

APRIL 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 April 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: 304912 | Passenger Vehicles: 289601 | Heavy Commercial Vehicles: 15311

Monthly Average Daily Traffic (MADT): 10164 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 510

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 06 AM and 08 AM

### 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 06 AM and 08 AM. 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 15311 HCVs, 867 of them were overweight <sup>3</sup>. These overweight HCVs contributed to 0.3% of total monthly volume, and 5.7% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Fridays, with lowest volumes reported on Saturdays. 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 10 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 70.3% 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 October.

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 ,5 NB vehicles exceeded 88,000 pounds (4 vehicles were Class 10's; 1 vehicles were Class 13's). Of vehicles traveling SB,

8 NB vehicles exceeded 88,000 pounds (5 vehicles were Class 10's; 2 vehicles were Class 9'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 9s and 10s in April 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 fully\_loaded Class 9's than empty 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 107296 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (56.9%) than SB (43.1%). 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 304912 vehicles with a combined GVW of 1808050 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 8689 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 59.2% of all ESALs were recorded NB while 40.8% was observed SB. In particular, 74% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 23% 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).

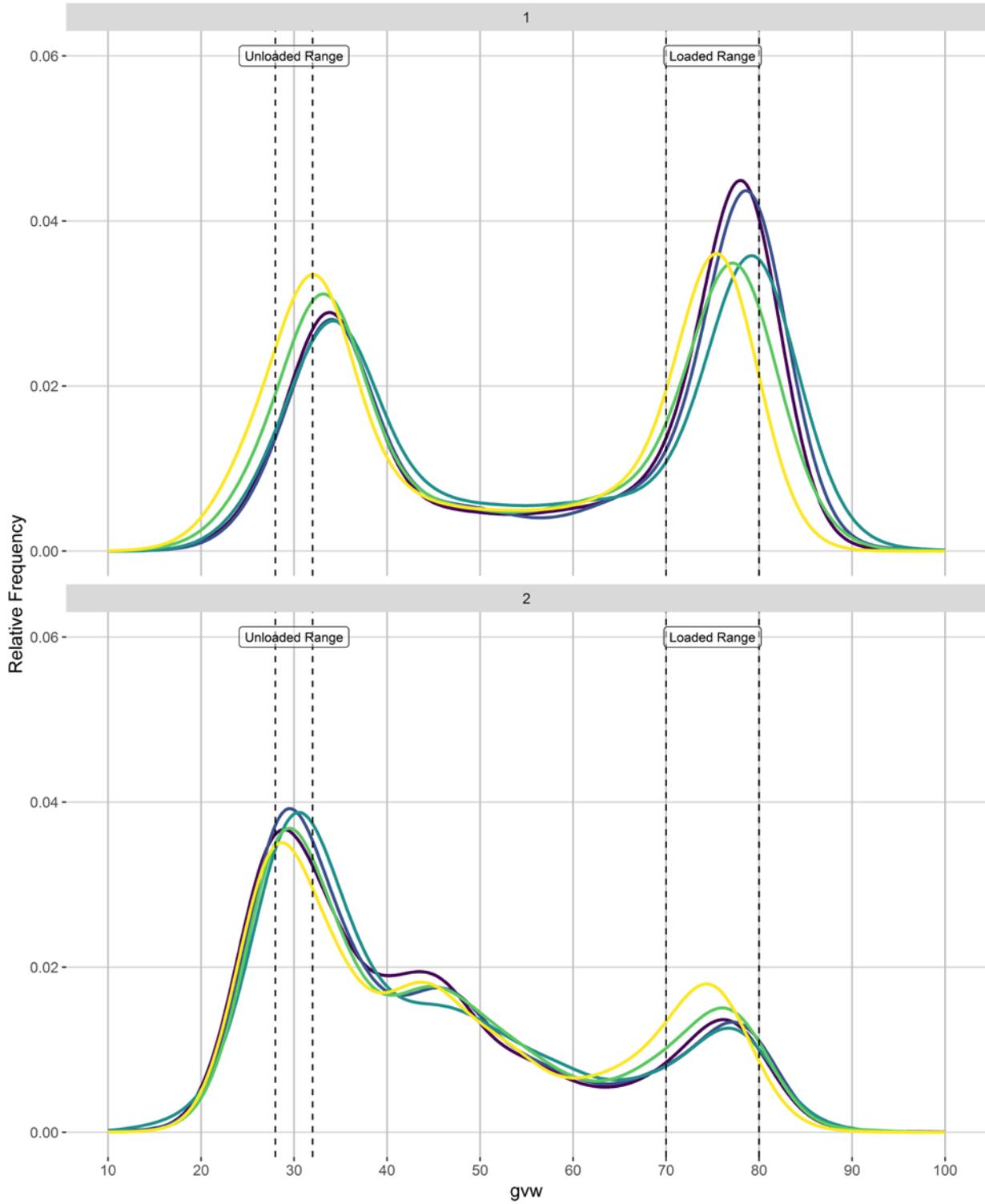
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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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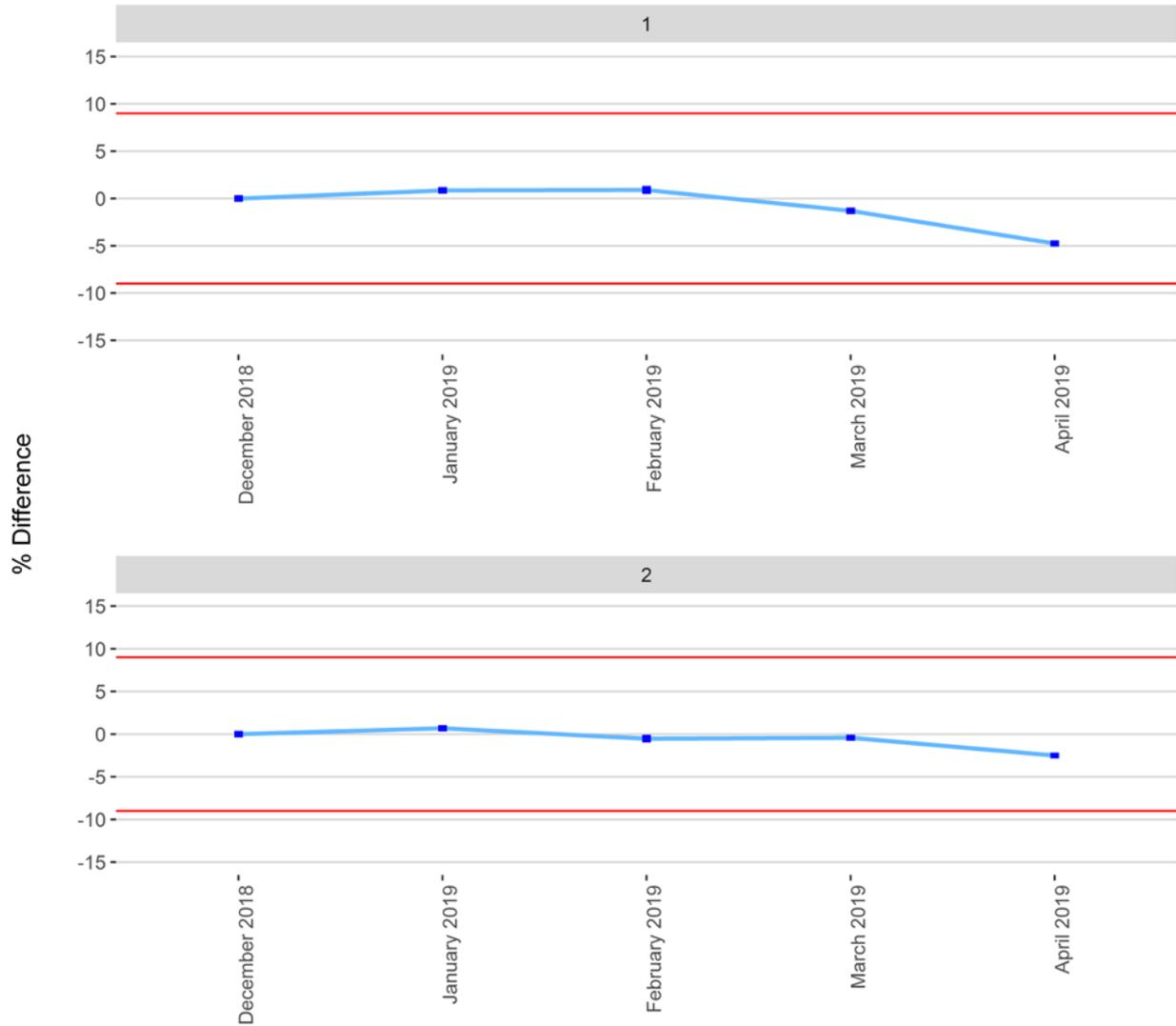
Figure 1 - Monthly Class 9 GVW Histogram



Time — December 2018 — January 2019 — February 2019 — March 2019 — April 2019

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

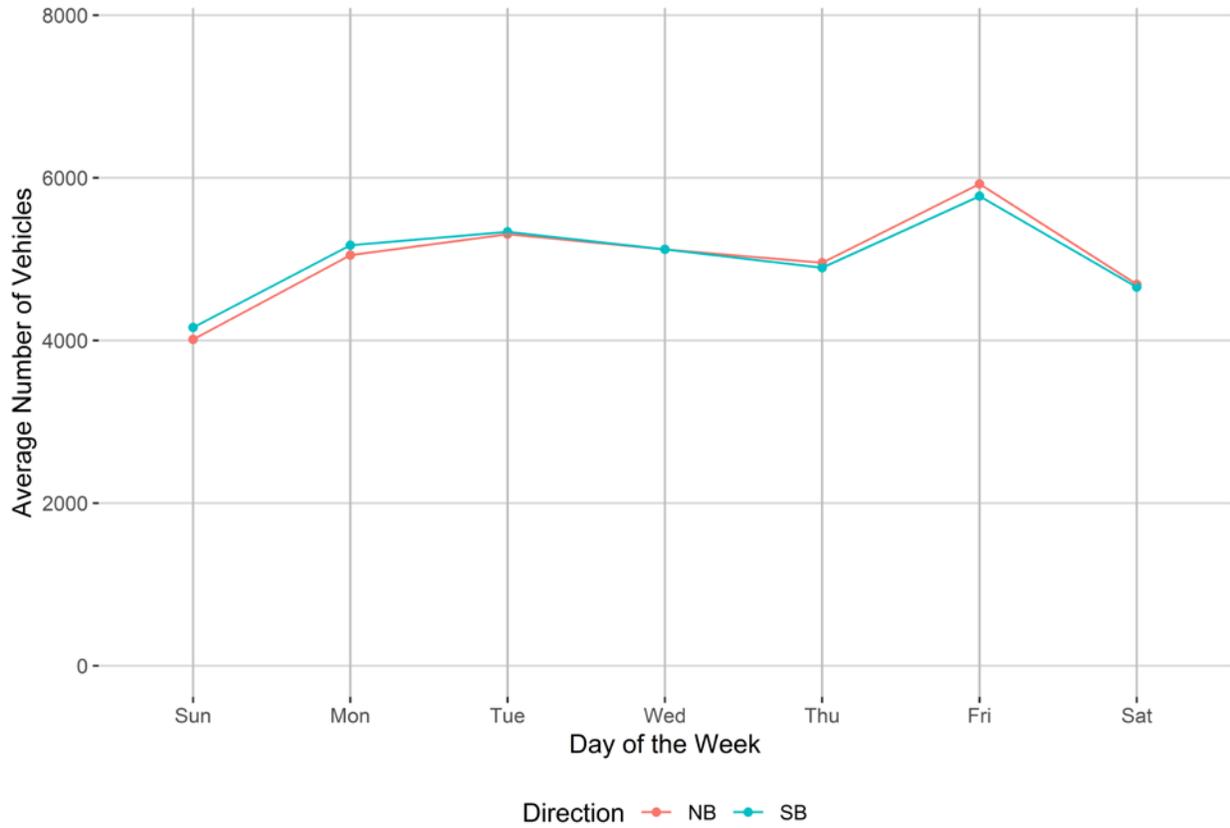


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

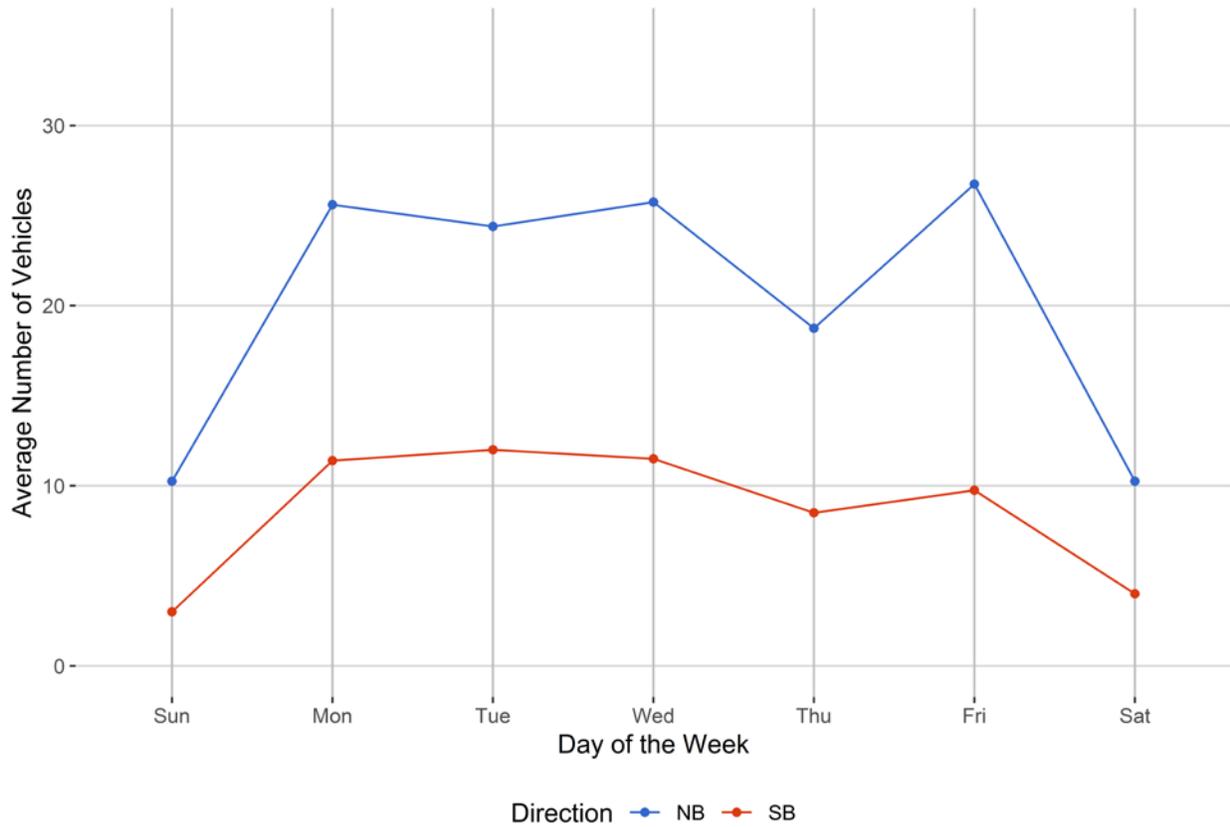


Figure 4 - Passenger Vehicles vs. Hour of the Day

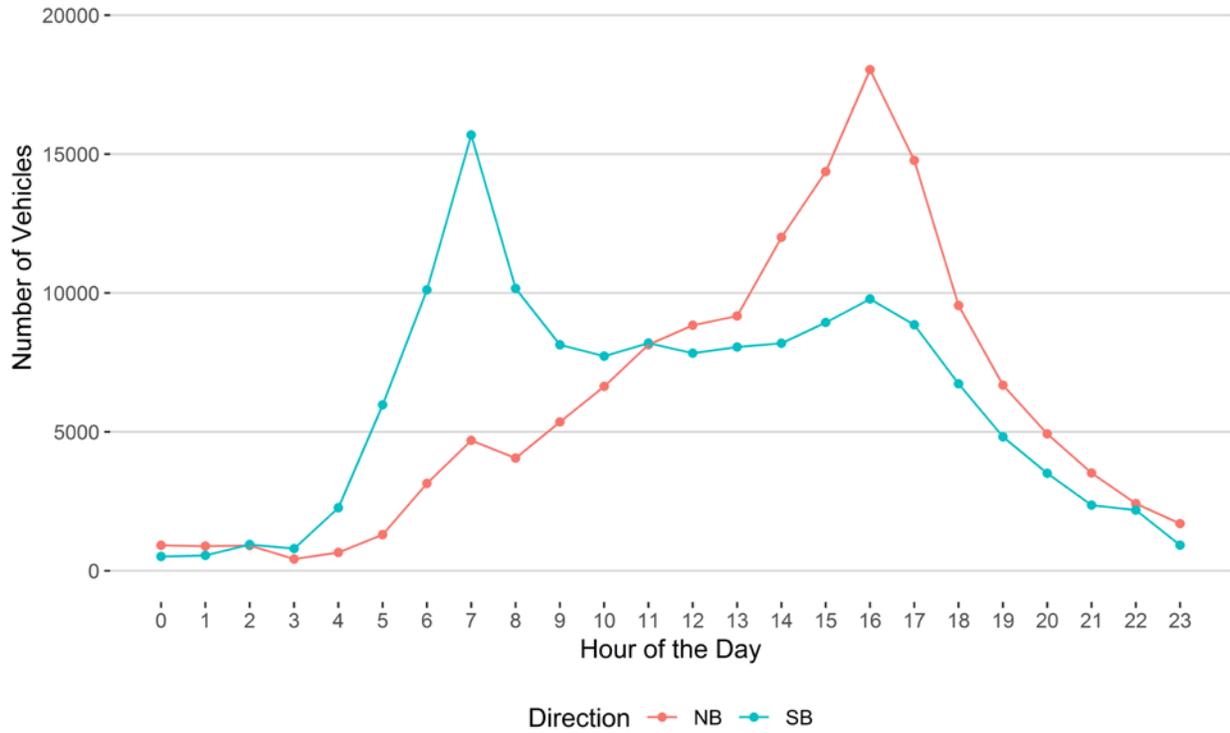


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

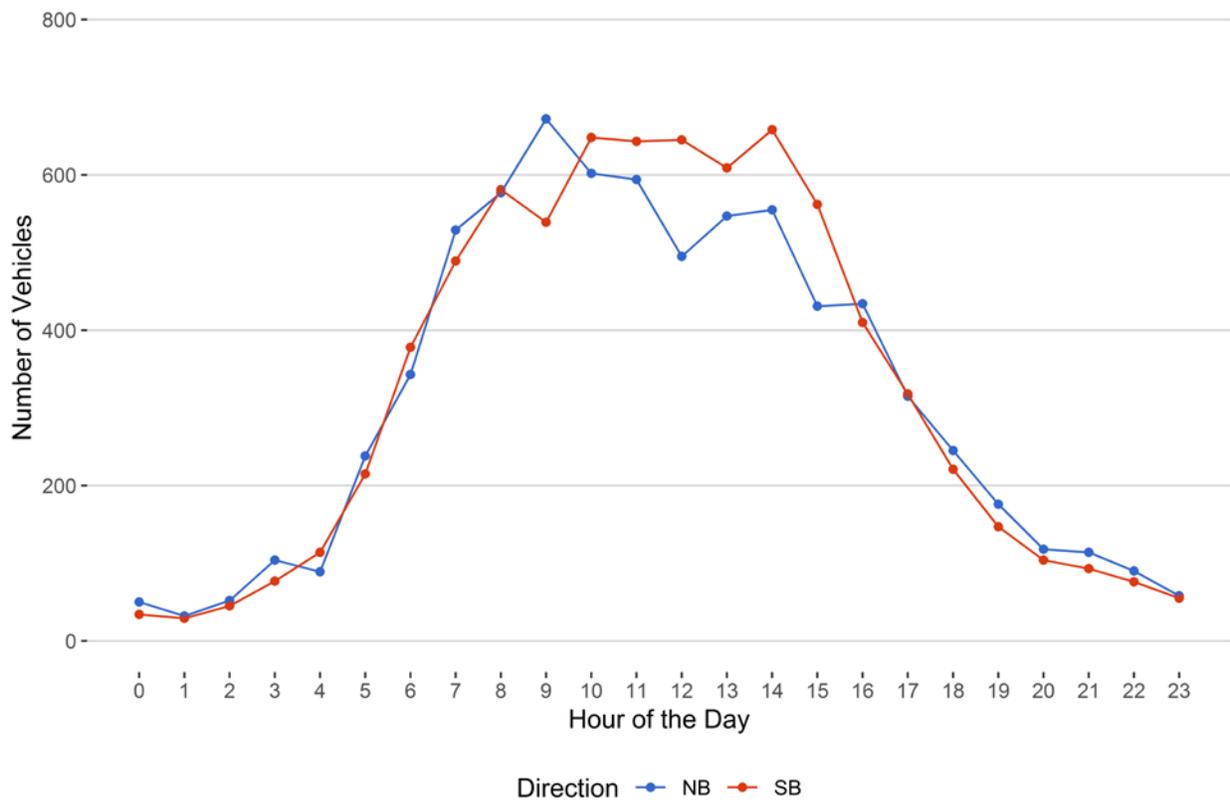


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

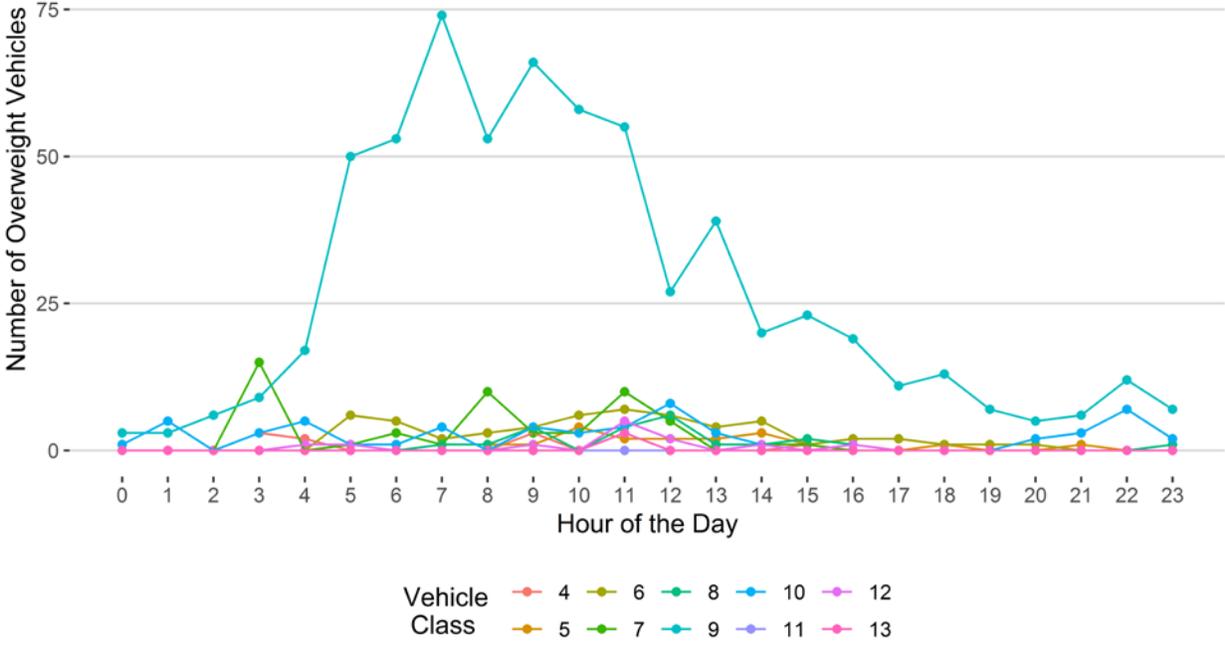


Figure 7 - Overweight Vehicles by Direction  
Hour of the Day

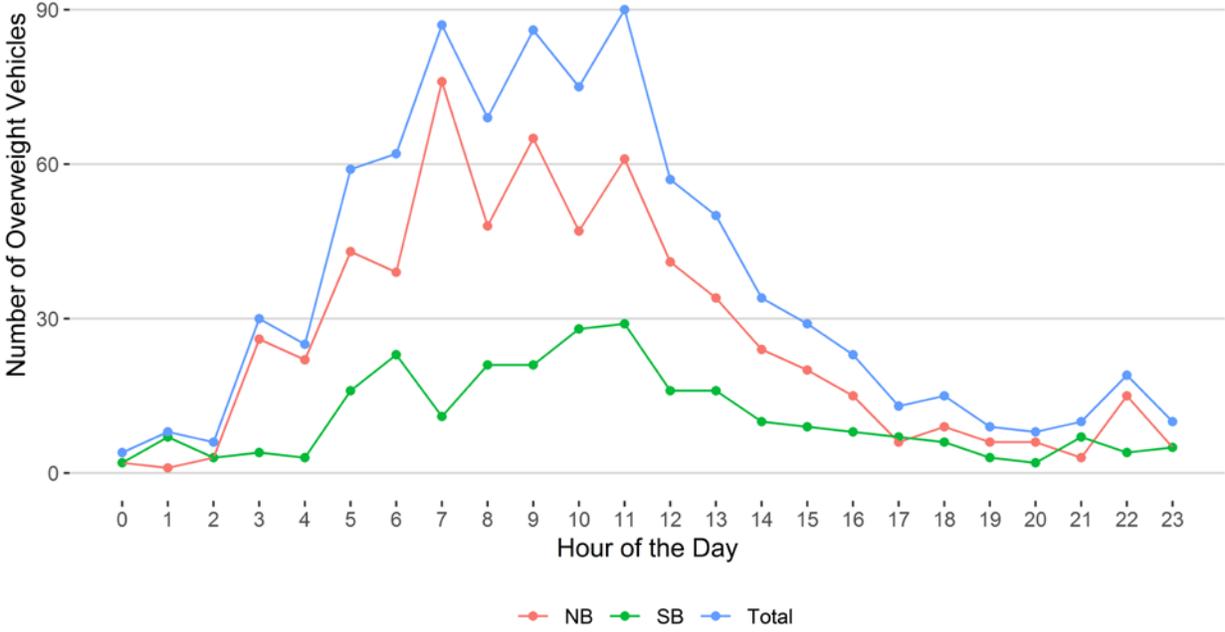
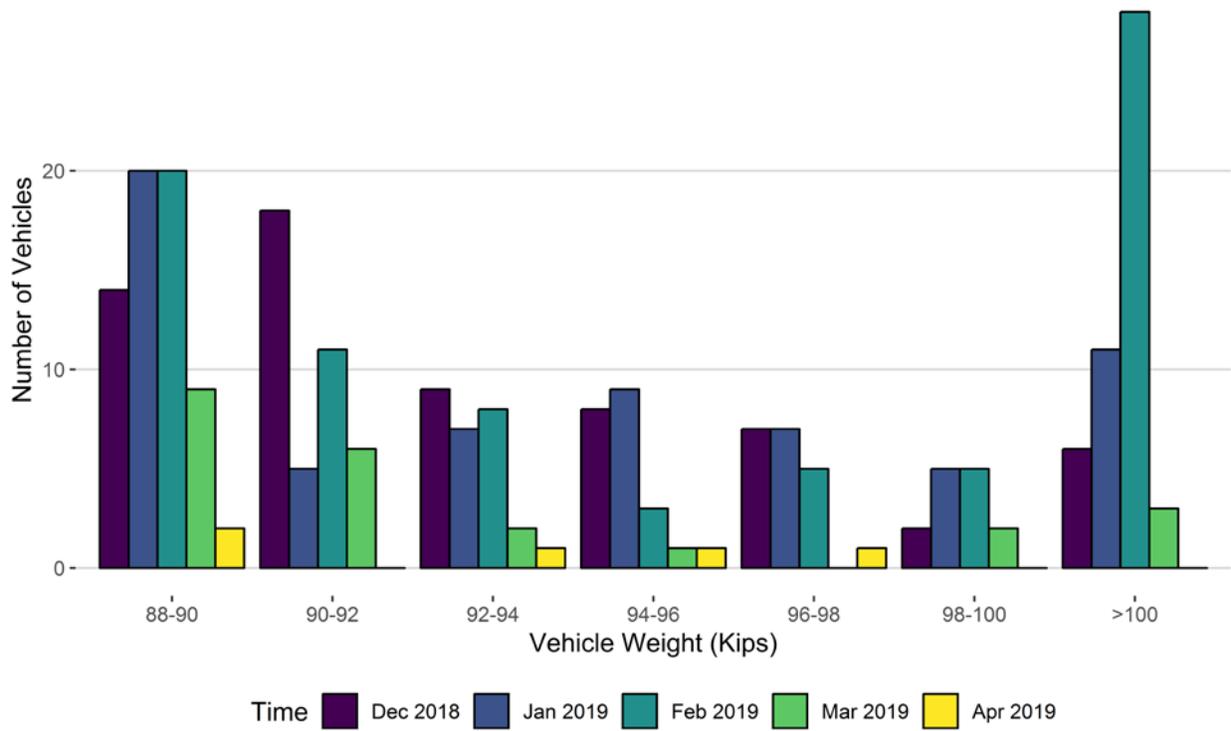
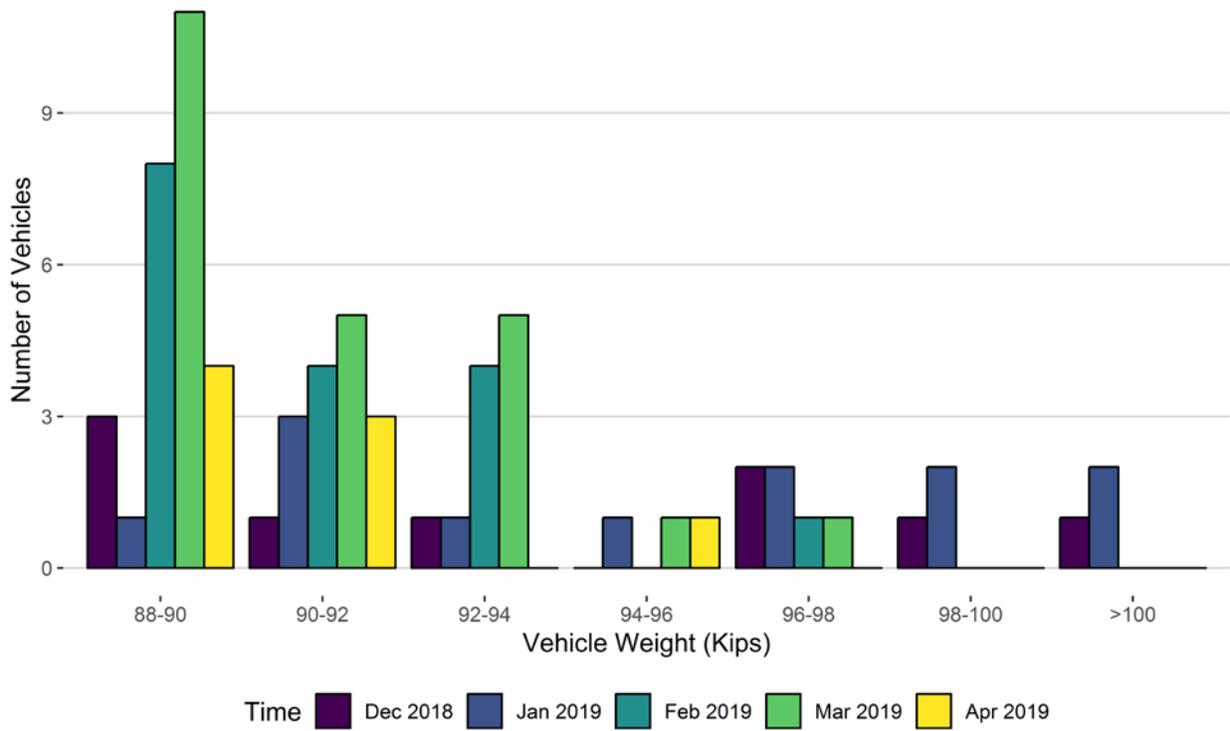


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Dec 2018</i>	<i>Jan 2019</i>	<i>Feb 2019</i>	<i>Mar 2019</i>	<i>Apr 2019</i>
88-90	14	20	20	9	2
90-92	18	5	11	6	0
92-94	9	7	8	2	1
94-96	8	9	3	1	1
96-98	7	7	5	0	1
98-100	2	5	5	2	0
>100	6	11	28	3	0
<b>Total</b>	<b>64</b>	<b>64</b>	<b>80</b>	<b>23</b>	<b>5</b>

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
88-90	3	1	8	11	4
90-92	1	3	4	5	3
92-94	1	1	4	5	0
94-96	0	1	0	1	1
96-98	2	2	1	1	0
98-100	1	2	0	0	0
>100	1	2	0	0	0
<b>Total</b>	<b>9</b>	<b>12</b>	<b>17</b>	<b>23</b>	<b>8</b>

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

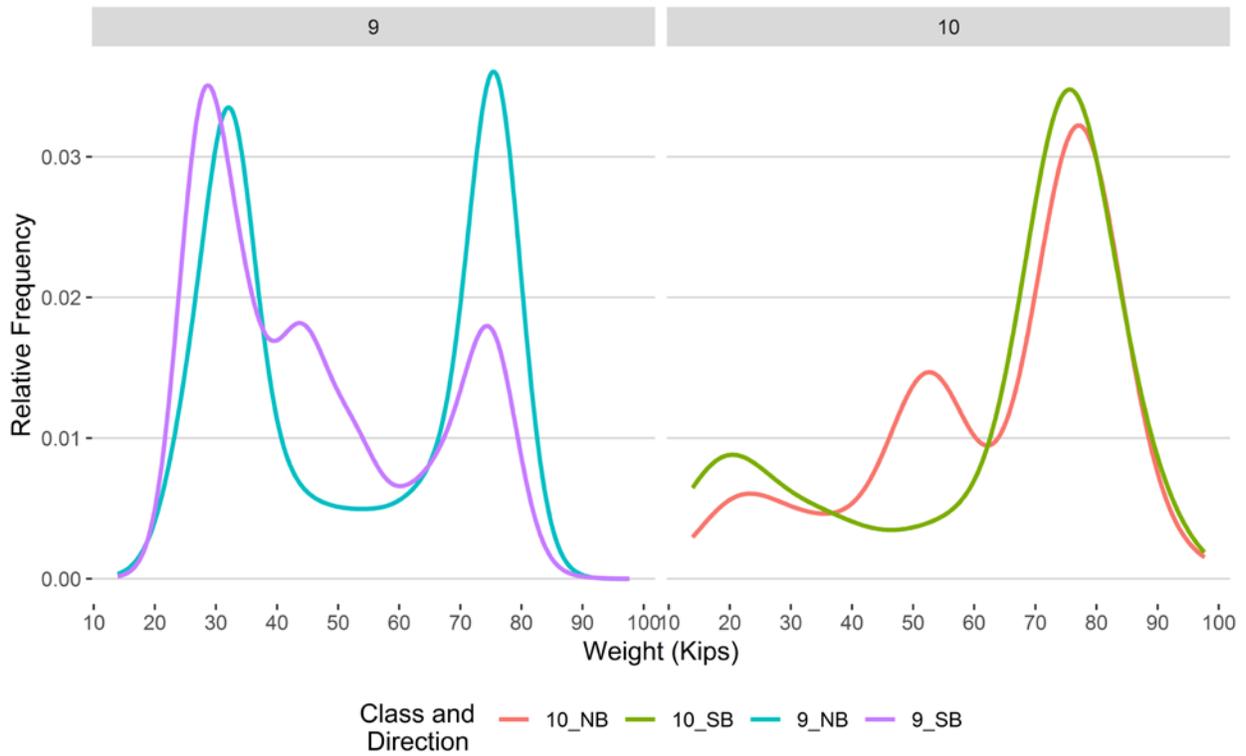


Figure 9 - Freight Percentage by Direction and Class

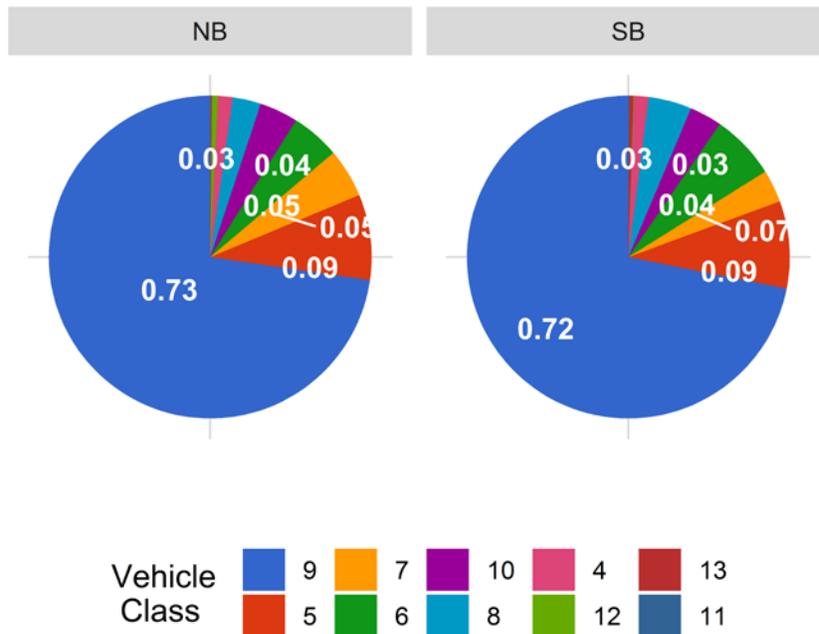


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

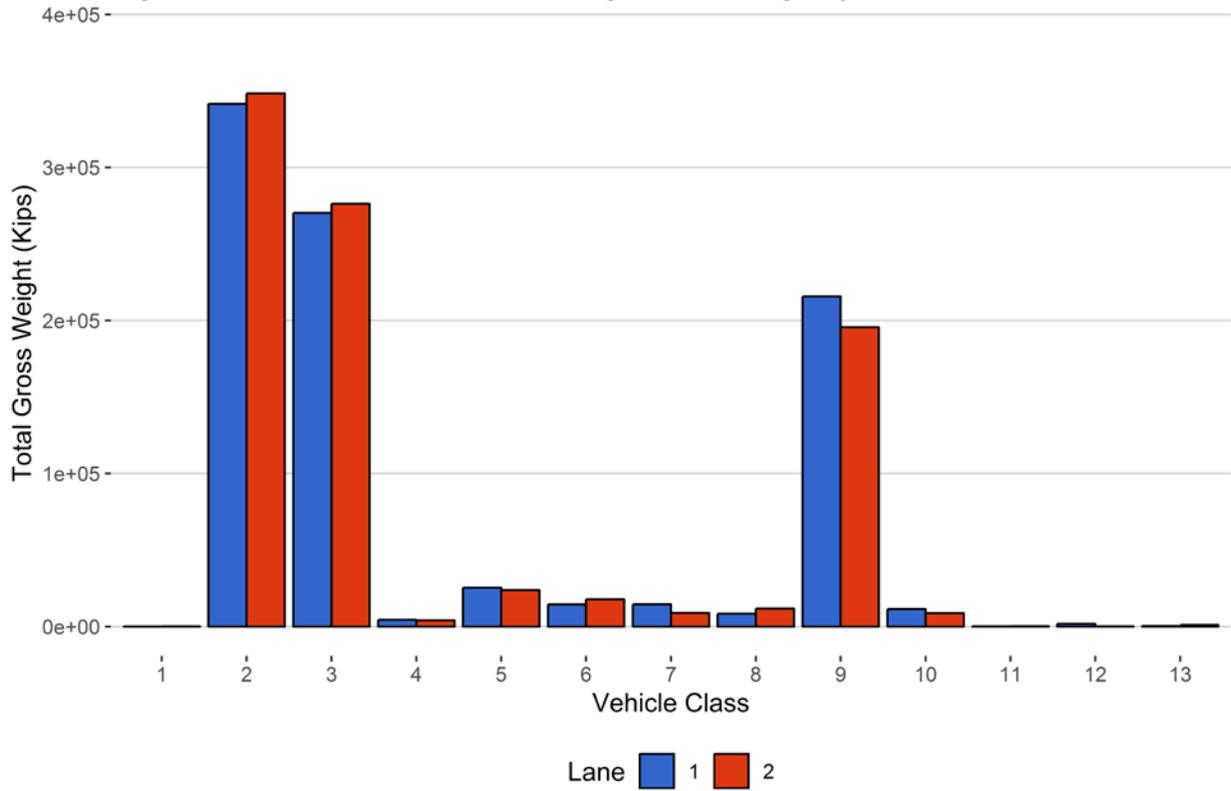


Figure 11 - Total Gross Vehicle Weight t

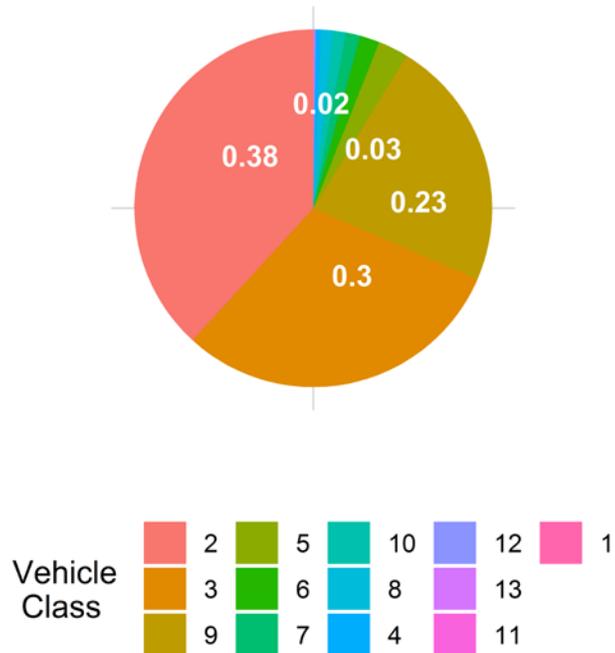


Figure 12 - Total ESALs by Class and Lane

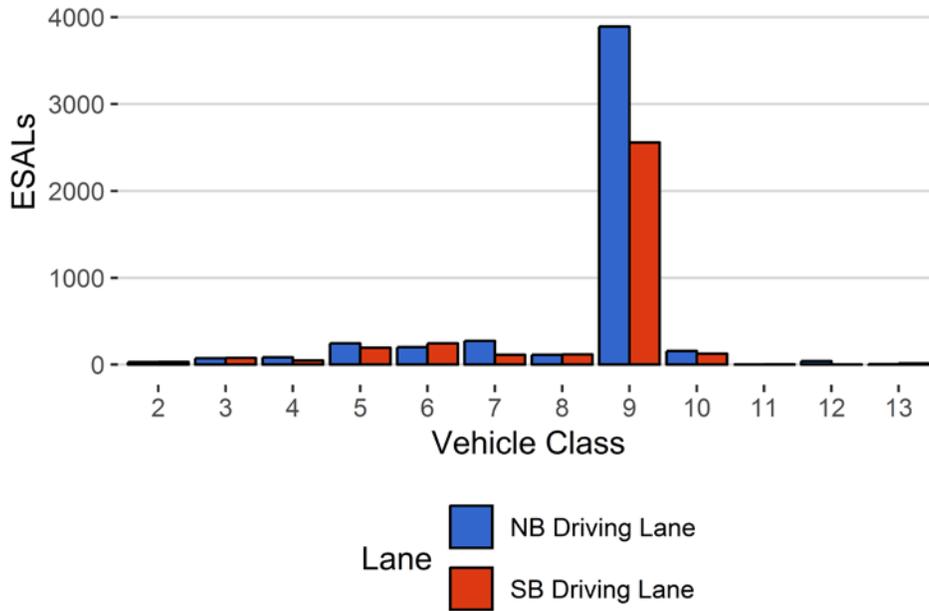
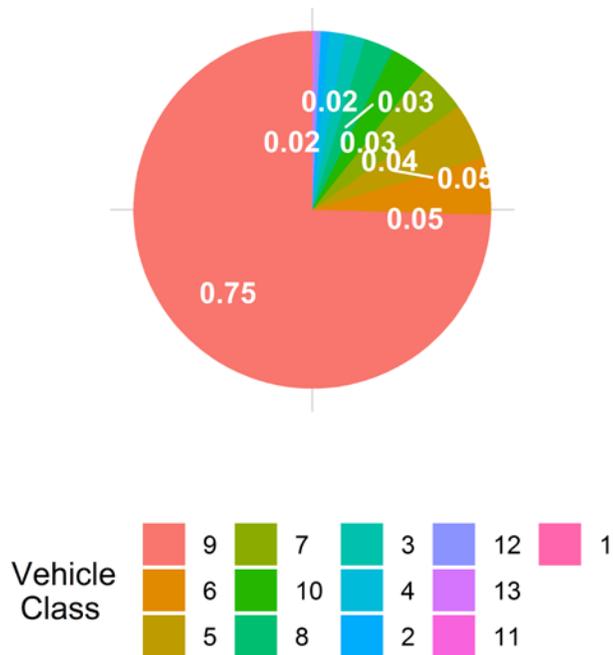


Figure 13 - ESALs by Class



**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

**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	170	0.1	0	0
2	6357	190704	62.5	0	0
3	3291	98727	32.4	0	0
4	10	309	0.1	9	1
5	134	4005	1.3	19	2.2
6	39	1173	0.4	56	6.5
7	12	359	0.1	53	6.1
8	22	664	0.2	22	2.5
9	281	8420	2.8	636	73.4
10	11	323	0.1	57	6.6
11	0	11	0	0	0
12	1	26	0	12	1.4
13	1	20	0	3	0.3
<b>TOTAL</b>	<b>10164</b>	<b>304912</b>	<b>100</b>	<b>867</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>
2019-04-26	Friday	09:35:08	10	NB	1	97.68
2019-04-22	Monday	07:25:22	10	NB	1	95.02
2019-04-09	Tuesday	03:44:26	9	SB	2	91.11
2019-04-10	Wednesday	12:41:04	10	SB	2	91.04
2019-04-09	Tuesday	01:41:06	10	SB	2	90.43
2019-04-10	Wednesday	01:55:29	10	SB	2	89.86
2019-04-30	Tuesday	07:33:27	10	NB	1	89.78
2019-04-05	Friday	07:26:38	10	NB	1	89.12
2019-04-11	Thursday	20:46:27	10	SB	2	89.09
2019-04-09	Tuesday	00:48:17	9	SB	2	89.04

**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	145	27	18.6	4039	352	1134
5	NB	8	2018	485	24	21909	3507	4822
6	NB	19	531	174	32.8	11490	3011	2354
7	NB	11.5	210	0	0	14560	0	6072
8	NB	31	265	110	41.5	5877	2460	536
9	NB	33	4078	1179	28.9	181189	34504	42761
10	NB	33.5	180	20	11.1	11014	460	2827
11	NB	36.5	5	4	80	37	125	0
12	NB	36.5	23	0	0	1763	0	462
13	NB	31.5	5	0	0	366	0	104
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>7460</b>	<b>1999</b>	<b>****</b>	<b>252243</b>	<b>****</b>	<b>61073</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	161	41	25.5	3442	532	821
5	SB	8	1945	457	23.5	20477	3310	4287
6	SB	19	630	165	26.2	14938	2841	3051
7	SB	11.5	145	1	0.7	8876	9	3610
8	SB	31	392	216	55.1	6578	5185	561
9	SB	33	4253	1474	34.7	154294	41291	31293
10	SB	33.5	140	26	18.6	8265	556	2223
11	SB	36.5	6	1	16.7	261	29	39
12	SB	36.5	3	1	33.3	114	34	20
13	SB	31.5	15	0	0	1106	0	317
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>7690</b>	<b>2382</b>	<b>****</b>	<b>218352</b>	<b>****</b>	<b>46223</b>
<b>GRAND TOTAL</b>	<b>****</b>	<b>****</b>	<b>15150</b>	<b>4381</b>	<b>471</b>	<b>470595</b>	<b>98205</b>	<b>107296</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	98	117	215	0
2	341502	348450	689952	38.2
3	270279	276322	546601	30.3
4	4391	3974	8365	0.5
5	25416	23788	49203	2.7
6	14501	17778	32280	1.8
7	14560	8885	23444	1.3
8	8337	11763	20100	1.1
9	215694	195585	411279	22.8
10	11474	8821	20295	1.1
11	162	291	452	0
12	1763	148	1910	0.1
13	366	1106	1472	0.1
<b>TOTAL</b>	<b>908541</b>	<b>897028</b>	<b>1805569</b>	<b>100</b>
<b>GVW/LANE</b>	<b>50.32</b>	<b>49.68</b>	<b>100</b>	<b>0.01</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	0.0059
2	30	32	63	0.7	7e-04
3	74	79	153	1.8	0.0032
4	86	46	132	1.5	0.87
5	246	194	440	5.1	0.22
6	201	245	446	5.2	0.77
7	274	112	387	4.5	2.17
8	114	117	231	2.7	0.71
9	3892	2556	6448	74.6	1.56
10	157	126	282	3.3	1.75
11	1	4	4	0	0.9
12	40	1	41	0.5	2.49
13	6	15	21	0.2	1.65
<b>TOTAL</b>	<b>5119</b>	<b>3528</b>	<b>8647</b>	<b>100</b>	<b>13</b>
<b>ESALS/LANE</b>	<b>59.2</b>	<b>40.8</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>
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
<b>TOTAL</b>	<b>1376282</b>	-	-	<b>1304621</b>	-	<b>71662</b>	-
<b>AVERAGE</b>	<b>275256</b>	<b>9104</b>	<b>475</b>	<b>260924</b>	<b>95</b>	<b>14332</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
<b>TOTAL</b>	<b>31233</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>AVERAGE</b>	<b>6247</b>	<b>3348</b>	<b>9595</b>	<b>1</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
<b>TOTAL</b>	<b>4394424</b>	<b>4155996</b>	<b>8550420</b>
<b>AVERAGE</b>	<b>878885</b>	<b>831199</b>	<b>1710084</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
<b>TOTAL</b>	<b>8294</b>	<b>-</b>	<b>-</b>	<b>305</b>	<b>68</b>
<b>AVERAGE</b>	<b>1658.8</b>	<b>0.6</b>	<b>11.7</b>	<b>61</b>	<b>13.6</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
<b>TOTAL</b>	<b>346148</b>	<b>202970</b>	<b>549118</b>	-	-
<b>AVERAGE</b>	<b>69229.6</b>	<b>40594</b>	<b>109823.7</b>	<b>63</b>	<b>37</b>