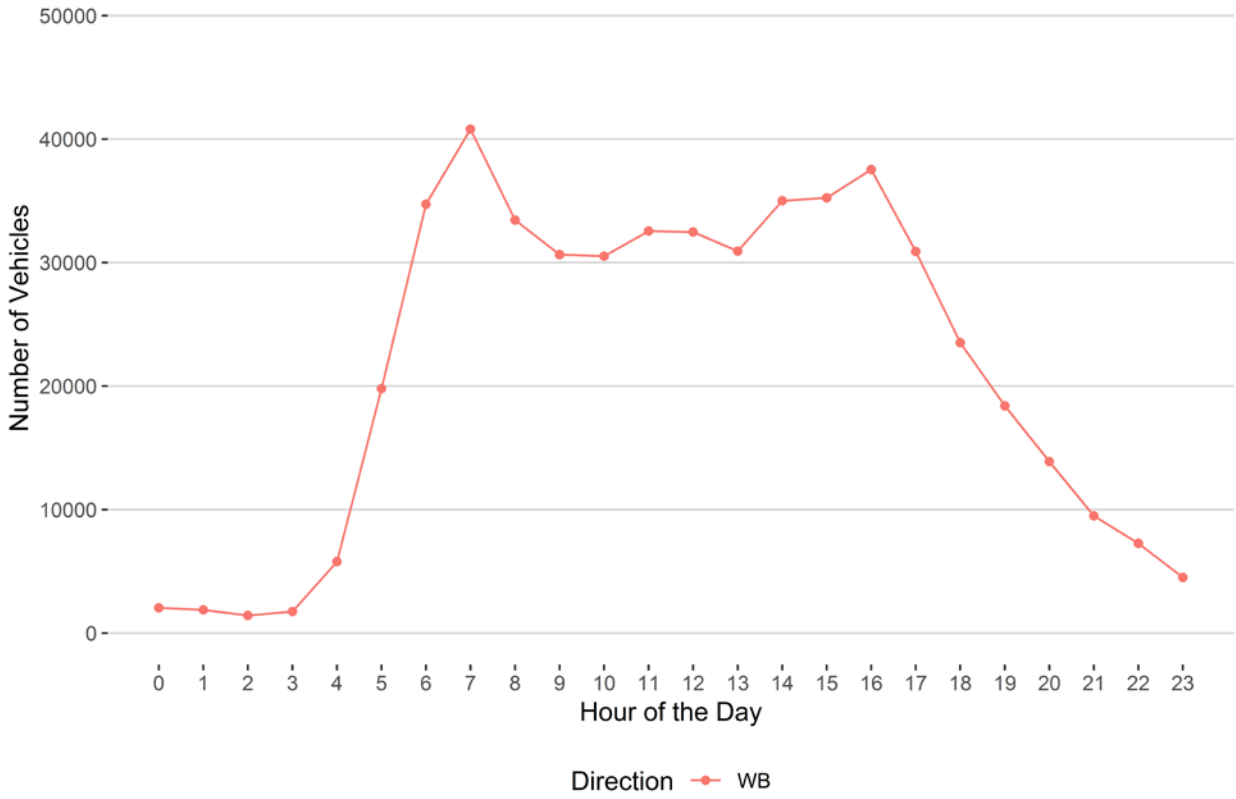


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

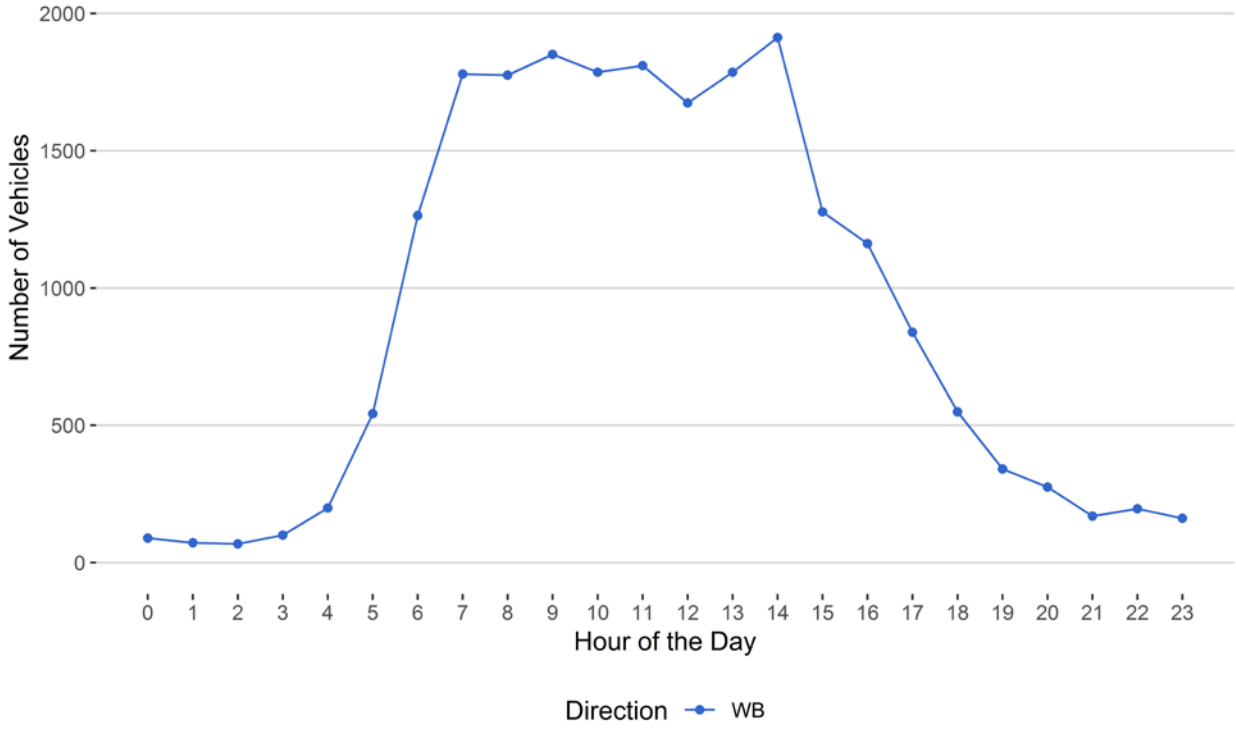


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

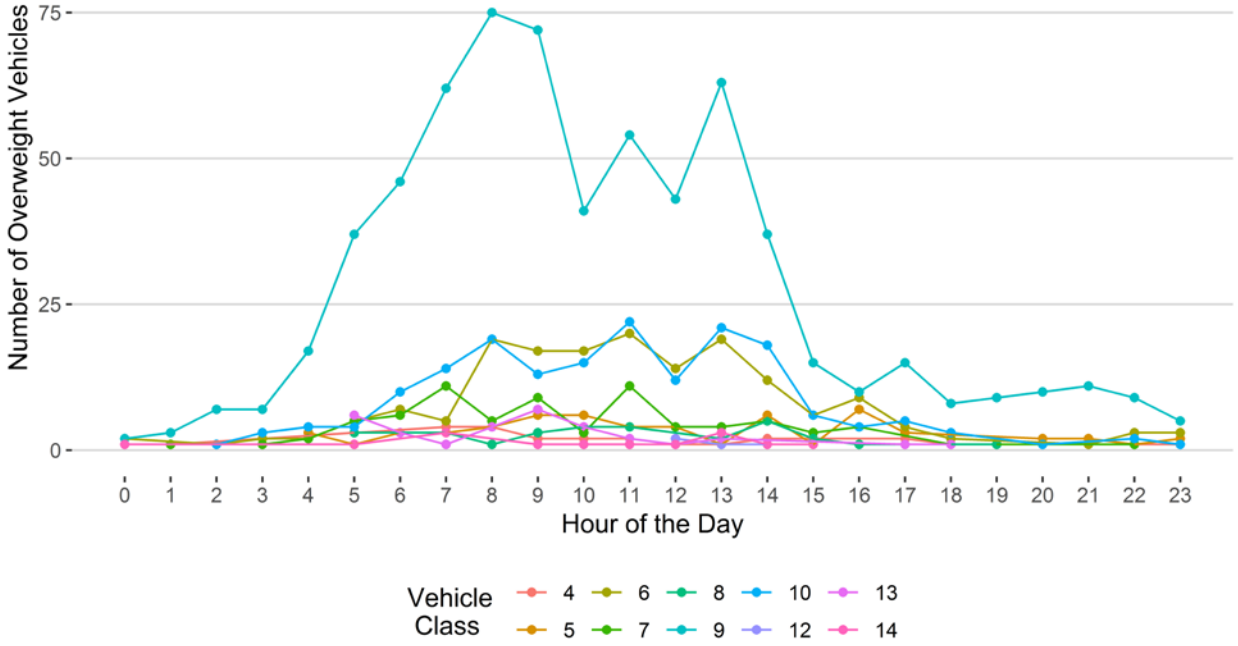


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

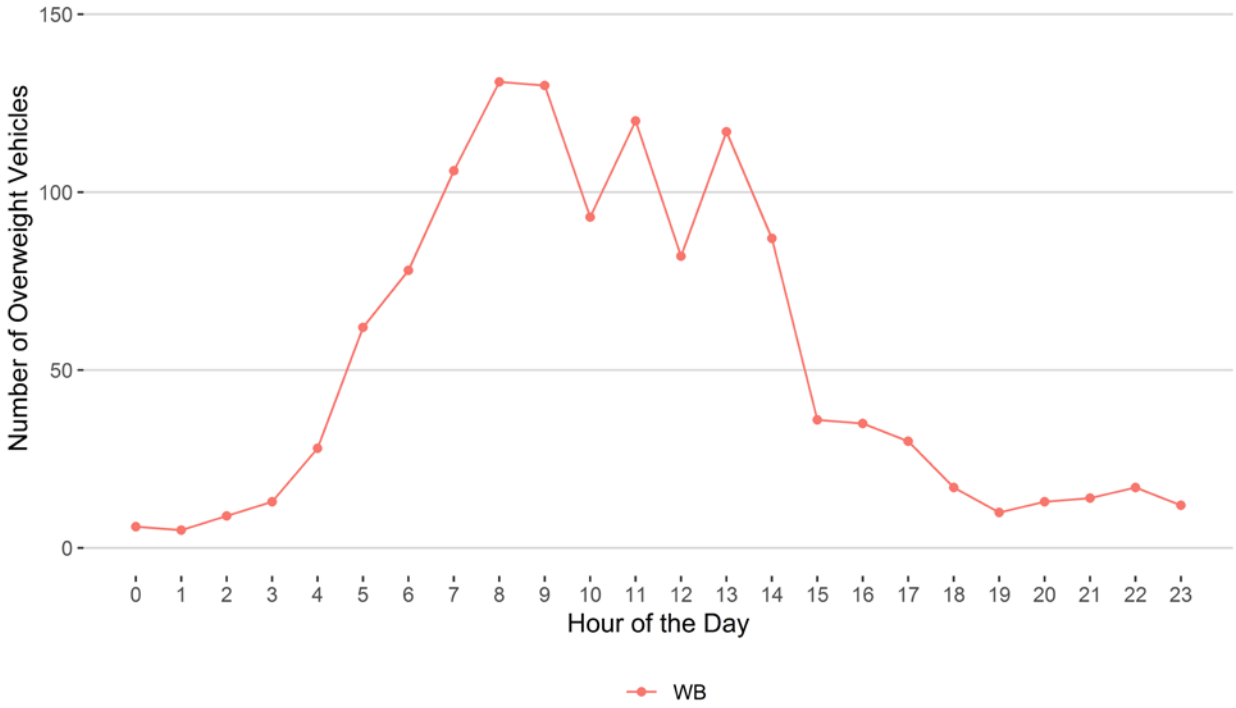
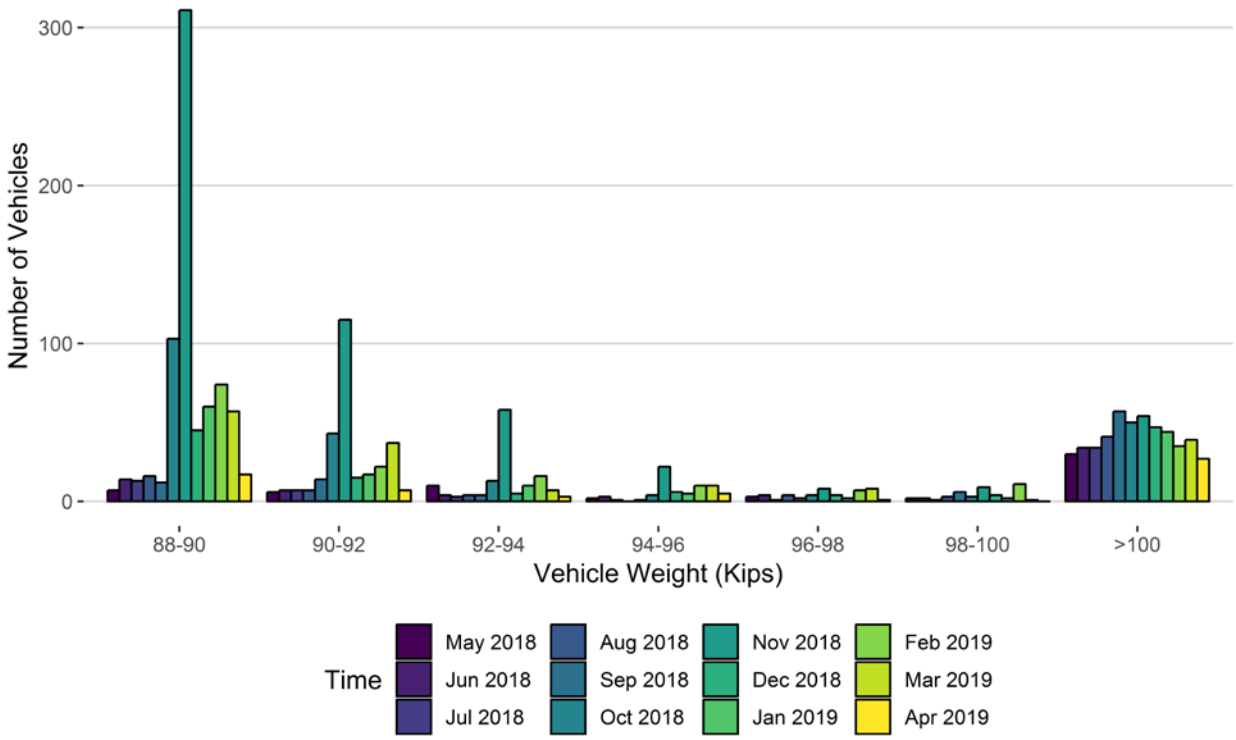


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*May 2018*	*Jun 2018*	*Jul 2018*	*Aug 2018*	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*
88-90	7	14	13	16	12	103	311	45	60	74	57	17
90-92	6	7	7	7	14	43	115	15	17	22	37	7
92-94	10	4	3	4	4	13	58	5	10	16	7	3
94-96	2	3	1	0	1	4	22	6	5	10	10	5
96-98	3	4	1	4	2	4	8	4	2	7	8	1
98-100	2	2	1	3	6	3	9	4	2	11	1	0
>100	30	34	34	41	57	50	54	47	44	35	39	27
Total	60	68	60	75	96	220	577	126	140	175	159	60

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

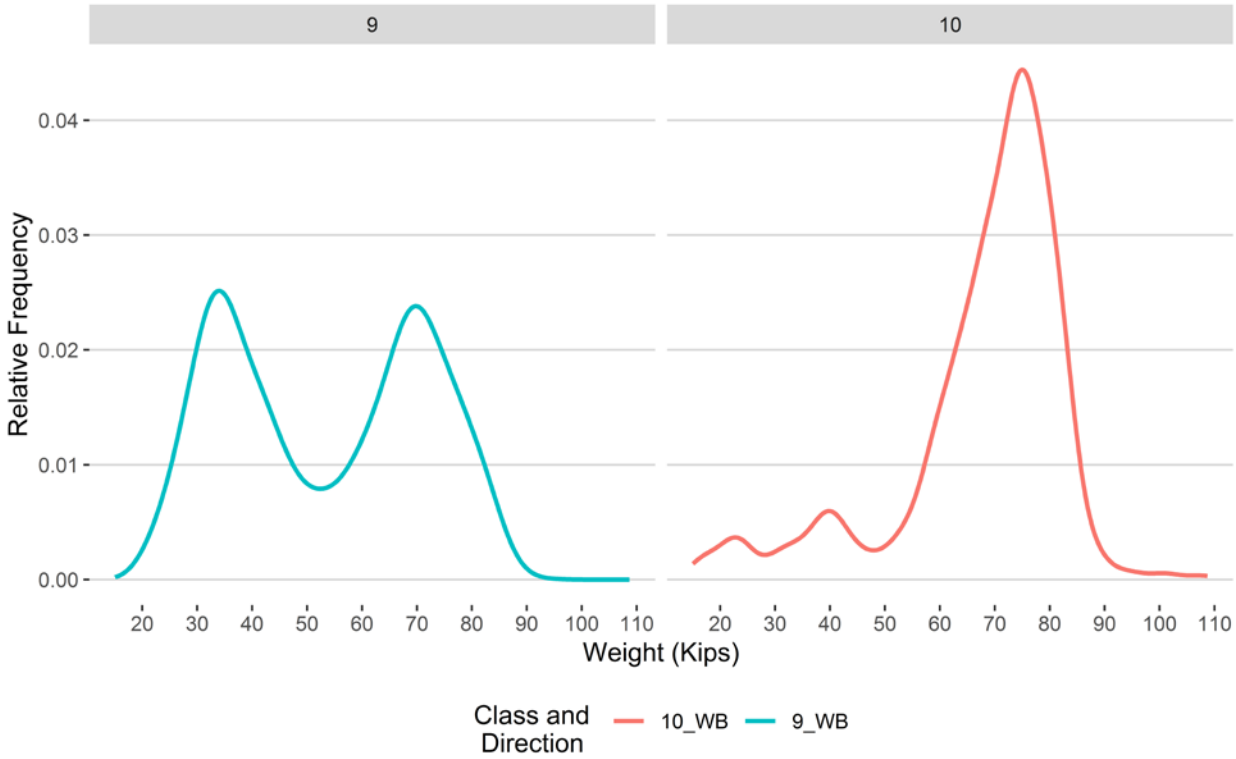


Figure 9 - Freight Percentage by Direction and Class

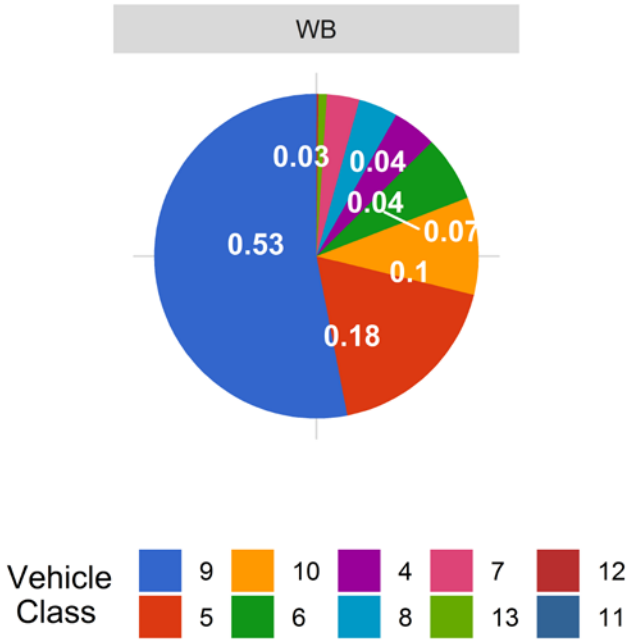


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

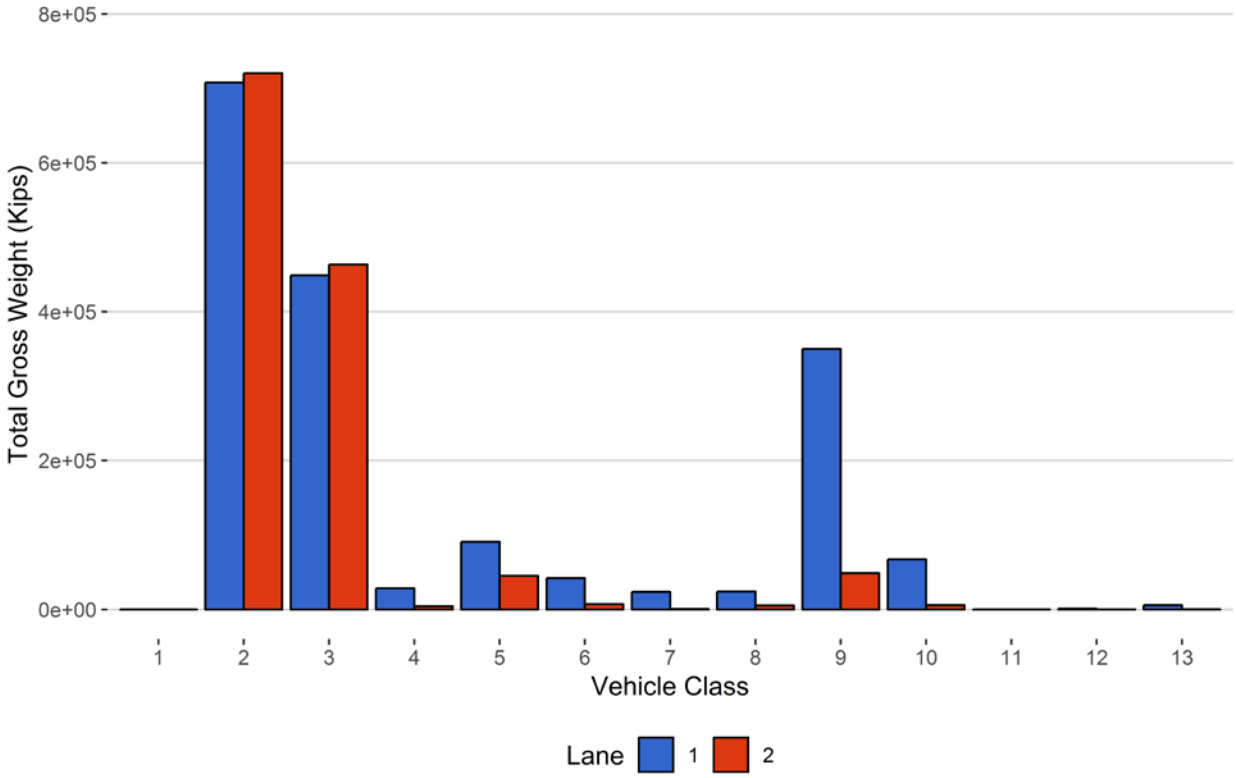


Figure 11 - Total Gross Vehicle Weight b

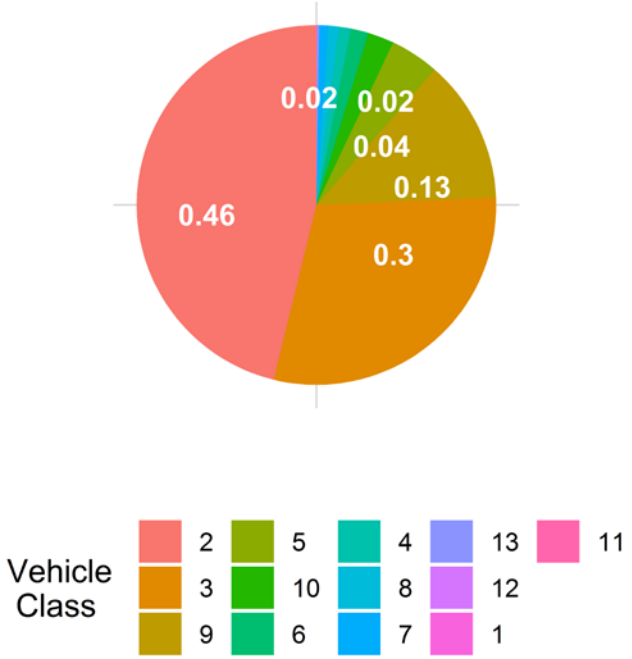


Figure 12 - Total ESALs by Class and Lane

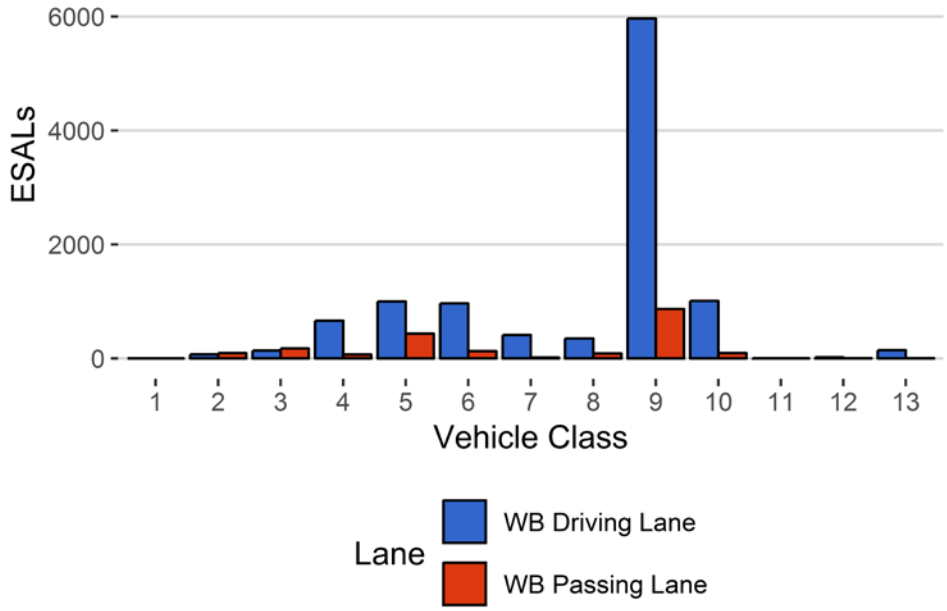


Figure 13 - ESALs by Class

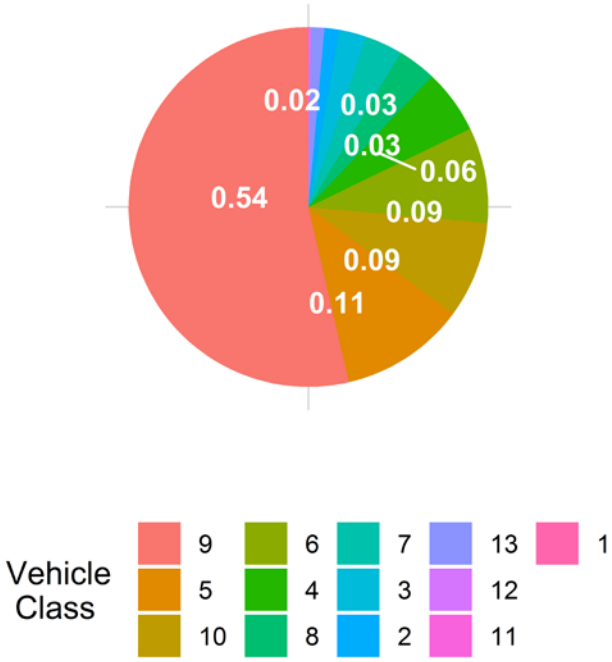


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
October 2017	NA	NA	10.62	0.00
November 2017	NA	NA	10.99	3.53
December 2017	NA	NA	11.20	5.49
January 2018	NA	NA	11.24	5.83
February 2018	NA	NA	11.23	5.72
March 2018	NA	NA	11.08	4.34
April 2018	NA	NA	10.87	2.38
May 2018	NA	NA	10.69	0.70
June 2018	NA	NA	10.70	0.81
July 2018	NA	NA	10.65	0.33
August 2018	NA	NA	10.66	0.42
September 2018	NA	NA	10.75	1.26
October 2018	NA	NA	11.05	4.02
November 2018	NA	NA	11.51	8.40
December 2018	11.51	0.00	11.47	8.05
January 2019	11.65	1.23	11.46	7.91
February 2019	11.72	1.87	11.48	8.13
March 2019	11.48	-0.29	11.45	7.84
April 2019	11.33	-1.56	11.01	3.68

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	11	331	0.1	0	0
2	12398	371941	67.6	0	0
3	5195	155860	28.3	0	0
4	30	905	0.2	27	2.2
5	318	9551	1.7	59	4.8
6	50	1493	0.3	170	13.7
7	15	439	0.1	76	6.1
8	33	989	0.2	33	2.7
9	255	7647	1.4	658	53.2
10	37	1105	0.2	178	14.4
11	0	3	0	0	0
12	1	25	0	4	0.3
13	2	74	0	32	2.6
TOTAL	**18345**	**550362**	**100**	**1237**	**100**

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

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-04-16	Tuesday	05:28:42	10	WB	1	108.71
2019-04-10	Wednesday	05:26:37	10	WB	1	107.37
2019-04-29	Monday	11:39:36	10	WB	1	104.07
2019-04-19	Friday	07:10:24	10	WB	1	101.29
2019-04-02	Tuesday	04:45:08	10	WB	1	100.26
2019-04-23	Tuesday	03:10:00	10	WB	1	100.06
2019-04-24	Wednesday	13:24:42	10	WB	1	96
2019-04-03	Wednesday	04:39:02	10	WB	1	95.36
2019-04-04	Thursday	09:44:36	9	WB	2	95.03
2019-04-18	Thursday	07:11:32	10	WB	1	94.55

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	882	124	14.1	31386	1582	10008
5	WB	8	9313	877	9.4	129935	6179	31224
6	WB	19	1456	156	10.7	46504	2621	10902
7	WB	11.5	428	0	0	24476	0	9777
8	WB	31	964	498	51.7	18255	11200	1904
9	WB	33	7457	1300	17.4	361580	37331	79199
10	WB	33.5	1077	57	5.3	71611	1373	18720
11	WB	36.5	3	1	33.3	142	16	35
12	WB	36.5	24	1	4.2	1394	36	277
13	WB	31.5	72	0	0	6184	0	1958
TOTAL	****	****	**21676**	**3014**	****	**691467**	****	**164005**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*WB Driving Lane*	*WB Passing Lane*	*Total*	*Percentage*
1	176	216	392	0
2	707849	720476	1428325	46.2
3	449011	463460	912471	29.5
4	28553	4415	32968	1.1
5	90970	45144	136114	4.4
6	42009	7116	49126	1.6
7	23679	796	24476	0.8
8	24037	5418	29455	1
9	350026	48885	398911	12.9
10	67239	5745	72984	2.4
11	158	0	158	0
12	1216	214	1430	0
13	5839	344	6184	0.2
TOTAL	**1790764**	**1302230**	**3092994**	**100**
GVW/LANE	**57.9**	**42.1**	**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	0.0031
2	72	96	168	1.3	9e-04
3	138	176	314	2.5	0.0042
4	665	70	734	5.8	1.67
5	1001	437	1438	11.3	0.31
6	967	130	1097	8.6	1.51
7	412	18	430	3.4	2
8	353	90	443	3.5	0.92
9	5968	870	6837	53.6	1.84
10	1010	97	1106	8.7	2.05
11	5	0	5	0	1.48
12	21	6	27	0.2	1.82
13	147	4	151	1.2	3.73
TOTAL	**10760**	**1992**	**12752**	**100**	**17**
ESALS/LANE	**84.4**	**15.6**	**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 %*
May 2018	631604	20374	910	603386	95.5	28218.3	4.5
Jun 2018	616280	20543	896	589399	95.6	26881.2	4.4
Jul 2018	629397	20303	816	604106	96	25291	4
Aug 2018	639471	20628	852	613071	95.9	26399.6	4.1
Sep 2018	581367	19379	761	558536	96.1	22831	3.9
Oct 2018	603853	19479	863	577094	95.6	26758.9	4.4
Nov 2018	538746	17958	798	514797	95.6	23948.6	4.4
Dec 2018	516018	16646	556	498770	96.7	17248.3	3.3
Jan 2019	495367	15980	561	477966	96.5	17401.3	3.5
Feb 2019	436896	15603	631	419227	96	17668.9	4
Mar 2019	516795	16671	611	497869	96.3	18926.3	3.7
Apr 2019	550362	18345	741	528132	96	22229.5	4
TOTAL	**6756156**	**–**	**–**	**6482353**	**–**	**273803**	**–**
AVERAGE	**563013**	**18492**	**750**	**540196**	**96**	**22817**	**4**

ESALs

Month	*ESALS WB Driving Lane*	*ESALS WB Passing Lane*	*Total ESALS*	*Pavement Life Decrease Months*
May 2018	16136	4234	20371	1.3
Jun 2018	16381	4040	20421	0.5
Jul 2018	14428	3471	17899	0.6
Aug 2018	13904	2848	16752	0.8
Sep 2018	10477	2044	12521	1.9
Oct 2018	14490	3770	18259	3.1
Nov 2018	15779	3985	19764	8.3
Dec 2018	7721	1769	9490	3.8
Jan 2019	7975	1784	9759	4.1
Feb 2019	7841	2152	9993	6.1
Mar 2019	8602	2101	10703	5.2
Apr 2019	10824	1999	12823	1
TOTAL	**144557**	**–**	**–**	**–**
AVERAGE	**12046**	**2850**	**14896**	**3**

Gross Vehicle Weight

Month	*GVW WB Driving Lane*	*GVW WB Passing Lane*	*Total GVW Kips*
May 2018	1556468	1153319	2709787
Jun 2018	1413706	1050516	2464222
Jul 2018	1614148	1220912	2835061
Aug 2018	1792921	1303199	3096120
Sep 2018	2142694	1524224	3666919
Oct 2018	2130628	1470981	3601608
Nov 2018	2091423	1471775	3563198
Dec 2018	2108134	1515344	3623478
Jan 2019	1844835	1368756	3213591
Feb 2019	2061600	1488458	3550057
Mar 2019	1911488	1343033	3254521
Apr 2019	1574809	1218296	2793105
TOTAL	**22242853**	**16128814**	**38371667**
AVERAGE	**1853571**	**1344068**	**3197639**

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*
May 2018	3328	0.5	11.9	62	32
Jun 2018	3351	0.6	12.6	68	36
Jul 2018	2745	0.4	11	61	36
Aug 2018	2318	0.4	8.9	75	44
Sep 2018	1579	0.3	7	96	63
Oct 2018	3095	0.5	11.7	220	53
Nov 2018	3757	0.7	15.9	578	63
Dec 2018	1337	0.3	7.8	126	51
Jan 2019	1371	0.3	8	140	46
Feb 2019	1436	0.3	8.2	176	46
Mar 2019	1444	0.3	7.7	159	40
Apr 2019	1251	0.2	5.7	60	27
TOTAL	**27012**	**–**	**–**	**1821**	**537**
AVERAGE	**2251**	**0.4**	**9.7**	**151.8**	**44.8**

Freight

Month	*WB Freight Tons*
May 2018	241700
Jun 2018	239504
Jul 2018	211420
Aug 2018	203867
Sep 2018	151578
Oct 2018	210014
Nov 2018	213790
Dec 2018	105242
Jan 2019	106411
Feb 2019	106822
Mar 2019	119391
Apr 2019	164005
TOTAL	**2073743**
AVERAGE	**172811.9**