

MAY 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 May 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: 1028083 | Passenger Vehicles: 892548 | Heavy Commercial Vehicles: 135535

Monthly Average Daily Traffic (MADT): 33164 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 4372

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 135535 HCVs, 9729 of them were overweight ³. These overweight HCVs contributed to 1% of total monthly volume, and 7.3% of total monthly

HCV volume. WB overweight vehicles typically reached highest numbers on Thursdays, 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 ,733 WB vehicles exceeded 88,000 pounds (285 vehicles were Class 9's; 246 vehicles were Class 13'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 9's and 10's in May 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 1252655 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 1028083 vehicles with a combined GVW of 10425385 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 103278 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 77% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 45% 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>

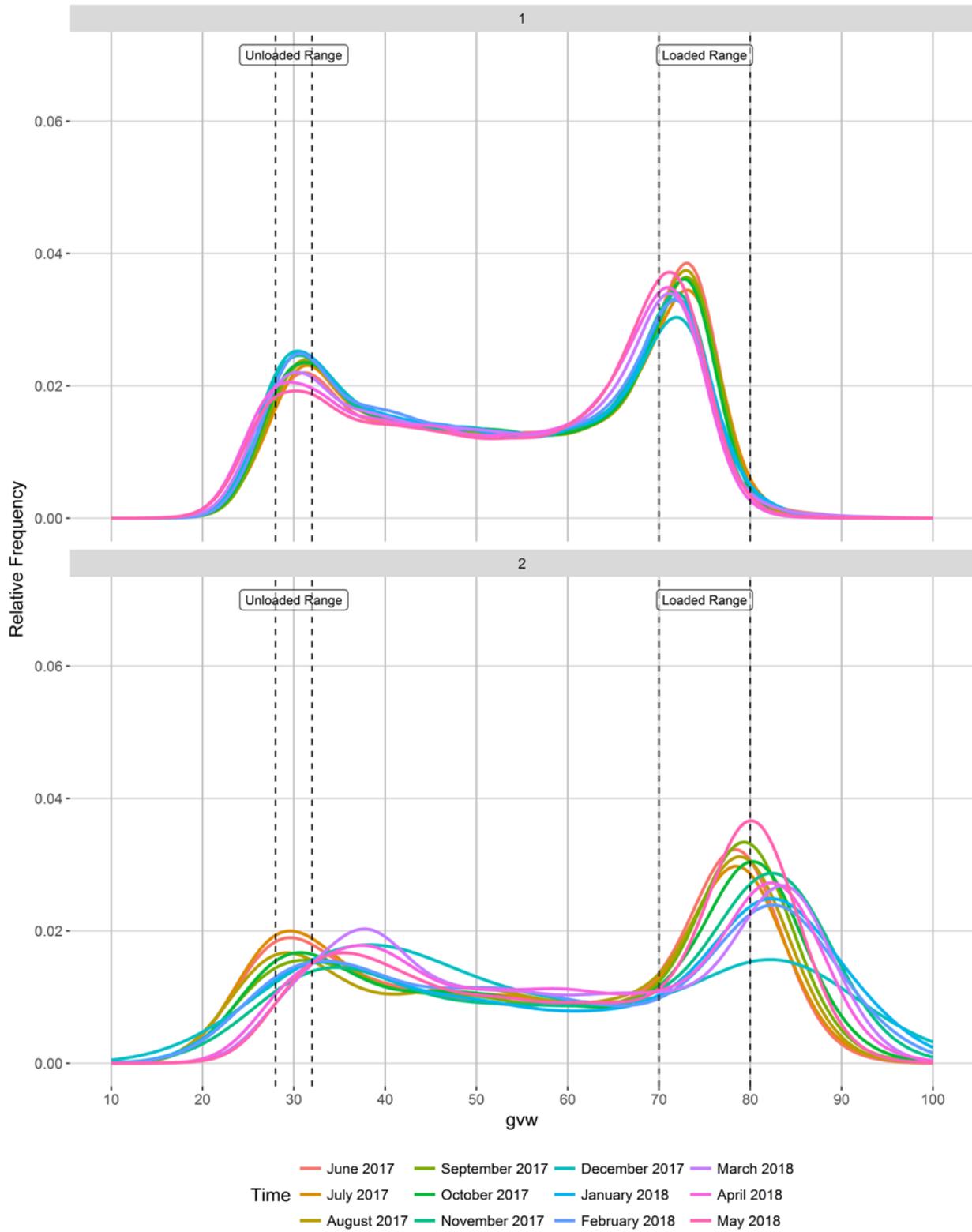
- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to

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.

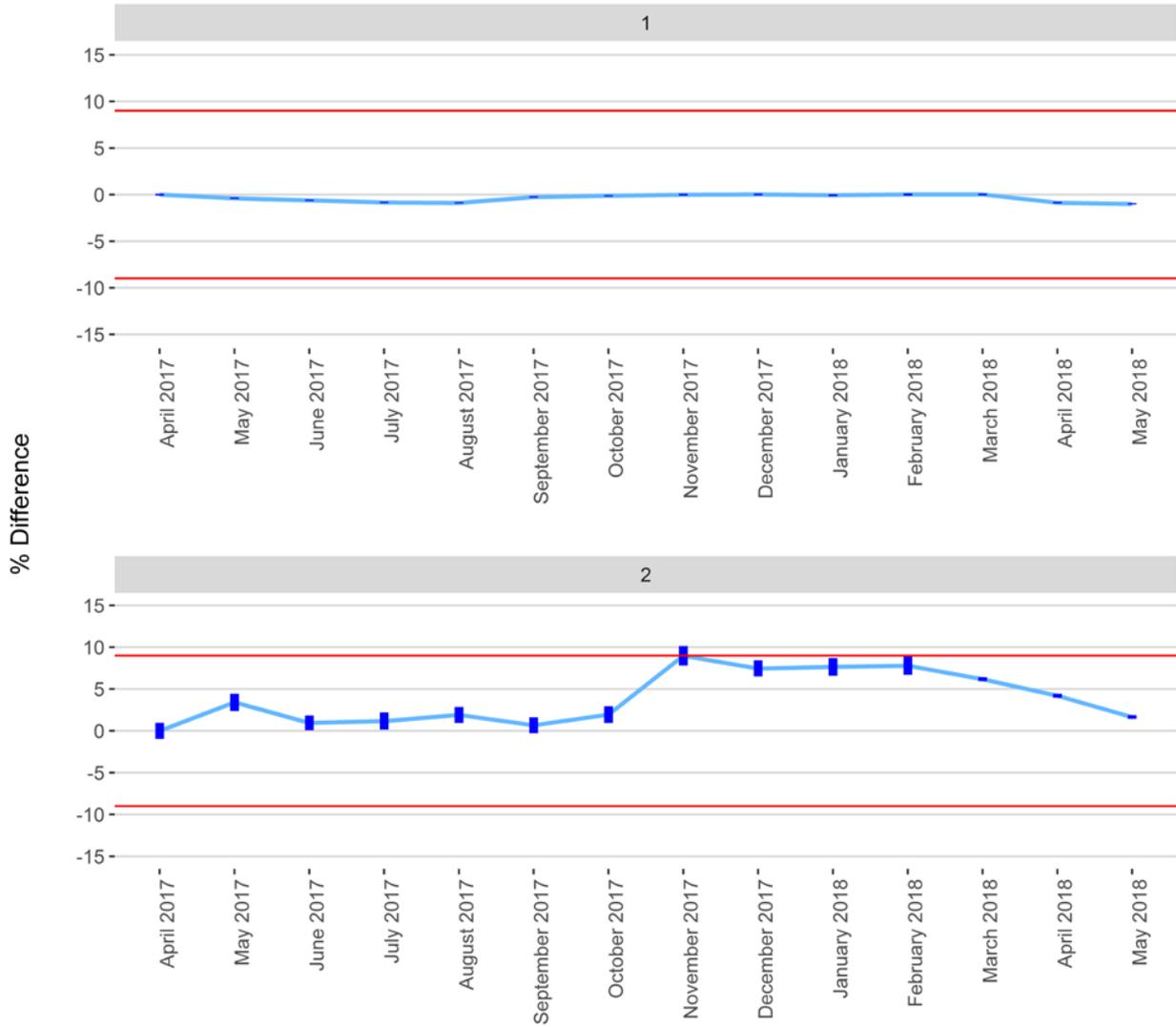
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Figure 1 - Monthly Class 9 GVW Histogram



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

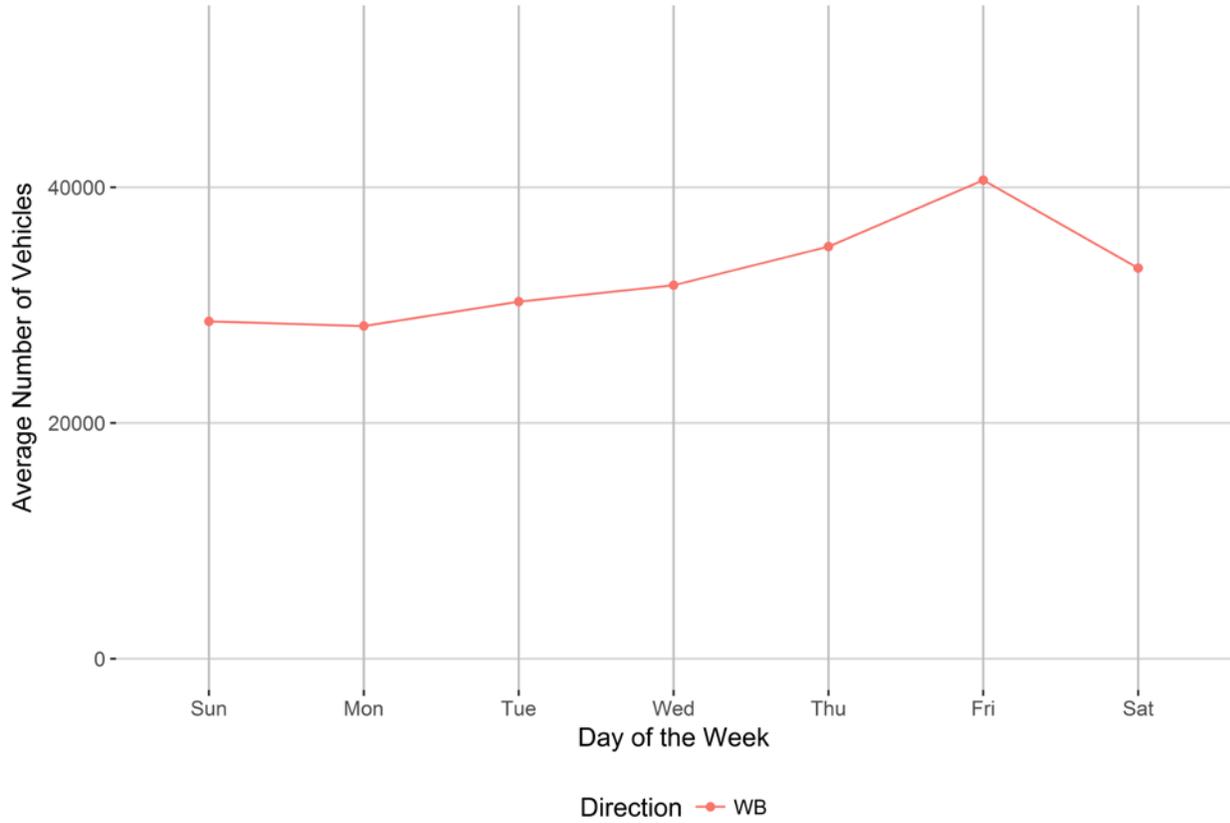


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

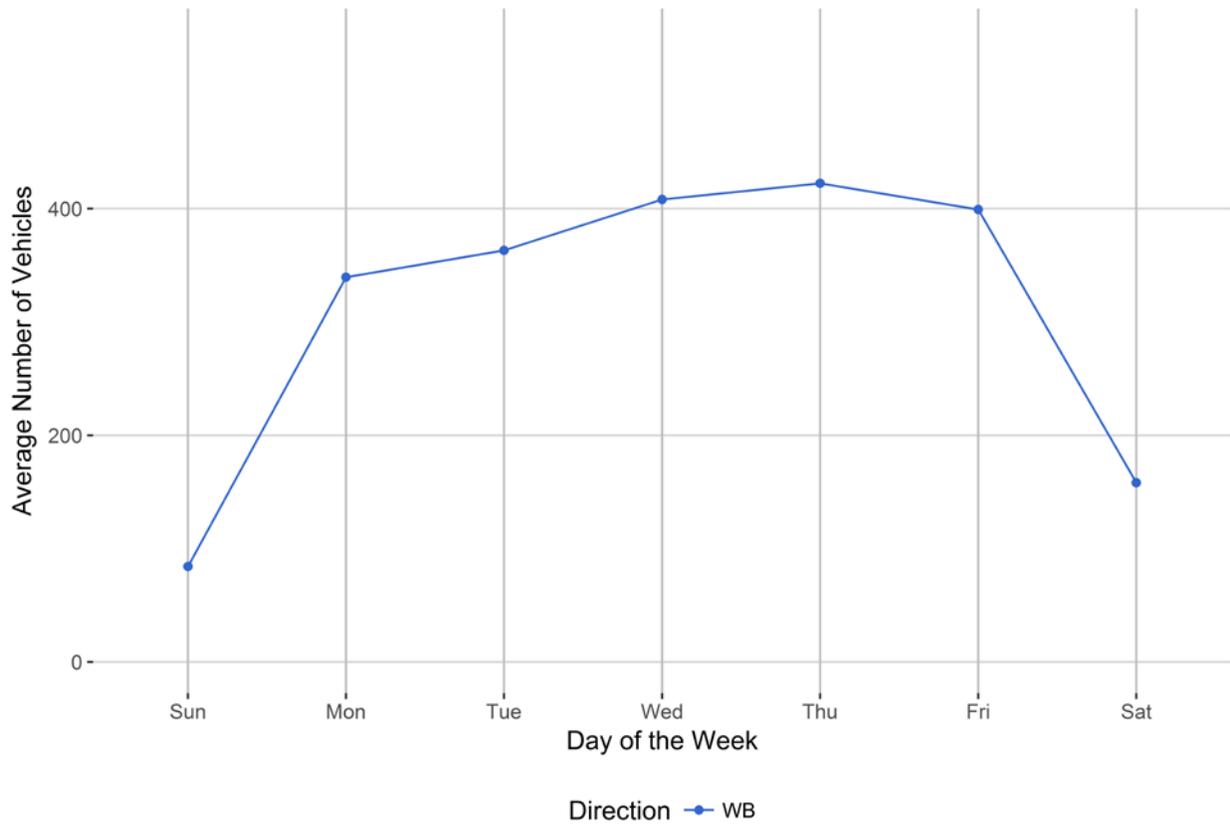


Figure 4 - Passenger Vehicles vs. Hour of the Day

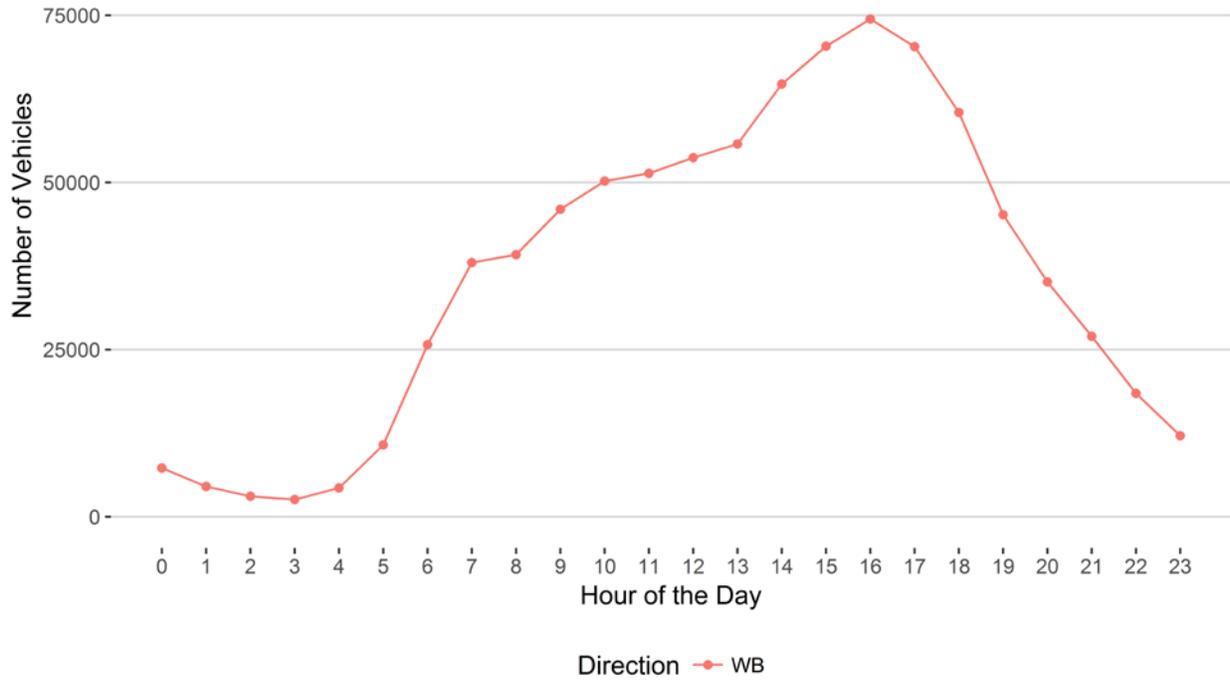


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

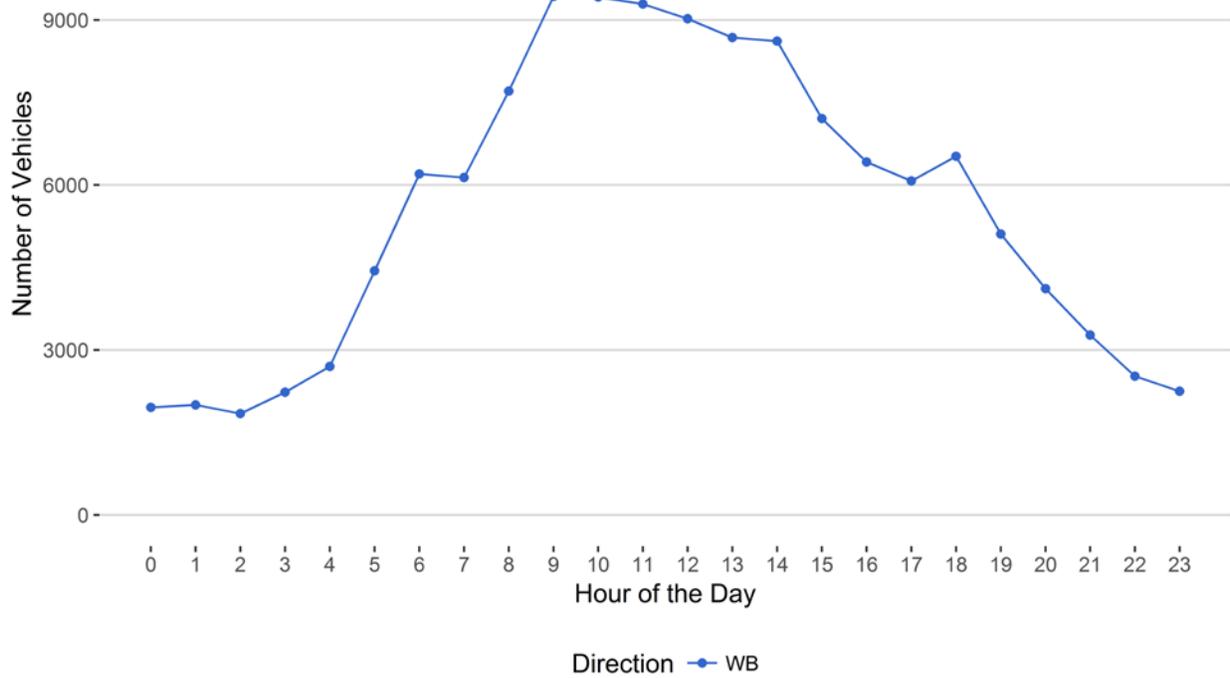


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

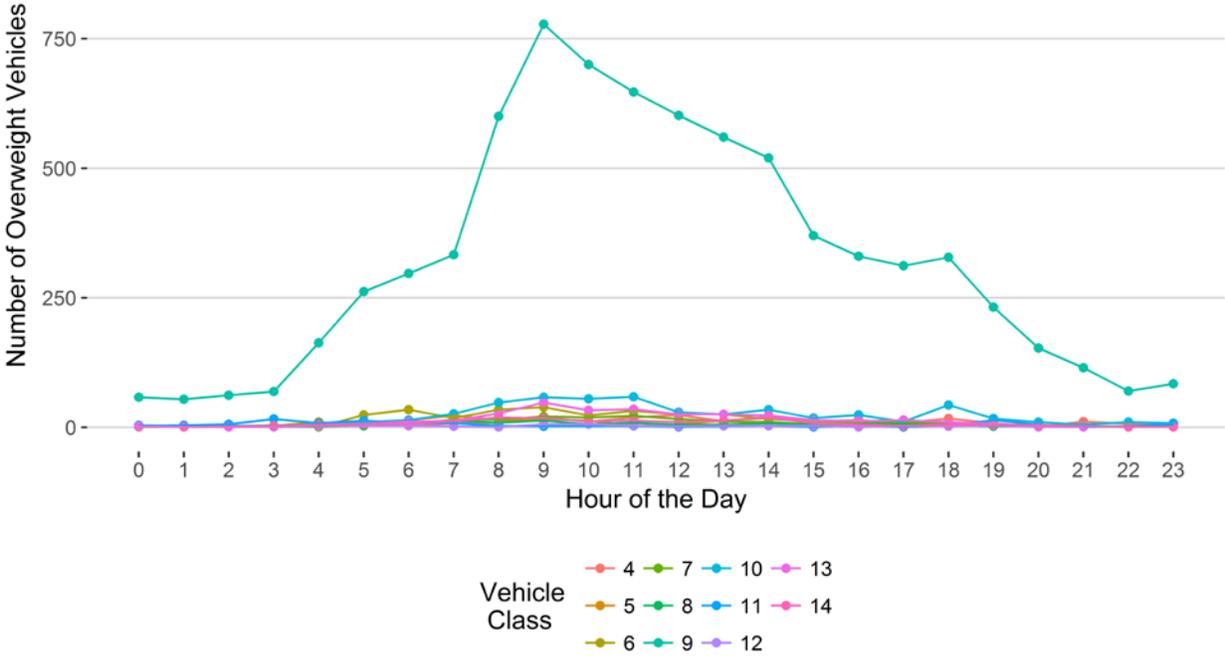


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

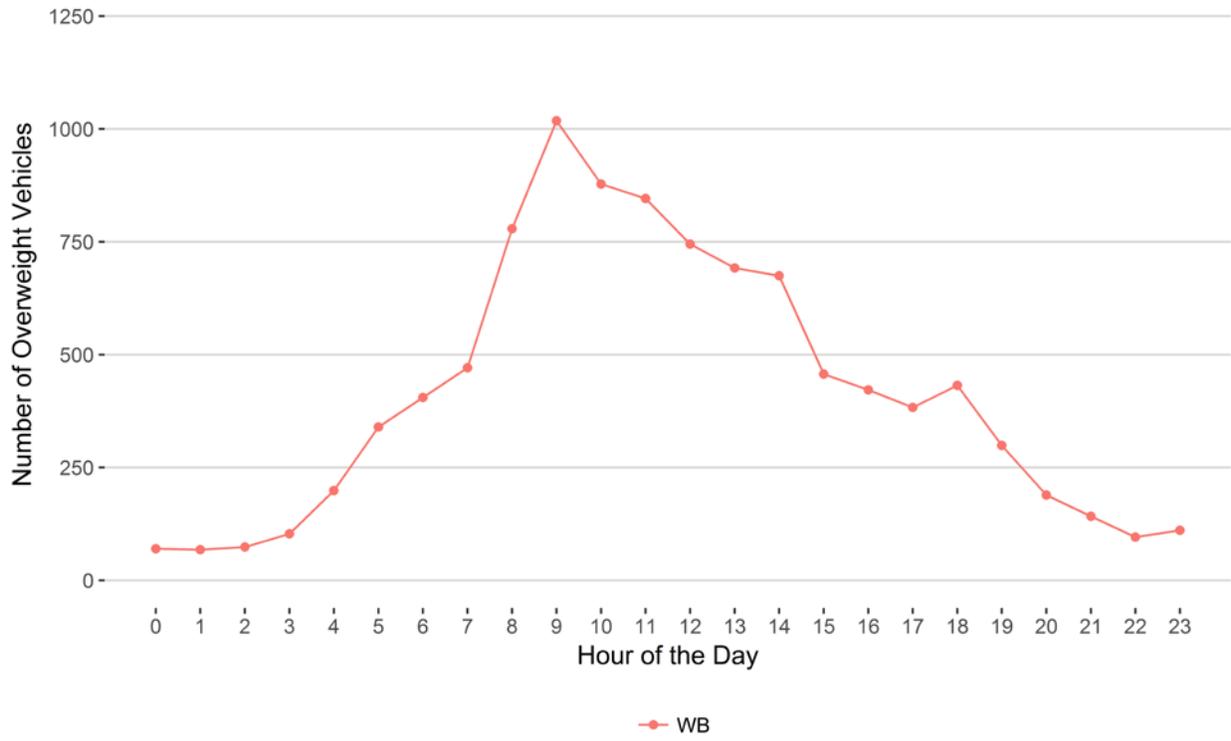
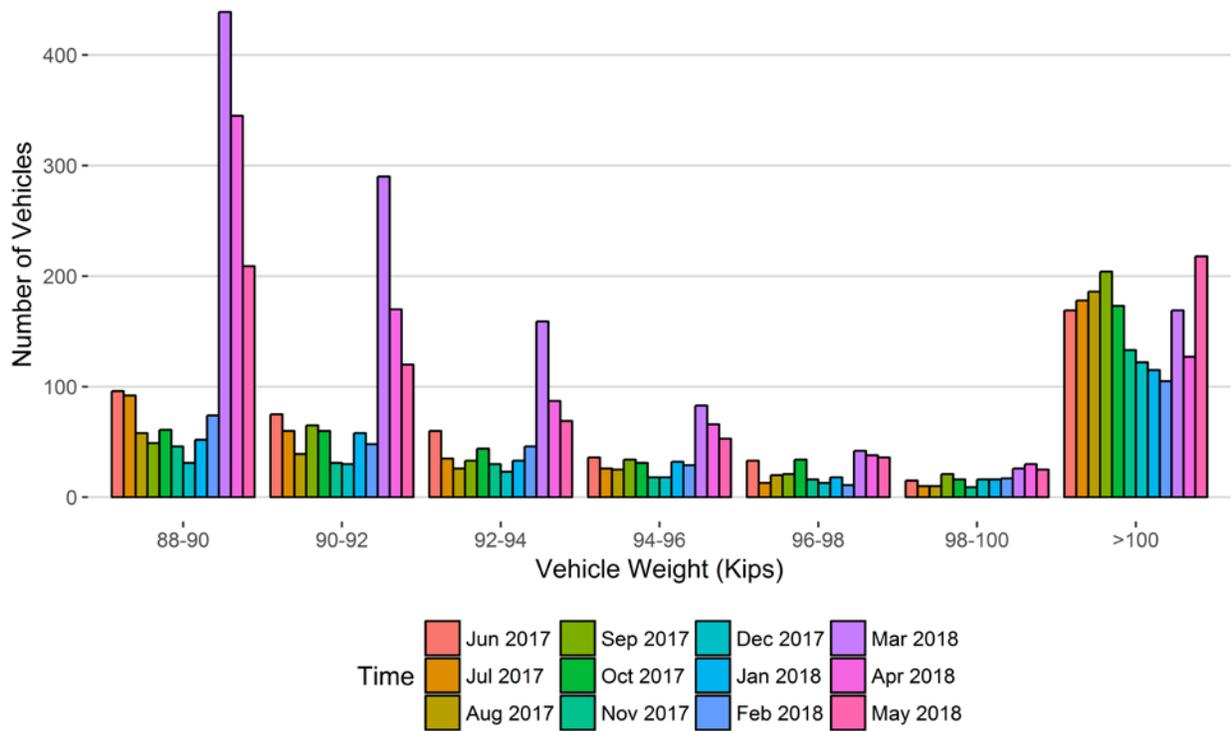


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	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	96	92	58	49	61	46	31	52	74	439	345	209
90-92	75	60	39	65	60	31	30	58	48	290	170	120
92-94	60	35	26	33	44	30	23	33	46	159	87	69
94-96	36	26	25	34	31	18	18	32	29	83	66	53
96-98	33	13	20	21	34	16	13	18	11	42	38	36
98-100	15	10	10	21	16	9	16	16	17	26	30	25
>100	169	178	186	204	173	133	122	115	105	169	127	218
Total	484	414	364	427	419	283	253	324	330	1208	863	730

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

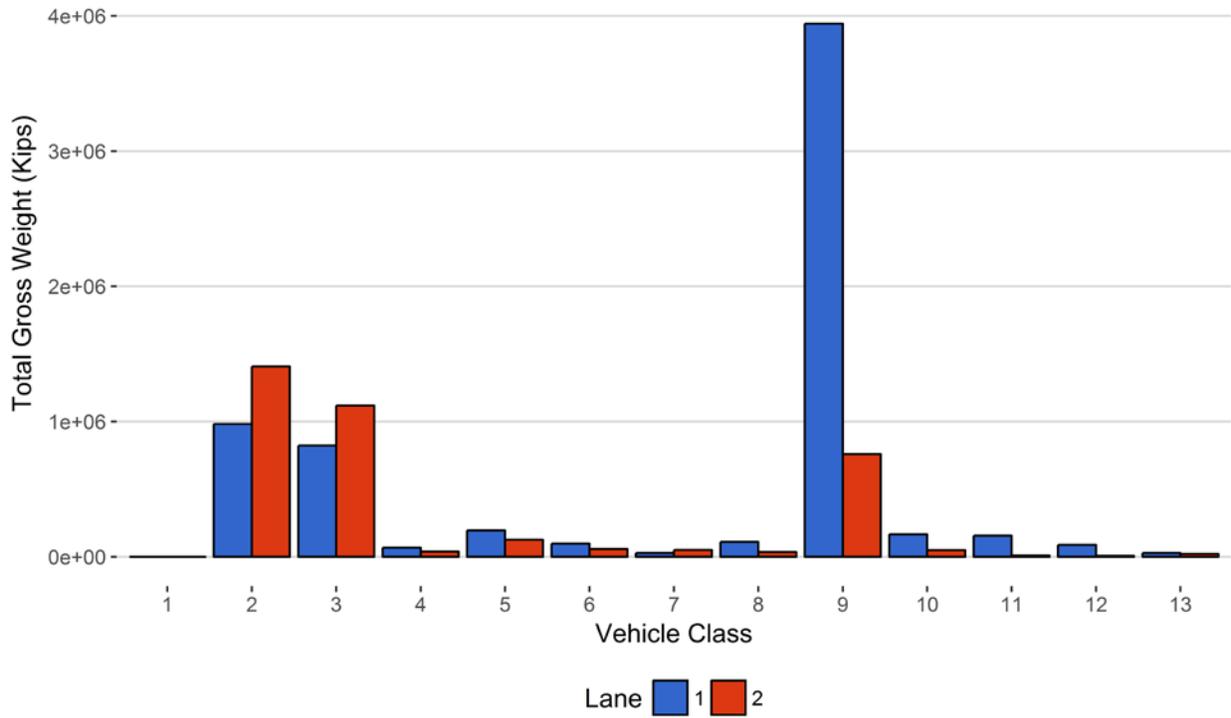


Figure 11 - Total Gross Vehicle Weight I

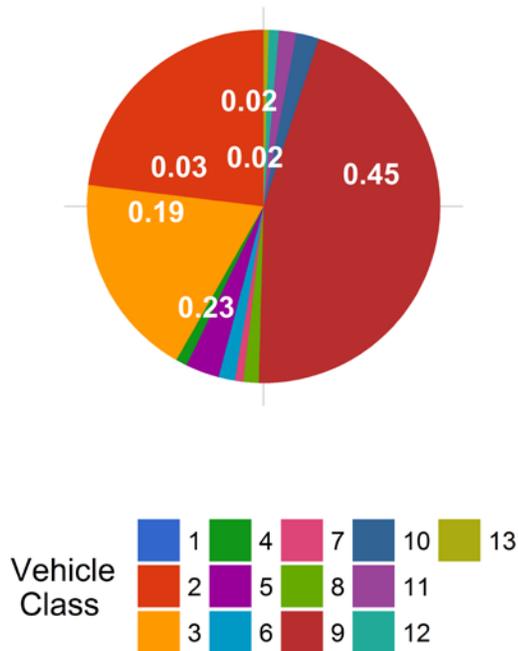


Figure 12 - Total ESALs by Class and Lane

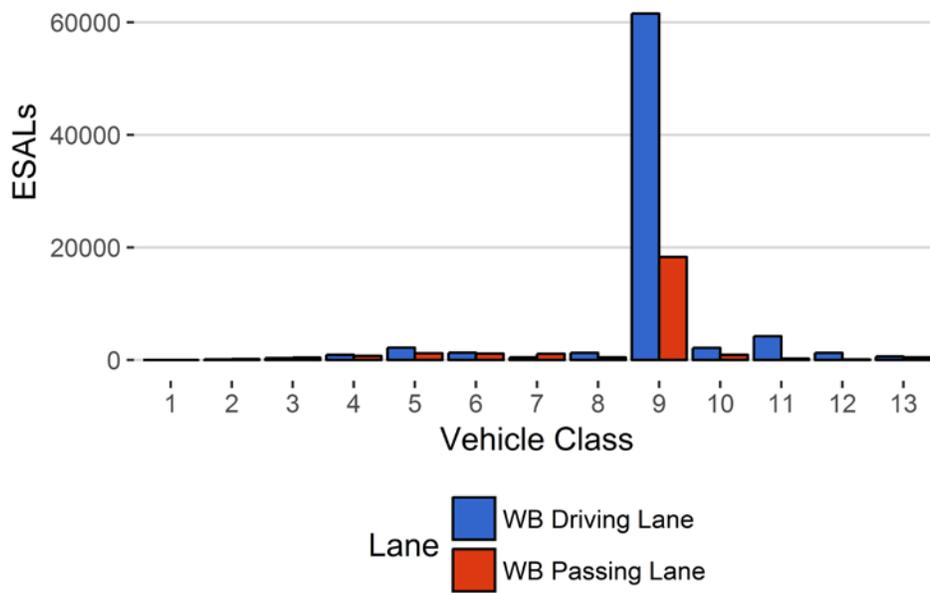


Figure 13 - ESALs by Class

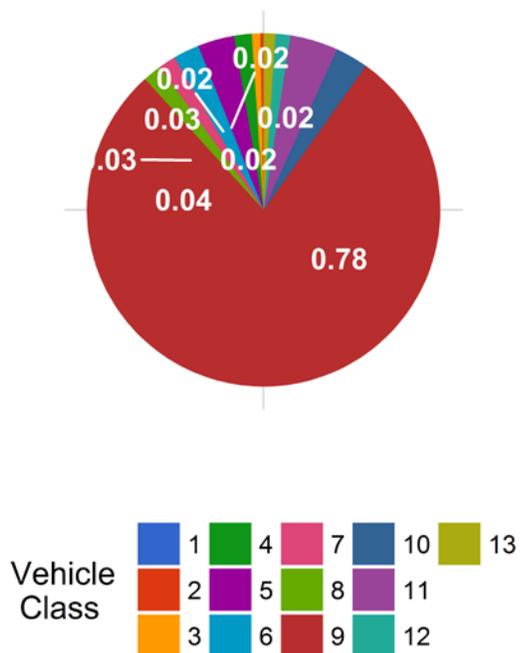


Table 1 Class 9 Front Axle Weight by Lane

<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
April 2018	10.45	-0.87	12.28	4.20
May 2018	10.44	-0.99	11.98	1.65

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	4	124	0	0	0
2	19218	595746	57.9	0	0
3	9570	296678	28.9	0	0
4	138	4288	0.4	218	2.2
5	751	23281	2.3	187	1.9
6	169	5231	0.5	321	3.3
7	69	2140	0.2	183	1.9
8	172	5318	0.5	112	1.2
9	2801	86838	8.4	7699	79.1
10	119	3680	0.4	523	5.4
11	85	2645	0.3	114	1.2
12	49	1524	0.1	50	0.5
13	19	589	0.1	322	3.3
TOTAL	33164	1028083	100	9729	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>
2018-05-10	Thursday	14:38:00	9	WB	2	147.74
2018-05-08	Tuesday	13:39:32	9	WB	2	146.76
2018-05-04	Friday	11:18:19	9	WB	2	139.76
2018-05-07	Monday	11:50:14	9	WB	2	138.42
2018-05-02	Wednesday	10:21:32	9	WB	2	138.32
2018-05-04	Friday	15:41:29	9	WB	2	136.15
2018-05-28	Monday	22:57:46	9	WB	2	134.85
2018-05-21	Monday	08:25:52	9	WB	2	131.89
2018-05-07	Monday	13:38:55	9	WB	2	130.59
2018-05-09	Wednesday	12:56:27	9	WB	2	129.1

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	4214	748	17.8	97530	9580	22770
5	WB	8	22877	1929	8.4	306047	13870	69232
6	WB	19	5140	561	10.9	144915	9765	28957
7	WB	11.5	2103	21	1	79469	222	27763
8	WB	31	5226	3156	60.4	81518	63989	8674
9	WB	33	85330	13785	16.2	4310711	391246	974863
10	WB	33.5	3616	582	16.1	199787	15682	49074
11	WB	36.5	2599	45	1.7	164289	1037	35534
12	WB	36.5	1498	24	1.6	93936	749	20067
13	WB	31.5	579	5	0.9	49522	125	15720
TOTAL	****	****	133182	20856	****	5527724	****	1252655

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	124	30	154	0
2	981898	1407106	2389003	23.1
3	822402	1118207	1940608	18.7
4	67840	39270	107110	1
5	194370	125547	319918	3.1
6	97577	57103	154680	1.5
7	29016	50675	79691	0.8
8	109921	35586	145507	1.4
9	3942978	758979	4701957	45.4
10	166374	49095	215469	2.1
11	156216	9110	165326	1.6
12	87782	6903	94684	0.9
13	28222	21426	49647	0.5
TOTAL	6684719	3679036	10363755	100
GVW/LANE	64.5	35.5	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	0.0081
2	112	187	300	0.3	0.001
3	337	458	795	0.8	0.0055
4	914	731	1645	1.6	0.78
5	2190	1213	3403	3.3	0.3
6	1285	1147	2432	2.4	0.95
7	496	1110	1606	1.6	1.53
8	1280	469	1748	1.7	0.67
9	61550	18311	79862	78.5	1.87
10	2153	912	3065	3	1.69
11	4225	243	4468	4.4	3.43
12	1276	105	1381	1.4	1.84
13	609	488	1097	1.1	3.73
TOTAL	76427	25375	101802	100	17
ESALS/LANE	75.1	24.9	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>
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
Apr 2018	865392	28846	3643	756114	87.4	109278.3	12.6
May 2018	1028083	33164	4372	892548	86.8	135535.5	13.2
TOTAL	11135263	--	--	9831414	--	1303851	--
AVERAGE	927939	30480	3568	819284	88	108654	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>
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
Apr 2018	65405	21901	87305	1.3
May 2018	76544	26734	103278	1.3
TOTAL	815738	--	--	--
AVERAGE	67978	14789	82768	2

Gross Vehicle Weight

<i>Month</i>	<i>GVW WB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>Total GVW Kips</i>
Jun 2017	5022577	2017371	7039948
Jul 2017	4627274	1899924	6527198
Aug 2017	5819299	3102304	8921603
Sep 2017	5225627	2958231	8183858
Oct 2017	6691316	3734069	10425385
Nov 2017	6656768	2984914	9641682
Dec 2017	6419065	2950979	9370045
Jan 2018	6869439	3007734	9877174
Feb 2018	6264517	2813582	9078098
Mar 2018	6472379	2845191	9317570
Apr 2018	5031471	2309308	7340779
May 2018	5296388	2102076	7398464
TOTAL	70396121	32725684	103121804
AVERAGE	5866343	2727140	8593484

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>
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
Apr 2018	7541	0.9	7.2	872	164
May 2018	9894	1	7.3	733	245
TOTAL	74828	--	--	6171	2146
AVERAGE	6235.7	0.7	5.7	514.2	178.8

Freight

<i>Month</i>	<i>WB Freight Tons</i>
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
Apr 2018	950237
May 2018	1252655
TOTAL	11405606
AVERAGE	950467.2