JUNE 2018

WIM #34
MN 23, MP 122.1
CLARA CITY, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #34 is located on MN 23 near Clara City in Chippewa county.

System Operation

WIM #34 was operational for the entire month of June 2018. Volume was computed using all monthly data.

System Calibration

WIM #34 was most recently calibrated on 2015-06-17. 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: 109507 | Passenger Vehicles: 94154 | Heavy Commercial Vehicles: 15353

Monthly Average Daily Traffic (MADT): 3650 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 512

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 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 05 PM. Similarly, SB PVs peaked in volume between 03 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 02 PM and 05 PM, while volume going SB peaked between 03 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 15353 HCVs, 1697 of them were overweight [3]. These overweight HCVs contributed to 1.6% of total monthly volume, and 11.1% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Saturdays. 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 9 and class 10 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 64% 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 March.
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 ,113 NB vehicles exceeded 88,000 pounds (72 vehicles were Class 13's; 21 vehicles were Class 10's). Of vehicles traveling SB,

120 NB vehicles exceeded 88,000 pounds (41 vehicles were Class 10's; 37 vehicles were Class 13's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from June 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in June 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 empty class 10 vehicles.

Freight Totals. A total of 124005 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (52.9%) than NB (47.1%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 12012 is approximately 3.8 miles north of WIM #34, and Bridge No. 12004 is 3.1 miles south of WIM #34. WIM #34 recorded a total of 109507 vehicles with a combined GVW of 1134172 kips (1 kip = 1,000 pounds = 0.5 tons) in June 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 11848 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 58% of all ESALs were recorded SB while 42% was observed NB. In particular, 67% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 39% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL

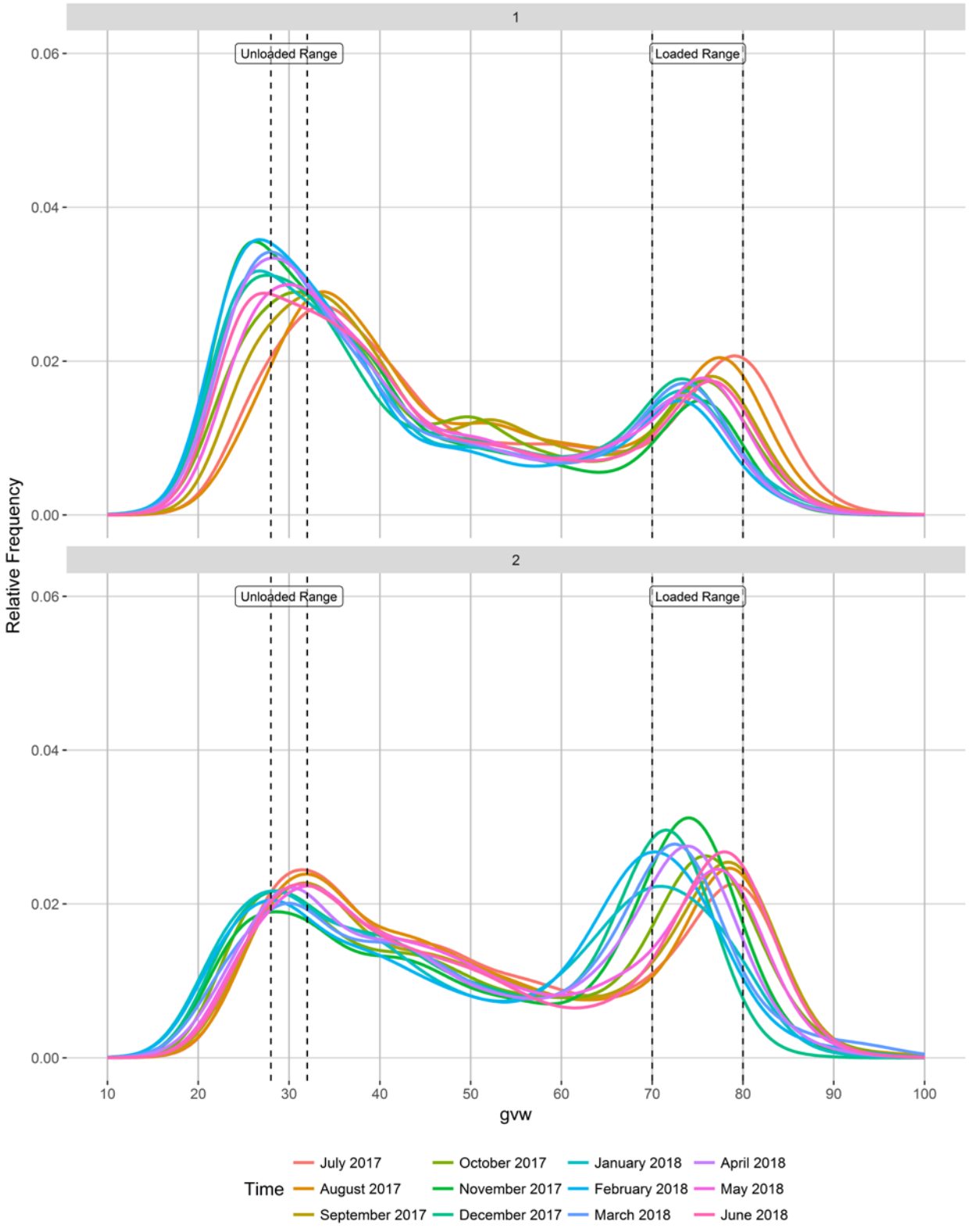
factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

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

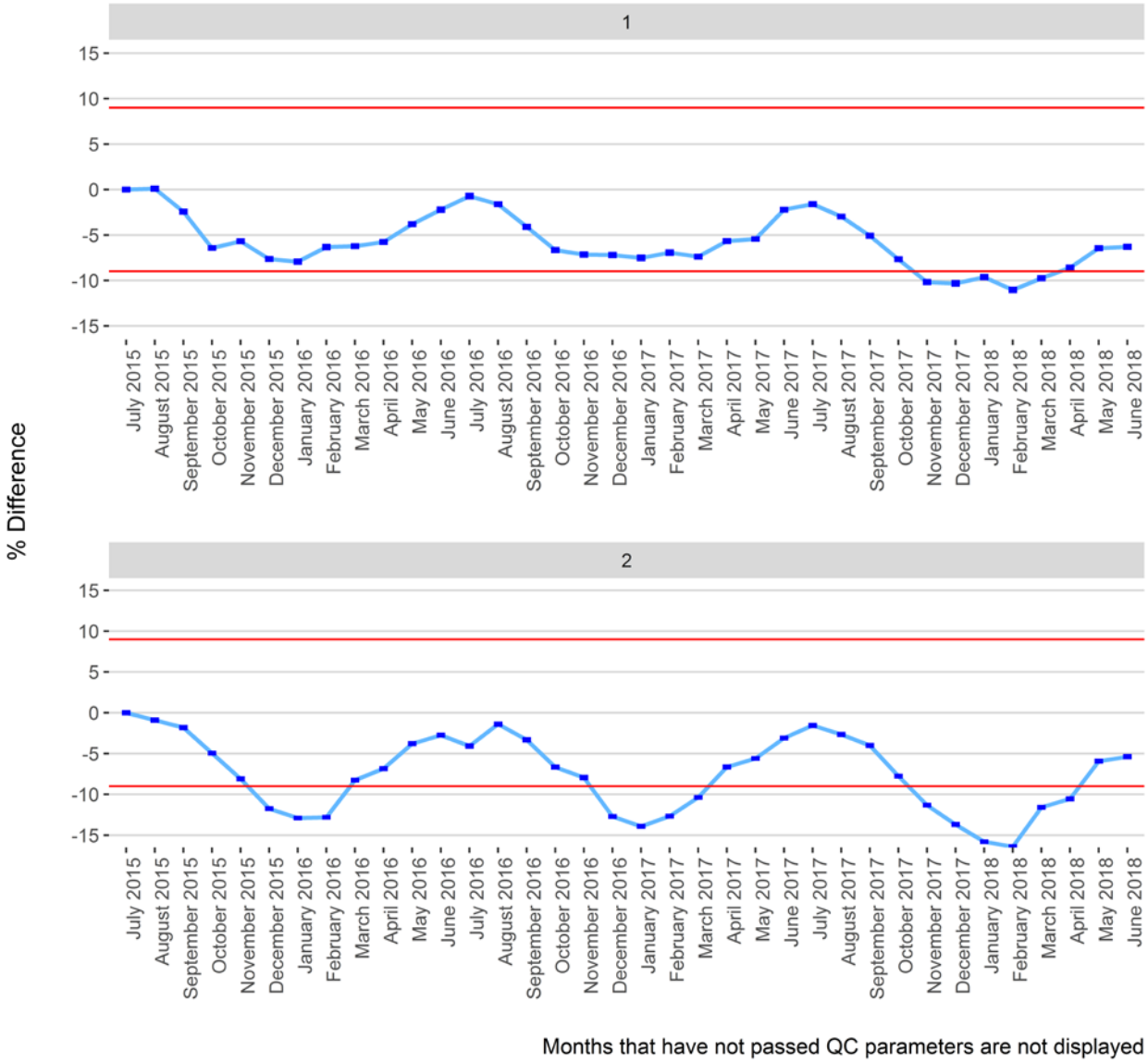
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values
- [2] Previous WIM research indicates that unloaded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

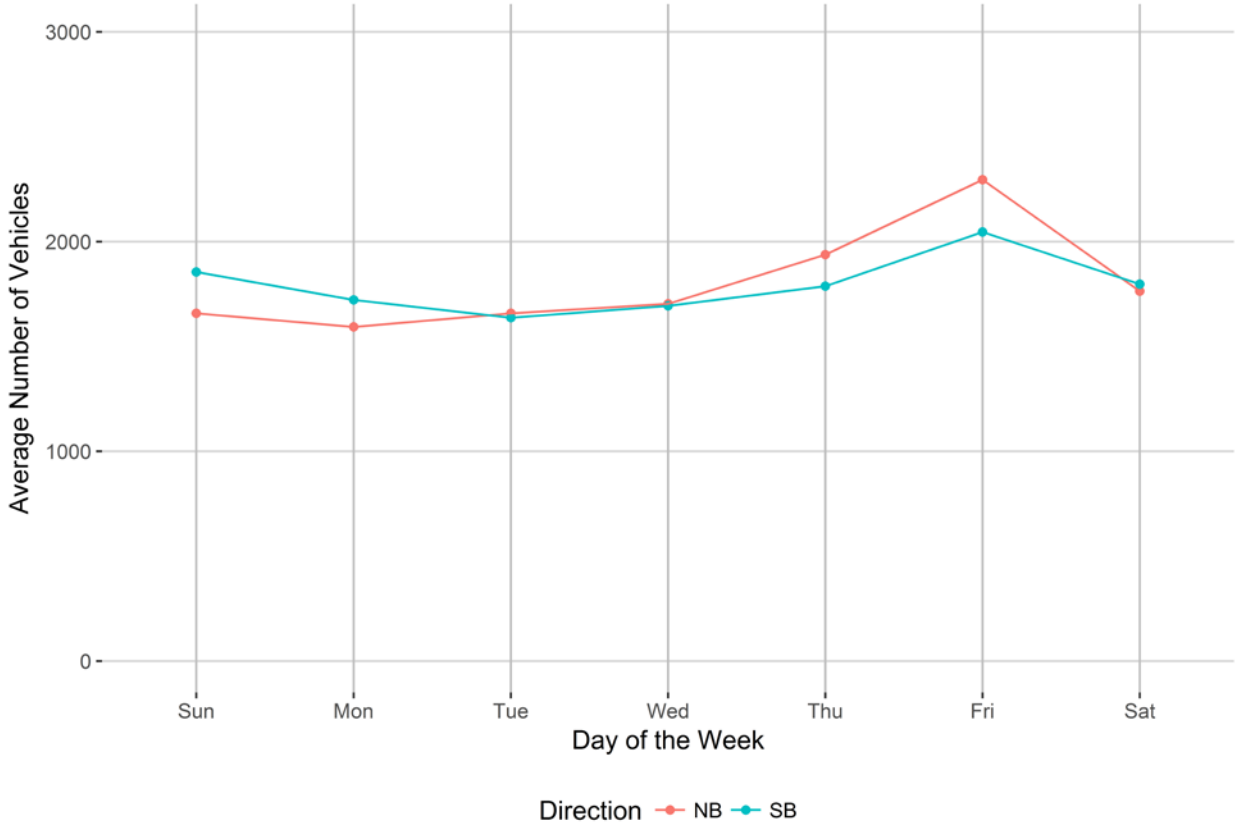


Figure 3 - Average Overweight Vehicle Volume
vs. Day of the Week

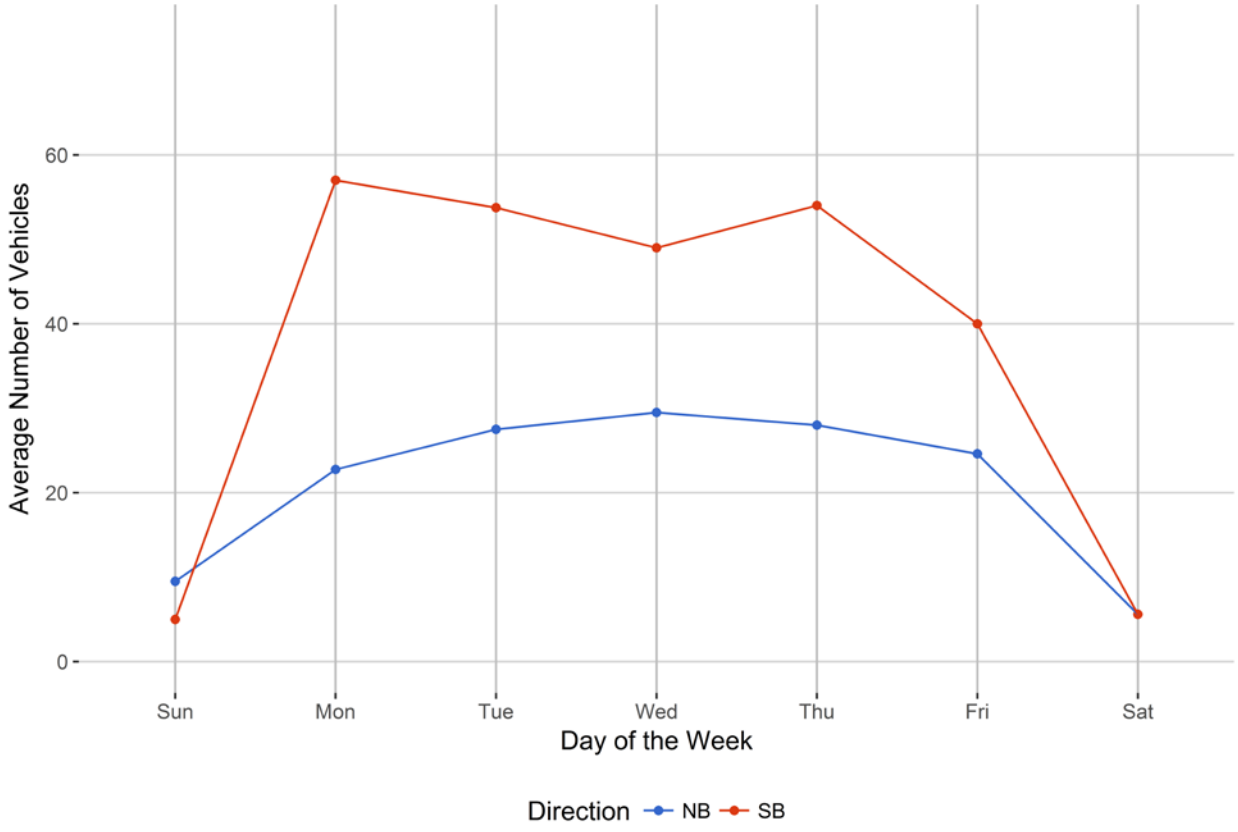


Figure 4 - Passenger Vehicles vs. Hour of the Day

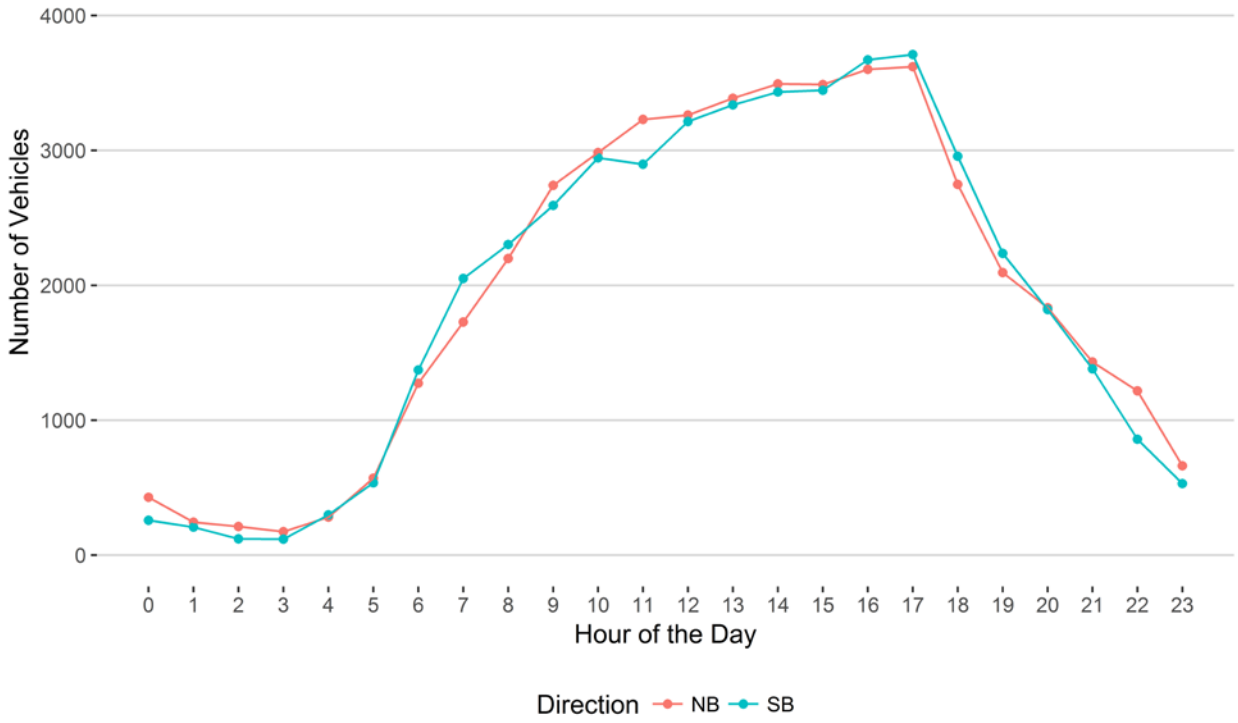


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

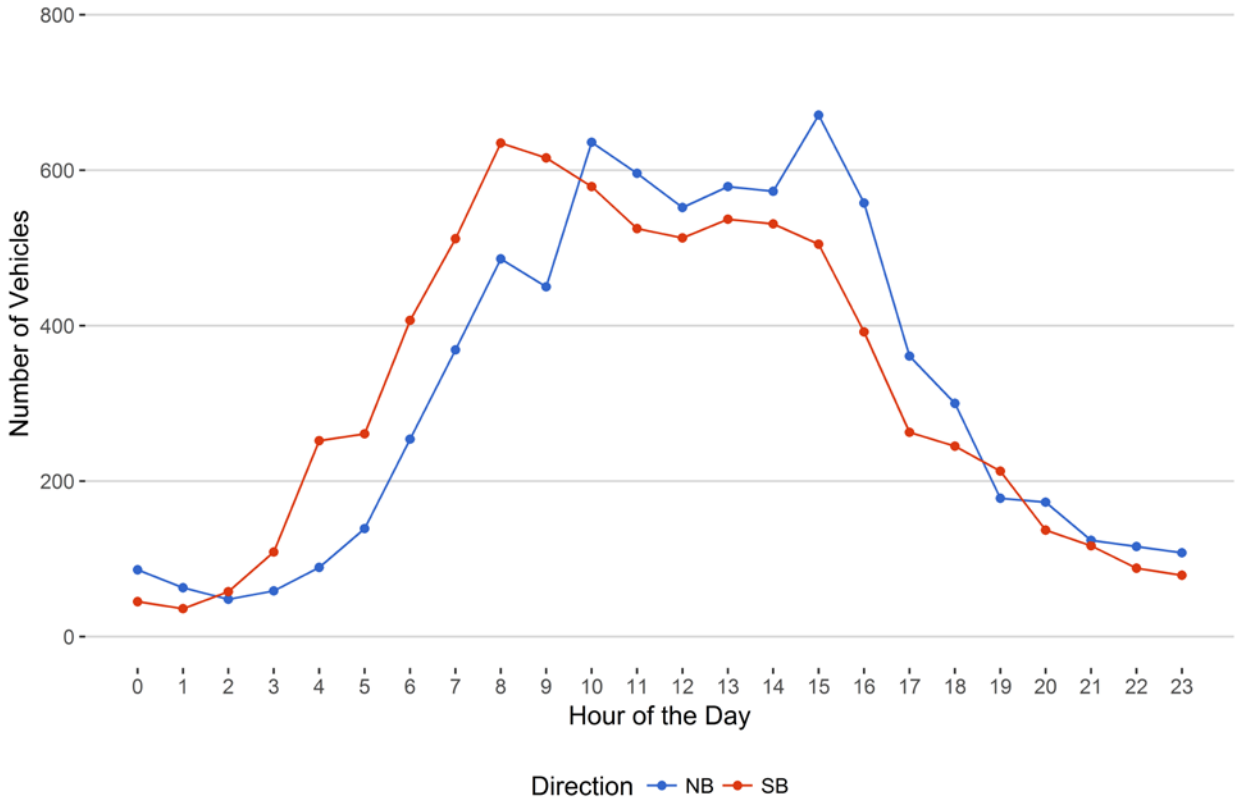


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

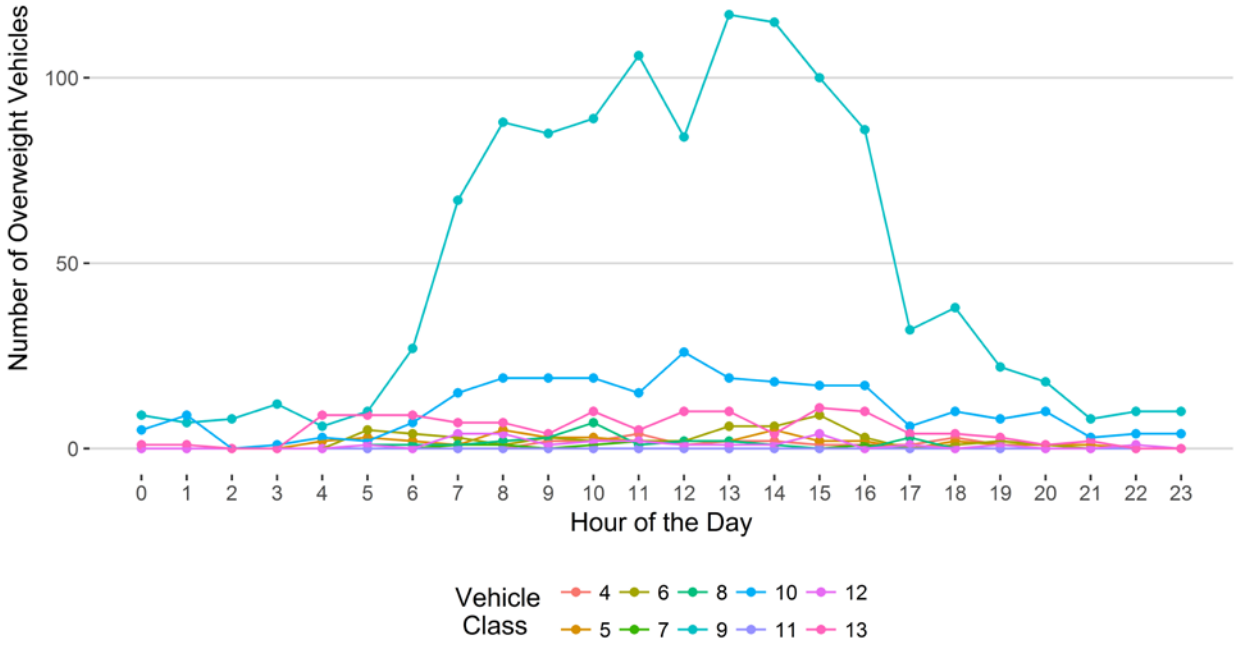


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

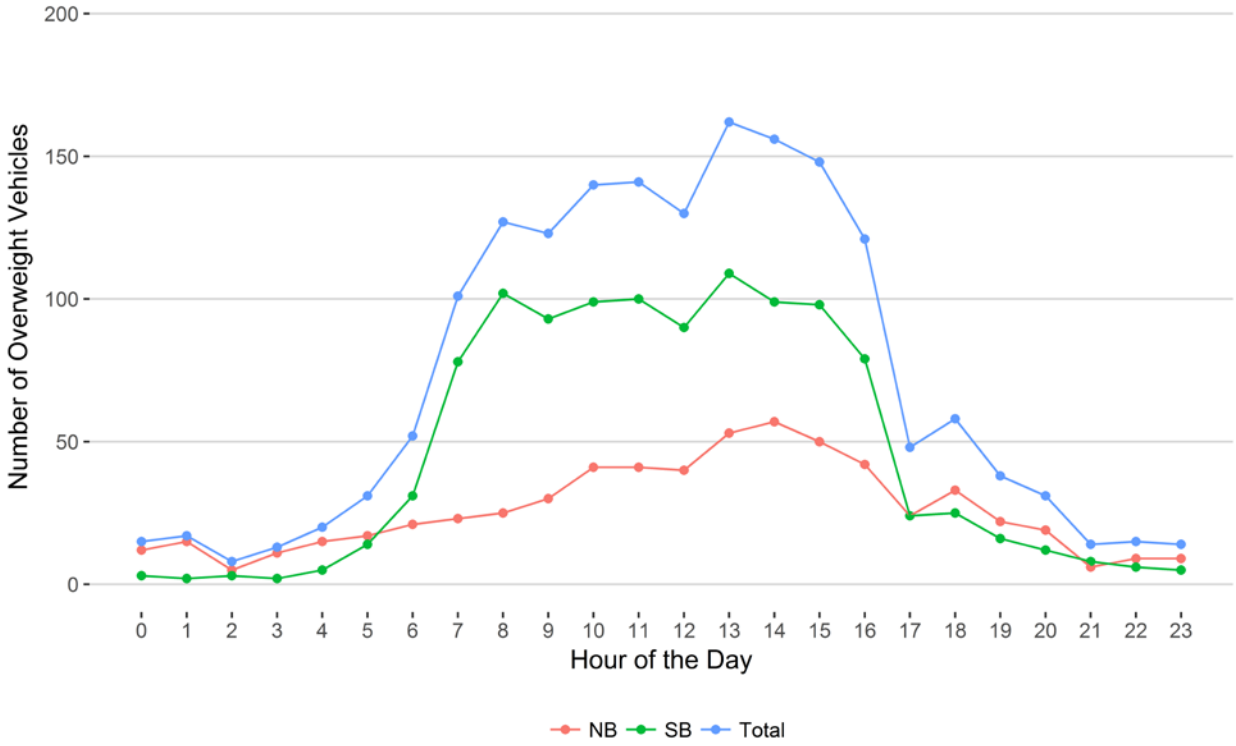
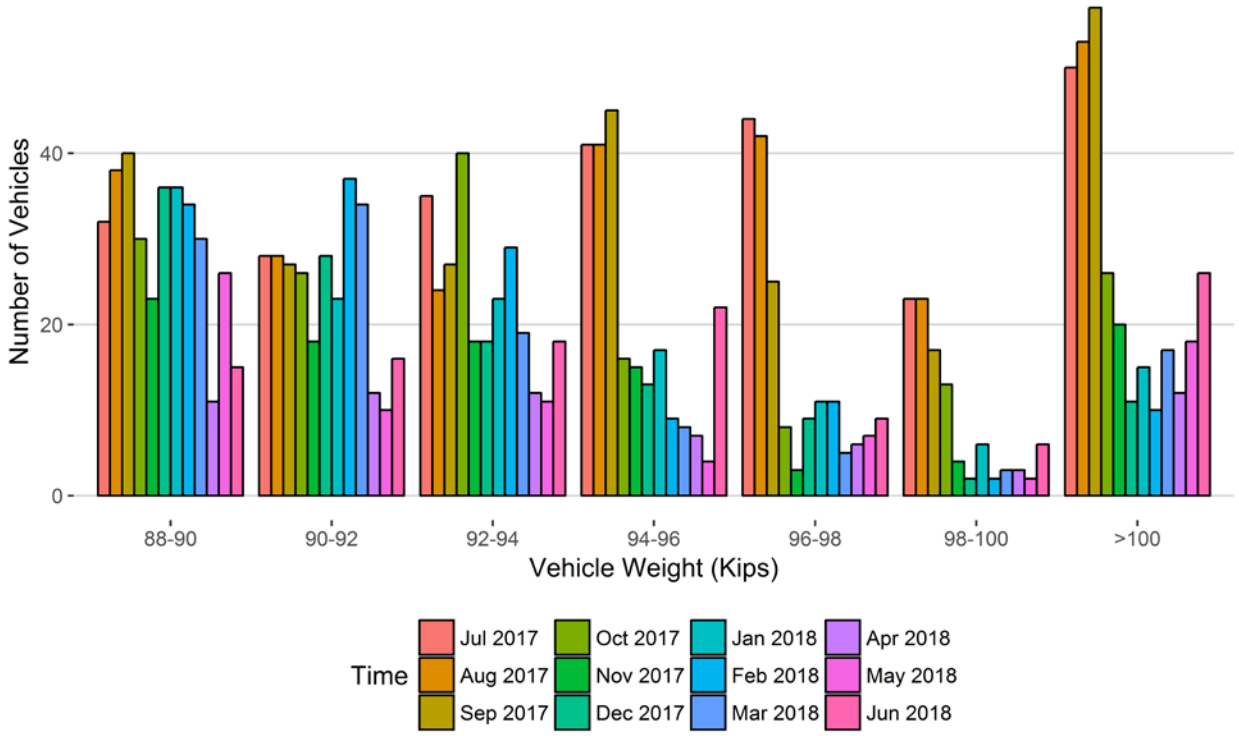
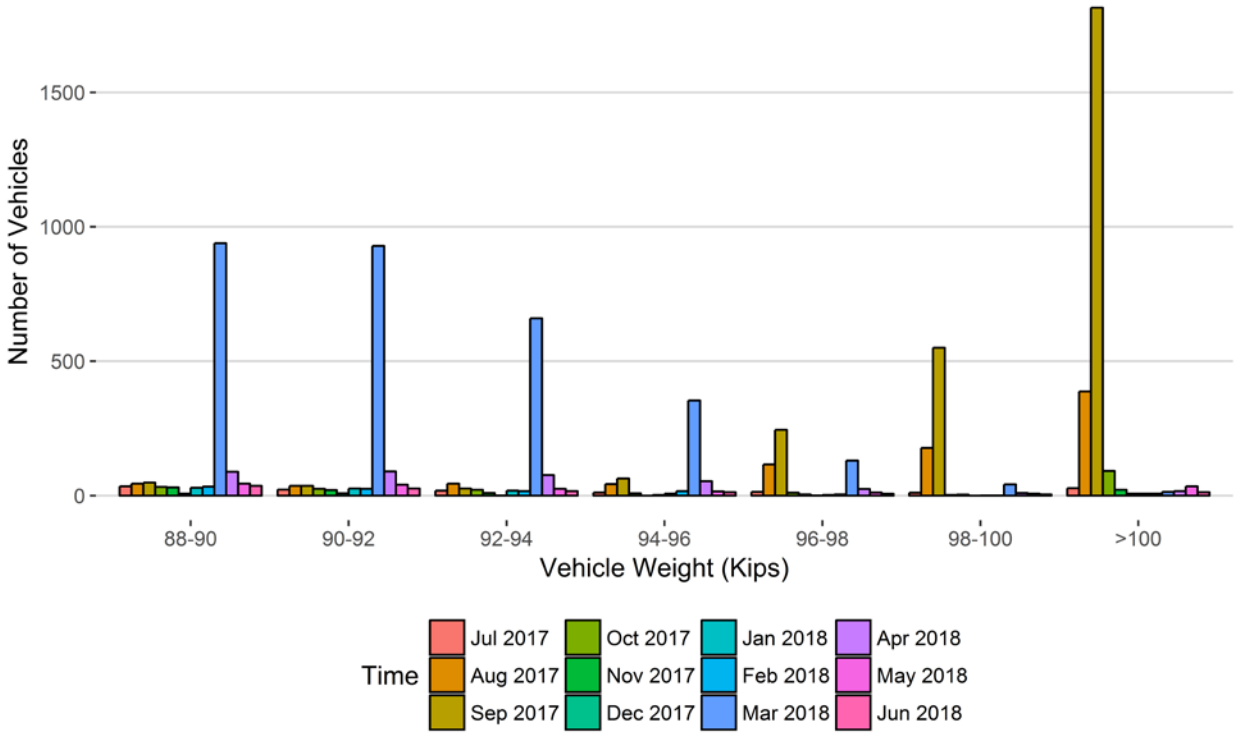


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Jul 2017*	*Aug 2017*	*Sep 2017*	*Oct 2017*	*Nov 2017*	*Dec 2017*	*Jan 2018*	*Feb 2018*	*Mar 2018*	*Apr 2018*	*May 2018*	*Jun 2018*
88-90	32	38	40	30	23	36	36	34	30	11	26	15
90-92	28	28	27	26	18	28	23	37	34	12	10	16
92-94	35	24	27	40	18	18	23	29	19	12	11	18
94-96	41	41	45	16	15	13	17	9	8	7	4	22
96-98	44	42	25	8	3	9	11	11	5	6	7	9
98-100	23	23	17	13	4	2	6	2	3	3	2	6
>100	50	53	57	26	20	11	15	10	17	12	18	26
Total	253	249	238	159	101	117	131	132	116	63	78	112

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



Vehicle Weights (Kips)	*Jul 2017*	*Aug 2017*	*Sep 2017*	*Oct 2017*	*Nov 2017*	*Dec 2017*	*Jan 2018*	*Feb 2018*	*Mar 2018*	*Apr 2018*	*May 2018*	*Jun 2018*
88-90	35	45	49	33	31	8	30	34	939	89	45	37
90-92	23	37	37	26	21	9	27	26	929	90	41	27
92-94	19	45	27	22	10	1	19	17	660	77	26	17
94-96	12	43	64	9	0	3	8	17	354	54	16	13
96-98	14	116	245	11	5	1	3	5	131	25	12	7
98-100	11	178	550	3	4	0	1	1	42	10	8	5
>100	28	388	1815	92	22	8	8	8	14	17	35	13
Total	142	852	2787	196	93	30	96	108	3069	362	183	119

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

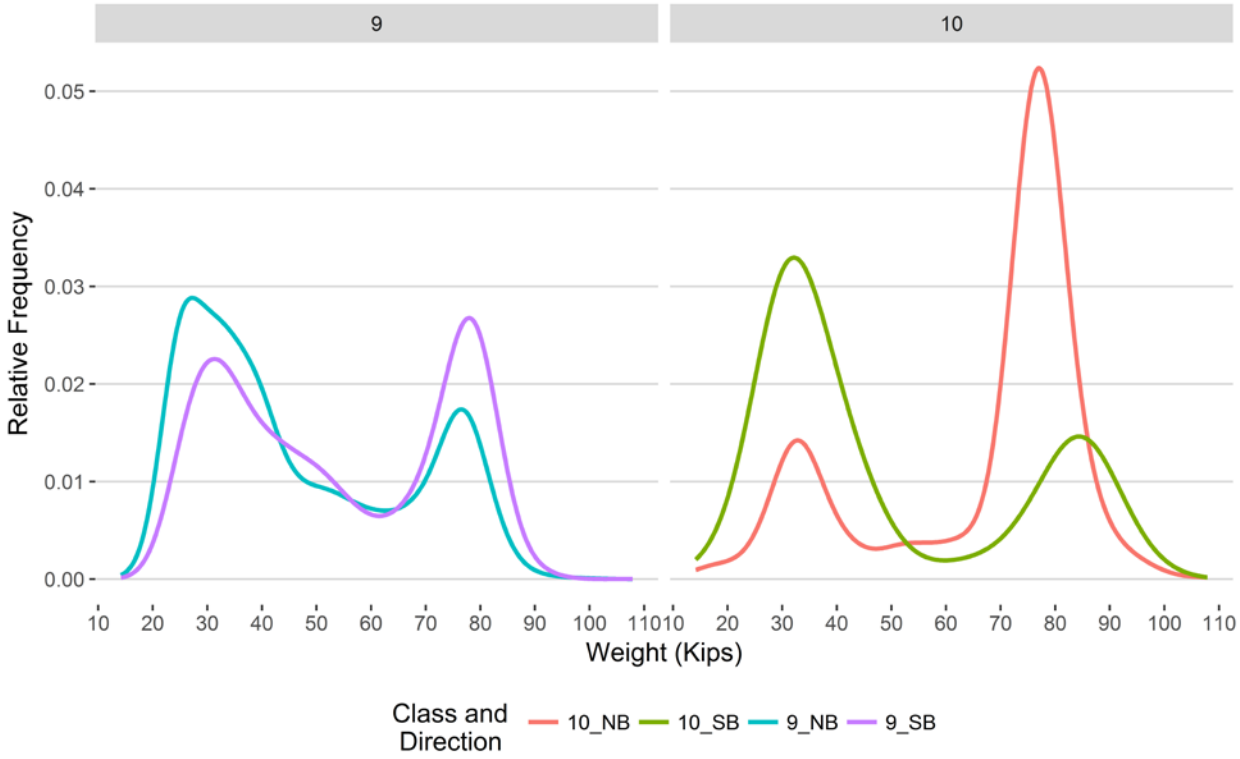


Figure 9 - Freight Percentage by Direction and Class

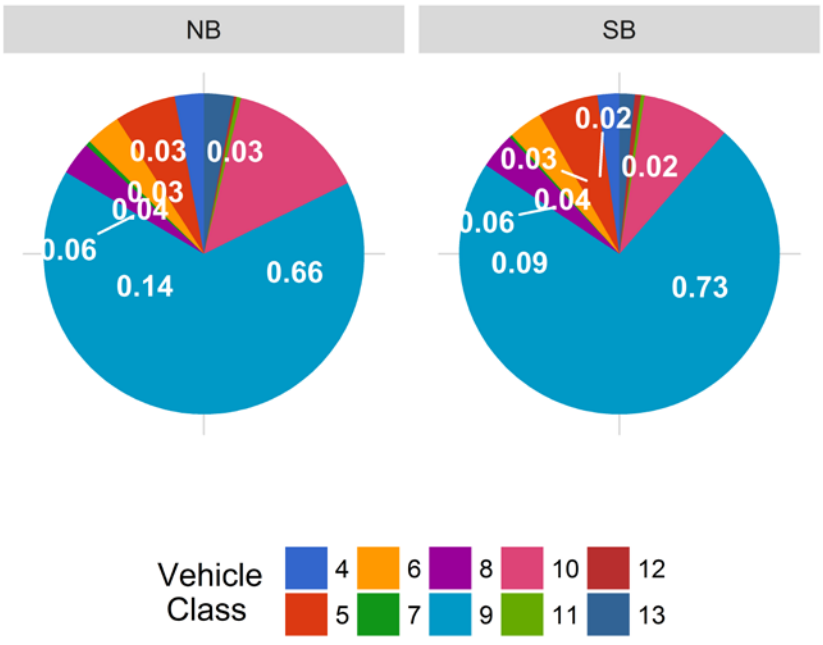


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

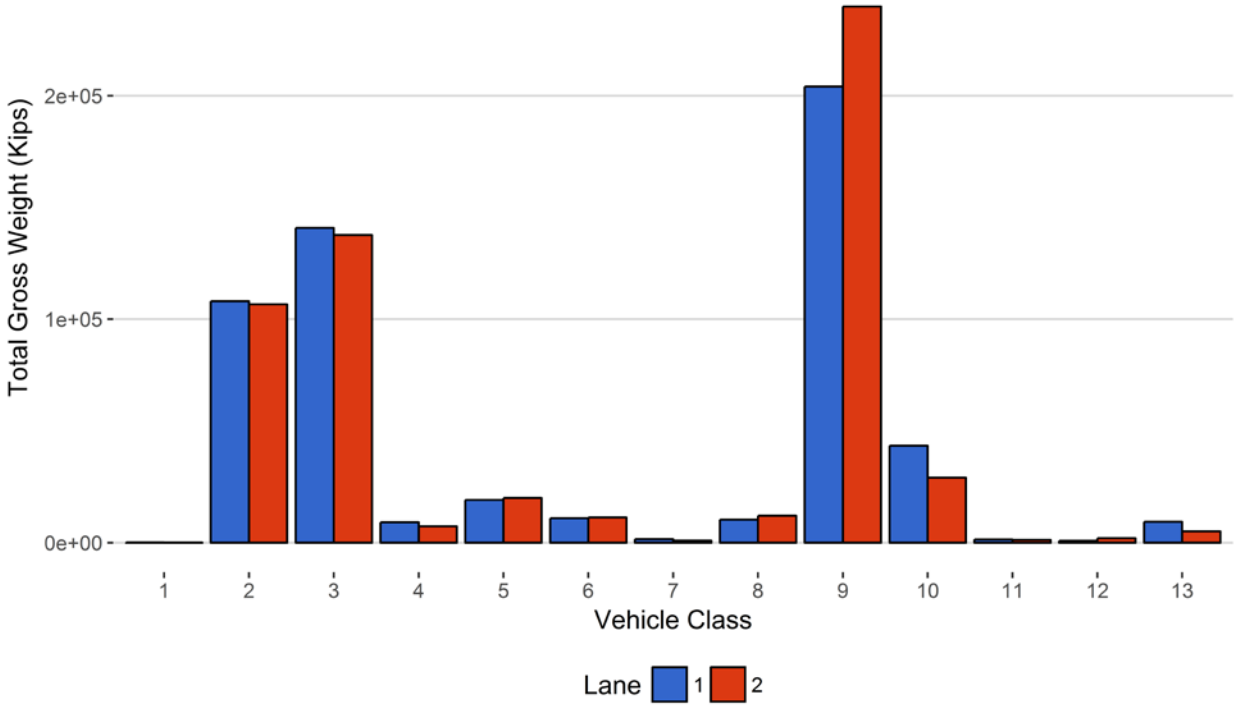


Figure 11 - Total Gross Vehicle Weight I

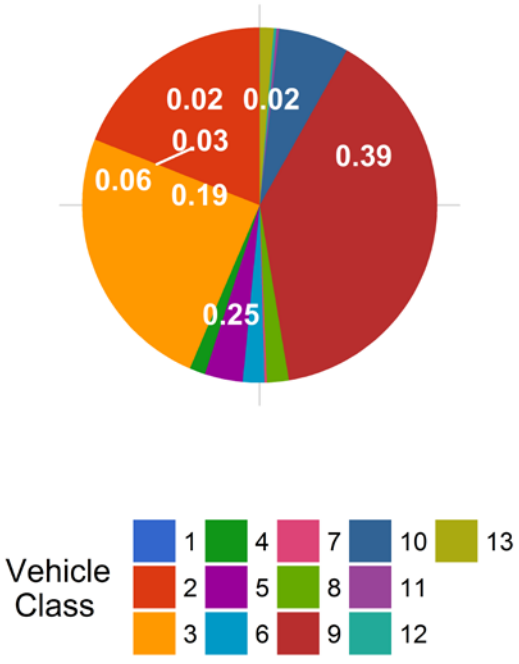


Figure 12 - Total ESALs by Class and Lane

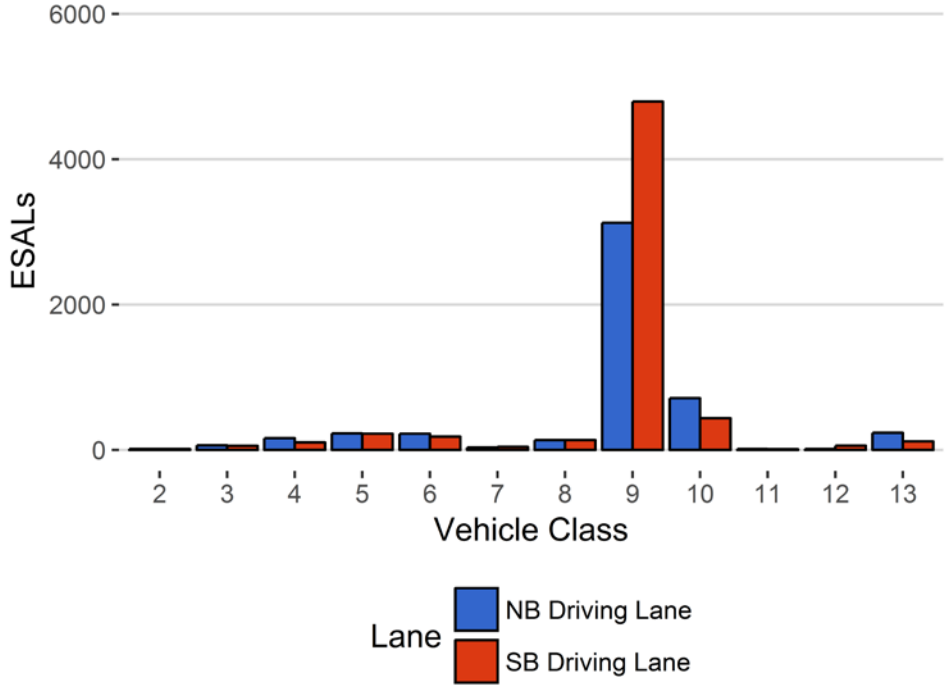


Figure 13 - ESALs by Class

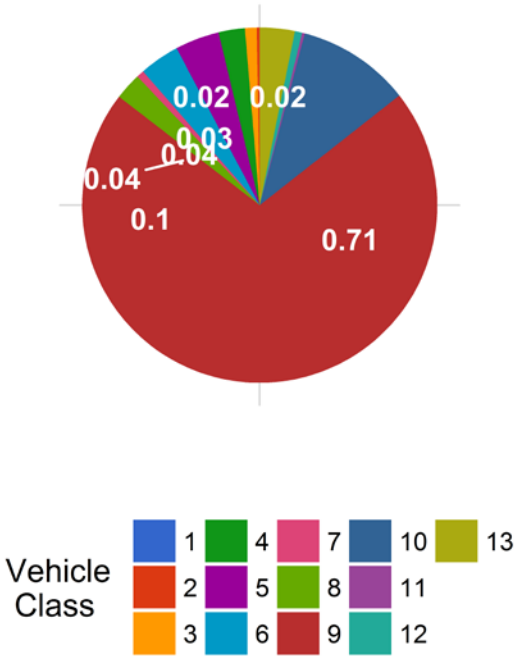


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
July 2015	11.97	0.00	12.29	0.00
August 2015	11.98	0.10	12.18	-0.91
September 2015	11.67	-2.43	12.07	-1.82
October 2015	11.20	-6.43	11.68	-4.95
November 2015	11.28	-5.69	11.29	-8.10
December 2015	11.05	-7.65	10.84	-11.75
January 2016	11.02	-7.92	10.70	-12.91
February 2016	11.21	-6.33	10.71	-12.81
March 2016	11.22	-6.23	11.27	-8.26
April 2016	11.28	-5.77	11.45	-6.85
May 2016	11.51	-3.81	11.82	-3.79
June 2016	11.70	-2.21	11.95	-2.75
July 2016	11.88	-0.72	11.79	-4.08
August 2016	11.77	-1.61	12.12	-1.39
September 2016	11.47	-4.10	11.88	-3.32
October 2016	11.17	-6.65	11.47	-6.67
November 2016	11.11	-7.15	11.31	-7.94
December 2016	11.10	-7.19	10.73	-12.70
January 2017	11.07	-7.51	10.58	-13.92
February 2017	11.14	-6.94	10.73	-12.67
March 2017	11.08	-7.37	11.01	-10.37
April 2017	11.29	-5.67	11.47	-6.64
May 2017	11.32	-5.43	11.60	-5.59
June 2017	11.70	-2.21	11.91	-3.10
July 2017	11.77	-1.60	12.10	-1.55
August 2017	11.61	-2.96	11.96	-2.66
September 2017	11.36	-5.08	11.80	-4.01
October 2017	11.05	-7.67	11.33	-7.77
November 2017	10.75	-10.18	10.90	-11.32
December 2017	10.73	-10.32	10.61	-13.69
January 2018	10.81	-9.63	10.35	-15.81
February 2018	10.64	-11.04	10.27	-16.40
March 2018	10.80	-9.75	10.87	-11.58
April 2018	10.94	-8.59	10.99	-10.55
May 2018	11.19	-6.45	11.56	-5.93
June 2018	11.21	-6.30	11.63	-5.38

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	4	122	0.1	0	0
2	1751	52529	48	0	0
3	1383	41503	37.9	0	0
4	20	600	0.5	20	1.2
5	93	2790	2.5	39	2.3
6	25	742	0.7	50	2.9
7	2	55	0.1	9	0.5
8	26	766	0.7	24	1.4
9	296	8883	8.1	1154	68
10	42	1253	1.1	256	15.1
11	2	74	0.1	0	0
12	1	39	0	24	1.4
13	5	150	0.1	121	7.1
TOTAL	**3650**	**109507**	**100**	**1697**	**100**

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

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2018-06-08	Friday	07:38:24	10	SB	2	116.8
2018-06-07	Thursday	11:43:36	10	SB	2	116.18
2018-06-07	Thursday	13:15:35	10	SB	2	113.76
2018-06-07	Thursday	13:26:41	9	SB	2	108.79
2018-06-01	Friday	15:44:03	9	SB	2	107.9
2018-06-06	Wednesday	14:23:01	10	NB	1	107.35
2018-06-16	Saturday	06:25:51	10	NB	1	106.53
2018-06-04	Monday	08:46:35	10	SB	2	106.24
2018-06-27	Wednesday	19:28:11	9	NB	1	102.74
2018-06-01	Friday	08:05:57	10	SB	2	101.15

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	314	34	10.8	8685	435	2243
5	NB	8	1352	109	8.1	18325	807	4190
6	NB	19	339	37	10.9	10331	637	2296
7	NB	11.5	33	0	0	1616	0	618
8	NB	31	347	178	51.3	6473	3855	617
9	NB	33	4385	1488	33.9	163704	40370	34051
10	NB	33.5	649	85	13.1	40890	2508	10998
11	NB	36.5	39	15	38.5	1120	327	122
12	NB	36.5	14	2	14.3	787	47	175
13	NB	31.5	96	0	0	9310	0	3143
TOTAL	****	****	**7568**	**1948**	****	**261240**	****	**58453**
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	281	39	13.9	6778	505	1574
5	SB	8	1414	114	8.1	19182	853	4391
6	SB	19	397	76	19.1	9982	1303	1942
7	SB	11.5	22	0	0	890	0	318
8	SB	31	413	234	56.7	6767	5295	609
9	SB	33	4423	964	21.8	212606	27329	49230
10	SB	33.5	593	248	41.8	21763	7351	5103
11	SB	36.5	34	17	50	868	355	124
12	SB	36.5	25	1	4	2002	17	563
13	SB	31.5	53	0	0	5068	0	1699
TOTAL	****	****	**7655**	**1693**	****	**285905**	****	**65552**
GRAND TOTAL	****	****	**15223**	**3641**	**396**	**547146**	**91993**	**124005**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*NB*	*SB*	*Total*	*Percentage*
1	115	57	172	0
2	108026	106618	214644	19
3	140825	137658	278483	24.6
4	9121	7283	16403	1.4
5	19131	20035	39166	3.5
6	10968	11285	22253	2
7	1616	890	2506	0.2
8	10328	12062	22391	2
9	204073	239935	444008	39.2
10	43398	29114	72512	6.4
11	1447	1223	2669	0.2
12	834	2019	2853	0.3
13	9310	5068	14378	1.3
TOTAL	**559192**	**573246**	**1132438**	**100**
GVW/LANE	**49.38**	**50.62**	**100**	**0.01**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*NB*	*SB*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0.0082
2	14	14	28	0.2	0.0011
3	63	58	121	1.1	0.006
4	161	105	266	2.4	0.9
5	228	222	450	4	0.33
6	223	185	408	3.7	1.11
7	34	43	78	0.7	2.62
8	137	136	273	2.4	0.72
9	3127	4794	7921	71	1.81
10	713	438	1151	10.3	1.85
11	14	12	27	0.2	0.77
12	15	60	75	0.7	3.18
13	236	118	354	3.2	4.47
TOTAL	**4965**	**6185**	**11151**	**100**	**18**
ESALS/LANE	**44.5**	**55.5**	**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 %*
Jul 2017	112064	3615	503	96468	86.1	15596.4	13.9
Aug 2017	116450	3756	564	98963	85	17487.3	15
Sep 2017	111812	3727	661	91971	82.3	19840.6	17.7
Oct 2017	108353	3495	533	91844	84.8	16509.1	15.2
Nov 2017	98568	3286	494	83733	84.9	14834.6	15.1
Dec 2017	91321	2946	385	79385	86.9	11936.2	13.1
Jan 2018	84152	2715	413	71364	84.8	12787.5	15.2
Feb 2018	77105	2754	435	64926	84.2	12178.7	15.8
Mar 2018	95909	3094	558	78620	82	17289.4	18
Apr 2018	89350	2978	453	75774	84.8	13576.4	15.2
May 2018	108754	3508	506	93068	85.6	15686.4	14.4
Jun 2018	109507	3650	512	94154	86	15353	14
TOTAL	**1203345**	**--**	**--**	**1020270**	**--**	**183076**	**--**
AVERAGE	**100279**	**3294**	**501**	**85022**	**85**	**15256**	**15**

ESALs

Month	*ESALS NB Driving Lane*	*ESALS SB Driving Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Jul 2017	6373	6484	12857	7.9
Aug 2017	6362	8803	15164	9.2
Sep 2017	5677	12779	18455	6.5
Oct 2017	4963	7456	12418	6
Nov 2017	3611	7436	11047	2.9
Dec 2017	3215	4055	7270	0.5
Jan 2018	3494	4778	8272	7.6
Feb 2018	3112	5050	8161	10.4
Mar 2018	3482	11316	14797	11.2
Apr 2018	3398	6249	9647	12.1
May 2018	4723	6847	11571	12.2
Jun 2018	4981	6868	11848	6.4
TOTAL	**53390**	**--**	**--**	**--**
AVERAGE	**4449**	**7343**	**11792**	**8**

Gross Vehicle Weight

Month	*GVW NB Driving Lane*	*GVW SB Driving Lane*	*Total GVW Kips*
Jul 2017	410686	456795	867481
Aug 2017	380931	430105	811036
Sep 2017	433134	867894	1301027
Oct 2017	422404	531030	953434
Nov 2017	542896	581854	1124749
Dec 2017	559697	574474	1134172
Jan 2018	593697	609564	1203261
Feb 2018	613330	711571	1324900
Mar 2018	611951	868853	1480804
Apr 2018	554209	621491	1175700
May 2018	472927	566640	1039567
Jun 2018	417109	450095	867205
TOTAL	**6012970**	**7270366**	**13283336**
AVERAGE	**501081**	**605864**	**1106945**

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*
Jul 2017	2235	2	14.3	399	115
Aug 2017	2972	2.6	16.9	1101	642
Sep 2017	4799	4.3	24.1	3027	2439
Oct 2017	1944	1.8	11.7	357	136
Nov 2017	1341	1.4	9	196	52
Dec 2017	773	0.8	6.5	148	22
Jan 2018	1134	1.4	8.9	227	30
Feb 2018	1021	1.3	8.4	241	22
Mar 2018	5264	5.5	30.5	3187	77
Apr 2018	1526	1.7	11.3	426	43
May 2018	1598	1.5	10.2	263	65
Jun 2018	1723	1.6	11.3	233	51
TOTAL	**26330**	**--**	**--**	**9805**	**3694**
AVERAGE	**2194.2**	**2.2**	**13.6**	**817.1**	**307.8**

Freight

Month	*NB Freight Tons*	*SB Freight Tons*	*Total Freight*	*NB Freight %*	*SB Freight %*
Jul 2017	69479	67954	137433	50.6	49.4
Aug 2017	72589	98882	171472	42.3	57.7
Sep 2017	63832	164954	228787	27.9	72.1
Oct 2017	60584	79341	139925	43.3	56.7
Nov 2017	43921	72755	116676	37.6	62.4
Dec 2017	39190	50579	89769	43.7	56.3
Jan 2018	42006	57239	99245	42.3	57.7
Feb 2018	36931	56998	93928	39.3	60.7
Mar 2018	42014	184856	226871	18.5	81.5
Apr 2018	39020	76169	115188	33.9	66.1
May 2018	54882	70343	125225	43.8	56.2
Jun 2018	58453	65552	124005	47.1	52.9
TOTAL	**622902**	**1045623**	**1668524**	**--**	**--**
AVERAGE	**51908.5**	**87135.2**	**139043.7**	**39.2**	**60.8**