

DECEMBER 2019



**WIM #48
CSAH 5,
MP 15.05
STORDEN, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #48 is located on CSAH 5 near Storden in Cottonwood county.

System Operation

WIM #48 was operational for the entire month of December 2019. Volume was computed using all monthly data.

System Calibration

WIM #48 was most recently calibrated on 2019-05-15. 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: 9838 | Passenger Vehicles: 8495 | Heavy Commercial Vehicles: 1343

Monthly Average Daily Traffic (MADT): 320 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 43

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 Mondays (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 07 AM and 04 PM. Similarly, SB PVs peaked in volume between 02 PM and 04 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 07 AM and 04 PM, while volume going SB peaked between 02 PM 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 1343 HCVs, 245 of them were overweight ³. These overweight HCVs contributed to 2.7% of total monthly volume, and 20% of total monthly HCV volume.

NB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Fridays, with lowest volumes reported on Saturdays. See Figure 3 .

The top two overweight violators by class were the class 9 and class 6 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 72.9% of all overweight vehicles traveling SB 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 ⁴.

Using normal load limits ,14 NB vehicles exceeded 88,000 pounds (6 vehicles were Class 10's; 5 vehicles were Class 13's). Of vehicles traveling SB,

143 NB vehicles exceeded 88,000 pounds (111 vehicles were Class 9's; 16 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 empty Class 9's than fully_loaded 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 10601 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (69.8%) than NB (30.2%). See Table 4 and Figure 11 for more freight information.

####Infrastructure Considerations Bridge. Bridge No. 97506 (a precast box culvert) is approximately 1.3 miles north of WIM #48. Bridge No. 97666 (a precast box culvert) is approximately .45 miles south of WIM #48. WIM #48 recorded a total of 9838 vehicles with a combined GVW of 96494 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 1434 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 76.8% of all ESALs were recorded SB while 23.2% was observed NB. In particular, 64% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 30% 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:

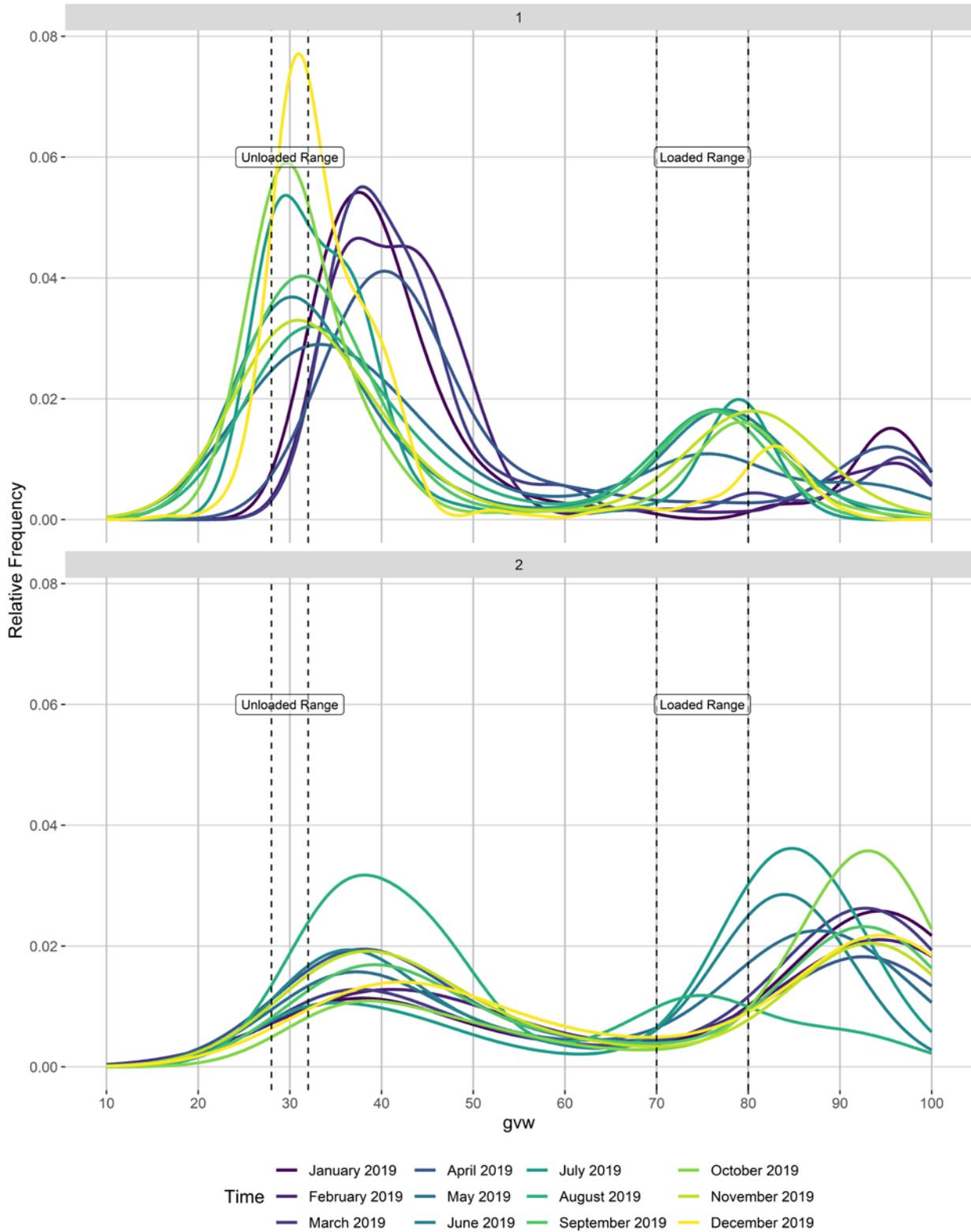
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

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.

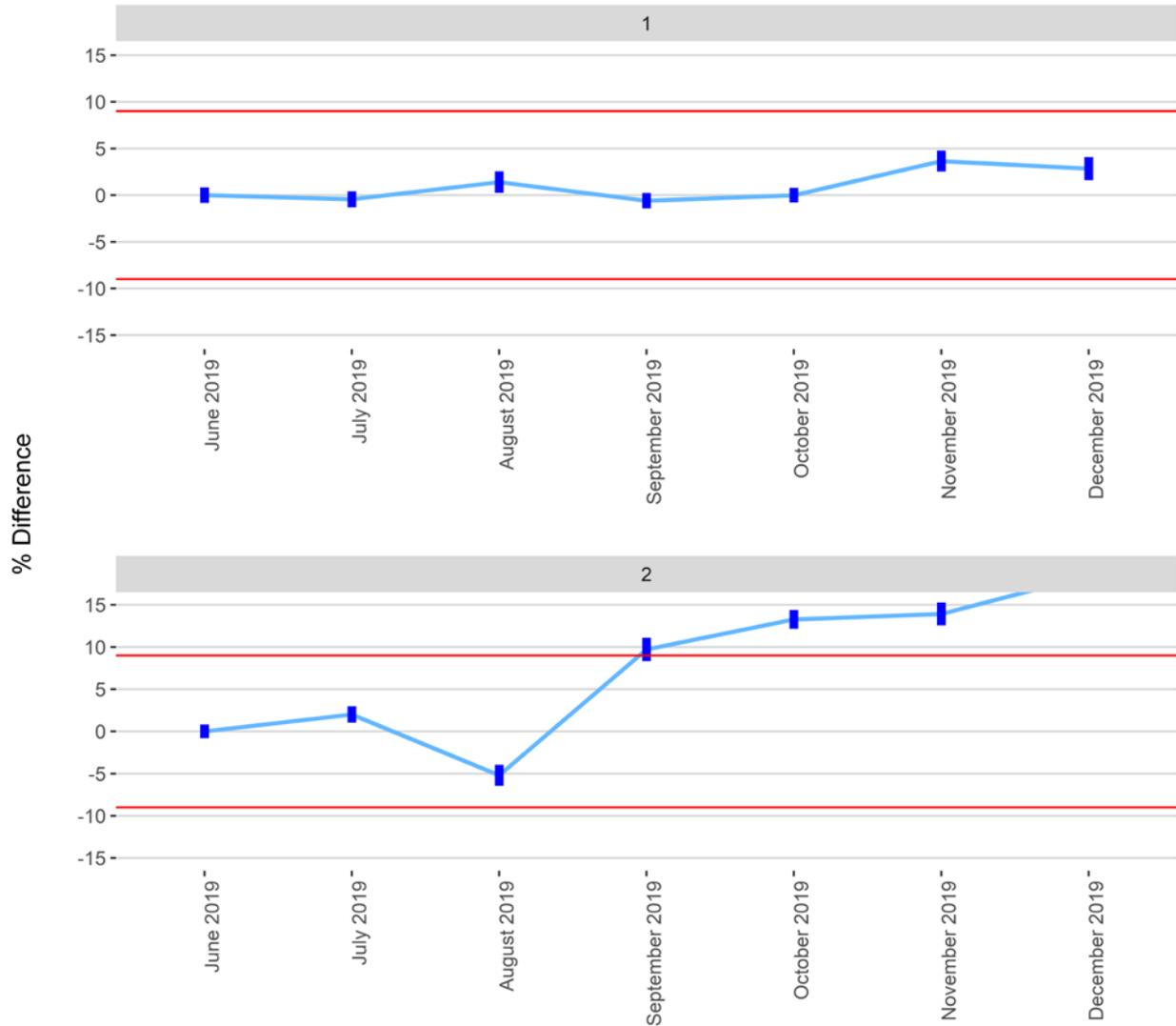
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Figure 1 - Monthly Class 9 GVW Histogram



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

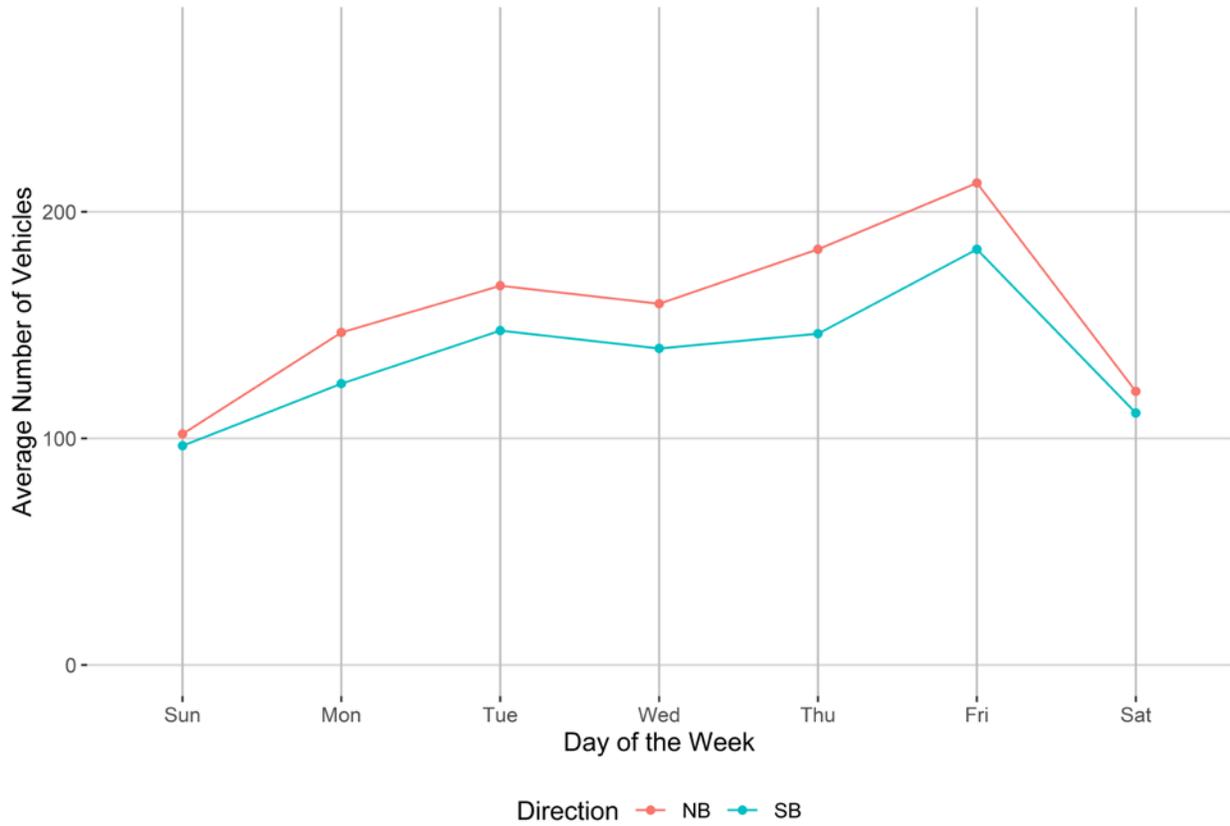


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

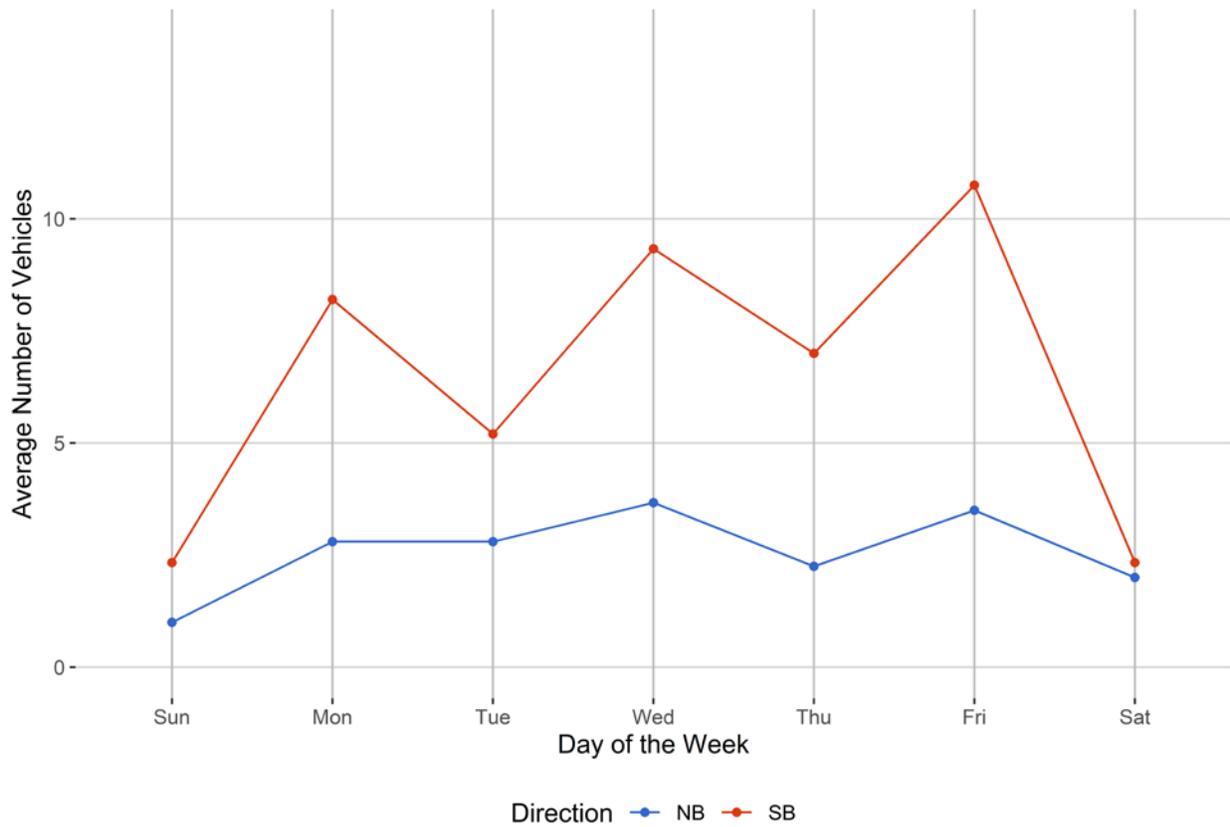


Figure 4 - Passenger Vehicles vs. Hour of the Day

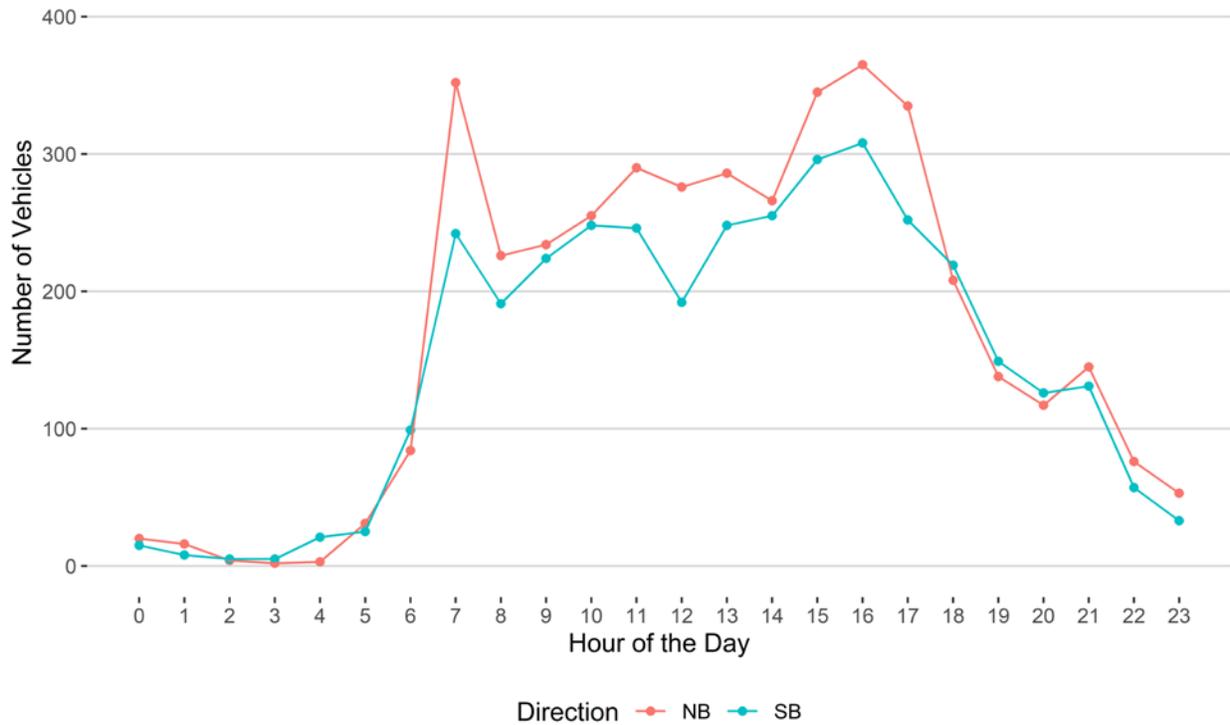


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

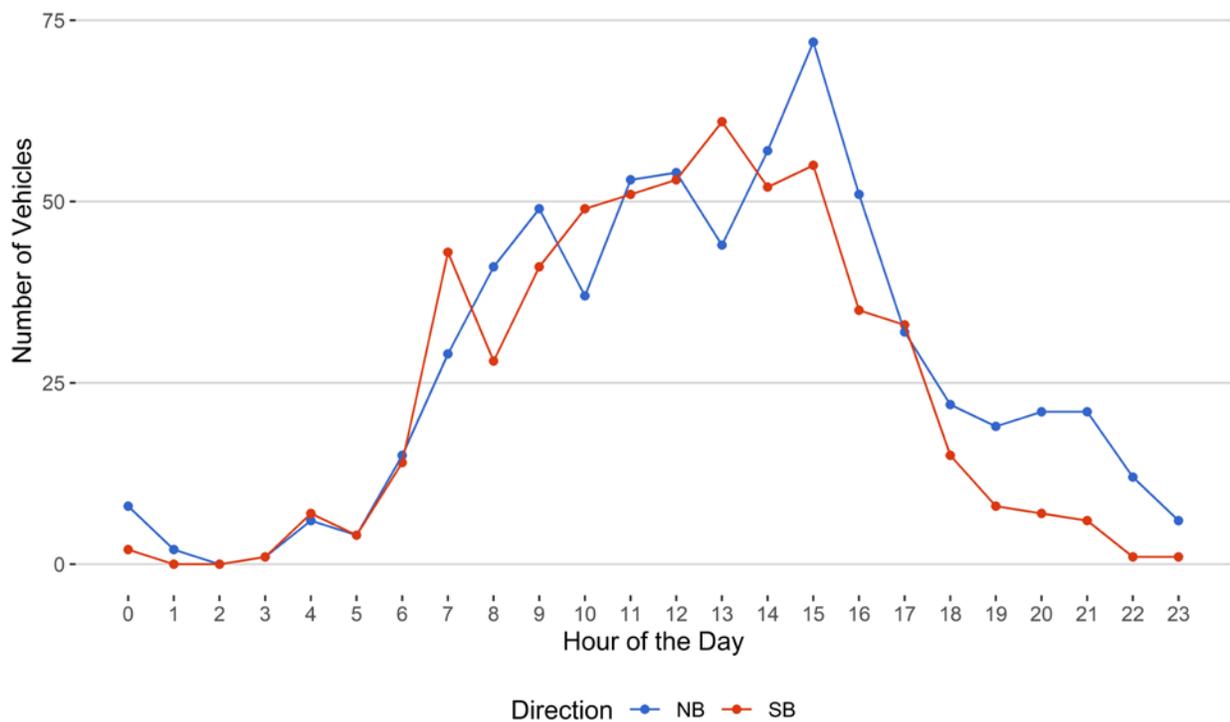


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

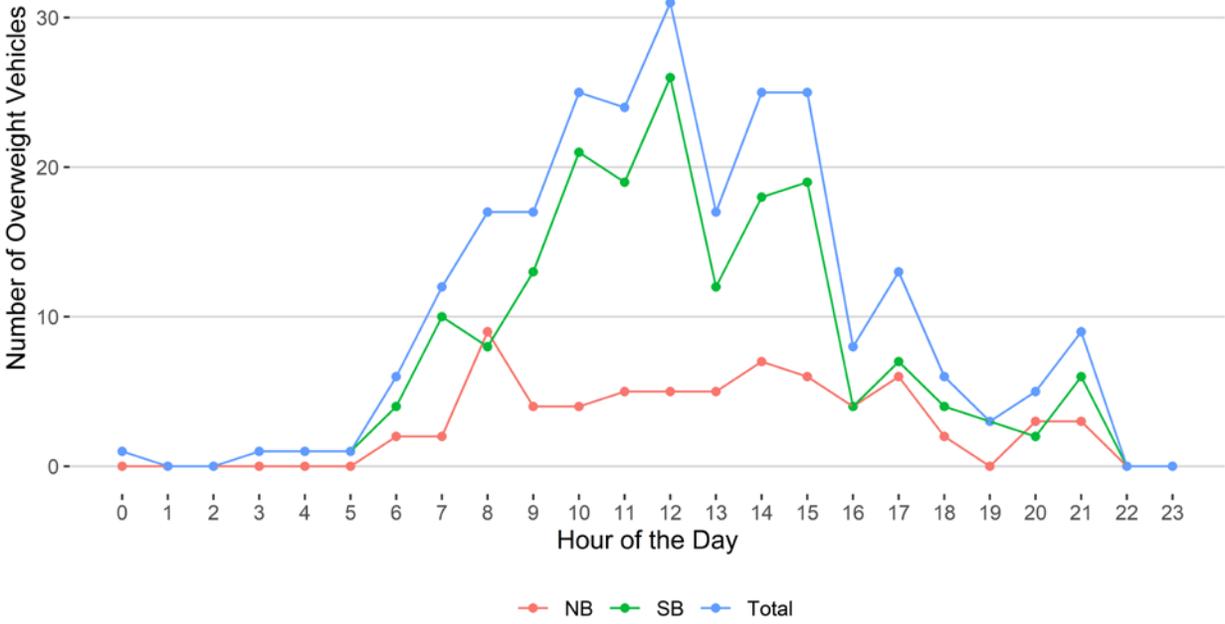
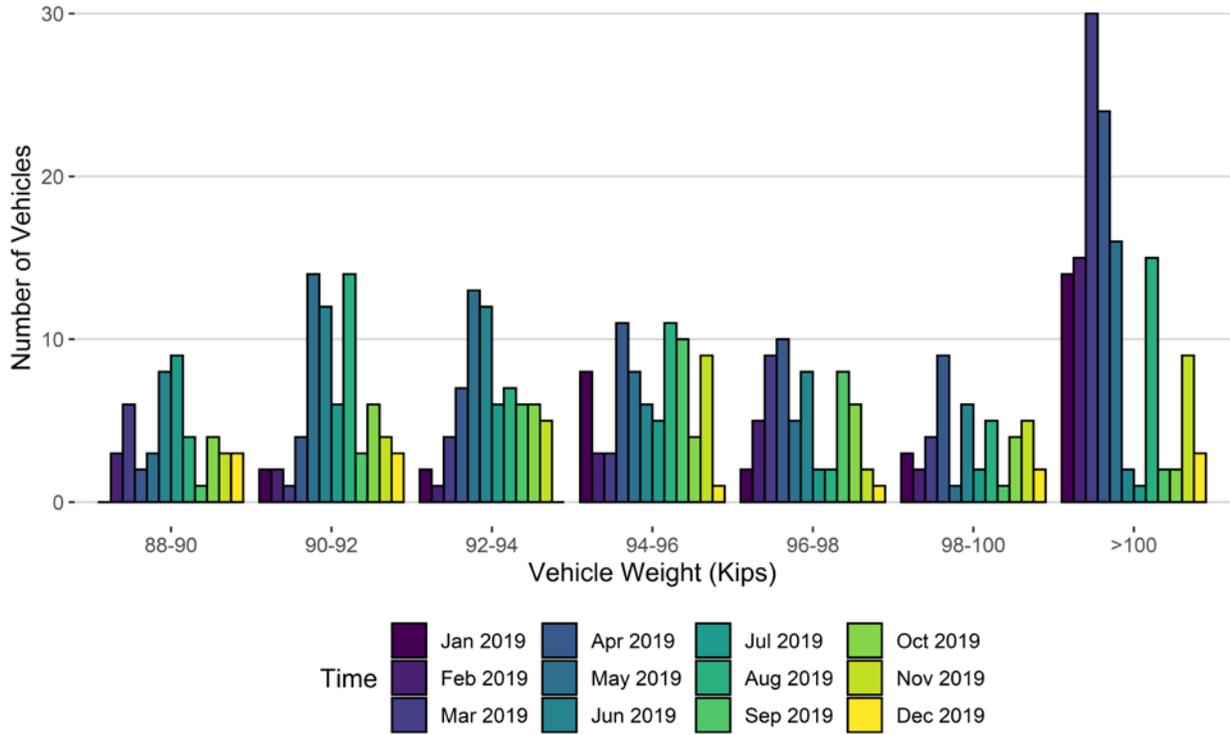
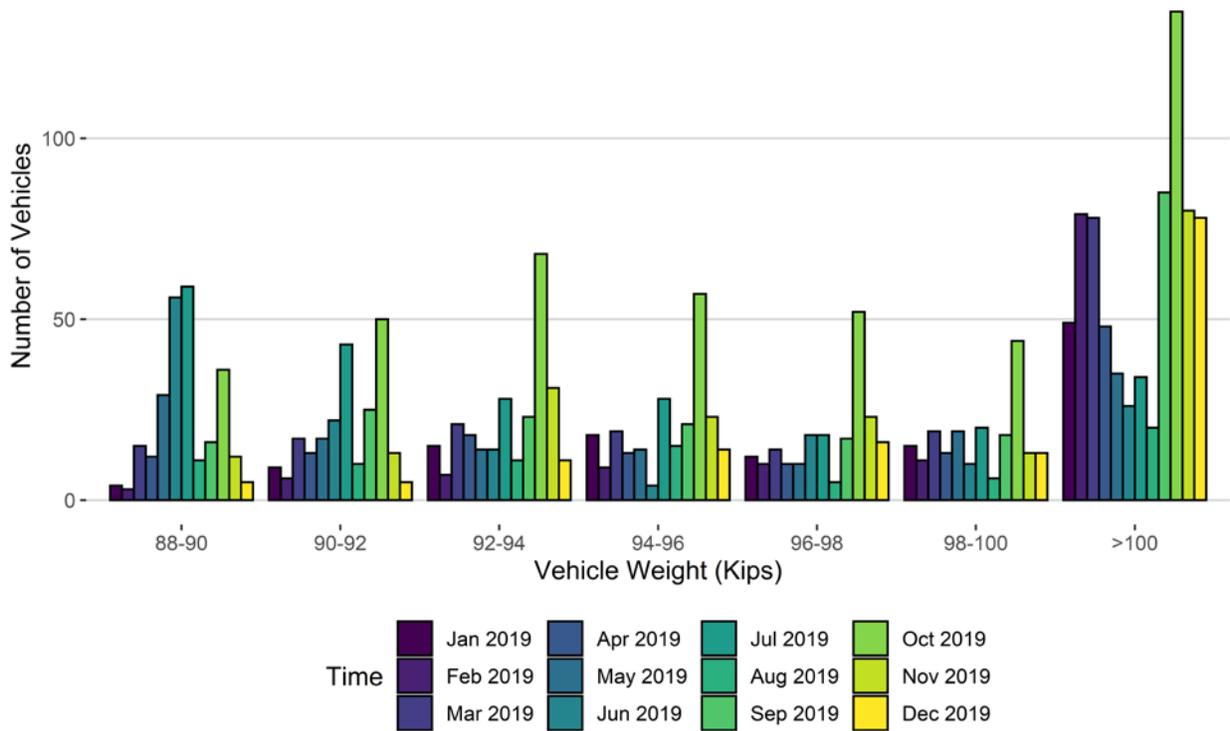


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



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	0	3	6	2	3	8	9	4	1	4	3	3
90-92	2	2	1	4	14	12	6	14	3	6	4	3
92-94	2	1	4	7	13	12	6	7	6	6	5	0
94-96	8	3	3	11	8	6	5	11	10	4	9	1
96-98	2	5	9	10	5	8	2	2	8	6	2	1
98-100	3	2	4	9	1	6	2	5	1	4	5	2
>100	14	15	30	24	16	2	1	15	2	2	9	3
Total	31	31	57	67	60	54	31	58	31	32	37	13

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	4	3	15	12	29	56	59	11	16	36	12	5
90-92	9	6	17	13	17	22	43	10	25	50	13	5
92-94	15	7	21	18	14	14	28	11	23	68	31	11
94-96	18	9	19	13	14	4	28	15	21	57	23	14
96-98	12	10	14	10	10	18	18	5	17	52	23	16
98-100	15	11	19	13	19	10	20	6	18	44	13	13
>100	49	79	78	48	35	26	34	20	85	135	80	78
Total	122	125	183	127	138	150	230	78	205	442	195	142

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

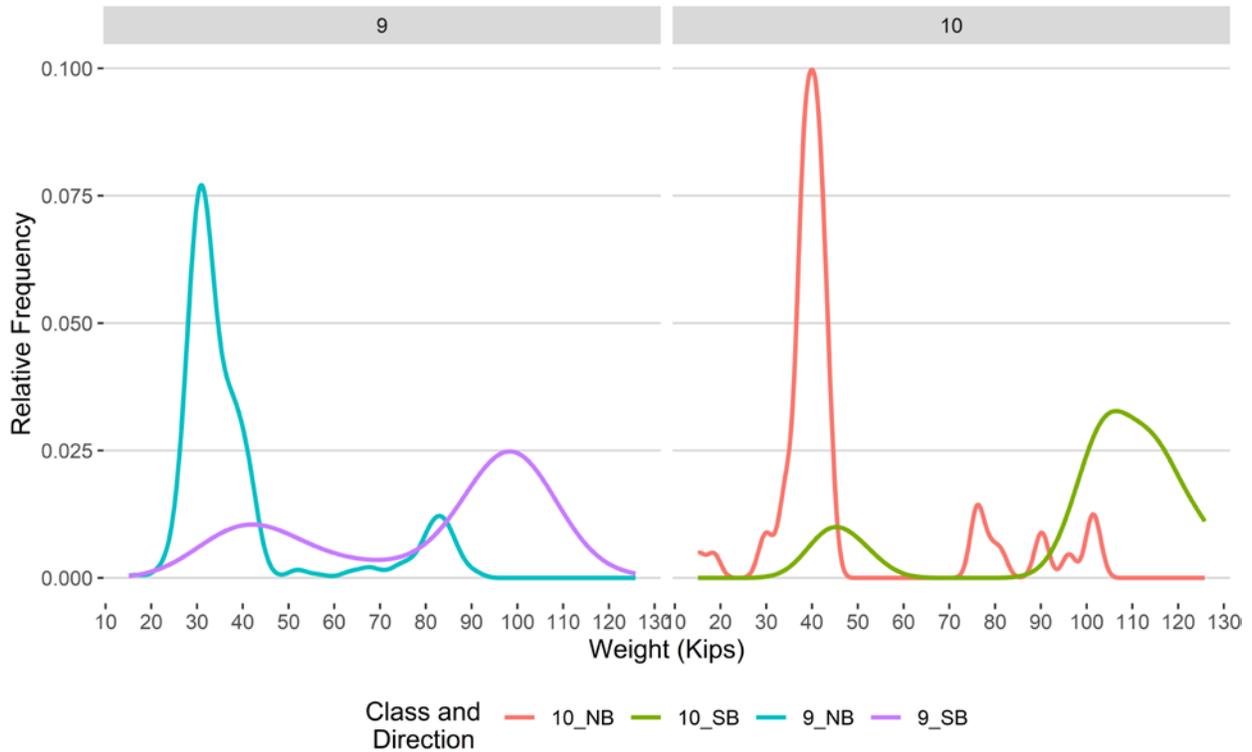


Figure 9 - Freight Percentage by Direction and Class

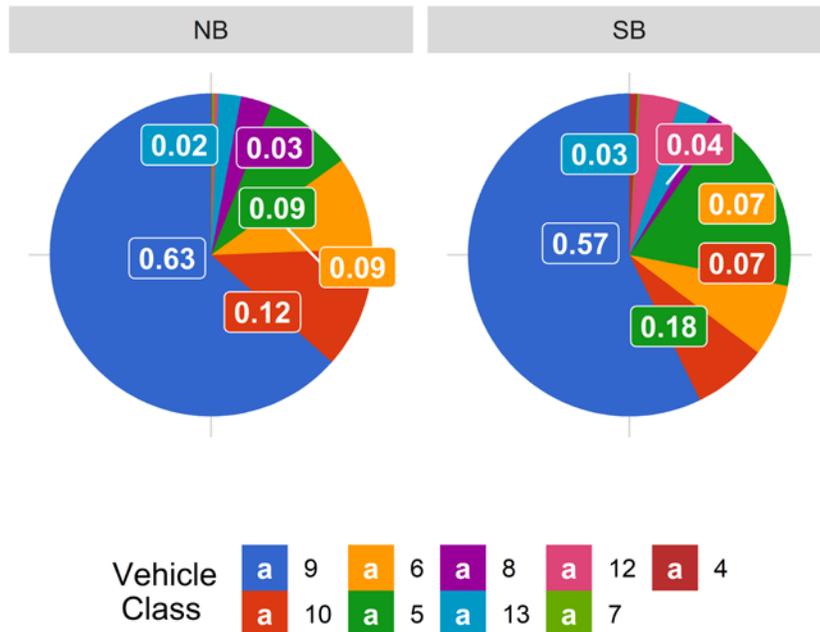


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

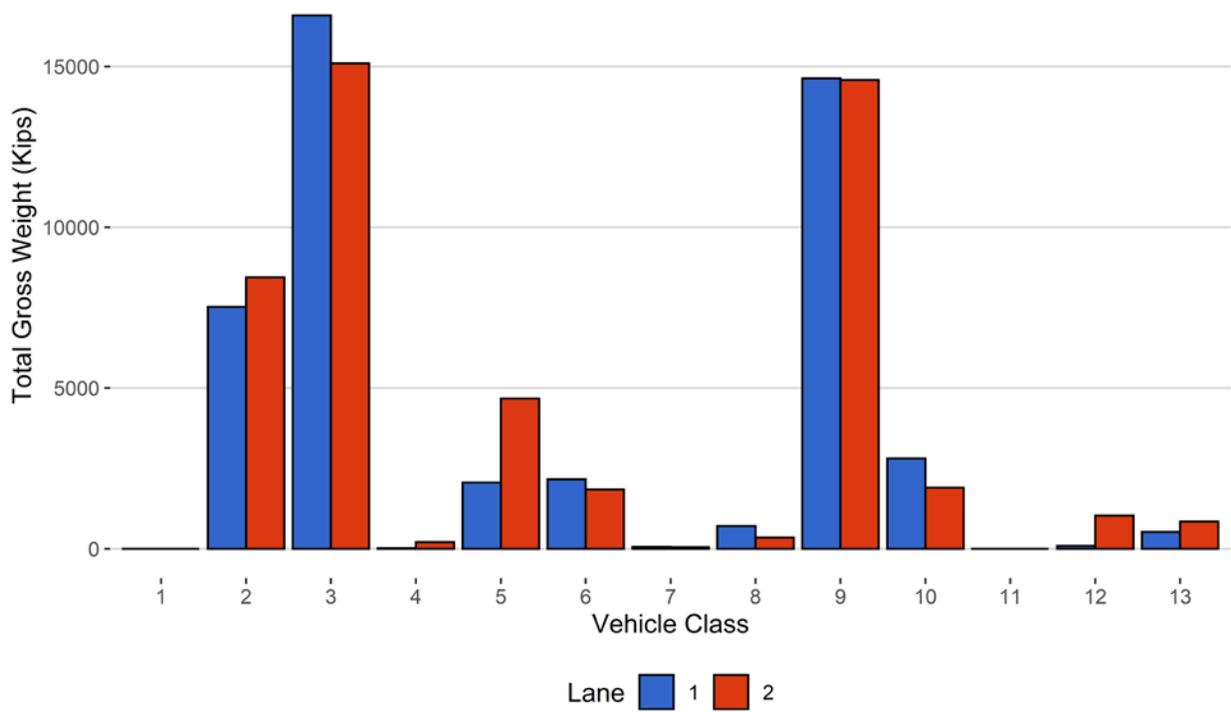


Figure 11 - Total Gross Vehicle Weight t

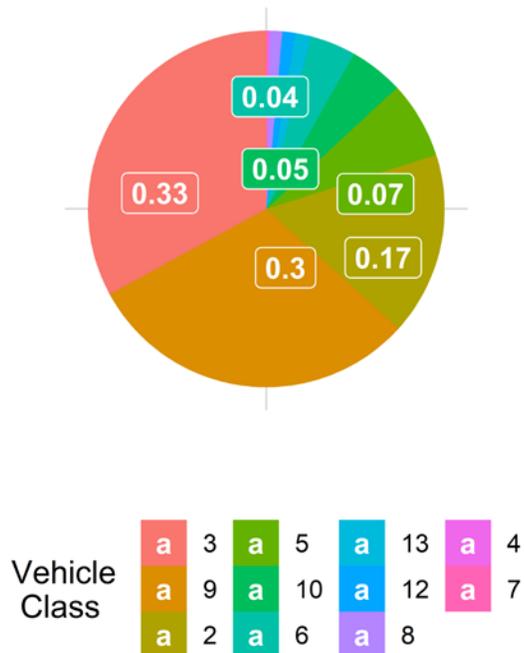


Figure 12 - Total ESALs by Class and Lane

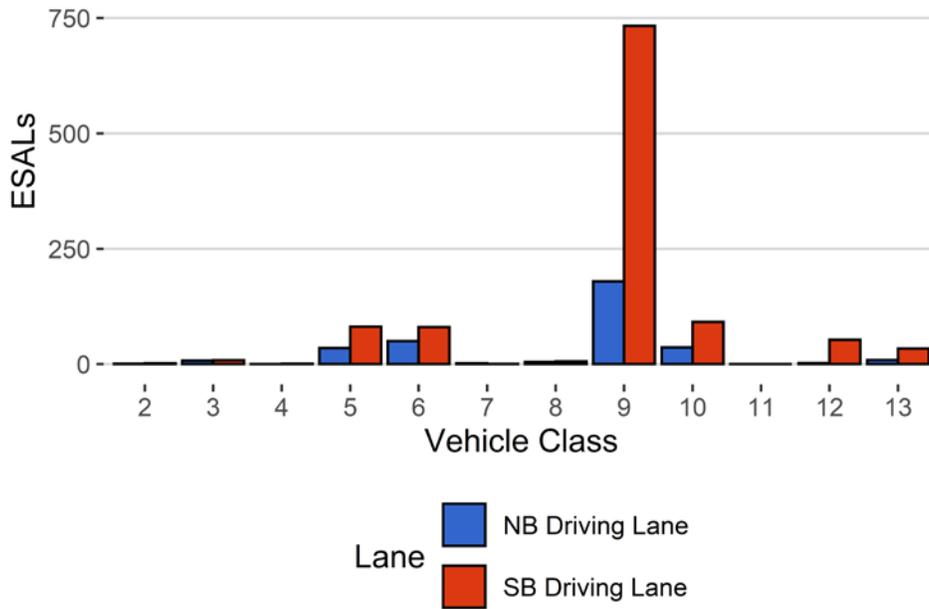


Figure 13 - ESALs by Class

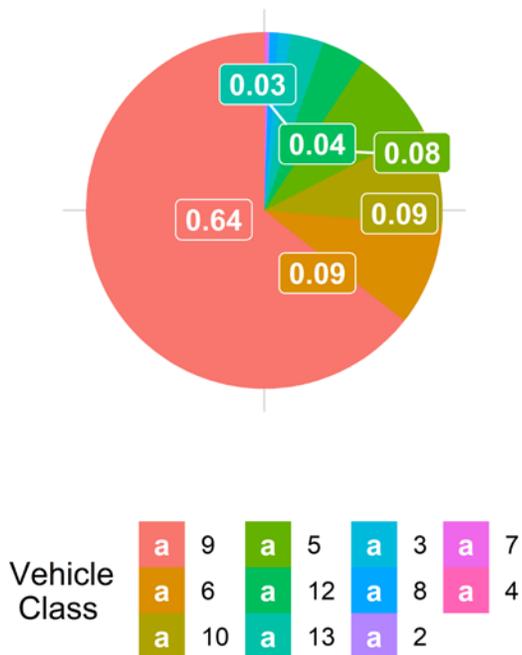


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
June 2019	10.37	0.00	11.18	0.00
July 2019	10.32	-0.45	11.41	2.00
August 2019	10.51	1.39	10.60	-5.20
September 2019	10.31	-0.60	12.27	9.71
October 2019	10.37	-0.01	12.67	13.27
November 2019	10.75	3.65	12.74	13.92
December 2019	10.66	2.84	13.25	18.46

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	116	3608	36.7	0	0
3	158	4888	49.7	0	0
4	0	10	0.1	0	0
5	15	469	4.8	10	4.1
6	4	112	1.1	31	12.7
7	0	2	0	0	0
8	1	35	0.4	1	0.4
9	19	603	6.1	159	64.9
10	3	86	0.9	23	9.4
11	0	0	0	0	0
12	0	12	0.1	9	3.7
13	0	14	0.1	12	4.9
TOTAL	317	9838	100	245	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>
2019-12-07	Saturday	08:06:45	10	SB	2	128.71
2019-12-04	Wednesday	07:49:47	10	SB	2	128.43
2019-12-20	Friday	10:25:10	10	SB	2	125.82
2019-12-19	Thursday	14:57:30	10	SB	2	124.25
2019-12-19	Thursday	15:46:46	9	SB	2	121.42
2019-12-14	Saturday	07:08:32	10	SB	2	118.83
2019-12-14	Saturday	06:25:15	9	SB	2	118.48
2019-12-21	Saturday	08:05:46	10	SB	2	117.43
2019-12-04	Wednesday	06:08:31	10	SB	2	117.42
2019-12-05	Thursday	19:25:37	10	SB	2	117.29

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	1	0	0	18	0	2
5	NB	8	136	2	1.5	2046	16	487
6	NB	19	63	4	6.3	2092	70	486
7	NB	11.5	1	0	0	58	0	23
8	NB	31	22	9	40.9	471	239	34
9	NB	33	367	181	49.3	9228	5404	1545
10	NB	33.5	59	5	8.5	2680	127	436
12	NB	36.5	1	0	0	87	0	25
13	NB	31.5	6	0	0	526	0	168
TOTAL	****	****	656	201	****	17207	****	3206
<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	8	0	0	203	0	42
5	SB	8	291	2	0.7	4658	16	1173
6	SB	19	39	0	0	1845	0	552
7	SB	11.5	1	0	0	51	0	20
8	SB	31	10	3	30	296	56	40
9	SB	33	182	4	2.2	14453	127	4289
10	SB	33.5	19	0	0	1903	0	633
12	SB	36.5	10	0	0	1034	0	334
13	SB	31.5	7	0	0	846	0	313
TOTAL	****	****	567	9	****	25288	****	7395
GRAND TOTAL	****	****	1223	210	139	42495	6053	10601

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	7522	8443	15965	16.6
3	16588	15096	31685	32.9
4	18	203	222	0.2
5	2061	4673	6735	7
6	2162	1845	4007	4.2
7	58	51	109	0.1
8	710	352	1062	1.1
9	14632	14579	29211	30.4
10	2807	1903	4710	4.9
12	87	1034	1121	1.2
13	526	846	1372	1.4
TOTAL	47172	49025	96197	100
GVW/LANE	49.04	50.96	100	0.1

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	1	2	3	0.2	0.0026
3	8	9	16	1.1	0.0081
4	0	1	1	0.1	0.49
5	35	81	116	8.2	0.57
6	50	80	130	9.2	2.55
7	2	1	3	0.2	1.39
8	5	6	11	0.8	0.76
9	179	733	912	64.4	3.4
10	36	91	127	9	3.11
12	2	53	55	3.9	5.48
13	9	34	42	3	3.89
TOTAL	326	1091	1417	100	22
ESALS/LANE	23	77	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	7052	282	28	6187	87.7	864.7	12.3
Feb 2019	7600	271	38	6535	86	1065.2	14
Mar 2019	9909	320	46	8474	85.5	1435.2	14.5
Apr 2019	10547	352	44	9227	87.5	1320.3	12.5
May 2019	12728	404	53	11098	87.2	1629.9	12.8
Jun 2019	12277	409	53	10701	87.2	1576.4	12.8
Jul 2019	13187	390	94	10276	77.9	2911.1	22.1
Aug 2019	12345	394	64	10346	83.8	1998.6	16.2
Sep 2019	12208	412	59	10433	85.5	1775.5	14.5
Oct 2019	13415	432	80	10947	81.6	2468.5	18.4
Nov 2019	11530	410	66	9558	82.9	1972.4	17.1
Dec 2019	9838	320	43	8495	86.4	1342.7	13.6
TOTAL	132636	-	-	112277	-	20360	-
AVERAGE	11053	366	56	9356	85	1697	15

###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	315	859	1173	100.9
Feb 2019	426	1097	1523	116.2
Mar 2019	617	1276	1894	103.2
Apr 2019	589	898	1486	78.3
May 2019	606	1263	1869	61.4
Jun 2019	955	2099	3054	30.8
Jul 2019	868	1894	2762	37.4
Aug 2019	734	856	1590	41.3
Sep 2019	576	1392	1968	88.5
Oct 2019	730	2917	3646	107.2
Nov 2019	778	1667	2445	89.2
Dec 2019	333	1101	1434	108.4
TOTAL	7526	-	-	-
AVERAGE	627	1443	2070	80

###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	27108	36968	64076
Feb 19	32684	39784	72467

Mar 19	47910	55089	102999
Apr 19	51115	53745	104860
May 19	60319	69785	130104
Jun 19	107647	132267	239913
Jul 19	88299	95336	183635
Aug 19	65508	67768	133277
Sep 19	64897	69318	134216
Oct 19	75551	99597	175148
Nov 19	65575	64479	130054
Dec 19	47308	49185	96494
TOTAL	733920	833322	1567242
AVERAGE	61160	69444	130604

###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	216	3.6	29.4	154	82
Feb 2019	237	3.8	26.4	156	107
Mar 2019	339	3.9	26.3	240	131
Apr 2019	261	2.7	21.2	194	94
May 2019	389	3.3	25.3	200	71
Jun 2019	716	3.2	24.7	204	44
Jul 2019	795	6.9	30.9	261	57
Aug 2019	347	3.2	19	137	47
Sep 2019	403	3.5	23.4	237	107
Oct 2019	725	5.7	30.9	475	186
Nov 2019	519	5	29	233	108
Dec 2019	247	2.8	20.1	157	98
TOTAL	5194	-	-	2648	1132
AVERAGE	432.8	4	25.6	220.7	94.3

###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	2455	5954	8409	29.2	70.8
Feb 2019	3307	6523	9830	33.6	66.4
Mar 2019	4989	9102	14091	35.4	64.6
Apr 2019	5153	7228	12381	41.6	58.4
May 2019	6527	9850	16377	39.9	60.1
Jun 2019	10389	17912	28301	36.7	63.3
Jul 2019	10842	19097	29939	36.2	63.8

Aug 2019	8529	8525	17054	50	50
Sep 2019	6457	10608	17065	37.8	62.2
Oct 2019	6915	19827	26742	25.9	74.1
Nov 2019	7365	10989	18354	40.1	59.9
Dec 2019	3206	7395	10601	30.2	69.8
TOTAL	76133	133010	209143	-	-
AVERAGE	6344.4	11084.2	17428.6	36.4	63.6
