

AUGUST 2018



**WIM #41
CSAH 14,
MP 14.9
CROOKSTON,
MINNESOTA**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #41 is located on CSAH 14 near Crookston in Polk county.

System Operation

WIM #41 was operational for the entire month of August 2018. Volume was computed using all monthly data.

System Calibration

WIM #41 was most recently calibrated on 2015-02-04. Table 1 summarizes the front axle weights of class 9s by lane ¹. Table 1 indicates that the class 9 front axle weights were all within +/- 9% of baseline calibration values for all lanes. 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: 17257 | Passenger Vehicles: 11618 | Heavy Commercial Vehicles: 5639

Monthly Average Daily Traffic (MADT): 557 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 182

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 Tuesdays, with lowest volumes reported on Fridays. SB vehicles typically reached highest volume levels on Wednesdays, 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 07 AM and 09 AM. Similarly, SB PVs peaked in volume between 02 PM and 05 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 09 AM, while volume going SB peaked between 02 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 5639 HCVs, 900 of them were overweight³. These overweight HCVs contributed to 8.6% of total monthly volume, and 26.1% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Sundays, with lowest volumes reported on Fridays. SB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on Sundays. See Figure 3 .

The top two overweight violators by class were the class 13 and class 9 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 69.2% 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 December.

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 report⁴.

Using normal load limits ,531 NB vehicles exceeded 88,000 pounds (434 vehicles were Class 13's; 51 vehicles were Class 10's). Of vehicles traveling SB,

59 NB vehicles exceeded 88,000 pounds (35 vehicles were Class 9's; 20 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from August 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in August 2018. Data suggests that there were greater numbers of empty Class 9's than fully_loaded 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 empty class 10 vehicles.

Freight Totals. A total of 36586 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (69.8%) than SB (30.2%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 97559 is approximately 0.1 miles north of WIM #41, and Bridge No. 60K60 is 3.2 miles south of WIM #41. WIM #41 recorded a total of 17257 vehicles with a combined GVW of 203266 kips (1 kip = 1,000 pounds = 0.5 tons) in August 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 5985 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 77.6% of all ESALs were recorded NB while 22.4% was observed SB. In particular, 56% of all ESALs were generated by the Class 13's (Class 13's were also responsible for generating 25% 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).

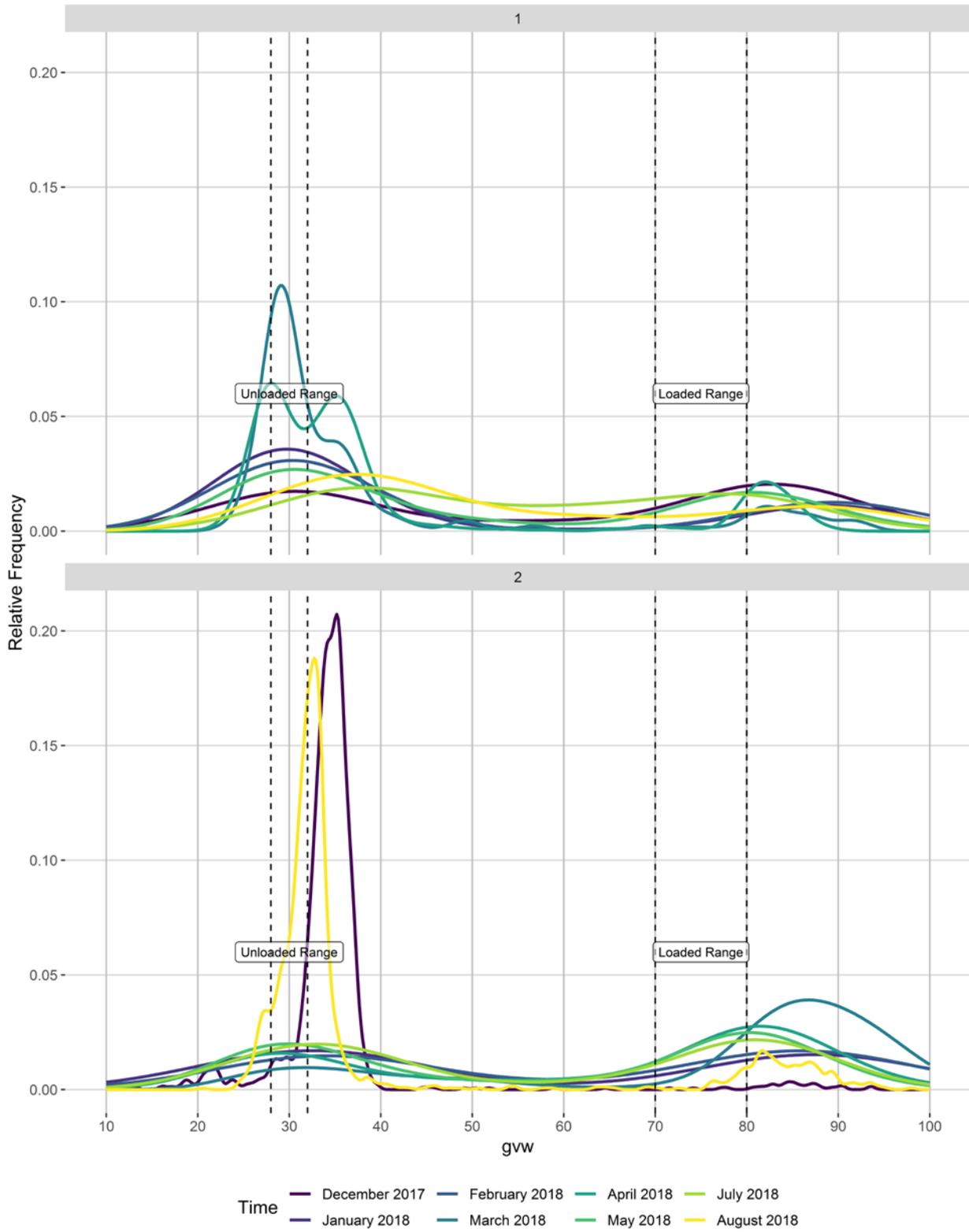
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

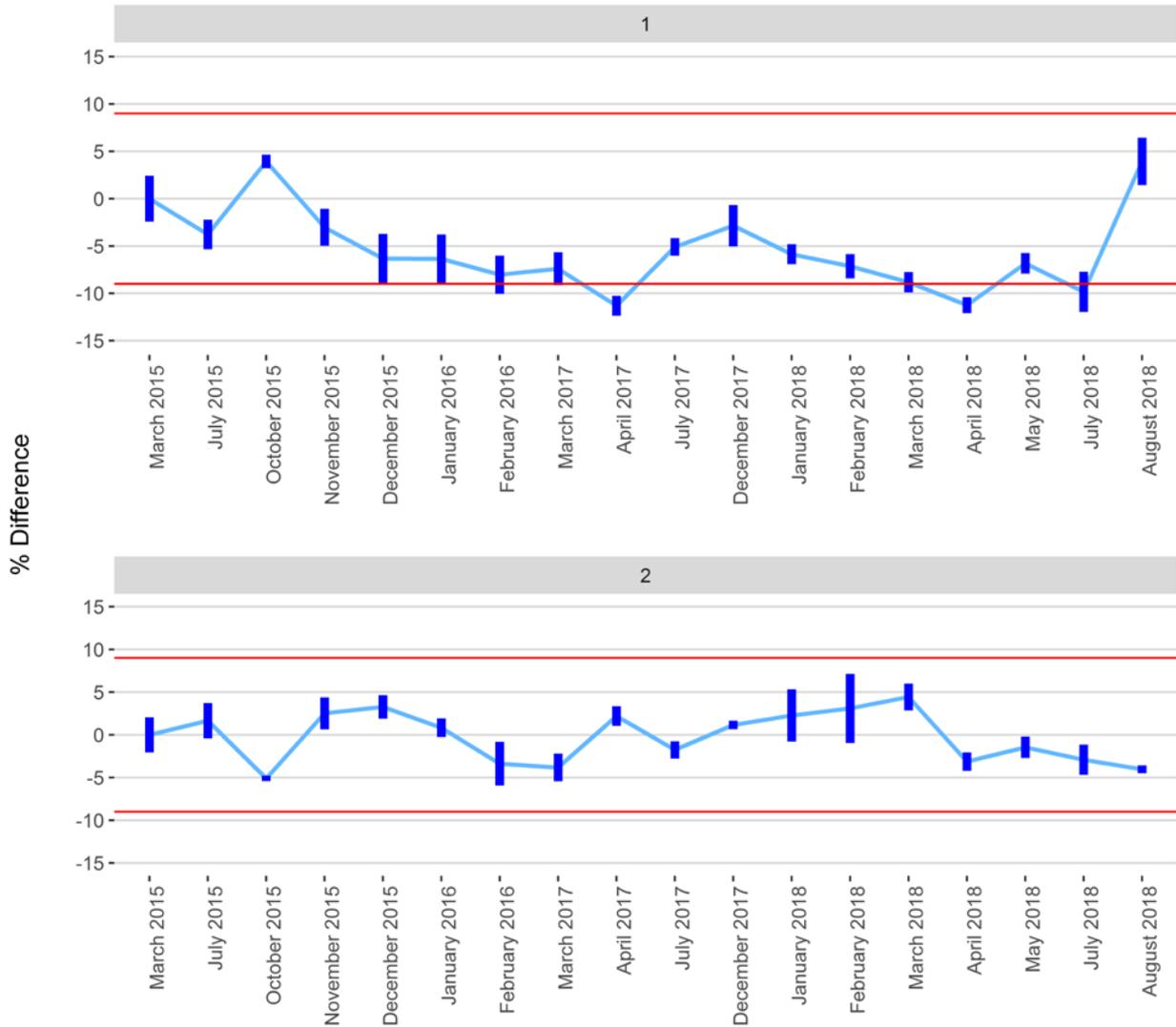
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

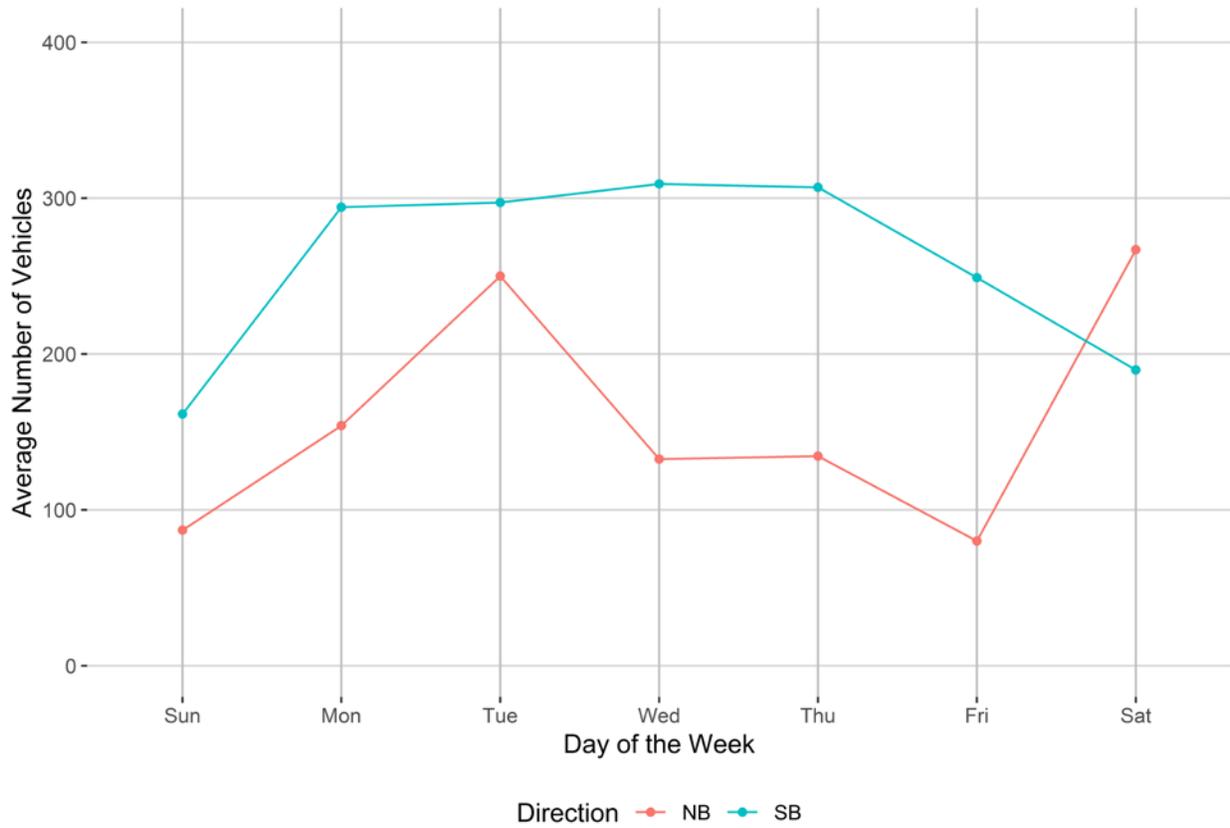


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

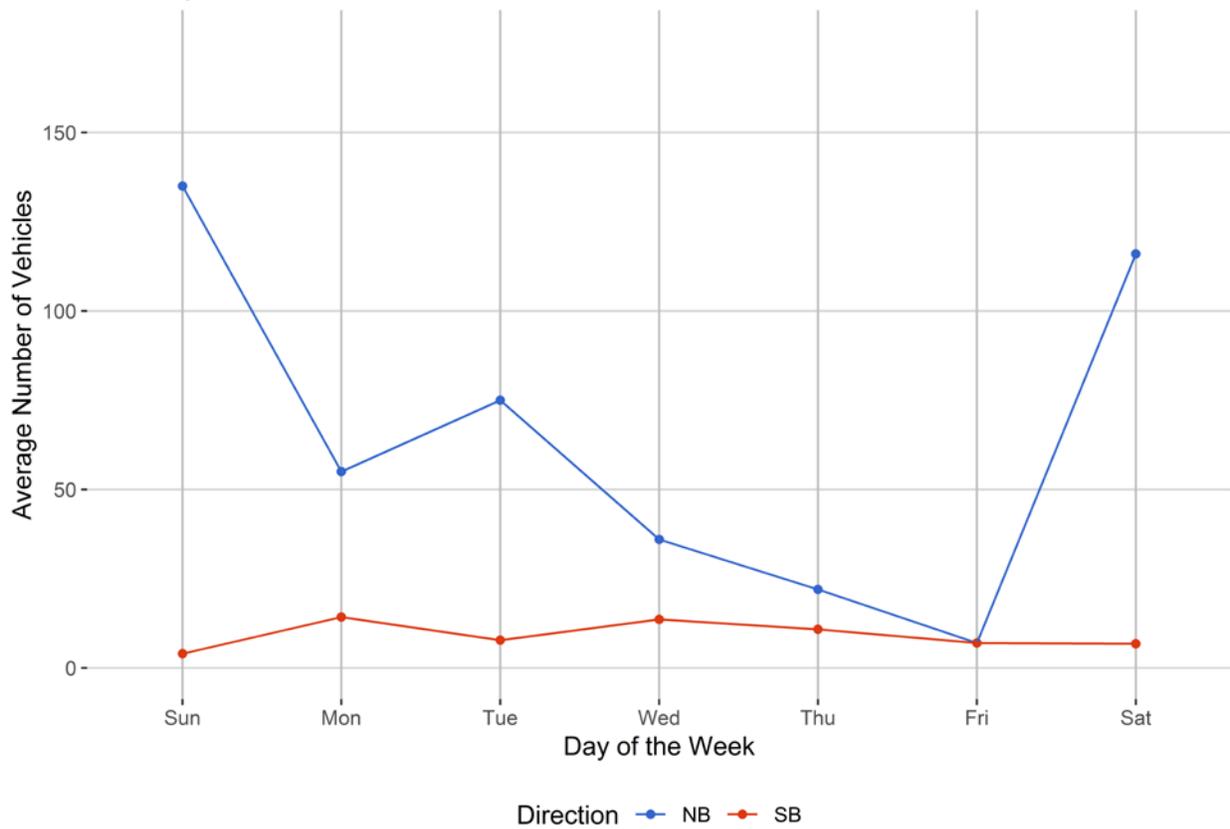


Figure 4 - Passenger Vehicles vs. Hour of the Day

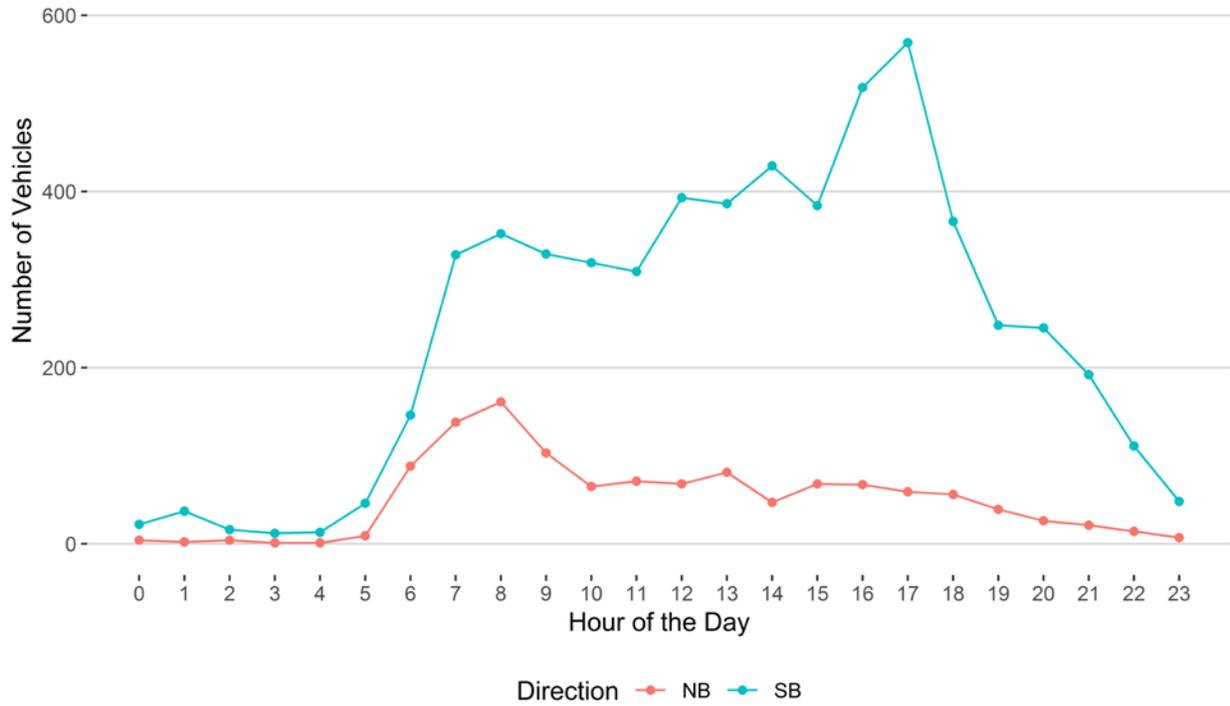


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

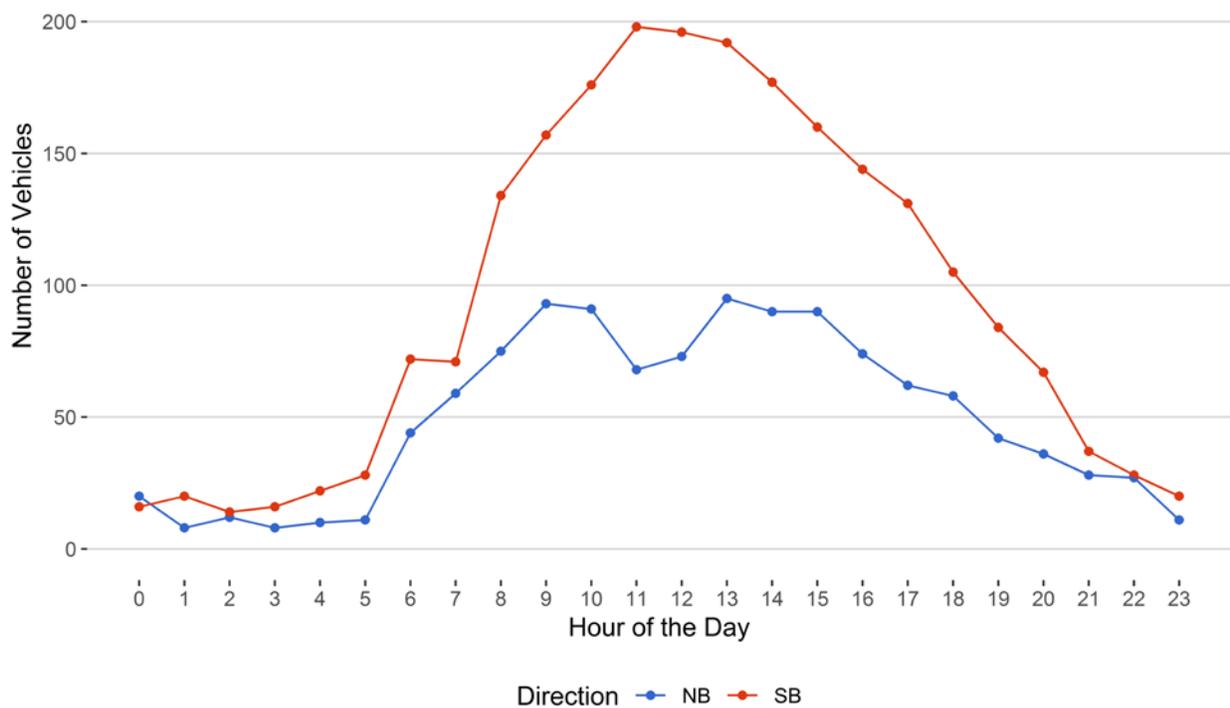


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

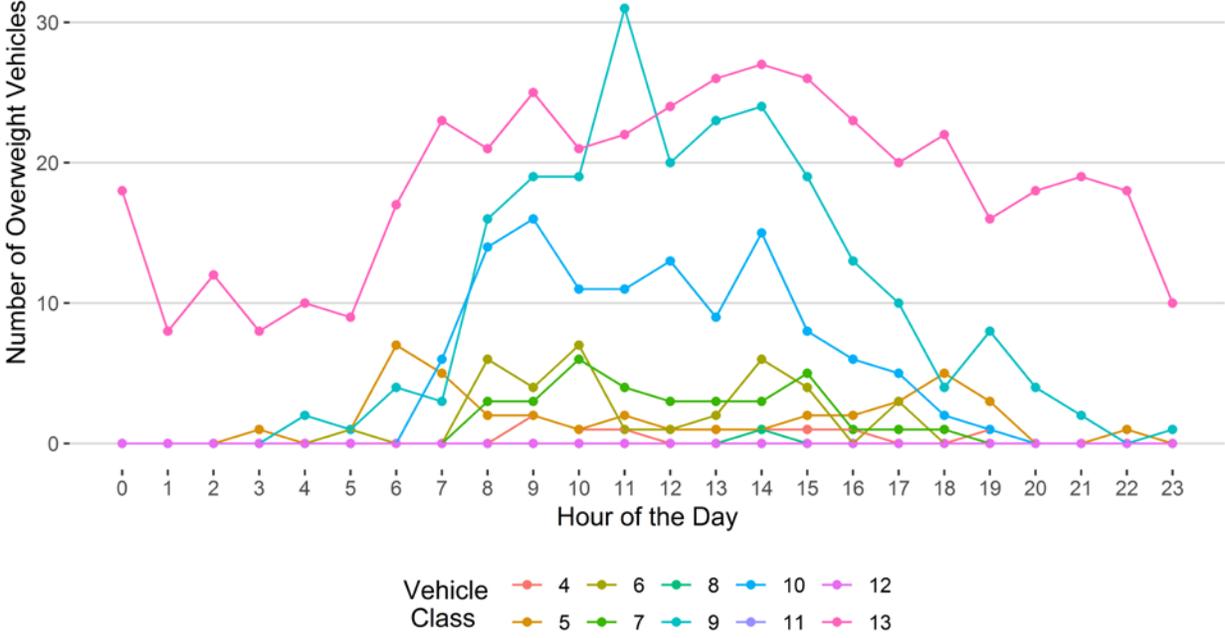


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

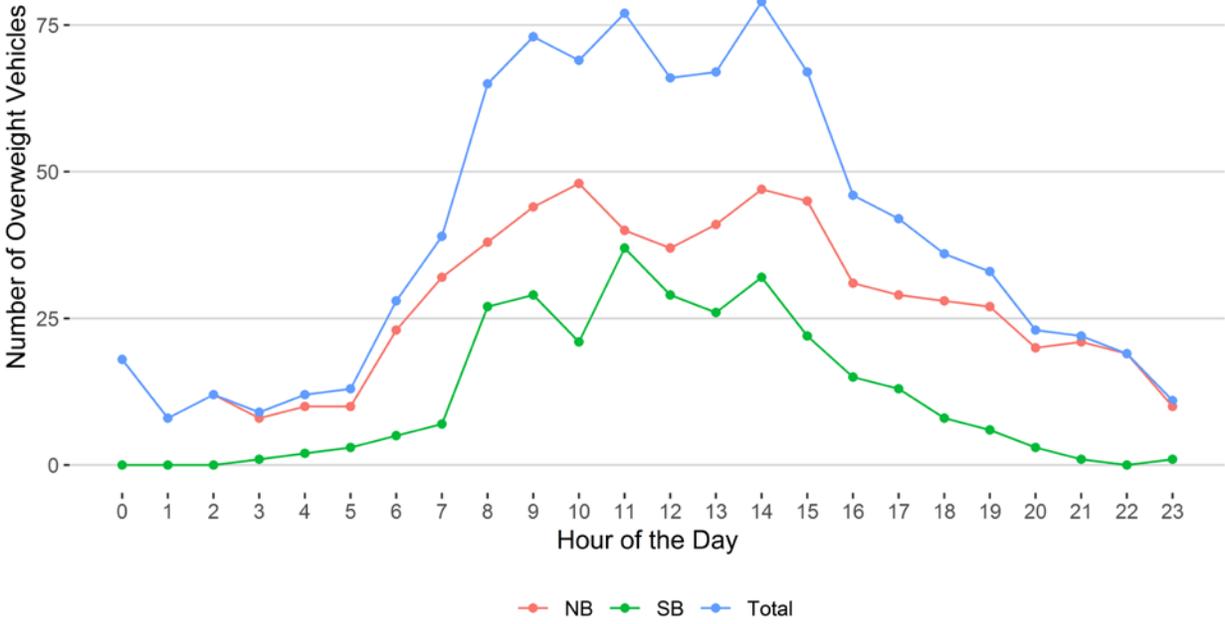
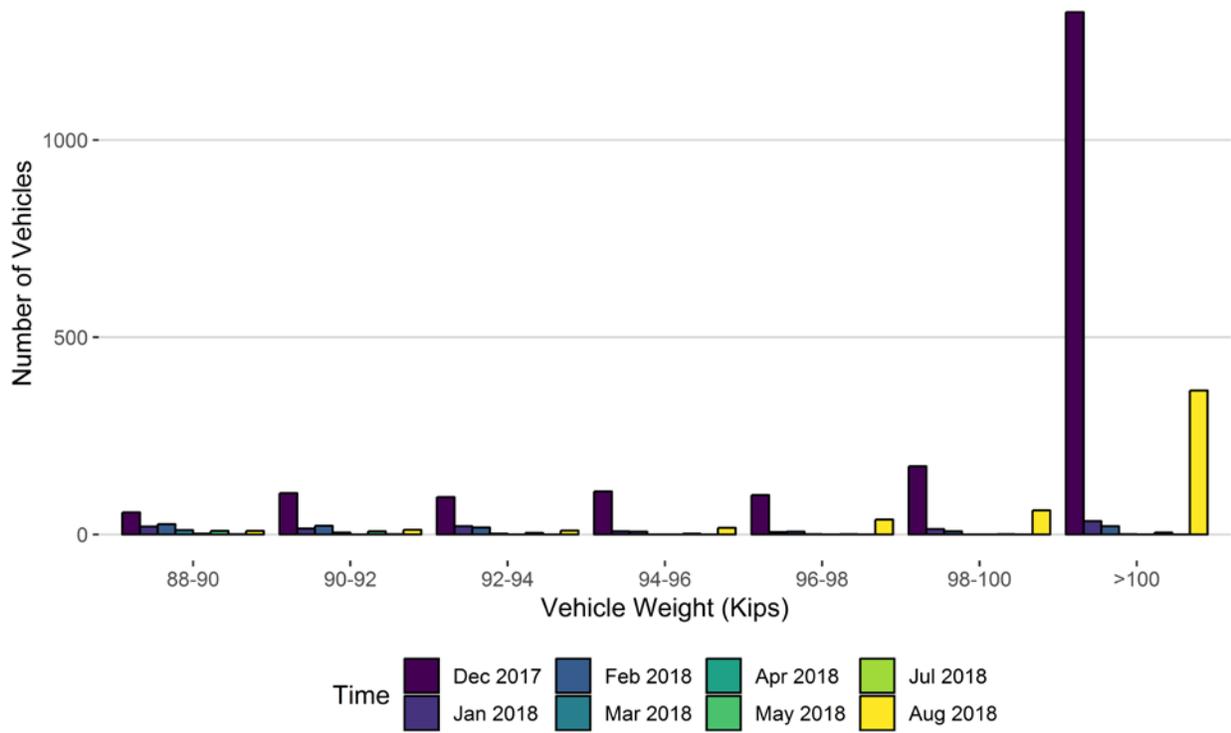
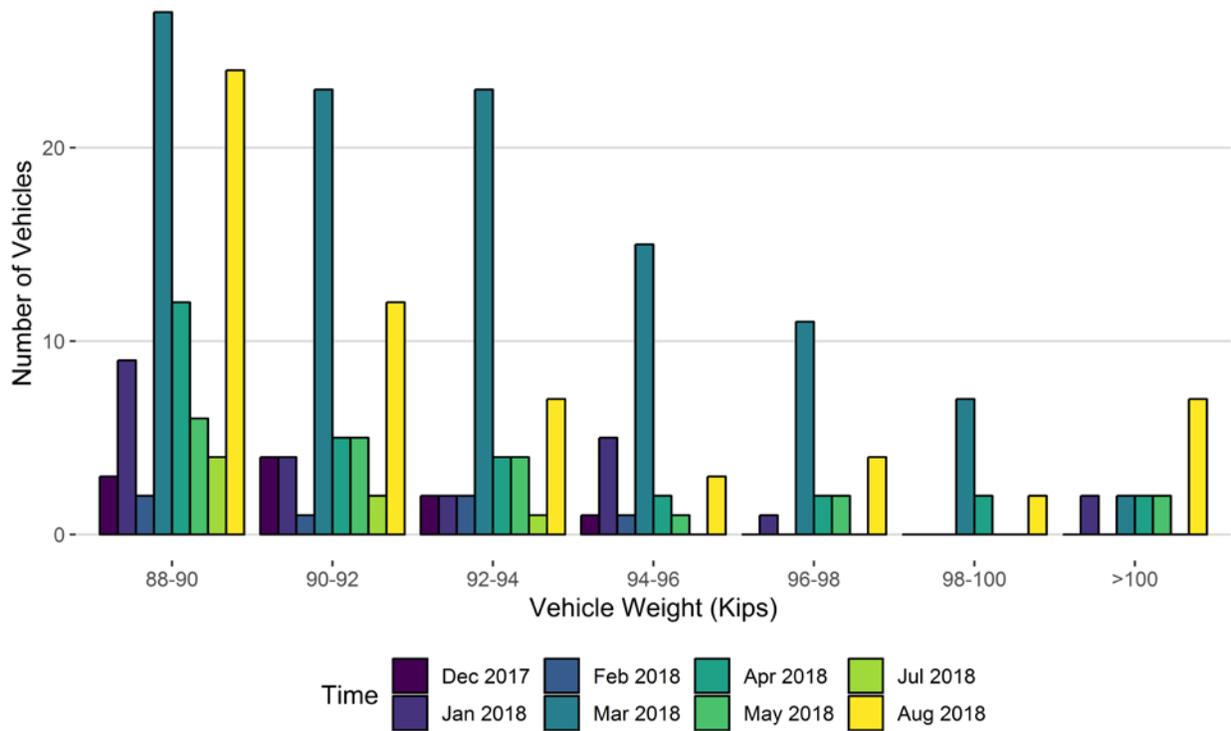


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jul 2018	Aug 2018
88-90	56	20	26	11	2	9	1	9
90-92	105	15	22	5	0	8	1	12
92-94	95	21	18	2	0	4	0	10
94-96	109	8	7	0	0	2	0	17
96-98	100	6	7	1	0	1	0	38
98-100	173	14	8	0	0	1	0	61
>100	1324	34	21	1	0	5	0	365
Total	1962	118	109	20	2	30	2	512

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



Vehicle Weights (Kips)	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jul 2018	Aug 2018
88-90	3	9	2	27	12	6	4	24
90-92	4	4	1	23	5	5	2	12
92-94	2	2	2	23	4	4	1	7
94-96	1	5	1	15	2	1	0	3
96-98	0	1	0	11	2	2	0	4
98-100	0	0	0	7	2	0	0	2
>100	0	2	0	2	2	2	0	7
Total	10	23	6	108	29	20	7	59

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

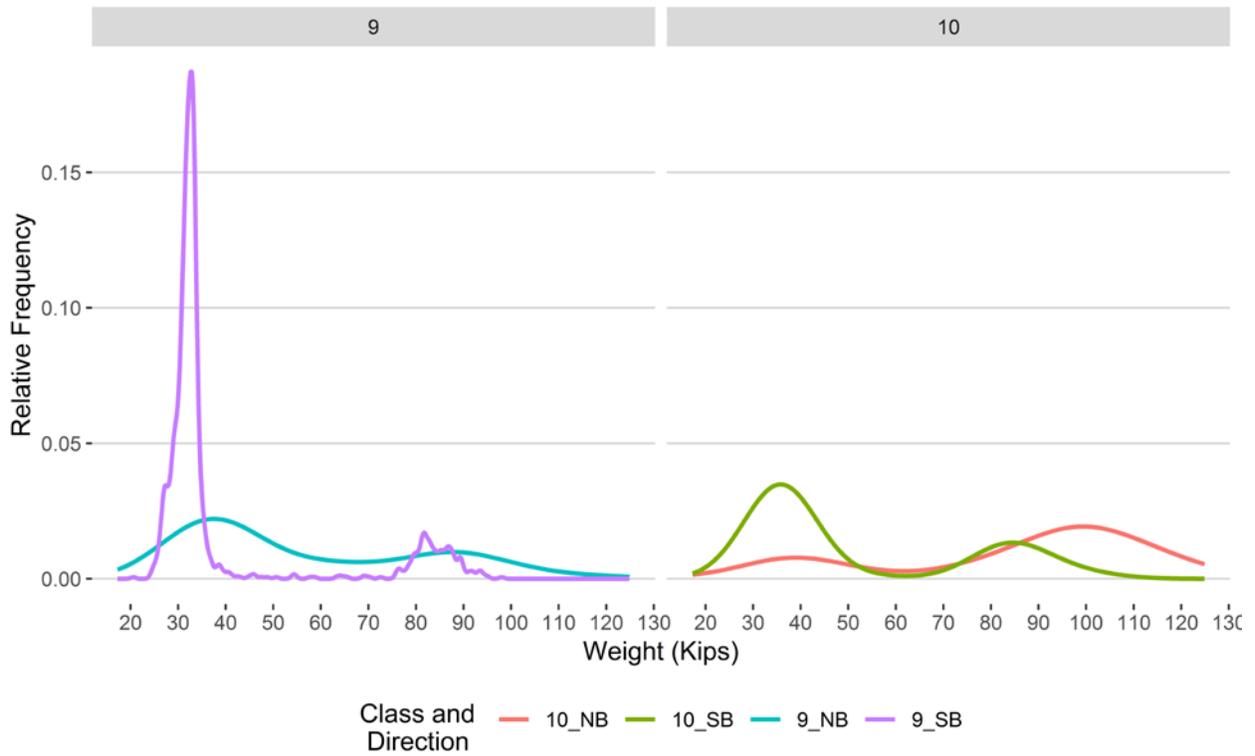


Figure 9 - Freight Percentage by Direction and Class

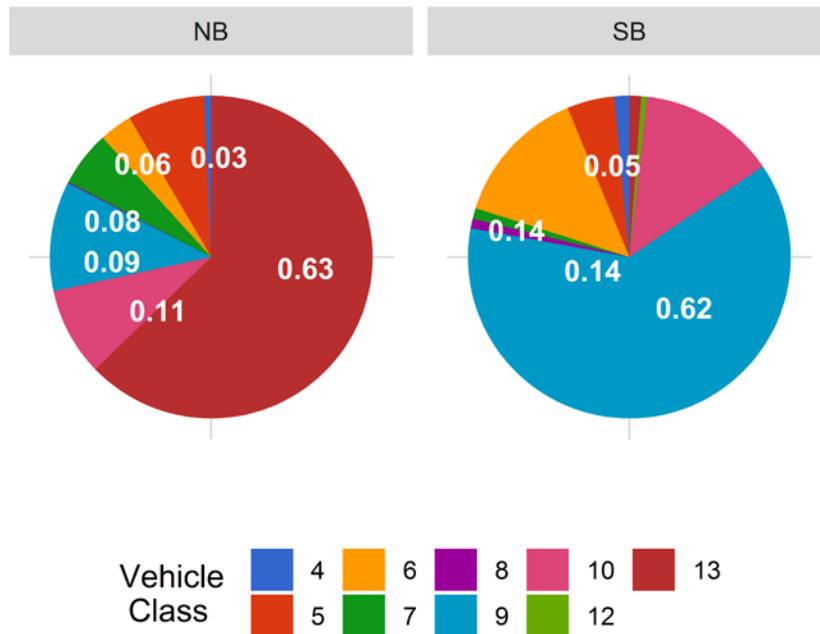


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

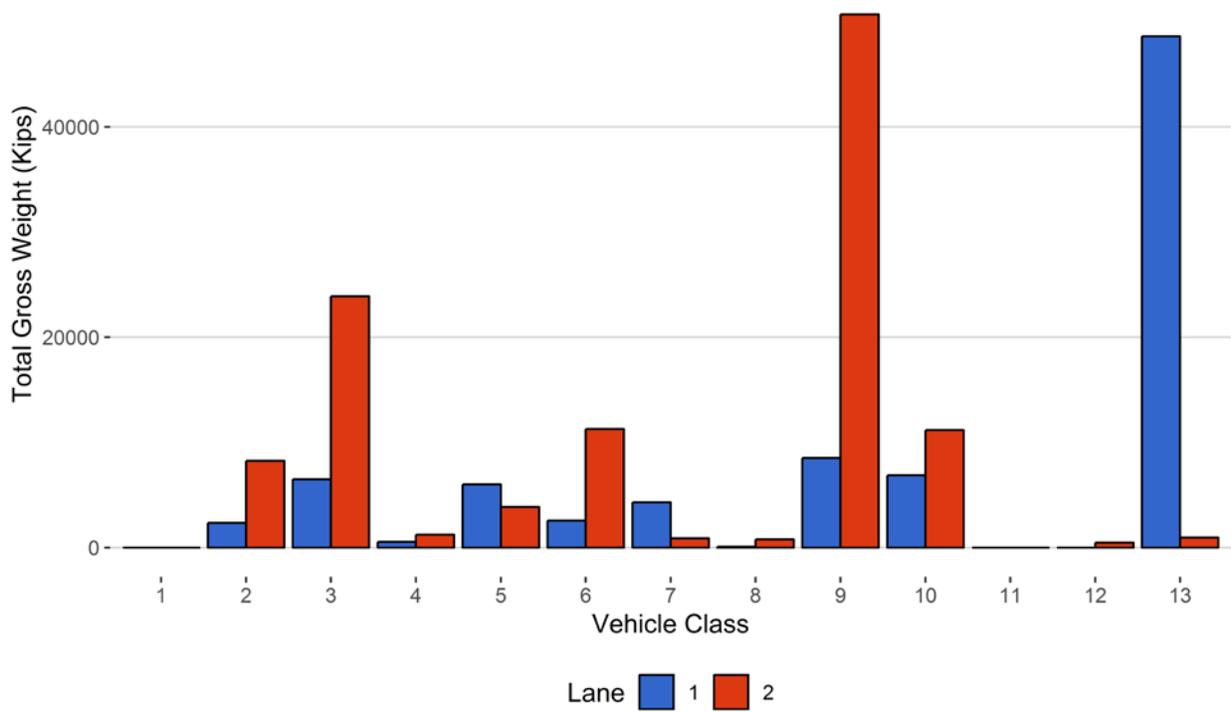


Figure 11 - Total Gross Vehicle Weight t

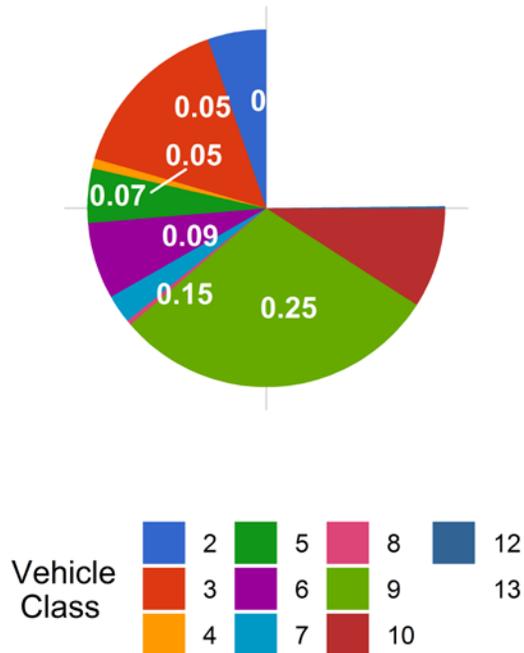


Figure 12 - Total ESALs by Class and Lane

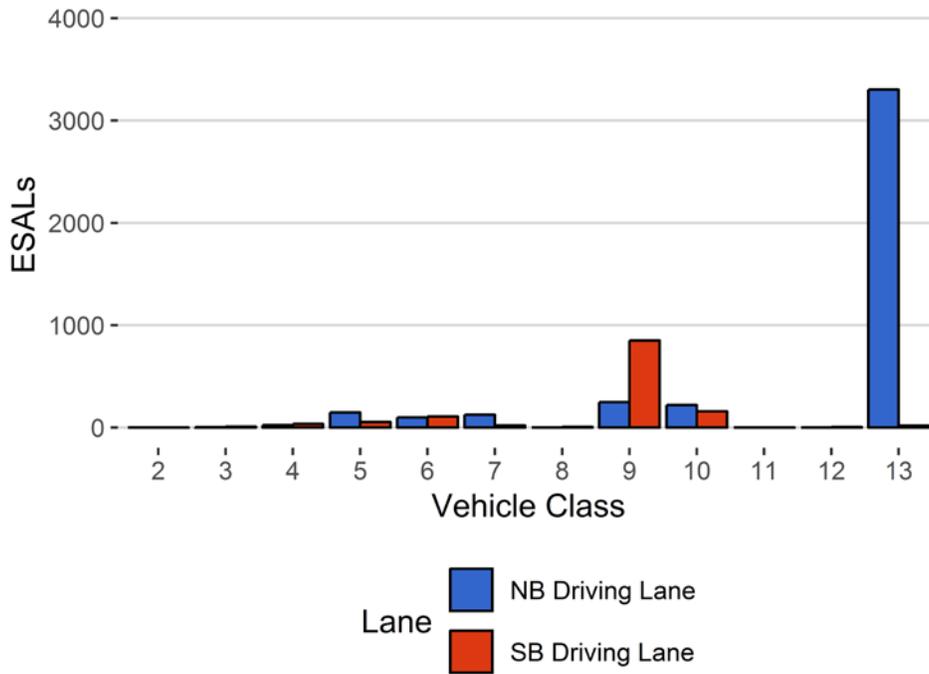


Figure 13 - ESALs by Class

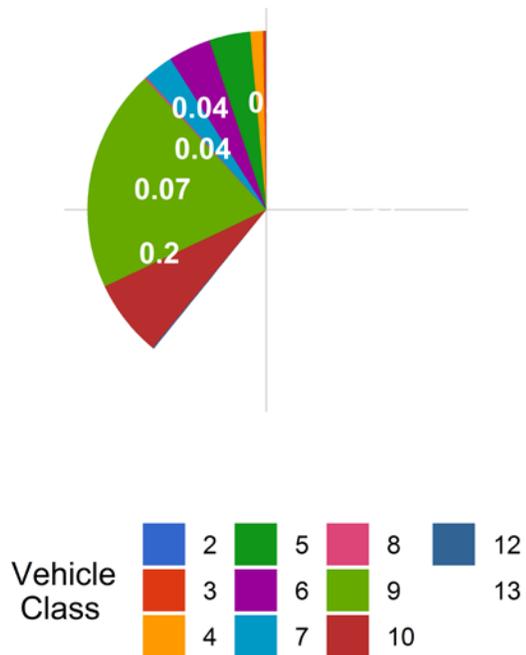


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
March 2015	12.00	0.00	11.45	0.00
July 2015	11.54	-3.77	11.64	1.65
October 2015	12.47	3.93	10.87	-5.10
November 2015	11.63	-3.03	11.74	2.52
December 2015	11.24	-6.34	11.83	3.27
January 2016	11.23	-6.36	11.55	0.82
February 2016	11.03	-8.02	11.06	-3.38
March 2017	11.11	-7.40	11.02	-3.81
April 2017	10.64	-11.31	11.70	2.19
July 2017	11.39	-5.09	11.25	-1.76
December 2017	11.65	-2.85	11.58	1.16
January 2018	11.29	-5.87	11.71	2.27
February 2018	11.14	-7.13	11.81	3.09
March 2018	10.94	-8.82	11.96	4.43
April 2018	10.65	-11.24	11.09	-3.13
May 2018	11.18	-6.83	11.28	-1.46
July 2018	10.82	-9.84	11.12	-2.91
August 2018	12.47	3.94	10.99	-4.03

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	138	4276	24.8	0	0
3	237	7342	42.5	0	0
4	2	64	0.4	8	0.9
5	36	1110	6.4	40	4.4
6	24	749	4.3	35	3.9
7	4	116	0.7	33	3.7
8	2	51	0.3	1	0.1
9	75	2321	13.4	223	24.8
10	16	485	2.8	117	13
11	0	0	0	0	0
12	0	11	0.1	0	0
13	24	732	4.2	443	49.2
TOTAL	557	17257	100	900	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>
2018-08-15	Wednesday	10:06:12	10	NB	1	126.6
2018-08-30	Thursday	09:36:21	10	NB	1	124.94
2018-08-16	Thursday	08:21:02	10	NB	1	124.89
2018-08-15	Wednesday	09:11:26	10	NB	1	123.89
2018-08-30	Thursday	11:54:23	10	NB	1	123.58
2018-08-21	Tuesday	05:17:55	9	NB	1	121.11
2018-08-22	Wednesday	10:30:41	9	NB	1	120.01
2018-08-15	Wednesday	09:19:57	10	NB	1	119.78
2018-08-30	Thursday	12:57:03	10	NB	1	119.36
2018-08-21	Tuesday	17:47:19	10	NB	1	116.57

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	13	1	7.7	534	14	177
5	NB	8	384	1	0.3	5997	8	1466
6	NB	19	59	1	1.7	2544	18	721
7	NB	11.5	57	0	0	4303	0	1824
8	NB	31	4	3	75	32	49	1
9	NB	33	150	22	14.7	7865	652	1821
10	NB	33.5	81	1	1.2	6859	17	2090
13	NB	31.5	437	0	0	48630	0	17432
TOTAL	****	****	1185	29	****	76764	****	25531
<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	26	0	0	1219	0	414
5	SB	8	295	23	7.8	3686	171	755
6	SB	19	399	10	2.5	11090	180	1849
7	SB	11.5	14	0	0	875	0	357
8	SB	31	27	15	55.6	440	332	34
9	SB	33	1270	748	58.9	27710	22998	5242
10	SB	33.5	216	29	13.4	10239	934	1987
12	SB	36.5	7	1	14.3	441	33	111
13	SB	31.5	11	0	0	955	0	304
TOTAL	****	****	2265	826	****	56656	****	11055
GRAND TOTAL	****	****	3450	855	253	133420	25405	36586

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	2341	8255	10596	5.3
3	6494	23889	30383	15.2
4	548	1219	1766	0.9
5	6005	3857	9862	4.9
6	2562	11270	13832	6.9
7	4303	875	5178	2.6
8	81	772	853	0.4
9	8517	50708	59225	29.6
10	6876	11173	18049	9
12	0	474	474	0.2
13	48630	955	49585	24.8
TOTAL	86357	113447	199804	100
GVW/LANE	43.22	56.78	100	0.05

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	1	2	0	0.0021
3	5	10	15	0.3	0.0074
4	26	36	62	1.1	3.02
5	149	55	204	3.7	0.61
6	100	109	210	3.8	0.93
7	126	20	147	2.7	3.89
8	0	9	9	0.2	0.69
9	250	852	1102	20.2	1.56
10	222	160	382	7	2.55
12	0	7	7	0.1	1.34
13	3302	20	3322	60.8	14.57
TOTAL	4182	1280	5461	100	29
ESALS/LANE	76.6	23.4	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>
Dec 2017	13625	440	164	8548	62.7	5076.5	37.3
Jan 2018	9334	301	31	8364	89.6	970.2	10.4
Feb 2018	8344	298	26	7623	91.4	721.4	8.6
Mar 2018	9347	302	37	8199	87.7	1148.1	12.3
Apr 2018	11791	393	57	10090	85.6	1701.3	14.4
May 2018	13681	441	68	11572	84.6	2109.3	15.4
Jul 2018	12791	413	57	11011	86.1	1780.1	13.9
Aug 2018	17257	557	182	11618	67.3	5639	32.7
TOTAL	96170	-	-	77025	-	19146	-
AVERAGE	12021	393	78	9628	82	2393	18

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 2017	5038	494	5532	9.3
Jan 2018	675	202	877	44.3
Feb 2018	628	248	876	53
Mar 2018	1032	825	1857	22.6
Apr 2018	379	871	1251	15.8
May 2018	604	715	1318	14.3
Jul 2018	308	492	800	6
Aug 2018	4646	1339	5985	16.6
TOTAL	13310	-	-	-
AVERAGE	1664	648	2312	23

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Dec 2017	53516	26950	80466
Jan 2018	46043	18588	64631
Feb 2018	42984	48768	91752
Mar 2018	56222	66743	122966
Apr 2018	56968	62127	119095
May 2018	25746	54565	80312
Jul 2018	89303	113962	203266
Aug 2018	254680	79312	333992
TOTAL	625462	471017	1096479
AVERAGE	78183	58877	137060

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 2017	2221	19	50.7	1972	1497
Jan 2018	245	2.9	27.8	141	50
Feb 2018	209	2.8	32	115	29
Mar 2018	305	3.4	27.2	128	10
Apr 2018	289	2.5	17.4	31	4
May 2018	309	2.8	18.1	50	8
Jul 2018	179	2.2	15.7	9	0
Aug 2018	934	8.9	26.7	590	448
TOTAL	4691	-	-	3036	2046
AVERAGE	586.4	5.6	26.9	379.5	255.8

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 2017	77434	3362	80796	95.8	4.2
Jan 2018	6853	1794	8647	79.2	20.8
Feb 2018	5819	802	6622	87.9	12.1
Mar 2018	2994	7001	9995	30	70
Apr 2018	3763	9950	13712	27.4	72.6
May 2018	6365	7033	13398	47.5	52.5
Jul 2018	4572	5546	10118	45.2	54.8
Aug 2018	25531	11055	36586	69.8	30.2
TOTAL	133329	46545	179874	-	-
AVERAGE	16666.2	5818.1	22484.2	60.4	39.6