

JULY 2019



**WIM #39  
MN 43, MP 45.2  
WINONA, MN**

**MONTHLY  
REPORT**



*Your Destination...Our Priority*



## WIM Site Location

WIM #39 is located on MN 43 near Winona in Winona county.

## System Operation

WIM #39 was operational for the entire month of July 2019. Volume was computed using all monthly data.

## System Calibration

WIM #39 was most recently calibrated on 2018-11-28. 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 Class 9 vehicles at this site for the last 12 months of operation <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: 348634 | Passenger Vehicles: 325932 | Heavy Commercial Vehicles: 22702

Monthly Average Daily Traffic (MADT): 11206 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 732

See Table 2 for vehicle class breakdown

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

**Volume trends.** NB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays. SB 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), NB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, SB PVs peaked in volume between 07 AM and 04 PM

### Heavy Commercial Vehicles (HCVs)

**Volume trends.** On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 03 PM and 05 PM, while volume going SB peaked between 07 AM and 04 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 22702 HCVs, 4561 of them were overweight <sup>3</sup>. These overweight HCVs contributed to 1.3% of total monthly volume, and 20.4% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Tuesdays, with lowest volumes reported on Sundays. See Figure 3 .

The top two overweight violators by class were the class 9 and class 7 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 61.2% of all overweight vehicles traveling NB this month (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 April.

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 ,96 NB vehicles exceeded 88,000 pounds (45 vehicles were Class 12's; 35 vehicles were Class 9's). Of vehicles traveling SB,

46 NB vehicles exceeded 88,000 pounds (32 vehicles were Class 9's; 12 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from July 2019.

**Loaded vs. Unloaded HCVs.** Figure 10 shows the GVW distributions of Class 9s and 10s in July 2019. Data suggests that there were greater numbers of fully\_loaded Class 9's than empty Class 9's traveling NB, while there were more empty Class 9's than fully\_loaded traveling SB. Data also suggests that there were more fully\_loaded Class 10's than empty traveling in the NB direction. In the SB direction, there were more fully\_loaded class 10 vehicles.

**Freight Totals.** A total of 197804 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (53.1%) than SB (46.9%). See Table 4 and Figure 11 for more freight information.

**####Infrastructure Considerations Bridge.** Bridge No. 5930 is approximately 0.1 miles north of WIM #39, and Bridge No. 5900 is 0.3 miles south of WIM #39. WIM #39 recorded a total of 348634 vehicles with a combined GVW of 2406240 kips (1 kip = 1,000 pounds = 0.5 tons) in July 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

**Pavement Design.** A total of 18908 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 54.9% of all ESALs were recorded NB while 45.1% was observed SB. In particular, 73% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 27% 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:

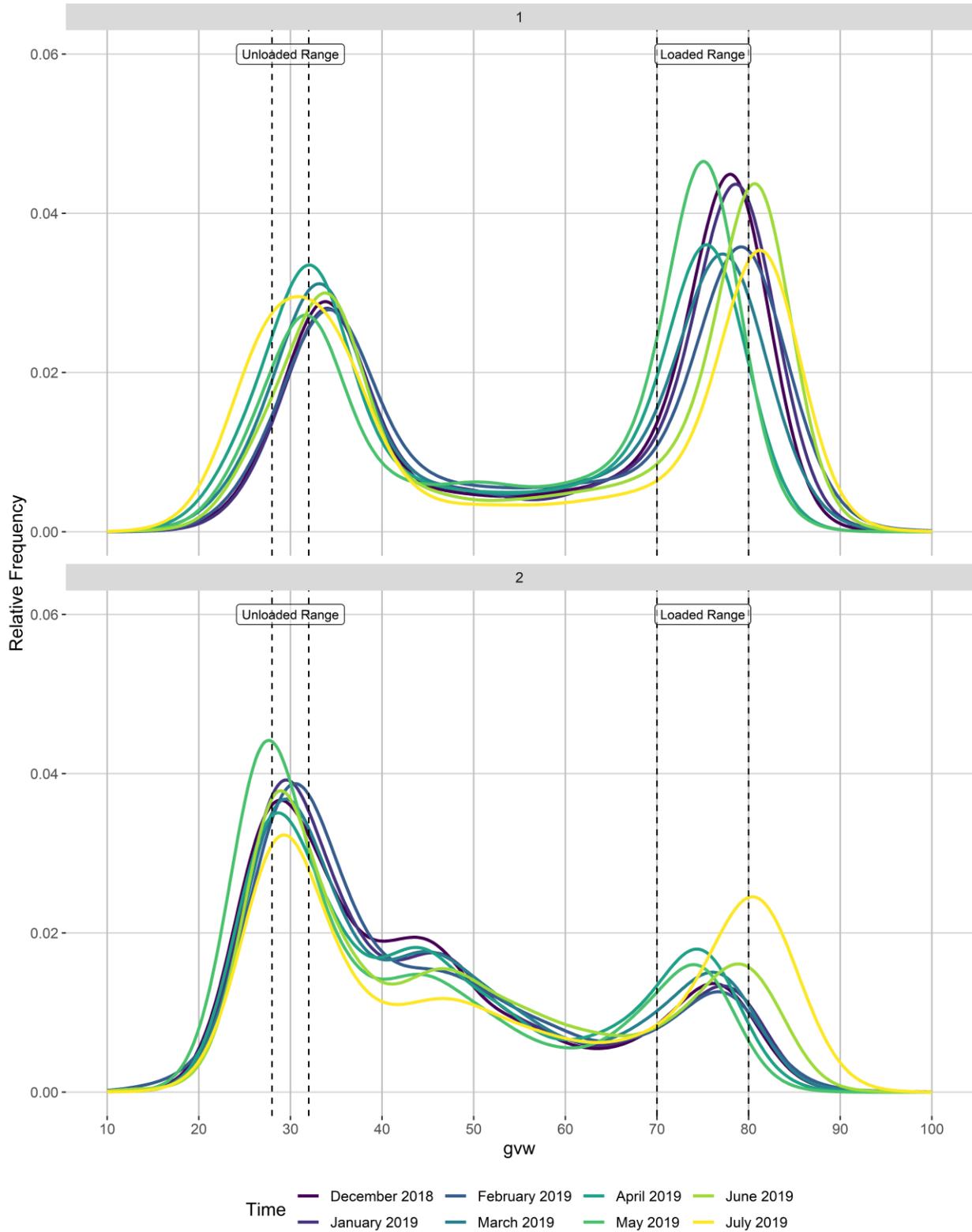
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

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.

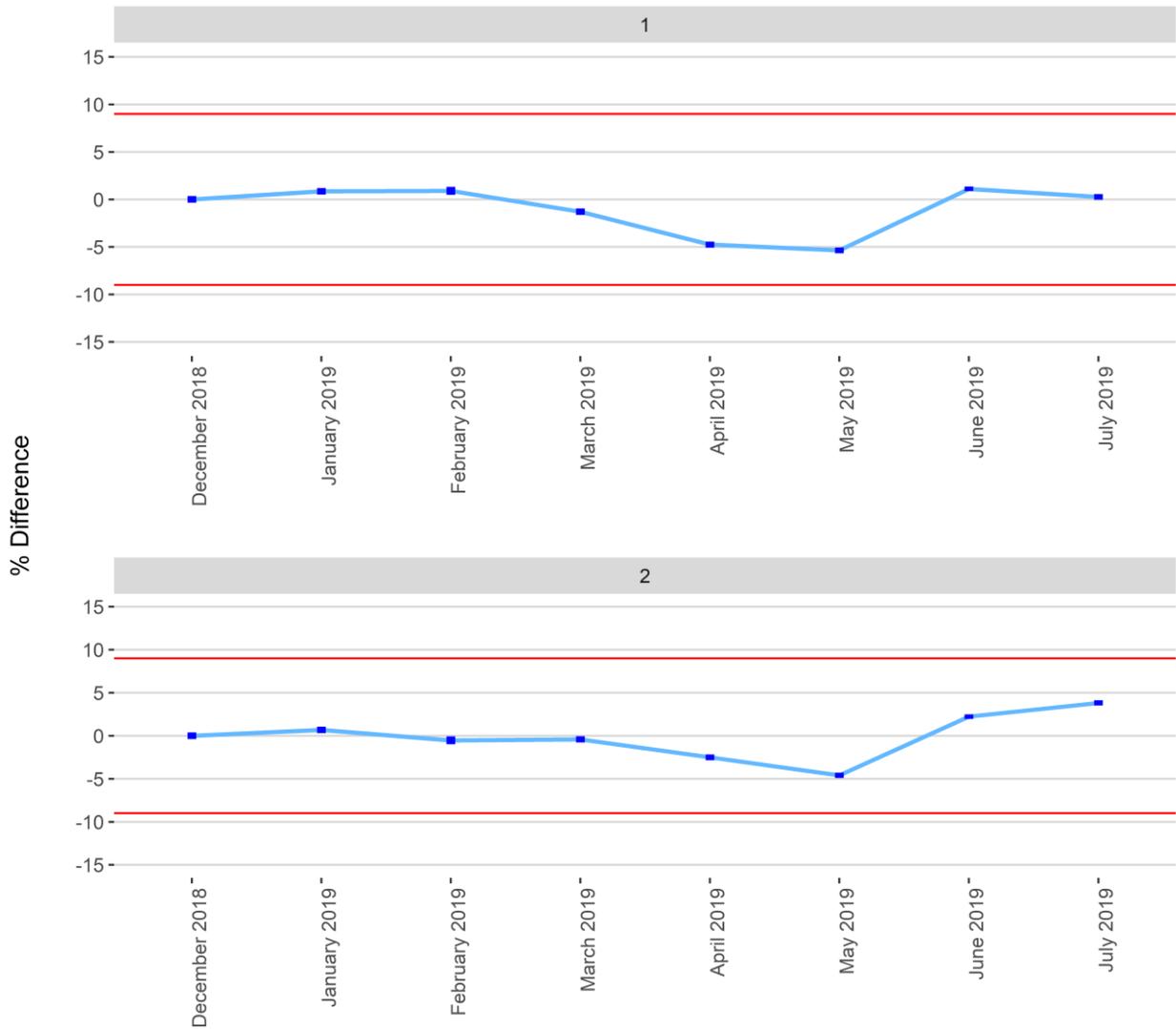
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Figure 1 - Monthly Class 9 GVW Histogram



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

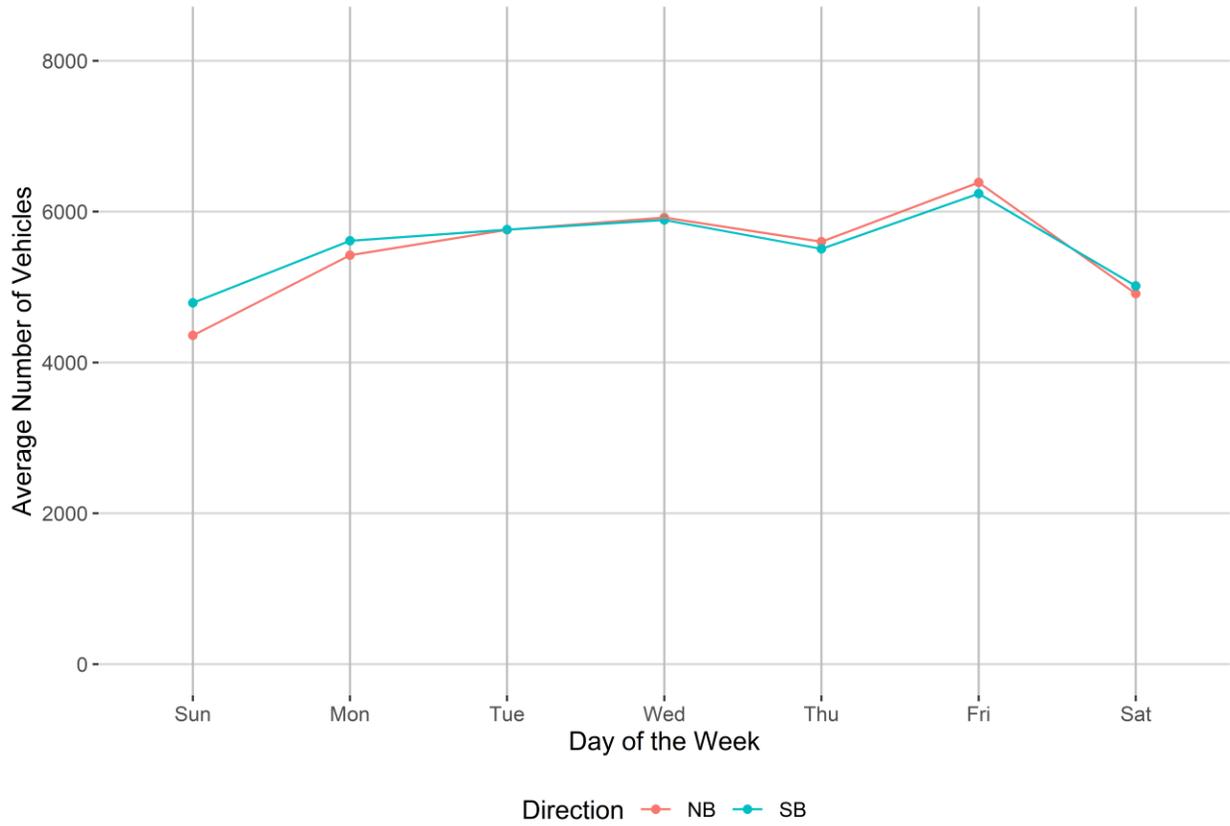


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

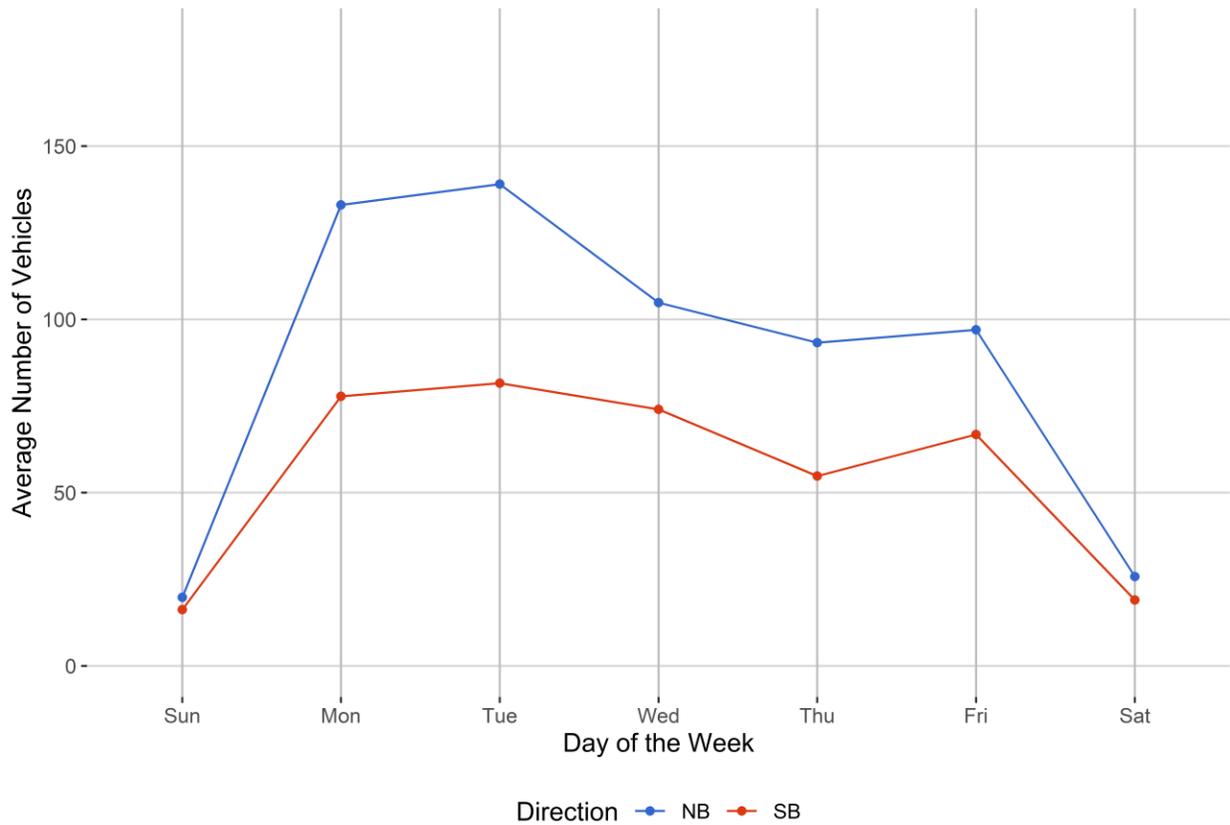


Figure 4 - Passenger Vehicles vs. Hour of the Day

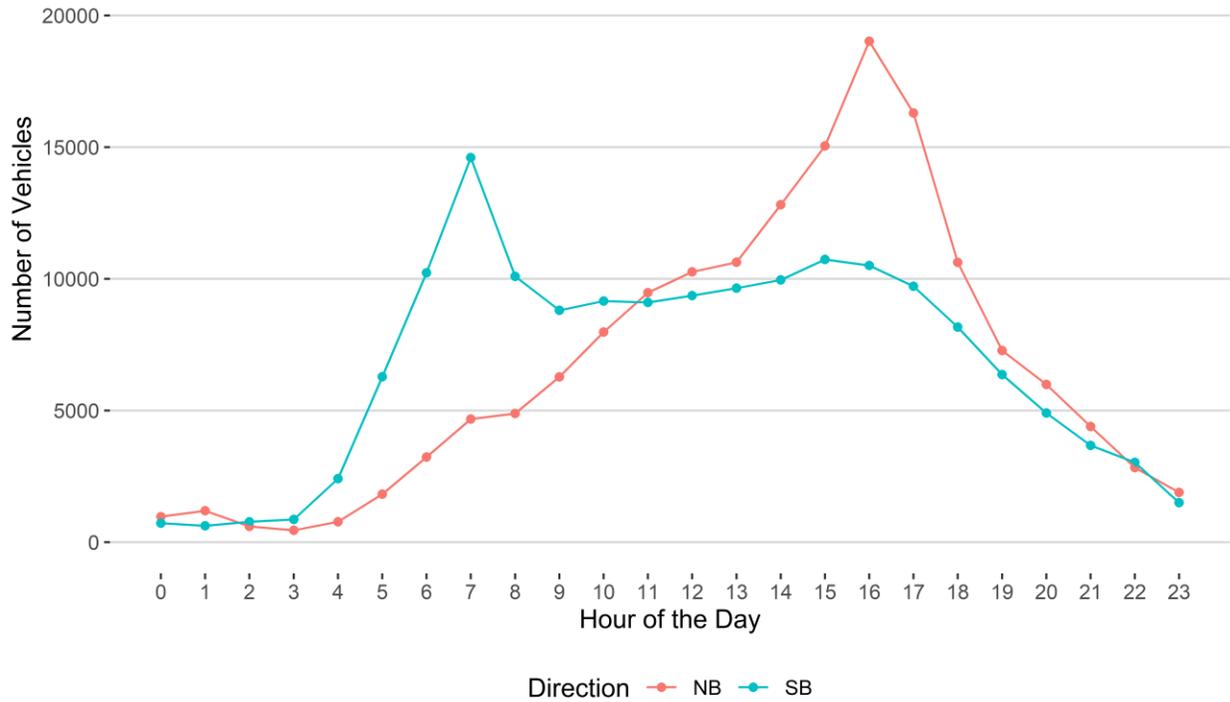


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

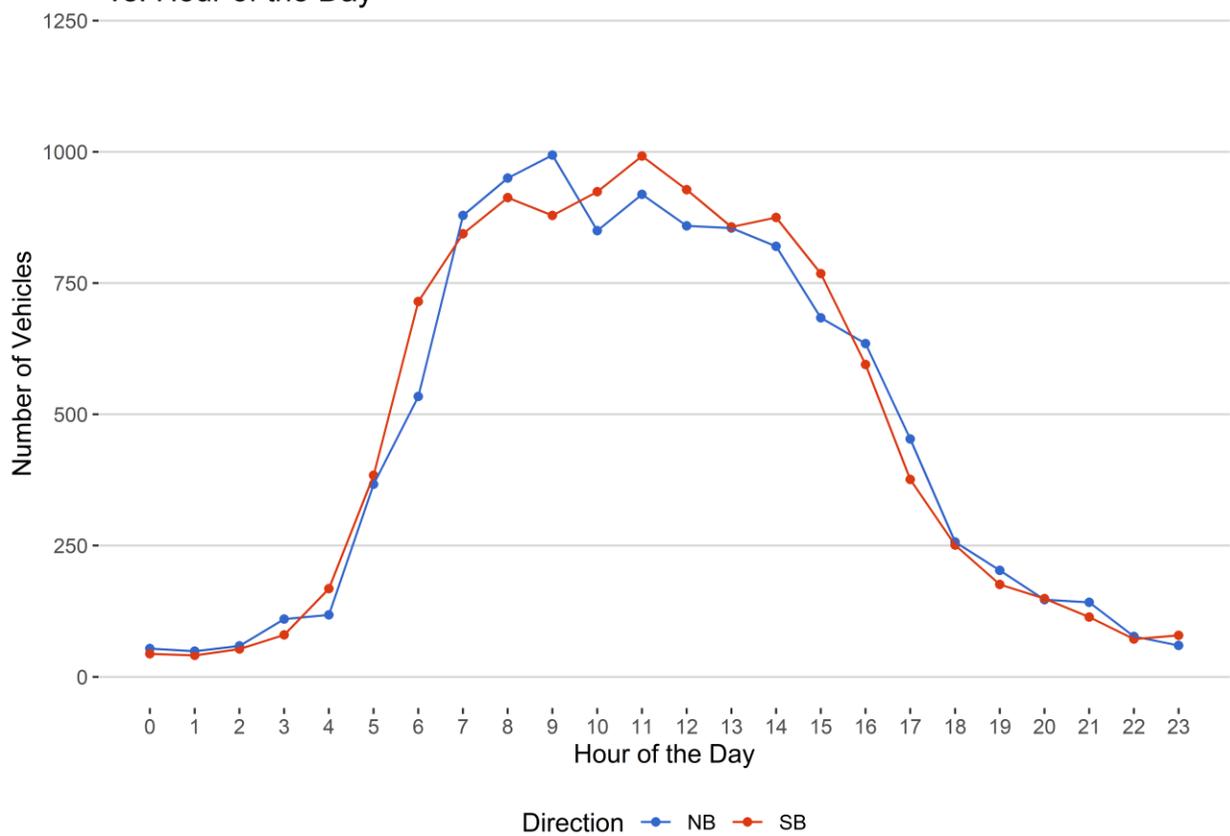


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

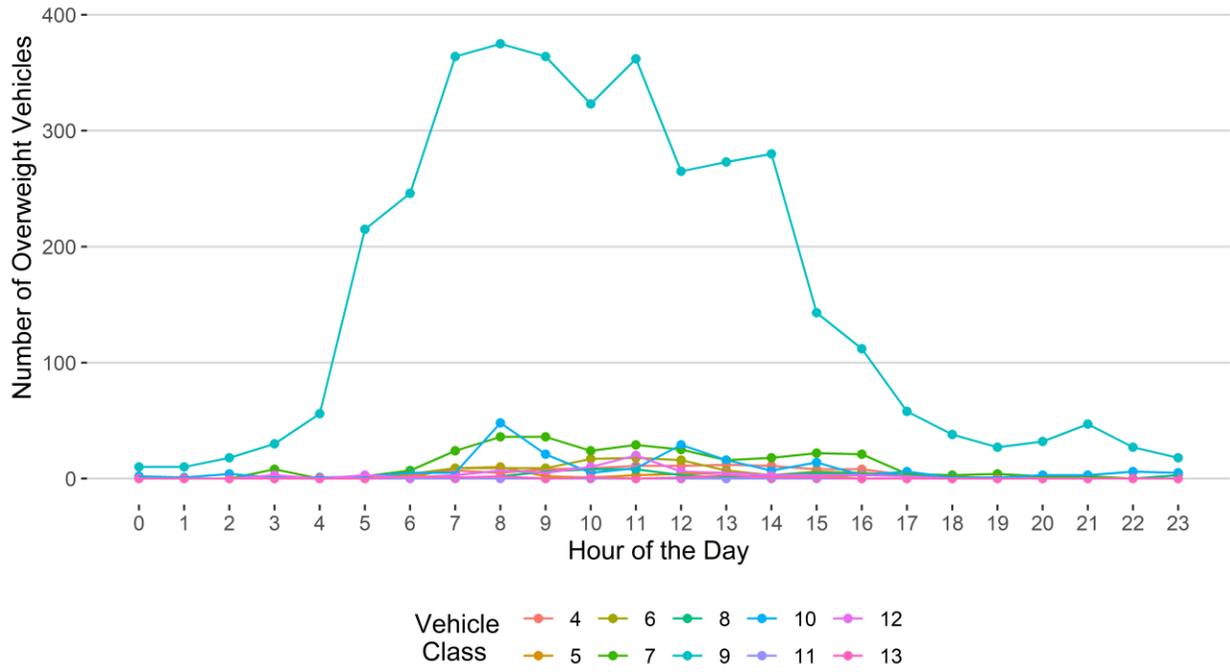


Figure 7 - Overweight Vehicles by Direction  
Hour of the Day

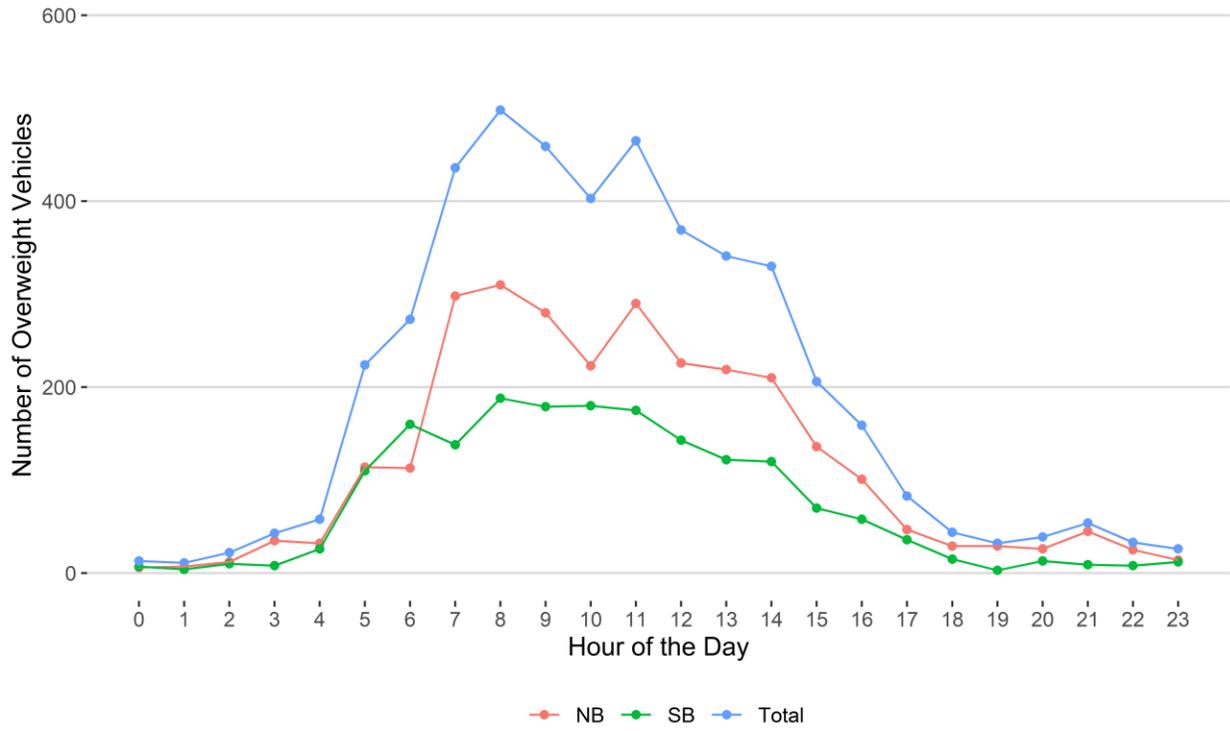
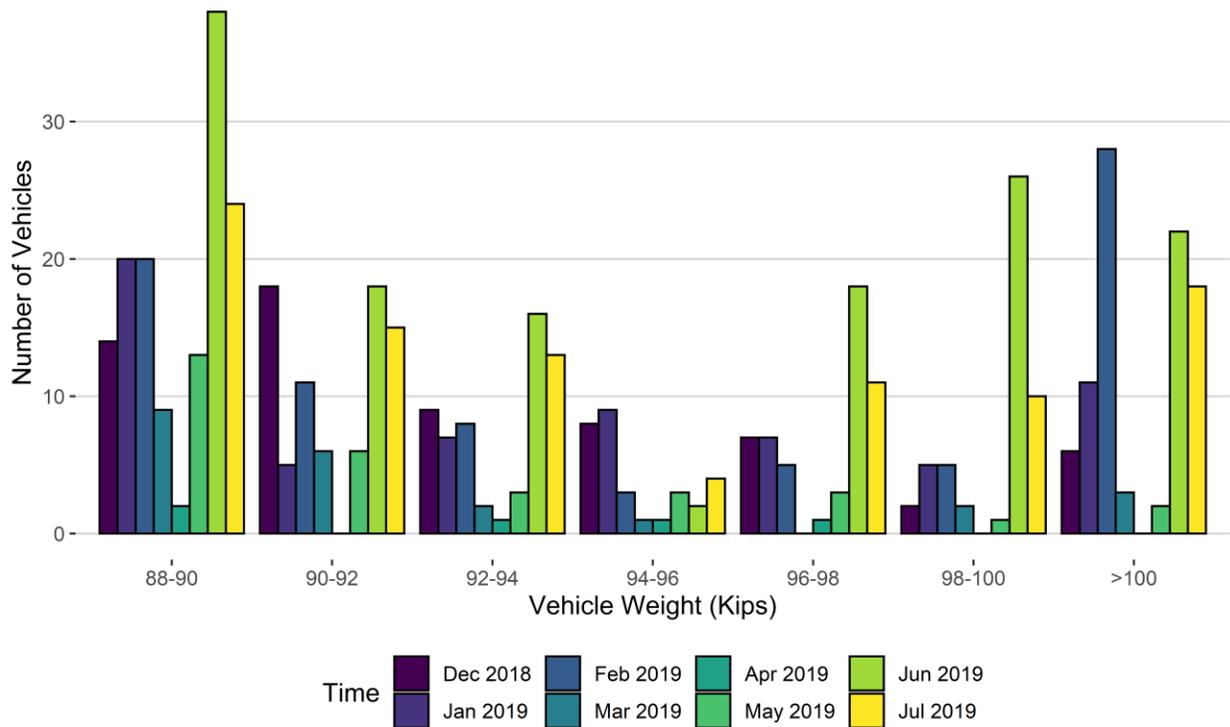
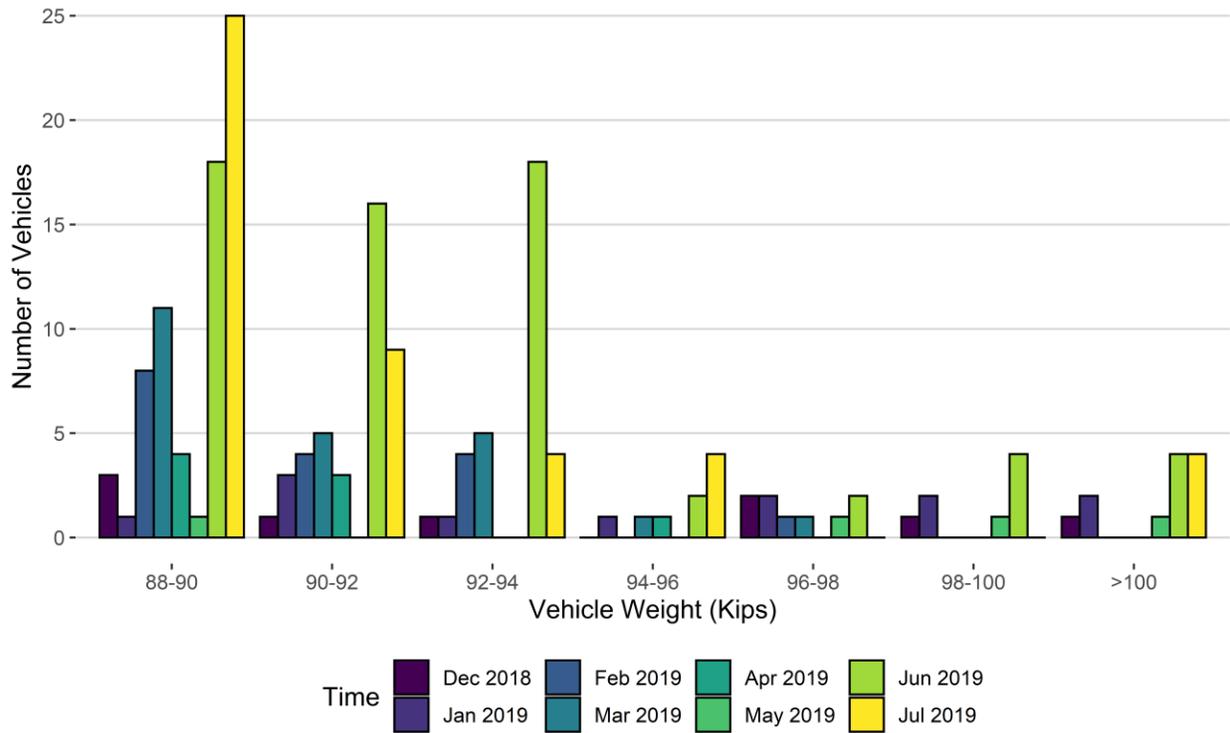


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019
88-90	14	20	20	9	2	13	38	24
90-92	18	5	11	6	0	6	18	15
92-94	9	7	8	2	1	3	16	13
94-96	8	9	3	1	1	3	2	4
96-98	7	7	5	0	1	3	18	11
98-100	2	5	5	2	0	1	26	10
>100	6	11	28	3	0	2	22	18
Total	64	64	80	23	5	31	140	95

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



Vehicle Weights (Kips)	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019
88-90	3	1	8	11	4	1	18	25
90-92	1	3	4	5	3	0	16	9
92-94	1	1	4	5	0	0	18	4
94-96	0	1	0	1	1	0	2	4
96-98	2	2	1	1	0	1	2	0
98-100	1	2	0	0	0	1	4	0
>100	1	2	0	0	0	1	4	4
<b>Total</b>	<b>9</b>	<b>12</b>	<b>17</b>	<b>23</b>	<b>8</b>	<b>4</b>	<b>64</b>	<b>46</b>

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

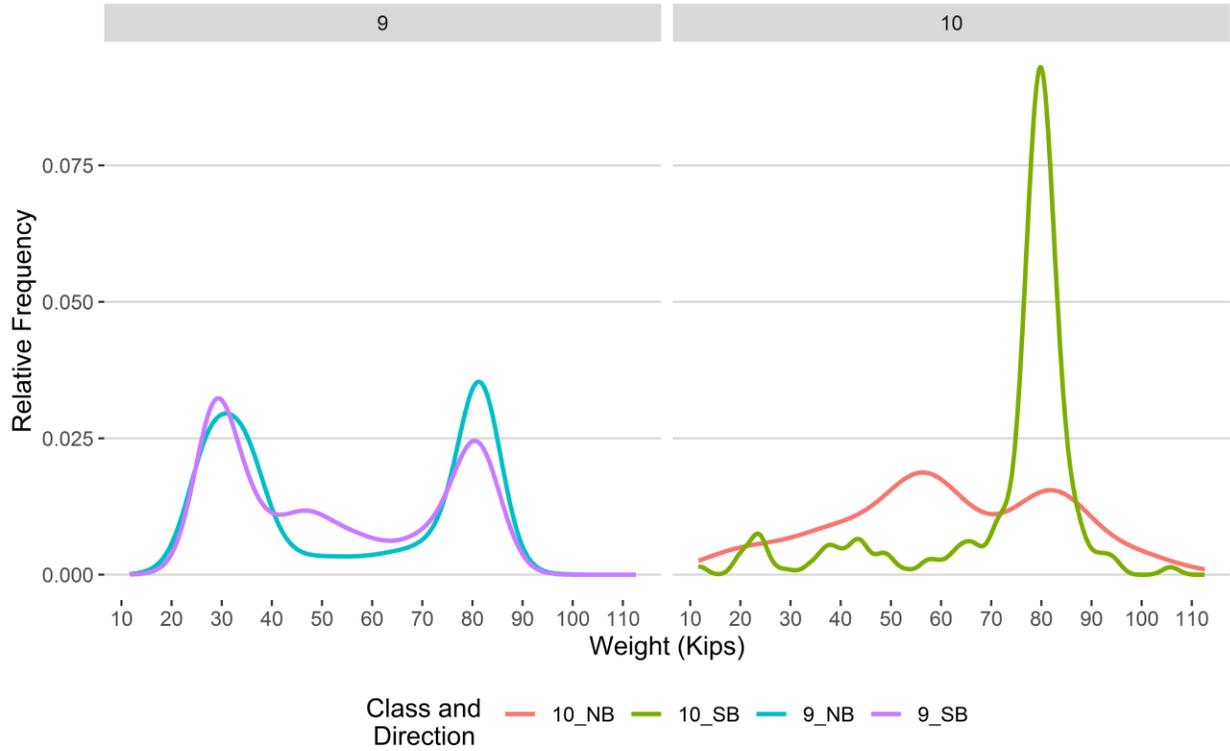


Figure 9 - Freight Percentage by Direction and Class

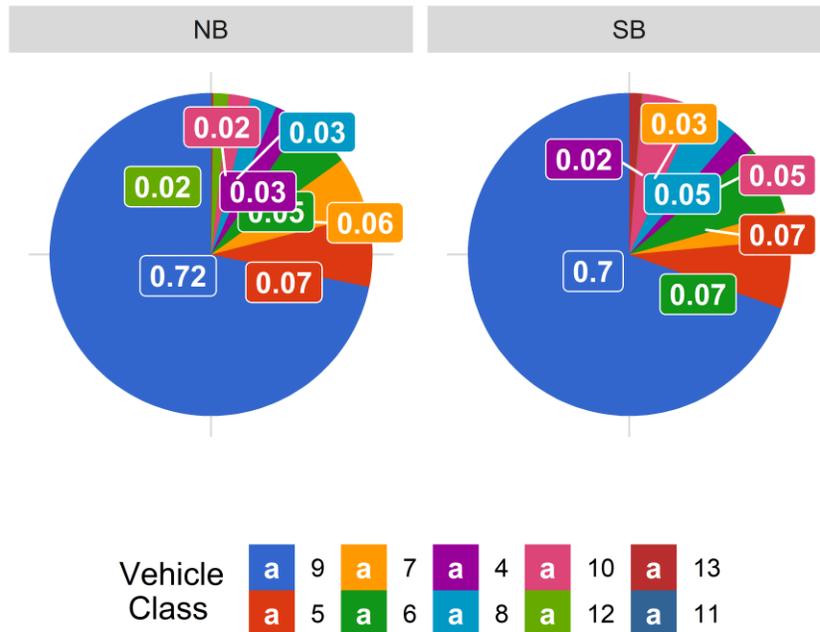


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

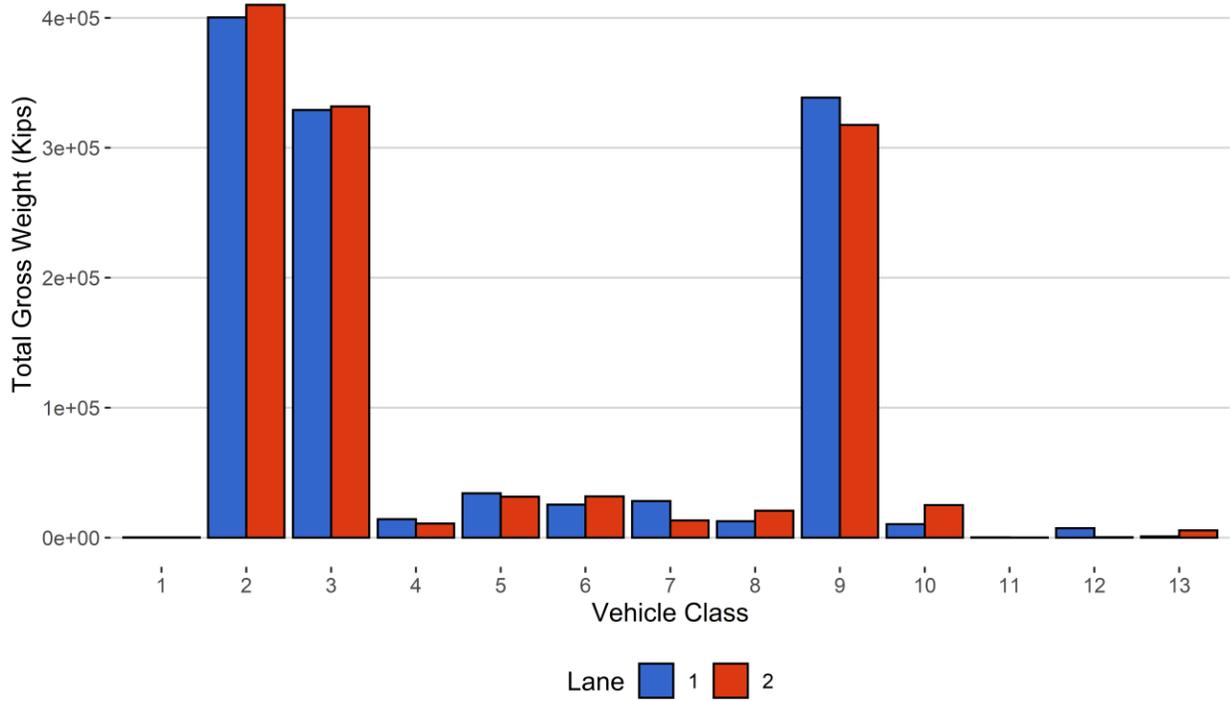


Figure 11 - Total Gross Vehicle Weight t

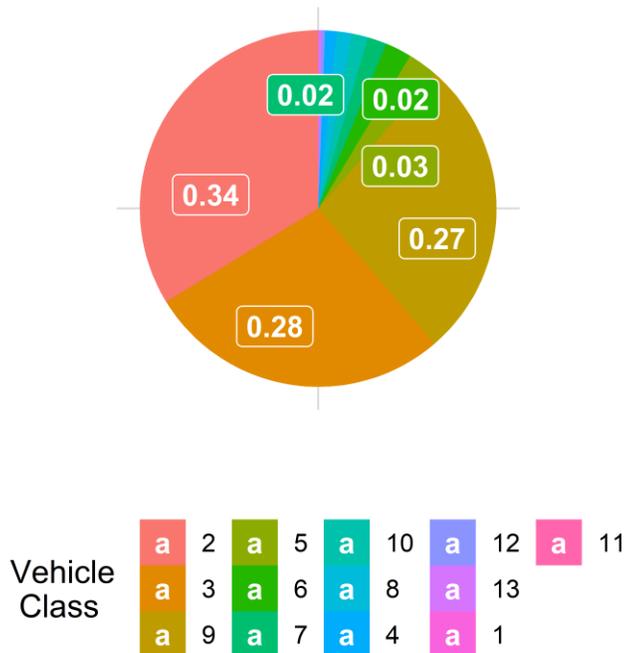


Figure 12 - Total ESALs by Class and Lane

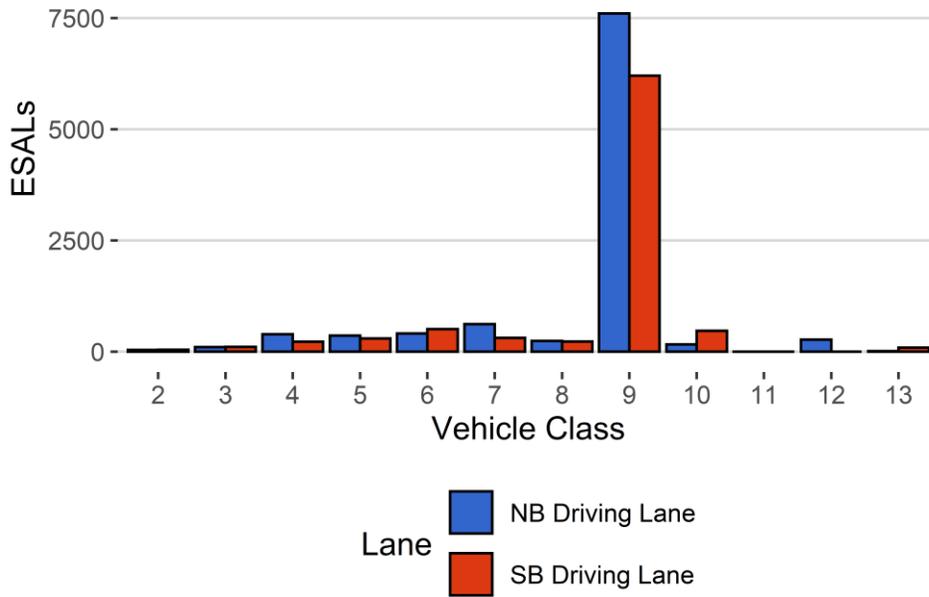
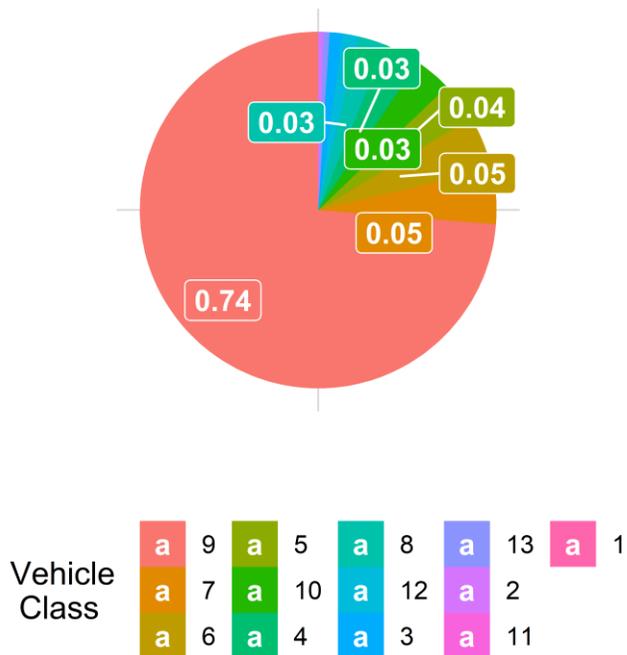


Figure 13 - ESALs by Class



**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>
December 2018	10.79	0.00	10.54	0.00
January 2019	10.88	0.85	10.62	0.68
February 2019	10.89	0.90	10.49	-0.53
March 2019	10.65	-1.30	10.50	-0.41
April 2019	10.27	-4.76	10.28	-2.50
May 2019	10.21	-5.37	10.06	-4.60
June 2019	10.91	1.11	10.78	2.22
July 2019	10.82	0.26	10.95	3.82

**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	10	321	0.1	0	0
2	6894	213701	61.3	0	0
3	3610	111910	32.1	0	0
4	26	795	0.2	97	2.1
5	166	5150	1.5	48	1.1
6	63	1939	0.6	109	2.4
7	20	613	0.2	283	6.2
8	34	1056	0.3	47	1
9	401	12440	3.6	3693	81
10	17	520	0.1	198	4.3
11	0	11	0	0	0
12	3	88	0	74	1.6
13	3	88	0	12	0.3
<b>TOTAL</b>	<b>11246</b>	<b>348634</b>	<b>100</b>	<b>4561</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>
2019-07-01	Monday	18:55:21	10	NB	1	112.59
2019-07-18	Thursday	14:56:27	10	SB	2	106.38
2019-07-25	Thursday	08:37:41	10	SB	2	105.14
2019-07-18	Thursday	14:51:49	10	NB	1	104.64
2019-07-05	Friday	05:36:09	9	SB	2	100.78
2019-07-13	Saturday	13:13:00	10	NB	1	100.58
2019-07-11	Thursday	12:36:35	10	NB	1	100.49
2019-07-09	Tuesday	13:13:28	10	NB	1	100.16
2019-07-03	Wednesday	13:24:54	10	NB	1	100.07
2019-07-31	Wednesday	12:33:40	9	NB	1	98.93

**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	NB	15	397	57	14.4	13475	733	4188
5	NB	8	2584	336	13	31617	2450	6816
6	NB	19	847	81	9.6	24000	1403	4723
7	NB	11.5	408	0	0	28147	0	11728
8	NB	31	378	144	38.1	9653	2908	1199
9	NB	33	6190	1793	29	288365	50198	71632
10	NB	33.5	169	19	11.2	9930	427	2452
11	NB	36.5	6	5	83.3	50	108	7
12	NB	36.5	82	0	0	7238	0	2122
13	NB	31.5	14	0	0	953	0	256
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>11075</b>	<b>2435</b>	<b>****</b>	<b>413428</b>	<b>****</b>	<b>105124</b>
<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	SB	15	386	55	14.2	10130	711	2583
5	SB	8	2487	393	15.8	28608	2835	5928
6	SB	19	1062	105	9.9	29883	1844	5850
7	SB	11.5	196	0	0	13201	0	5473
8	SB	31	662	339	51.2	12370	8349	1178
9	SB	33	6058	1920	31.7	262793	54753	63120
10	SB	33.5	343	20	5.8	24526	451	6853
11	SB	36.5	5	5	100	0	109	0
12	SB	36.5	5	0	0	283	0	50
13	SB	31.5	73	0	0	5589	0	1645
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>11277</b>	<b>2837</b>	<b>****</b>	<b>387384</b>	<b>****</b>	<b>92680</b>
<b>GRAND TOTAL</b>	<b>****</b>	<b>****</b>	<b>22352</b>	<b>5272</b>	<b>427</b>	<b>800811</b>	<b>127279</b>	<b>197804</b>

**Table 5 Gross Vehicle Weight by Class and Lane**

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>
1	175	233	408	0
2	400271	409986	810257	33.8
3	329015	331775	660790	27.5
4	14209	10842	25051	1
5	34067	31444	65511	2.7
6	25403	31727	57129	2.4
7	28147	13201	41348	1.7
8	12561	20719	33280	1.4
9	338563	317546	656109	27.3
10	10357	24977	35334	1.5
11	157	109	266	0
12	7238	283	7521	0.3
13	953	5589	6542	0.3
<b>TOTAL</b>	<b>1201116</b>	<b>1198430</b>	<b>2399546</b>	<b>100</b>
<b>GVW/LANE</b>	<b>50.06</b>	<b>49.94</b>	<b>100</b>	<b>0</b>

**Table 6 ESALs by Class and Lane and Flexible ESAL Factors**

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.0032
2	40	43	84	0.4	8e-04
3	107	110	217	1.2	0.004
4	391	226	618	3.3	1.58
5	364	297	661	3.5	0.26
6	412	508	920	4.9	0.97
7	622	312	934	5	3.08
8	243	229	472	2.5	0.91
9	7600	6202	13803	73.7	2.26
10	164	469	633	3.4	2.45
11	1	0	1	0	0.59
12	271	2	273	1.5	5.65
13	13	92	105	0.6	2.24
<b>TOTAL</b>	<b>10228</b>	<b>8492</b>	<b>18720</b>	<b>100</b>	<b>20</b>
<b>ESALS/LANE</b>	<b>54.6</b>	<b>45.4</b>	<b>100</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>
Dec 2018	283227	9136	450	269265	95.1	13962.3	4.9
Jan 2019	265163	8554	466	250711	94.5	14452.3	5.5
Feb 2019	230485	8232	479	217063	94.2	13422.1	5.8
Mar 2019	292495	9435	468	277981	95	14514.1	5
Apr 2019	304912	10164	510	289601	95	15311	5
May 2019	343068	10956	596	324607	94.6	18461.5	5.4
Jun 2019	324777	10826	573	307593	94.7	17184.2	5.3
Jul 2019	348634	11206	732	325932	93.5	22701.9	6.5
<b>TOTAL</b>	<b>2392761</b>	<b>-</b>	<b>-</b>	<b>2262753</b>	<b>-</b>	<b>130009</b>	<b>-</b>
<b>AVERAGE</b>	<b>299095</b>	<b>9814</b>	<b>534</b>	<b>282844</b>	<b>95</b>	<b>16251</b>	<b>5</b>

###ESALS

<i>Month</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Dec 2018	6281	3102	9384	0.7
Jan 2019	6958	3377	10335	1.7
Feb 2019	6867	3100	9967	2.7
Mar 2019	5986	3613	9599	1.4
Apr 2019	5142	3547	8689	0.3
May 2019	6985	3777	10762	0.4
Jun 2019	15760	9229	24989	2.2
Jul 2019	10375	8533	18908	2.3
<b>TOTAL</b>	<b>64354</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>AVERAGE</b>	<b>8044</b>	<b>4785</b>	<b>12829</b>	<b>2</b>

###Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Dec 18	897732	839106	1736837
Jan 19	877835	821194	1699029
Feb 19	799415	718048	1517463
Mar 19	909278	879764	1789041
Apr 19	910165	897884	1808050
May 19	1065247	1008542	2073788
Jun 19	2088761	1979618	4068379
Jul 19	1206334	1199906	2406240
<b>TOTAL</b>	<b>8754766</b>	<b>8344062</b>	<b>17098828</b>
<b>AVERAGE</b>	<b>1094346</b>	<b>1043008</b>	<b>2137354</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>
Dec 2018	1669	0.6	12	73	10
Jan 2019	2033	0.8	14.1	76	20
Feb 2019	2171	1	16.1	97	33
Mar 2019	1543	0.5	10.7	46	5
Apr 2019	878	0.3	5.8	13	0
May 2019	998	0.3	5.4	35	5
Jun 2019	5488	0.9	16.2	206	56
Jul 2019	4621	1.3	20.5	142	32
<b>TOTAL</b>	<b>19401</b>	<b>-</b>	<b>-</b>	<b>688</b>	<b>161</b>
<b>AVERAGE</b>	<b>2425.1</b>	<b>0.7</b>	<b>12.6</b>	<b>86</b>	<b>20.1</b>

### ###Freight

<i>Month</i>	<i>NB Freight Tons</i>	<i>SB Freight Tons</i>	<i>Total Freight</i>	<i>NB Freight %</i>	<i>SB Freight %</i>
Dec 2018	68684	36498	105183	65.3	34.7
Jan 2019	74186	39952	114137	65	35
Feb 2019	75948	36919	112867	67.3	32.7
Mar 2019	66257	43378	109635	60.4	39.6
Apr 2019	61073	46223	107296	56.9	43.1
May 2019	82977	48135	131113	63.3	36.7
Jun 2019	158224	107695	265919	59.5	40.5
Jul 2019	105124	92680	197804	53.1	46.9
<b>TOTAL</b>	<b>692473</b>	<b>451480</b>	<b>1143954</b>	<b>-</b>	<b>-</b>
<b>AVERAGE</b>	<b>86559.2</b>	<b>56435</b>	<b>142994.2</b>	<b>61.4</b>	<b>38.6</b>