

DECEMBER 2019



**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 December 2019. 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. 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: 139120 | Passenger Vehicles: 114343 | Heavy Commercial Vehicles: 24777

Monthly Average Daily Traffic (MADT): 4780 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 799

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 Sundays. WB vehicles typically reached highest volume levels on Fridays, 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), 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 13's.

Overweight HCVs

Volume trends. Of a total of 24777 HCVs, 4601 of them were overweight ³. These overweight HCVs contributed to 3.5% of total monthly volume, and 19.4% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Saturdays. WB overweight vehicles tended to reach highest volumes on Saturdays, with lowest volumes reported on Mondays. See Figure 3 .

The top two overweight violators by class were the class 13 and class 10 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 85% of all overweight vehicles traveling WB 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 January.

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 ,116 EB vehicles exceeded 88,000 pounds (79 vehicles were Class 13's; 34 vehicles were Class 10's). Of vehicles traveling WB,

937 EB vehicles exceeded 88,000 pounds (883 vehicles were Class 13's; 53 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from December 2019.

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

Freight Totals. A total of 268187 tons of freight was recorded to have crossed the WIM. More freight was shipped WB (72.7%) than EB (27.3%). 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 139120 vehicles with a combined GVW of 1699735 kips (1 kip = 1,000 pounds = 0.5 tons) in December 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 15727 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 60.4% of all ESALs were recorded WB while 39.6% was observed EB. In particular, 47% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 29% 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:

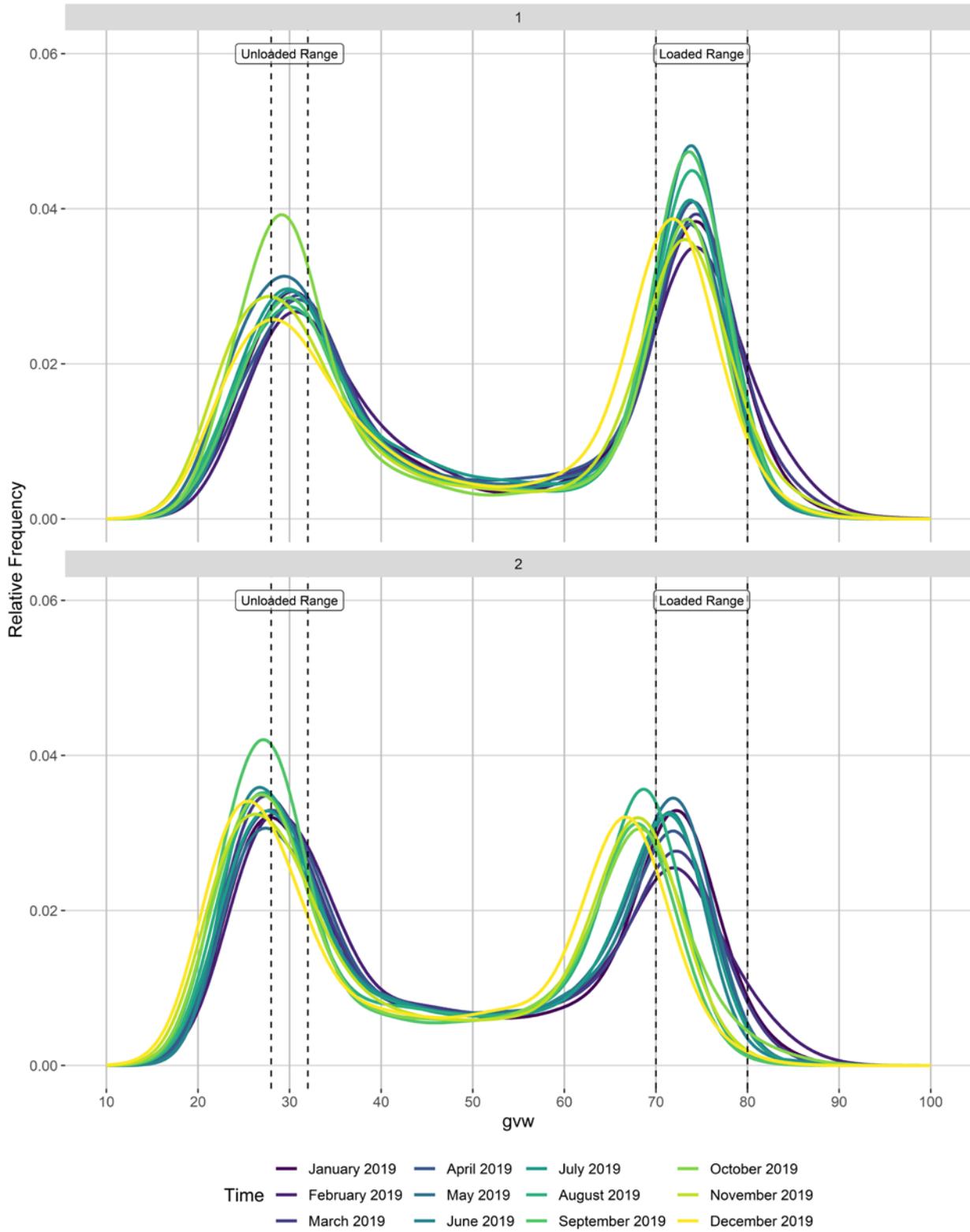
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

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.

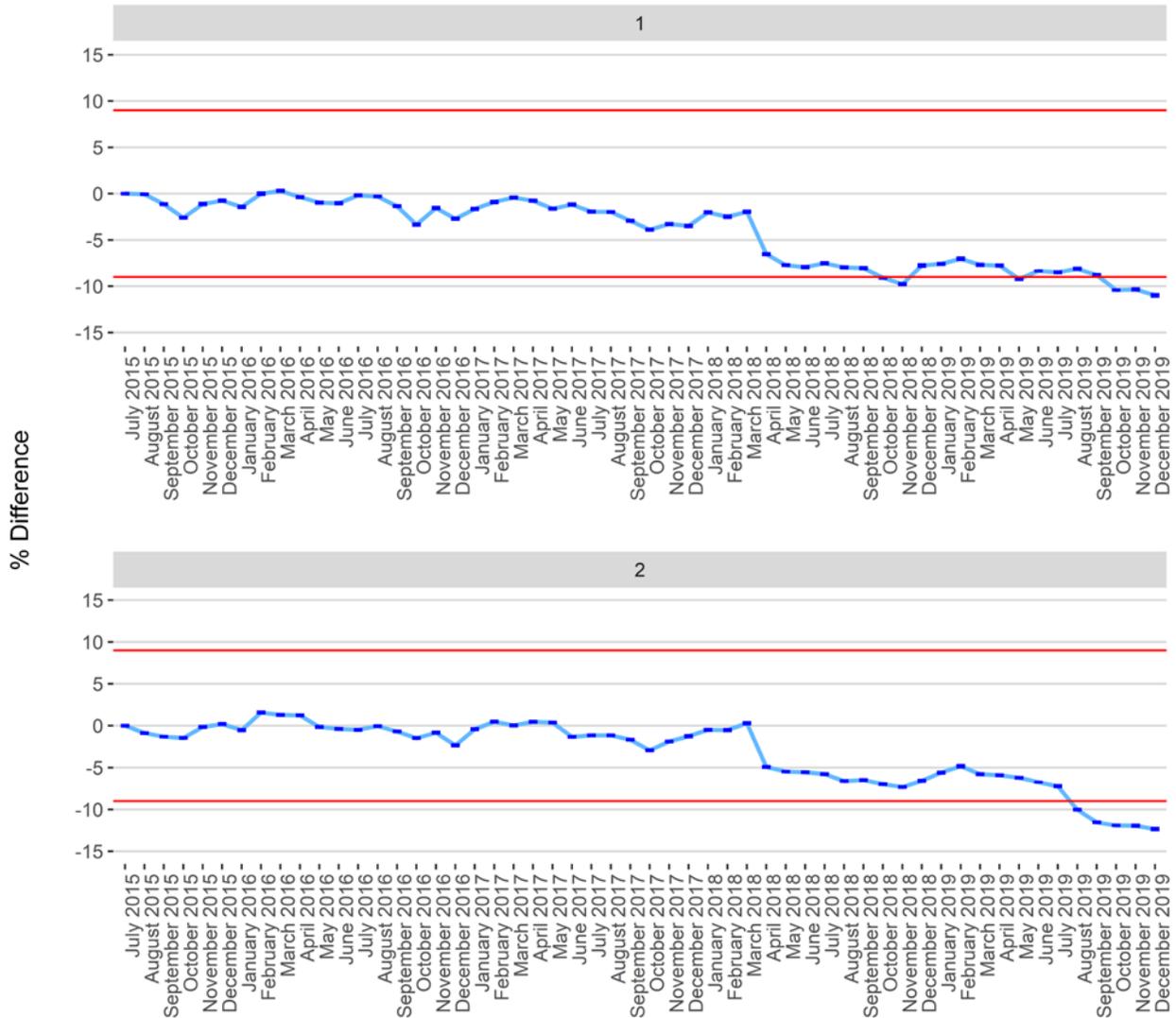
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

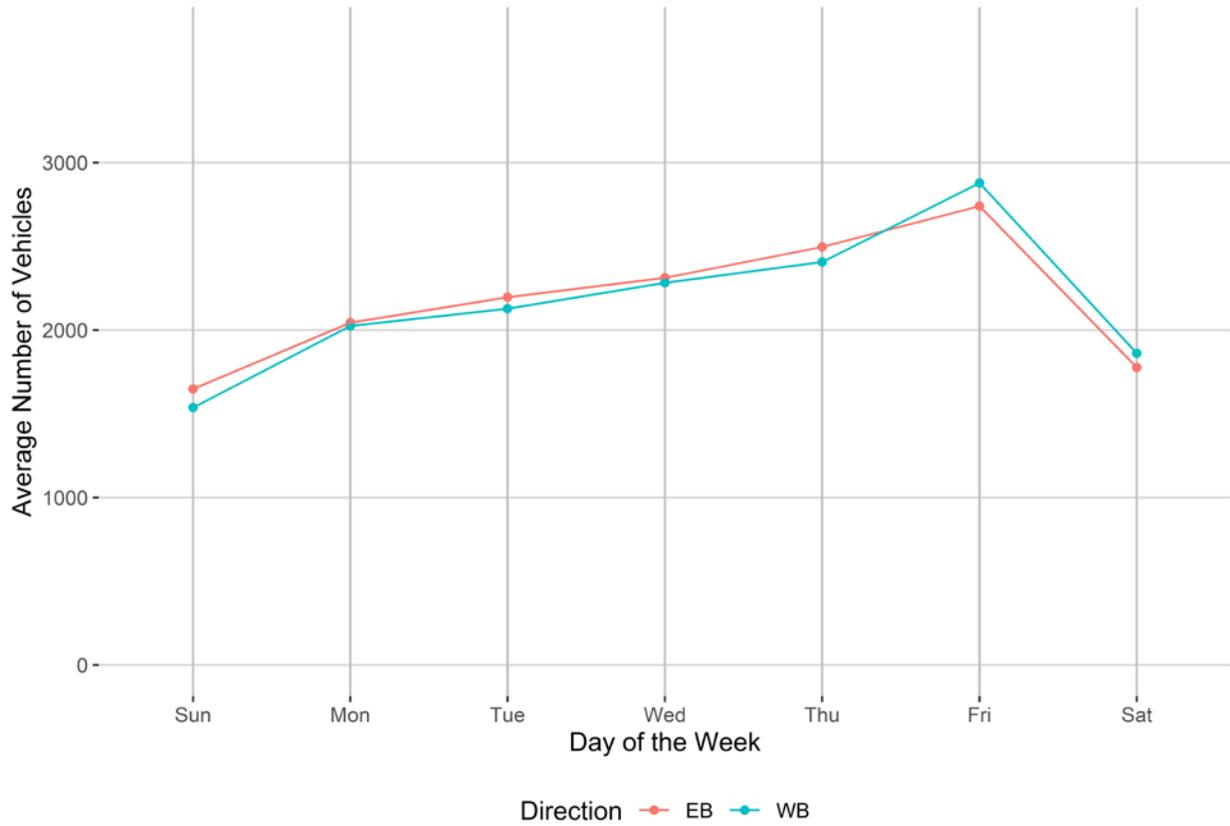


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

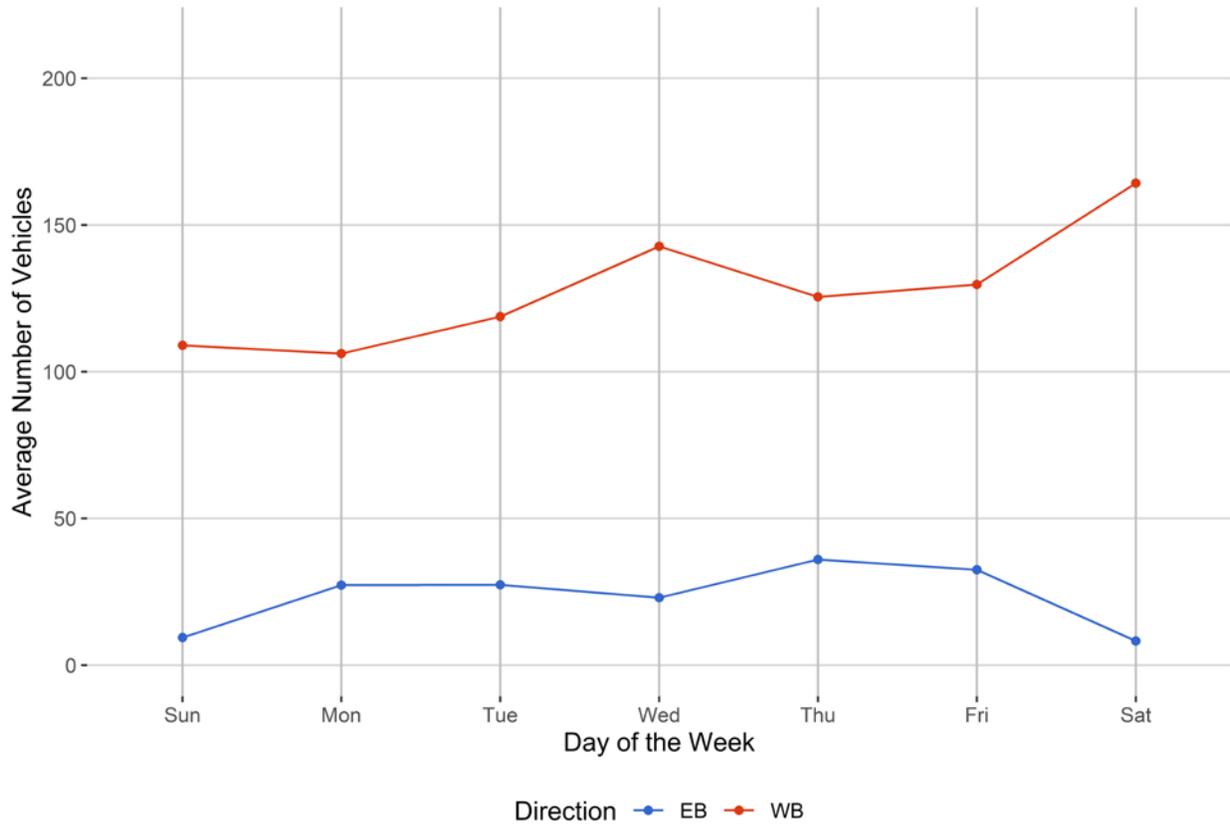


Figure 4 - Passenger Vehicles vs. Hour of the Day

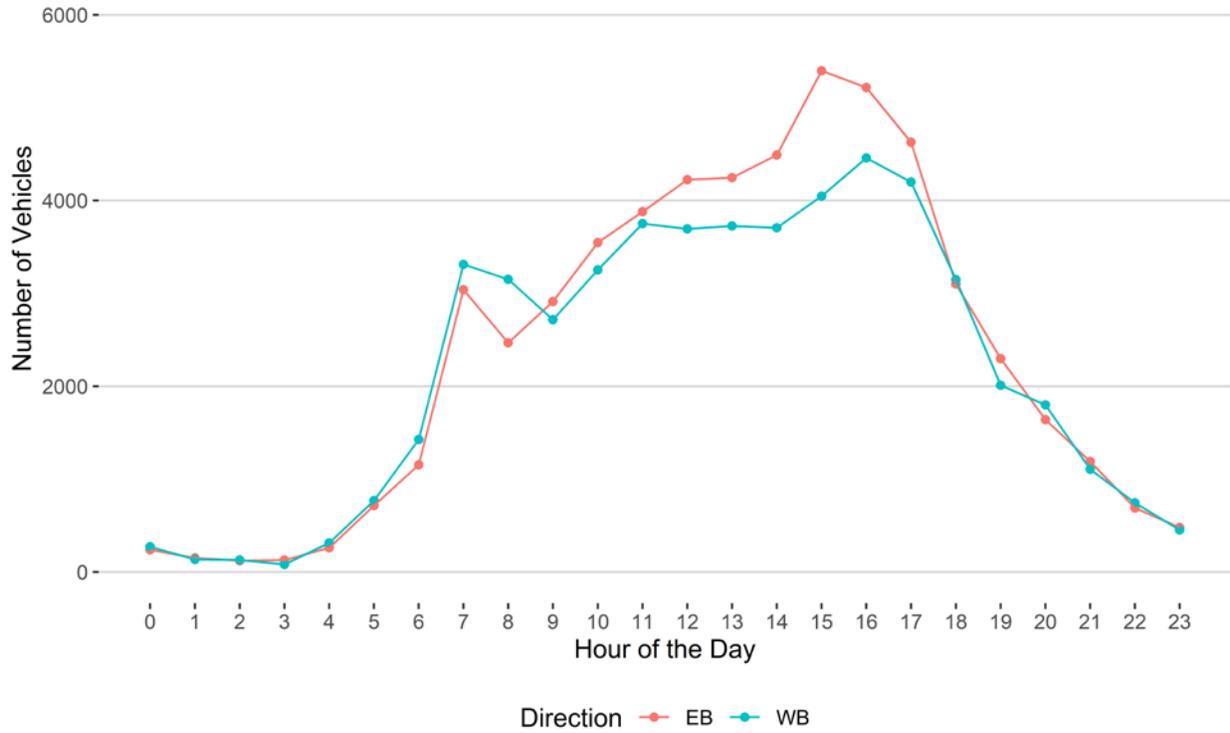


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

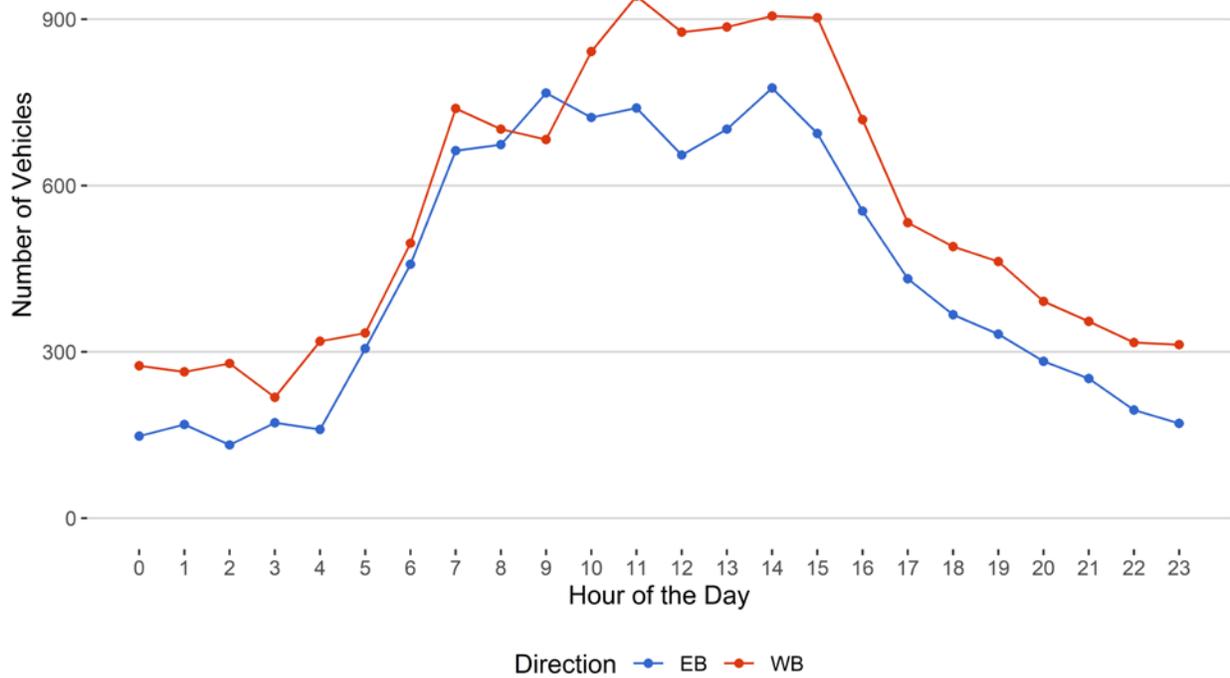


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

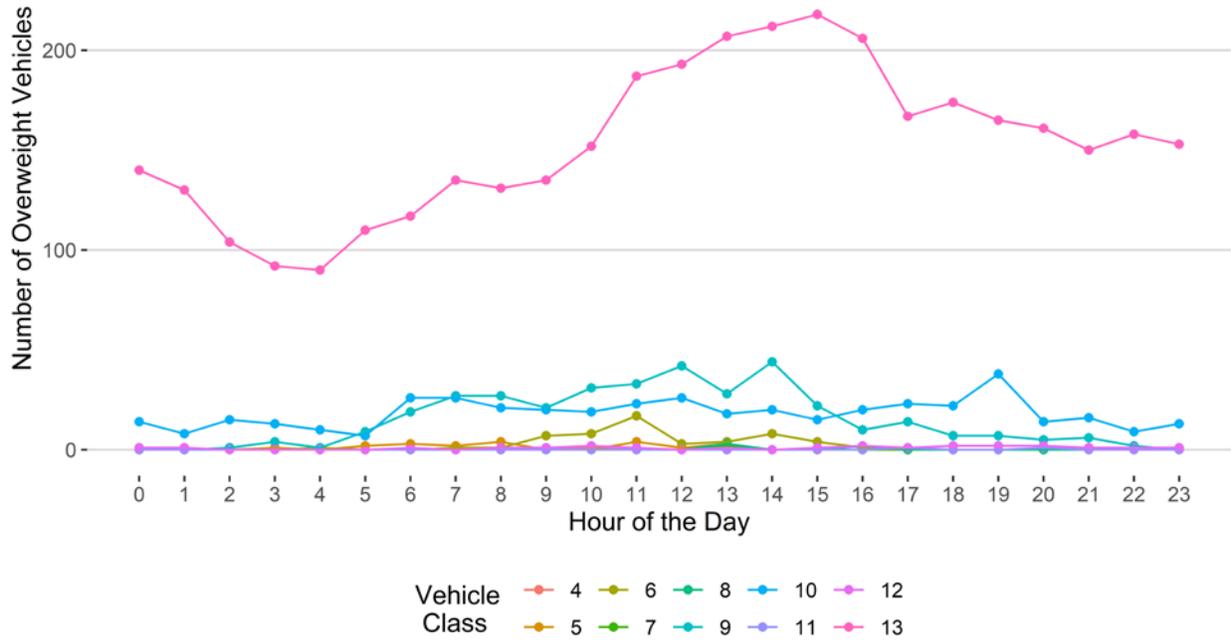


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

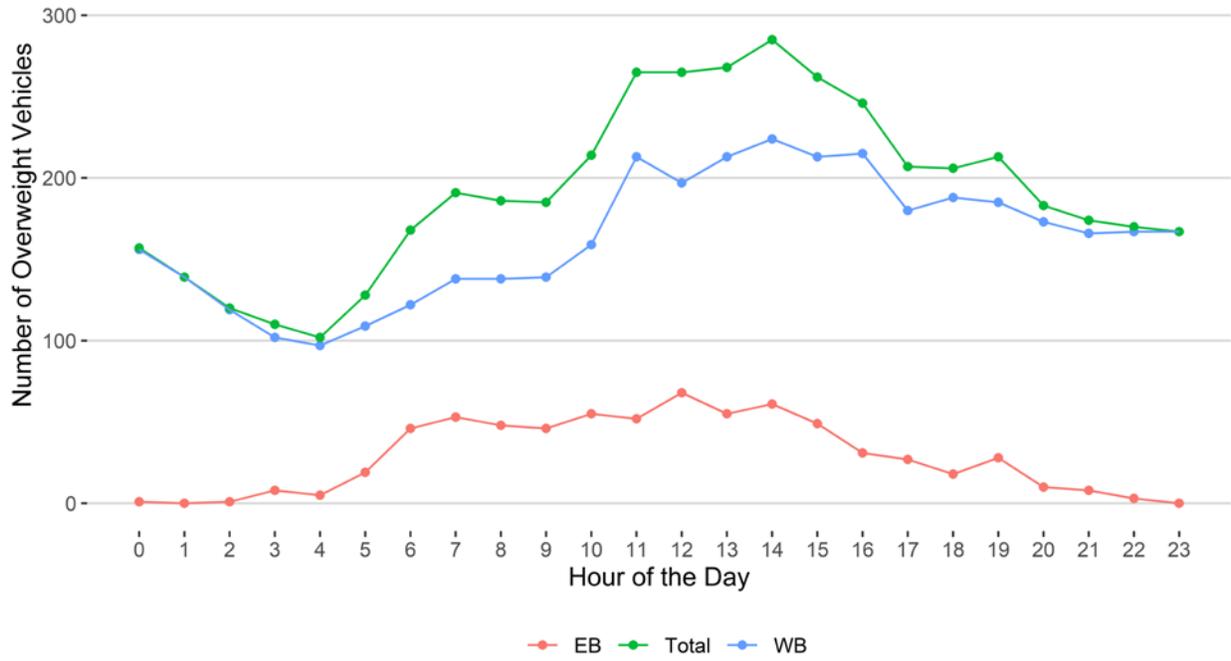
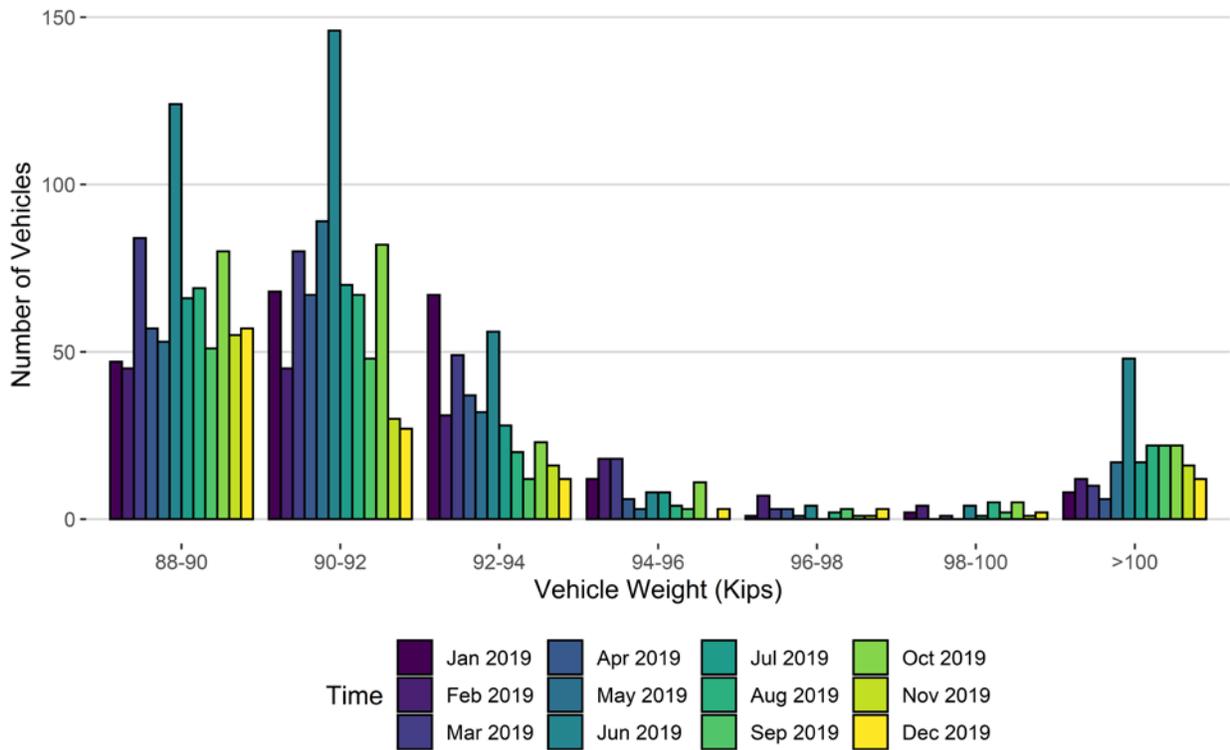
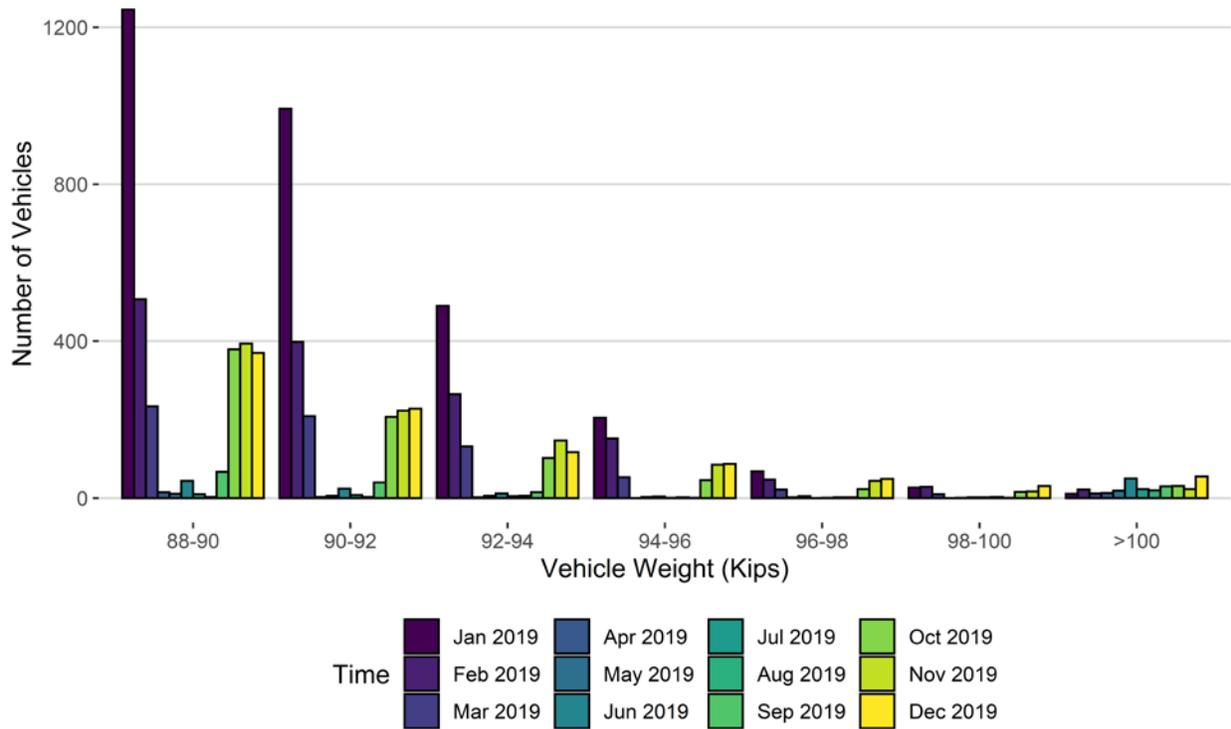


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	47	45	84	57	53	124	66	69	51	80	55	57
90-92	68	45	80	67	89	146	70	67	48	82	30	27
92-94	67	31	49	37	32	56	28	20	12	23	16	12
94-96	12	18	18	6	3	8	8	4	3	11	0	3
96-98	1	7	3	3	1	4	0	2	3	1	1	3
98-100	2	4	0	1	0	4	1	5	2	5	1	2
>100	8	12	10	6	17	48	17	22	22	22	16	12
Total	205	162	244	177	195	390	190	189	141	224	119	116

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



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	1245	507	234	15	11	44	10	3	67	379	394	370
90-92	992	398	209	3	6	24	8	3	40	207	223	228
92-94	490	265	132	2	6	12	5	6	15	102	147	117
94-96	205	152	53	0	3	4	1	2	1	46	85	87
96-98	68	47	22	2	5	0	1	2	2	23	44	49
98-100	27	29	10	0	1	2	2	3	1	16	17	31
>100	11	22	12	13	19	50	23	20	30	31	23	55
Total	3038	1420	672	35	51	136	50	39	156	804	933	937

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

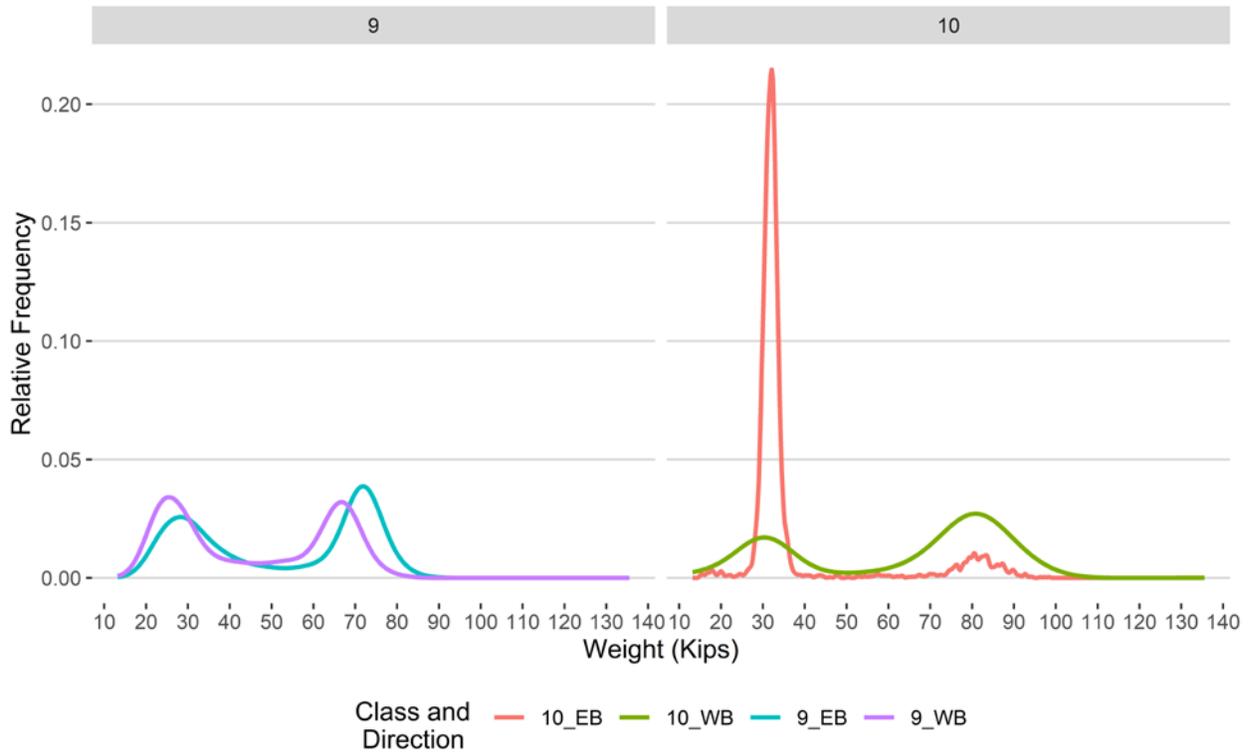


Figure 9 - Freight Percentage by Direction and Class

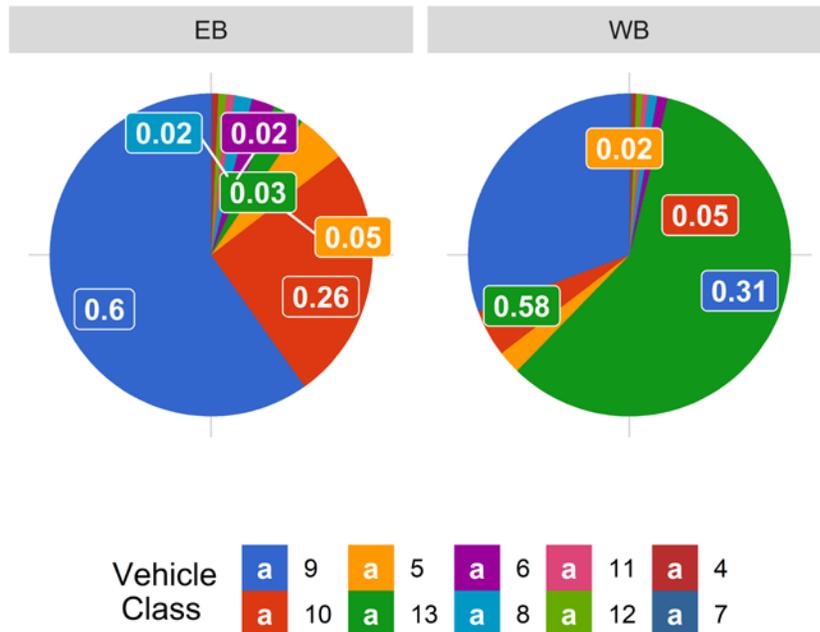


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

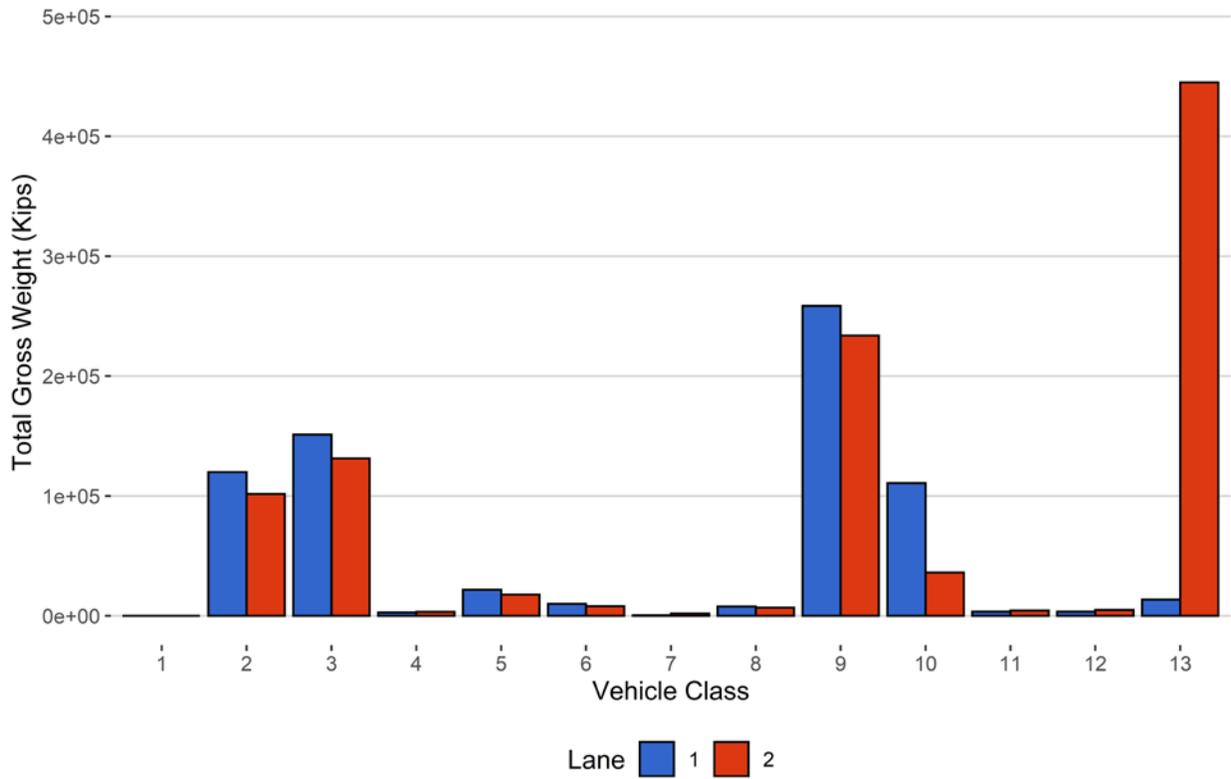


Figure 11 - Total Gross Vehicle Weight t

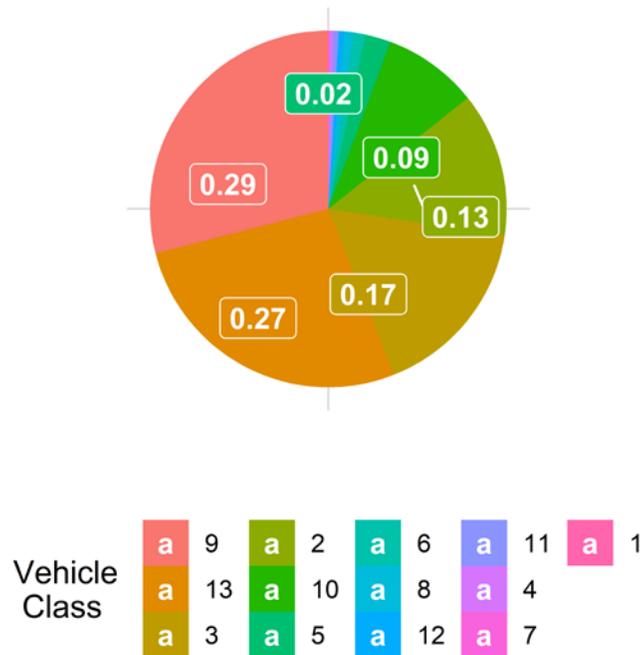


Figure 12 - Total ESALs by Class and Lane

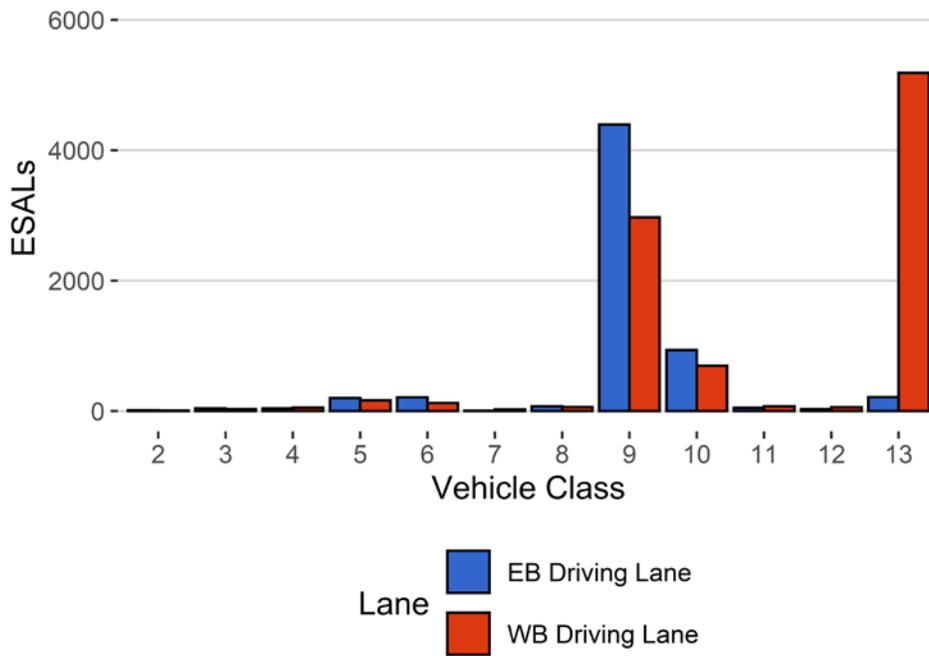


Figure 13 - ESALs by Class

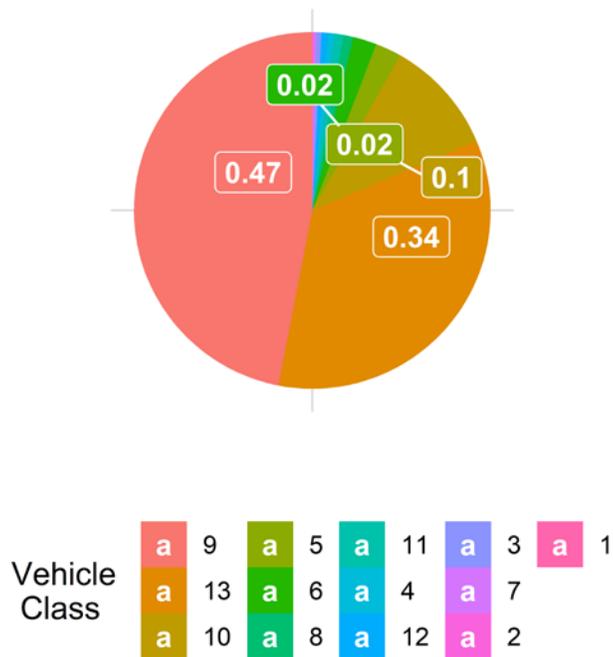


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
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	11.53	-1.97	11.02	0.30
April 2018	10.99	-6.53	10.44	-4.92
May 2018	10.85	-7.73	10.38	-5.48
June 2018	10.82	-7.93	10.37	-5.55
July 2018	10.87	-7.53	10.35	-5.78
August 2018	10.82	-7.97	10.26	-6.62
September 2018	10.81	-8.05	10.27	-6.50

October 2018	10.69	-9.08	10.22	-6.98
November 2018	10.61	-9.77	10.18	-7.32
December 2018	10.84	-7.77	10.26	-6.58
January 2019	10.86	-7.59	10.37	-5.61
February 2019	10.93	-7.03	10.45	-4.83
March 2019	10.85	-7.70	10.35	-5.79
April 2019	10.84	-7.77	10.33	-5.92
May 2019	10.67	-9.22	10.30	-6.22
June 2019	10.78	-8.35	10.24	-6.74
July 2019	10.76	-8.49	10.19	-7.23
August 2019	10.80	-8.12	9.88	-10.04
September 2019	10.72	-8.79	9.71	-11.55
October 2019	10.53	-10.42	9.67	-11.91
November 2019	10.54	-10.34	9.67	-11.95
December 2019	10.47	-10.98	9.63	-12.35

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	2	0	0	0
2	1951	60483	43.5	0	0
3	1737	53857	38.7	0	0
4	7	217	0.2	6	0.1
5	98	3039	2.2	22	0.5
6	22	668	0.5	56	1.2
7	2	48	0	2	0
8	17	520	0.4	7	0.2
9	338	10489	7.5	361	7.8
10	119	3675	2.6	436	9.5
11	5	167	0.1	2	0
12	5	158	0.1	22	0.5
13	187	5795	4.2	3687	80.1
TOTAL	4488	139120	100	4601	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>
2019-12-03	Tuesday	07:11:55	10	WB	2	135.55
2019-12-09	Monday	11:25:41	10	EB	1	98.42
2019-12-05	Thursday	00:17:14	10	WB	2	98
2019-12-03	Tuesday	14:30:37	10	WB	2	97.82
2019-12-22	Sunday	14:50:20	10	EB	1	97.39
2019-12-28	Saturday	20:34:36	10	WB	2	97.22
2019-12-25	Wednesday	04:25:02	10	WB	2	96.99
2019-12-27	Friday	01:52:07	10	WB	2	96.95
2019-12-29	Sunday	03:19:04	10	WB	2	96.86
2019-12-28	Saturday	23:17:56	10	WB	2	96.46

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	EB	15	108	20	18.5	2526	262	603
5	EB	8	1576	241	15.3	20001	1731	4661
6	EB	19	351	100	28.5	8210	1682	1721
7	EB	11.5	7	0	0	362	0	141
8	EB	31	265	169	63.8	3695	3980	359
9	EB	33	4952	1544	31.2	216732	41815	52134
10	EB	33.5	2954	2219	75.1	41566	69103	8472
11	EB	36.5	77	21	27.3	2772	678	364
12	EB	36.5	73	22	30.1	2681	754	410
13	EB	31.5	162	4	2.5	13427	123	4225
TOTAL	****	****	10525	4340	****	311972	****	73089
<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	WB	15	100	16	16	3121	198	931
5	WB	8	1340	262	19.6	15794	1842	3585
6	WB	19	290	103	35.5	6264	1645	1355
7	WB	11.5	39	0	0	1821	0	686
8	WB	31	234	154	65.8	2923	3858	222
9	WB	33	5111	2133	41.7	178905	54859	40315
10	WB	33.5	572	165	28.8	31394	4689	8880
11	WB	36.5	83	3	3.6	4198	97	639
12	WB	36.5	79	0	0	4897	0	1007
13	WB	31.5	5398	1	0	444963	20	137479
TOTAL	****	****	13246	2837	****	694281	****	195099
GRAND TOTAL	****	****	23771	7177	503	1006252	187336	268187

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>EB</i>	<i>WB</i>	<i>Total</i>	<i>Percentage</i>
1	0	1	1	0
2	119912	101594	221506	13
3	151118	131368	282486	16.6
4	2787	3320	6107	0.4
5	21733	17636	39368	2.3
6	9893	7909	17802	1
7	362	1821	2183	0.1
8	7675	6782	14456	0.9
9	258547	233764	492311	29
10	110669	36083	146752	8.6
11	3450	4295	7745	0.5
12	3435	4897	8333	0.5
13	13549	444982	458532	27
TOTAL	703130	994452	1697582	100
GVW/LANE	41.42	58.58	100	0.01

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>EB</i>	<i>WB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.3333
2	14	10	24	0.2	9e-04
3	44	31	75	0.5	0.003
4	41	55	96	0.6	0.92
5	202	166	367	2.3	0.25
6	211	124	335	2.1	1.05
7	6	26	32	0.2	1.33
8	75	64	139	0.9	0.56
9	4393	2972	7365	47	1.47
10	938	696	1634	10.4	0.93
11	51	74	125	0.8	1.53
12	32	59	91	0.6	1.19
13	215	5186	5401	34.4	1.95
TOTAL	6221	9462	15683	100	12
ESALS/LANE	39.7	60.3	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>
Jan 2019	136631	4407	857	110055	80.5	26575.5	19.5
Feb 2019	114260	4081	721	94070	82.3	20190.2	17.7
Mar 2019	138776	4477	648	118679	85.5	20096.7	14.5
Apr 2019	140330	4678	641	121113	86.3	19216.6	13.7
May 2019	162937	5174	679	141887	87.1	21050.5	12.9
Jun 2019	156866	5229	642	137597	87.7	19269.2	12.3
Jul 2019	159420	5102	597	140916	88.4	18504.3	11.6
Aug 2019	169242	5447	713	147124	86.9	22117.7	13.1
Sep 2019	152884	5138	780	129490	84.7	23393.9	15.3
Oct 2019	164055	5262	921	135502	82.6	28553.2	17.4
Nov 2019	148982	5013	985	119426	80.2	29556	19.8
Dec 2019	139120	4780	799	114343	82.2	24777.3	17.8
TOTAL	1783503	-	-	1510202	-	273301	-
AVERAGE	148625	4899	749	125850	85	22775	15

###ESALS

<i>Month</i>	<i>ESALS EB Driving Lane</i>	<i>ESALS WB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Jan 2019	7551	12934	20486	3.3
Feb 2019	7266	8726	15992	3.6
Mar 2019	7505	7468	14973	2.2
Apr 2019	7081	5767	12848	0.6
May 2019	7030	6625	13655	0.7
Jun 2019	14609	11559	26168	1
Jul 2019	7391	4814	12205	1.8
Aug 2019	8503	6385	14889	2.2
Sep 2019	8209	6482	14690	0.9
Oct 2019	12116	14023	26139	1.7
Nov 2019	8078	10721	18799	1.8
Dec 2019	6229	9498	15727	3.1
TOTAL	101569	-	-	-
AVERAGE	8464	8750	17214	2

###Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Jan 19	748717	1130601	1879318
Feb 19	624281	797364	1421645

Mar 19	705802	775079	1480881
Apr 19	705844	678545	1384390
May 19	771941	774947	1546888
Jun 19	1512692	1451859	2964551
Jul 19	779280	638532	1417812
Aug 19	836256	809778	1646034
Sep 19	806828	821209	1628037
Oct 19	1250632	1500920	2751552
Nov 19	843318	1106210	1949528
Dec 19	703311	996424	1699735
TOTAL	10288905	11481469	21770373
AVERAGE	857409	956789	1814198

###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>
Jan 2019	6767	5	25.7	3243	48
Feb 2019	4196	3.8	21.2	1582	67
Mar 2019	2644	1.9	13.3	916	32
Apr 2019	1066	0.8	5.6	213	20
May 2019	1059	0.7	5.1	246	37
Jun 2019	2304	0.7	6	528	106
Jul 2019	1055	0.7	5.9	240	43
Aug 2019	1367	0.8	6.2	229	51
Sep 2019	2137	1.4	9.2	297	55
Oct 2019	5352	2.3	13.2	1028	74
Nov 2019	4939	3.4	16.8	1052	57
Dec 2019	4611	3.5	19	1053	100
TOTAL	37497	-	-	10627	690
AVERAGE	3124.8	2.1	12.3	885.6	57.5

###Freight

<i>Month</i>	<i>EB Freight Tons</i>	<i>WB Freight Tons</i>	<i>Total Freight</i>	<i>EB Freight %</i>	<i>WB Freight %</i>
Jan 2019	81765	228122	309886	26.4	73.6
Feb 2019	80540	135572	216113	37.3	62.7
Mar 2019	86502	104160	190662	45.4	54.6
Apr 2019	86278	71227	157505	54.8	45.2
May 2019	85927	83228	169155	50.8	49.2
Jun 2019	176389	142159	318548	55.4	44.6

Jul 2019	89515	60126	149641	59.8	40.2
Aug 2019	100384	84516	184900	54.3	45.7
Sep 2019	98378	104905	203283	48.4	51.6
Oct 2019	141637	238961	380597	37.2	62.8
Nov 2019	89319	204493	293812	30.4	69.6
Dec 2019	73089	195099	268187	27.3	72.7
TOTAL	1189722	1652568	2842290	-	-
AVERAGE	99143.5	137714	236857.5	43.9	56.1
