

DECEMBER 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 December 2019. Volume was computed using all monthly data.

System Calibration

WIM #39 was most recently calibrated on 2019-06-02. Table 1 summarizes the front axle weights of class 9s by lane ¹. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation 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: 281826 | Passenger Vehicles: 266465 | Heavy Commercial Vehicles: 15361

Monthly Average Daily Traffic (MADT): 9145 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 496

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 03 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 03 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 15361 HCVs, 3530 of them were overweight ³. These overweight HCVs contributed to 1.3% of total monthly volume, and 23.1% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Fridays, 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 75.4% 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 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 ,1264 NB vehicles exceeded 88,000 pounds (892 vehicles were Class 9's; 159 vehicles were Class 10's). Of vehicles traveling SB,

186 NB vehicles exceeded 88,000 pounds (167 vehicles were Class 9's; 7 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from December 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in December 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 148348 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (64.5%) than SB (35.5%). 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 281826 vehicles with a combined GVW of 1978575 kips (1 kip = 1,000 pounds = 0.5 tons) in December 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 16933 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 68.3% of all ESALs were recorded NB while 31.7% was observed SB. In particular, 66% 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:

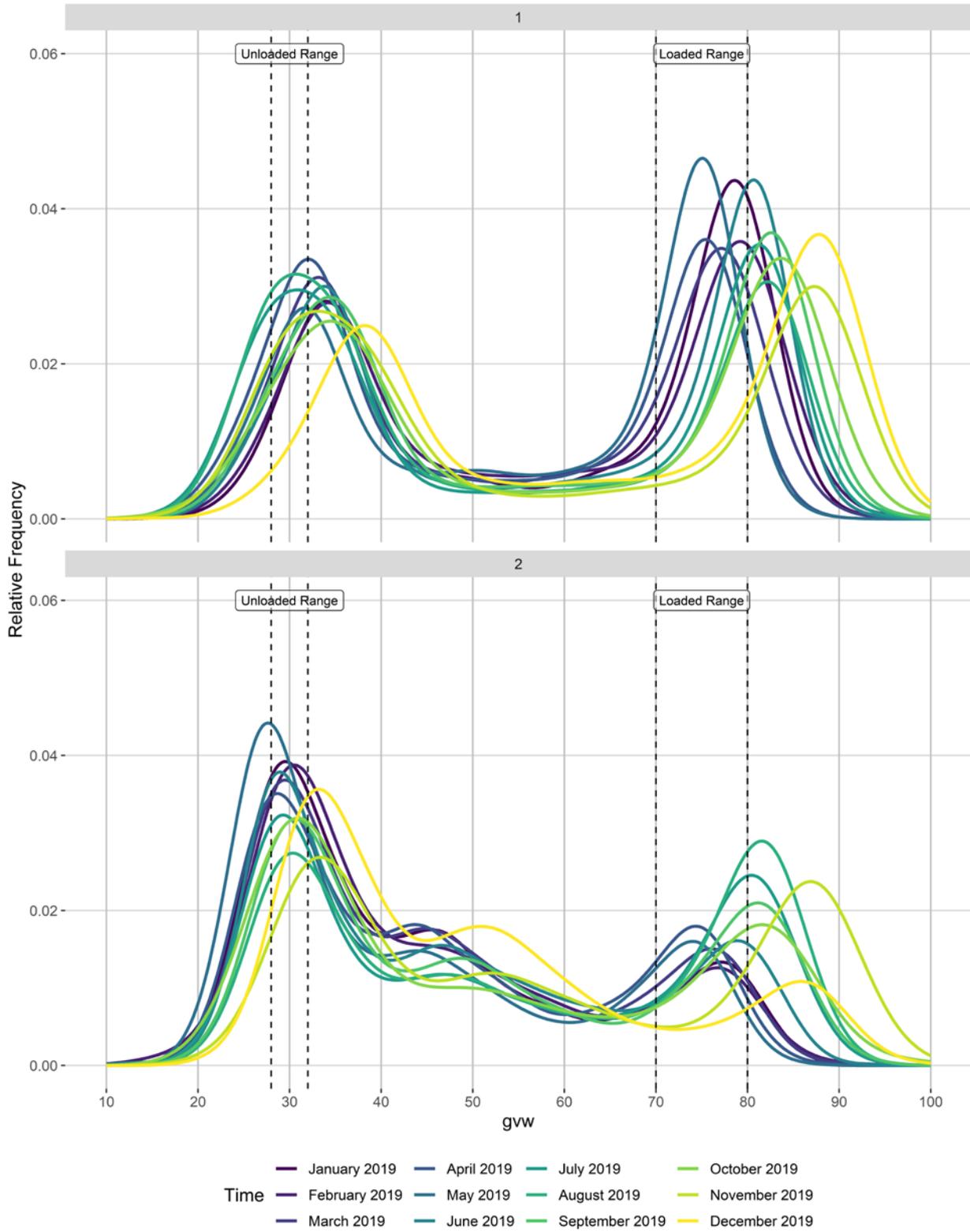
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

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>

- 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.

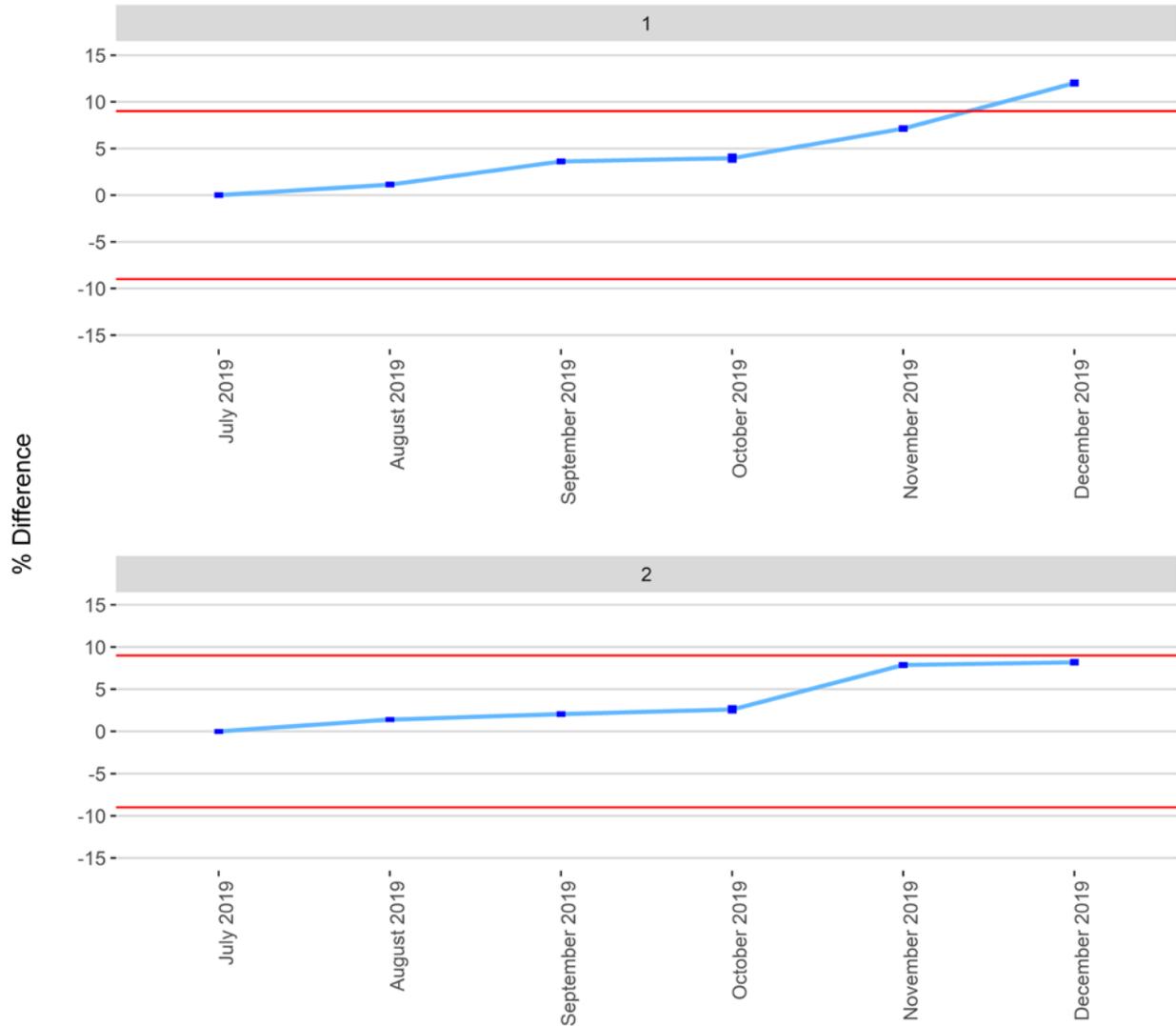
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Figure 1 - Monthly Class 9 GWW Histogram



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

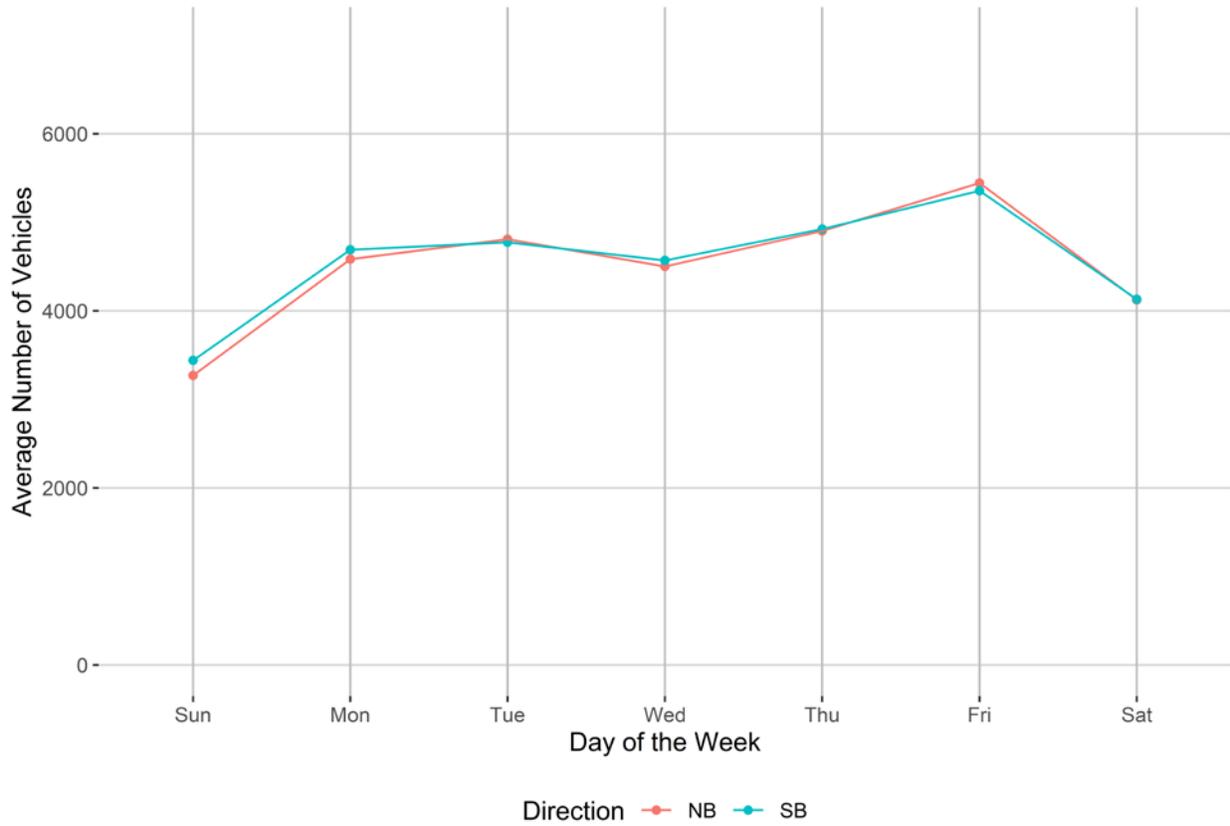


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

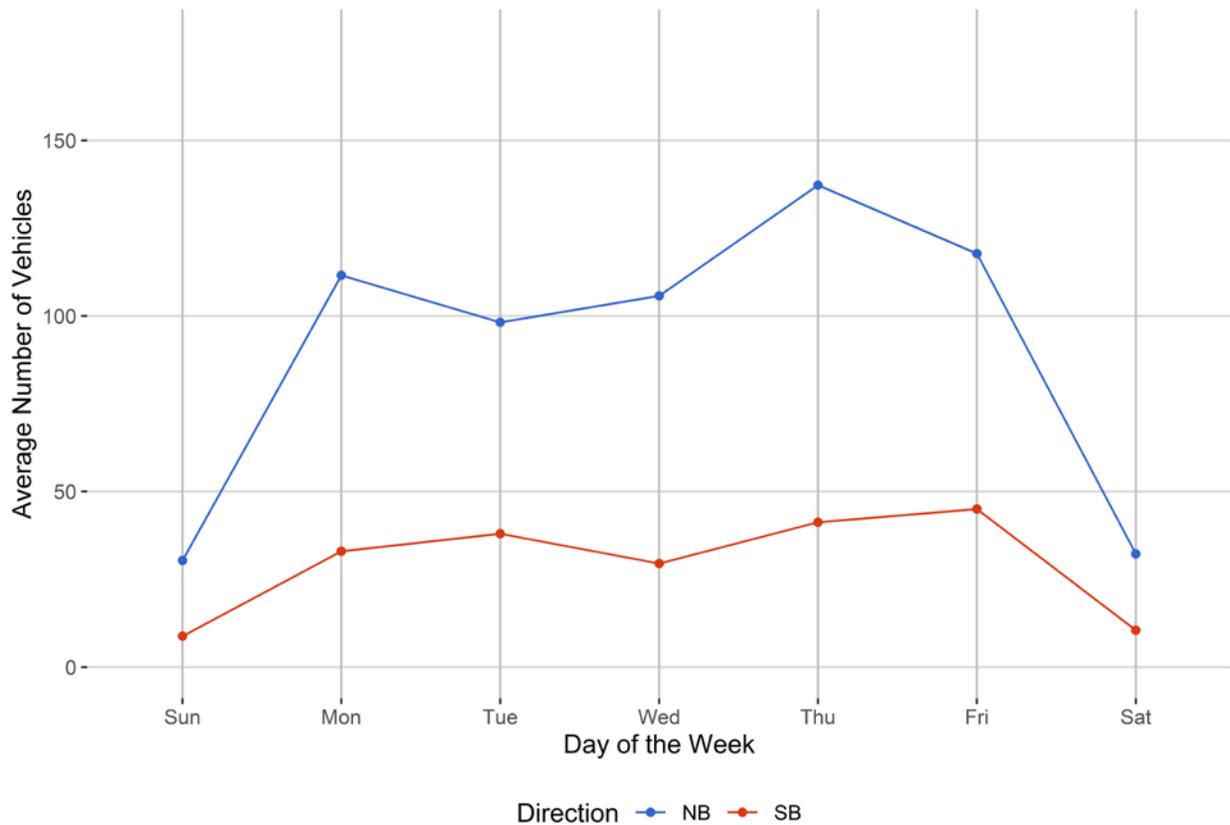


Figure 4 - Passenger Vehicles vs. Hour of the Day

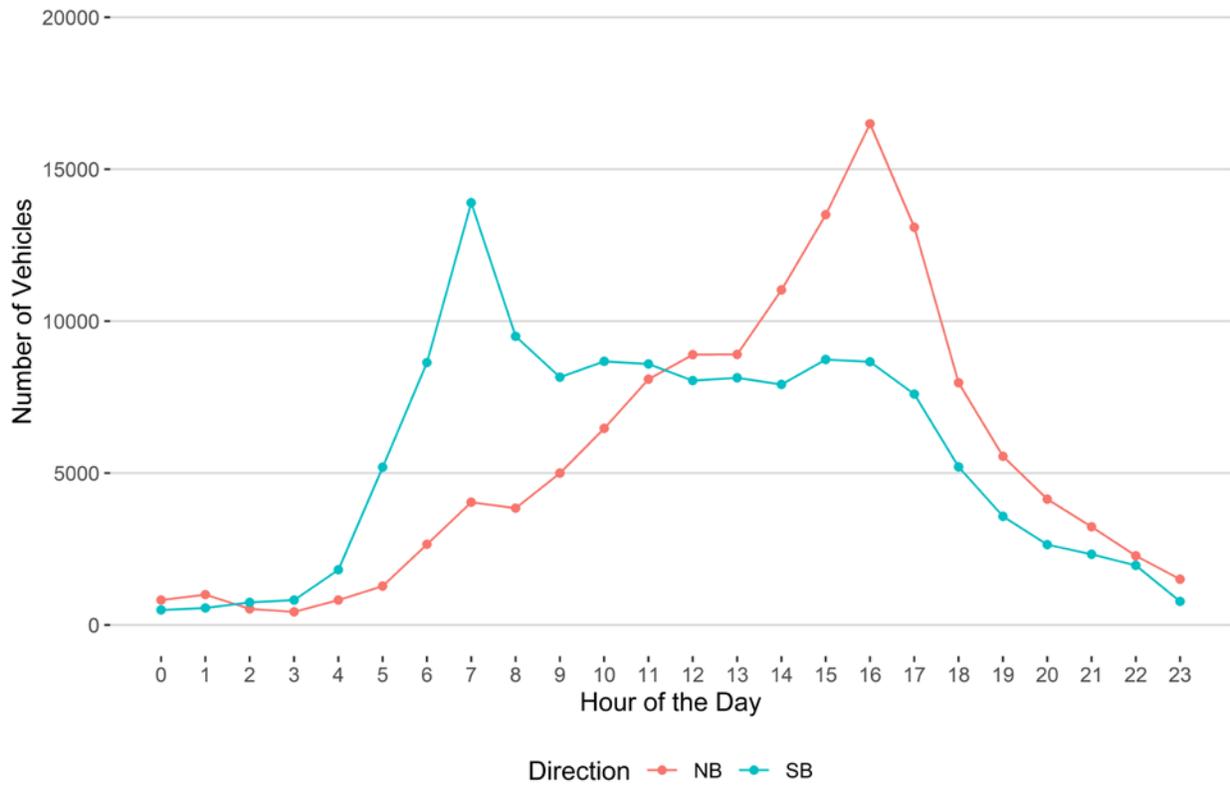


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

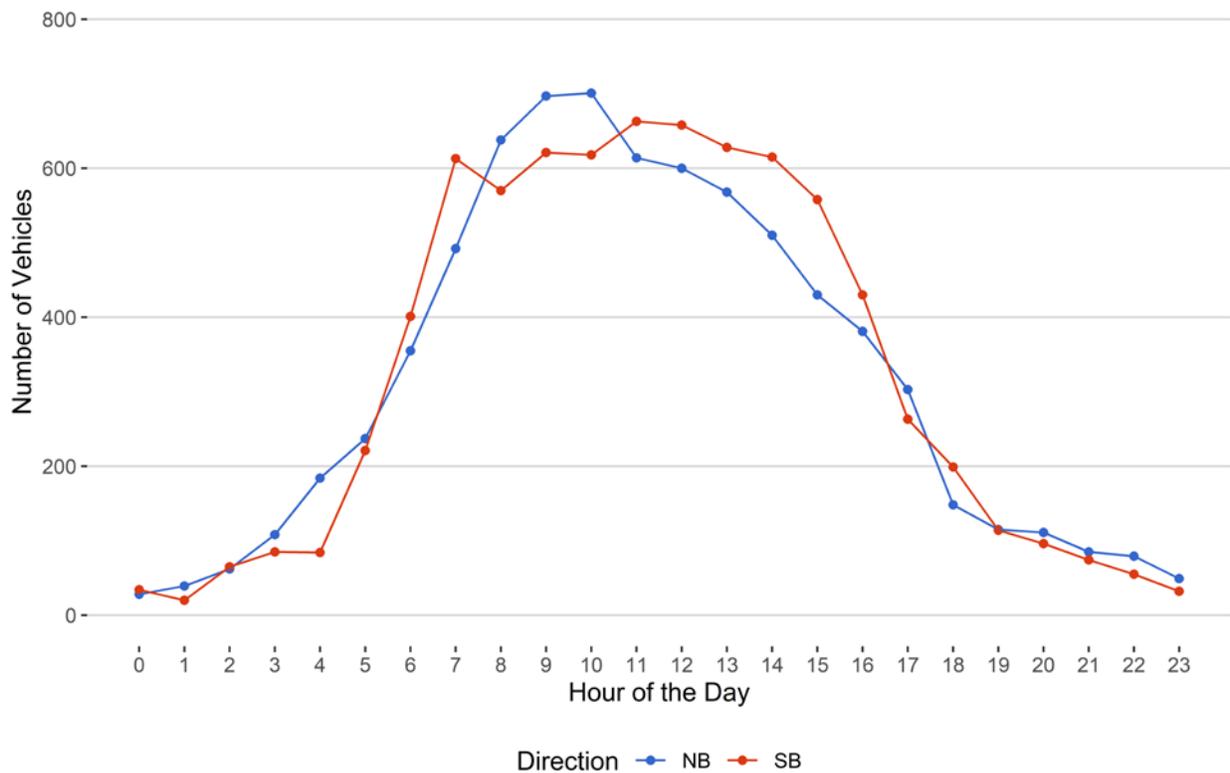


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

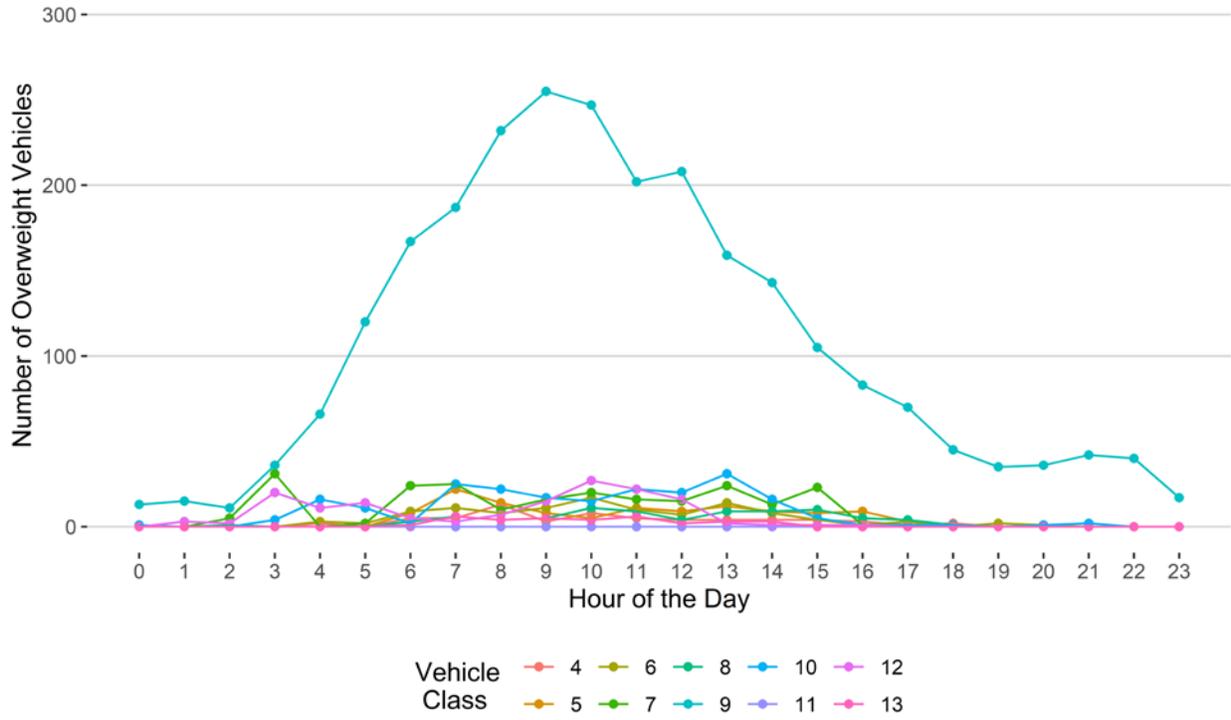


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

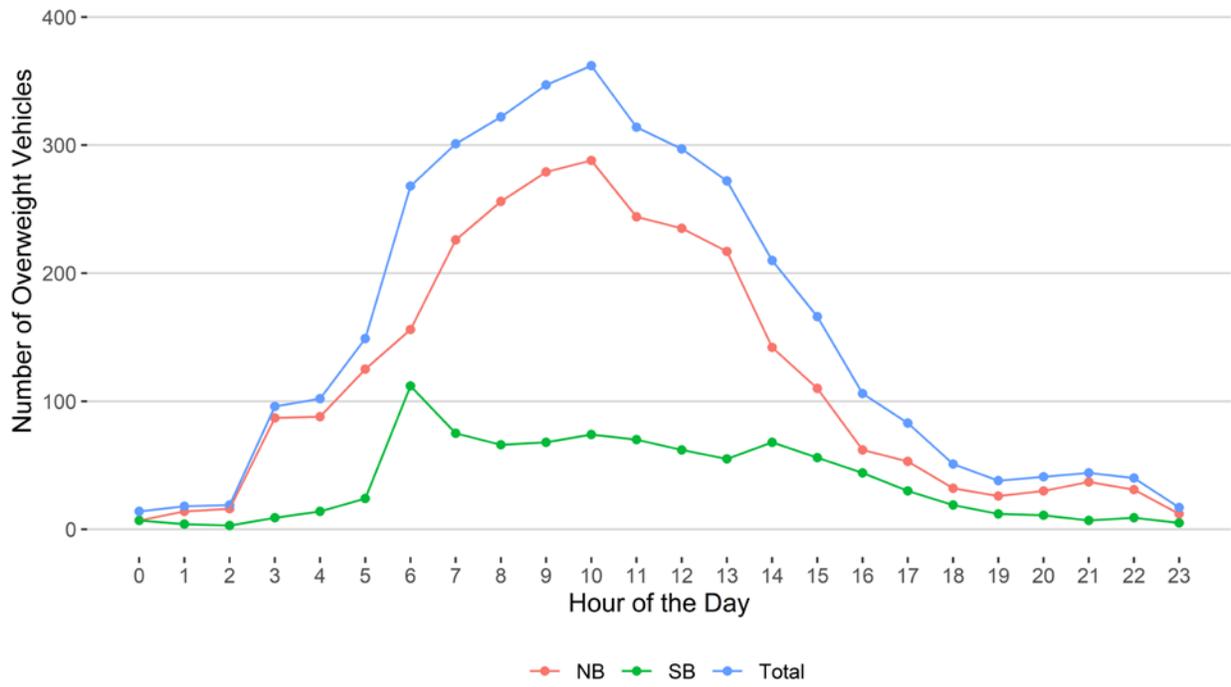
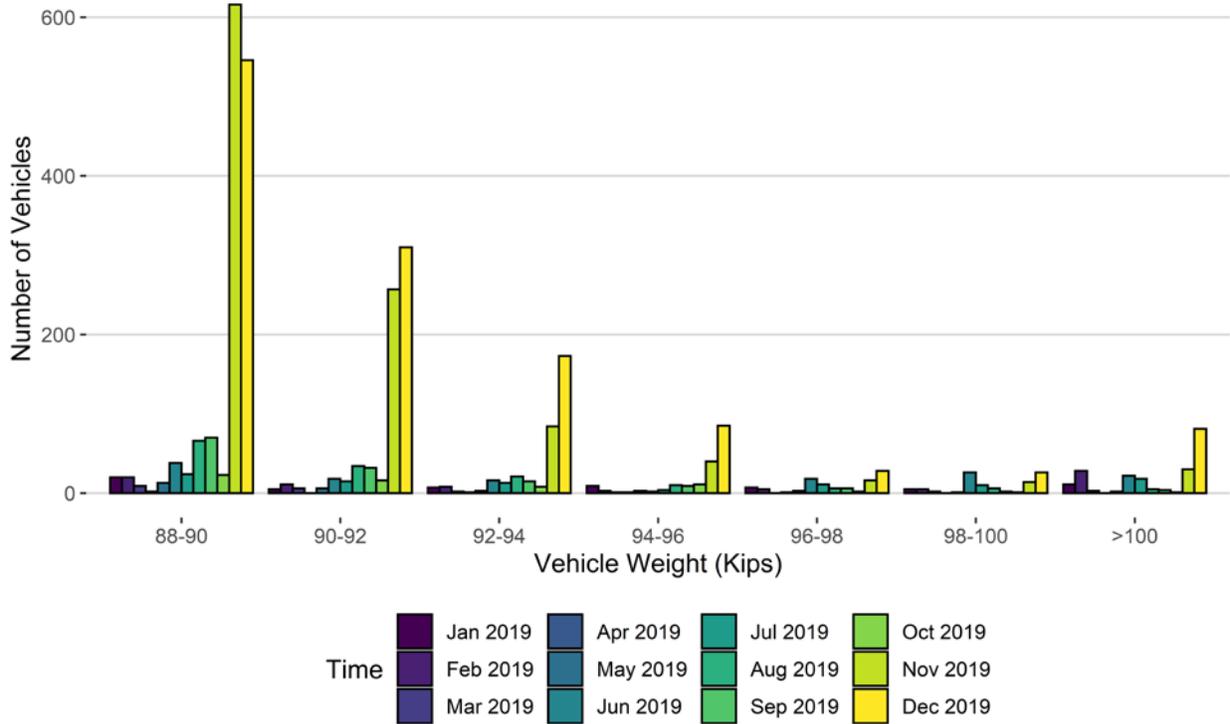
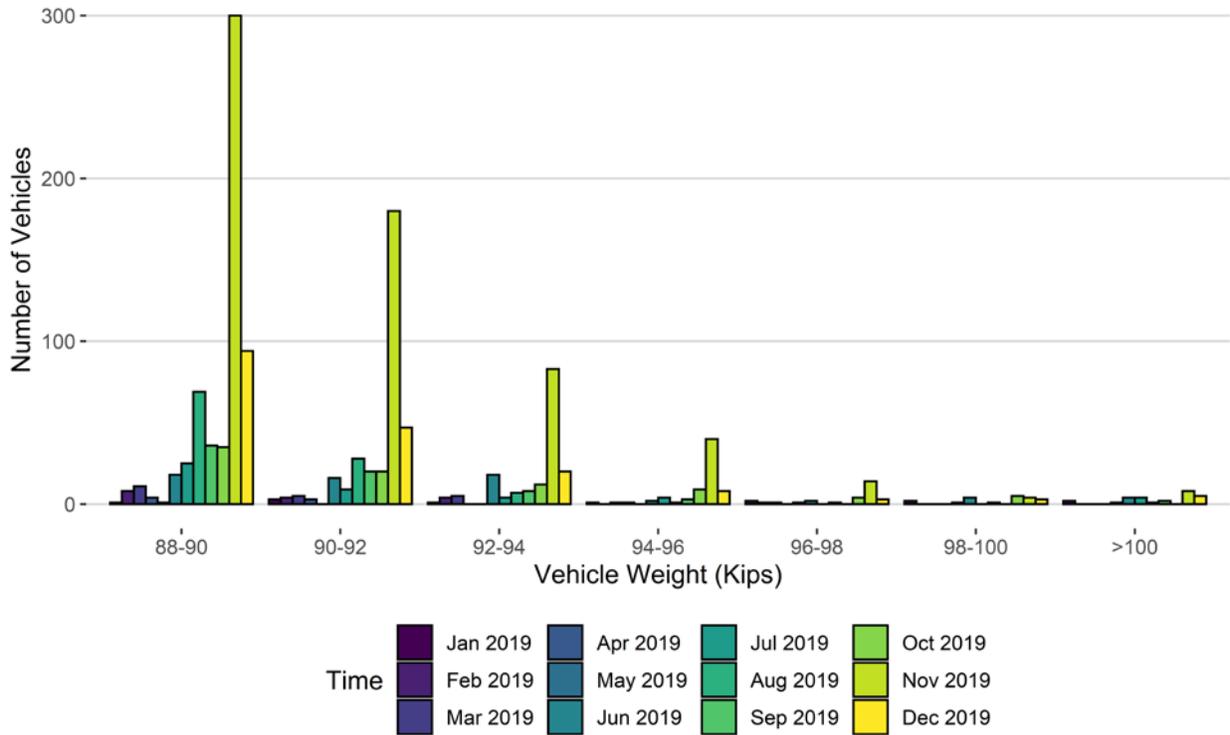


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	20	20	9	2	13	38	24	66	70	23	616	546
90-92	5	11	6	0	6	18	15	34	32	16	257	310
92-94	7	8	2	1	3	16	13	21	15	8	84	173
94-96	9	3	1	1	3	2	4	10	9	11	40	85
96-98	7	5	0	1	3	18	11	6	6	2	16	28
98-100	5	5	2	0	1	26	10	6	2	1	14	26
>100	11	28	3	0	2	22	18	5	4	1	30	81
Total	64	80	23	5	31	140	95	148	138	62	1057	1249

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



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	1	8	11	4	1	18	25	69	36	35	300	94
90-92	3	4	5	3	0	16	9	28	20	20	180	47
92-94	1	4	5	0	0	18	4	7	8	12	83	20
94-96	1	0	1	1	0	2	4	1	3	9	40	8
96-98	2	1	1	0	1	2	0	1	0	4	14	3
98-100	2	0	0	0	1	4	0	1	0	5	4	3
>100	2	0	0	0	1	4	4	1	2	0	8	5
Total	12	17	23	8	4	64	46	108	69	85	629	180

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

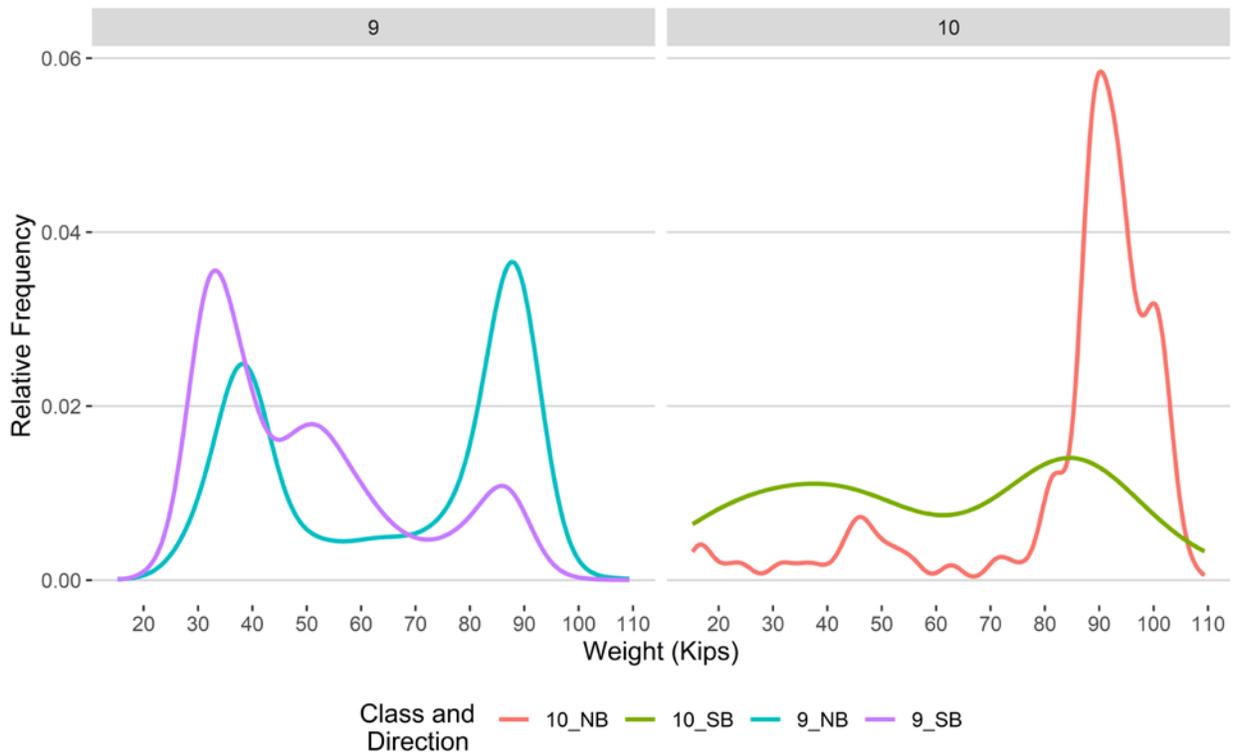


Figure 9 - Freight Percentage by Direction and Class

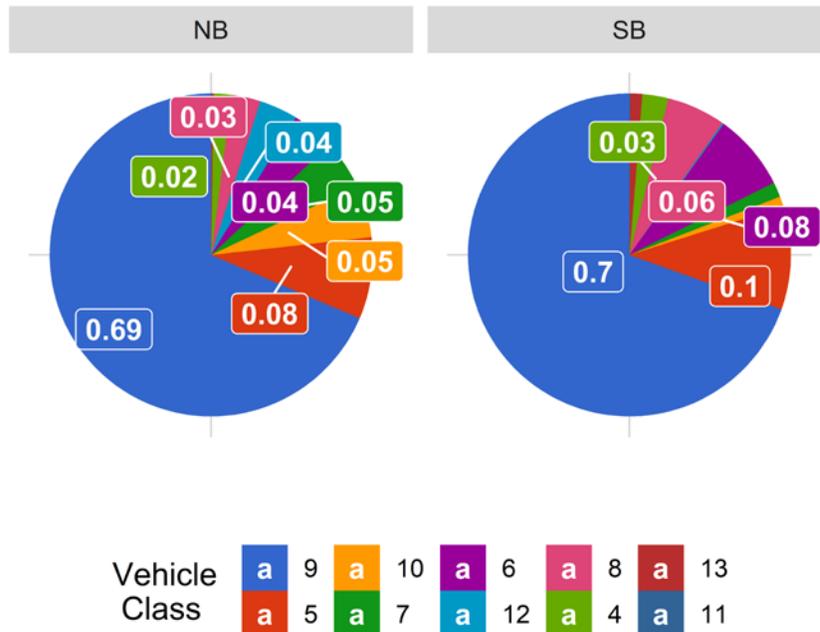


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

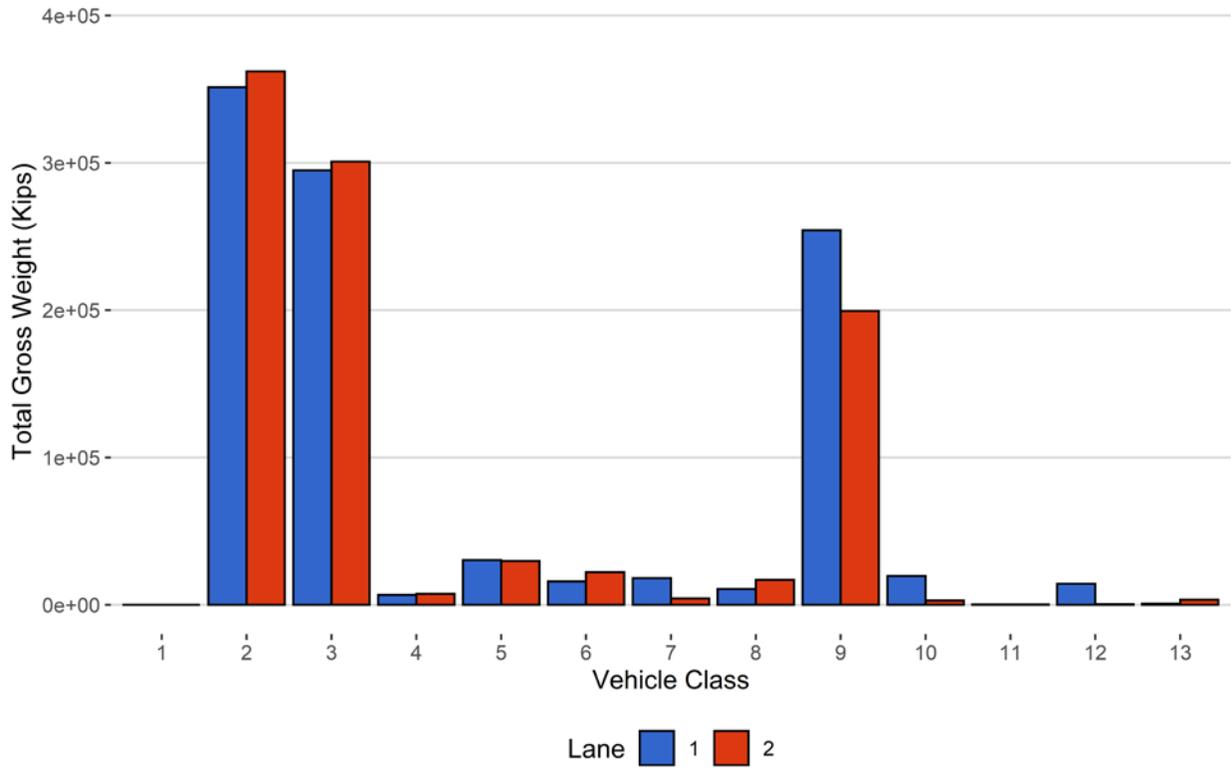


Figure 11 - Total Gross Vehicle Weight t

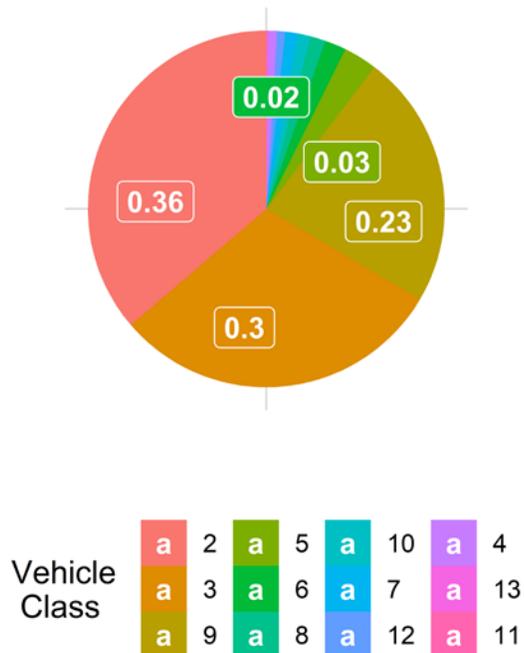


Figure 12 - Total ESALs by Class and Lane

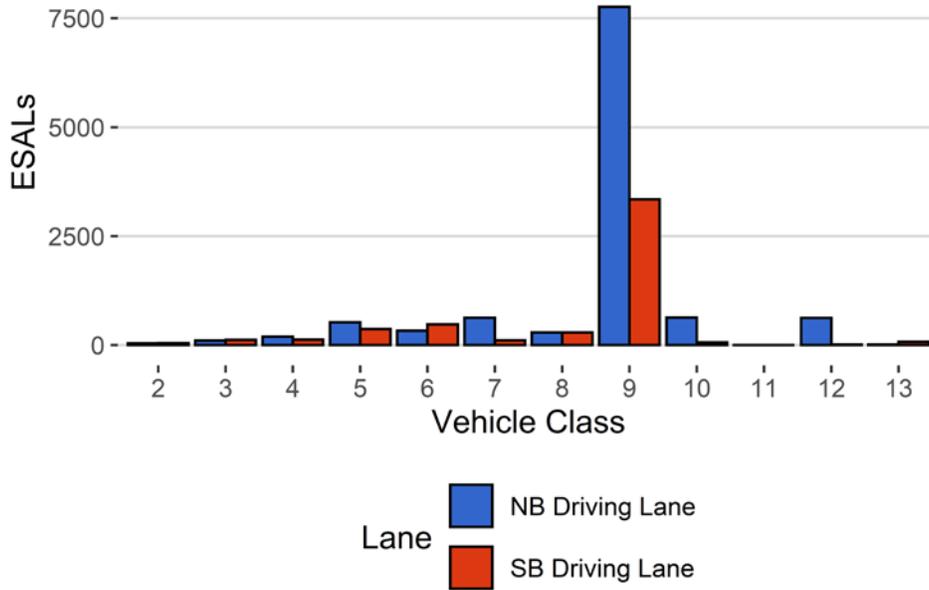


Figure 13 - ESALs by Class

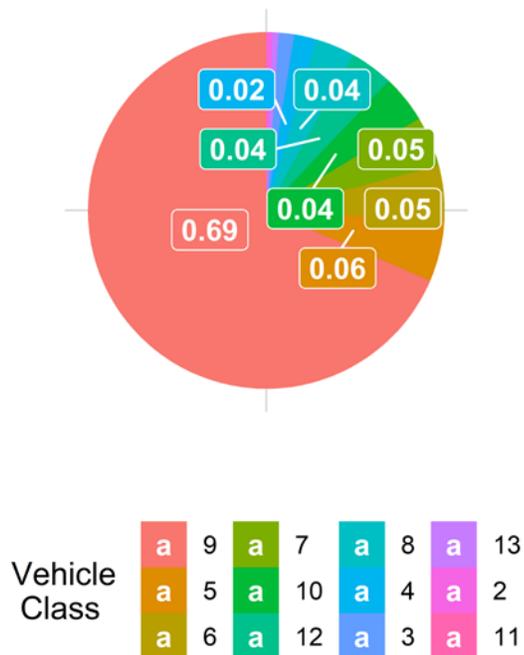


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
July 2019	10.82	0.00	10.95	0.00
August 2019	10.94	1.13	11.10	1.41
September 2019	11.21	3.62	11.17	2.06
October 2019	11.24	3.96	11.23	2.60
November 2019	11.59	7.13	11.81	7.87
December 2019	12.12	12.02	11.84	8.19

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	0	0	0	0	0
2	5534	171569	60.9	0	0
3	3061	94896	33.7	0	0
4	15	472	0.2	63	1.8
5	137	4248	1.5	119	3.4
6	38	1183	0.4	111	3.1
7	9	282	0.1	225	6.4
8	24	748	0.3	81	2.3
9	256	7926	2.8	2534	71.8
10	9	281	0.1	213	6
11	0	7	0	0	0
12	5	159	0.1	150	4.2
13	2	53	0	34	1
TOTAL	9091	281826	100	3530	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>
2019-12-13	Friday	03:52:46	9	NB	1	109.36
2019-12-17	Tuesday	14:03:00	10	SB	2	108.6
2019-12-03	Tuesday	05:42:45	9	NB	1	107.23
2019-12-15	Sunday	09:26:28	10	NB	1	106.99
2019-12-20	Friday	14:05:26	10	SB	2	106.68
2019-12-30	Monday	04:46:41	9	SB	2	106.38
2019-12-16	Monday	06:03:46	9	NB	1	105.76
2019-12-31	Tuesday	07:01:28	9	NB	1	105.72
2019-12-20	Friday	09:38:00	10	NB	1	104.69
2019-12-19	Thursday	08:37:30	9	NB	1	104.25

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	211	26	12.3	6348	359	1787
5	NB	8	2089	168	8	29093	1214	6863
6	NB	19	492	24	4.9	15415	409	3262
7	NB	11.5	222	0	0	18124	0	7786
8	NB	31	275	60	21.8	9524	1154	1430
9	NB	33	3848	198	5.1	248415	5857	63982
10	NB	33.5	231	10	4.3	19387	216	5992
11	NB	36.5	3	0	0	131	0	11
12	NB	36.5	153	1	0.7	14314	17	4383
13	NB	31.5	10	0	0	776	0	230
TOTAL	****	****	7534	487	****	361527	****	95724
<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	258	22	8.5	7186	296	1823
5	SB	8	2129	162	7.6	28492	1185	6378
6	SB	19	683	33	4.8	21535	581	4593
7	SB	11.5	58	0	0	4280	0	1807
8	SB	31	468	140	29.9	13359	3537	1595
9	SB	33	4021	879	21.9	172761	26658	34537
10	SB	33.5	48	10	20.8	2663	222	695
11	SB	36.5	4	0	0	195	0	25
12	SB	36.5	5	0	0	411	0	114
13	SB	31.5	43	0	0	3467	0	1056
TOTAL	****	****	7717	1246	****	254350	****	52624
GRAND TOTAL	****	****	15251	1733	151	615877	41704	148348

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>
2	351313	362088	713401	36.3
3	294936	300874	595810	30.3
4	6707	7482	14189	0.7
5	30307	29677	59984	3
6	15824	22116	37940	1.9
7	18124	4280	22404	1.1
8	10678	16895	27573	1.4
9	254272	199418	453691	23.1
10	19603	2885	22488	1.1
11	131	195	326	0
12	14331	411	14742	0.7
13	776	3467	4243	0.2
TOTAL	1017002	949790	1966792	100
GVW/LANE	51.71	48.29	100	0.01

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>
2	42	46	88	0.5	0.001
3	107	119	226	1.4	0.0048
4	196	127	322	2	1.37
5	525	369	894	5.5	0.43
6	332	475	807	5	1.38
7	629	112	741	4.6	5.2
8	292	291	583	3.6	1.57
9	7759	3344	11103	68.5	2.83
10	636	64	700	4.3	4.89
11	1	2	3	0	0.97
12	625	15	640	4	7.63
13	14	76	90	0.6	2.94
TOTAL	11156	5040	16197	100	29
ESALS/LANE	68.9	31.1	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>
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
Aug 2019	357135	11454	713	335033	93.8	22101.6	6.2
Sep 2019	327603	11010	645	308264	94.1	19338.7	5.9
Oct 2019	NA	11311	NA	NA	NA	NA	NA
Nov 2019	260831	9710	581	243402	93.3	17428.9	6.7
Dec 2019	281826	9145	496	266465	94.5	15361.2	5.5
TOTAL	NA	-	-	NA	-	NA	-
AVERAGE	NA	10167	NA	NA	NA	NA	NA

###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>
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
Aug 2019	9916	9751	19667	3.7
Sep 2019	9773	7133	16906	4.9
Oct 2019	4634	3118	7753	4.9
Nov 2019	11233	9010	20243	32.3
Dec 2019	11560	5373	16933	41.3
TOTAL	105190	-	-	-
AVERAGE	8766	5797	14563	8

###Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
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
Aug 19	1215957	1248274	2464231
Sep 19	1118507	1094331	2212838
Oct 19	460493	432488	892981
Nov 19	998227	971557	1969784
Dec 19	1023183	955392	1978575
TOTAL	12673402	12206999	24880401
AVERAGE	1056117	1017250	2073367

###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>
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
Aug 2019	4984	1.4	22.7	262	14
Sep 2019	4099	1.3	21.2	213	8
Oct 2019	1929	1.6	23.1	151	8
Nov 2019	4777	1.8	27.5	1703	61
Dec 2019	3677	1.3	23.9	1450	118
TOTAL	37198	-	-	4394	360
AVERAGE	3099.8	1	17.3	366.2	30

###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>
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

Aug 2019	95517	101710	197227	48.4	51.6
Sep 2019	93197	75504	168701	55.2	44.8
Oct 2019	43214	31801	75015	57.6	42.4
Nov 2019	95072	82742	177814	53.5	46.5
Dec 2019	95724	52624	148348	64.5	35.5
TOTAL	1046513	759362	1805875	-	-
AVERAGE	87209.4	63280.2	150489.6	58.7	41.3
