

SEPTEMBER 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 September 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: 762407 | Passenger Vehicles: 673849 | Heavy Commercial Vehicles: 88558

Monthly Average Daily Traffic (MADT): 31767 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 2952

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 Tuesdays (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 15's and Class 9's.

Overweight HCVs

Volume trends. Of a total of 88558 HCVs, 7242 of them were overweight ³. These overweight HCVs contributed to 1% of total monthly volume, and 8.6% 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 ,920 WB vehicles exceeded 88,000 pounds (608 vehicles were Class 9's; 149 vehicles were Class 13's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from September 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9's and 10's in September 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 748630 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 762407 vehicles with a combined GVW of 7034828 kips (1 kip = 1,000 pounds = 0.5 tons) in September 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 63334 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 78% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 41% 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>

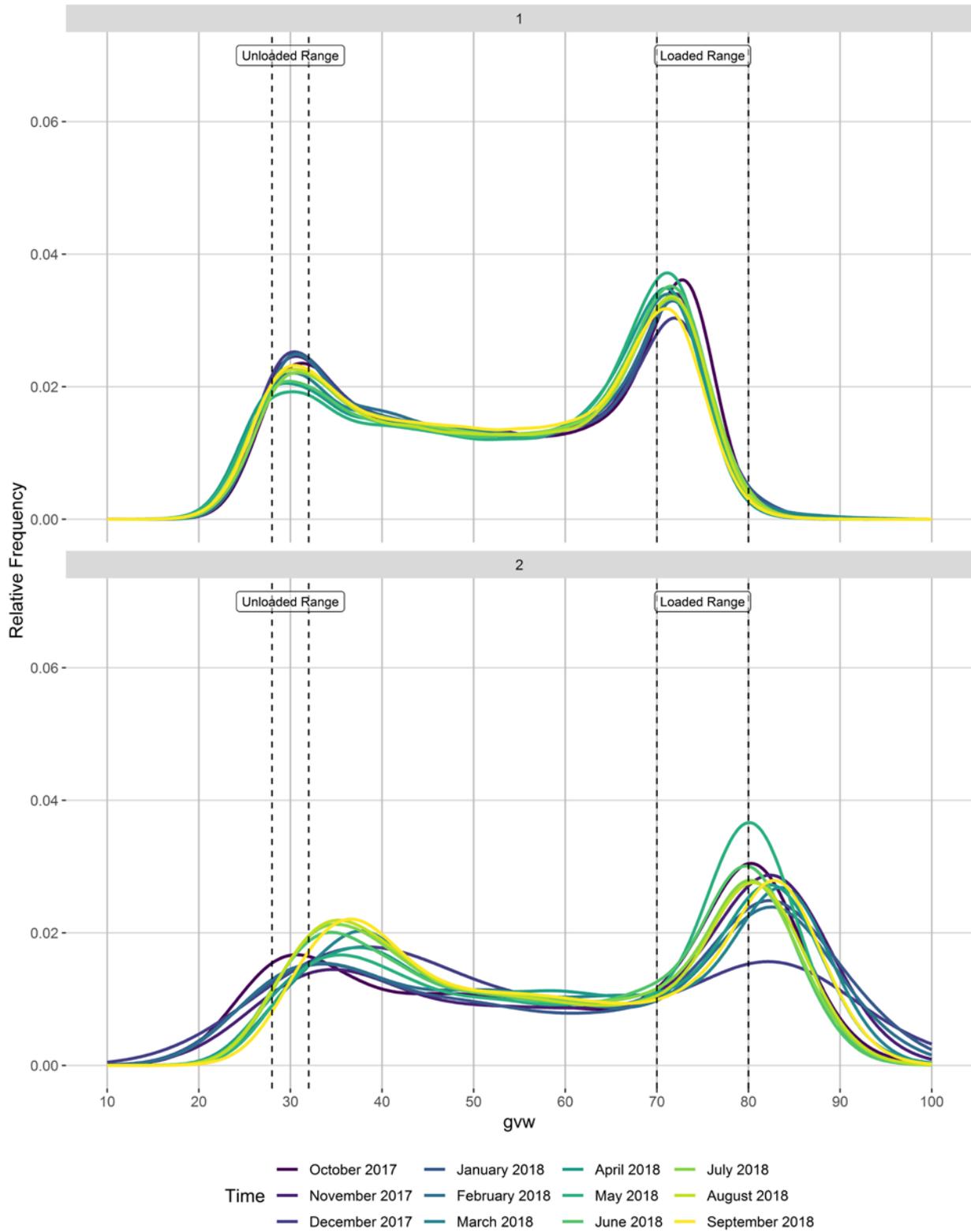
- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to

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.

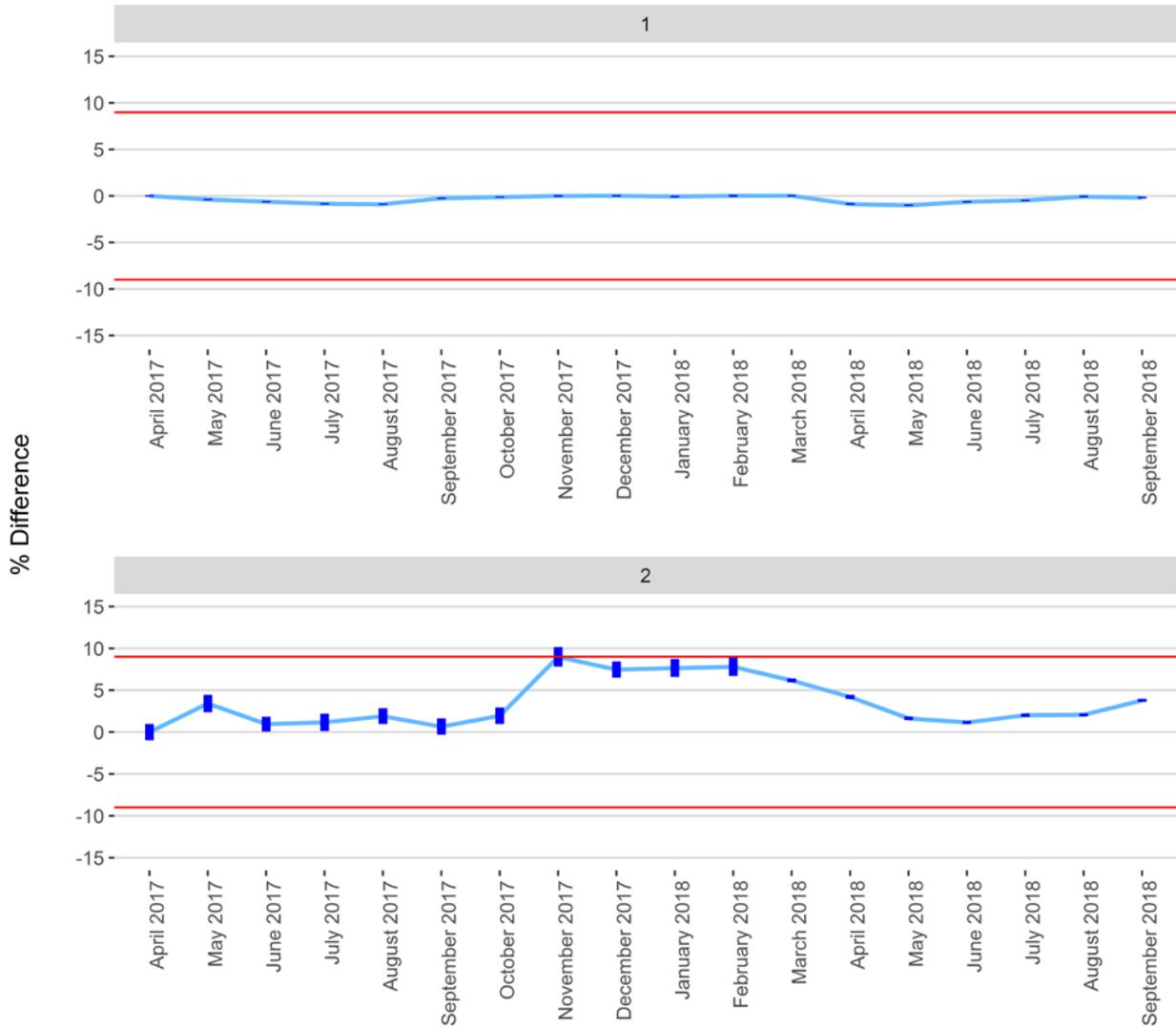
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Figure 1 - Monthly Class 9 GVW Histogram



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

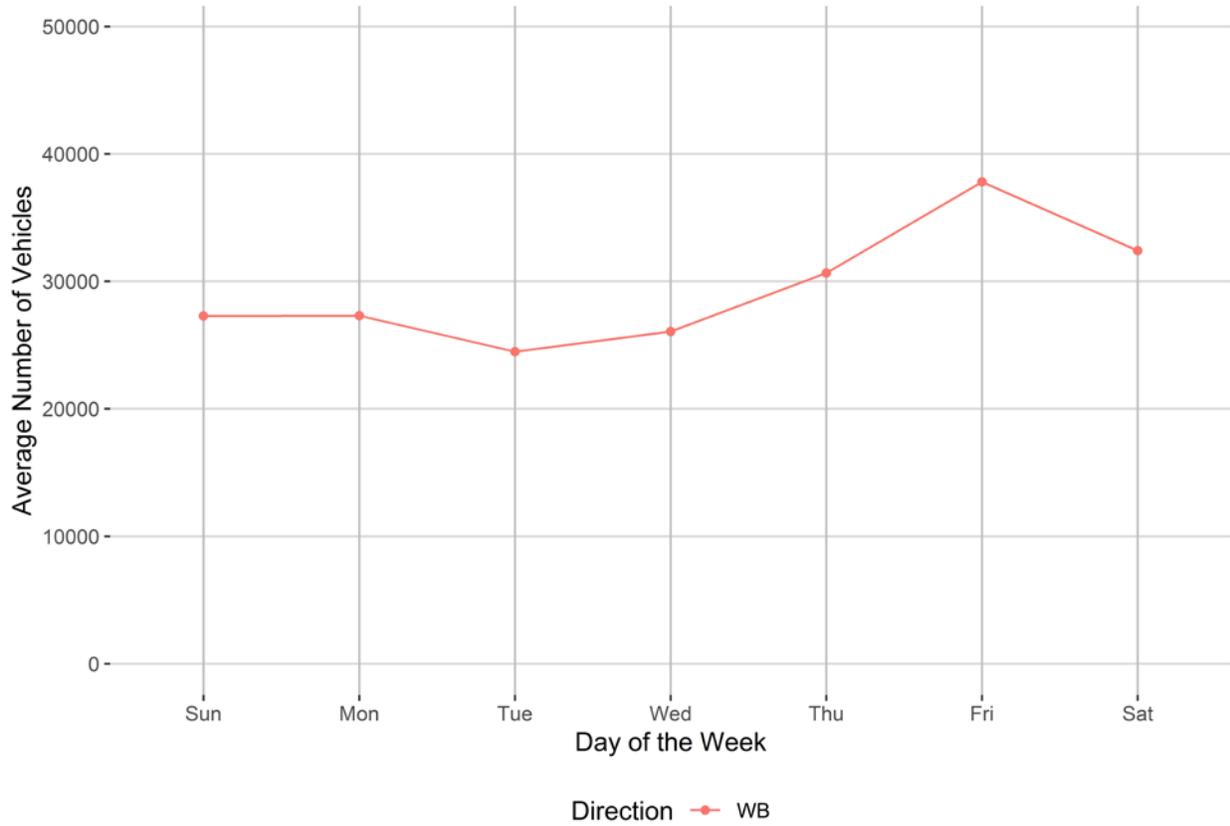


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

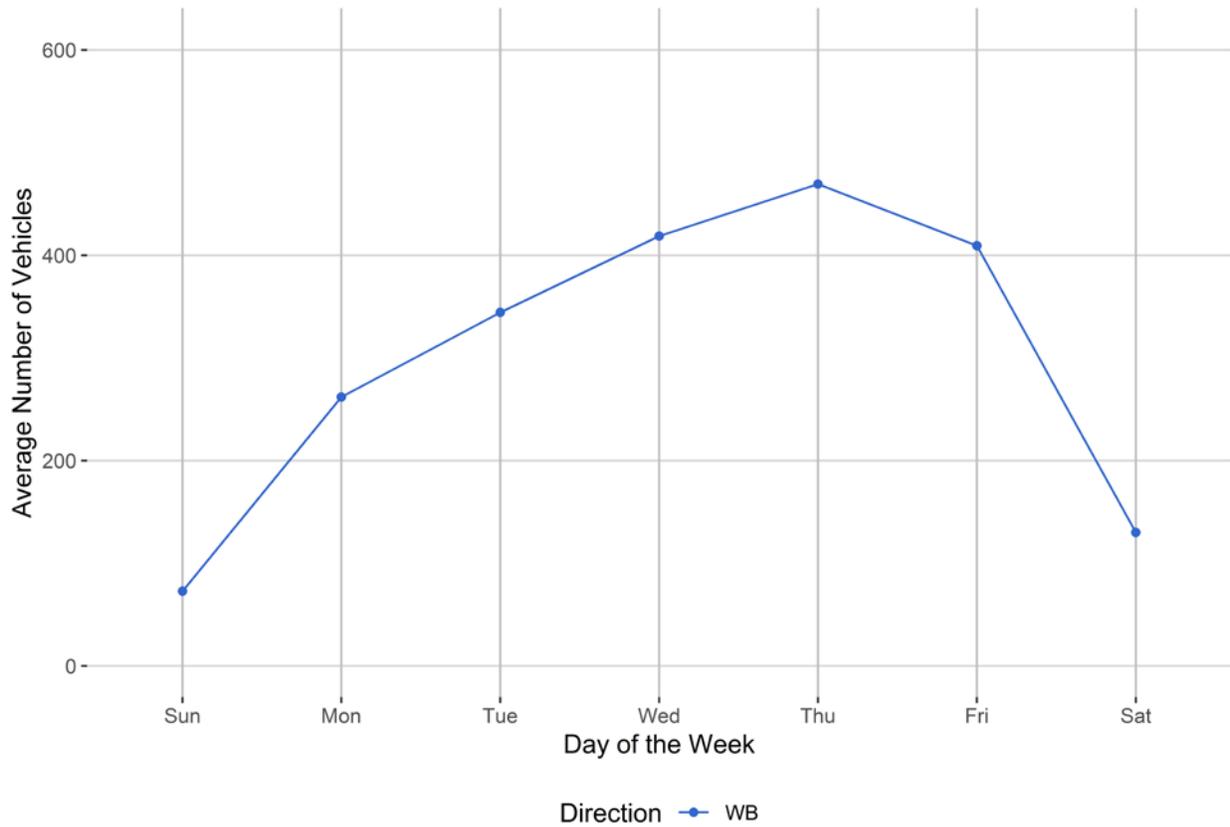


Figure 4 - Passenger Vehicles vs. Hour of the Day

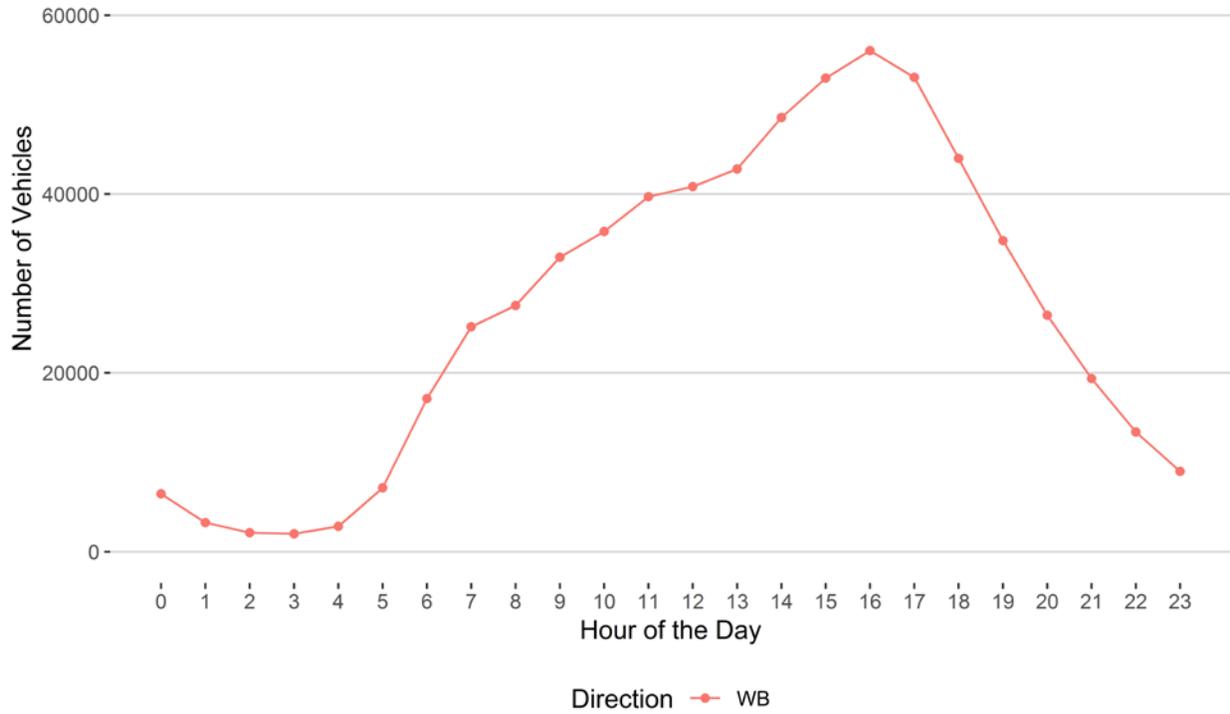


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

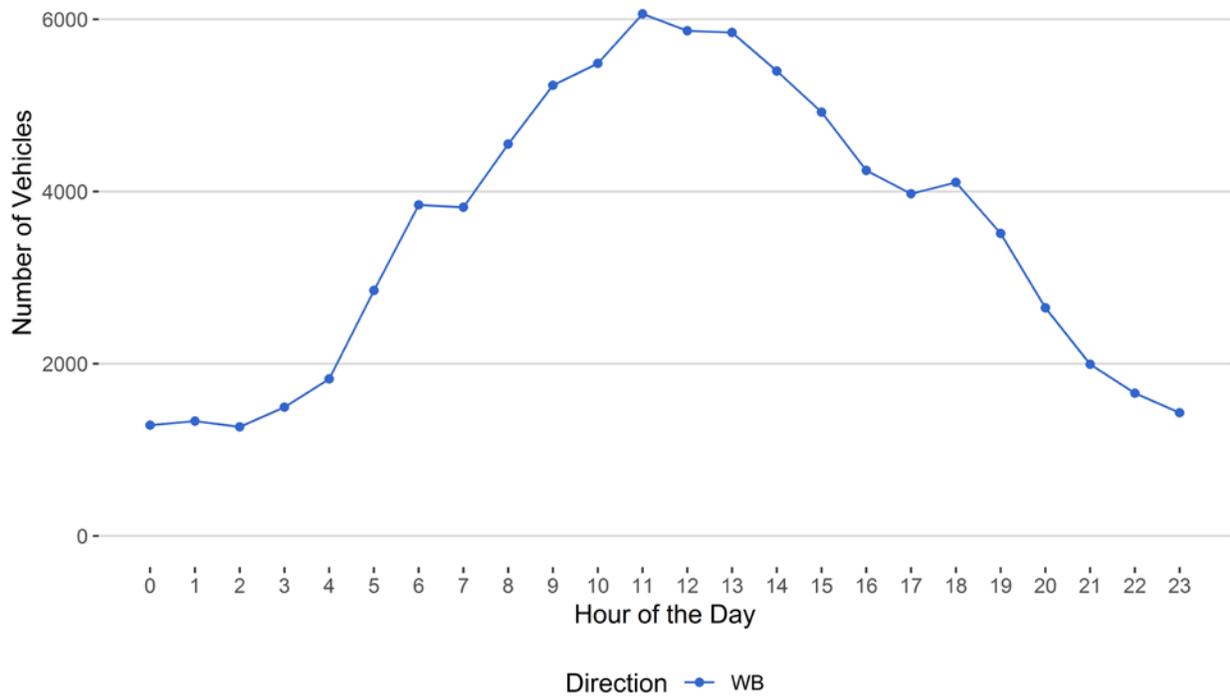


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

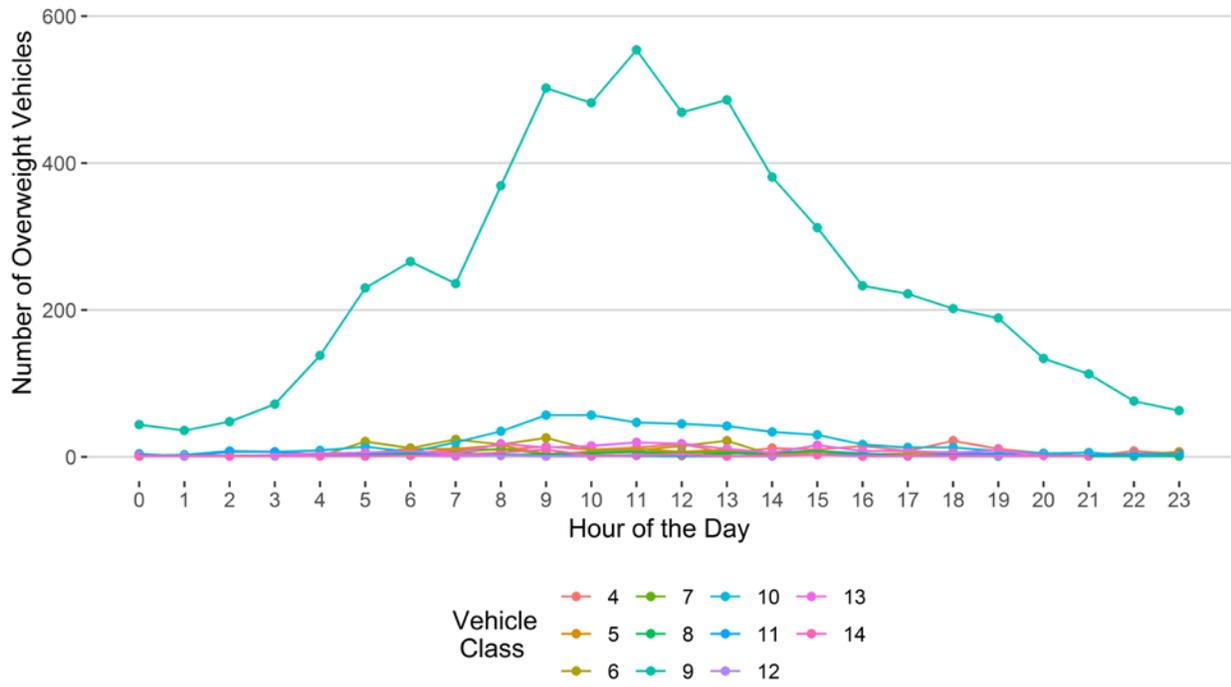


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

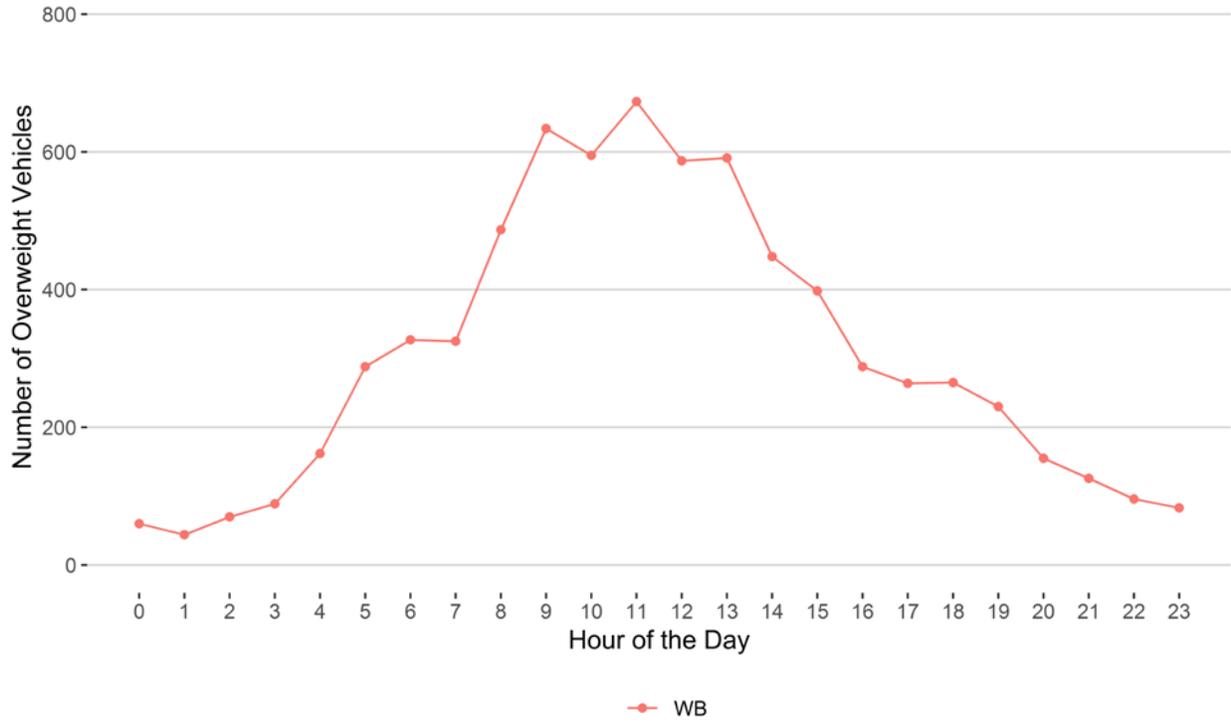
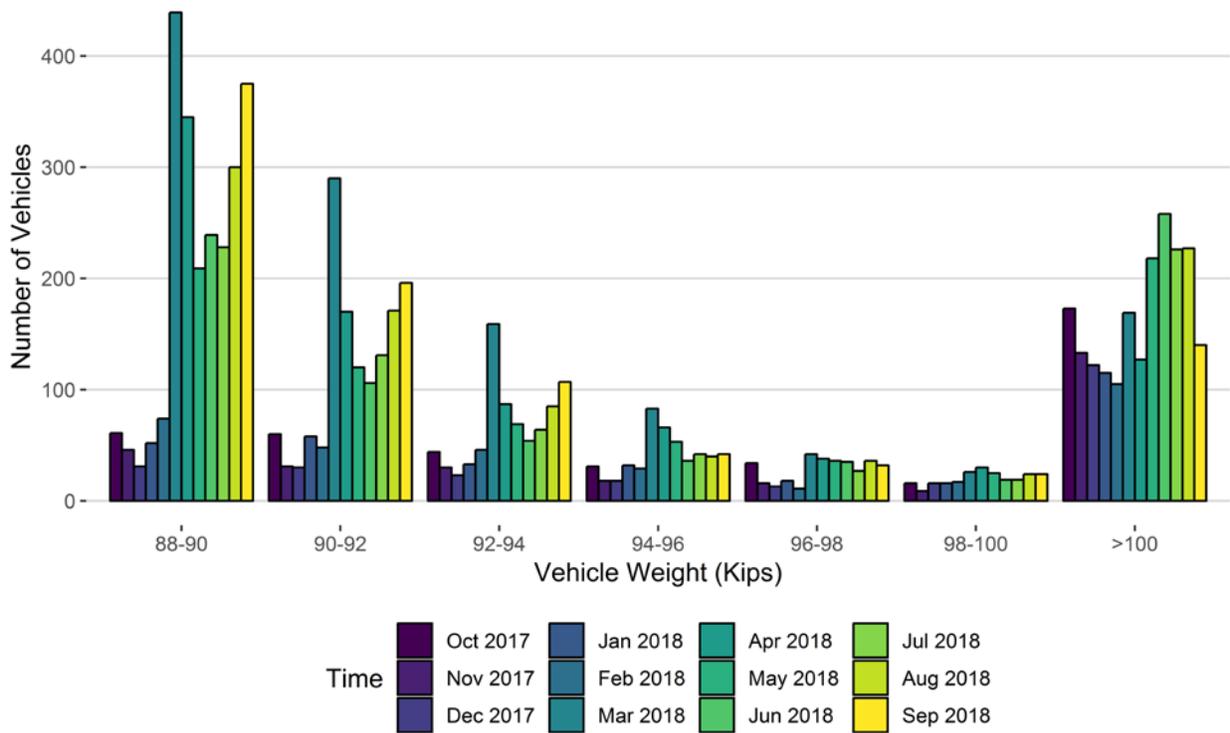


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018
88-90	61	46	31	52	74	439	345	209	239	228	300	375
90-92	60	31	30	58	48	290	170	120	106	131	171	196
92-94	44	30	23	33	46	159	87	69	54	64	85	107
94-96	31	18	18	32	29	83	66	53	36	42	40	42
96-98	34	16	13	18	11	42	38	36	35	27	36	32
98-100	16	9	16	16	17	26	30	25	19	19	24	24
>100	173	133	122	115	105	169	127	218	258	226	227	140
Total	419	283	253	324	330	1208	863	730	747	737	883	916

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

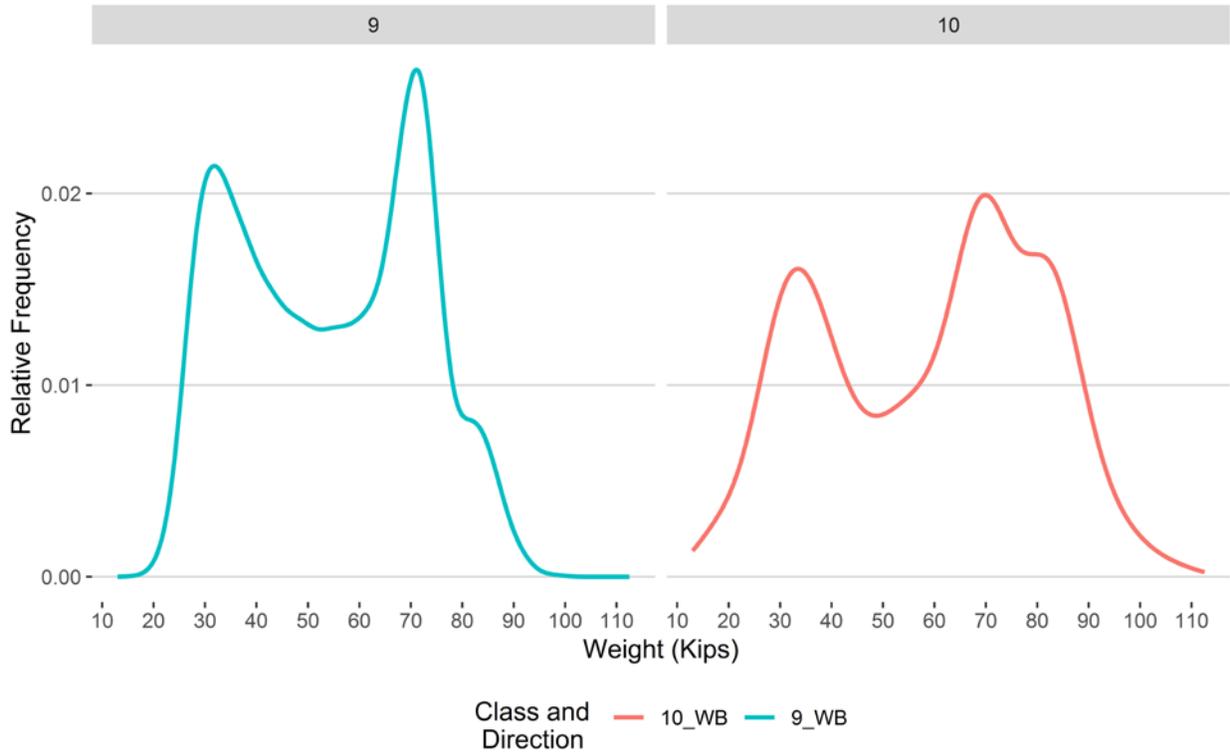


Figure 9 - Freight Percentage by Direction and Class

WB

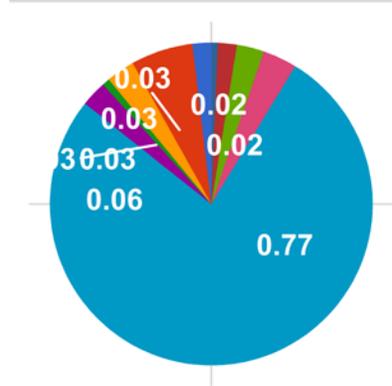


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

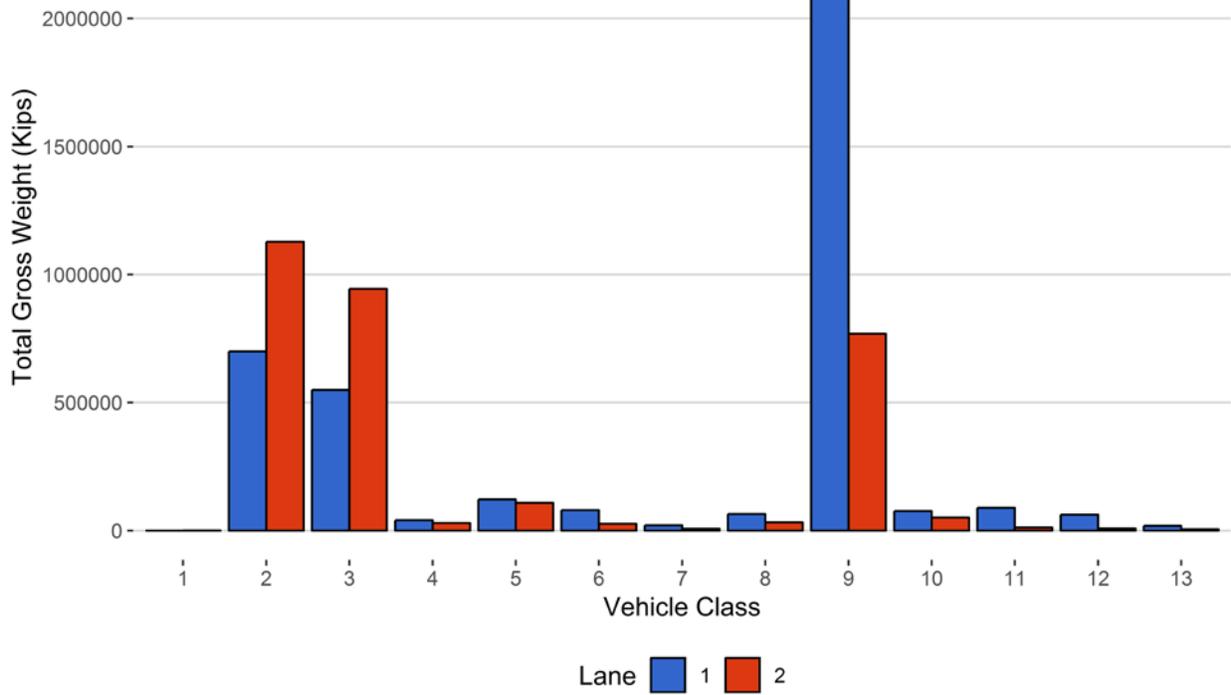


Figure 11 - Total Gross Vehicle Weight t

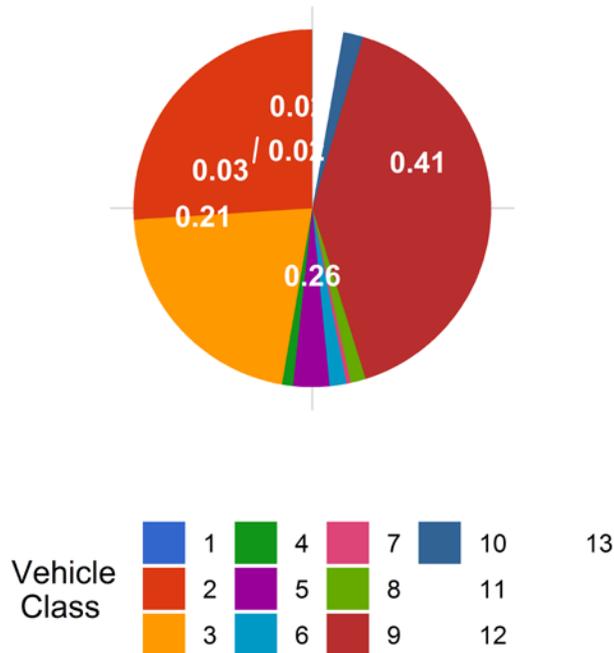


Table 1 Class 9 Front Axle Weight by Lane

<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
June 2018	10.48	-0.64	11.92	1.16
July 2018	10.49	-0.48	12.02	2.01
August 2018	10.54	-0.07	12.03	2.06
September 2018	10.52	-0.18	12.23	3.79

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	118	0	0	0
2	14836	445073	58.4	0	0
3	7622	228658	30	0	0
4	90	2713	0.4	192	2.7
5	600	17987	2.4	113	1.6
6	121	3619	0.5	187	2.6
7	17	524	0.1	65	0.9
8	113	3395	0.4	71	1
9	1832	54956	7.2	5857	80.9
10	75	2240	0.3	485	6.7
11	56	1691	0.2	64	0.9
12	39	1172	0.2	32	0.4
13	9	260	0	176	2.4
TOTAL	25414	762407	100	7242	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>
2018-09-01	Saturday	12:16:16	9	WB	1	142.99
2018-09-01	Saturday	11:44:55	9	WB	1	140.93
2018-09-01	Saturday	12:06:29	9	WB	1	131.59
2018-09-04	Tuesday	12:13:12	9	WB	1	129.59
2018-09-01	Saturday	11:28:47	9	WB	1	123.05
2018-09-21	Friday	10:18:58	9	WB	1	120.34
2018-09-04	Tuesday	15:32:53	9	WB	1	119.16
2018-09-04	Tuesday	08:03:36	10	WB	1	118.73
2018-09-04	Tuesday	10:55:50	9	WB	1	118.45
2018-09-04	Tuesday	14:10:22	9	WB	1	118.19

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	2594	335	12.9	65202	4490	15658
5	WB	8	17196	1206	7	221795	8714	46937
6	WB	19	3460	287	8.3	101224	4980	20469
7	WB	11.5	501	0	0	27286	0	10762
8	WB	31	3246	1734	53.4	58640	37758	5884
9	WB	33	52540	8544	16.3	2603870	247510	576001
10	WB	33.5	2142	361	16.9	117350	9899	28843
11	WB	36.5	1617	28	1.7	100419	680	21210
12	WB	36.5	1120	15	1.3	69967	386	14817
13	WB	31.5	249	3	1.2	23845	83	8048
TOTAL	****	****	84665	12513	****	3389598	****	748630

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	42	104	146	0
2	699922	1128016	1827938	26
3	549388	944259	1493647	21.3
4	40372	29319	69691	1
5	121888	108620	230509	3.3
6	79854	26350	106204	1.5
7	20275	7011	27286	0.4
8	64467	31930	96398	1.4
9	2082659	768721	2851380	40.6
10	76413	50836	127249	1.8
11	89162	11937	101099	1.4
12	61974	8379	70353	1
13	18498	5431	23929	0.3
TOTAL	3904913	3120915	7025828	100
GVW/LANE	55.58	44.42	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	0.0088
2	85	166	251	0.4	0.0012
3	233	417	650	1	0.006
4	622	604	1226	1.9	0.95
5	1362	722	2084	3.3	0.24
6	1110	604	1714	2.7	0.99
7	364	156	520	0.8	2.06
8	754	391	1145	1.8	0.71
9	30652	18670	49322	78.2	1.88
10	982	992	1975	3.1	1.84
11	2252	329	2581	4.1	3.18
12	854	134	987	1.6	1.76
13	471	144	615	1	4.75
TOTAL	39740	23329	63069	100	18
ESALS/LANE	63	37	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>
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
Jun 2018	1062451	35415	4414	930017	87.5	132434.5	12.5
Jul 2018	1072651	34602	4186	942884	87.9	129767	12.1
Aug 2018	1122311	36204	4092	995460	88.7	126851.1	11.3
Sep 2018	762407	31767	2952	673849	88.4	88558.1	11.6
TOTAL	11019754	-	-	9711135	-	1308621	-
AVERAGE	918313	30682	3580	809261	88	109052	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>
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
Jun 2018	72524	26971	99496	1.2
Jul 2018	70515	25002	95518	1.3
Aug 2018	62410	29879	92289	1
Sep 2018	39826	23509	63334	1.2
TOTAL	760583	-	-	-
AVERAGE	63382	18742	82124	2

Gross Vehicle Weight

<i>Month</i>	<i>GVW WB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>Total GVW Kips</i>
Oct 2017	5022577	2017371	7039948
Nov 2017	4627274	1899924	6527198
Dec 2017	5819299	3102304	8921603
Jan 2018	5225627	2958231	8183858
Feb 2018	6691316	3734069	10425385
Mar 2018	6556272	3927565	10483836
Apr 2018	6501613	3913029	10414641
May 2018	6040668	4371275	10411943
Jun 2018	3908977	3125851	7034828
Jul 2018	6472379	2845191	9317570
Aug 2018	5031471	2309308	7340779
Sep 2018	5296388	2102076	7398464
TOTAL	67193860	36306195	103500055
AVERAGE	5599488	3025516	8625005

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>
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
Jun 2018	9918	1	7.6	754	280
Jul 2018	9377	0.9	7.3	744	247
Aug 2018	9894	0.9	7.9	888	253
Sep 2018	7285	1	8.6	920	165
TOTAL	85775	-	-	7765	2288
AVERAGE	7147.9	0.8	6.5	647.1	190.7

Freight

<i>Month</i>	<i>WB Freight Tons</i>
Oct 2017	1063947
Nov 2017	728121
Dec 2017	735210
Jan 2018	745526
Feb 2018	694995
Mar 2018	1048394
Apr 2018	950237
May 2018	1252655
Jun 2018	1203088
Jul 2018	1158446
Aug 2018	1105836
Sep 2018	748630
TOTAL	11435087
AVERAGE	952923.9