

APRIL 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 April 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: 913816 | Passenger Vehicles: 802585 | Heavy Commercial Vehicles: 111231

Monthly Average Daily Traffic (MADT): 30461 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 3708

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 Thursdays (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 5's.

Overweight HCVs

Volume trends. Of a total of 111231 HCVs, 8319 of them were overweight ³. These overweight HCVs contributed to 1% of total monthly volume, and 7.9% 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 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 March.

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 ,1703 WB vehicles exceeded 88,000 pounds (1288 vehicles were Class 9's; 208 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 879281 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 913816 vehicles with a combined GVW of 8402778 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 76082 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 77% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 42% 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>

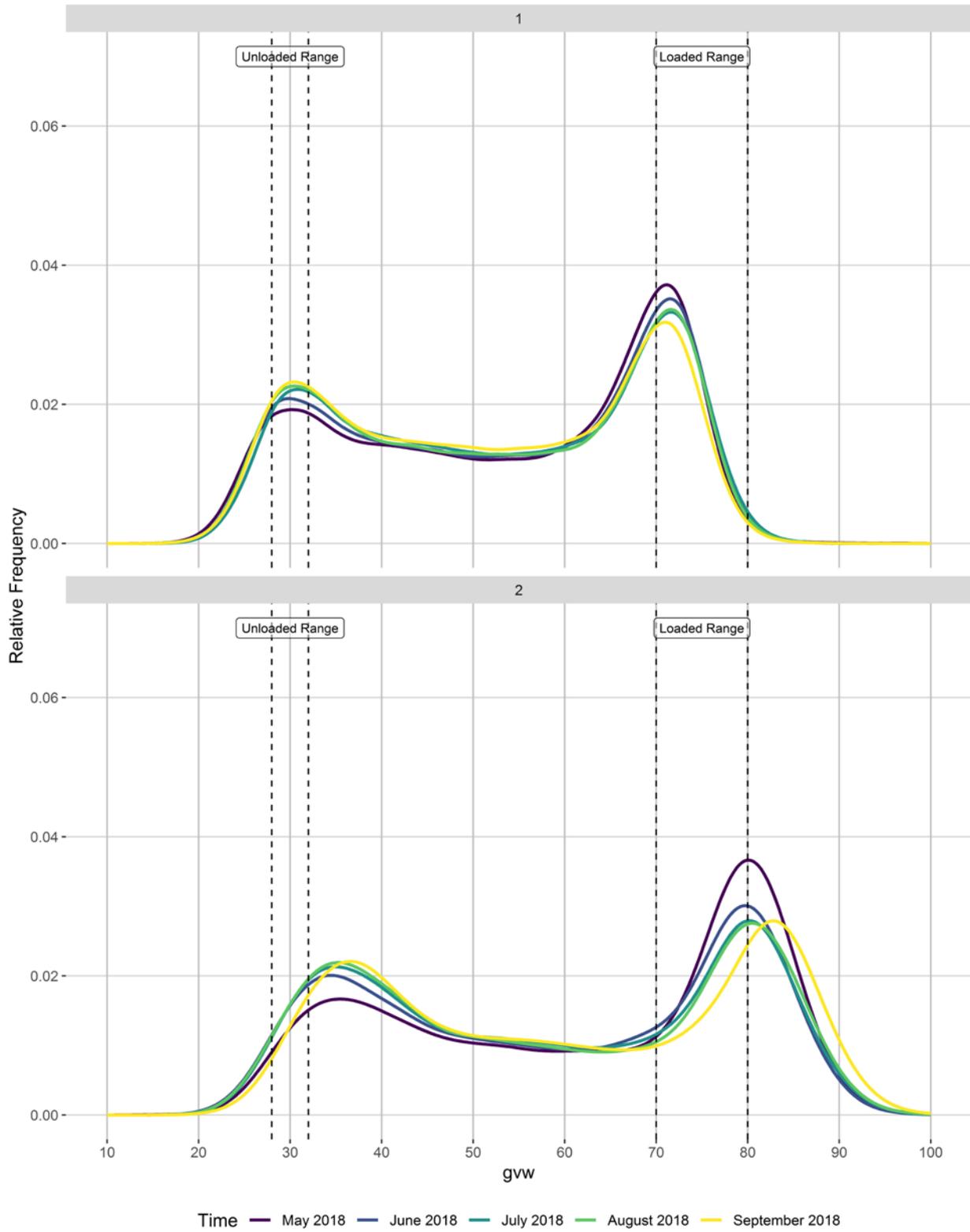
MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at: <http://www.dot.state.mn.us/traffic/data/data-products.html#weight>

- 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.

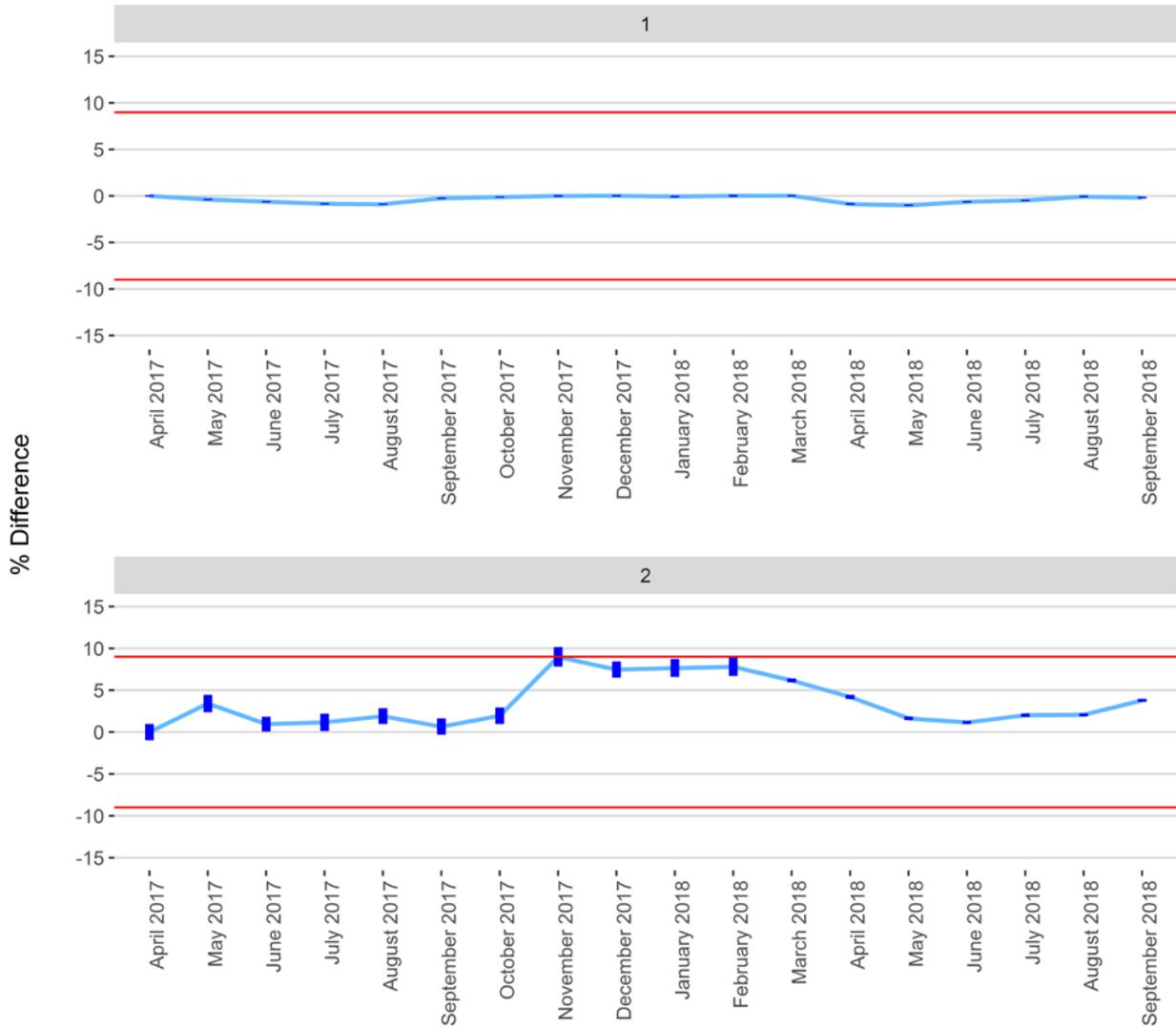
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Figure 1 - Monthly Class 9 GVW Histogram



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

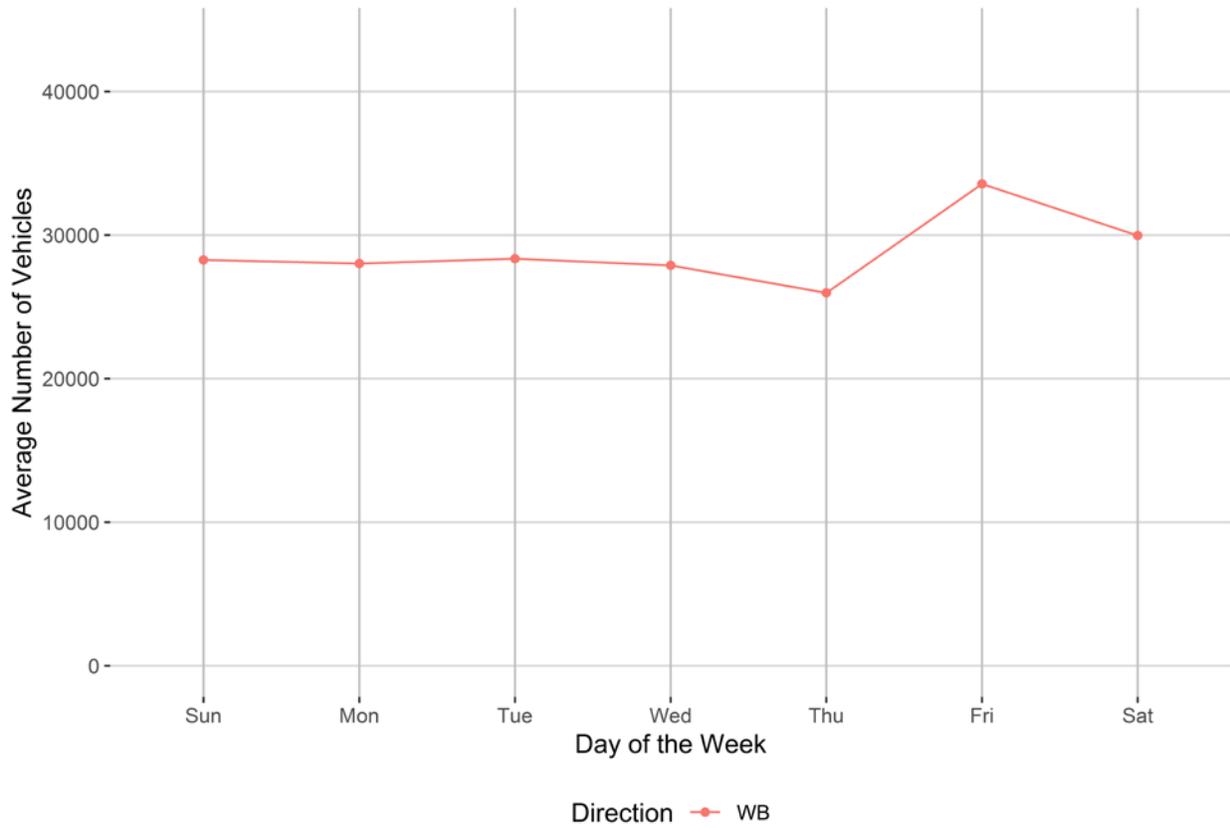


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

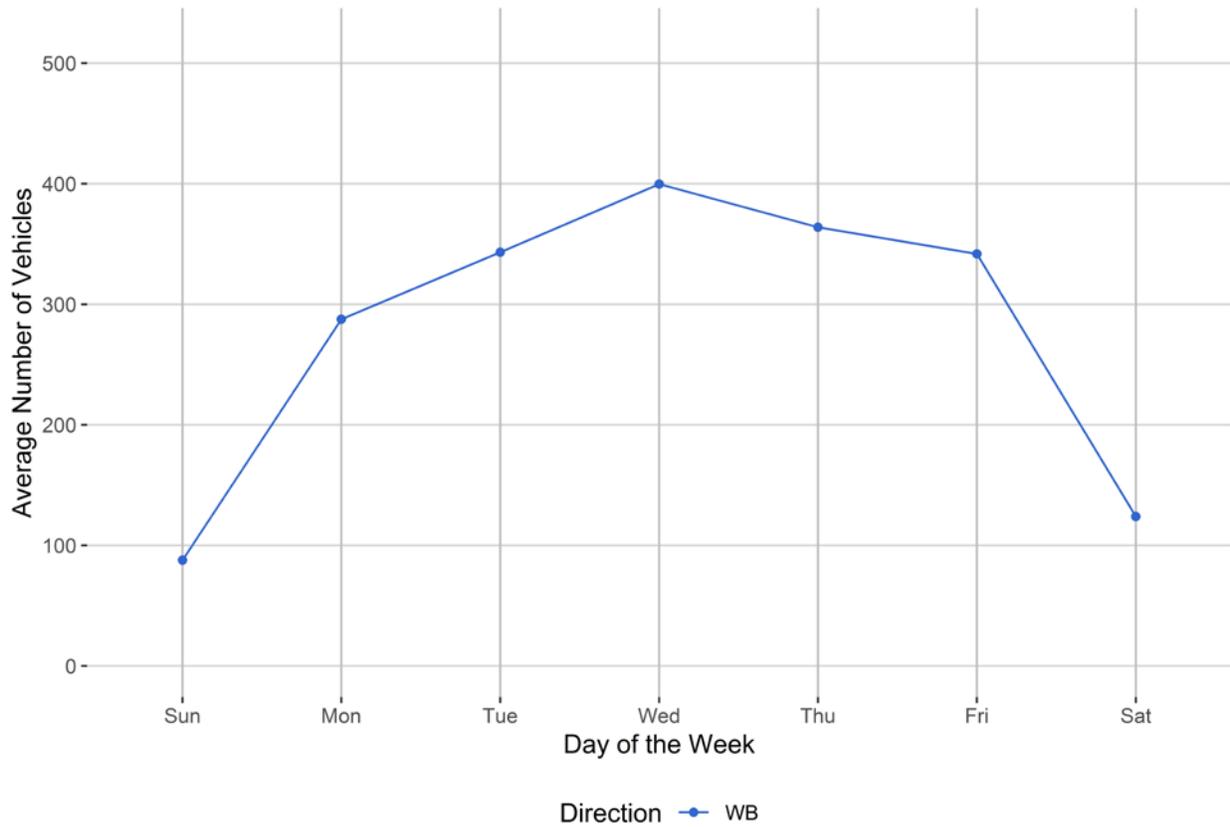


Figure 4 - Passenger Vehicles vs. Hour of the Day

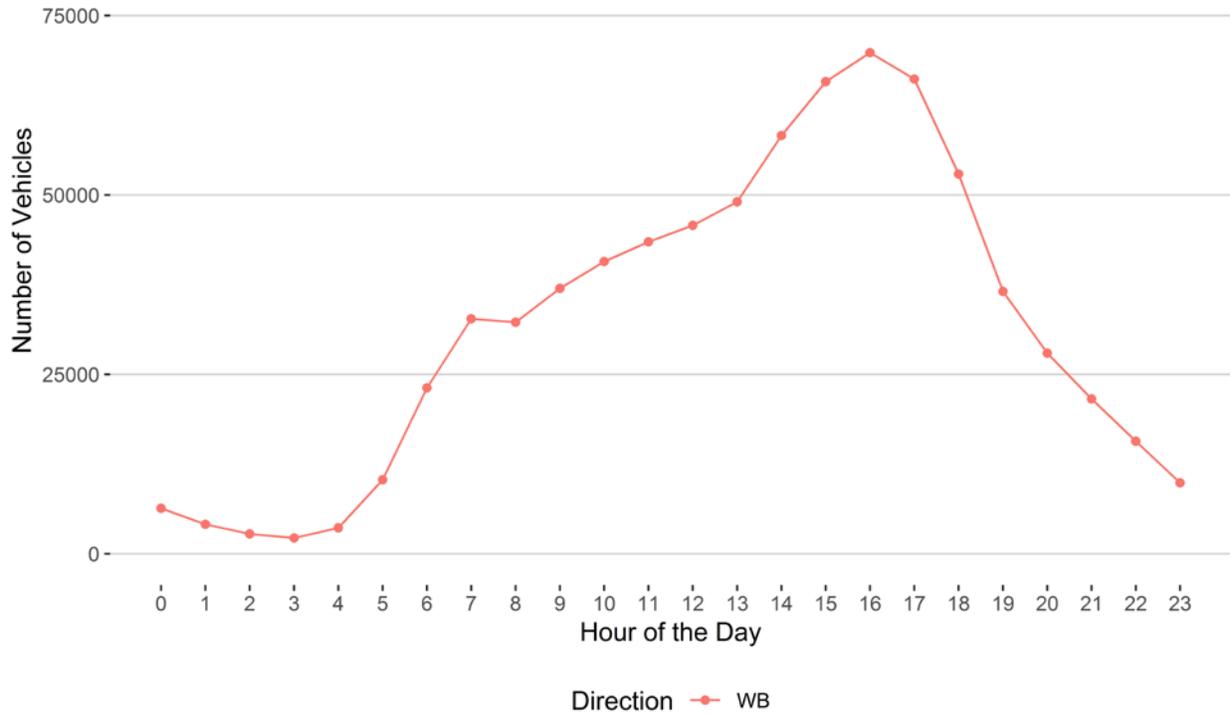


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

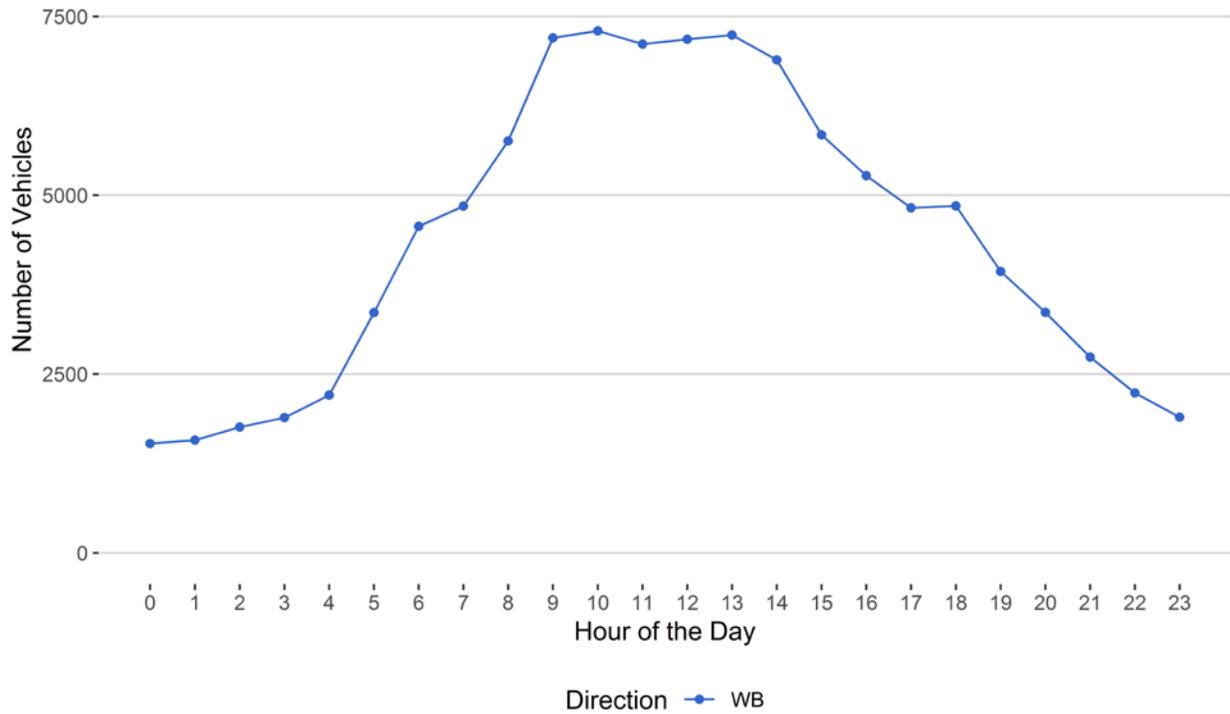


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

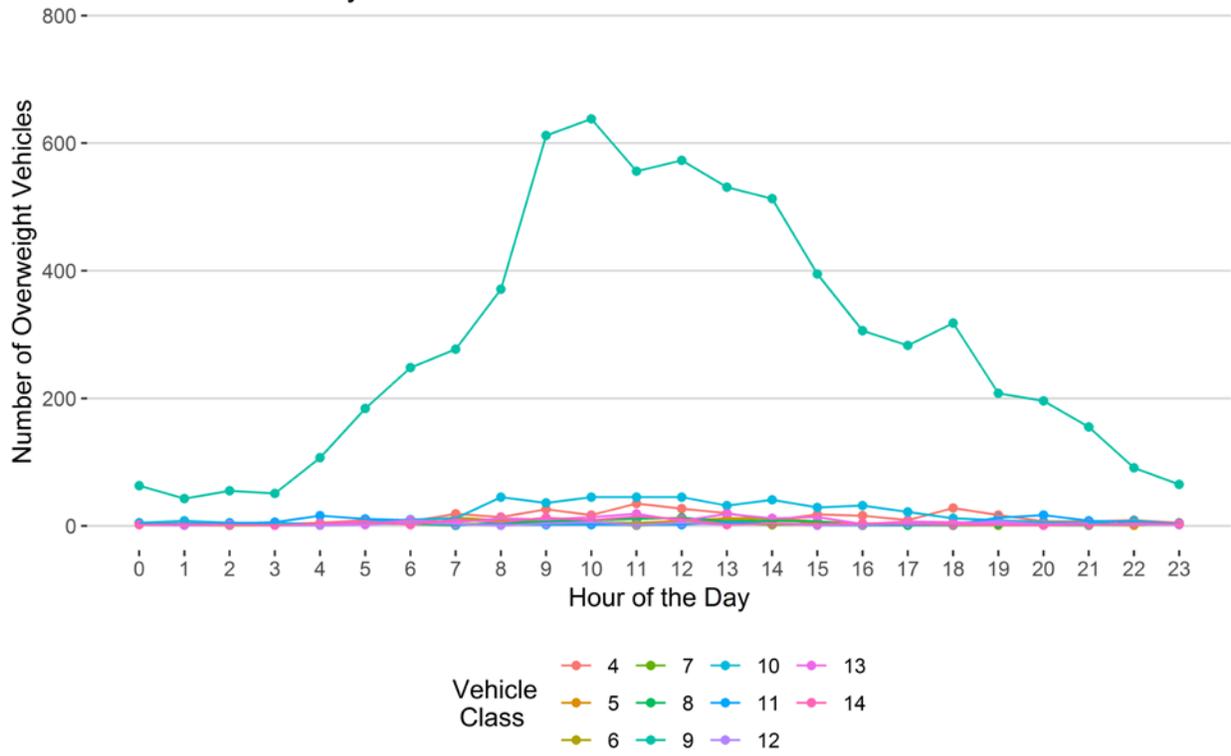


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

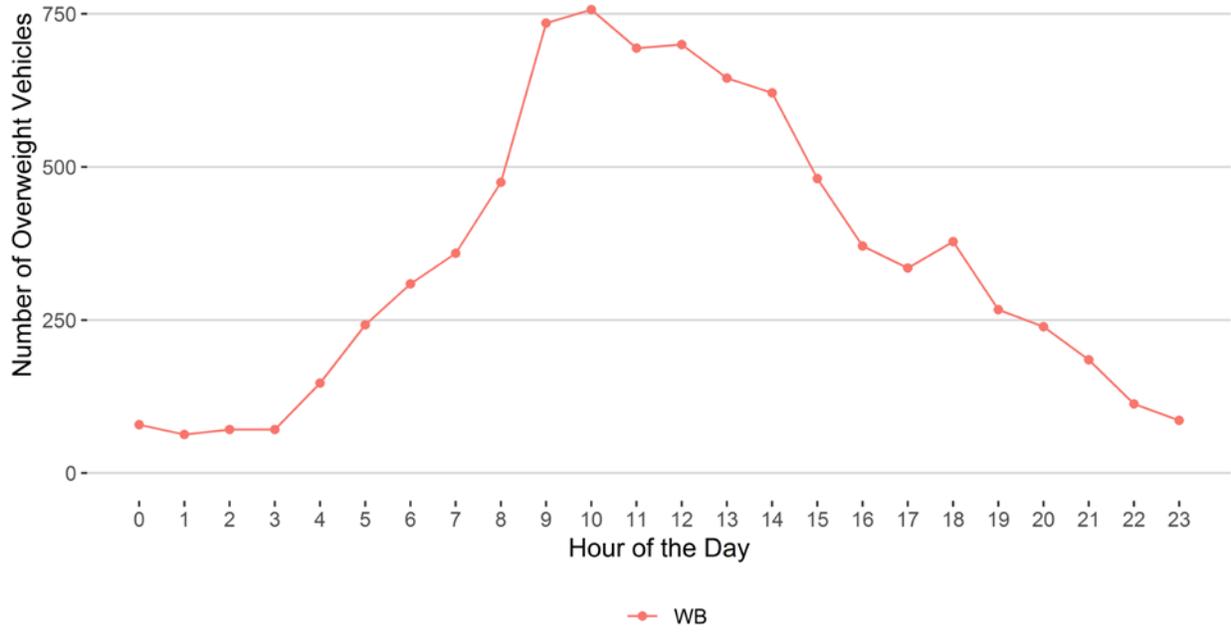
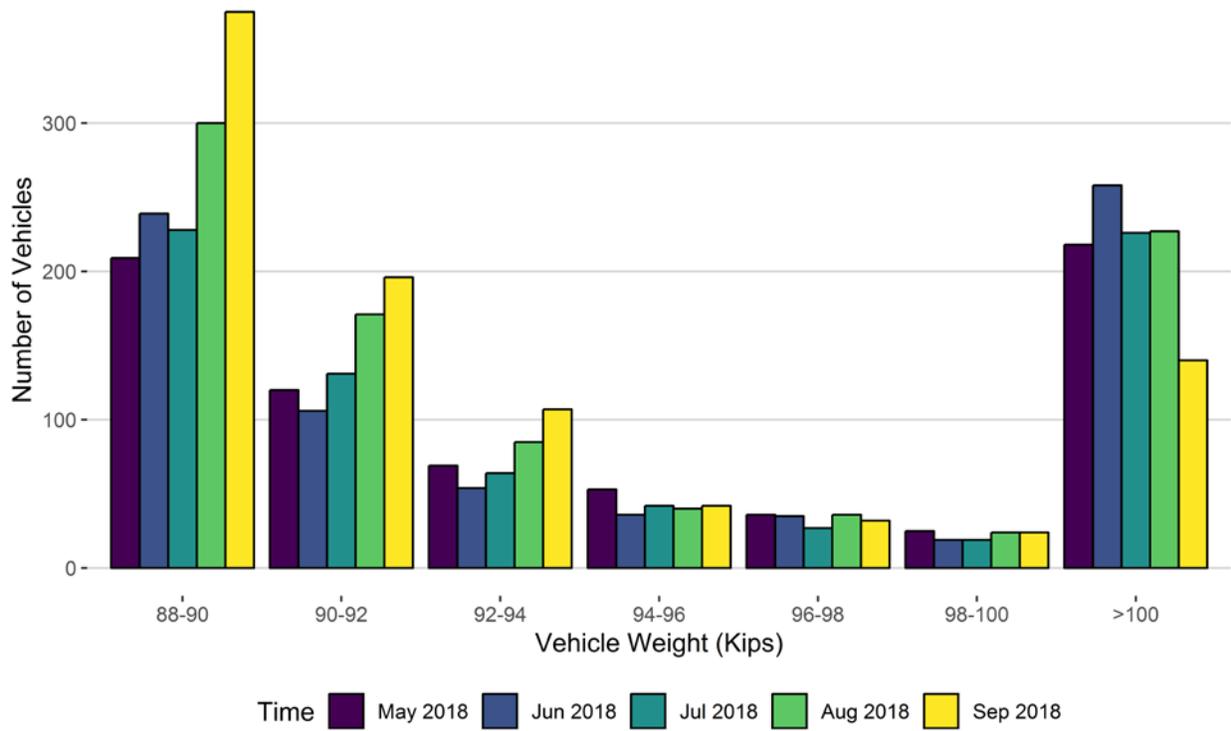


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>May 2018</i>	<i>Jun 2018</i>	<i>Jul 2018</i>	<i>Aug 2018</i>	<i>Sep 2018</i>
88-90	209	239	228	300	375
90-92	120	106	131	171	196
92-94	69	54	64	85	107
94-96	53	36	42	40	42
96-98	36	35	27	36	32
98-100	25	19	19	24	24
>100	218	258	226	227	140
Total	730	747	737	883	916

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

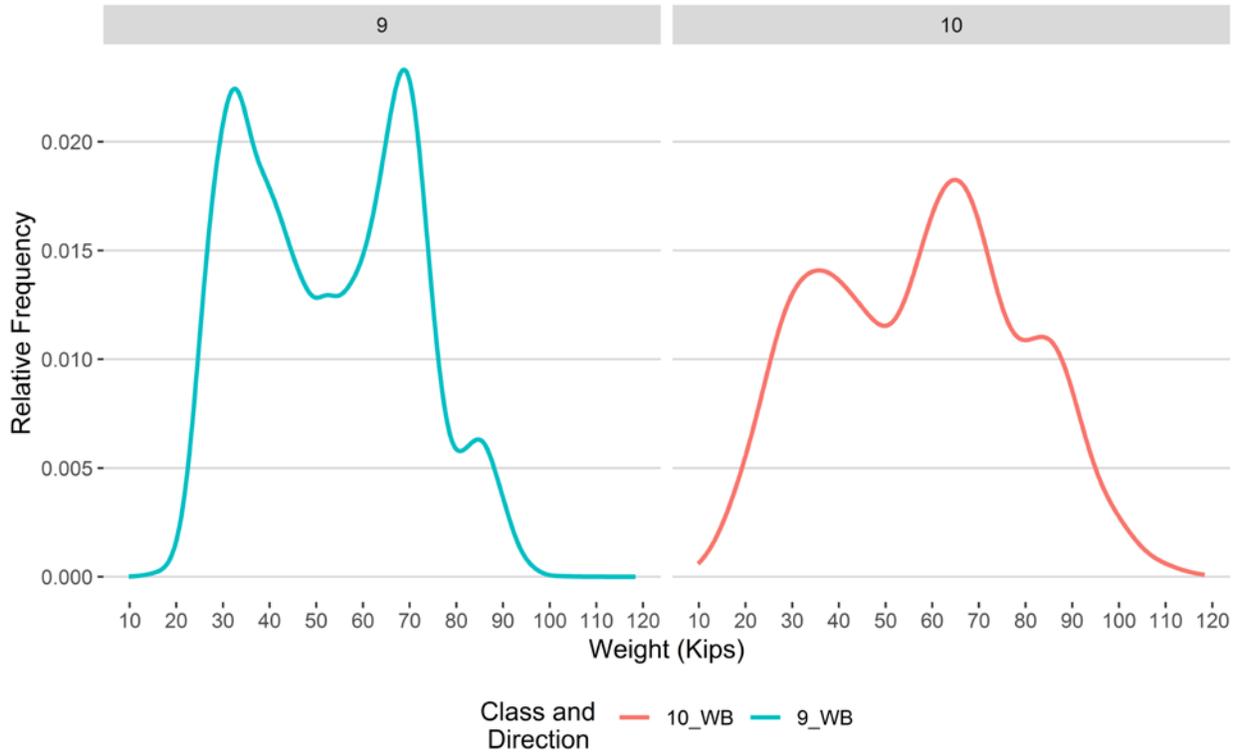


Figure 9 - Freight Percentage by Direction and Class

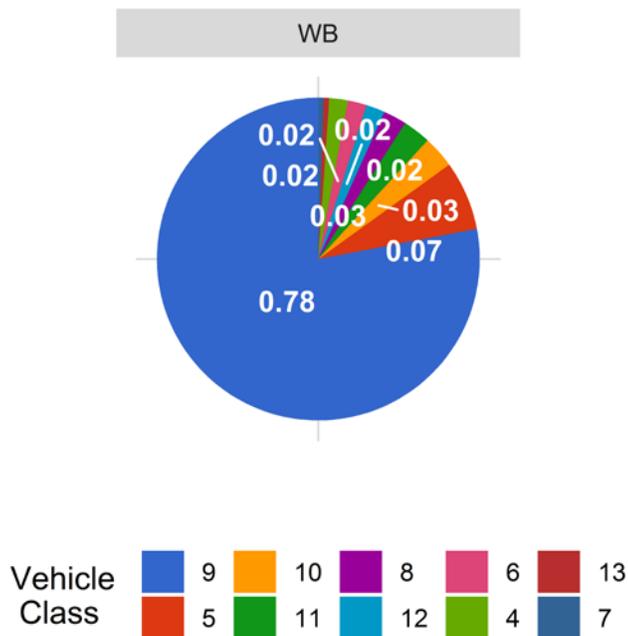


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

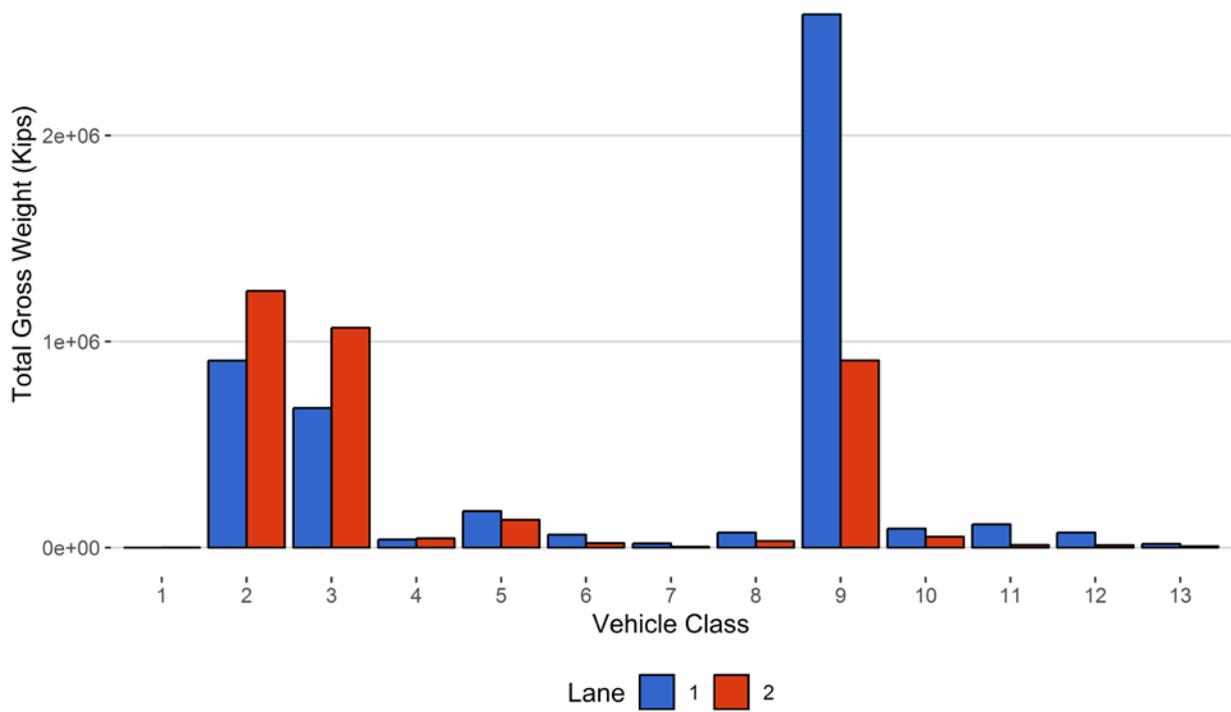


Figure 11 - Total Gross Vehicle Weight t

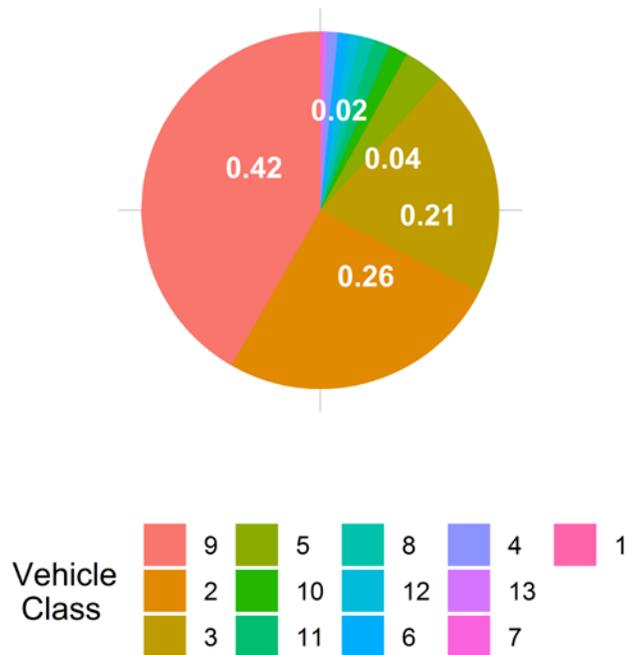


Figure 12 - Total ESALs by Class and Lane

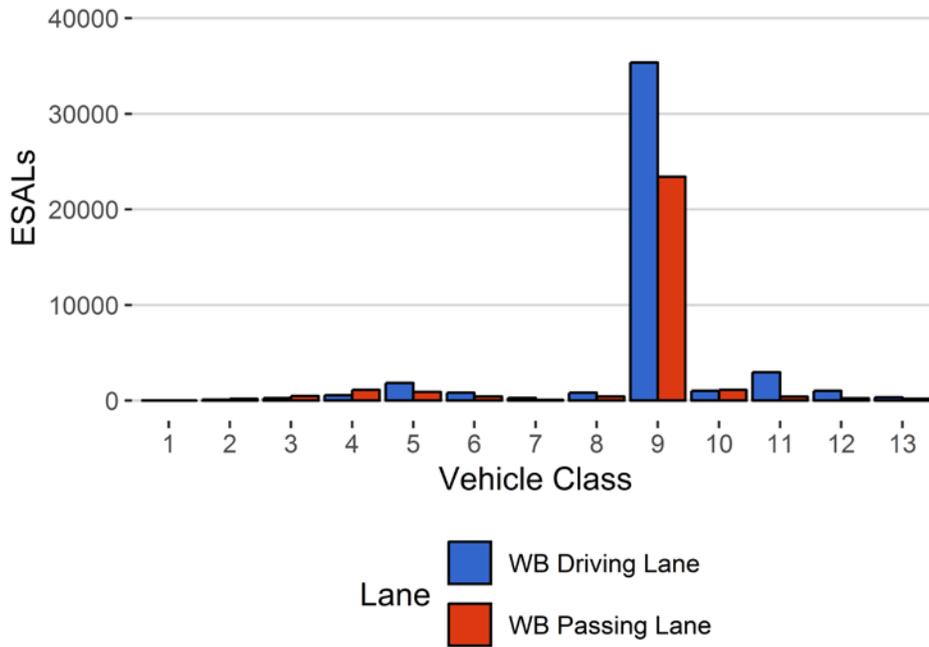


Figure 13 - ESALs by Class

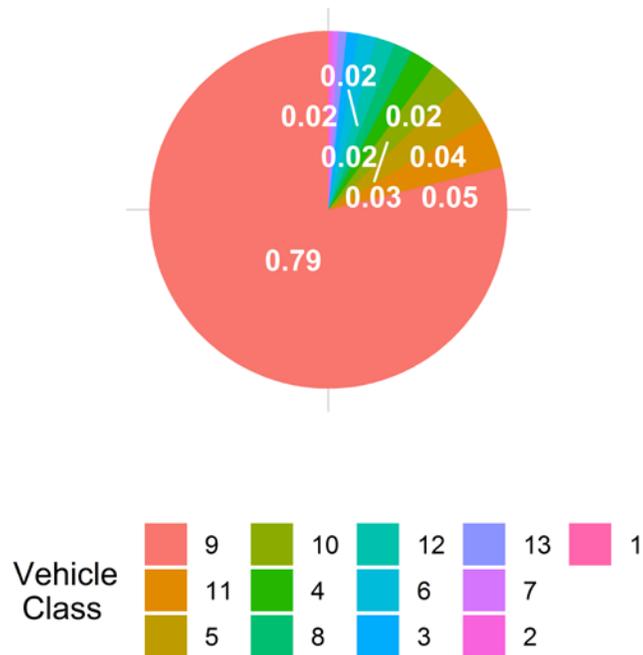


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
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

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	3	85	0	0	0
2	17668	530042	58	0	0
3	9082	272457	29.8	0	0
4	104	3117	0.3	309	3.7
5	814	24414	2.7	138	1.7
6	102	3060	0.3	97	1.2
7	17	515	0.1	42	0.5
8	124	3731	0.4	88	1.1
9	2332	69959	7.7	6839	82.2
10	88	2651	0.3	470	5.6
11	69	2078	0.2	116	1.4
12	48	1429	0.2	62	0.7
13	9	279	0	158	1.9
TOTAL	30461	913816	100	8319	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>
2019-04-05	Friday	05:47:59	9	WB	2	118.44
2019-04-24	Wednesday	14:13:51	10	WB	2	118.39
2019-04-10	Wednesday	10:08:35	10	WB	2	111.92
2019-04-25	Thursday	10:40:10	10	WB	2	111.8
2019-04-28	Sunday	00:04:34	10	WB	1	111.76
2019-04-03	Wednesday	19:26:14	10	WB	2	111.21
2019-04-27	Saturday	21:13:51	10	WB	2	110.82
2019-04-19	Friday	17:44:09	10	WB	2	110.67
2019-04-01	Monday	19:18:56	10	WB	1	110.65
2019-04-06	Saturday	02:45:15	9	WB	1	110.22

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	WB	15	2953	410	13.9	78733	5423	20294
5	WB	8	23132	1746	7.5	298341	12479	63626
6	WB	19	2899	288	9.9	79231	4929	14811
7	WB	11.5	488	0	0	24007	0	9198
8	WB	31	3535	2021	57.2	59375	45017	6221
9	WB	33	66286	11957	18	3155371	340450	681257
10	WB	33.5	2512	426	17	133071	11257	31595
11	WB	36.5	1969	19	1	124386	567	26605
12	WB	36.5	1354	13	1	84463	325	17758
13	WB	31.5	264	0	0	24147	0	7915
TOTAL	****	****	105392	16880	****	4061125	****	879281

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>WB Driving Lane</i>	<i>WB Passing Lane</i>	<i>Total</i>	<i>Percentage</i>
1	22	86	108	0
2	907176	1245300	2152476	25.7
3	676927	1066707	1743635	20.8
4	38908	45249	84157	1
5	176477	134343	310820	3.7
6	62309	21851	84160	1
7	19795	4212	24007	0.3
8	73067	31325	104392	1.2
9	2587809	908012	3495822	41.7
10	91934	52394	144328	1.7
11	112556	12396	124952	1.5
12	72723	12065	84789	1
13	17765	6382	24147	0.3
TOTAL	4837469	3540323	8377791	100
GVW/LANE	57.74	42.26	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>WB Driving Lane</i>	<i>WB Passing Lane</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.0122
2	112	190	302	0.4	0.0012
3	276	485	762	1	0.0059
4	560	1132	1692	2.3	1.15
5	1858	916	2774	3.7	0.24
6	824	434	1257	1.7	0.87
7	286	97	383	0.5	1.56
8	836	434	1270	1.7	0.72
9	35357	23407	58764	78.8	1.77
10	1027	1121	2147	2.9	1.71
11	2966	401	3367	4.5	3.41
12	1026	240	1266	1.7	1.86
13	354	190	544	0.7	3.98
TOTAL	45482	29046	74528	100	17
ESALS/LANE	61	39	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>
May 2018	1028083	33164	4372	892548	86.8	135535.5	13.2
Jun 2018	1062451	35415	4414	930017	87.5	132434.5	12.5
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
TOTAL	5047903	-	-	4434758	-	613146	-
AVERAGE	1009581	34230	4003	886952	88	122629	12

ESALS

<i>Month</i>	<i>ESALS WB Driving Lane</i>	<i>ESALS WB Passing Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
May 2018	76544	26734	103278	1.3
Jun 2018	72524	26971	99496	1.2
Jul 2018	70515	25002	95518	1.3
Aug 2018	62410	29879	92289	1
Sep 2018	39826	23509	63334	1.2
TOTAL	321819	-	-	-
AVERAGE	64364	26419	90783	1

Gross Vehicle Weight

<i>Month</i>	<i>GVW WB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>Total GVW Kips</i>
May 2018	6691316	3734069	10425385
Jun 2018	6556272	3927565	10483836
Jul 2018	6501613	3913029	10414641
Aug 2018	6040668	4371275	10411943
Sep 2018	3908977	3125851	7034828
TOTAL	29698844	19071789	48770634
AVERAGE	5939769	3814358	9754127

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>
May 2018	9894	1	7.3	733	245
Jun 2018	9918	1	7.6	754	280
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
TOTAL	46368	-	-	4039	1190
AVERAGE	9273.6	1	7.7	807.8	238

Freight

<i>Month</i>	<i>WB Freight Tons</i>
May 2018	1252655
Jun 2018	1203088
Jul 2018	1158446
Aug 2018	1105836
Sep 2018	748630
TOTAL	5468655
AVERAGE	1093731.1