

MAY 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 May 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 <sup>1</sup>. Figure 1 shows the distribution of gross vehicle weights (GVW) in the Class 9s at this site for the last 12 months <sup>2</sup>. 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: 1067629 | Passenger Vehicles: 920637 | Heavy Commercial Vehicles: 146992

Monthly Average Daily Traffic (MADT): 34440 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 4742

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 5's.

### Overweight HCVs

**Volume trends.** Of a total of 146992 HCVs, 11375 of them were overweight <sup>3</sup>. These overweight HCVs contributed to 1.1% 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 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 <sup>4</sup>.

Using normal load limits ,2156 WB vehicles exceeded 88,000 pounds (1412 vehicles were Class 9's; 351 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from May 2019.

**Loaded vs. Unloaded HCVs.** Figure 10 shows the GVW distributions of Class 9's and 10's in May 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 1230391 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 1067629 vehicles with a combined GVW of 10943390 kips (1 kip = 1,000 pounds = 0.5 tons) in May 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

**Pavement Design.** A total of 104215 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 44% 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>*

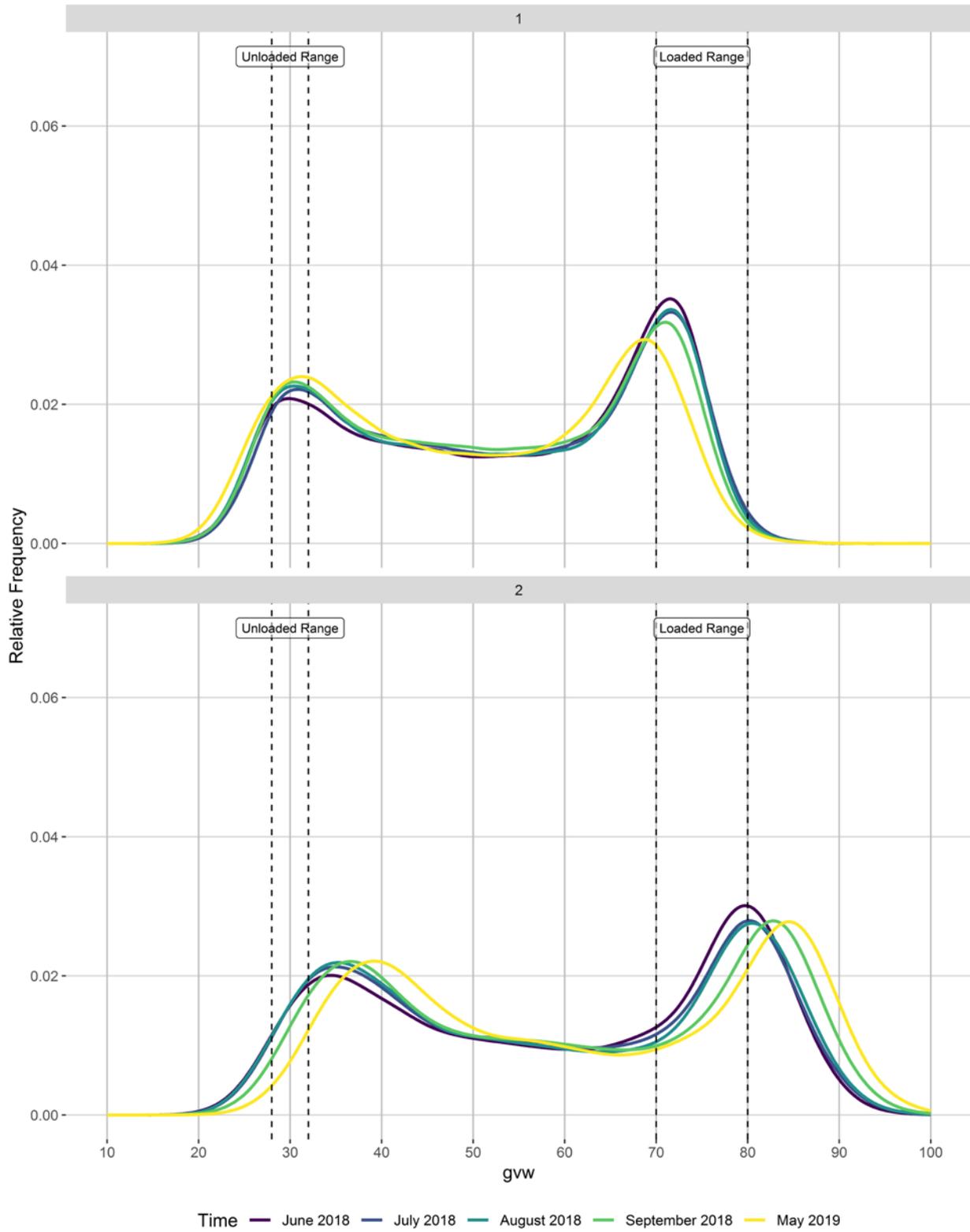
MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at: <http://www.dot.state.mn.us/traffic/data/data-products.html#weight>

- <sup>1</sup> 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

- <sup>2</sup> 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.
- <sup>3</sup> 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](http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp)
- <sup>4</sup> 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.

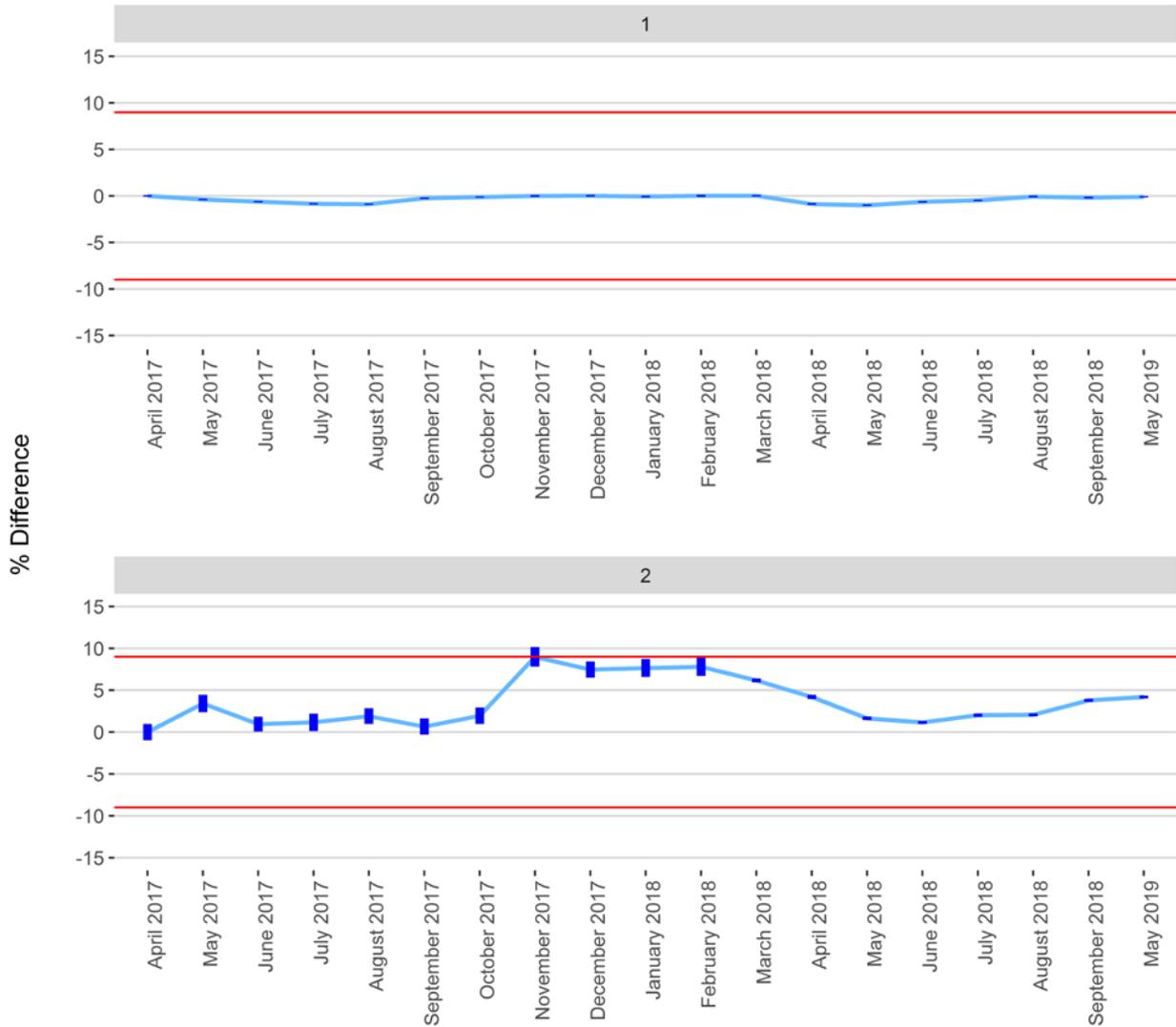
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Figure 1 - Monthly Class 9 GVW Histogram



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

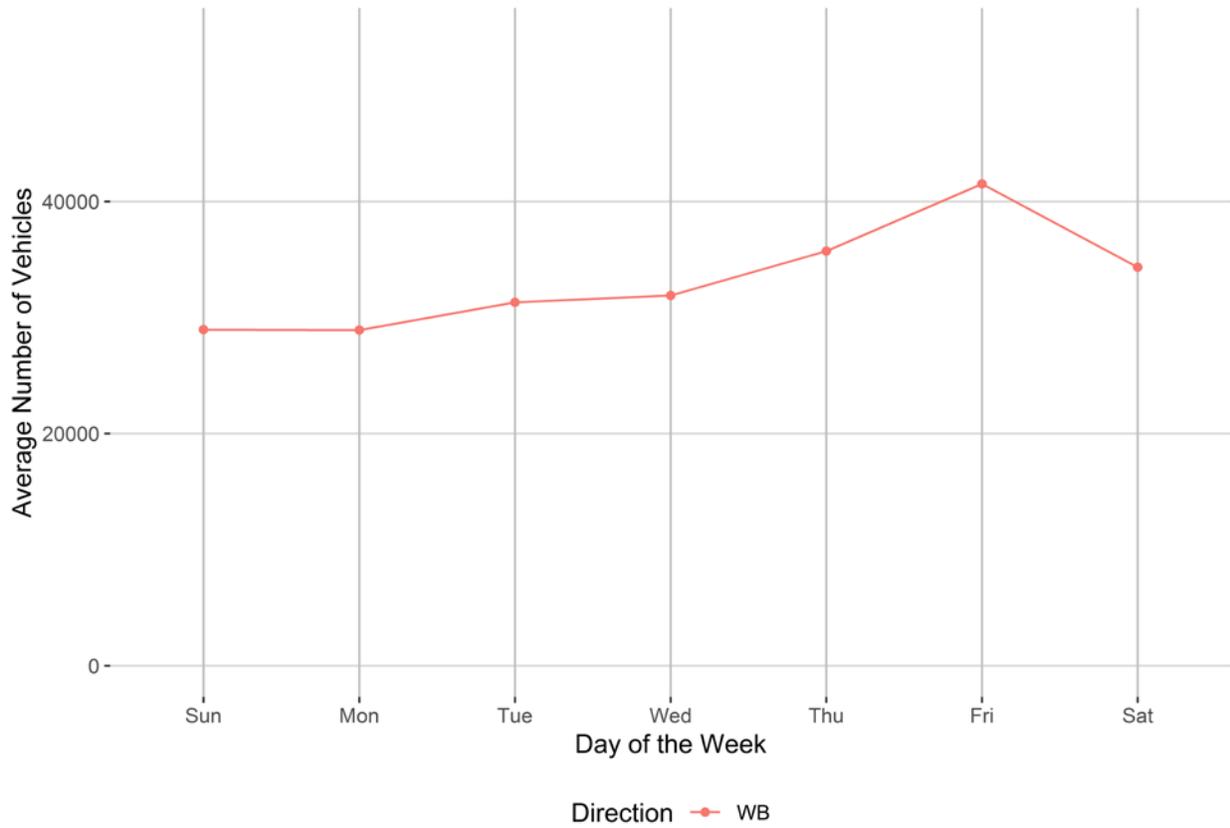


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

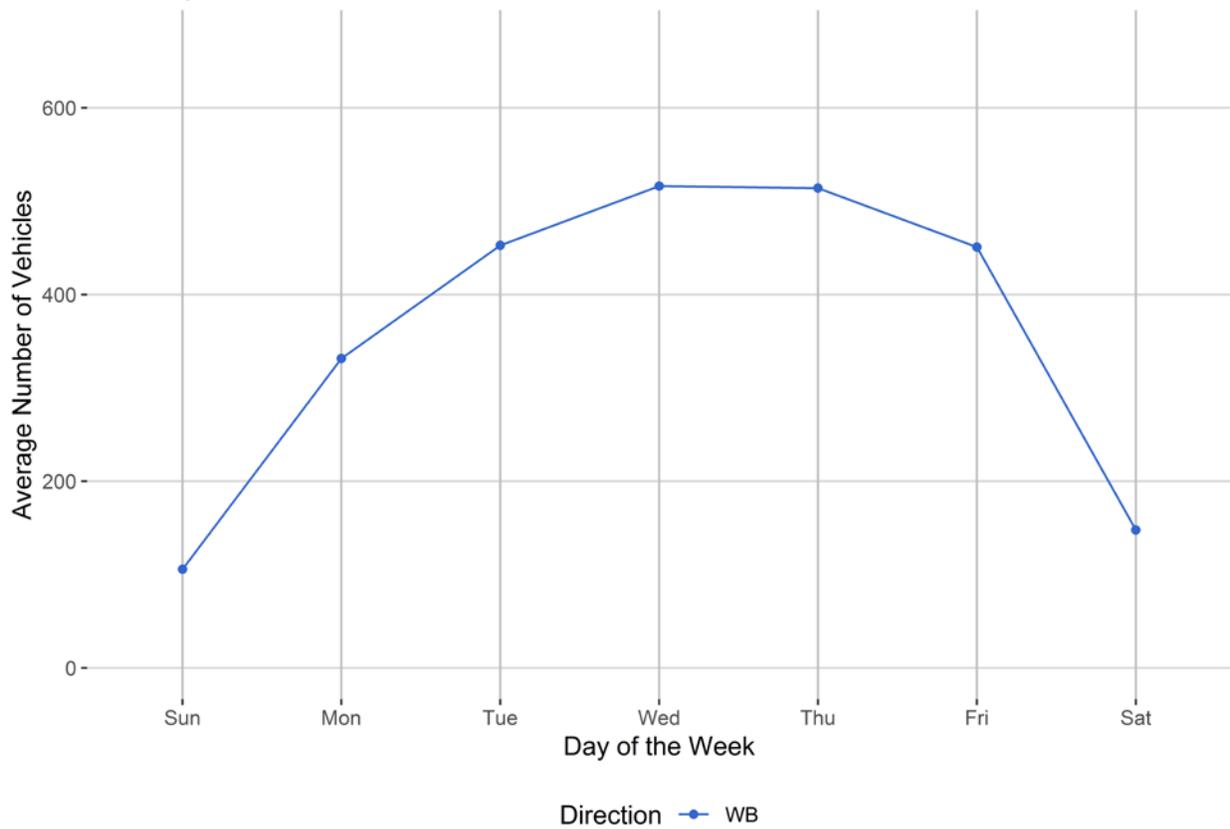


Figure 4 - Passenger Vehicles vs. Hour of the Day

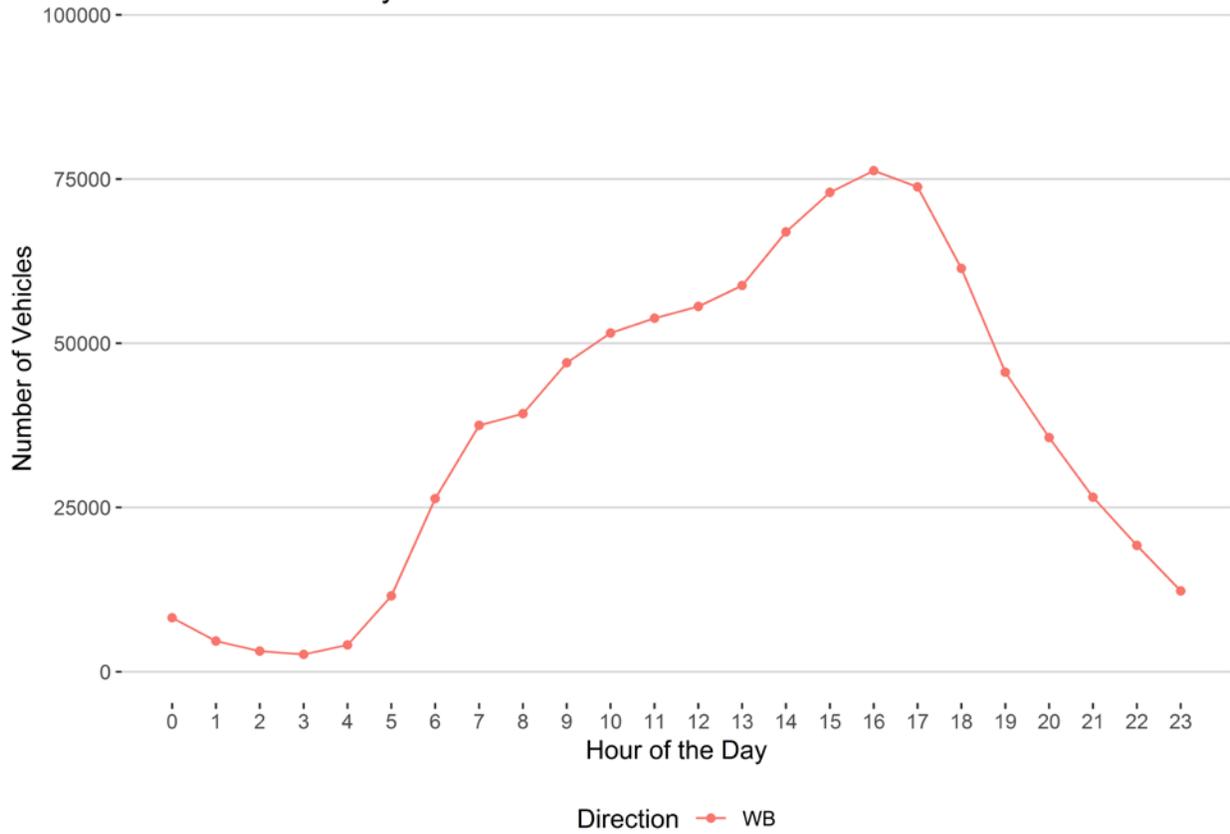


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

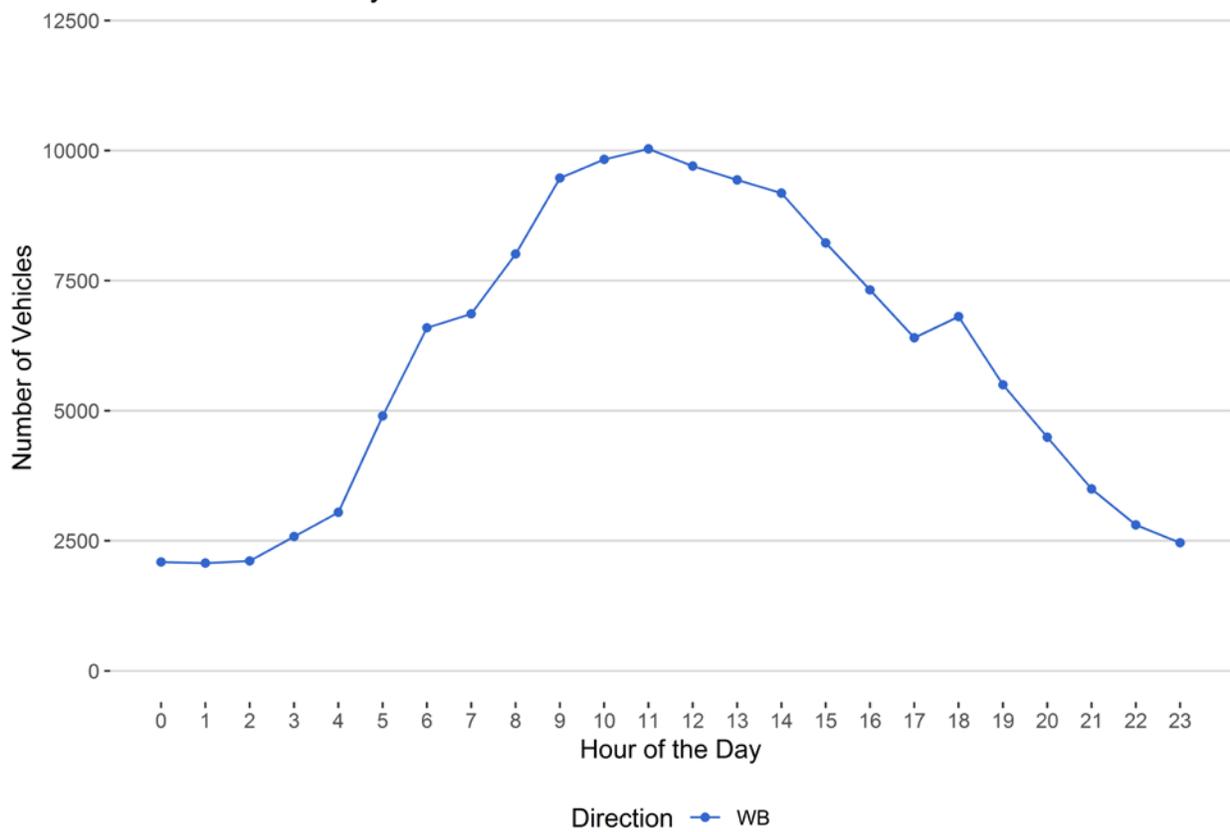


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

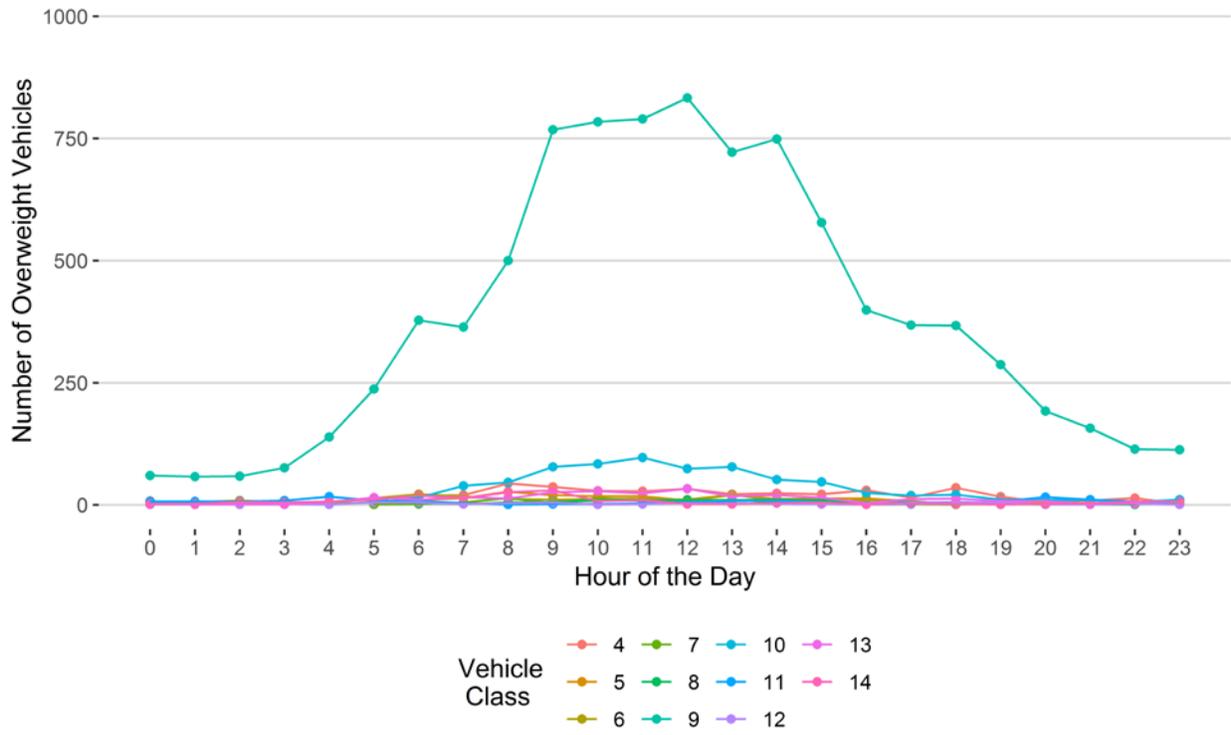


Figure 7 - Overweight Vehicles by Direction  
Hour of the Day

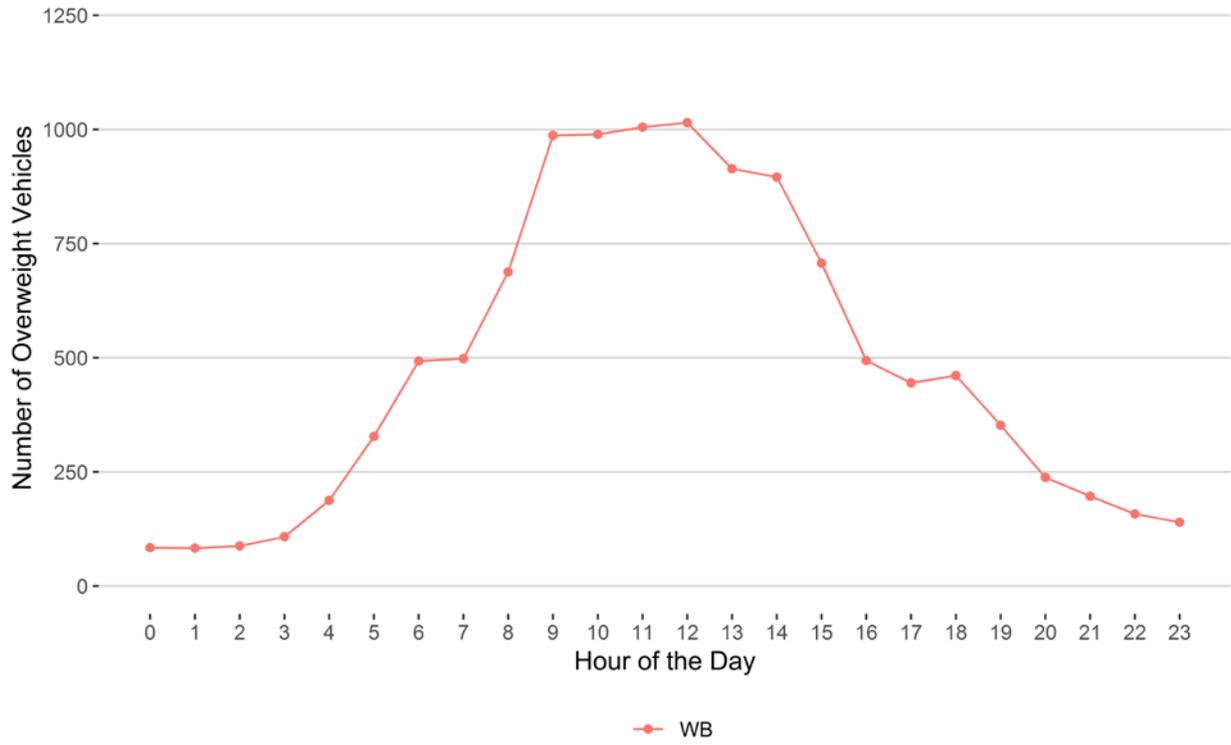
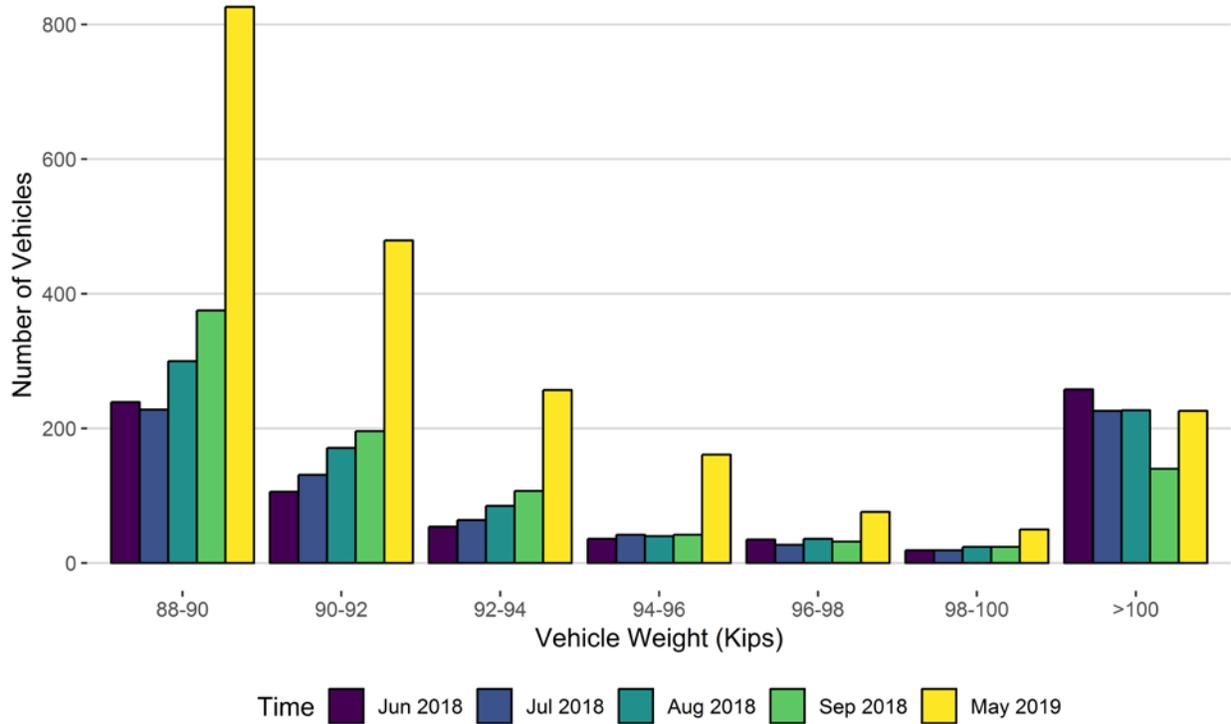


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Jun 2018</i>	<i>Jul 2018</i>	<i>Aug 2018</i>	<i>Sep 2018</i>	<i>May 2019</i>
88-90	239	228	300	375	826
90-92	106	131	171	196	479
92-94	54	64	85	107	257
94-96	36	42	40	42	161
96-98	35	27	36	32	76
98-100	19	19	24	24	50
>100	258	226	227	140	226
<b>Total</b>	<b>747</b>	<b>737</b>	<b>883</b>	<b>916</b>	<b>2075</b>

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

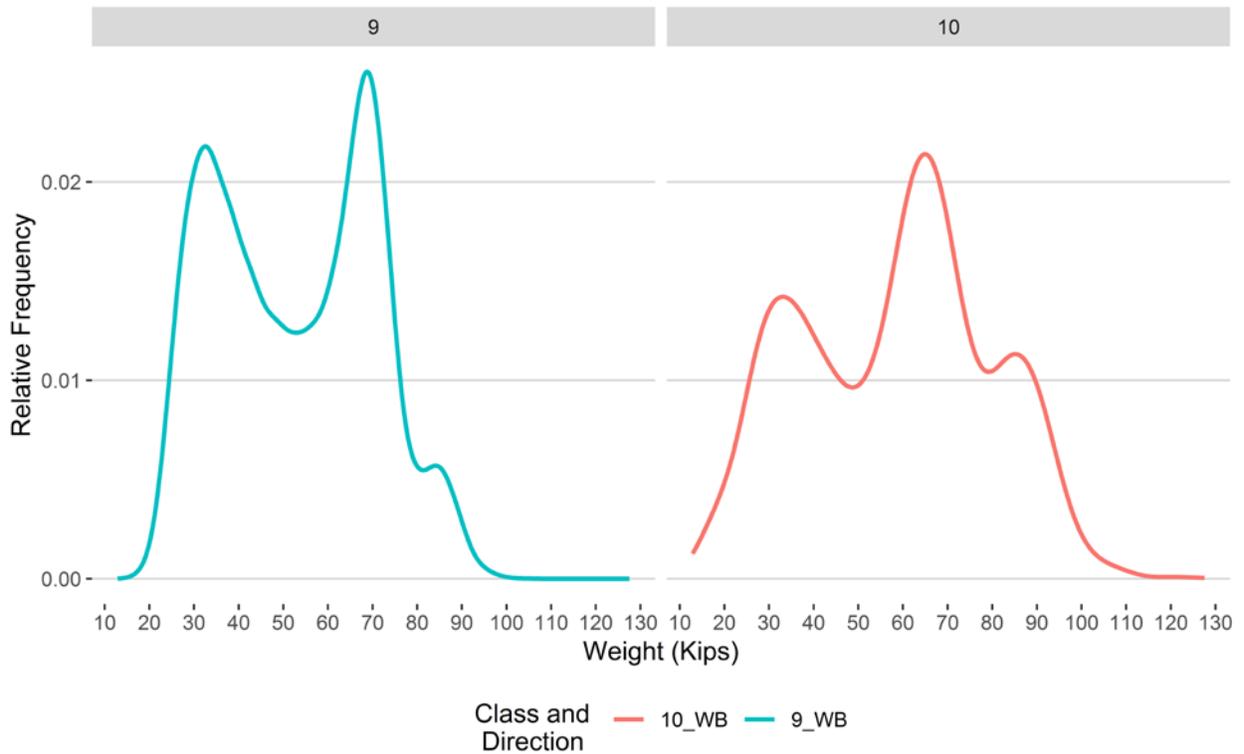
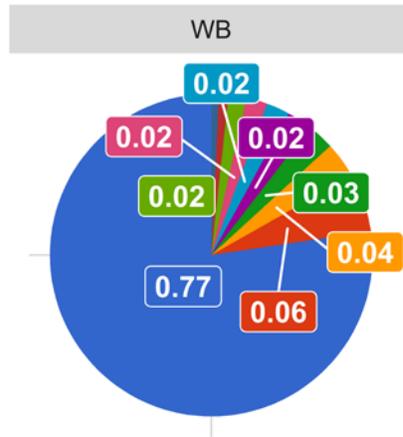


Figure 9 - Freight Percentage by Direction and Class



Vehicle Class	a	9	a	10	a	8	a	4	a	7
	a	5	a	11	a	6	a	12	a	13

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

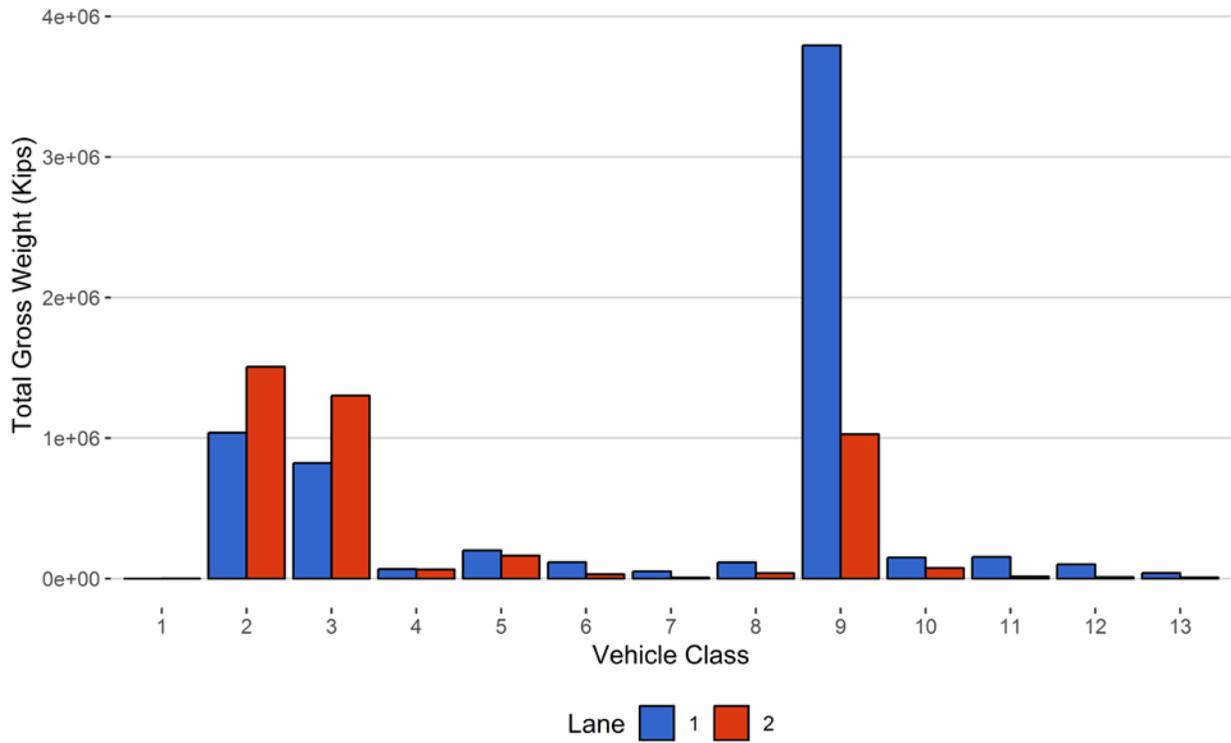


Figure 11 - Total Gross Vehicle Weight t

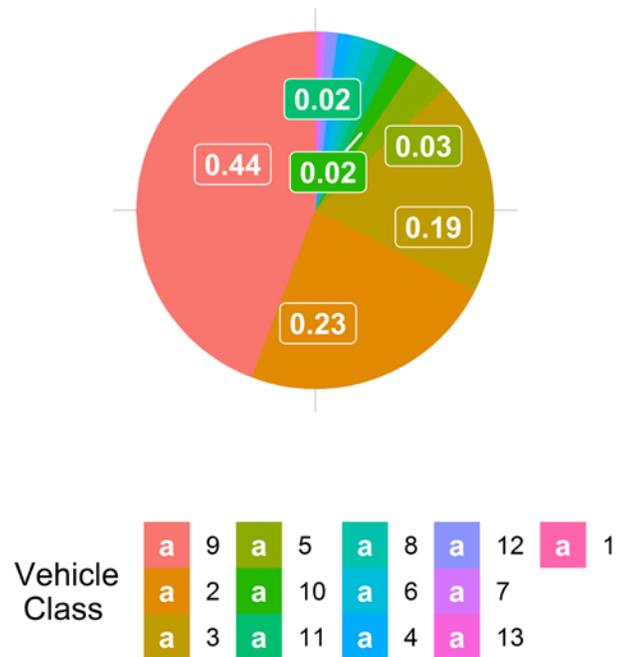


Figure 12 - Total ESALs by Class and Lane

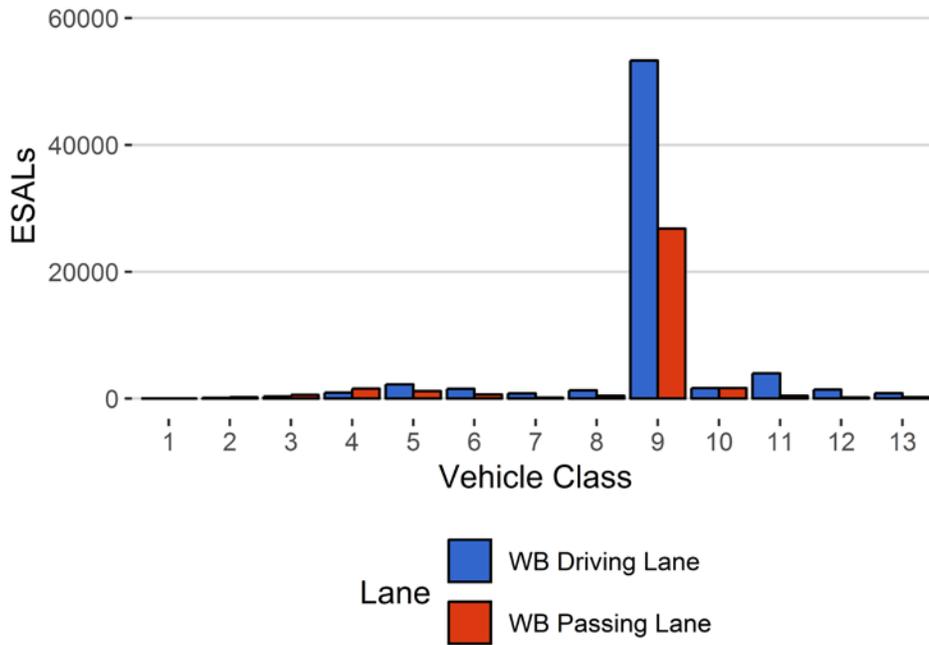
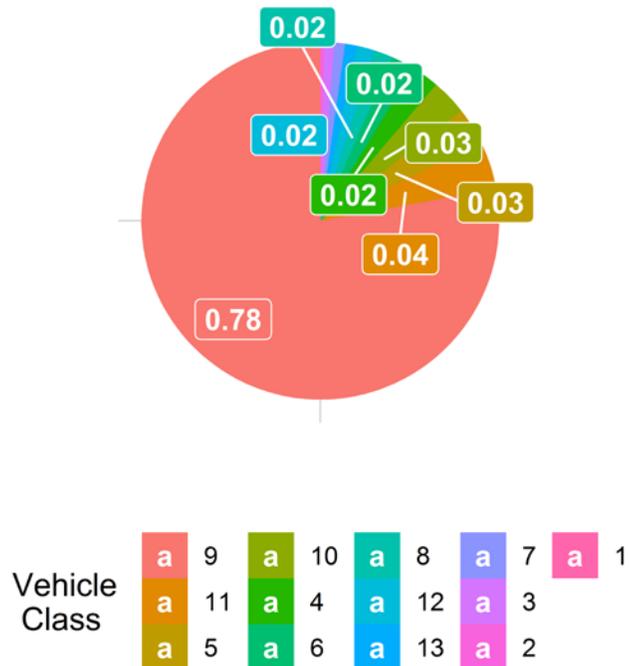


Figure 13 - ESALs by Class



Vehicle Class	a	9	a	10	a	8	a	7	a	1
	a	11	a	4	a	12	a	3	a	2
	a	5	a	6	a	13	a	2		

**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
May 2019	10.53	-0.10	12.28	4.19

**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	6	173	0	0	0
2	19542	605789	56.7	0	0
3	10151	314674	29.5	0	0
4	155	4810	0.5	444	3.9
5	889	27574	2.6	213	1.9
6	165	5120	0.5	196	1.7
7	39	1195	0.1	89	0.8
8	177	5486	0.5	107	0.9
9	3023	93701	8.8	9092	79.9
10	128	3956	0.4	751	6.6
11	89	2754	0.3	148	1.3
12	60	1852	0.2	58	0.5
13	18	544	0.1	277	2.4
<b>TOTAL</b>	<b>34440</b>	<b>1067629</b>	<b>100</b>	<b>11375</b>	<b>100</b>

**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>
2019-05-24	Friday	09:47:21	10	WB	2	127.55
2019-05-24	Friday	17:13:10	10	WB	2	121.47
2019-05-24	Friday	01:02:45	9	WB	2	120.86
2019-05-04	Saturday	22:29:41	10	WB	2	120.76
2019-05-10	Friday	10:21:26	9	WB	2	120.3
2019-05-11	Saturday	22:40:11	10	WB	2	119.91
2019-05-09	Thursday	12:40:33	10	WB	2	113.22
2019-05-16	Thursday	19:12:01	10	WB	1	112.78
2019-05-17	Friday	06:01:49	10	WB	2	111.25
2019-05-07	Tuesday	20:35:51	9	WB	2	110.45

**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	4694	663	14.1	123636	8809	31585
5	WB	8	26911	1952	7.3	350212	14018	75270
6	WB	19	4997	366	7.3	141157	6355	26584
7	WB	11.5	1166	1	0.1	59336	11	22969
8	WB	31	5354	3125	58.4	87006	67587	8954
9	WB	33	91448	16554	18.1	4353421	469474	940960
10	WB	33.5	3861	642	16.6	207950	17210	50057
11	WB	36.5	2688	41	1.5	168169	1034	35777
12	WB	36.5	1807	24	1.3	111256	689	23088
13	WB	31.5	531	1	0.2	46989	24	15147
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>143457</b>	<b>23369</b>	<b>****</b>	<b>5649133</b>	<b>****</b>	<b>1230391</b>

**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	61	167	229	0
2	1038698	1506766	2545464	23.3
3	821511	1303103	2124614	19.5
4	67918	64527	132445	1.2
5	200778	163452	364230	3.3
6	116999	30513	147512	1.4
7	51850	7497	59347	0.5
8	116049	38544	154593	1.4
9	3794965	1027931	4822896	44.2
10	149942	75218	225159	2.1
11	154059	15144	169203	1.6
12	100989	10956	111945	1
13	38934	8080	47014	0.4
<b>TOTAL</b>	<b>6652753</b>	<b>4251898</b>	<b>10904651</b>	<b>100</b>
<b>GVW/LANE</b>	<b>61.01</b>	<b>38.99</b>	<b>100</b>	<b>0</b>

**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	0.0059
2	128	230	358	0.4	0.0012
3	353	595	948	0.9	0.0062
4	945	1591	2536	2.5	1.08
5	2241	1198	3438	3.3	0.26
6	1541	644	2185	2.1	0.88
7	832	152	983	1	1.68
8	1314	478	1792	1.7	0.67
9	53303	26806	80110	77.9	1.75
10	1666	1672	3338	3.2	1.73
11	4007	456	4463	4.3	3.31
12	1440	200	1640	1.6	1.81
13	851	238	1089	1.1	4.03
<b>TOTAL</b>	<b>68620</b>	<b>34261</b>	<b>102881</b>	<b>100</b>	<b>17</b>
<b>ESALS/LANE</b>	<b>66.7</b>	<b>33.3</b>	<b>100</b>	<b>-</b>	<b>-</b>

**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>
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
May 2019	1067629	34440	4742	920637	86.2	146992	13.8
<b>TOTAL</b>	<b>5087449</b>	-	-	<b>4462847</b>	-	<b>624603</b>	-
<b>AVERAGE</b>	<b>1017490</b>	<b>34485</b>	<b>4077</b>	<b>892569</b>	<b>88</b>	<b>124921</b>	<b>12</b>

## 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>
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
May 2019	68732	35483	104215	0.8
<b>TOTAL</b>	<b>314007</b>	-	-	-
<b>AVERAGE</b>	<b>62802</b>	<b>28169</b>	<b>90970</b>	<b>1</b>

## Gross Vehicle Weight

<i>Month</i>	<i>GVW WB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>Total GVW Kips</i>
Jun 2018	6660185	4283216	10943402
Jul 2018	6556272	3927565	10483836
Aug 2018	6501613	3913029	10414641
Sep 2018	6040668	4371275	10411943
May 2019	3908977	3125851	7034828
<b>TOTAL</b>	<b>29667714</b>	<b>19620936</b>	<b>49288650</b>
<b>AVERAGE</b>	<b>5933543</b>	<b>3924187</b>	<b>9857730</b>

## 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>
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
May 2019	11556	1.1	8	2156	290
<b>TOTAL</b>	<b>48030</b>	<b>-</b>	<b>-</b>	<b>5462</b>	<b>1235</b>
<b>AVERAGE</b>	<b>9606</b>	<b>1</b>	<b>7.9</b>	<b>1092.4</b>	<b>247</b>

## Freight

<i>Month</i>	<i>WB Freight Tons</i>
Jun 2018	1203088
Jul 2018	1158446
Aug 2018	1105836
Sep 2018	748630
May 2019	1230391
<b>TOTAL</b>	<b>5446391</b>
<b>AVERAGE</b>	<b>1089278.3</b>