OCTOBER 2018

WIM #26
I-35, MP 30.1
OWATONNA, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #26 is located on I-35 near Owatonna in Steele county.

System Operation

WIM #26 was operational for the entire month of October 2018. Volume was computed using all monthly data.

System Calibration

WIM #26 was most recently calibrated on 2018-06-21. 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: 661987 | Passenger Vehicles: 500370 | Heavy Commercial Vehicles: 161617

Monthly Average Daily Traffic (MADT): 21354 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 5213

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 Sundays, with lowest volumes reported on Tuesdays. SB vehicles typically reached highest volume levels on Sundays, with lowest volumes reported on Tuesdays (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 02 PM and 04 PM. Similarly, SB PVs peaked in volume between 10 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 02 PM and 04 PM, while volume going SB peaked between 10 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 161617 HCVs, 36264 of them were overweight [3]. These overweight HCVs contributed to 5.6% of total monthly volume, and 22.9% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Thursdays, 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 6 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 57.9% 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 [4].
Using normal load limits ,1537 NB vehicles exceeded 88,000 pounds (1117 vehicles were Class 9's; 274 vehicles were Class 10's). Of vehicles traveling SB,

413 NB vehicles exceeded 88,000 pounds (167 vehicles were Class 9's; 123 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from October 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in October 2018. 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 1895900 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (52%) than SB (48%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 91086 (a box culvert) is approximately 0.5 miles north of WIM #26, and Bridge No. 91095 (also a box culvert) is 6.9 miles south of WIM #26. WIM #26 recorded a total of 661987 vehicles with a combined GVW of 10927794 kips (1 kip = 1,000 pounds = 0.5 tons) in October 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 181974 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 53.5% of all ESALs were recorded NB while 46.5% was observed SB. In particular, 81% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 63% 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

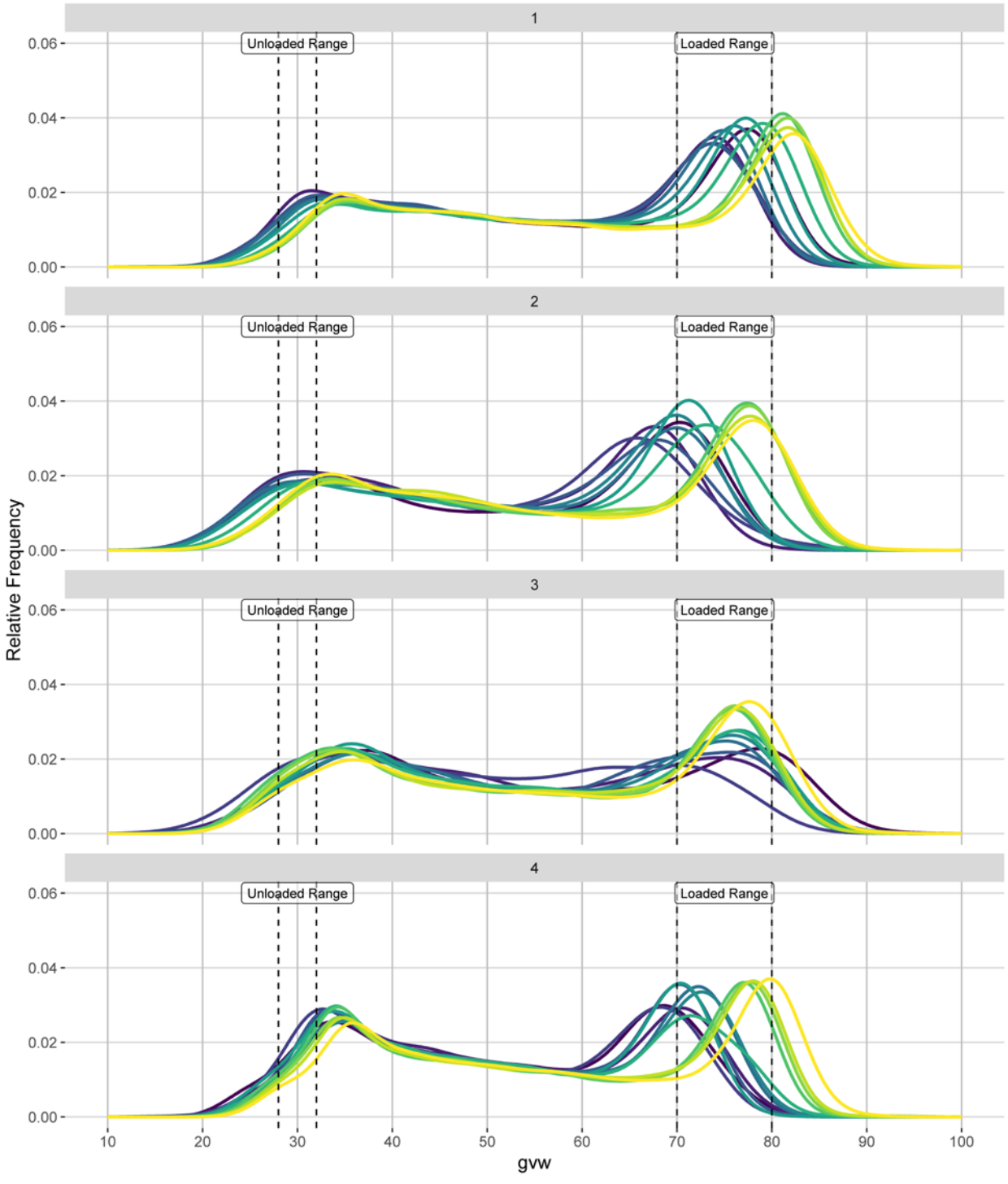
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [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

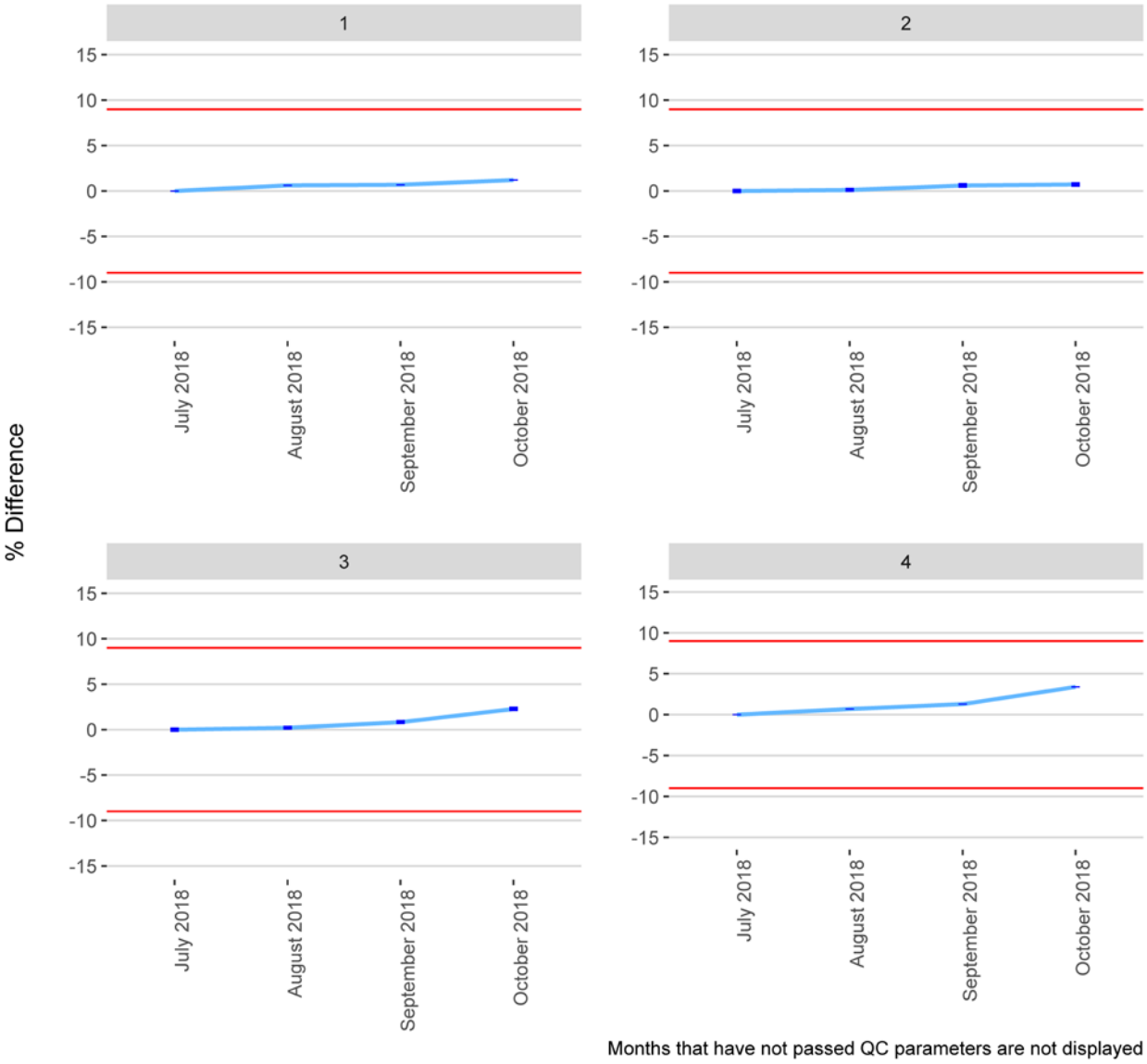
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

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

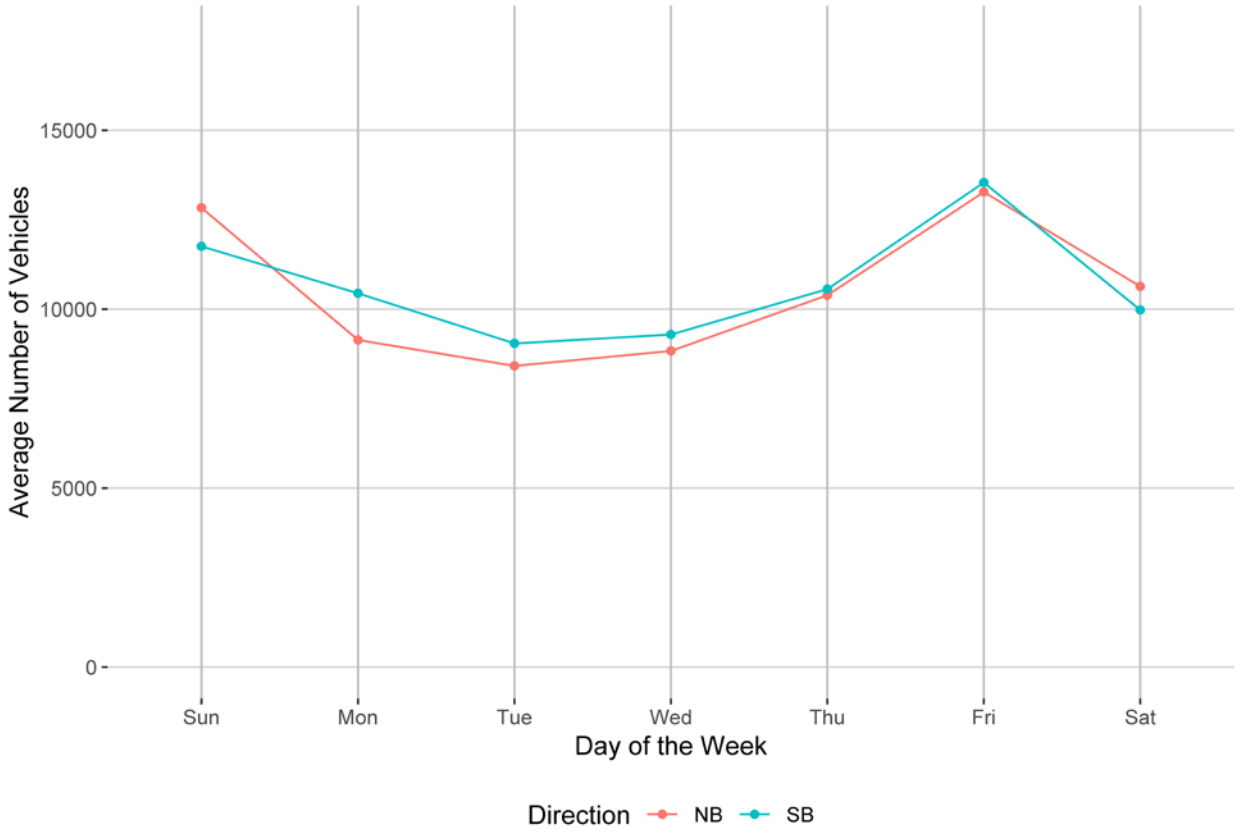


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

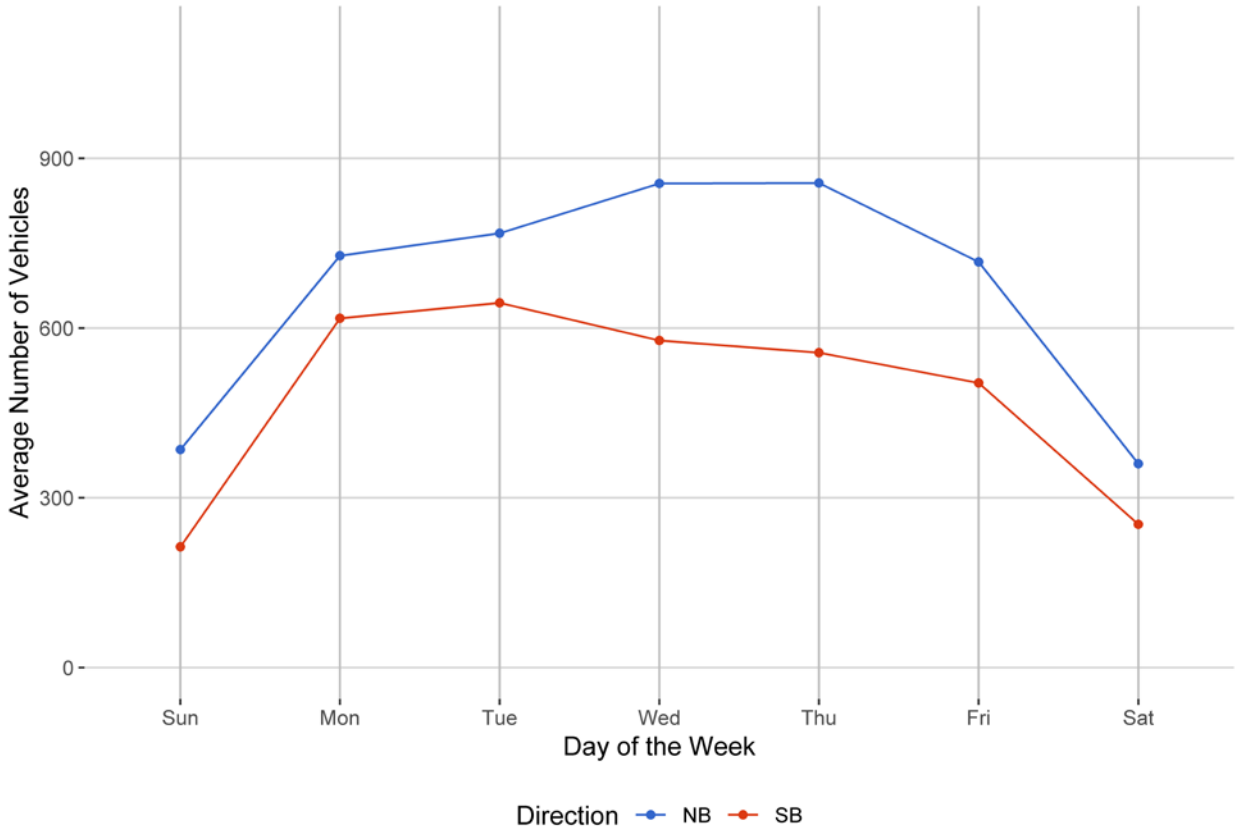


Figure 4 - Passenger Vehicles vs. Hour of the Day

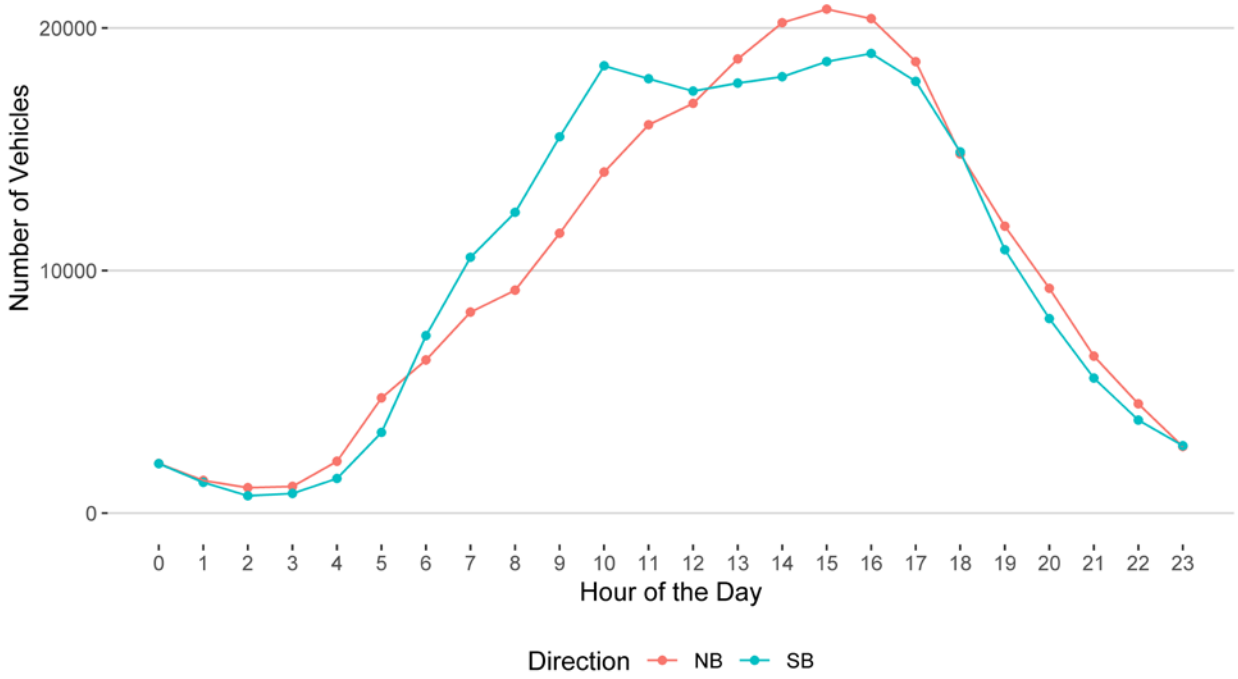


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

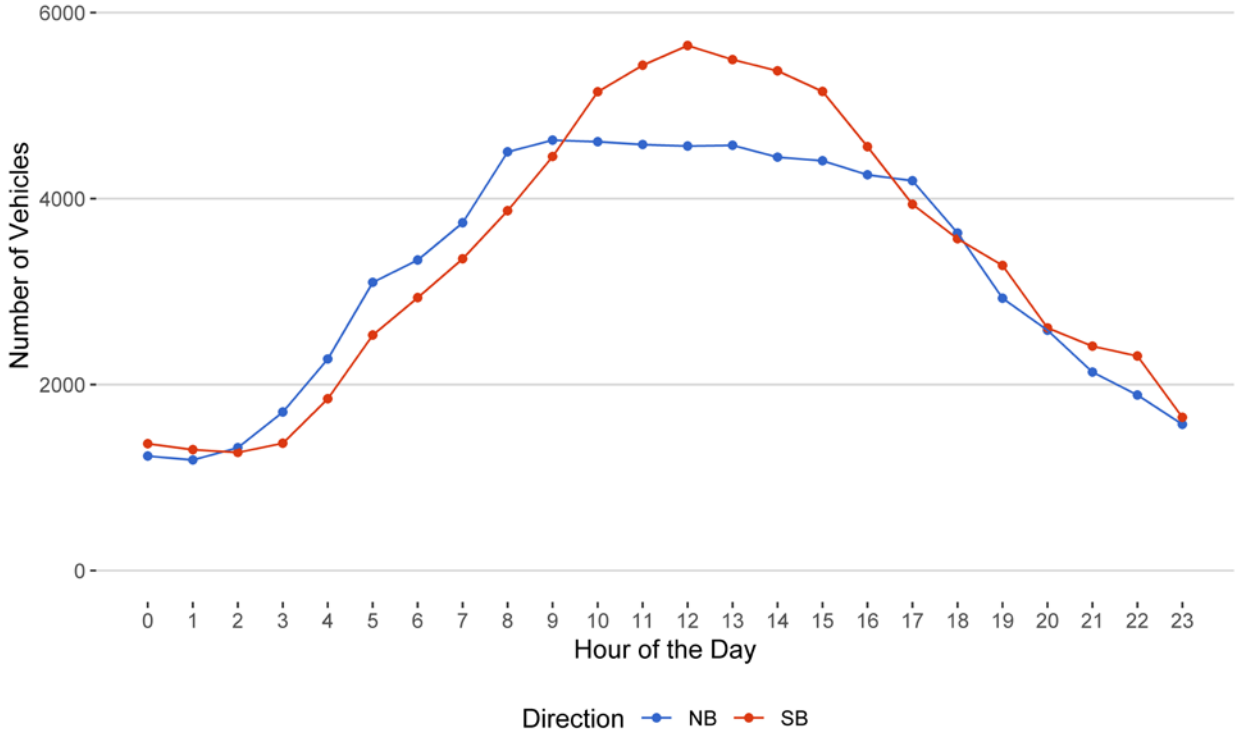


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

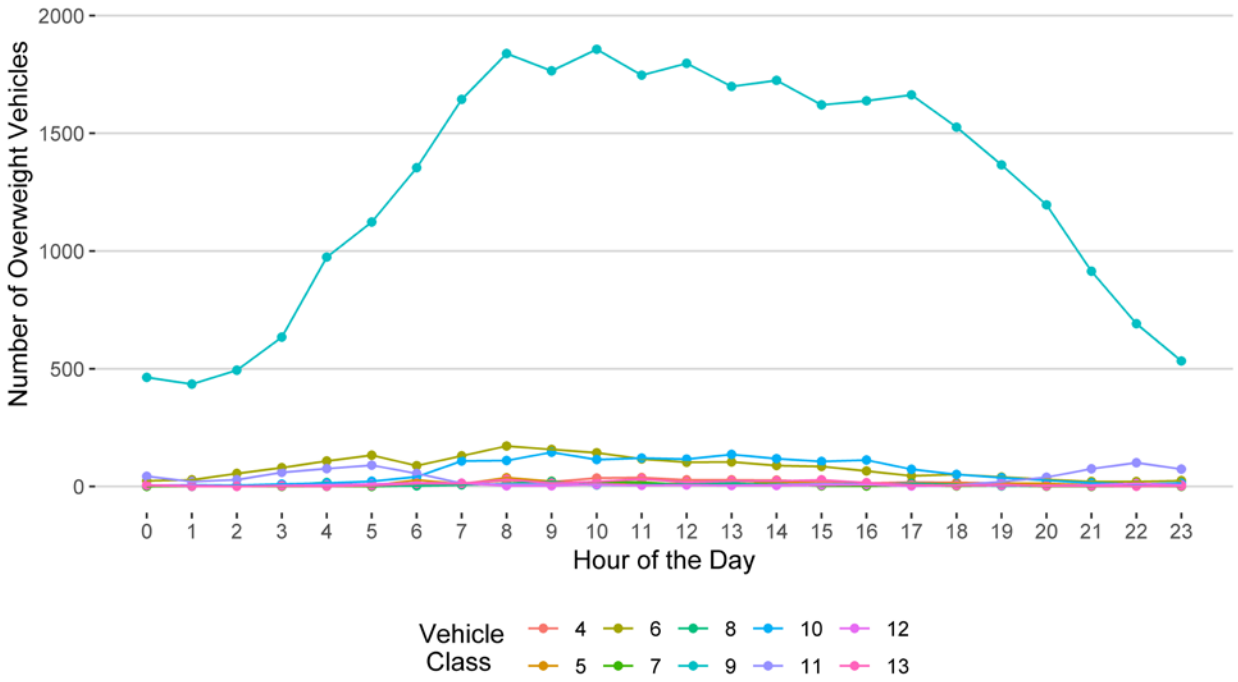


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

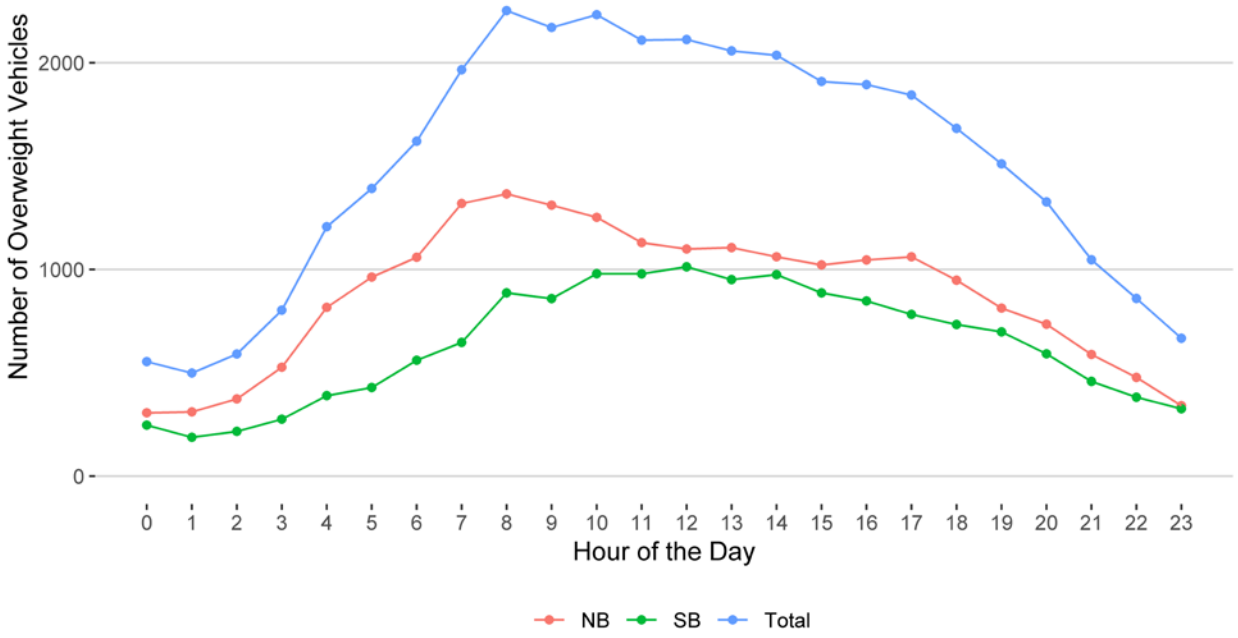
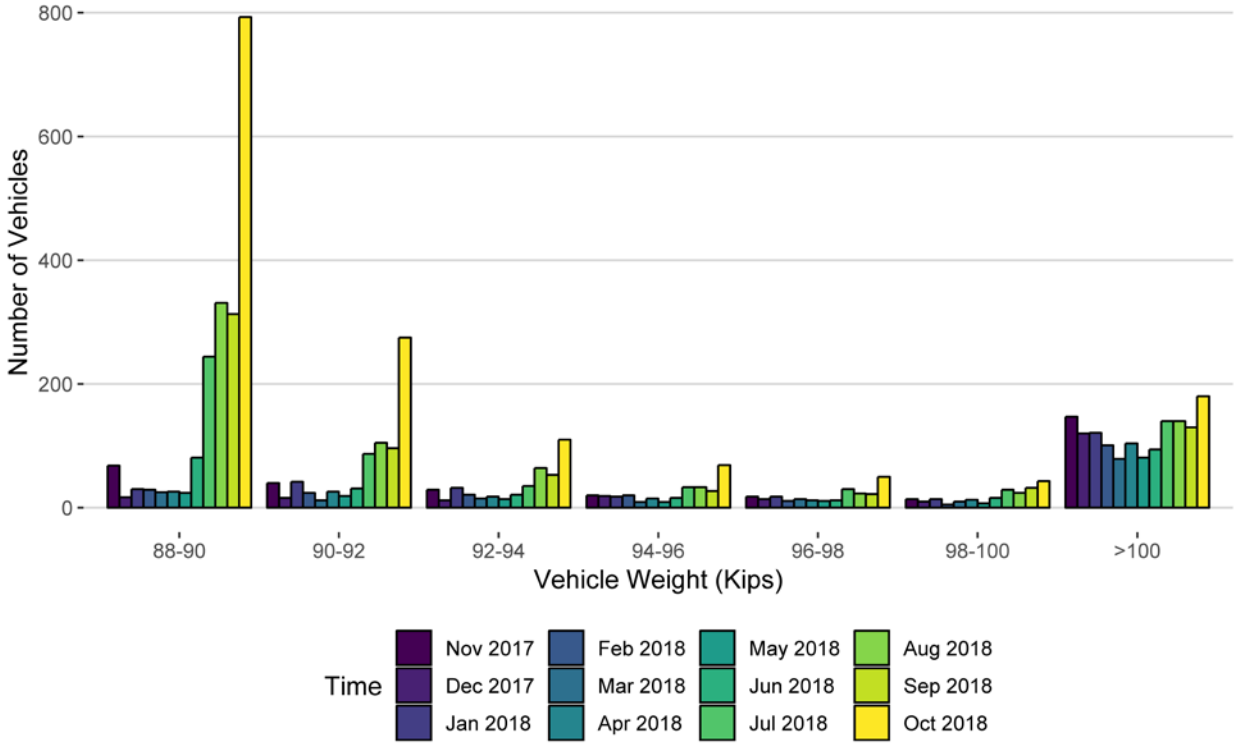
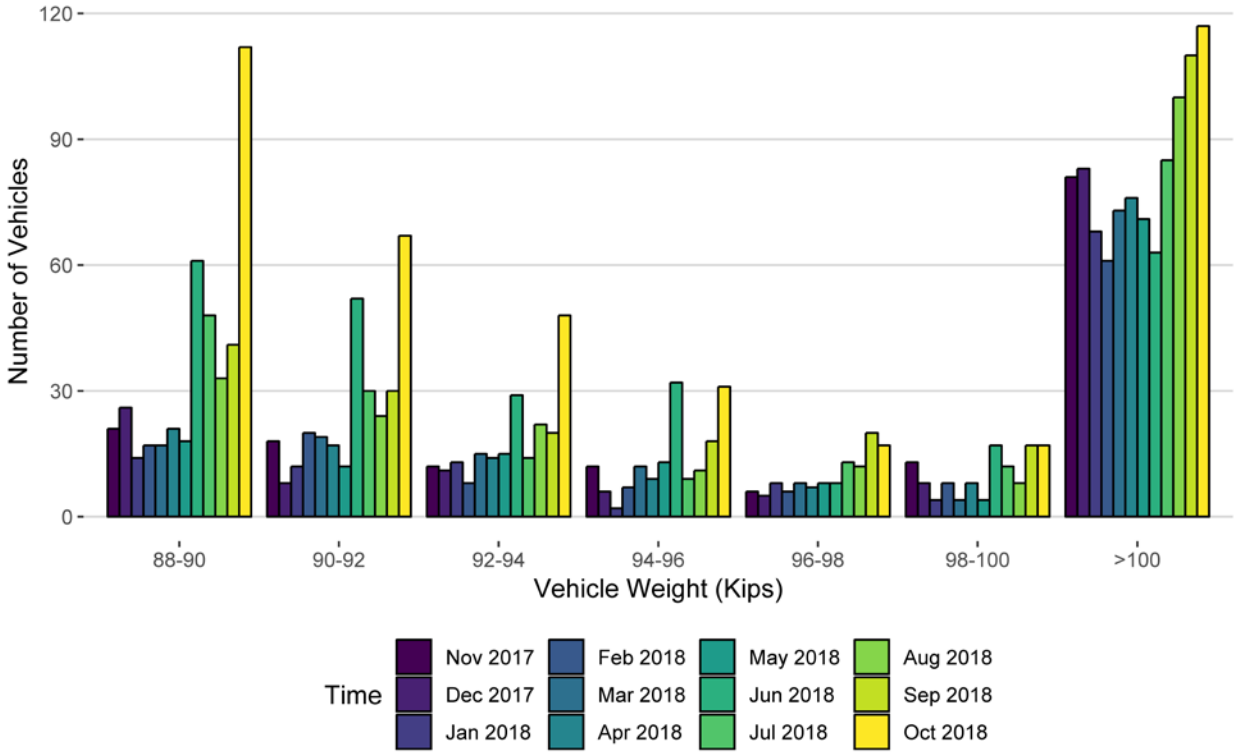


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Nov 2017*	*Dec 2017*	*Jan 2018*	*Feb 2018*	*Mar 2018*	*Apr 2018*	*May 2018*	*Jun 2018*	*Jul 2018*	*Aug 2018*	*Sep 2018*	*Oct 2018*
88-90	68	17	30	29	25	26	24	81	244	331	313	793
90-92	40	16	42	24	12	26	19	31	87	105	96	275
92-94	29	12	32	21	15	18	14	21	35	64	53	110
94-96	20	19	18	20	9	15	9	16	33	33	27	69
96-98	18	14	18	11	14	12	11	12	30	23	22	50
98-100	14	10	14	5	10	13	7	16	29	24	32	43
>100	147	120	121	101	79	104	81	94	140	140	130	180
Total	336	208	275	211	164	214	165	271	598	720	673	1520

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



Vehicle Weights (Kips)	*Nov 2017*	*Dec 2017*	*Jan 2018*	*Feb 2018*	*Mar 2018*	*Apr 2018*	*May 2018*	*Jun 2018*	*Jul 2018*	*Aug 2018*	*Sep 2018*	*Oct 2018*
88-90	21	26	14	17	17	21	18	61	48	33	41	112
90-92	18	8	12	20	19	17	12	52	30	24	30	67
92-94	12	11	13	8	15	14	15	29	14	22	20	48
94-96	12	6	2	7	12	9	13	32	9	11	18	31
96-98	6	5	8	6	8	7	8	8	13	12	20	17
98-100	13	8	4	8	4	8	4	17	12	8	17	17
>100	81	83	68	61	73	76	71	63	85	100	110	117
Total	163	147	121	127	148	152	141	262	211	210	256	409

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

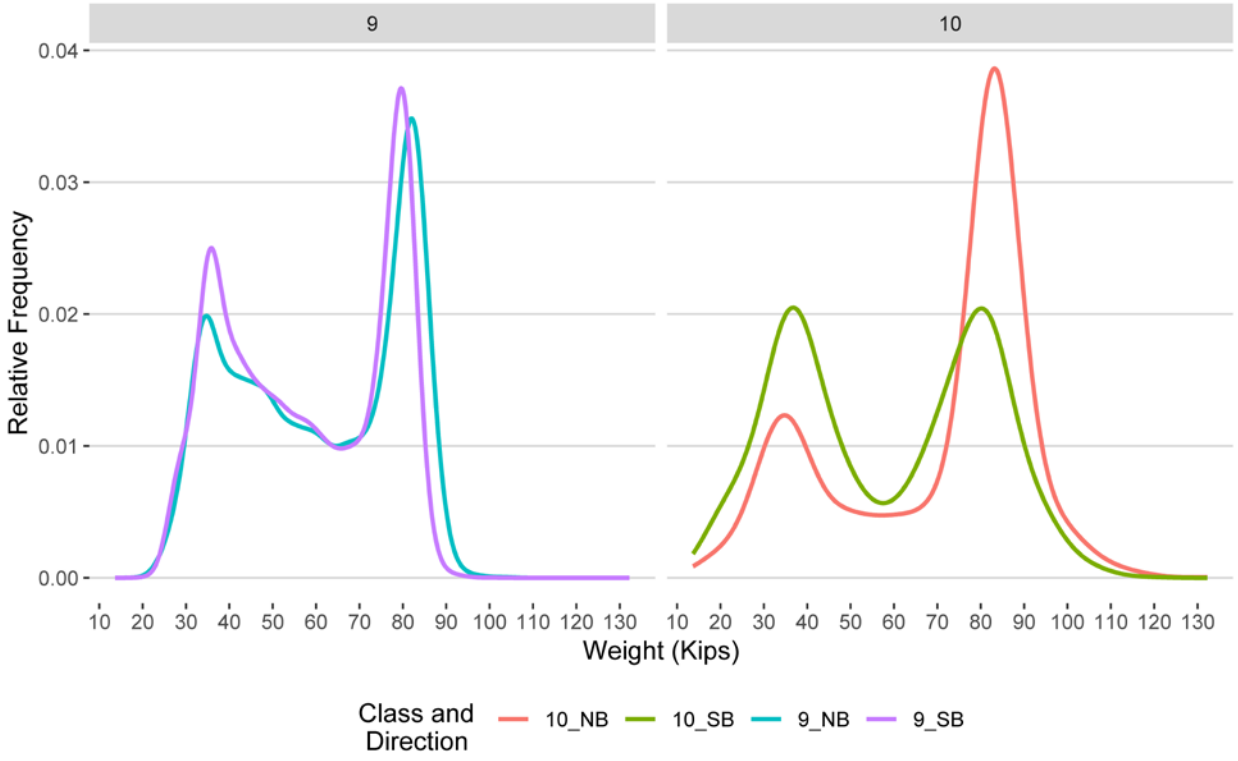


Figure 9 - Freight Percentage by Direction and Class

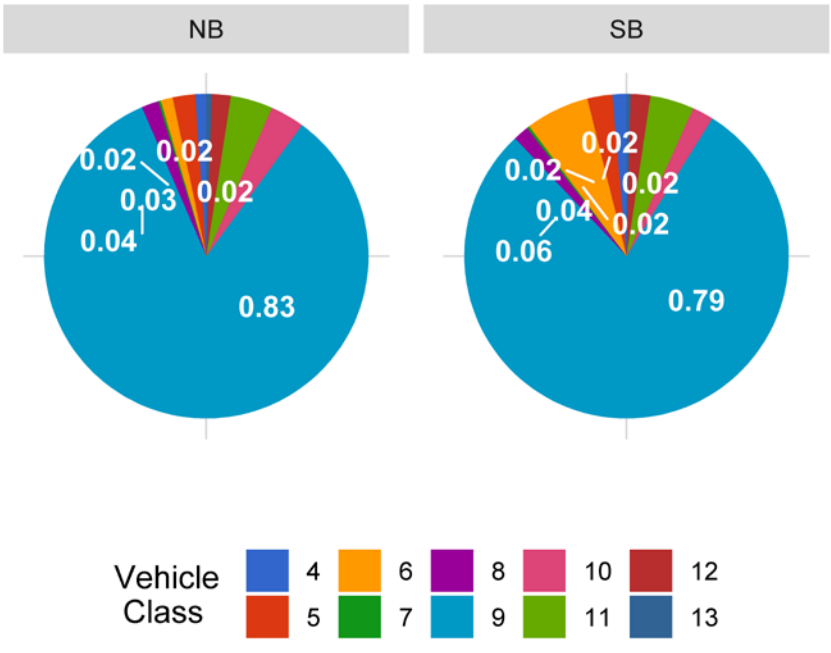


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

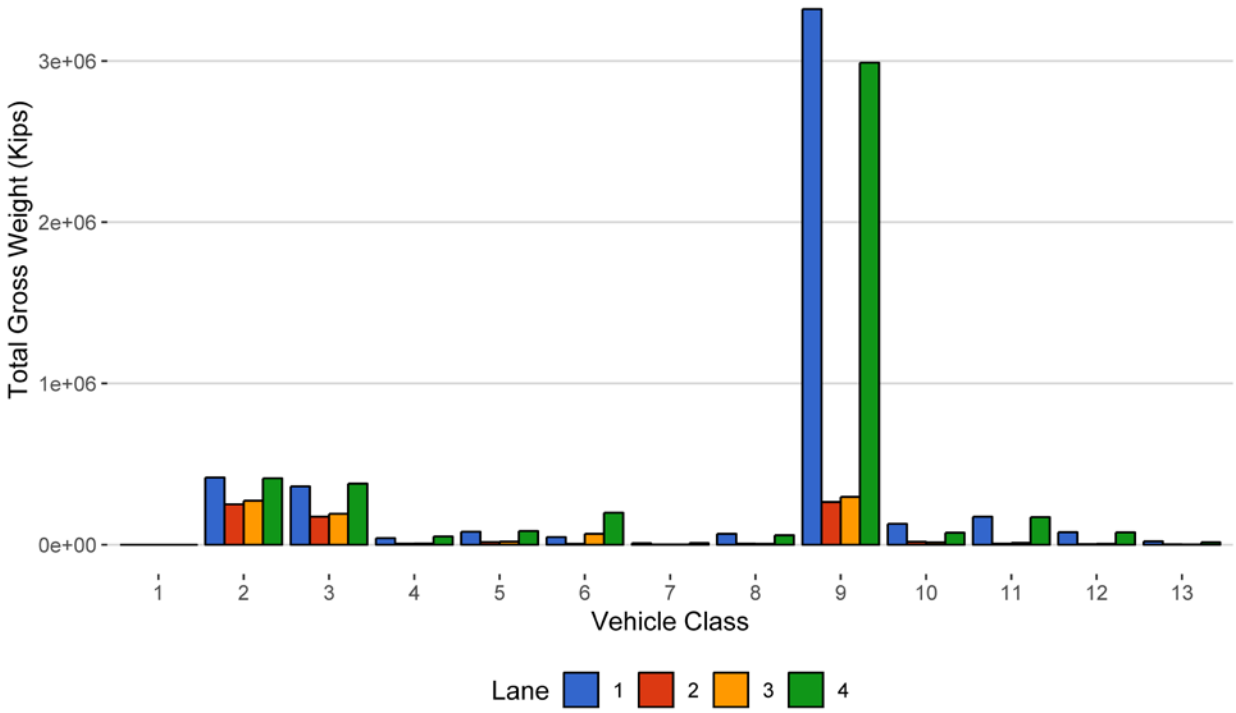


Figure 11 - Total Gross Vehicle Weight b

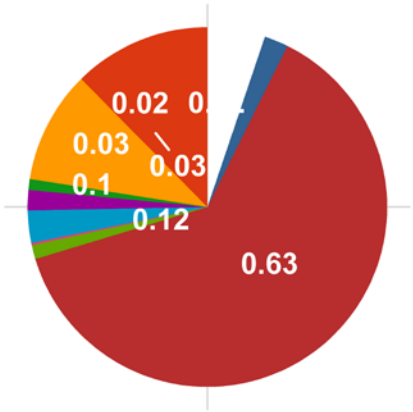


Figure 12 - Total ESALs by Class and Lane

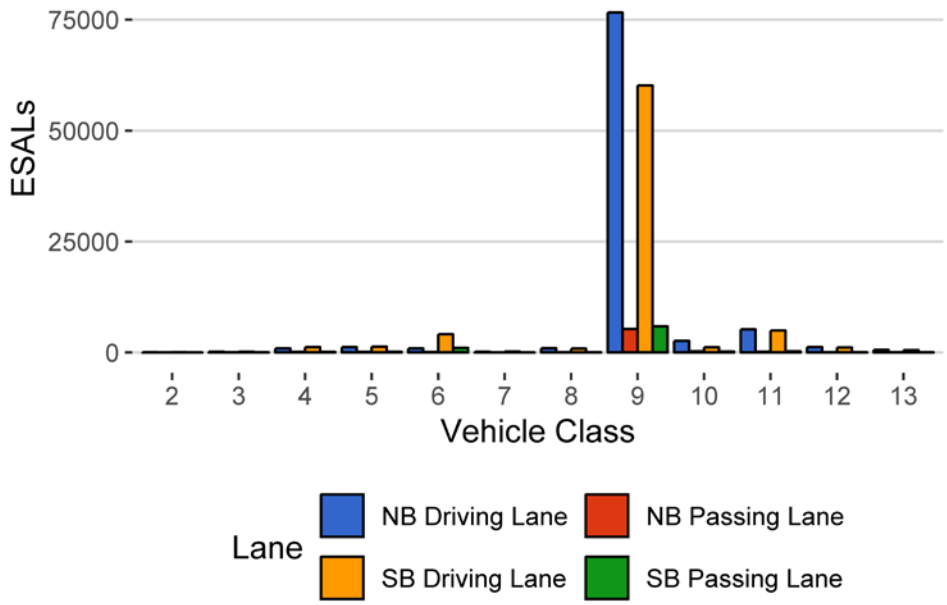


Figure 13 - ESALs by Class

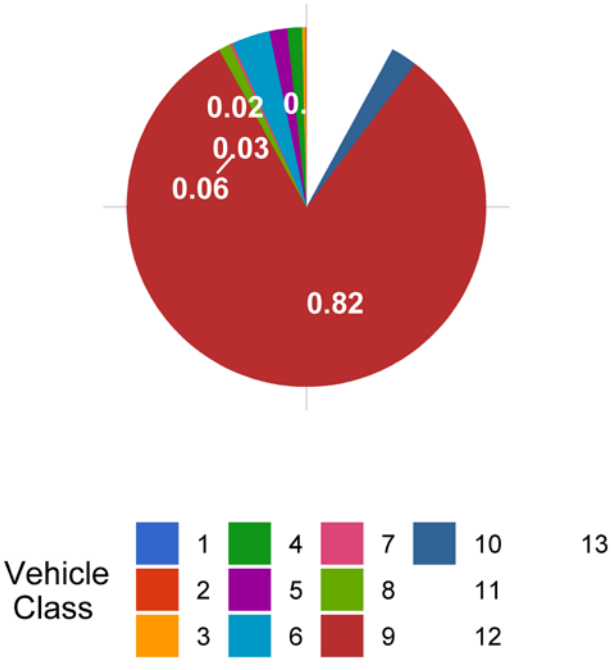


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*	*Lane 3 (Kips)*	*Front Axle +/- 9%*	*Lane 4 (kips)*	*Front Axle +/- 9%*
July 2018	11.67	0.00	11.30	0.00	11.46	0.00	11.42	0.00
August 2018	11.75	0.62	11.31	0.12	11.49	0.20	11.50	0.69
September 2018	11.75	0.68	11.37	0.61	11.56	0.83	11.57	1.30
October 2018	11.82	1.21	11.38	0.71	11.72	2.28	11.81	3.39

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
1	0	15	0	0	0
2	10795	334652	50.6	0	0
3	5345	165702	25	0	0
4	113	3500	0.5	372	1
5	432	13380	2	269	0.7
6	317	9837	1.5	1915	5.3
7	14	427	0.1	120	0.3
8	138	4268	0.6	181	0.5
9	3798	117738	17.8	30698	84.7
10	119	3696	0.6	1515	4.2
11	187	5796	0.9	775	2.1
12	83	2563	0.4	151	0.4
13	13	411	0.1	268	0.7
TOTAL	**21354**	**661987**	**100**	**36264**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2018-10-12	Friday	09:16:42	10	NB	1	132.26
2018-10-16	Tuesday	01:19:38	10	NB	1	120.05
2018-10-12	Friday	12:57:45	10	SB	3	118.53
2018-10-12	Friday	21:34:32	10	NB	1	118.3
2018-10-28	Sunday	05:11:38	9	SB	4	117.55
2018-10-14	Sunday	11:34:06	10	NB	1	117.07
2018-10-10	Wednesday	18:15:10	10	NB	1	115.91
2018-10-06	Saturday	09:00:29	10	NB	1	114.96
2018-10-23	Tuesday	08:11:15	10	NB	1	114.3
2018-10-26	Friday	08:11:56	10	NB	1	113.66

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	NB	15	1551	154	9.9	45289	1994	12167
5	NB	8	6394	576	9	92031	4163	22743
6	NB	19	1767	312	17.7	46731	5470	9543
7	NB	11.5	190	0	0	10923	0	4369
8	NB	31	2243	992	44.2	49390	23658	5305
9	NB	33	58841	4557	7.7	3449931	136640	829279
10	NB	33.5	2106	220	10.4	140838	6182	38828
11	NB	36.5	2810	37	1.3	179253	1247	39019
12	NB	36.5	1265	6	0.5	80753	185	17400
13	NB	31.5	246	0	0	23527	0	7889
TOTAL	****	****	**77413**	**6854**	****	**4118665**	****	**986542**
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	SB	15	1877	131	7	56474	1750	15142
5	SB	8	6711	439	6.5	100092	3168	24958
6	SB	19	7868	194	2.5	261395	3435	57794
7	SB	11.5	228	0	0	11350	0	4364
8	SB	31	1937	739	38.2	47984	16385	5423
9	SB	33	56474	4389	7.8	3156623	129993	718909
10	SB	33.5	1514	228	15.1	82476	6045	19698
11	SB	36.5	2867	31	1.1	181210	902	38848
12	SB	36.5	1245	10	0.8	81705	219	18314
13	SB	31.5	157	0	0	16762	0	5908
TOTAL	****	****	**80878**	**6161**	****	**3996071**	****	**909358**
GRAND TOTAL	****	****	**158291**	**13015**	**180**	**8114736**	**341438**	**1895900**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*NB Driving Lane*	*NB Passing Lane*	*SB Passing Lane*	*SB Driving Lane*	*Total*	*Percentage*
1	8	7	3	2	20	0
2	416713	250488	272834	411289	1351324	12.4
3	361479	173584	191031	379303	1105396	10.1
4	40485	6798	7636	50589	105507	1
5	80292	15902	18923	84337	199454	1.8
6	46829	5372	66881	197949	317031	2.9
7	9621	1302	1120	10229	22272	0.2
8	66971	6077	5546	58823	137417	1.3
9	3322188	264383	296901	2989716	6873188	63
10	129286	17734	14158	74363	235541	2.2
11	173680	6820	11017	171095	362613	3.3
12	77291	3647	5476	76447	162862	1.5
13	20753	2774	1977	14785	40289	0.4
TOTAL	**4745596**	**754888**	**893502**	**4518927**	**10912914**	**100**
GVW/LANE	**43.49**	**6.92**	**8.19**	**41.41**	**100**	**0**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*NB Driving Lane*	*NB Passing Lane*	*SB Passing Lane*	*SB Driving Lane*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0	0	0.0625
2	52	30	35	53	170	0.09	0.001
3	186	63	75	212	536	0.3	0.0066
4	920	129	152	1254	2454	1.35	1.43
5	1227	145	189	1301	2862	1.58	0.44
6	915	95	1070	4119	6200	3.42	1.29
7	192	22	23	224	460	0.25	2.18
8	953	66	58	893	1971	1.09	0.94
9	76626	5304	5935	60165	148030	81.59	2.57
10	2618	291	215	1203	4327	2.38	2.39
11	5232	176	296	4970	10674	5.88	3.76
12	1214	44	76	1157	2490	1.37	1.98
13	640	59	48	518	1264	0.7	6.11
TOTAL	**90775**	**6424**	**8171**	**76069**	**181439**	**100**	**23**
ESALS/LANE	**50**	**3.5**	**4.5**	**41.9**	**100**	**–**	**–**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*	*Heavy Commercial Vehicles in Driving Lane %*	*Heavy Commercial Vehicles in Passing Lane %*
Nov 2017	630878	21029	4385	499321	79.1	131556.6	20.9	92.9	7.1
Dec 2017	598759	19315	3752	482443	80.6	116315.6	19.4	91.9	8.1
Jan 2018	498163	16070	3966	375222	75.3	122941	24.7	88.4	11.6
Feb 2018	464482	16589	4150	348276	75	116206.3	25	92	8
Mar 2018	610968	19709	4160	482021	78.9	128946.7	21.1	93.1	6.9
Apr 2018	580205	19340	4325	450468	77.6	129736.9	22.4	91.8	8.2
May 2018	719401	23206	4783	571124	79.4	148276.5	20.6	91.1	8.9
Jun 2018	747544	24918	4473	613365	82.1	134179	17.9	90.9	9.1
Jul 2018	778261	25105	4938	625188	80.3	153073.3	19.7	90	10
Aug 2018	761407	24562	5156	601556	79	159850.7	21	87.3	12.7
Sep 2018	657910	21930	4758	515162	78.3	142748	21.7	89	11
Oct 2018	661987	21354	5213	500370	75.6	161617.4	24.4	89.5	10.5
TOTAL	**7709965**	**–**	**–**	**6064516**	**–**	**1645448**	**–**	**–**	**–**
AVERAGE	**642497**	**21094**	**4505**	**505376**	**78**	**137121**	**22**	**91**	**9**

ESALs

Month	*ESALS NB Passing Lane*	*ESALS NB Driving Lane*	*ESALS SB Driving Lane*	*ESALS SB Passing Lane*	*Total ESALS*	*Driving Lane ESALS %*	*Passing Lane ESALS %*	*Pavement Life Decrease Months*
Nov 2017	60237	2750	4767	39203	106958	93	7	2.4
Dec 2017	151523	2537	4138	37192	195390	97	3	1.5
Jan 2018	46740	3145	5747	31738	87370	90	10	2.6
Feb 2018	45003	2704	4412	36670	88789	92	8	1.3
Mar 2018	51869	2660	4158	45512	104199	93	7	0.8
Apr 2018	53425	3150	5206	45592	107375	92	8	1.2
May 2018	65022	3953	6376	43927	119277	91	9	0.8
Jun 2018	65146	4085	5477	43627	118334	92	8	1.6
Jul 2018	84400	6449	5875	59420	156145	92	8	3.5
Aug 2018	87730	8168	7986	62288	166172	90	10	4
Sep 2018	78475	5239	7369	58608	149690	92	8	4.4
Oct 2018	90986	6433	8273	76282	181974	92	8	8.5
TOTAL	**880556**	**51273**	**69784**	**580060**	**1581672**	**–**	**–**	**–**
AVERAGE	**73380**	**4273**	**5815**	**48338**	**131806**	**92**	**8**	**3**

Gross Vehicle Weight

Month	*GVW NB Passing Lane*	*GVW NB Driving Lane*	*GVW SB Passing Lane*	*GVW SB Driving Lane*	*Total GVW Kips*
Nov 2017	3275872	466854	698236	2966421	7407383
Dec 2017	3170037	420956	496963	3061183	7149139
Jan 2018	3711268	525438	606268	3615881	8458855
Feb 2018	3624977	545528	630879	3546495	8347880
Mar 2018	4186867	740631	818945	3906425	9652869
Apr 2018	4025326	788976	859885	3638548	9312736
May 2018	4721860	908715	910021	4255066	10795661
Jun 2018	4778193	996057	1037615	4252269	11064134
Jul 2018	4333349	700326	885304	3901307	9820285
Aug 2018	4750482	755225	896476	4525612	10927794
Sep 2018	3855881	557231	673377	3560603	8647091
Oct 2018	3245594	531065	608746	3263953	7649358
TOTAL	**47679706**	**7937001**	**9122715**	**44493762**	**109233184**
AVERAGE	**3973309**	**661417**	**760226**	**3707814**	**9102765**

Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
Nov 2017	8945	1.5	7	502	256
Dec 2017	3916	0.7	3.4	479	326
Jan 2018	4115	0.9	3.5	400	207
Feb 2018	4373	1	3.9	340	176
Mar 2018	5137	0.9	4.1	314	166
Apr 2018	6713	1.2	5.4	367	201
May 2018	8892	1.3	6.2	310	163
Jun 2018	13748	1.9	10.7	534	191
Jul 2018	25547	3.4	17	823	274
Aug 2018	28197	3.8	17.9	935	276
Sep 2018	26035	4	18.5	932	289
Oct 2018	36341	5.6	22.9	1950	369
TOTAL	**171959**	**–**	**–**	**7886**	**2894**
AVERAGE	**14329.9**	**2.2**	**10**	**657.2**	**241.2**

Freight

Month	*NB Freight Tons*	*SB Freight Tons*	*Total Freight*	*NB Freight %*	*SB Freight %*
Nov 2017	707648	586202	1293850	54.7	45.3
Dec 2017	542161	526583	1068744	50.7	49.3
Jan 2018	600277	513278	1113555	53.9	46.1
Feb 2018	574758	537046	1111805	51.7	48.3
Mar 2018	650592	625947	1276539	51	49
Apr 2018	658557	636211	1294768	50.9	49.1
May 2018	777383	660394	1437777	54.1	45.9
Jun 2018	752229	604505	1356734	55.4	44.6
Jul 2018	944419	750020	1694439	55.7	44.3
Aug 2018	986853	794470	1781322	55.4	44.6
Sep 2018	864472	740989	1605461	53.8	46.2
Oct 2018	986542	909358	1895900	52	48
TOTAL	**9045892**	**7885003**	**16930895**	**–**	**–**
AVERAGE	**753824.3**	**657083.6**	**1410907.9**	**53.3**	**46.7**