MAY 2019

WIM #49
I-90,
MP 42.6
WORTHINGTON, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #49 is located on I-90 near Worthington in Nobles county.

System Operation

WIM #49 was operational for the entire month of May 2019. Volume was computed using all monthly data.

System Calibration

WIM #49 was most recently calibrated on 2019-01-24. 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: 360874 | Passenger Vehicles: 303630 | Heavy Commercial Vehicles: 57244

Monthly Average Daily Traffic (MADT): 11568 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 1847

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 Wednesdays. WB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Wednesdays (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 02 PM and 04 PM. Similarly, WB PVs peaked in volume between 02 PM and 04 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 02 PM and 04 PM, while volume going WB 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 57244 HCVs, 1030 of them were overweight [3]. These overweight HCVs contributed to 0.3% of total monthly volume, and 1.9% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Thursdays, with lowest volumes reported on Saturdays. See Figure 3 .
The top two overweight violators by class were the class 9 and class 13 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 79.8% 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 November.
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 ,345 EB vehicles exceeded 88,000 pounds (317 vehicles were Class 9's; 18 vehicles were Class 10's). Of vehicles traveling WB,

29 EB vehicles exceeded 88,000 pounds (24 vehicles were Class 13's; 3 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from May 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in May 2019. Data suggests that there were greater numbers of empty Class 9's than fully_loaded Class 9's traveling EB, while there were more empty Class 9's than fully_loaded 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 empty class 10 vehicles.

Freight Totals. A total of 410564 tons of freight was recorded to have crossed the WIM. More freight was shipped WB (51.5%) than EB (48.5%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 53815 and 53816 (Prestressted Beam Span) are approximately .18 miles east of WIM #49. Bridge No. 53813 and 53814 (Prestressted Beam Span) are approximately .43 miles west of WIM #49. WIM #49 recorded a total of 360874 vehicles with a combined GVW of 3649951 kips (1 kip = 1,000 pounds = 0.5 tons) in May 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 29025 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 52.4% of all ESALs were recorded EB while 47.6% was observed WB. In particular, 86% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 55% 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

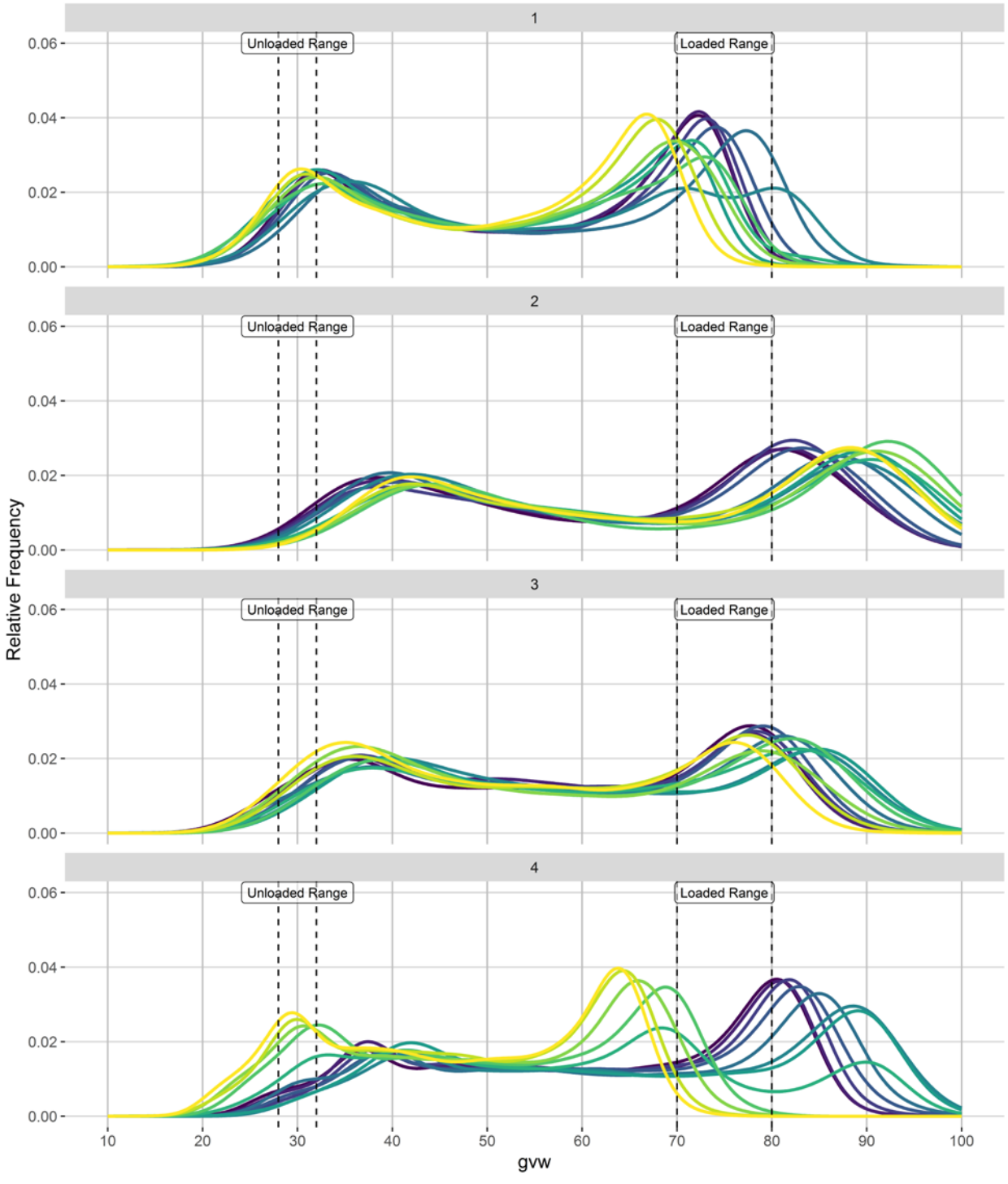
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [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

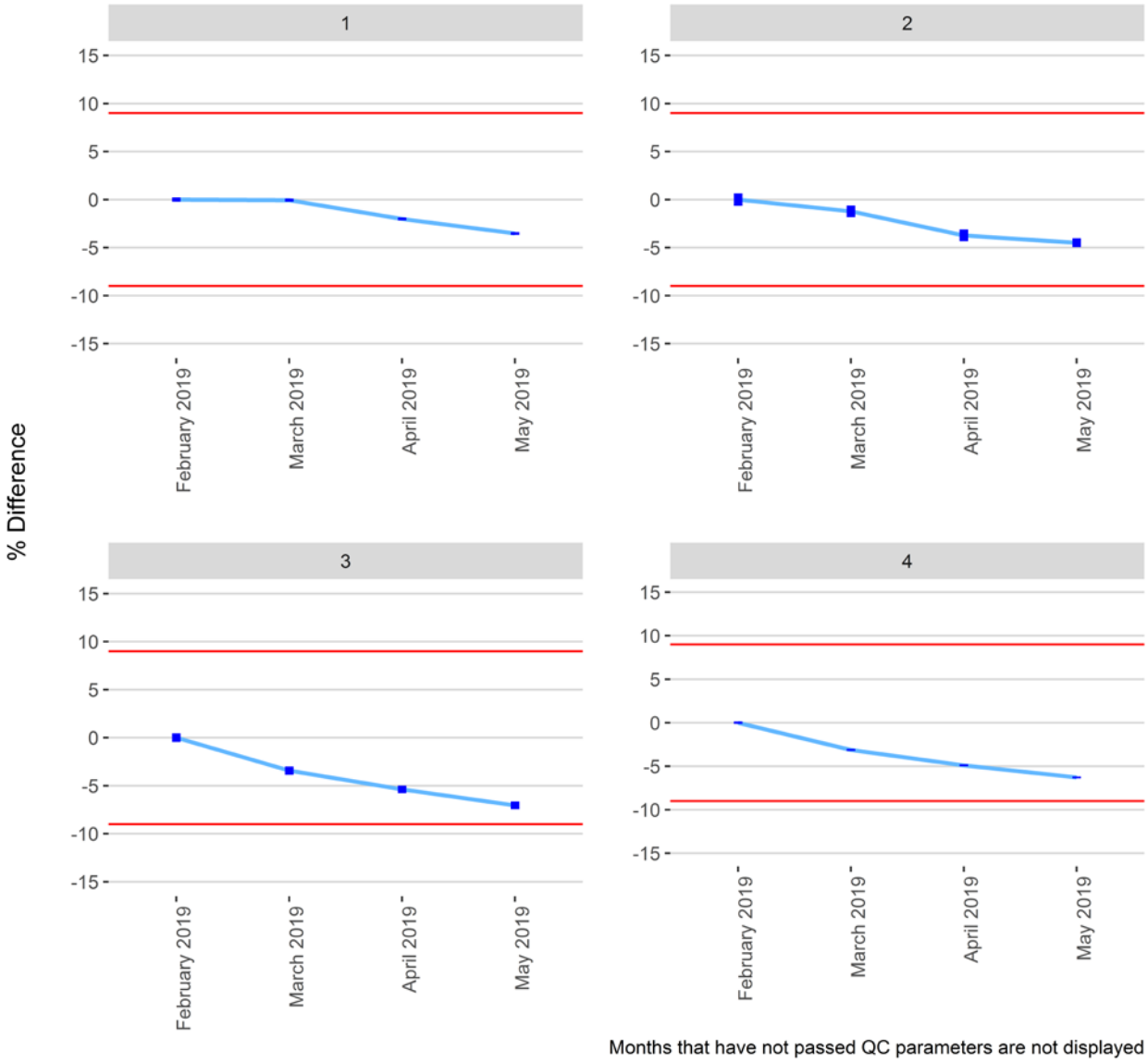
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened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

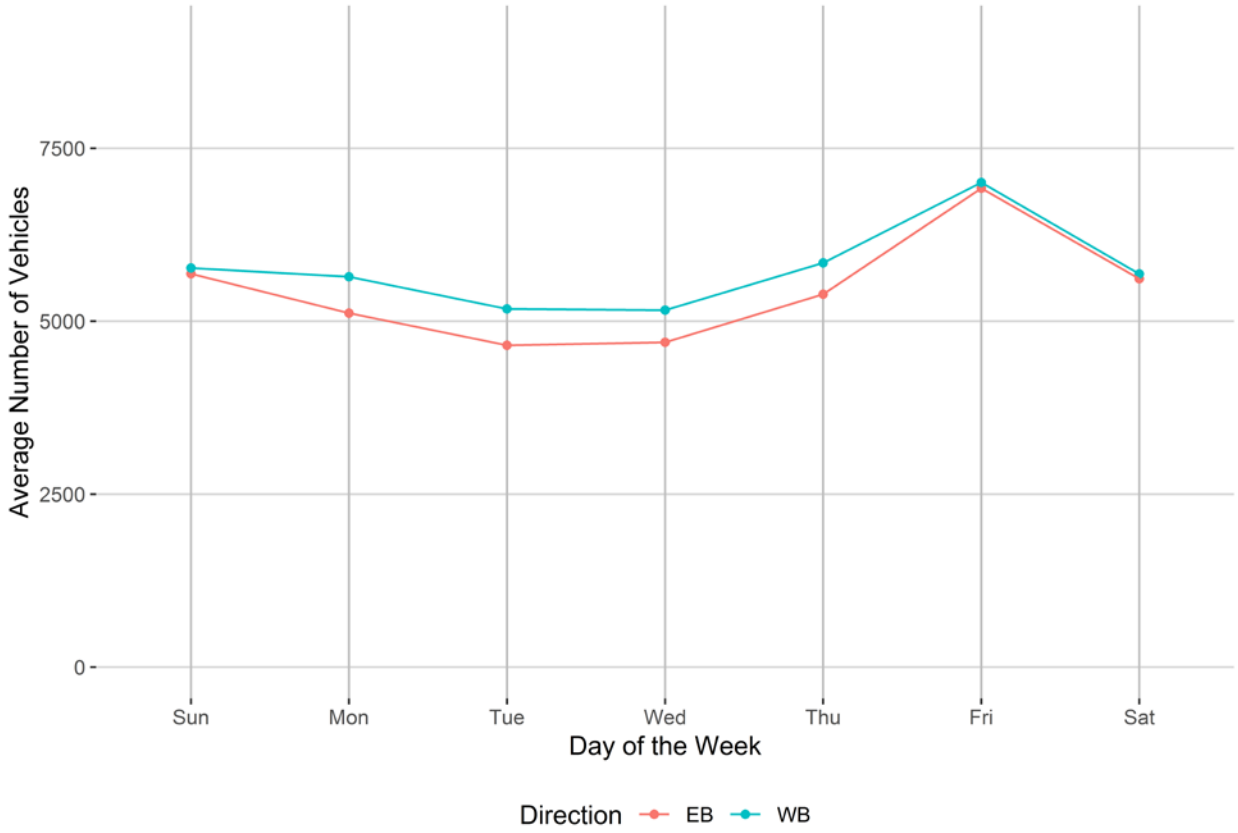


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

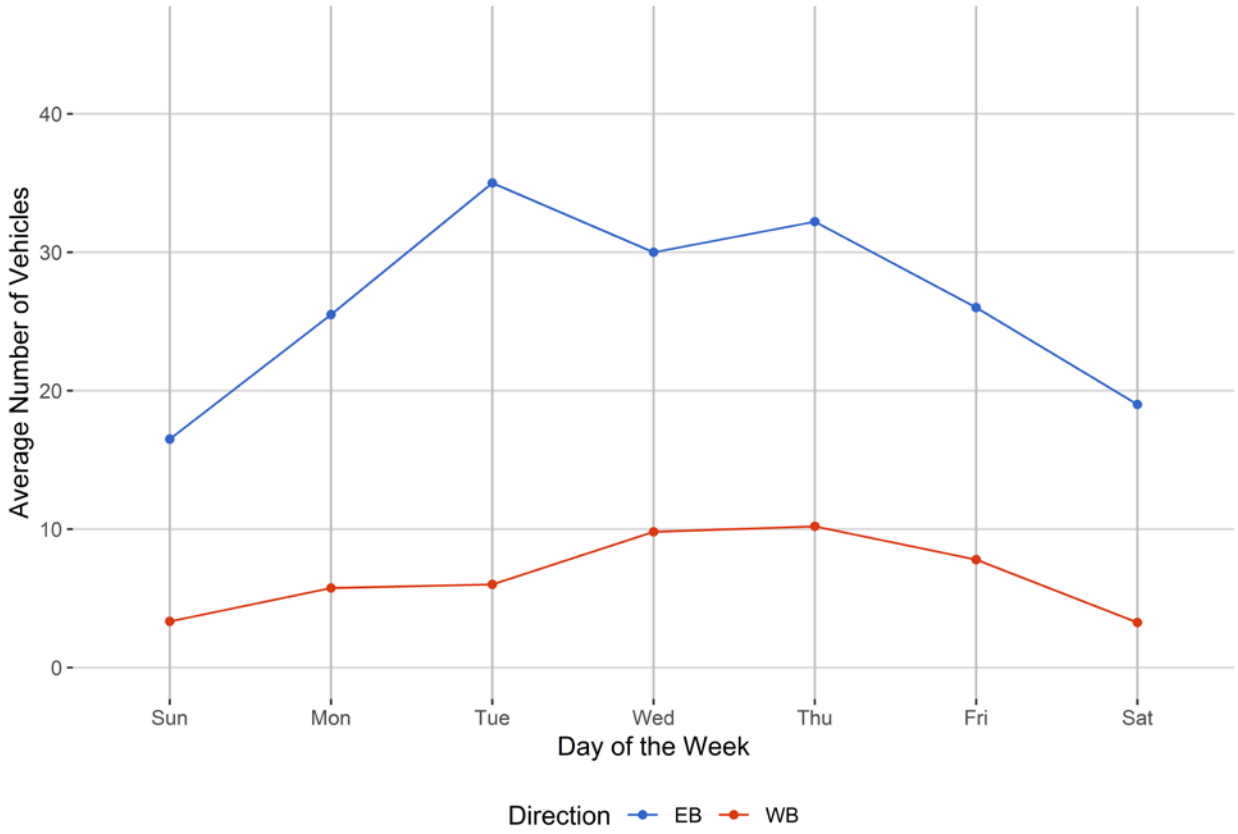


Figure 4 - Passenger Vehicles vs. Hour of the Day

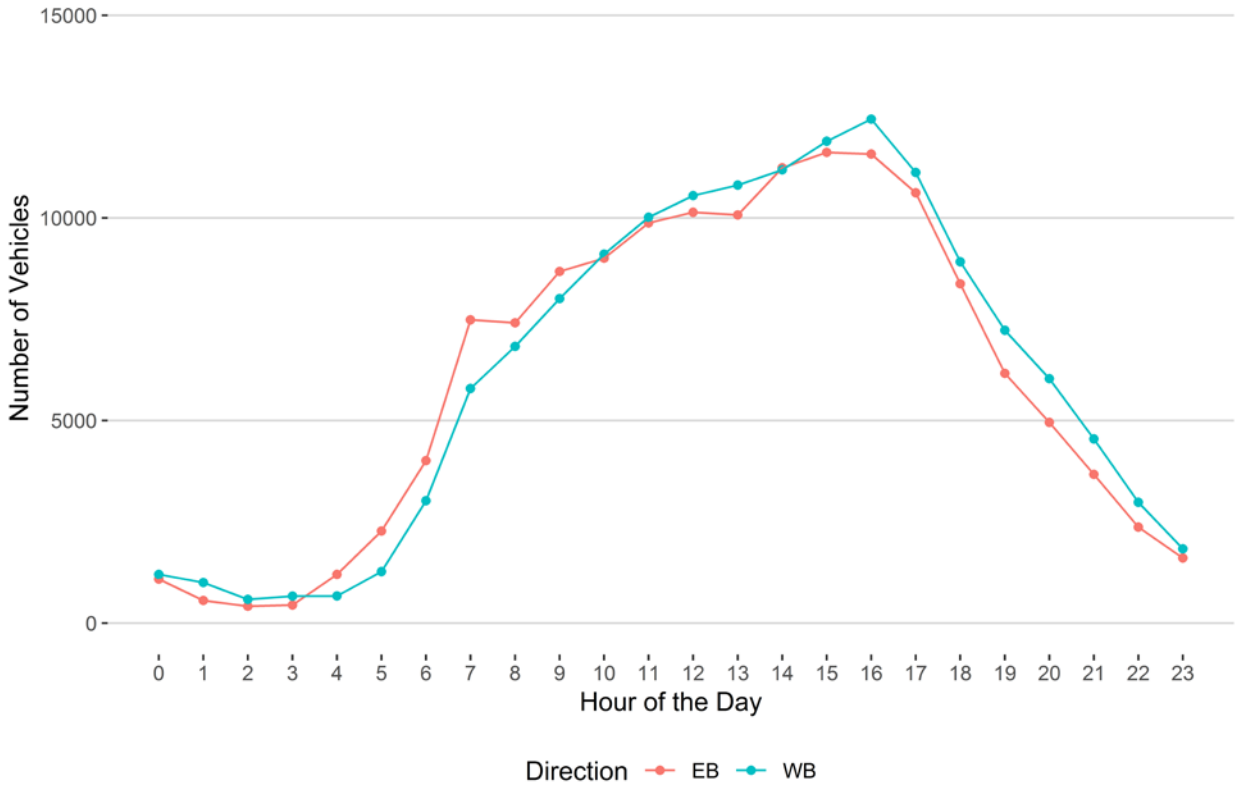


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

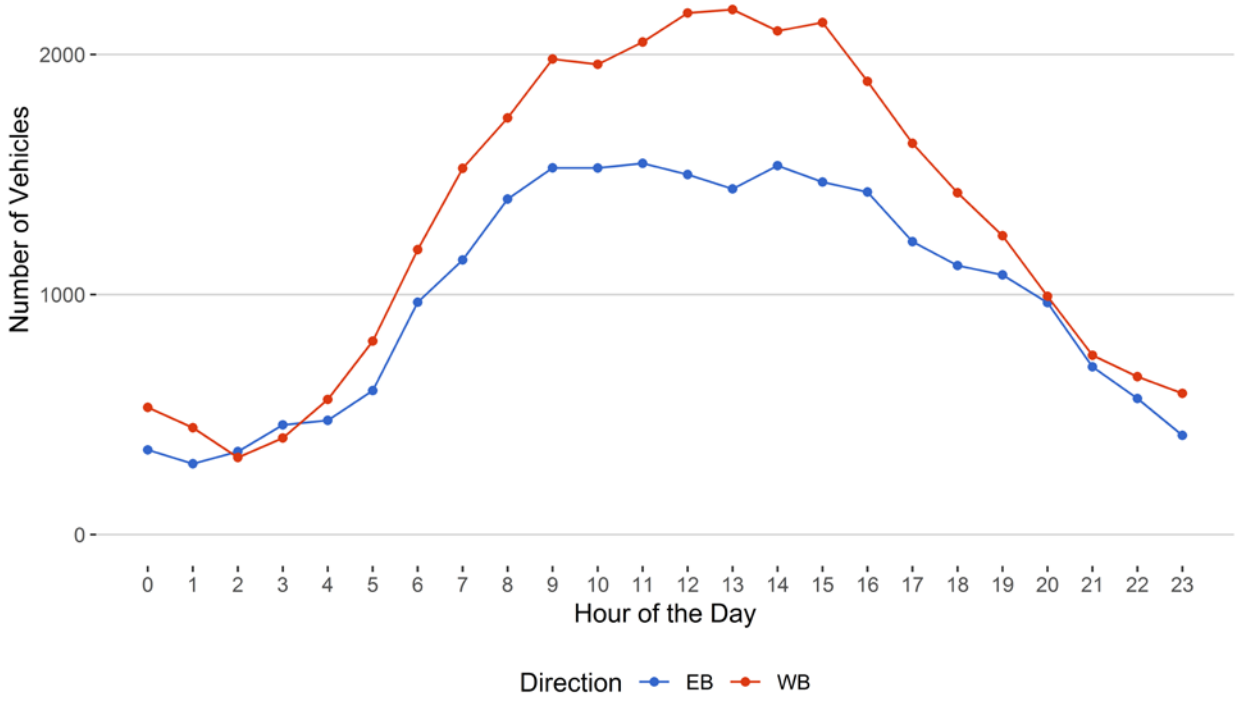


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

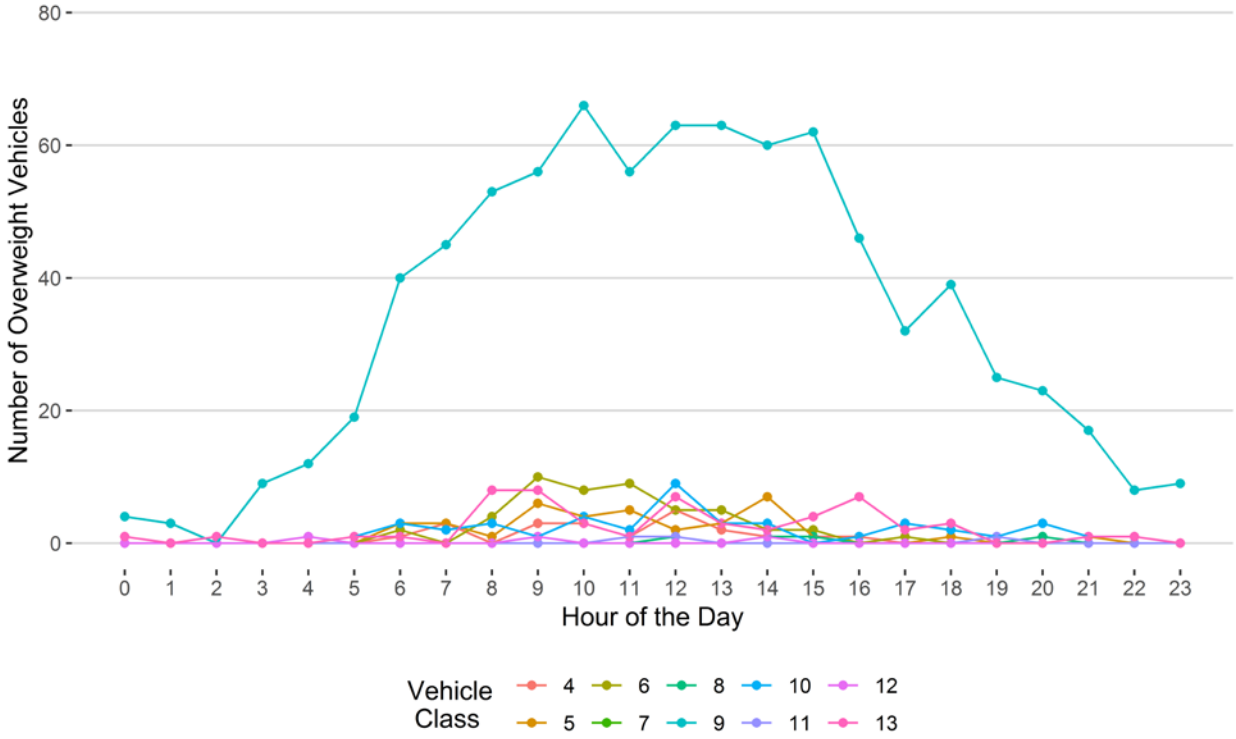


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

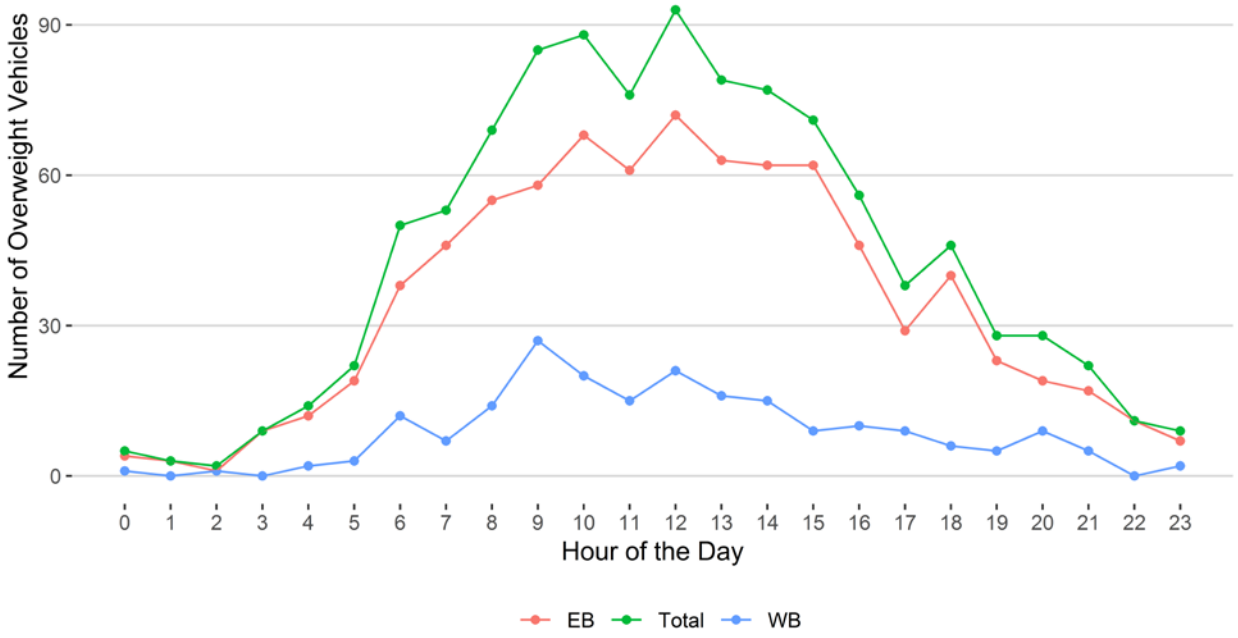
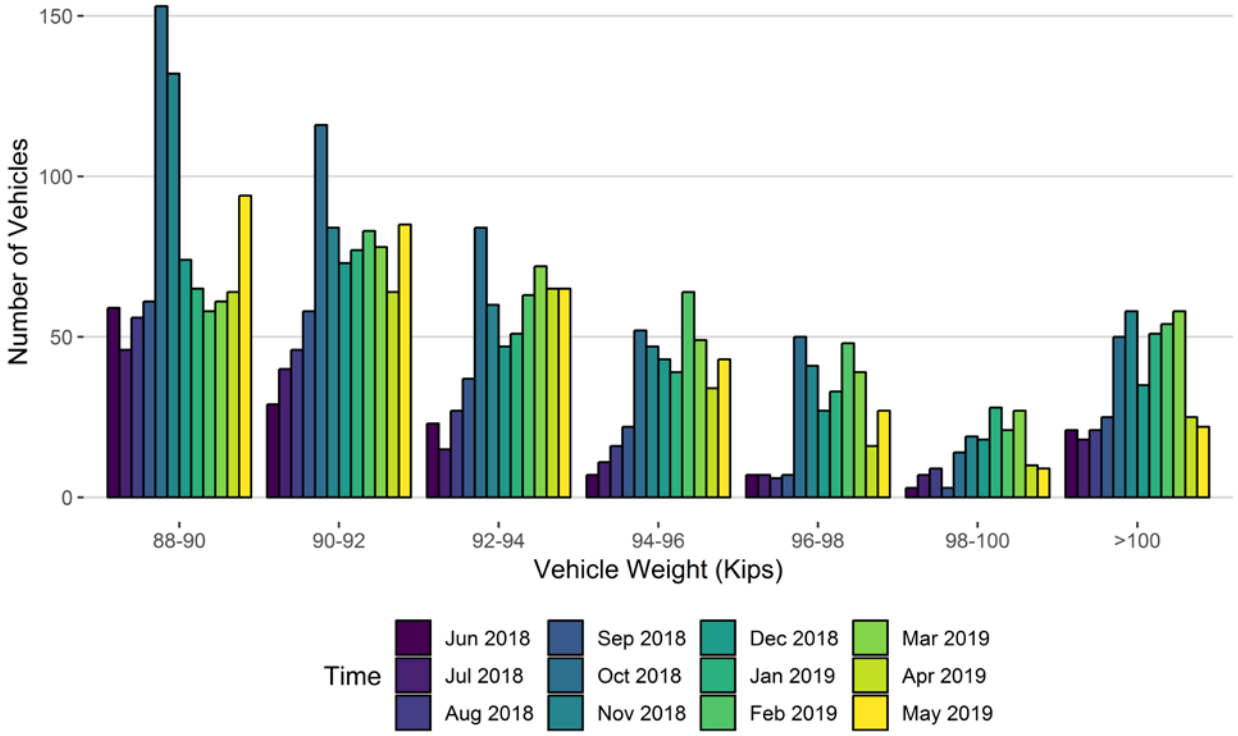
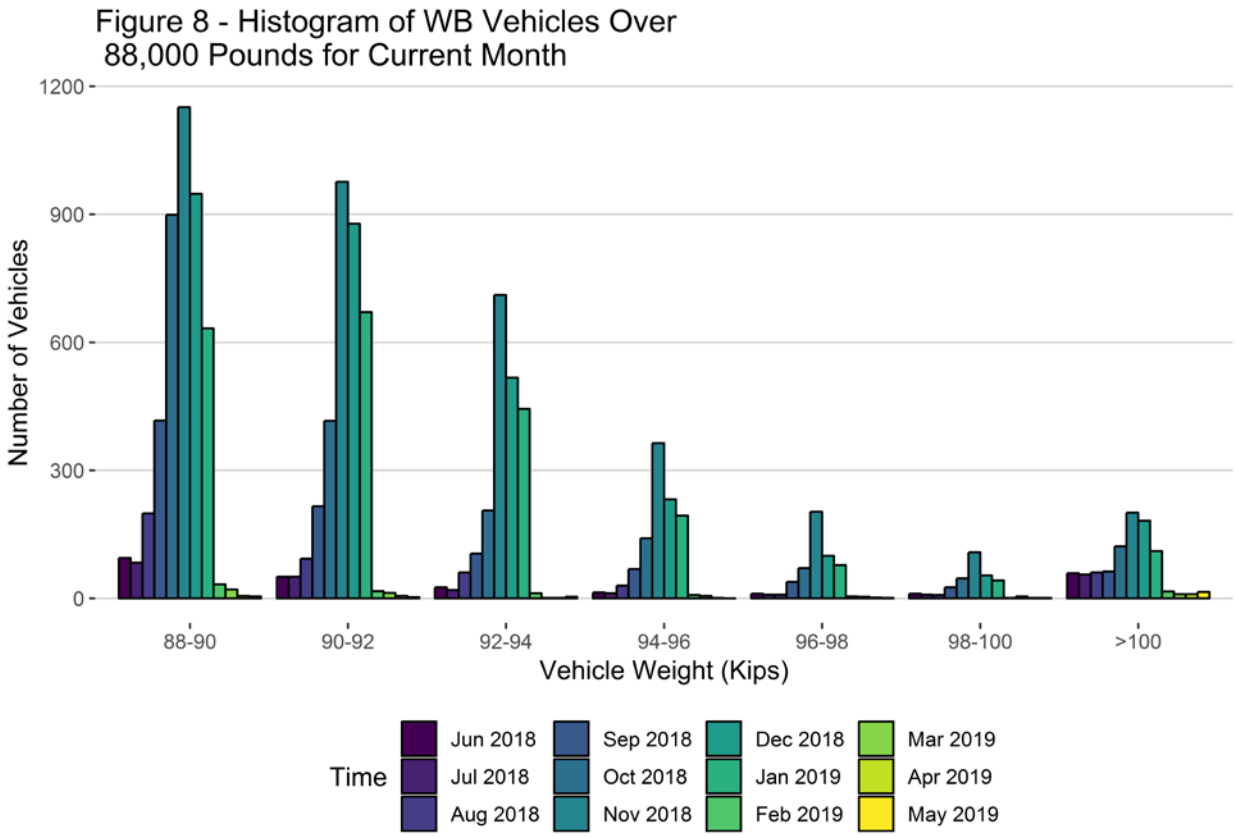


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Jun 2018*	*Jul 2018*	*Aug 2018*	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*
88-90	59	46	56	61	153	132	74	65	58	61	64	94
90-92	29	40	46	58	116	84	73	77	83	78	64	85
92-94	23	15	27	37	84	60	47	51	63	72	65	65
94-96	7	11	16	22	52	47	43	39	64	49	34	43
96-98	7	7	6	7	50	41	27	33	48	39	16	27
98-100	3	7	9	3	14	19	18	28	21	27	10	9
>100	21	18	21	25	50	58	35	51	54	58	25	22
Total	149	144	181	213	519	441	317	344	391	384	278	345



Vehicle Weights (Kips)	*Jun 2018*	*Jul 2018*	*Aug 2018*	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*
88-90	95	84	199	417	899	1151	948	633	33	21	6	5
90-92	51	51	93	216	416	976	878	671	17	13	6	3
92-94	26	20	61	105	206	711	517	444	12	1	1	4
94-96	14	12	30	69	141	364	232	194	8	6	1	0
96-98	11	9	9	39	71	203	100	78	5	4	2	1
98-100	11	9	8	26	47	108	54	42	1	5	1	1
>100	59	56	61	63	122	201	182	111	16	10	10	15
Total	267	241	461	935	1902	3714	2911	2173	92	60	27	29

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

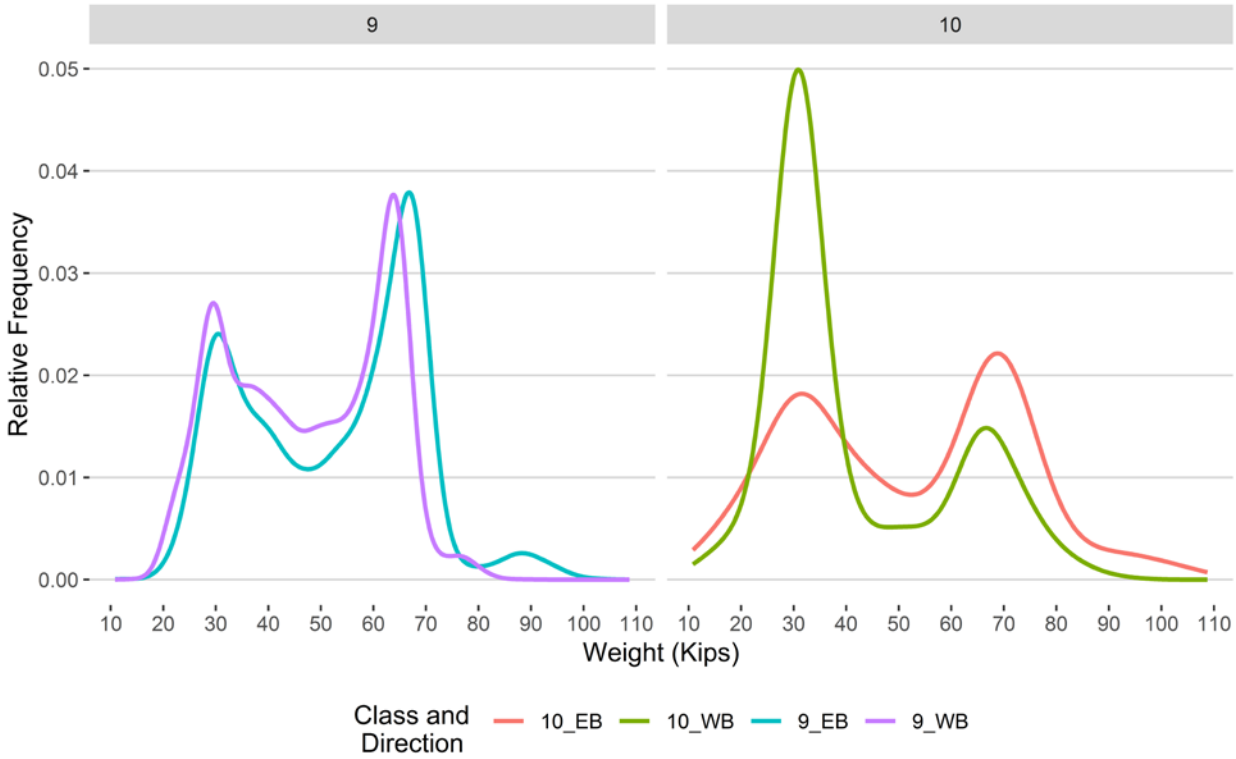


Figure 9 - Freight Percentage by Direction and Class

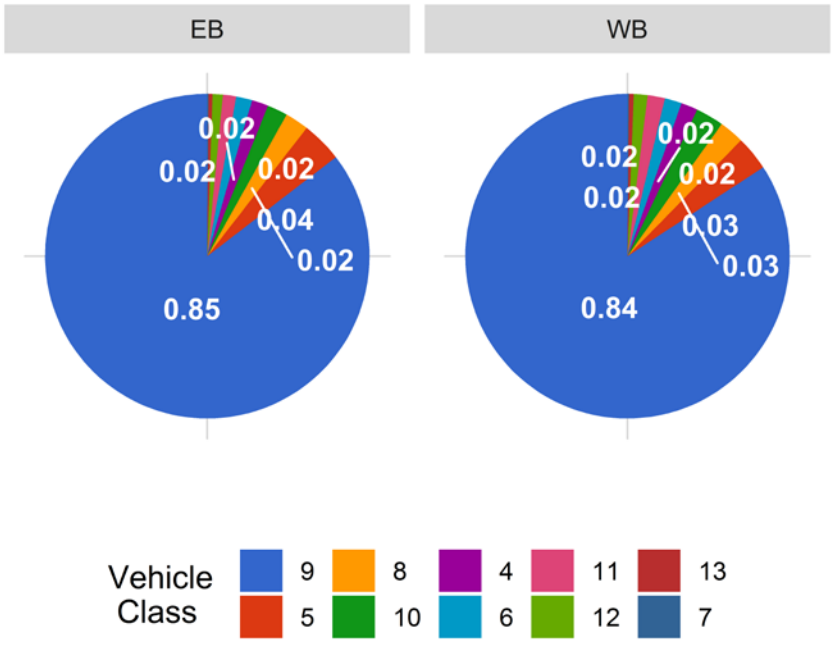


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

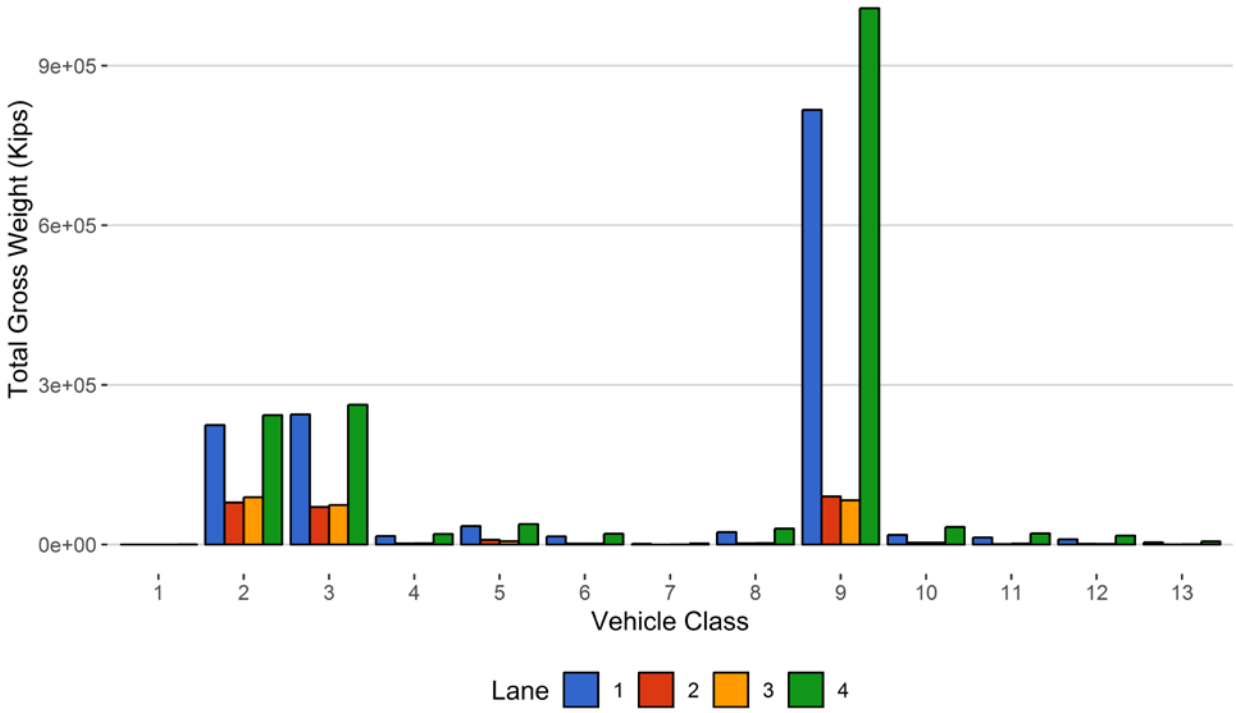


Figure 11 - Total Gross Vehicle Weight b

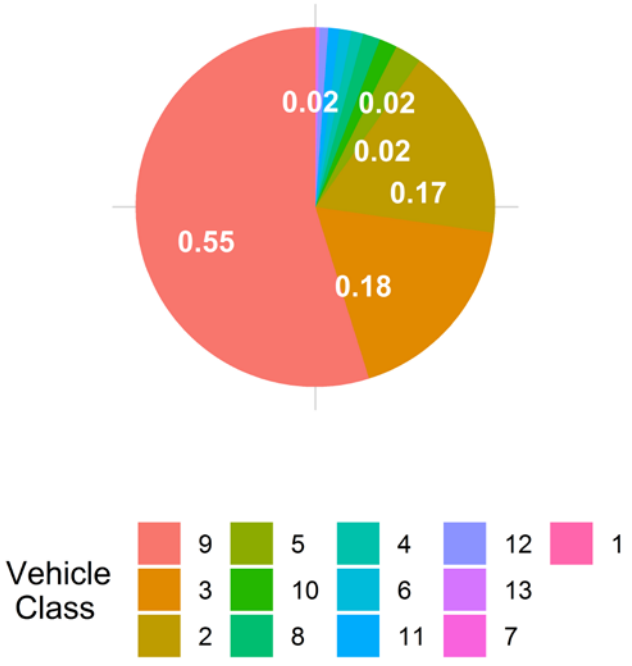


Figure 12 - Total ESALs by Class and Lane

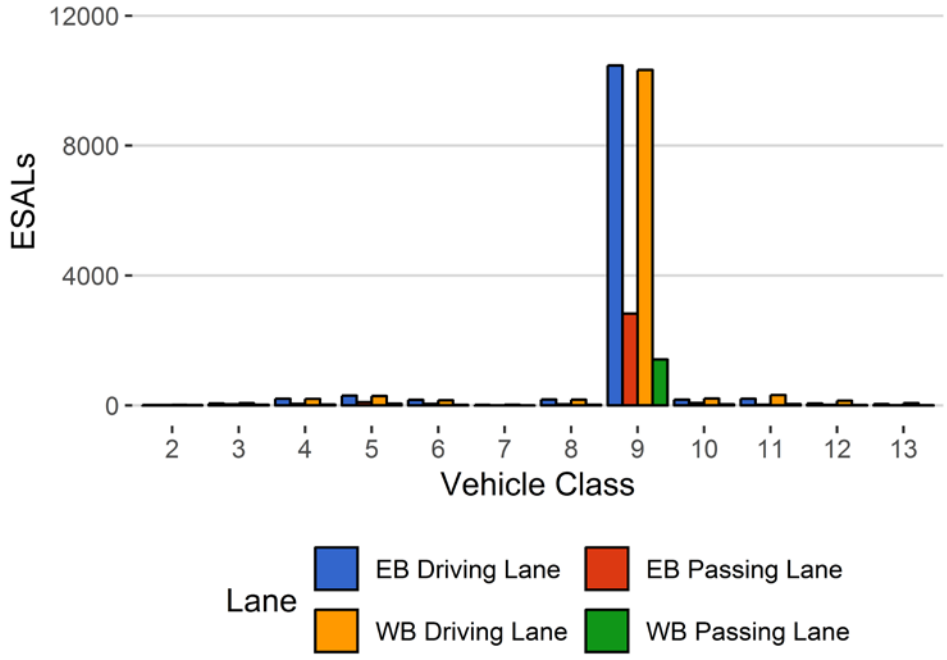


Figure 13 - ESALs by Class

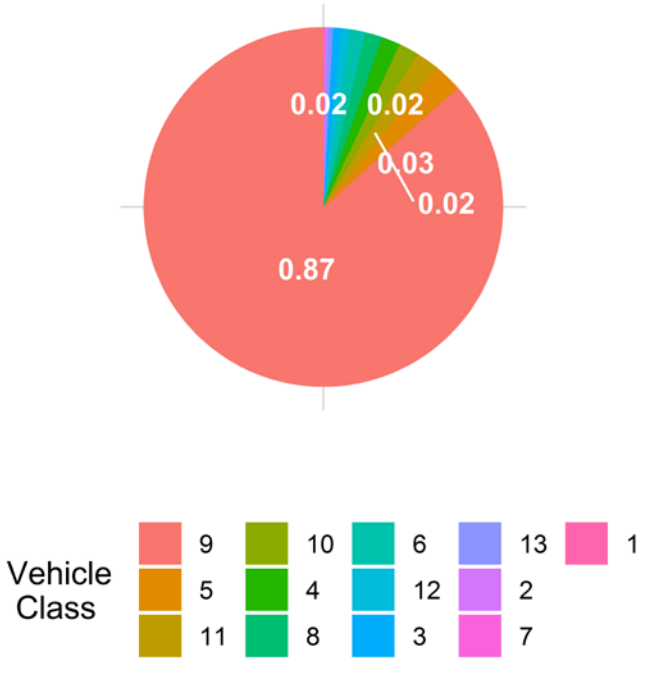


Table 1 Class 9 Front Axle Weight by Lane

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%*
February 2019	9.78	0.00	13.14	0.00	12.28	0.00	9.93	0.00
March 2019	9.78	-0.06	12.98	-1.23	11.86	-3.43	9.62	-3.12
April 2019	9.58	-2.02	12.65	-3.73	11.62	-5.38	9.44	-4.90
May 2019	9.44	-3.53	12.55	-4.49	11.42	-7.04	9.31	-6.28

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	2	52	0	0	0
2	5974	185200	51.3	0	0
3	3819	118378	32.8	0	0
4	54	1682	0.5	23	2.2
5	234	7248	2	38	3.7
6	54	1660	0.5	48	4.7
7	3	91	0	1	0.1
8	70	2158	0.6	4	0.4
9	1344	41659	11.5	810	78.6
10	43	1325	0.4	44	4.3
11	23	724	0.2	3	0.3
12	18	565	0.2	5	0.5
13	4	133	0	54	5.2
TOTAL	**11641**	**360874**	**100**	**1030**	**100**

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

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-05-19	Sunday	22:02:54	10	EB	2	108.75
2019-05-30	Thursday	11:11:02	9	WB	4	106.58
2019-05-27	Monday	19:50:41	10	EB	2	105.64
2019-05-21	Tuesday	05:18:44	10	WB	4	105.57
2019-05-28	Tuesday	16:28:43	9	EB	2	104.49
2019-05-06	Monday	11:09:56	9	WB	4	103.68
2019-05-20	Monday	22:21:43	9	EB	2	103.52
2019-05-17	Friday	06:41:47	9	EB	2	102.93
2019-05-21	Tuesday	06:53:37	9	EB	2	102.89
2019-05-23	Thursday	16:45:16	10	EB	2	102.43

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	691	115	16.6	16055	1460	3708
5	EB	8	3441	953	27.7	36580	6546	8338
6	EB	19	664	274	41.3	12466	4466	2528
7	EB	11.5	36	1	2.8	1345	8	471
8	EB	31	881	574	65.2	11460	13652	971
9	EB	33	17384	3398	19.5	809782	97545	174122
10	EB	33.5	415	119	28.7	18436	3115	4260
11	EB	36.5	286	59	20.6	12248	1851	1981
12	EB	36.5	229	43	18.8	9436	1419	1323
13	EB	31.5	53	0	0	4118	0	1224
TOTAL	****	****	**24080**	**5536**	****	**931927**	****	**198928**
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	935	216	23.1	18858	2746	4037
5	WB	8	3567	856	24	38507	5986	8410
6	WB	19	941	406	43.1	15357	6594	2596
7	WB	11.5	52	0	0	1928	0	665
8	WB	31	1206	876	72.6	11787	20368	778
9	WB	33	22898	5469	23.9	938825	152111	181834
10	WB	33.5	866	491	56.7	21782	14326	4610
11	WB	36.5	414	15	3.6	21972	356	3704
12	WB	36.5	317	11	3.5	17493	259	3162
13	WB	31.5	76	1	1.3	6044	26	1841
TOTAL	****	****	**31272**	**8341**	****	**1092553**	****	**211636**
GRAND TOTAL	****	****	**55352**	**13877**	**493**	**2024480**	**332837**	**410564**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*EB Driving Lane*	*EB Passing Lane*	*WB Passing Lane*	*WB Driving Lane*	*Total*	*Percentage*
1	19	10	7	27	63	0
2	224560	78947	88976	242832	635316	17.4
3	244487	70288	74171	262496	651441	17.9
4	15640	1876	2094	19511	39120	1.1
5	34556	8571	6182	38312	87621	2.4
6	15174	1759	1732	20219	38884	1.1
7	1337	17	104	1824	3282	0.1
8	22959	2152	2402	29753	57267	1.6
9	816924	90403	82886	1008051	1998264	54.8
10	18119	3432	3329	32779	57659	1.6
11	13224	875	1498	20830	36426	1
12	9491	1364	1147	16605	28607	0.8
13	3906	212	362	5707	10188	0.3
TOTAL	**1420396**	**259904**	**264889**	**1698947**	**3644137**	**100**
GVW/LANE	**38.98**	**7.13**	**7.27**	**46.62**	**100**	**0**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*EB Driving Lane*	*EB Passing Lane*	*WB Passing Lane*	*WB Driving Lane*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0	0	0.0196
2	15	13	12	23	63	0.22	7e-04
3	62	35	28	75	201	0.69	0.0035
4	208	48	34	203	493	1.7	0.61
5	302	106	59	296	762	2.63	0.22
6	174	48	22	161	405	1.4	0.51
7	18	0	2	25	45	0.15	1.02
8	187	39	23	181	430	1.49	0.42
9	10468	2828	1422	10330	25048	86.51	1.25
10	182	80	39	216	517	1.79	0.81
11	208	28	43	325	603	2.08	1.71
12	60	18	15	152	245	0.85	0.9
13	46	8	11	75	140	0.49	2.07
TOTAL	**11931**	**3251**	**1710**	**12061**	**28953**	**100**	**10**
ESALS/LANE	**41.2**	**11.2**	**5.9**	**41.7**	**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 %*
Jun 2018	403413	13447	1991	343676	85.2	59737.3	14.8	91.1	8.9
Jul 2018	433111	13971	2018	370548	85.6	62563	14.4	91.2	8.8
Aug 2018	437569	14115	2112	372092	85	65476.8	15	90.9	9.1
Sep 2018	366152	12205	1991	306435	83.7	59717.1	16.3	91.6	8.4
Oct 2018	343352	11076	1957	282691	82.3	60660.8	17.7	90.5	9.5
Nov 2018	304874	10162	1707	253655	83.2	51219.4	16.8	92	8
Dec 2018	249836	8615	1330	208619	83.5	41216.7	16.5	91.7	8.3
Jan 2019	237632	7666	1585	188493	79.3	49138.8	20.7	93.6	6.4
Feb 2019	203760	7277	1529	160956	79	42803.6	21	92.4	7.6
Mar 2019	275186	8877	1710	222175	80.7	53010.7	19.3	93.1	6.9
Apr 2019	290206	9674	1771	237070	81.7	53135.6	18.3	92.9	7.1
May 2019	360874	11568	1847	303630	84.1	57244.3	15.9	91.7	8.3
TOTAL	**3905965**	**–**	**–**	**3250040**	**–**	**655924**	**–**	**–**	**–**
AVERAGE	**325497**	**10721**	**1796**	**270837**	**83**	**54660**	**17**	**92**	**8**

ESALs

Month	*ESALS EB Passing Lane*	*ESALS EB Driving Lane*	*ESALS WB Driving Lane*	*ESALS WB Passing Lane*	*Total ESALS*	*Driving Lane ESALS %*	*Passing Lane ESALS %*	*Pavement Life Decrease Months*
Jun 2018	18041	2590	2413	31030	54075	91	9	3.1
Jul 2018	18401	3035	2196	32322	55954	91	9	2.8
Aug 2018	20552	3197	2709	34960	61418	90	10	4.9
Sep 2018	19972	2728	2340	36203	61243	92	8	10.4
Oct 2018	23230	4308	2613	40888	71039	90	10	19.1
Nov 2018	20520	2451	2346	36773	62090	92	8	45.4
Dec 2018	12572	2548	2315	27559	44994	89	11	44.8
Jan 2019	15427	2515	2039	26307	46288	90	10	35.2
Feb 2019	11829	3709	2133	13009	30680	81	19	0.4
Mar 2019	14419	2617	1904	14178	33118	86	14	0.5
Apr 2019	12589	3407	1777	12322	30096	83	17	0.3
May 2019	11950	3256	1712	12107	29025	83	17	0.1
TOTAL	**199503**	**36360**	**26498**	**317659**	**580020**	**–**	**–**	**–**
AVERAGE	**16625**	**3030**	**2208**	**26472**	**48335**	**88**	**12**	**14**

Gross Vehicle Weight

Month	*GVW EB Passing Lane*	*GVW EB Driving Lane*	*GVW WB Passing Lane*	*GVW WB Driving Lane*	*Total GVW Kips*
Jun 18	1730907	271875	339657	2137868	4480307
Jul 18	1788923	325935	348429	2277404	4740692
Aug 18	1915875	339615	366948	2302915	4925352
Sep 18	1720129	252992	288908	2083638	4345667
Oct 18	1717957	290836	276910	2210236	4495940
Nov 18	1554196	195512	237763	1815173	3802644
Dec 18	1297542	166610	203153	1450218	3117523
Jan 19	1318897	132672	166003	1612384	3229956
Feb 19	1052899	129123	157838	1259469	2599329
Mar 19	1361595	164259	199086	1585945	3310885
Apr 19	1325756	180407	211379	1556974	3274517
May 19	1423938	260130	265009	1700873	3649951
TOTAL	**18208613**	**2709966**	**3061084**	**21993098**	**45972761**
AVERAGE	**1517384**	**225831**	**255090**	**1832758**	**3831063**

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 2018	7233	1.8	12.4	417	95
Jul 2018	7532	1.8	12.3	389	93
Aug 2018	8919	2.1	14	647	103
Sep 2018	9527	2.7	16.7	1171	119
Oct 2018	13380	4.1	22.9	2426	234
Nov 2018	11759	4.1	24.3	4157	387
Dec 2018	6713	2.7	16.2	3230	289
Jan 2019	5490	2.4	11.7	2523	234
Feb 2019	1777	0.9	4.4	487	93
Mar 2019	1390	0.5	2.7	447	100
Apr 2019	958	0.3	1.9	306	47
May 2019	1034	0.3	1.9	374	47
TOTAL	**75712**	**–**	**–**	**16574**	**1841**
AVERAGE	**6309.3**	**2**	**11.8**	**1381.2**	**153.4**

Freight

Month	*EB Freight Tons*	*WB Freight Tons*	*Total Freight*	*EB Freight %*	*WB Freight %*
Jun 2018	249273	351320	600593	41.5	58.5
Jul 2018	258038	359867	617905	41.8	58.2
Aug 2018	280790	385307	666097	42.2	57.8
Sep 2018	263585	371797	635381	41.5	58.5
Oct 2018	295906	409353	705259	42	58
Nov 2018	249601	342900	592501	42.1	57.9
Dec 2018	189465	263947	453412	41.8	58.2
Jan 2019	214358	285394	499753	42.9	57.1
Feb 2019	169293	197643	366936	46.1	53.9
Mar 2019	210425	229917	440342	47.8	52.2
Apr 2019	195045	212731	407776	47.8	52.2
May 2019	198928	211636	410564	48.5	51.5
TOTAL	**2774707**	**3621811**	**6396519**	**–**	**–**
AVERAGE	**231225.6**	**301817.6**	**533043.2**	**43.8**	**56.2**