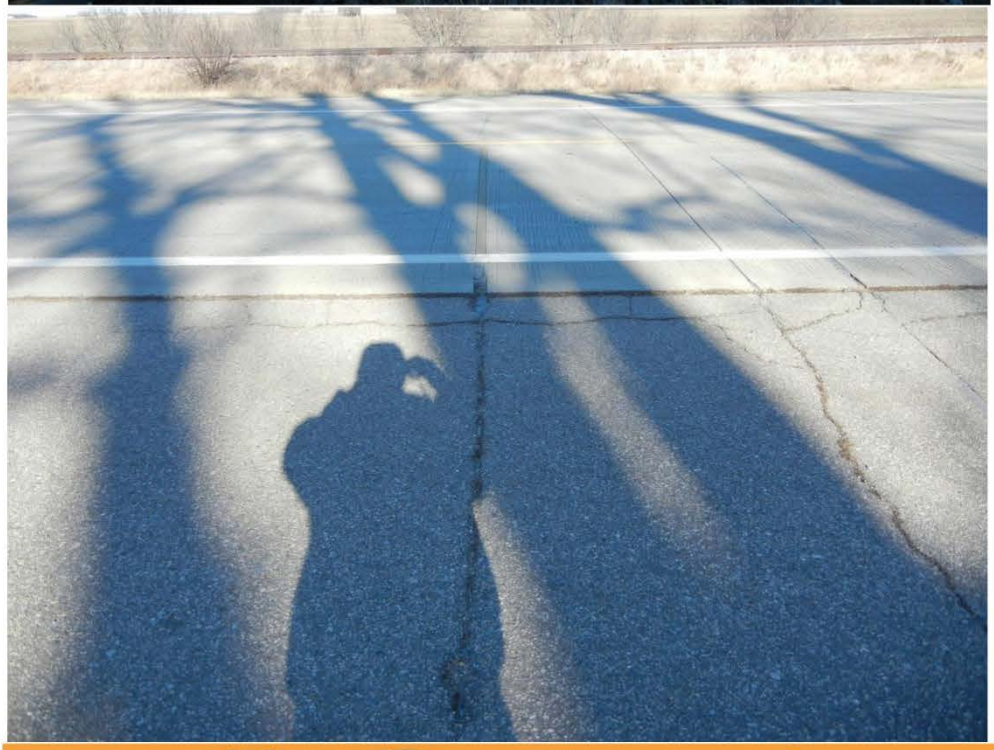
MAY 2018



WIM #33
US 212, MP 78.5
OLIVIA, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #33 is located on US 212 near Olivia in Renville county.

System Operation

WIM #33 was operational for the entire month of May 2018. Volume was computed using all monthly data.

System Calibration

WIM #33 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: 166568 | Passenger Vehicles: 142675 | Heavy Commercial Vehicles: 23893

Monthly Average Daily Traffic (MADT): 5373 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 771

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. EB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Saturdays. WB 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), EB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, WB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 03 PM and 05 PM, while volume going WB 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 23893 HCVs, 1516 of them were overweight [3]. These overweight HCVs contributed to 0.9% of total monthly volume, and 6.4% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Wednesdays, 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 62.6% of all overweight vehicles traveling EB 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 report [4].
Using normal load limits ,177 EB vehicles exceeded 88,000 pounds (147 vehicles were Class 13's; 17 vehicles were Class 10's). Of vehicles traveling WB,

58 EB vehicles exceeded 88,000 pounds (47 vehicles were Class 13's; 8 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from May 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in May 2018. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling EB, while there were more fully_loaded Class 9's than empty traveling WB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the EB direction. In the WB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 211732 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (50.8%) than WB (49.2%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 6299 (a box culvert) is approximately 13.4 miles east of WIM #33, and Bridge No. 96640 (a box culvert) is 2.5 miles west of WIM #33. WIM #33 recorded a total of 166568 vehicles with a combined GVW of 1727214 kips (1 kip = 1,000 pounds = 0.5 tons) in May 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 17499 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 52.1% of all ESALs were recorded EB while 47.9% was observed WB. In particular, 78% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 46% 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

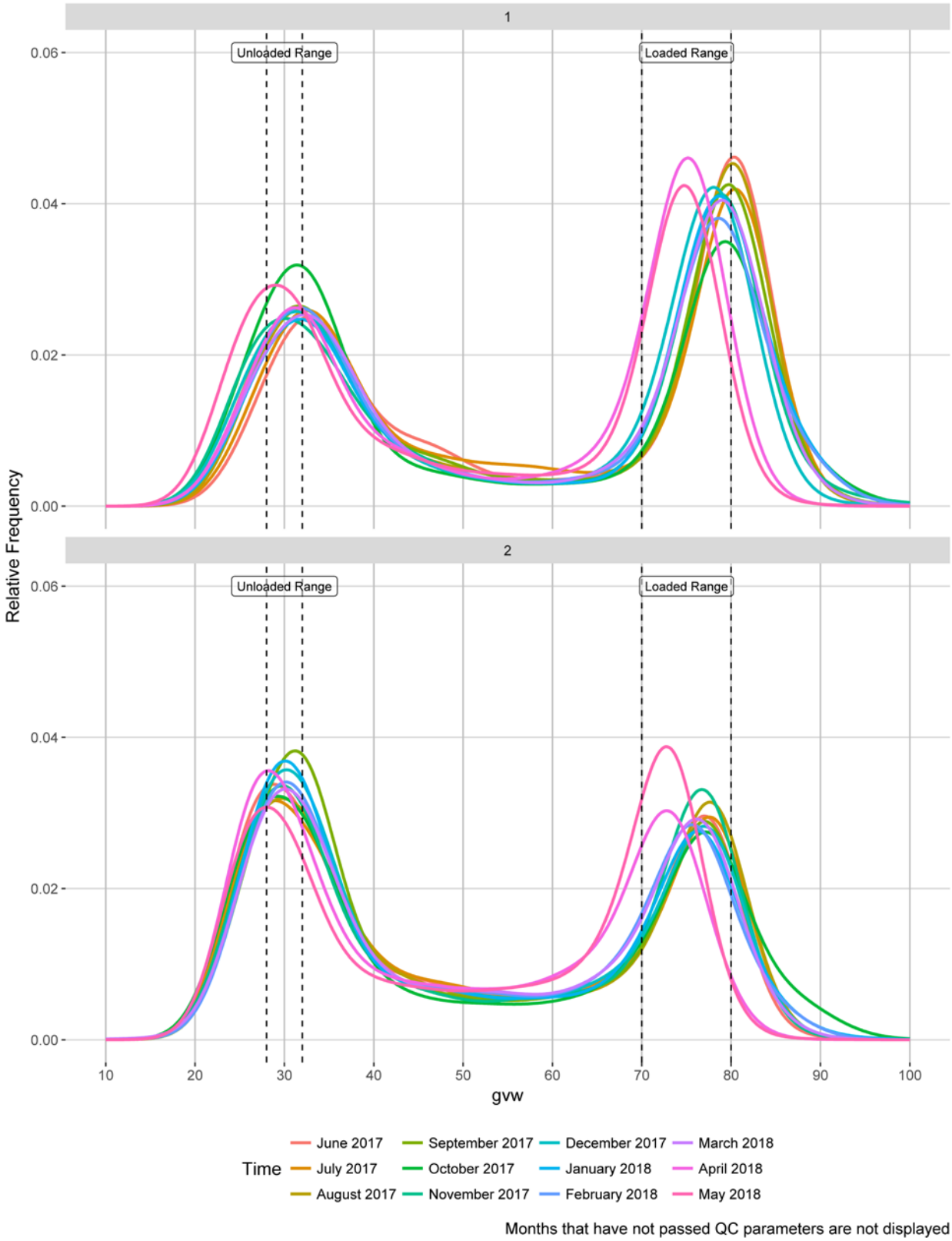
- [2] Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of 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.

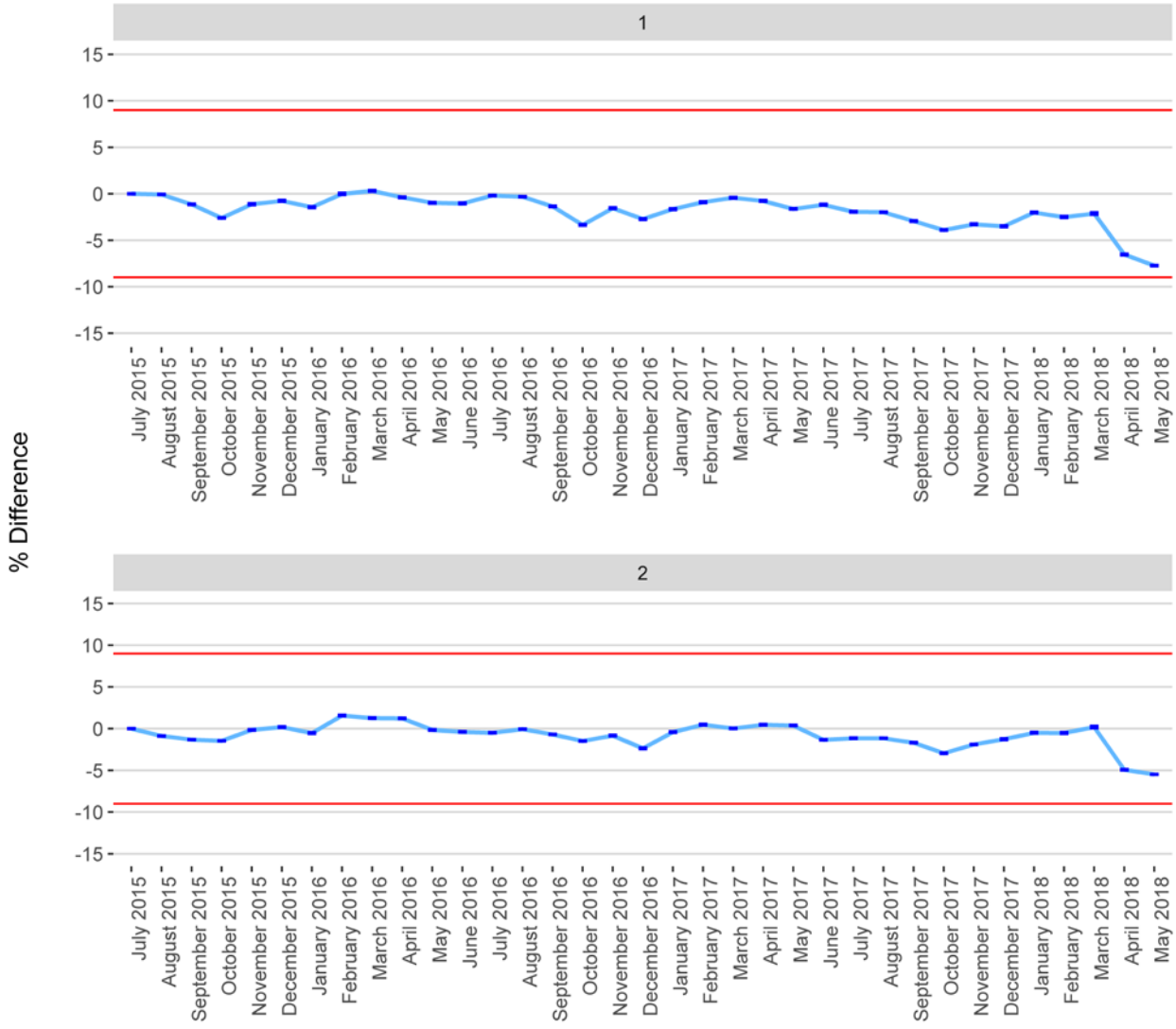
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

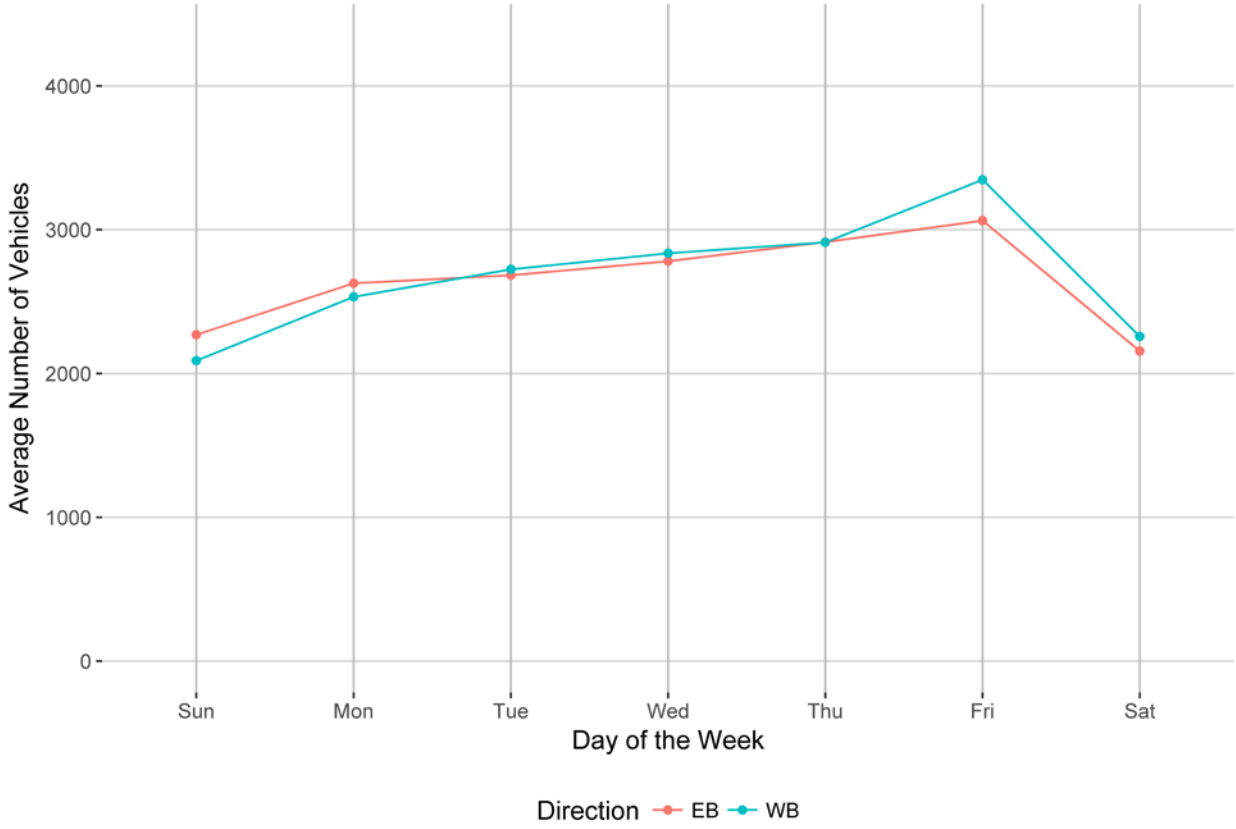


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

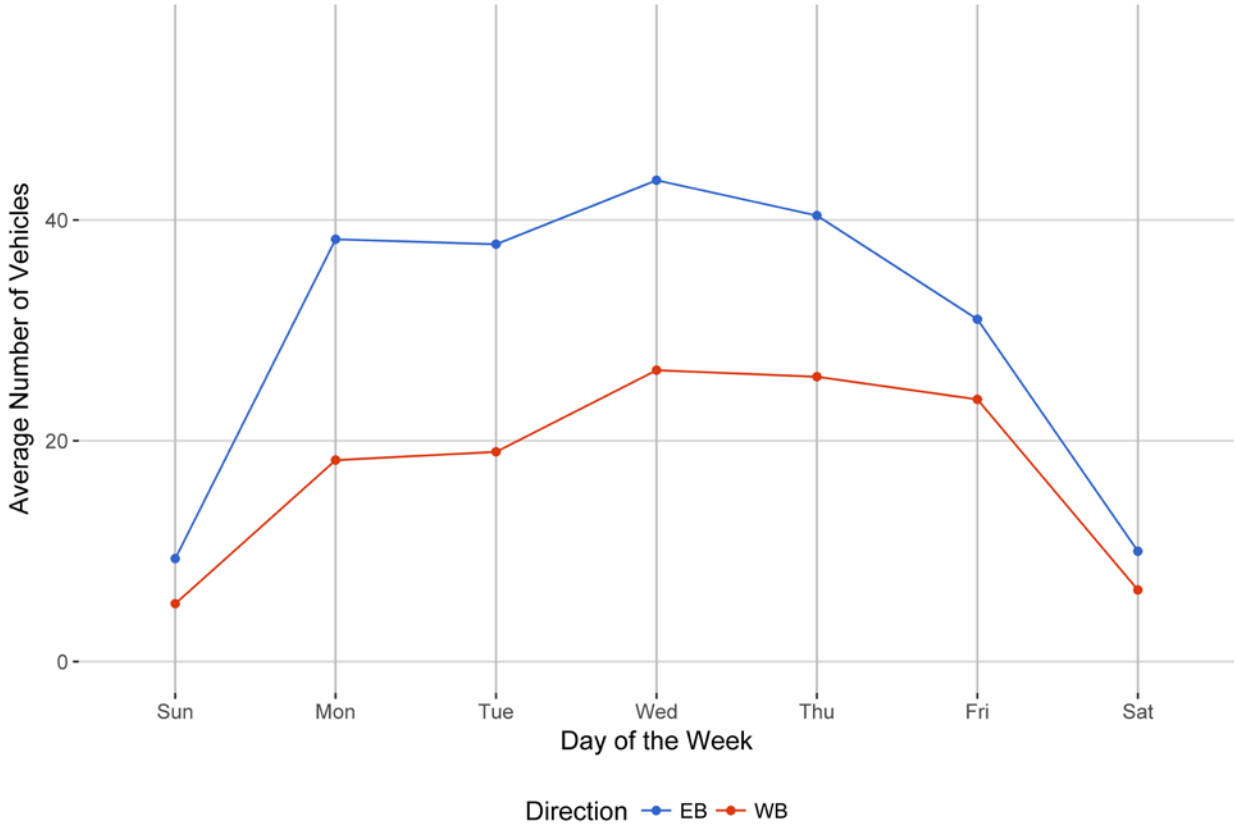


Figure 4 - Passenger Vehicles vs. Hour of the Day

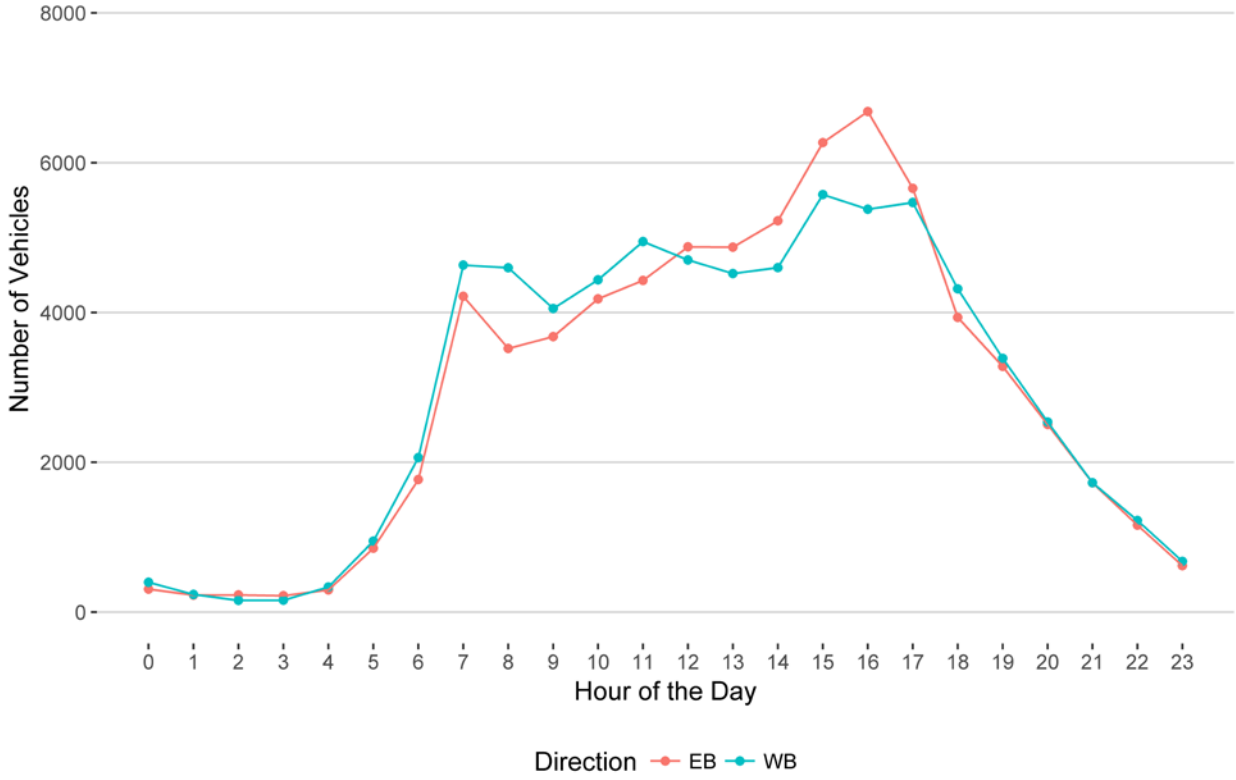


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

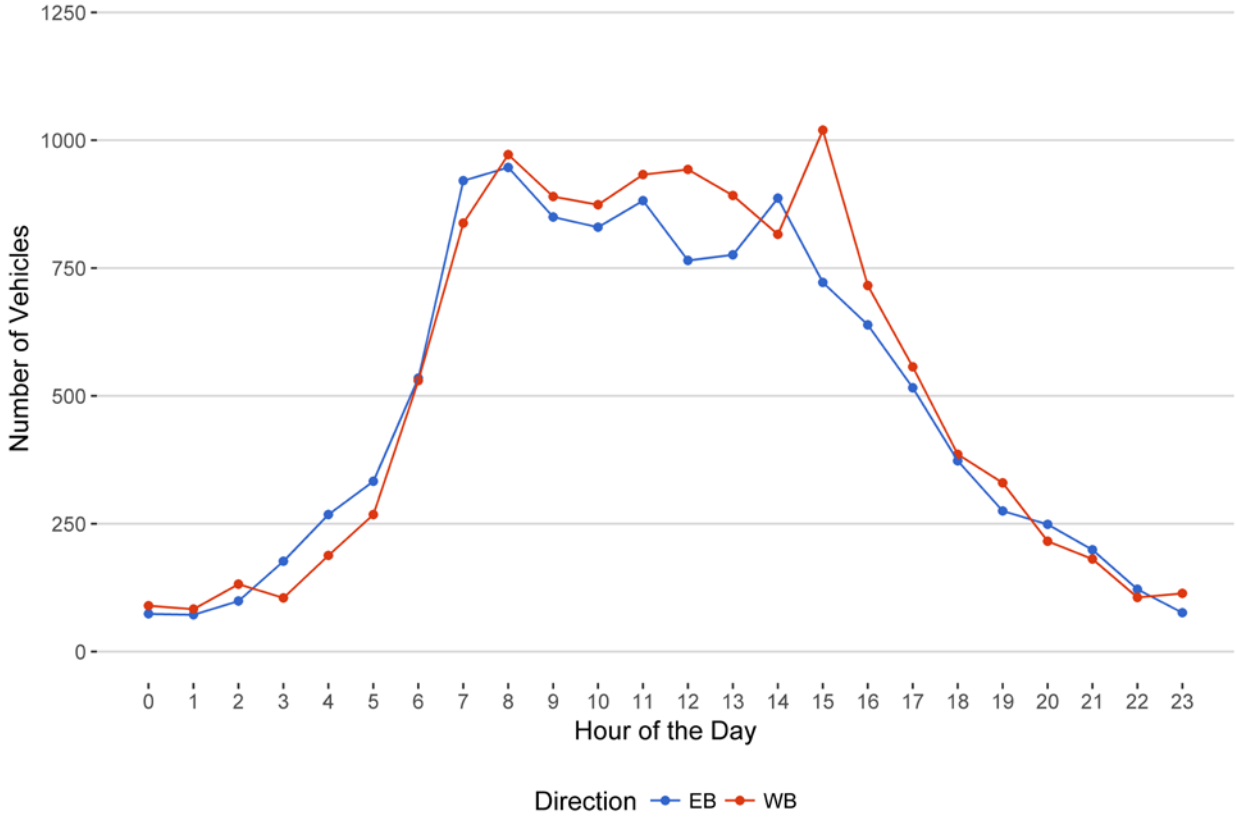


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

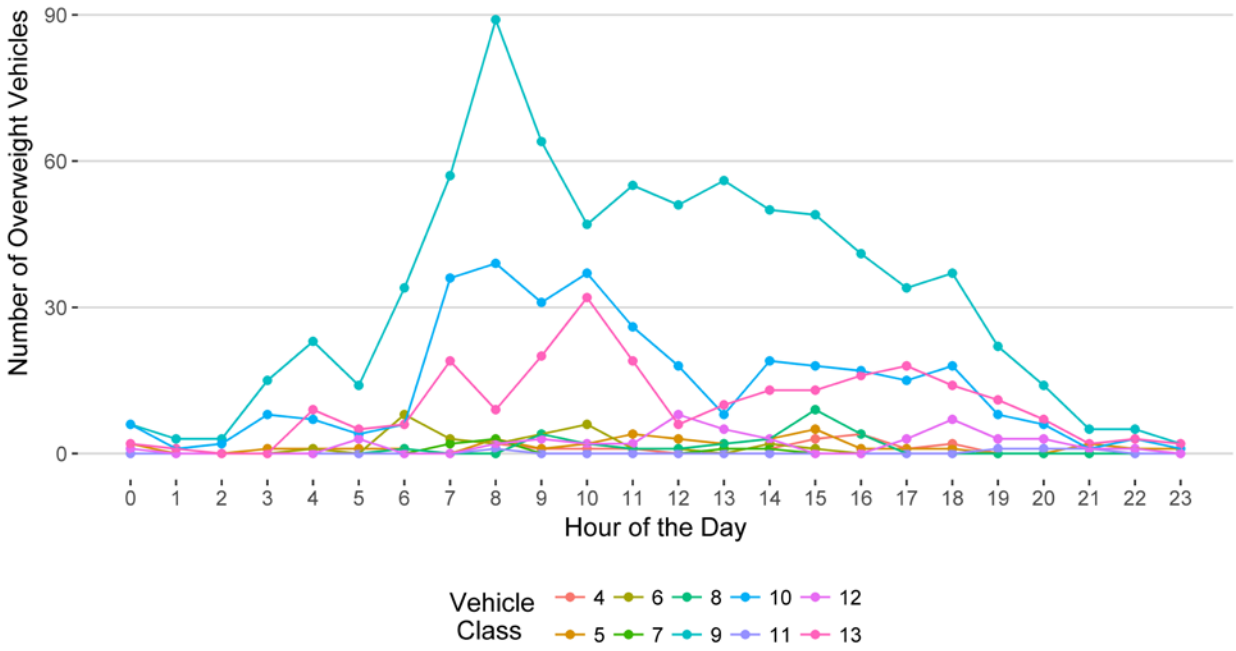
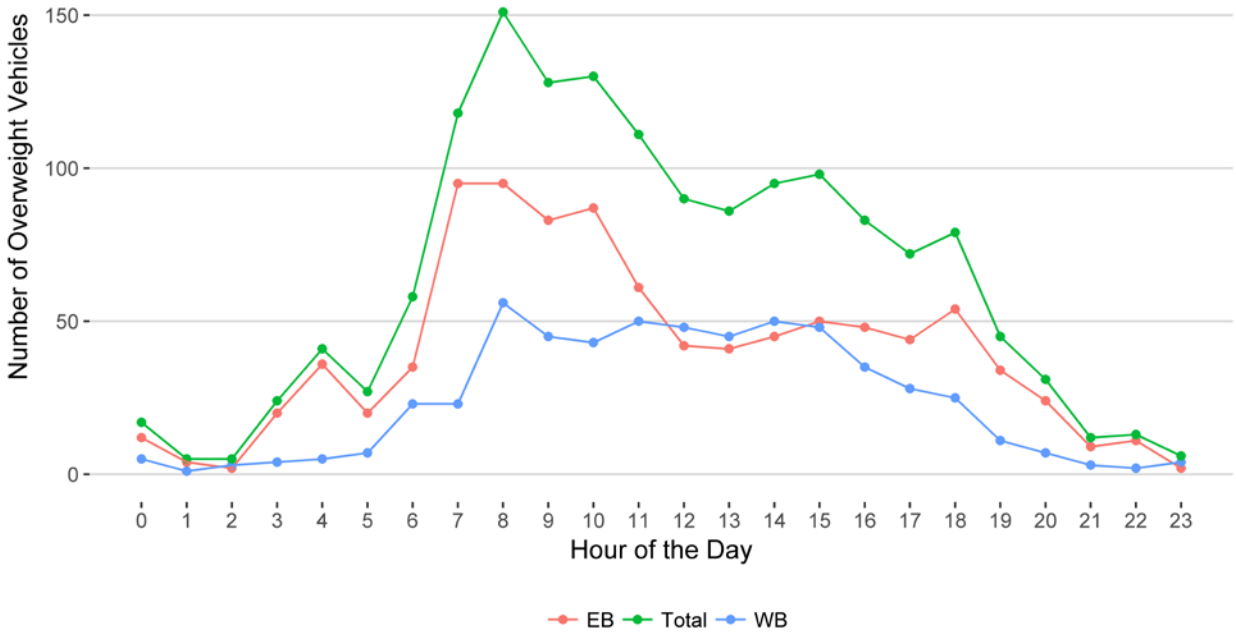
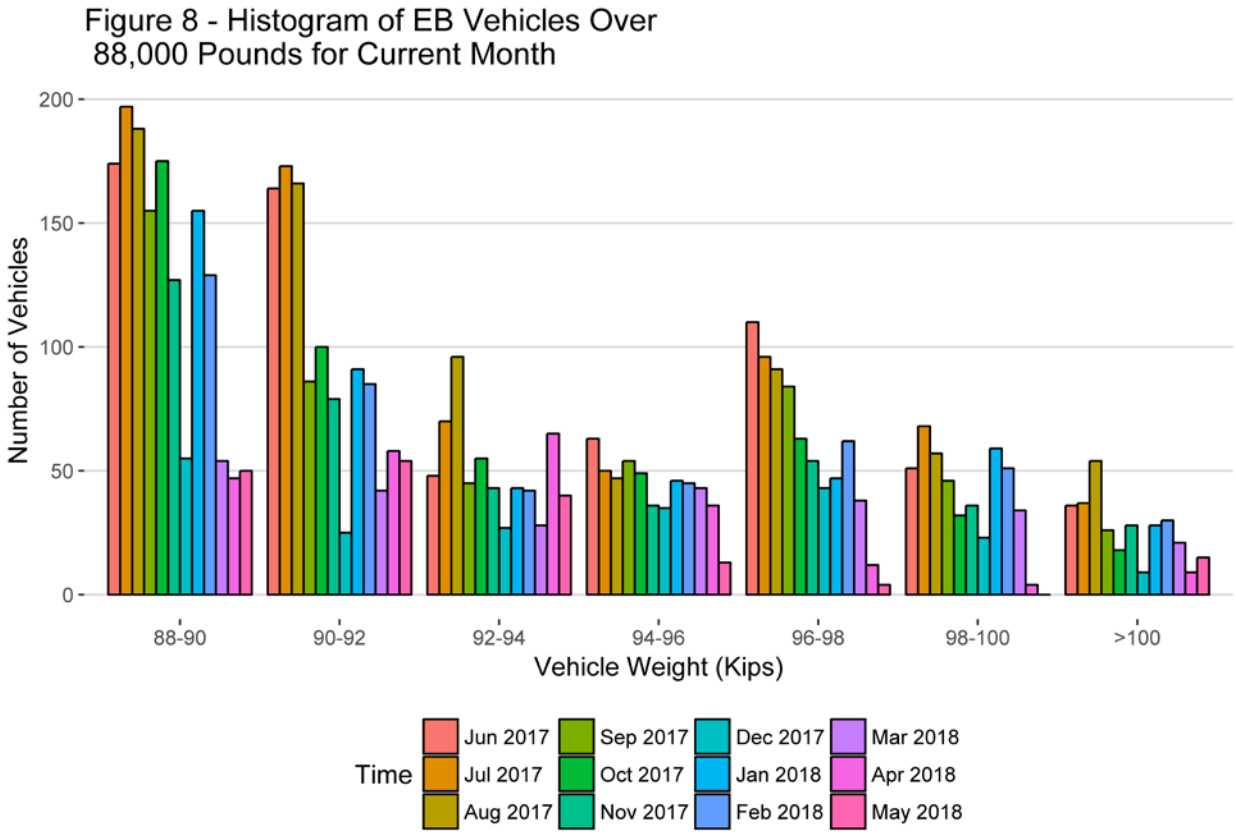
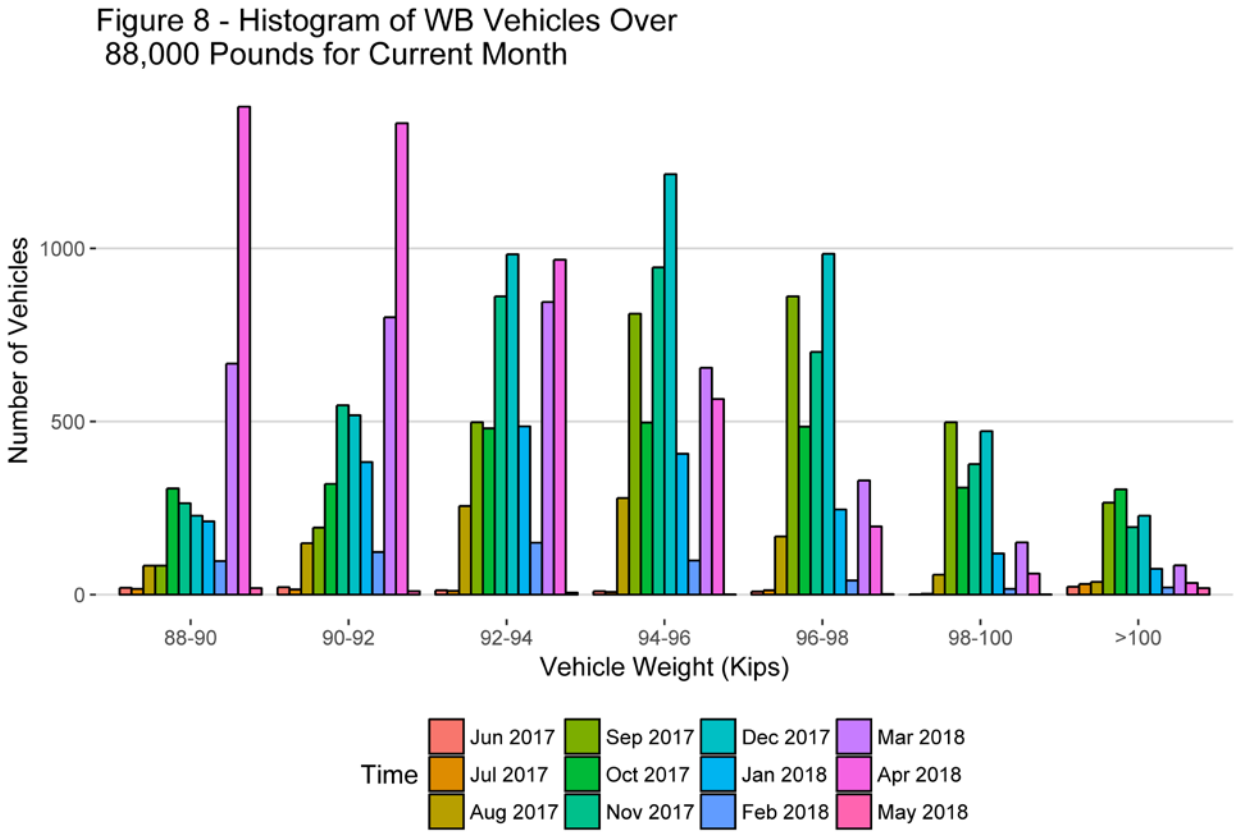


Figure 7 - Overweight Vehicles by Direction
Hour of the Day





Vehicle Weights (Kips)	*Jun 2017*	*Jul 2017*	*Aug 2017*	*Sep 2017*	*Oct 2017*	*Nov 2017*	*Dec 2017*	*Jan 2018*	*Feb 2018*	*Mar 2018*	*Apr 2018*	*May 2018*
88-90	174	197	188	155	175	127	55	155	129	54	47	50
90-92	164	173	166	86	100	79	25	91	85	42	58	54
92-94	48	70	96	45	55	43	27	43	42	28	65	40
94-96	63	50	47	54	49	36	35	46	45	43	36	13
96-98	110	96	91	84	63	54	43	47	62	38	12	4
98-100	51	68	57	46	32	36	23	59	51	34	4	0
>100	36	37	54	26	18	28	9	28	30	21	9	15
Total	646	691	699	496	492	403	217	469	444	260	231	176



Vehicle Weights (Kips)	*Jun 2017*	*Jul 2017*	*Aug 2017*	*Sep 2017*	*Oct 2017*	*Nov 2017*	*Dec 2017*	*Jan 2018*	*Feb 2018*	*Mar 2018*	*Apr 2018*	*May 2018*
88-90	20	17	84	84	307	264	228	212	97	667	1409	19
90-92	22	15	149	194	320	547	518	383	123	801	1361	10
92-94	13	11	256	498	480	861	983	486	150	845	967	6
94-96	10	8	279	811	497	945	1214	407	99	655	565	1
96-98	9	13	168	861	485	701	984	246	41	330	197	2
98-100	1	3	58	498	309	377	472	119	17	151	61	1
>100	23	31	37	266	304	195	228	75	21	85	34	19
Total	98	98	1031	3212	2702	3890	4627	1928	548	3534	4594	58

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

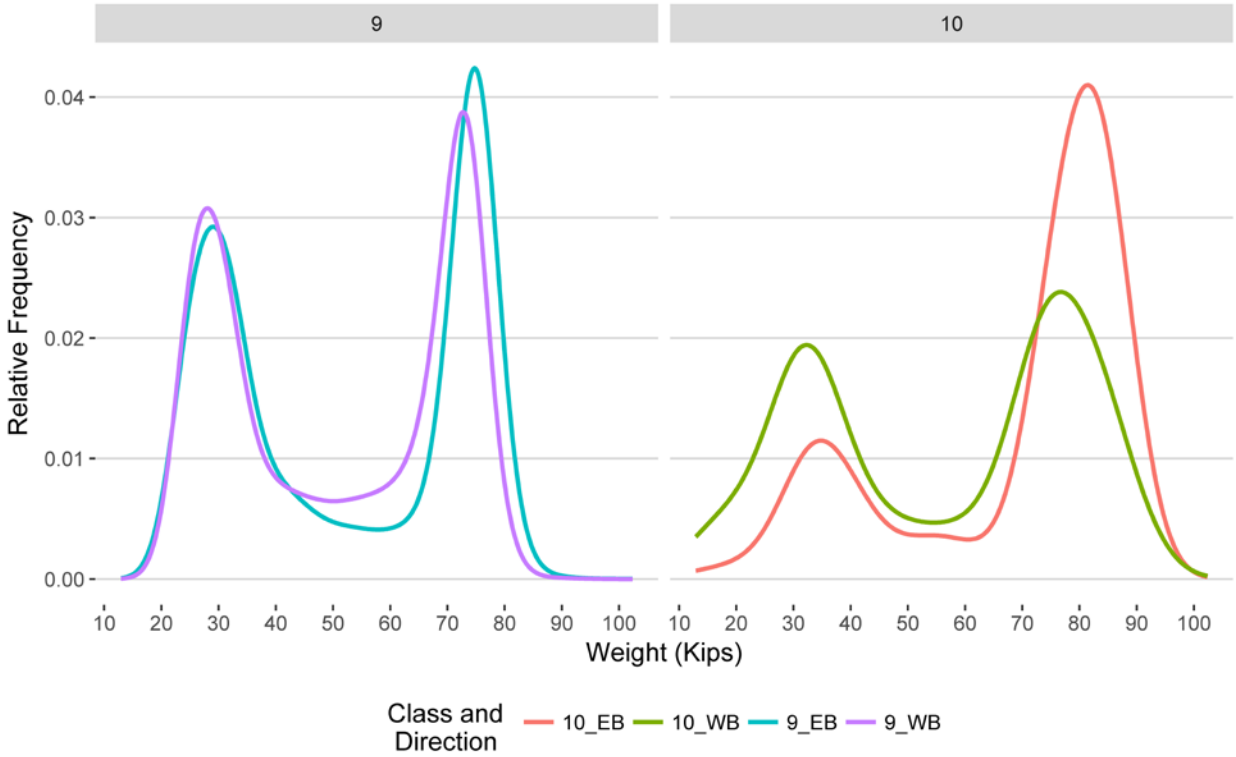


Figure 9 - Freight Percentage by Direction and Class

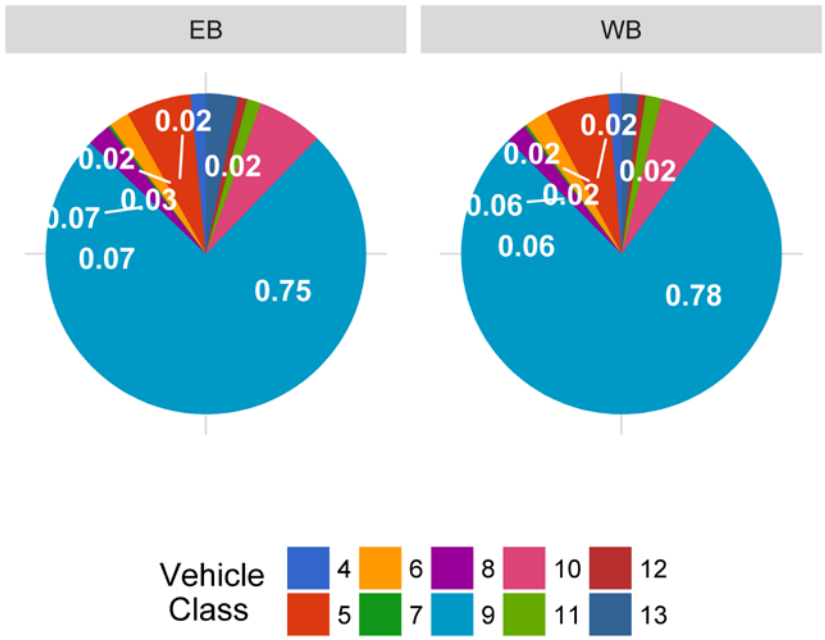


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

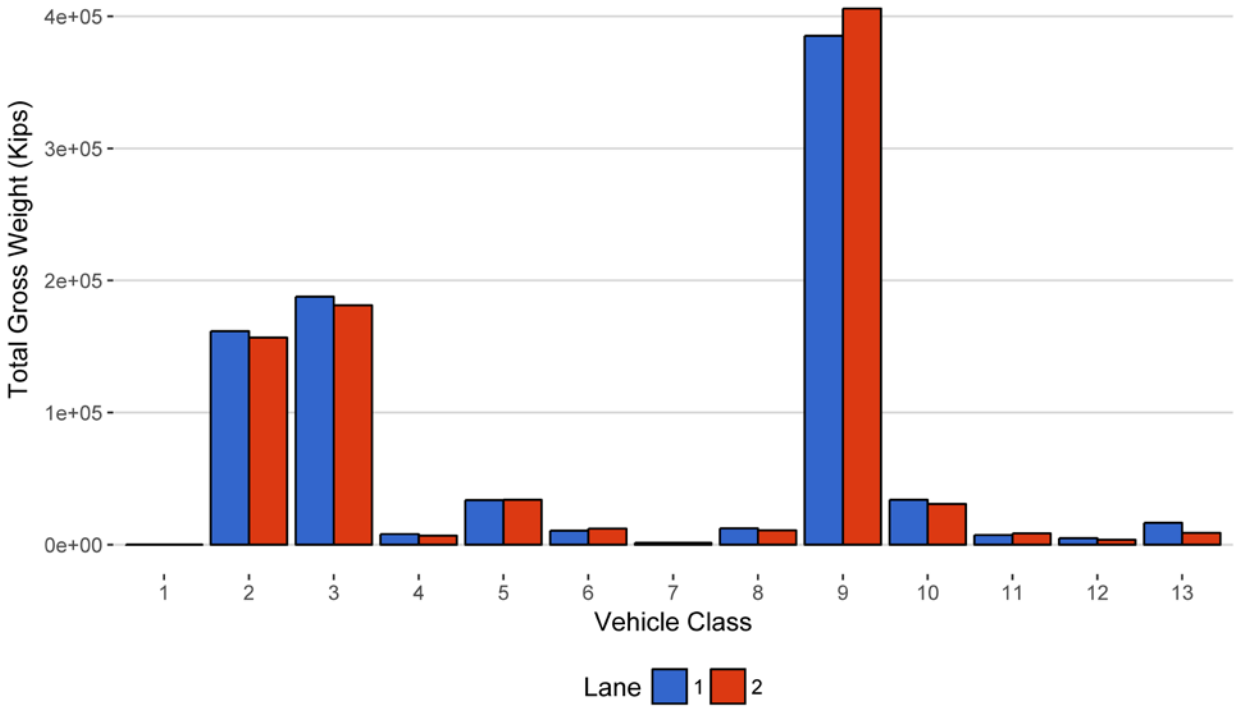


Figure 11 - Total Gross Vehicle Weight I

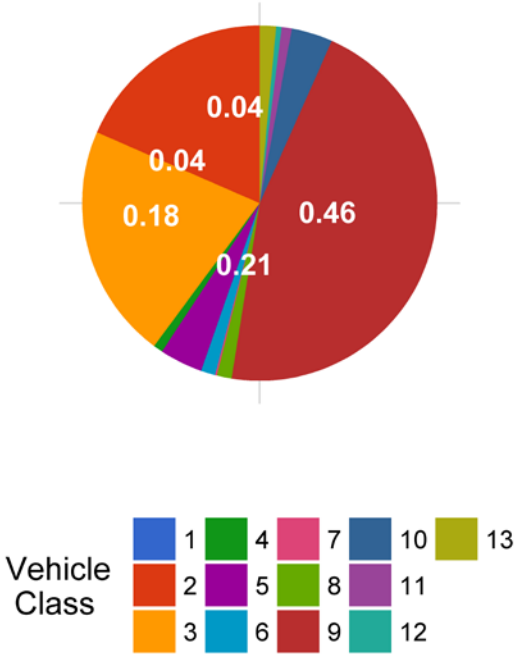


Figure 12 - Total ESALs by Class and Lane

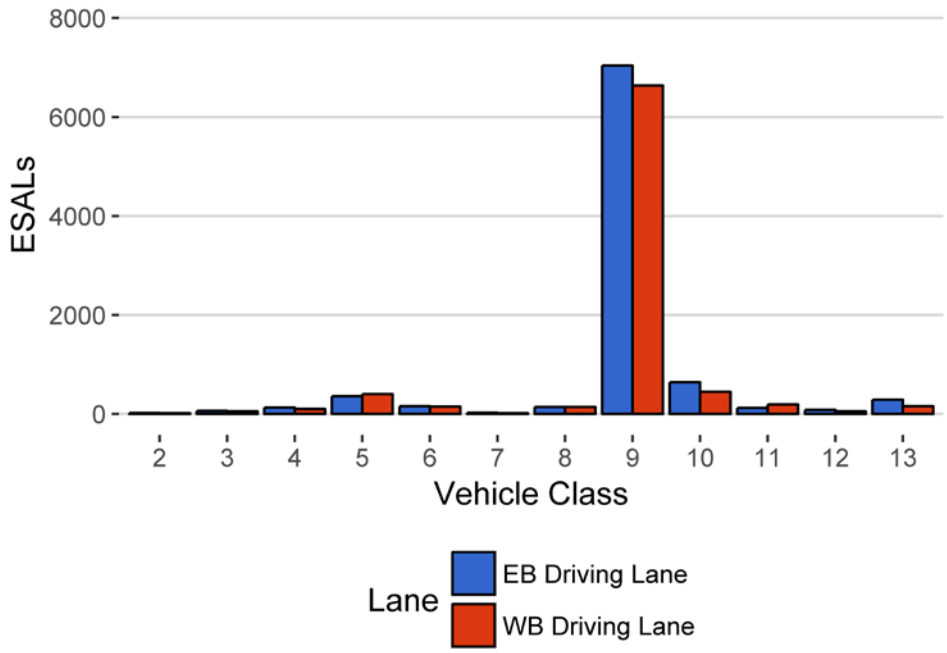


Figure 13 - ESALs by Class

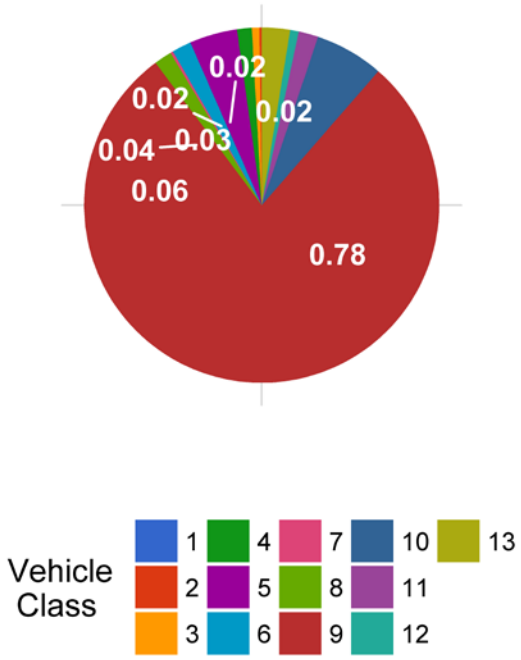


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
July 2015	11.76	0.00	10.98	0.00
August 2015	11.75	-0.07	10.89	-0.88
September 2015	11.62	-1.13	10.84	-1.31
October 2015	11.45	-2.60	10.82	-1.46
November 2015	11.63	-1.12	10.97	-0.15
December 2015	11.67	-0.76	11.00	0.20
January 2016	11.59	-1.44	10.92	-0.53
February 2016	11.76	-0.01	11.16	1.58
March 2016	11.79	0.31	11.12	1.28
April 2016	11.71	-0.37	11.12	1.23
May 2016	11.64	-0.97	10.97	-0.15
June 2016	11.64	-1.04	10.94	-0.39
July 2016	11.74	-0.19	10.93	-0.49
August 2016	11.72	-0.31	10.98	-0.05
September 2016	11.60	-1.36	10.91	-0.69
October 2016	11.36	-3.35	10.82	-1.48
November 2016	11.58	-1.55	10.89	-0.83
December 2016	11.44	-2.72	10.72	-2.35
January 2017	11.56	-1.65	10.94	-0.41
February 2017	11.65	-0.91	11.03	0.47
March 2017	11.71	-0.43	10.99	0.03
April 2017	11.67	-0.77	11.03	0.46
May 2017	11.57	-1.63	11.02	0.37
June 2017	11.62	-1.18	10.84	-1.33
July 2017	11.53	-1.94	10.86	-1.15
August 2017	11.53	-1.98	10.86	-1.15
September 2017	11.41	-2.94	10.80	-1.68
October 2017	11.30	-3.90	10.66	-2.94
November 2017	11.37	-3.28	10.77	-1.89
December 2017	11.35	-3.49	10.84	-1.26
January 2018	11.52	-2.02	10.93	-0.49
February 2018	11.46	-2.50	10.93	-0.52
March 2018	11.51	-2.12	11.00	0.19
April 2018	10.99	-6.53	10.44	-4.92
May 2018	10.85	-7.73	10.38	-5.48

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	3	80	0	0	0
2	2610	80902	48.6	0	0
3	1990	61693	37	0	0
4	17	513	0.3	18	1.2
5	151	4692	2.8	36	2.4
6	27	830	0.5	29	1.9
7	2	59	0	7	0.5
8	25	789	0.5	27	1.8
9	492	15245	9.2	776	51.2
10	34	1040	0.6	335	22.1
11	10	308	0.2	4	0.3
12	4	125	0.1	47	3.1
13	9	292	0.2	237	15.6
TOTAL	**5373**	**166568**	**100**	**1516**	**100**

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

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2018-05-14	Monday	07:47:27	9	EB	1	102.38
2018-05-11	Friday	08:49:13	9	EB	1	97.74
2018-05-24	Thursday	16:58:35	9	EB	1	96.28
2018-05-27	Sunday	10:17:12	9	WB	2	94.97
2018-05-17	Thursday	06:39:00	9	EB	1	93.76
2018-05-24	Thursday	10:18:55	10	EB	1	92.8
2018-05-21	Monday	10:06:34	10	WB	2	92.38
2018-05-02	Wednesday	08:52:22	10	WB	2	92
2018-05-16	Wednesday	16:33:03	9	WB	2	91.3
2018-05-15	Tuesday	16:59:42	9	EB	1	90.95

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	EB	15	272	37	13.6	7544	466	2010
5	EB	8	2290	276	12.1	31659	2037	7774
6	EB	19	382	86	22.5	9165	1449	1770
7	EB	11.5	27	0	0	1392	0	541
8	EB	31	425	264	62.1	6159	6164	584
9	EB	33	7284	2385	32.7	318736	66538	78534
10	EB	33.5	490	48	9.8	32628	1396	8911
11	EB	36.5	158	48	30.4	5772	1556	879
12	EB	36.5	71	2	2.8	4854	40	1168
13	EB	31.5	188	0	0	16519	0	5299
TOTAL	****	****	**11587**	**3146**	****	**434428**	****	**107468**
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	WB	15	238	40	16.8	6288	517	1659
5	WB	8	2377	379	15.9	31231	2748	7624
6	WB	19	444	91	20.5	10542	1549	1917
7	WB	11.5	32	0	0	1418	0	525
8	WB	31	360	205	56.9	5986	4829	591
9	WB	33	7881	2594	32.9	334017	71918	79773
10	WB	33.5	545	152	27.9	26656	4177	6745
11	WB	36.5	148	7	4.7	8455	151	1654
12	WB	36.5	53	1	1.9	3726	36	914
13	WB	31.5	102	0	0	8937	0	2862
TOTAL	****	****	**12180**	**3469**	****	**437255**	****	**104264**
GRAND TOTAL	****	****	**23767**	**6615**	**364**	**871683**	**165570**	**211732**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*EB*	*WB*	*Total*	*Percentage*
1	49	64	113	0
2	161657	156787	318444	18.5
3	187734	181285	369019	21.4
4	8011	6804	14815	0.9
5	33696	33980	67675	3.9
6	10613	12091	22704	1.3
7	1392	1418	2810	0.2
8	12323	10815	23138	1.3
9	385274	405935	791209	45.9
10	34025	30833	64857	3.8
11	7328	8606	15934	0.9
12	4894	3761	8655	0.5
13	16519	8937	25456	1.5
TOTAL	**863514**	**861314**	**1724828**	**100**
GVW/LANE	**50.06**	**49.94**	**100**	**0.01**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*EB*	*WB*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0.0124
2	19	17	36	0.2	9e-04
3	63	57	120	0.7	0.004
4	130	103	233	1.3	0.92
5	358	401	759	4.3	0.33
6	158	150	308	1.8	0.75
7	25	18	42	0.2	1.4
8	140	141	281	1.6	0.72
9	7039	6636	13675	78.4	1.81
10	643	449	1092	6.3	2.11
11	120	193	313	1.8	2.01
12	82	55	137	0.8	2.1
13	290	158	448	2.6	3.01
TOTAL	**9067**	**8378**	**17444**	**100**	**15**
ESALS/LANE	**52**	**48**	**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 %*
Jun 2017	169392	5646	808	145148	85.7	24243.7	14.3
Jul 2017	175467	5660	756	152027	86.6	23439.6	13.4
Aug 2017	184728	5959	907	156600	84.8	28127.6	15.2
Sep 2017	174582	5819	1022	143917	82.4	30665.3	17.6
Oct 2017	168933	5450	991	138200	81.8	30732.8	18.2
Nov 2017	157271	5242	946	128891	82	28380.1	18
Dec 2017	151645	4892	863	124901	82.4	26744.2	17.6
Jan 2018	134369	4334	714	112230	83.5	22139.3	16.5
Feb 2018	121042	4323	646	102947	85.1	18095.1	14.9
Mar 2018	148999	4806	935	120016	80.5	28983	19.5
Apr 2018	142113	4737	837	117010	82.3	25103.3	17.7
May 2018	166568	5373	771	142675	85.7	23892.8	14.3
TOTAL	**1895109**	**--**	**--**	**1584562**	**--**	**310547**	**--**
AVERAGE	**157926**	**5187**	**850**	**132047**	**84**	**25879**	**16**

ESALs

Month	*ESALS EB Driving Lane*	*ESALS WB Driving Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Jun 2017	14427	8888	23315	12
Jul 2017	13642	9390	23032	15.7
Aug 2017	15767	12453	28221	13.5
Sep 2017	14359	14776	29134	4.4
Oct 2017	13340	16038	29378	10.4
Nov 2017	11998	15611	27609	7.5
Dec 2017	9912	14401	24312	6.4
Jan 2018	11044	10493	21537	13.7
Feb 2018	9442	7840	17282	15.9
Mar 2018	8342	12669	21011	17.3
Apr 2018	8199	14246	22446	3.3
May 2018	9112	8387	17499	1.6
TOTAL	**139583**	**--**	**--**	**--**
AVERAGE	**11632**	**12099**	**23731**	**10**

Gross Vehicle Weight

Month	*GVW EB Driving Lane*	*GVW WB Driving Lane*	*Total GVW Kips*
Jun 2017	793221	873170	1666391
Jul 2017	682600	690756	1373356
Aug 2017	711950	939405	1651356
Sep 2017	727732	1226632	1954364
Oct 2017	865371	861844	1727214
Nov 2017	1004884	871882	1876766
Dec 2017	1000624	888551	1889175
Jan 2018	1106394	1067194	2173587
Feb 2018	1071249	1199149	2270398
Mar 2018	1012456	1200320	2212776
Apr 2018	927055	1192270	2119325
May 2018	890224	1132994	2023218
TOTAL	**10793759**	**12144167**	**22937926**
AVERAGE	**899480**	**1012014**	**1911494**

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*
Jun 2017	5047	3	20.9	746	113
Jul 2017	5248	3	22.5	792	142
Aug 2017	6914	3.8	24.7	1731	207
Sep 2017	8234	4.7	26.9	3710	837
Oct 2017	7755	4.6	25.3	3194	663
Nov 2017	8139	5.2	28.8	4294	637
Dec 2017	7745	5.2	29.1	4844	732
Jan 2018	5586	4.2	25.4	2397	281
Feb 2018	3644	3	20.2	992	119
Mar 2018	6820	6	30.5	3794	291
Apr 2018	7653	5.5	30.7	4826	109
May 2018	1525	0.9	6.4	235	36
TOTAL	**74310**	**--**	**--**	**31555**	**4167**
AVERAGE	**6192.5**	**4.1**	**24.3**	**2629.6**	**347.2**

Freight

Month	*EB Freight Tons*	*WB Freight Tons*	*Total Freight*	*EB Freight %*	*WB Freight %*
Jun 2017	149152	96741	245893	60.7	39.3
Jul 2017	140199	101769	241969	57.9	42.1
Aug 2017	161829	146070	307899	52.6	47.4
Sep 2017	147260	204769	352029	41.8	58.2
Oct 2017	130713	210740	341452	38.3	61.7
Nov 2017	120349	225464	345812	34.8	65.2
Dec 2017	100081	223681	323763	30.9	69.1
Jan 2018	111522	140745	252267	44.2	55.8
Feb 2018	94761	92652	187413	50.6	49.4
Mar 2018	82554	190642	273196	30.2	69.8
Apr 2018	96393	254998	351391	27.4	72.6
May 2018	107468	104264	211732	50.8	49.2
TOTAL	**1442280**	**1992534**	**3434814**	**--**	**--**
AVERAGE	**120190**	**166044.5**	**286234.5**	**43.3**	**56.7**