

MARCH 2018



**WIM #37
I-94, MP 200.1
OTSEGO, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #37 is located on I-94 near Otsego in Wright county. The WIM is located only on the westbound (WB) side of I-94, meaning that all data mentioned in this report pertains to WB traffic only (Lanes 1 and 2).

System Operation

WIM #37 was operational for the entire month of March 2018. Volume was computed using all monthly data.

System Calibration

WIM #37 was most recently calibrated on 2017-03-23. 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 the Class 9s at this site for the last 12 months 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: 891514 | Passenger Vehicles: 777288 | Heavy Commercial Vehicles: 114226

Monthly Average Daily Traffic (MADT): 28759 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 3685

See Table 2 for vehicle class breakdown

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

Volume trends. 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), WB PVs generally reached peak volume levels between 03 PM and 05 PM.

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling WB typically reached peak volume levels 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 114226 HCVs, 8635 of them were overweight ³. These overweight HCVs contributed to 1% of total monthly volume, and 7.7% of total monthly

HCV volume. WB overweight vehicles typically reached highest numbers 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 (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 ,1213 WB vehicles exceeded 88,000 pounds (814 vehicles were Class 9's; 201 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from March 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9's and 10's in March 2018. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling WB Data also suggests that there were more NA Class 10's than NA traveling in the WB direction.

Freight Totals. A total of 1048394 tons of freight was recorded to have crossed the WIM. See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 86817 is approximately 1.2 miles east of WIM #37 and Bridge No. 86813 is approximately 4.7 miles west of WIM #37. WIM #37 recorded a total of 891514 vehicles with a combined GVW of 8921497 kips (1 kip = 1,000 pounds = 0.5 tons) in March 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 90998 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 76% 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>

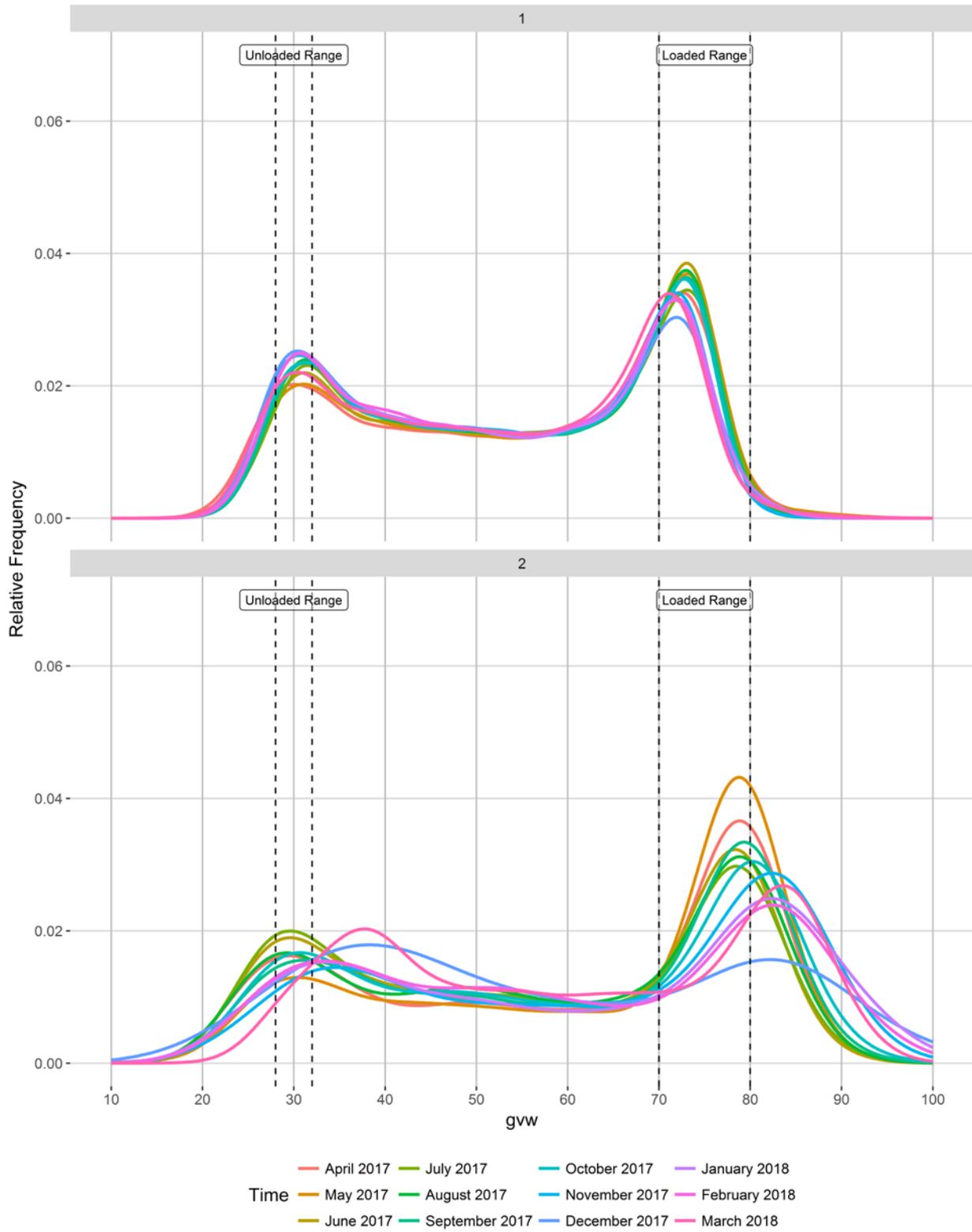
- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to

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.

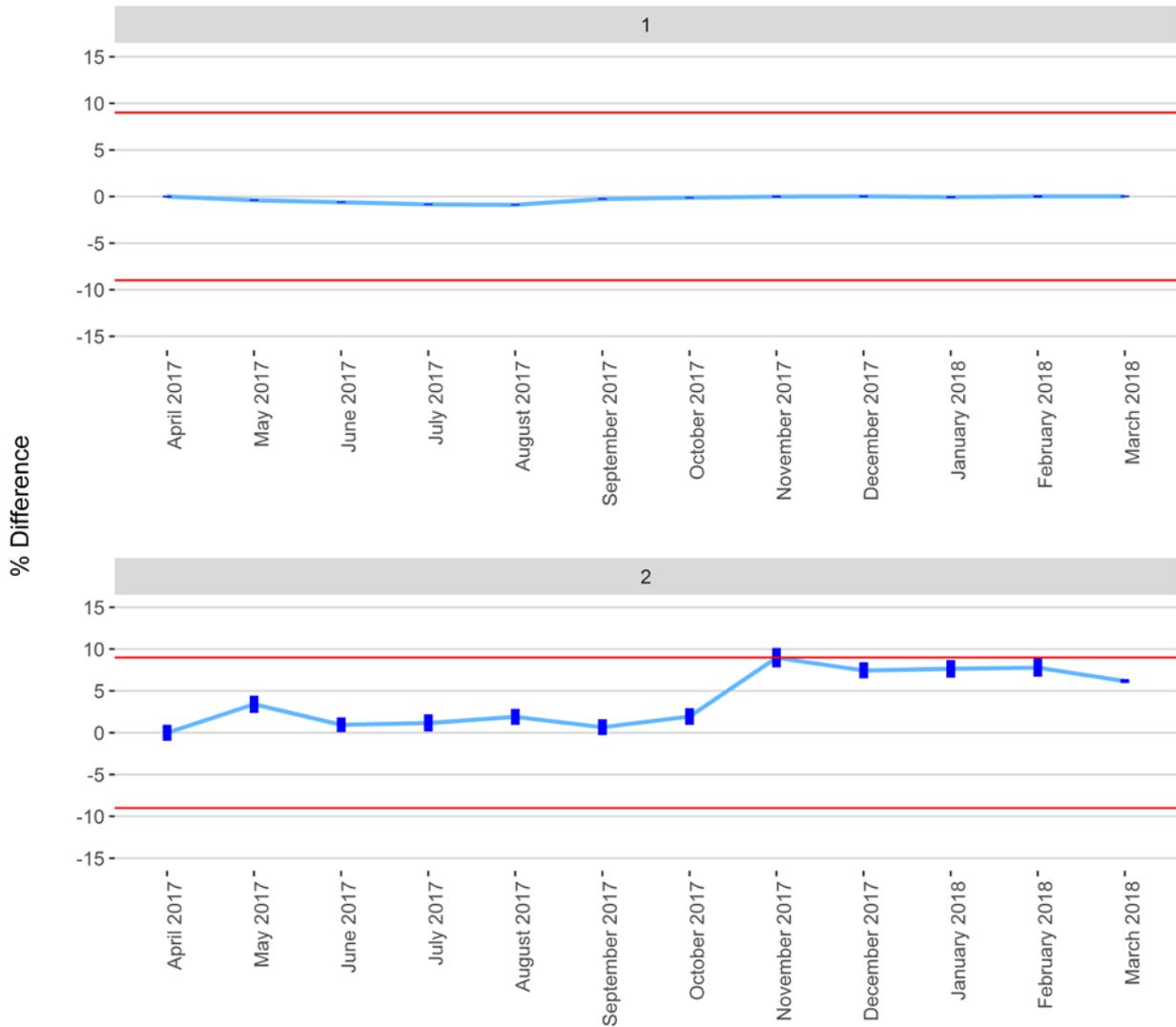
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Figure 1 - Monthly Class 9 GVW Histogram



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

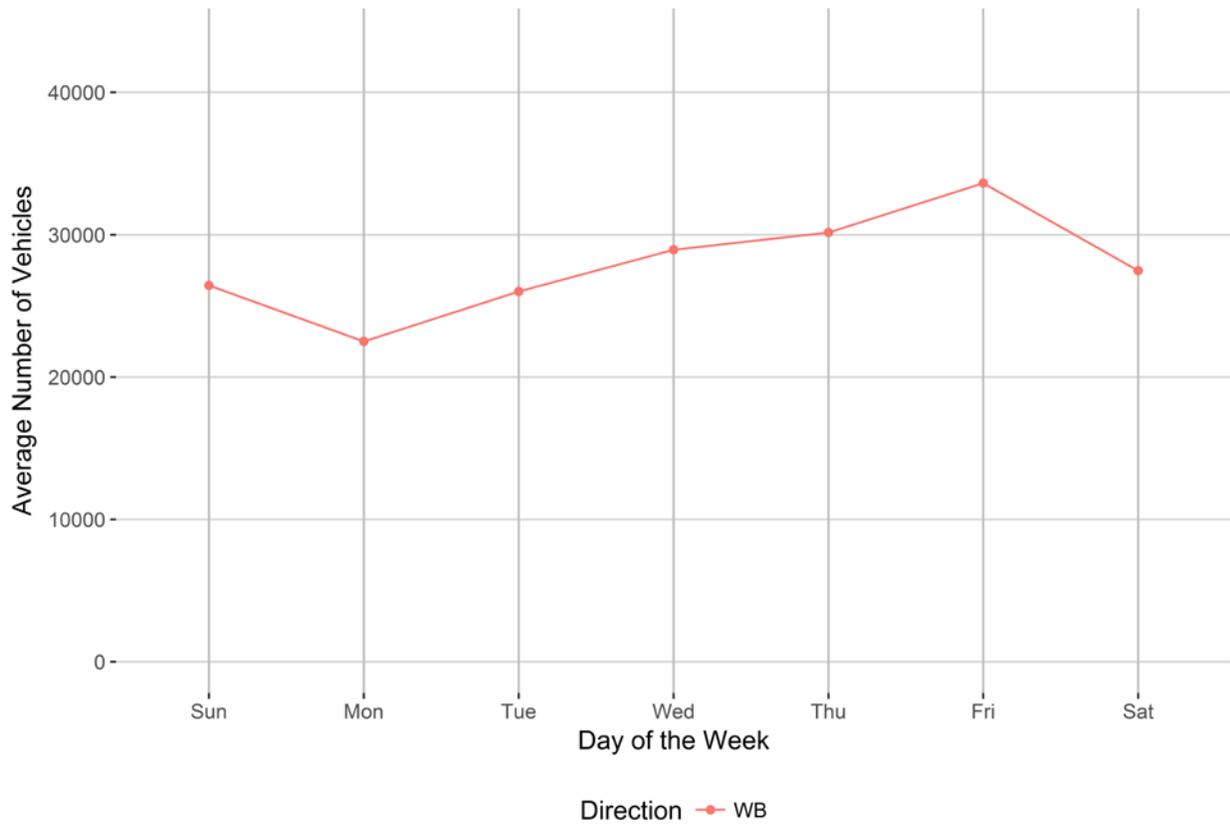


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

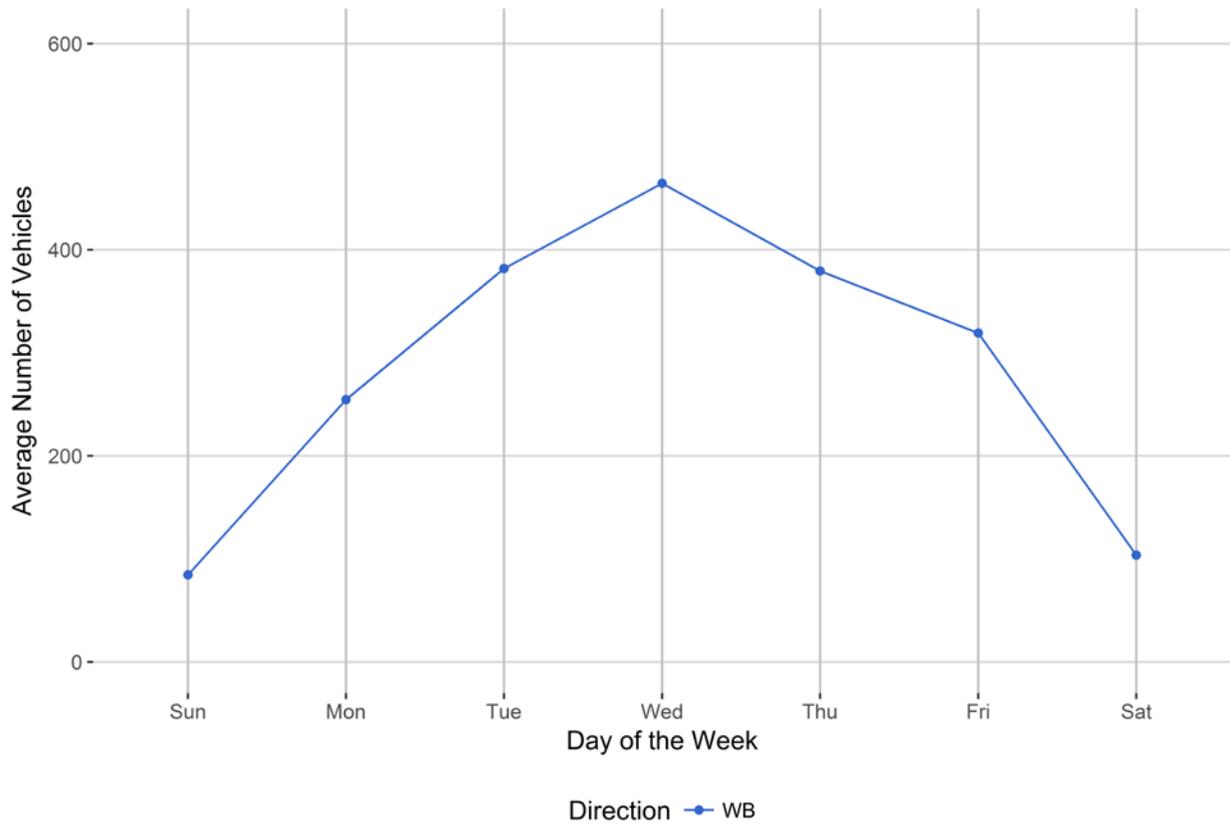


Figure 4 - Passenger Vehicles vs. Hour of the Day

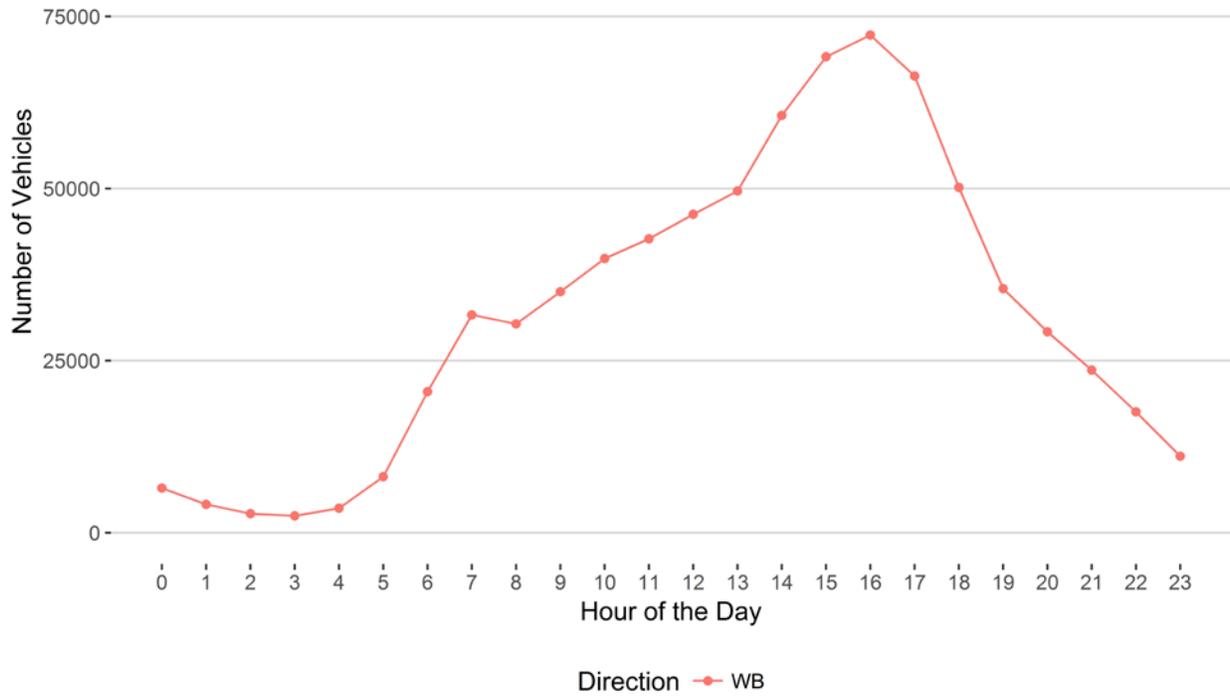


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

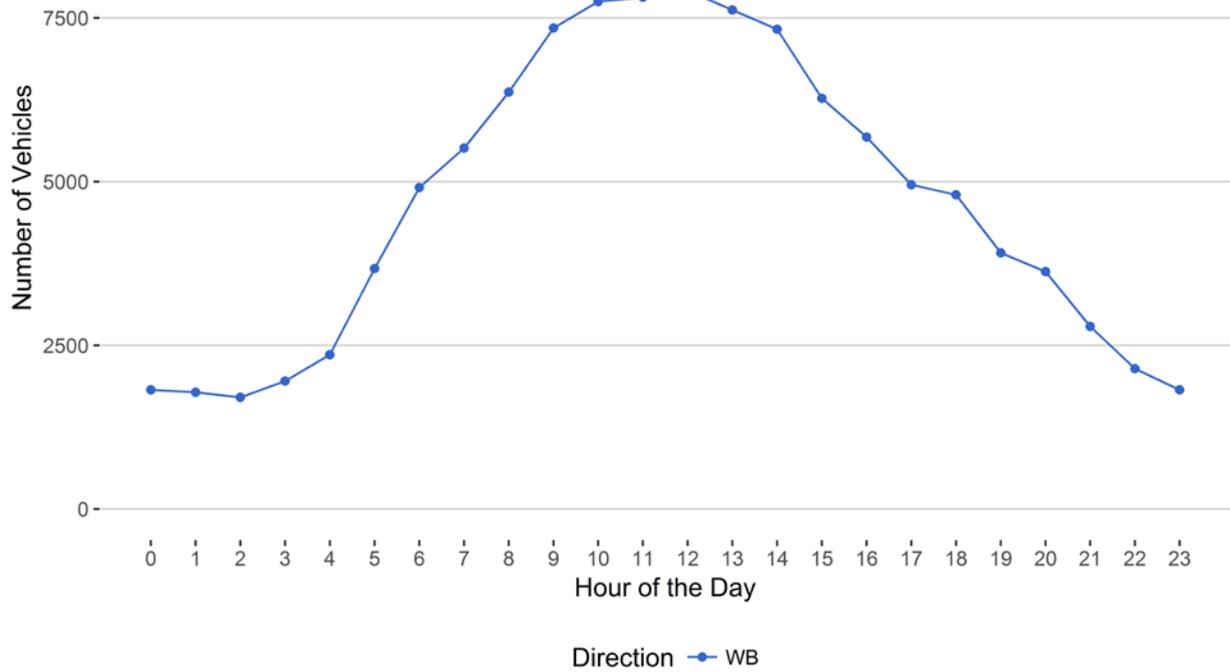


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

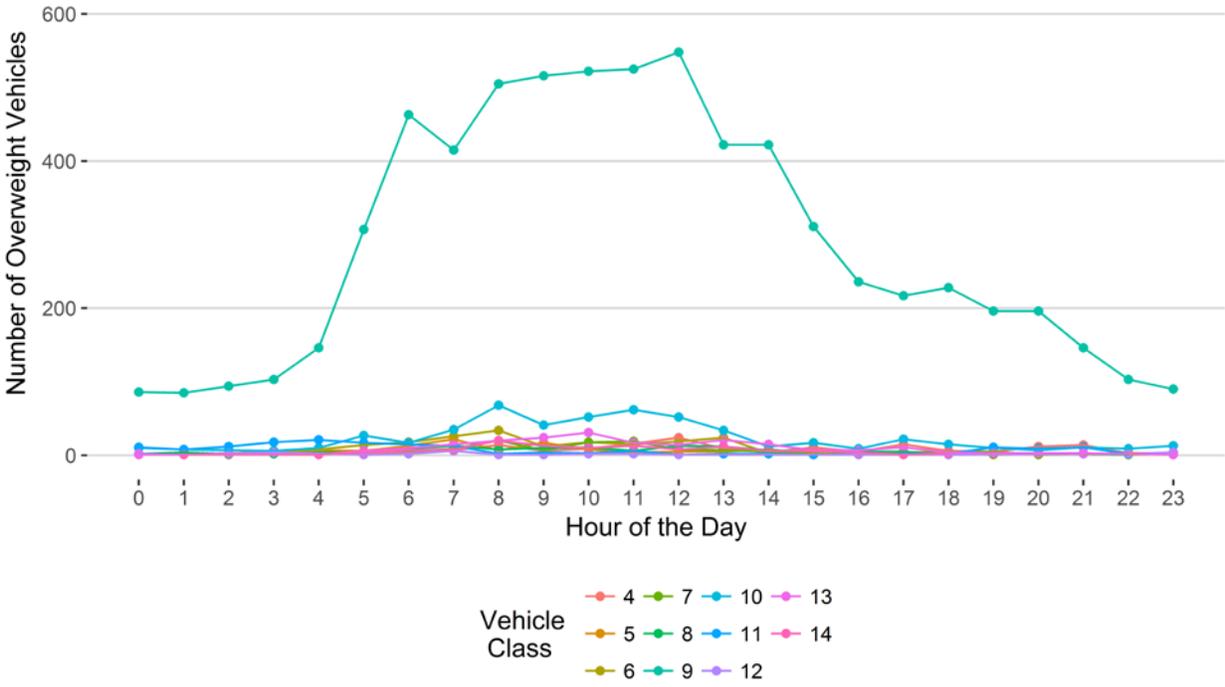


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

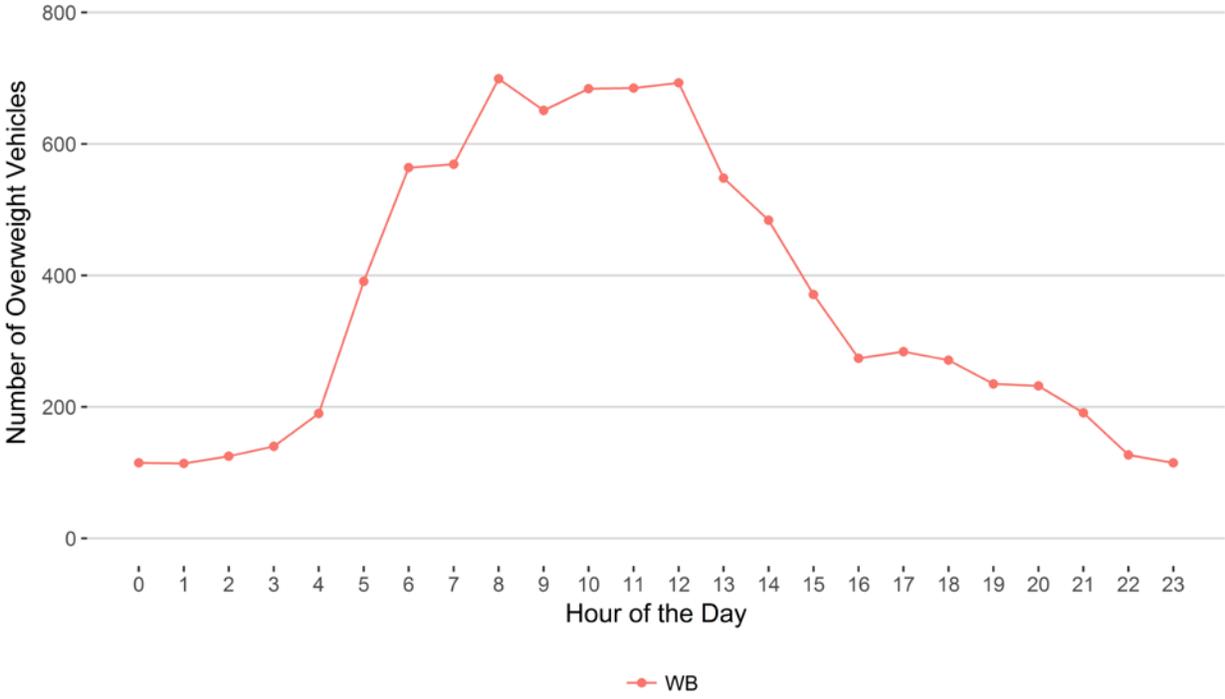
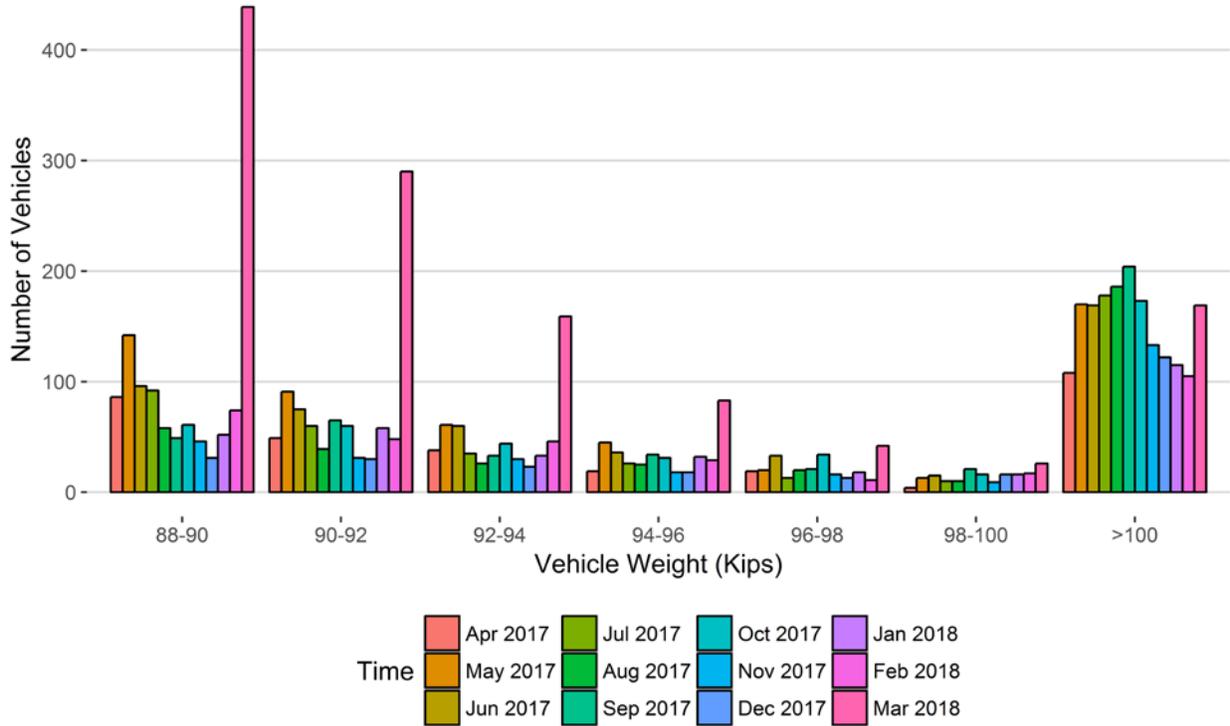


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Apr 2017	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018
88-90	86	142	96	92	58	49	61	46	31	52	74	439
90-92	49	91	75	60	39	65	60	31	30	58	48	290
92-94	38	61	60	35	26	33	44	30	23	33	46	159
94-96	19	45	36	26	25	34	31	18	18	32	29	83
96-98	19	20	33	13	20	21	34	16	13	18	11	42
98-100	4	13	15	10	10	21	16	9	16	16	17	26
>100	108	170	169	178	186	204	173	133	122	115	105	169
Total	323	542	484	414	364	427	419	283	253	324	330	1208

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

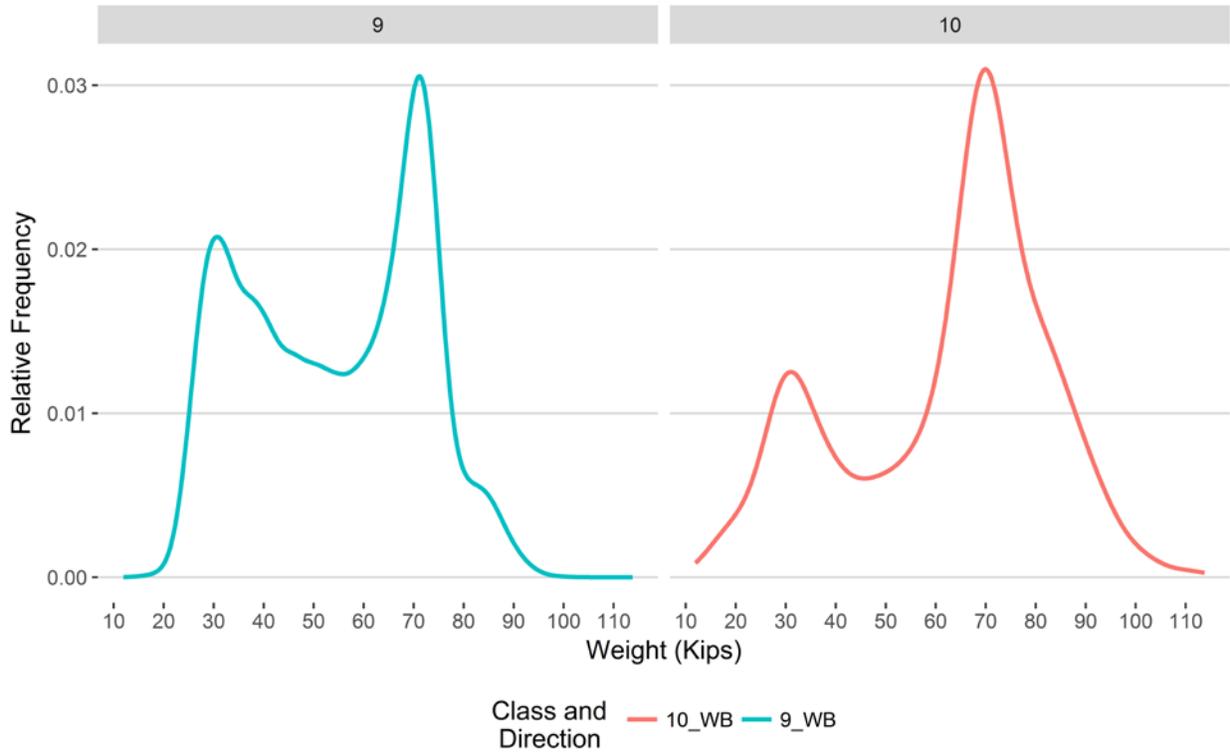


Figure 9 - Freight Percentage by Direction and Class

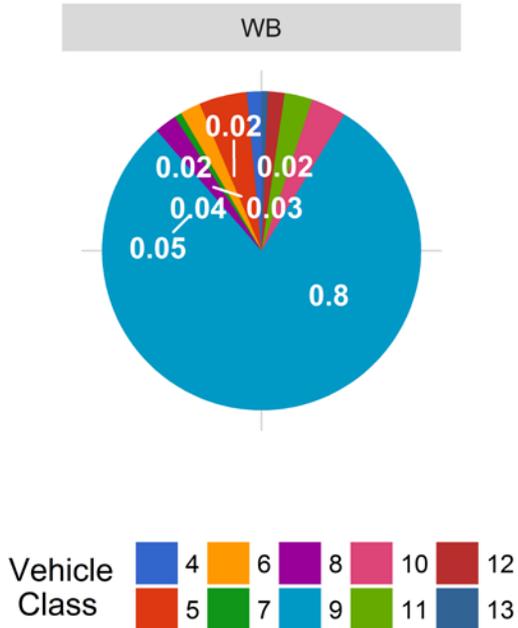


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

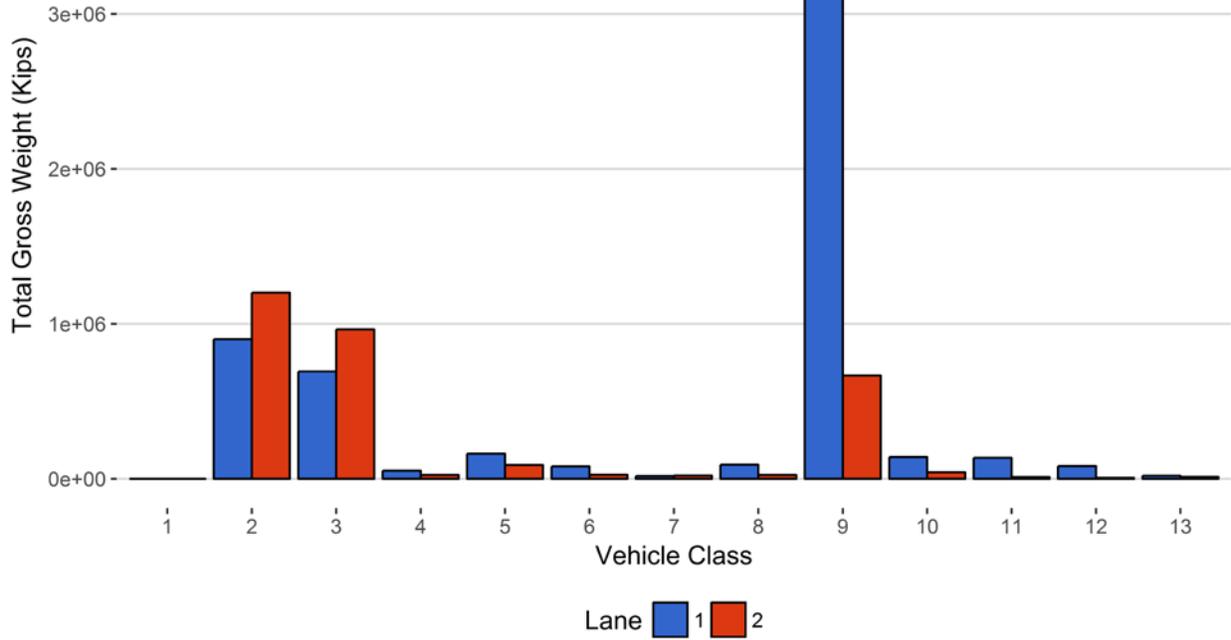


Figure 11 - Total Gross Vehicle Weight I

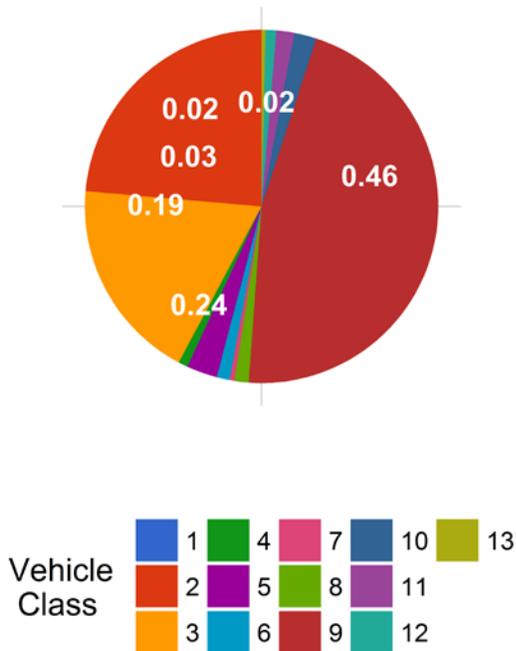


Figure 12 - Total ESALs by Class and Lane

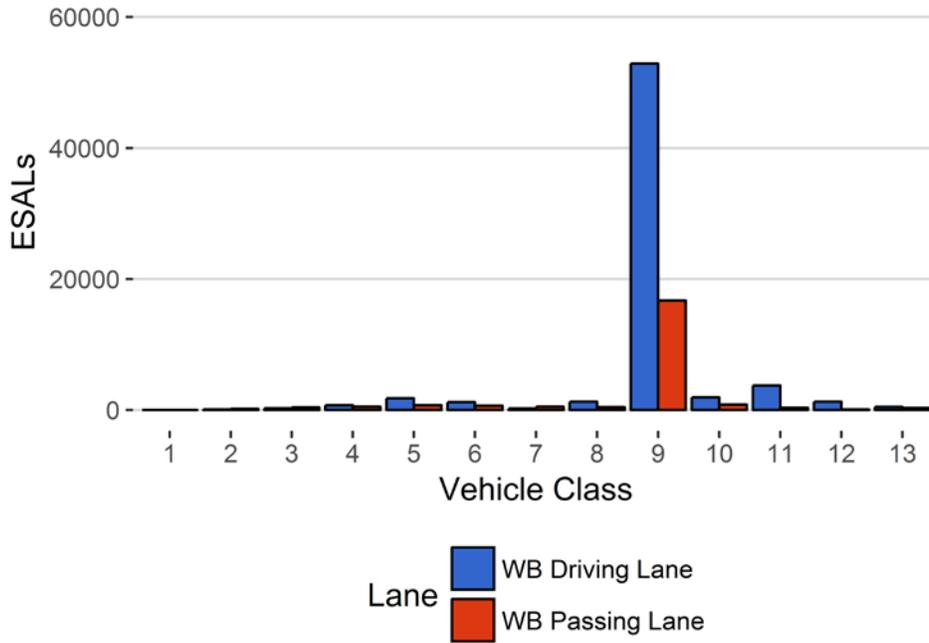


Figure 13 - ESALs by Class

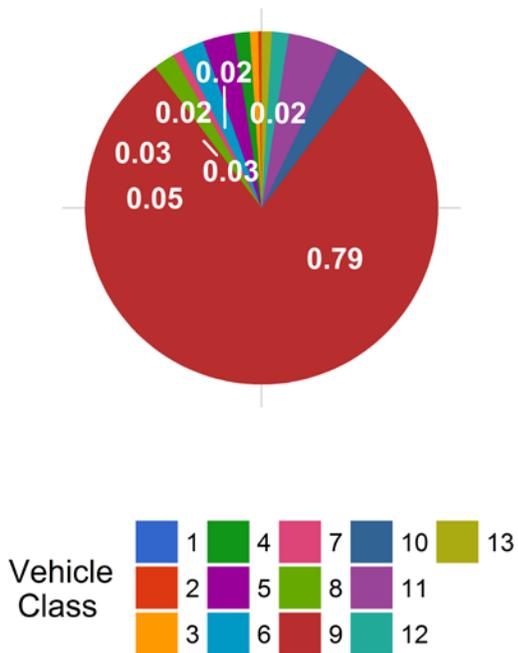


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
April 2017	10.54	0.00	11.79	0.00
May 2017	10.50	-0.39	12.19	3.41
June 2017	10.48	-0.62	11.90	0.95
July 2017	10.45	-0.84	11.92	1.16
August 2017	10.45	-0.89	12.01	1.90
September 2017	10.52	-0.26	11.86	0.67
October 2017	10.53	-0.12	12.02	1.94
November 2017	10.54	0.00	12.84	8.98
December 2017	10.55	0.02	12.67	7.46
January 2018	10.54	-0.06	12.69	7.65
February 2018	10.55	0.02	12.70	7.79
March 2018	10.55	0.02	12.51	6.17

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	4	0	0	0
2	16720	518319	58.1	0	0
3	8354	258965	29	0	0
4	94	2912	0.3	172	2
5	597	18518	2.1	132	1.5
6	115	3552	0.4	218	2.5
7	32	1000	0.1	124	1.4
8	127	3952	0.4	129	1.5
9	2493	77268	8.7	6882	79.7
10	96	2969	0.3	554	6.4
11	75	2315	0.3	173	2
12	45	1380	0.2	36	0.4
13	12	360	0	215	2.5
TOTAL	28759	891514	100	8635	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>
2018-03-15	Thursday	08:24:21	9	WB	2	160.88
2018-03-27	Tuesday	04:27:31	9	WB	2	154.82
2018-03-13	Tuesday	08:13:48	9	WB	2	148.77
2018-03-07	Wednesday	09:08:31	9	WB	2	148.46
2018-03-20	Tuesday	10:48:24	9	WB	2	144.65
2018-03-02	Friday	11:01:00	9	WB	2	126.92
2018-03-04	Sunday	10:25:38	10	WB	2	125.77
2018-03-12	Monday	00:56:36	9	WB	2	119.69
2018-03-13	Tuesday	10:50:26	9	WB	2	119.22
2018-03-13	Tuesday	11:28:15	10	WB	2	118.4

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	WB	15	2852	480	16.8	70270	6406	17345
5	WB	8	18134	1642	9.1	238561	11895	53313
6	WB	19	3478	503	14.5	96831	8746	20153
7	WB	11.5	979	7	0.7	38679	76	13751
8	WB	31	3870	2154	55.7	67912	47797	7358
9	WB	33	75665	12708	16.8	3741355	365404	831887
10	WB	33.5	2907	433	14.9	169699	11768	43410
11	WB	36.5	2267	34	1.5	144766	1056	31631
12	WB	36.5	1351	21	1.6	86877	645	19166
13	WB	31.5	353	4	1.1	31755	101	10381
TOTAL	****	****	111856	17986	****	4686706	****	1048394

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>WB Driving Lane</i>	<i>WB Passing Lane</i>	<i>Total</i>	<i>Percentage</i>
1	3	2	4	0
2	901219	1200878	2102096	23.6
3	692417	964265	1656682	18.6
4	52276	24401	76677	0.9
5	161734	88723	250456	2.8
6	79998	25579	105577	1.2
7	17461	21295	38756	0.4
8	91264	24445	115709	1.3
9	3440635	666125	4106759	46.1
10	139944	41524	181467	2
11	135410	10412	145822	1.6
12	81413	6109	87522	1
13	19556	12300	31856	0.4
TOTAL	5813327	3086058	8899385	100
GVW/LANE	65.32	34.68	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>WB Driving Lane</i>	<i>WB Passing Lane</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.2
2	103	168	272	0.3	0.0011
3	267	404	671	0.8	0.0053
4	744	508	1252	1.4	0.88
5	1795	744	2539	2.9	0.28
6	1200	658	1857	2.1	1.07
7	241	511	752	0.9	1.53
8	1260	435	1695	1.9	0.88
9	52889	16712	69601	79.4	1.84
10	1927	828	2755	3.1	1.89
11	3750	349	4099	4.7	3.61
12	1257	94	1351	1.5	1.99
13	488	331	818	0.9	4.51
TOTAL	65920	21743	87663	100	19
ESALS/LANE	75.2	24.8	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>
Apr 2017	914072	30469	3503	808983	88.5	105088.6	11.5
May 2017	980832	31640	3814	862596	87.9	118235.9	12.1
Jun 2017	1035311	34510	4042	914057	88.3	121254	11.7
Jul 2017	1042528	33630	3684	928333	89	114195.2	11
Aug 2017	1085741	35024	3979	962396	88.6	123345.5	11.4
Sep 2017	971749	32392	3802	857703	88.3	114045.8	11.7
Oct 2017	964314	31107	3898	843483	87.5	120831.4	12.5
Nov 2017	870827	29028	2971	781684	89.8	89143	10.2
Dec 2017	861735	27798	2856	773186	89.7	88548.6	10.3
Jan 2018	786355	25366	2885	696926	88.6	89429.4	11.4
Feb 2018	731714	26133	3001	647696	88.5	84018.2	11.5
Mar 2018	891514	28758	3685	777288	87.2	114225.9	12.8
TOTAL	11136692	--	--	9854331	--	1282362	--
AVERAGE	928058	30488	3510	821194	88	106863	12

ESALS

<i>Month</i>	<i>ESALS WB Driving Lane</i>	<i>ESALS WB Passing Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Apr 2017	68500	9043	77543	1.4
May 2017	79233	11675	90908	2.4
Jun 2017	78317	11346	89663	2.1
Jul 2017	72545	11473	84018	1.6
Aug 2017	78120	17210	95329	1.2
Sep 2017	71448	17904	89353	1.1
Oct 2017	74092	13806	87898	1
Nov 2017	52468	12005	64473	1.7
Dec 2017	56619	5356	61975	1.9
Jan 2018	68067	10039	78106	1.2
Feb 2018	53421	7393	60815	1.6
Mar 2018	68692	22307	90998	2.7
TOTAL	821522	--	--	--
AVERAGE	68460	12463	80923	2

Gross Vehicle Weight

<i>Month</i>	<i>GVW WB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>Total GVW Kips</i>
Apr 2017	5022577	2017371	7039948
May 2017	4627274	1899924	6527198
Jun 2017	5819299	3102304	8921603
Jul 2017	5828012	2490336	8318348
Aug 2017	6519459	2682815	9202274
Sep 2017	6656768	2984914	9641682
Oct 2017	6419065	2950979	9370045
Nov 2017	6869439	3007734	9877174
Dec 2017	6264517	2813582	9078098
Jan 2018	6472379	2845191	9317570
Feb 2018	5031471	2309308	7340779
Mar 2018	5296388	2102076	7398464
TOTAL	70826648	31206535	102033183
AVERAGE	5902221	2600545	8502765

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>
Apr 2017	6274	0.7	5.9	329	113
May 2017	7310	0.8	6.2	553	188
Jun 2017	6542	0.7	5.3	491	186
Jul 2017	6484	0.6	5.6	420	190
Aug 2017	6125	0.6	4.9	366	198
Sep 2017	6376	0.7	5.5	435	229
Oct 2017	6672	0.7	5.4	423	189
Nov 2017	4048	0.5	4.6	286	142
Dec 2017	3927	0.5	4.5	254	139
Jan 2018	4659	0.6	5.3	344	141
Feb 2018	3808	0.5	4.6	334	125
Mar 2018	8752	1	7.8	1213	198
TOTAL	70977	--	--	5448	2038
AVERAGE	5914.8	0.7	5.5	454	169.8

Freight

<i>Month</i>	<i>WB Freight Tons</i>
Apr 2017	939132
May 2017	1081072
Jun 2017	1087451
Jul 2017	1008664
Aug 2017	1076902
Sep 2017	1013502
Oct 2017	1063947
Nov 2017	728121
Dec 2017	735210
Jan 2018	745526
Feb 2018	694995
Mar 2018	1048394
TOTAL	11222917
AVERAGE	935243.1