

APRIL 2018



**WIM #47
MN 36, MP 202.9
OAK PARK
HEIGHTS, MN**

**MONTHLY
REPORT**



Your Destination... Our Priority



WIM Site Location

WIM #47 is located on MN 36 near Oak Park Heights in Washington county. The WIM is located only on the westbound (WB) side of MN 36, meaning that all data mentioned in this report pertains to WB traffic only (Lanes 1 and 2).

System Operation

WIM #47 was operational for the entire month of April 2018. Volume was computed using all monthly data.

System Calibration

WIM #47 was most recently calibrated on 2017-09-18. 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: 517859 | Passenger Vehicles: 495274 | Heavy Commercial Vehicles: 22585

Monthly Average Daily Traffic (MADT): 17262 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 753

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 Sundays (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 07 AM and 04 PM.

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling WB typically reached peak volume levels between 07 AM and 04 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 5's and Class 9's.

Overweight HCVs

Volume trends. Of a total of 22585 HCVs, 3361 of them were overweight ³. These overweight HCVs contributed to 0.7% of total monthly volume, and 15.1% 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 February.

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 ,242 WB vehicles exceeded 88,000 pounds (188 vehicles were Class 9's; 27 vehicles were Class 13's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from April 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9's and 10's in April 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 193752 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. 82045 (an extradosed cable stayed) is approximately 1 mile east of WIM #47. WIM #47 recorded a total of 517859 vehicles with a combined GVW of 3008338 kips (1 kip = 1,000 pounds = 0.5 tons) in April 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 17857 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 73% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 18% 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>

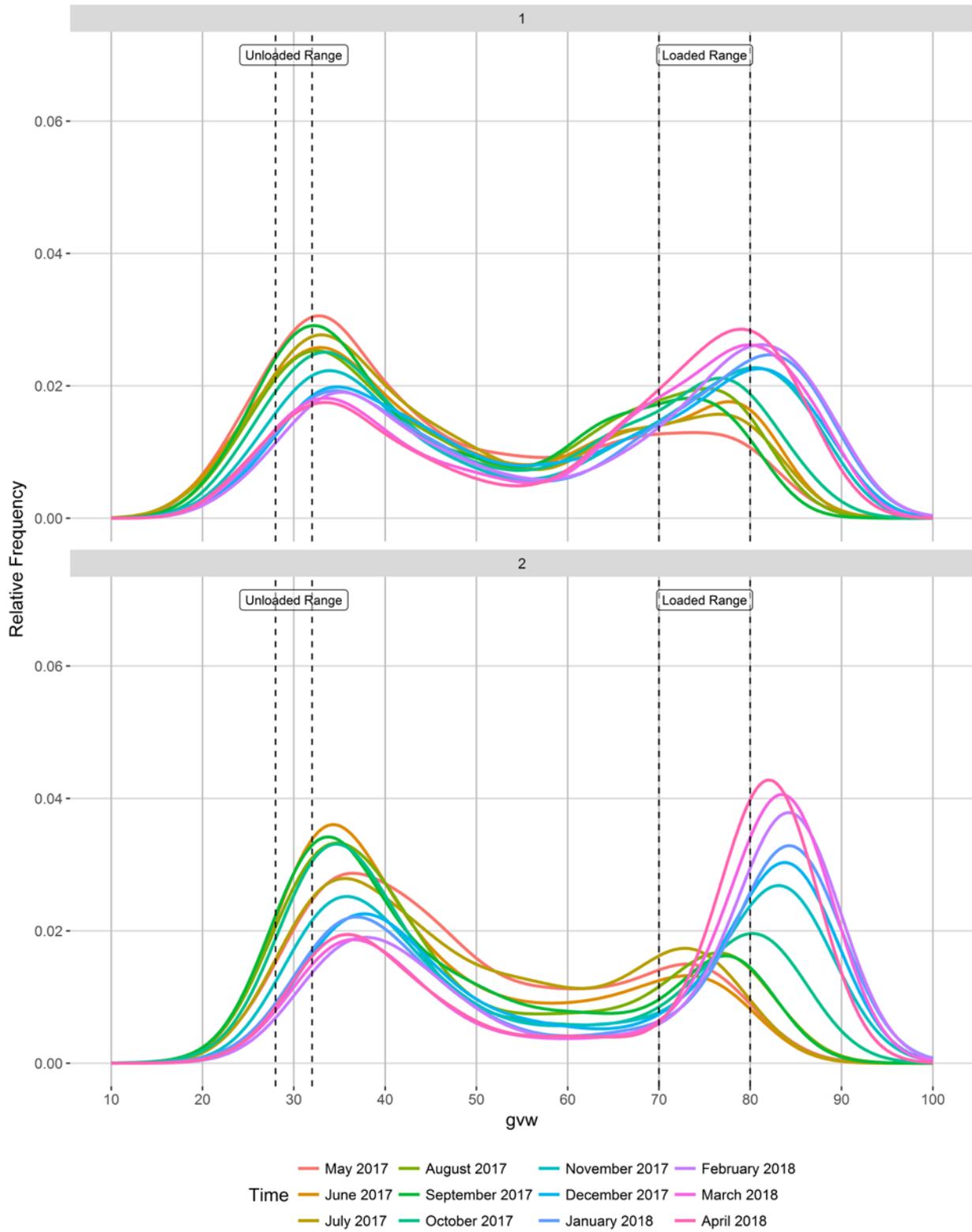
- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to

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.

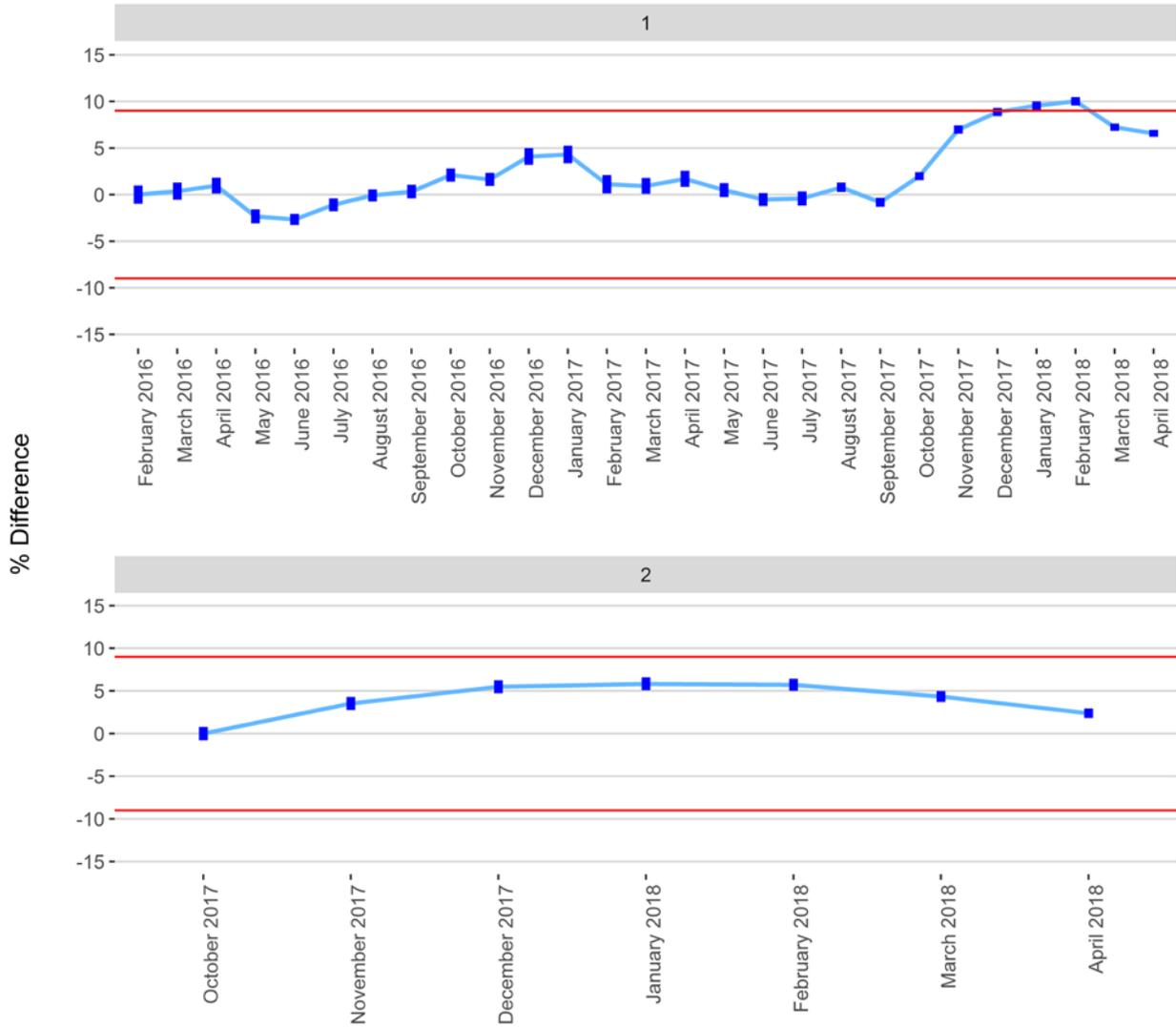
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Figure 1 - Monthly Class 9 GVW Histogram



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

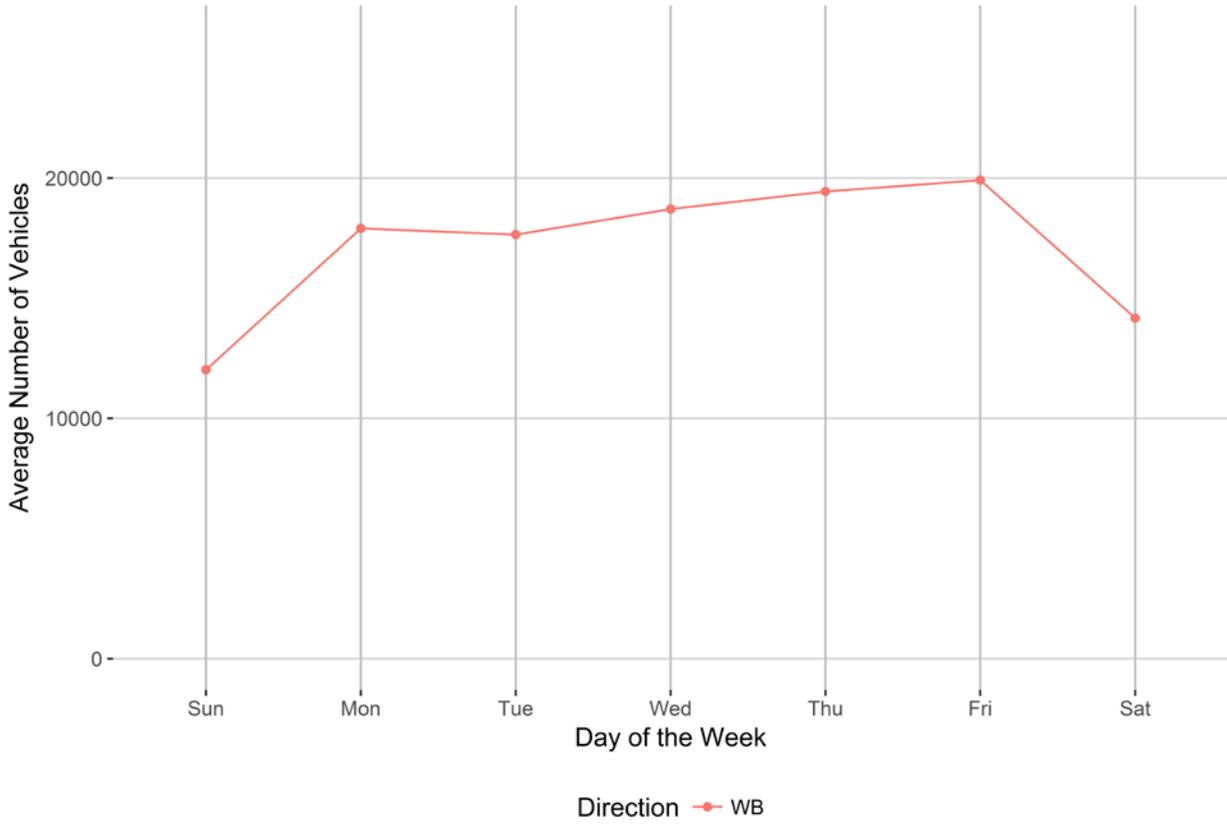


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

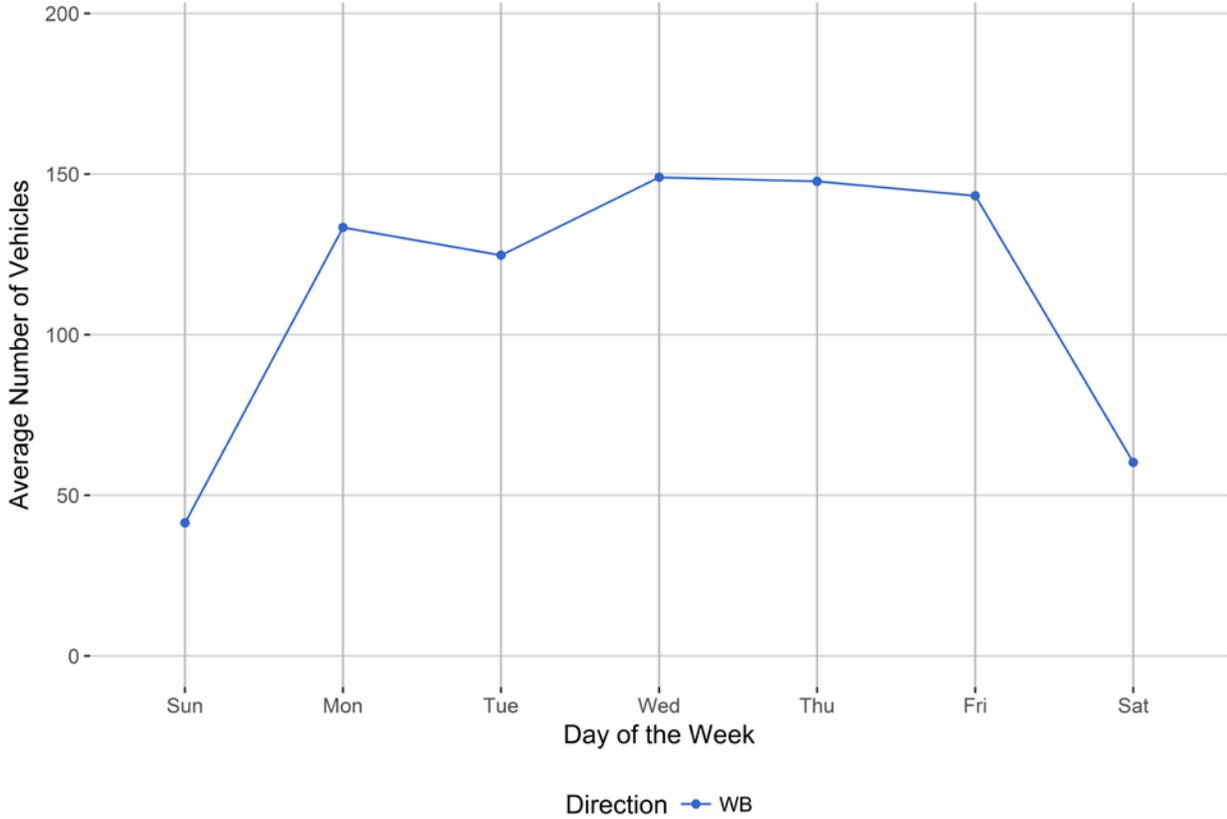


Figure 4 - Passenger Vehicles vs. Hour of the Day

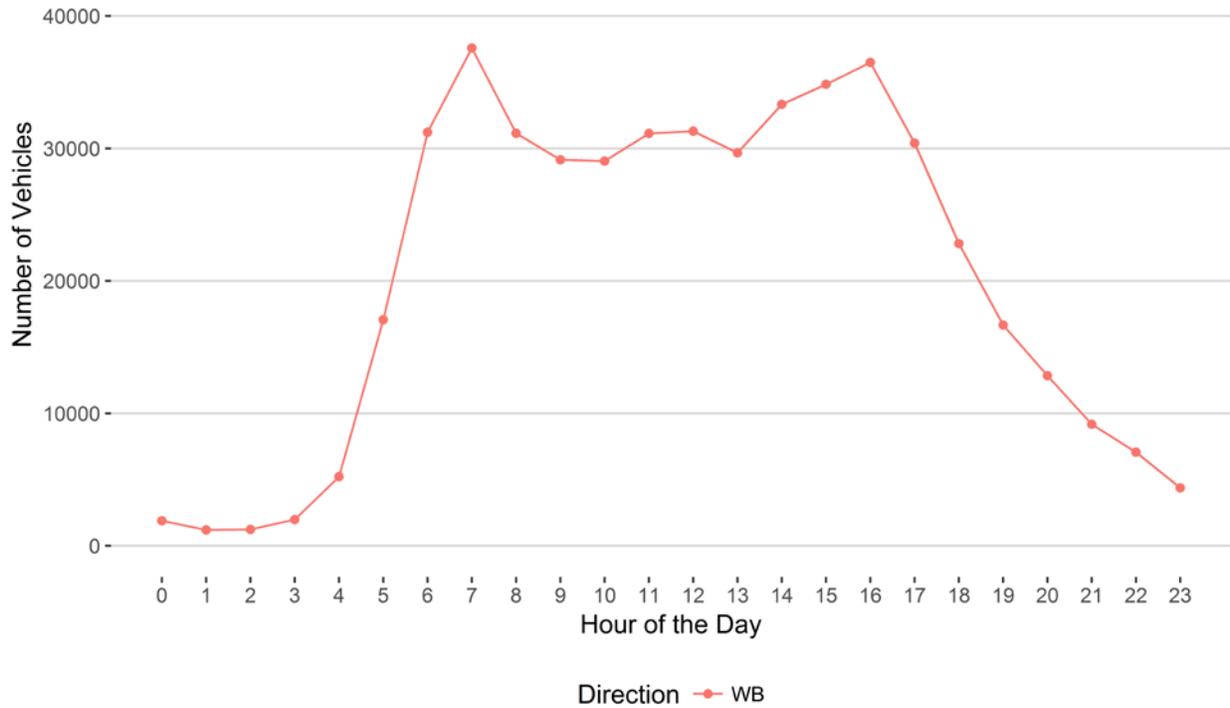


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

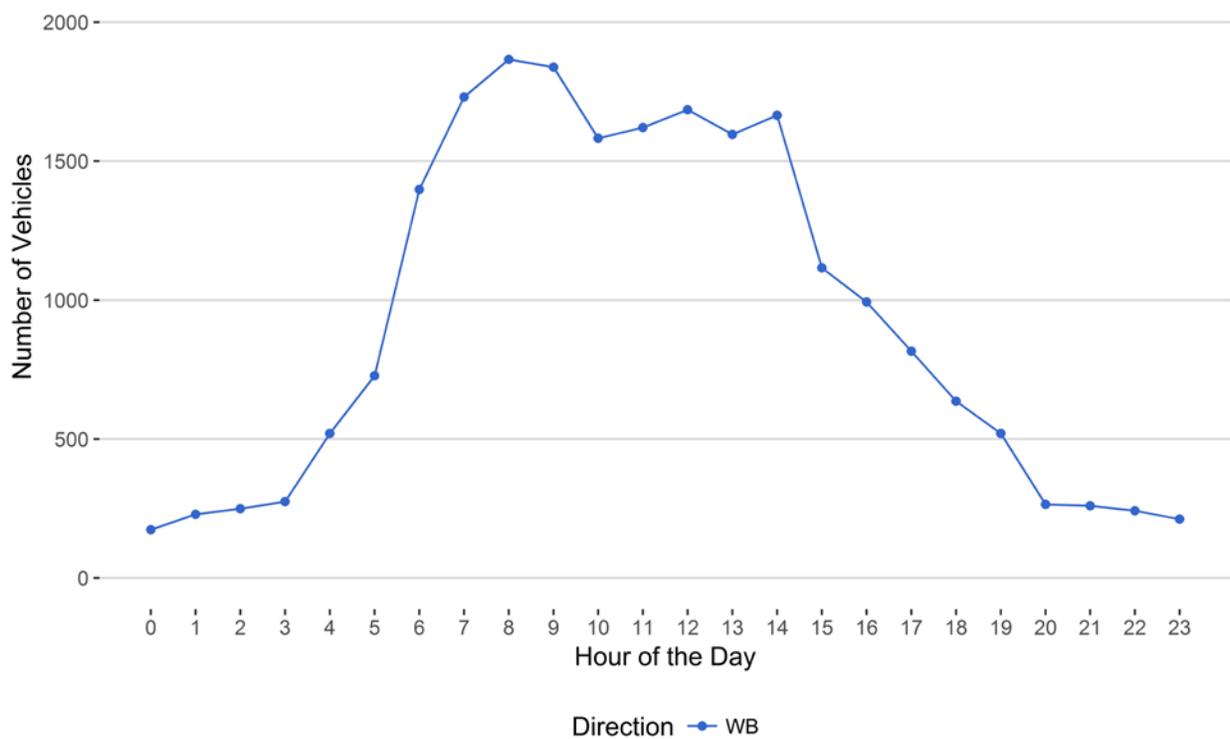


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

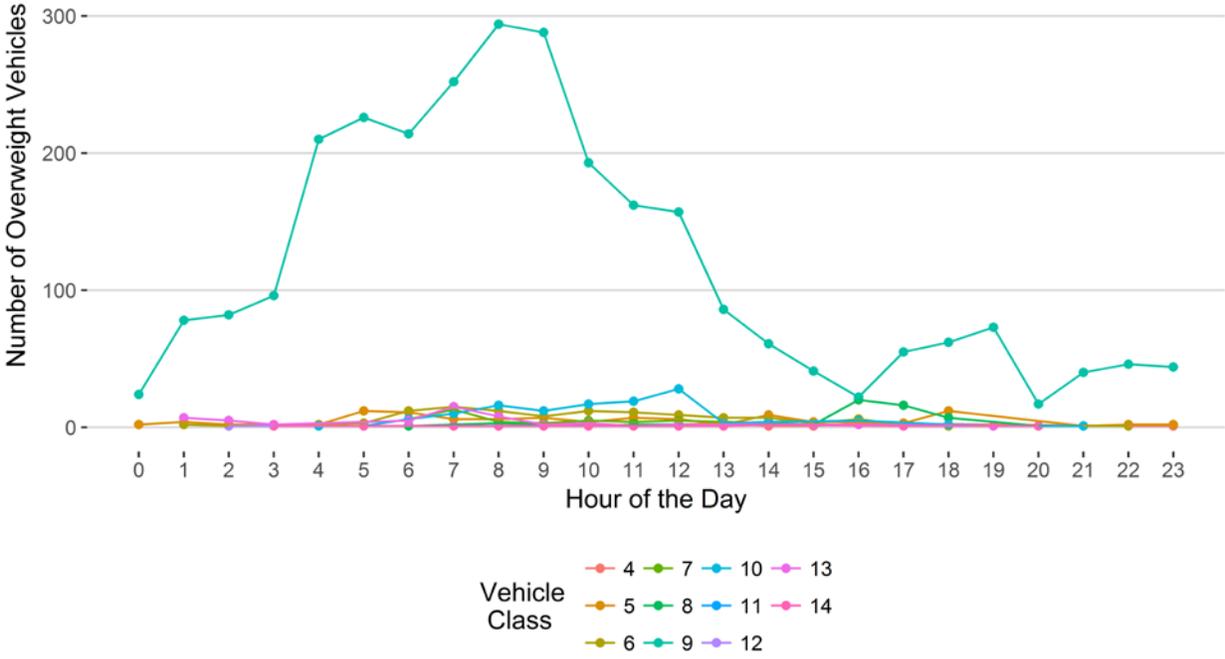


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

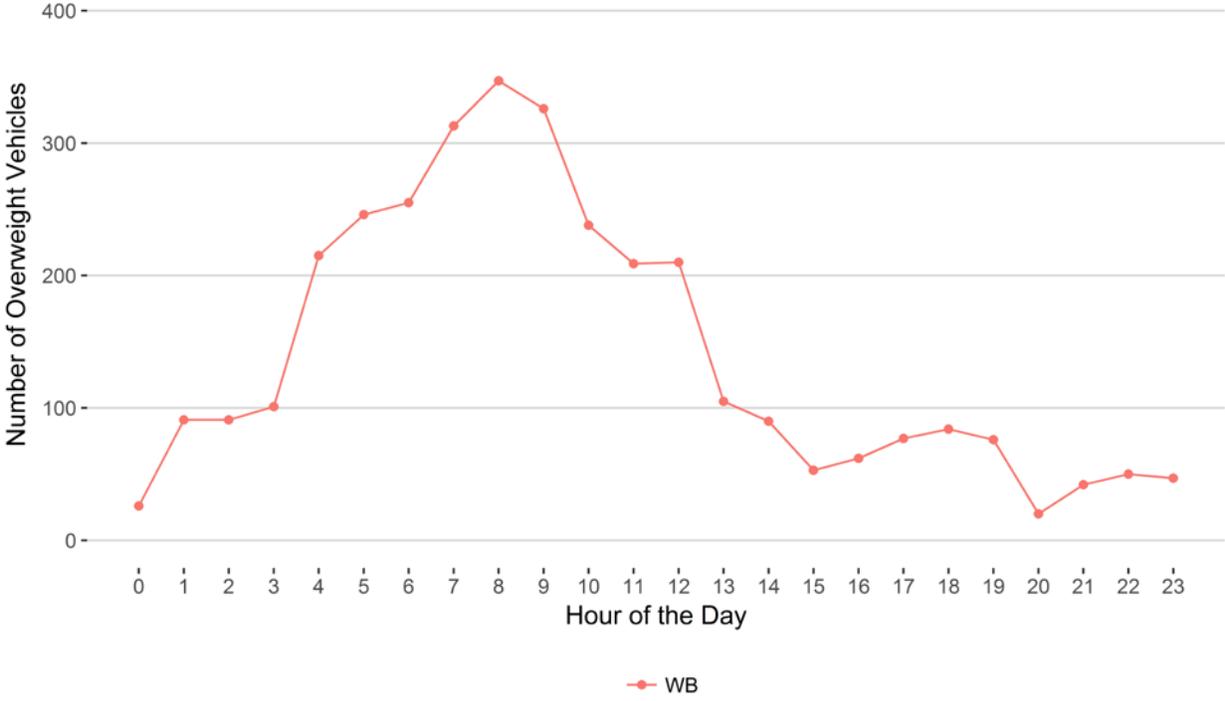
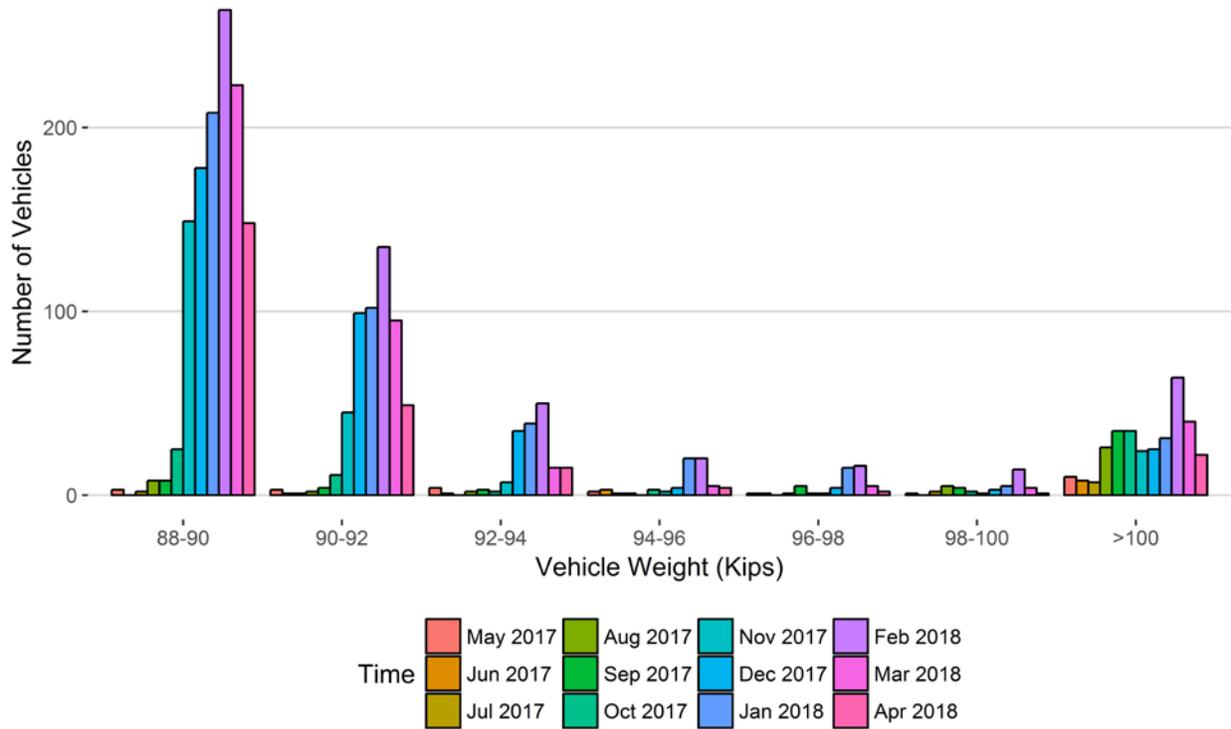


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018
88-90	3	0	2	8	8	25	149	178	208	264	223	148
90-92	3	1	1	2	4	11	45	99	102	135	95	49
92-94	4	1	0	2	3	2	7	35	39	50	15	15
94-96	2	3	1	1	0	3	2	4	20	20	5	4
96-98	1	1	0	1	5	1	1	4	15	16	5	2
98-100	1	0	2	5	4	2	1	3	5	14	4	1
>100	10	8	7	26	35	35	24	25	31	64	40	22
Total	24	14	13	45	59	79	229	348	420	563	387	241

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

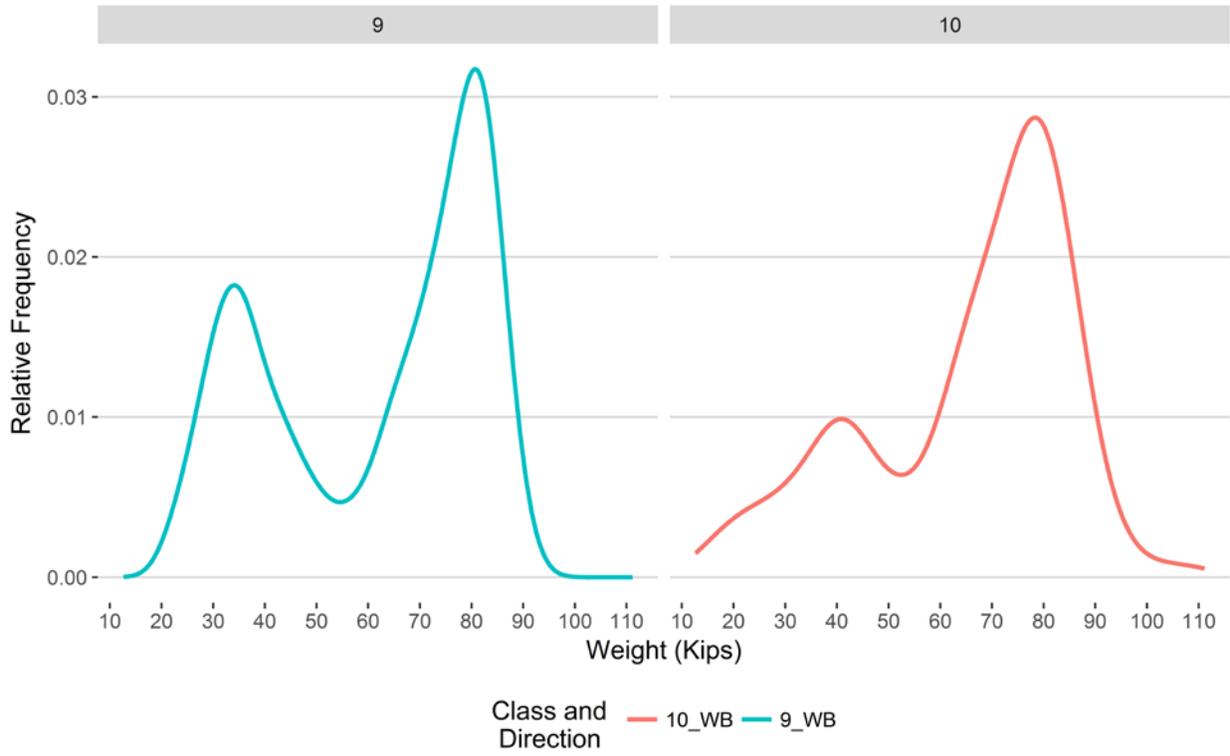


Figure 9 - Freight Percentage by Direction and Class

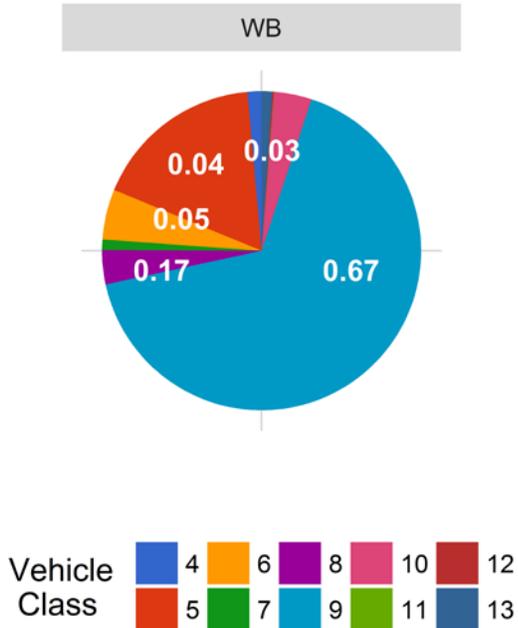


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

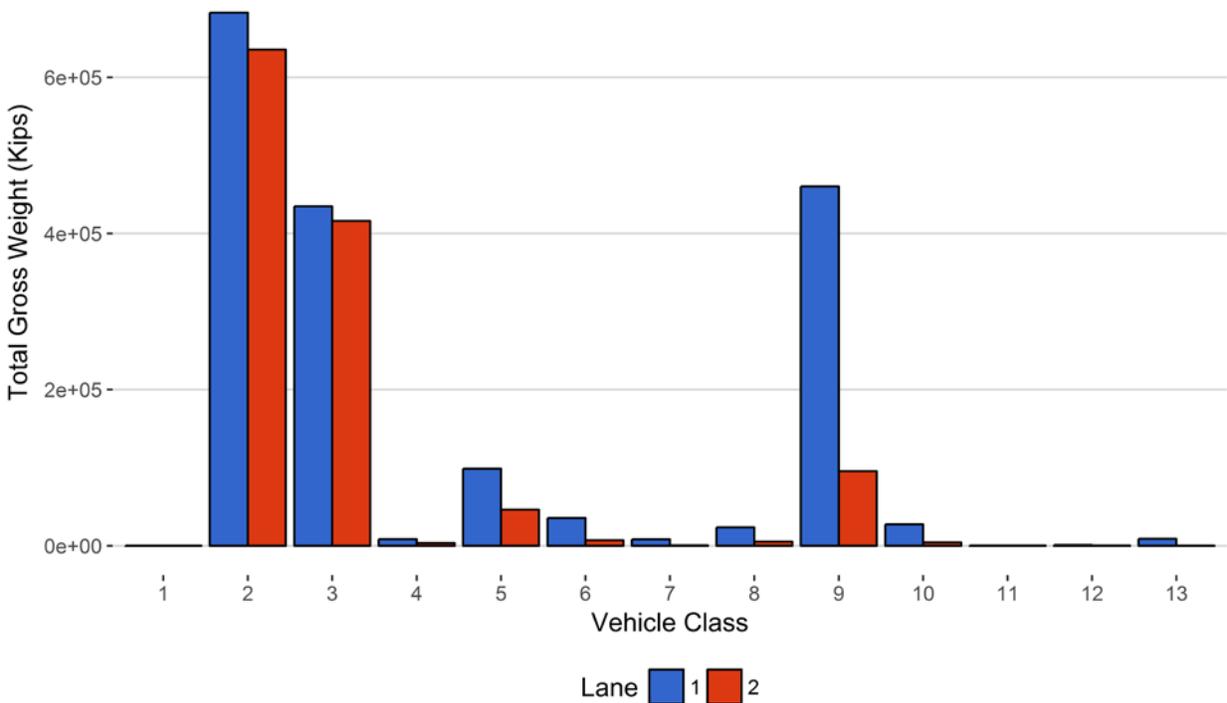


Figure 11 - Total Gross Vehicle Weight I

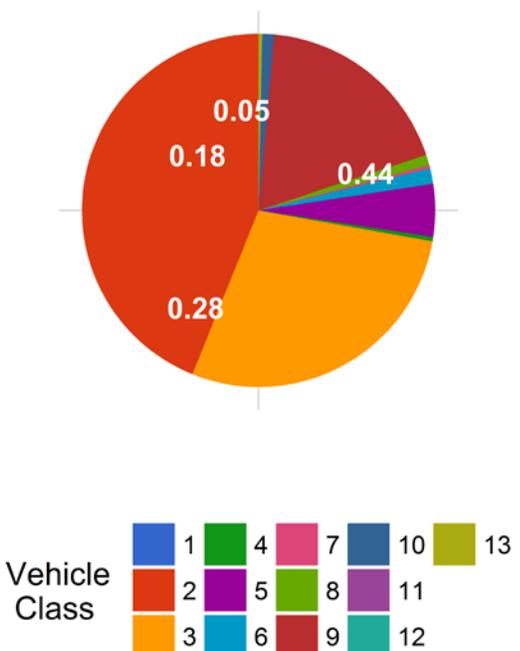


Figure 12 - Total ESALs by Class and Lane

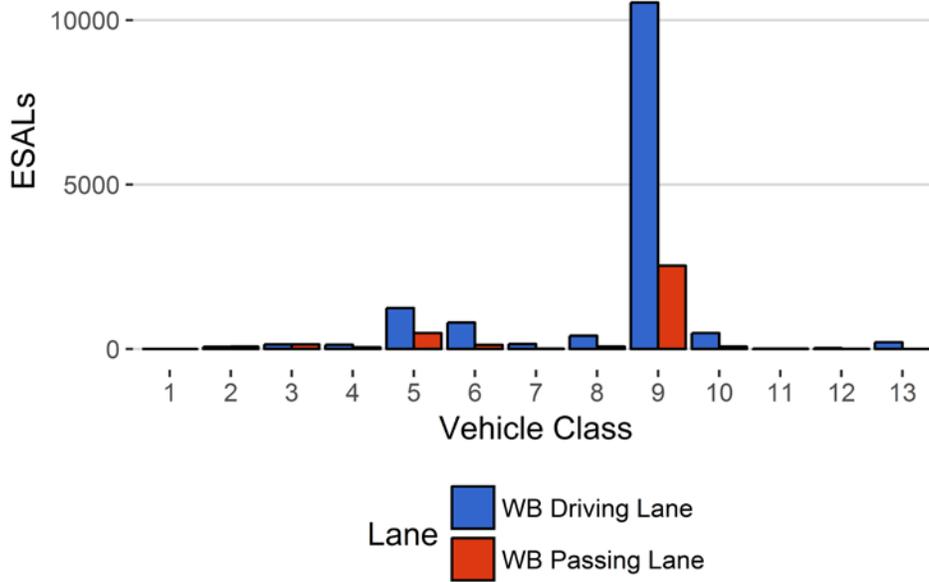


Figure 13 - ESALs by Class

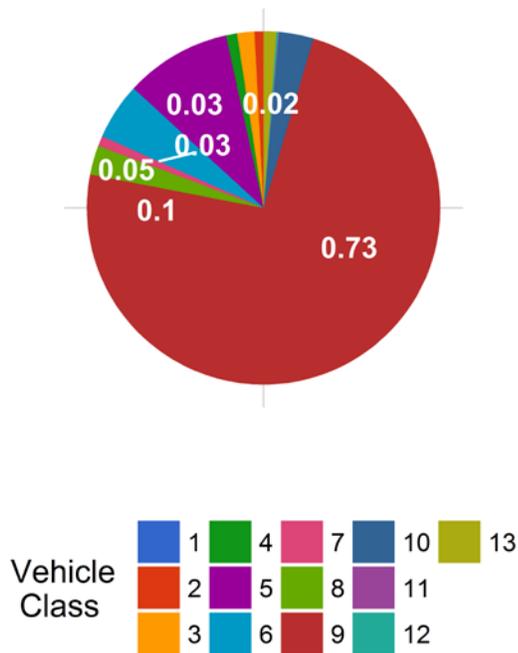


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
February 2016	10.70	0.00	NA	NA
March 2016	10.74	0.38	NA	NA
April 2016	10.80	0.97	NA	NA
May 2016	10.45	-2.34	NA	NA
June 2016	10.41	-2.66	NA	NA
July 2016	10.58	-1.10	NA	NA
August 2016	10.69	-0.08	NA	NA
September 2016	10.73	0.32	NA	NA
October 2016	10.92	2.10	NA	NA
November 2016	10.87	1.63	NA	NA
December 2016	11.14	4.10	NA	NA
January 2017	11.16	4.31	NA	NA
February 2017	10.82	1.12	NA	NA
March 2017	10.80	0.93	NA	NA
April 2017	10.88	1.70	NA	NA
May 2017	10.75	0.50	NA	NA
June 2017	10.64	-0.53	NA	NA
July 2017	10.65	-0.41	NA	NA
August 2017	10.78	0.79	NA	NA
September 2017	10.61	-0.82	NA	NA
October 2017	10.91	1.99	10.62	0.00
November 2017	11.45	6.99	10.99	3.53
December 2017	11.65	8.87	11.20	5.49
January 2018	11.72	9.56	11.24	5.83
February 2018	11.77	10.02	11.23	5.72
March 2018	11.47	7.24	11.08	4.34
April 2018	11.40	6.58	10.87	2.38

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	6	192	0	0	0
2	11592	347770	67.2	0	0
3	4910	147312	28.4	0	0
4	15	450	0.1	18	0.5
5	329	9883	1.9	108	3.2
6	44	1321	0.3	117	3.5
7	6	167	0	44	1.3
8	32	948	0.2	62	1.8
9	306	9184	1.8	2823	84
10	16	492	0.1	127	3.8
11	0	4	0	2	0.1
12	1	19	0	5	0.1
13	4	117	0	55	1.6
TOTAL	17262	517859	100	3361	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>
2018-04-04	Wednesday	08:19:10	10	WB	1	111.17
2018-04-17	Tuesday	11:22:43	10	WB	1	109.72
2018-04-18	Wednesday	12:17:01	10	WB	1	105.79
2018-04-06	Friday	12:12:25	10	WB	1	104.34
2018-04-06	Friday	04:03:24	10	WB	1	103.58
2018-04-26	Thursday	11:39:34	10	WB	1	101.18
2018-04-19	Thursday	12:12:29	10	WB	1	99.04
2018-04-10	Tuesday	07:11:00	10	WB	1	96.33
2018-04-05	Thursday	11:44:33	10	WB	1	94.88
2018-04-02	Monday	11:28:18	10	WB	1	94.87

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	443	92	20.8	10689	1157	2712
5	WB	8	9722	891	9.2	138694	6321	34023
6	WB	19	1299	142	10.9	40118	2417	9067
7	WB	11.5	164	0	0	8891	0	3502
8	WB	31	933	460	49.3	18304	10614	1820
9	WB	33	9034	1209	13.4	521342	34506	131559
10	WB	33.5	484	42	8.7	30735	1023	7964
11	WB	36.5	4	0	0	290	0	72
12	WB	36.5	19	2	10.5	1181	47	280
13	WB	31.5	115	0	0	9125	0	2751
TOTAL	****	****	22217	2838	****	779369	****	193752

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	91	141	232	0
2	682965	635520	1318485	43.9
3	434922	416062	850984	28.3
4	8407	3439	11846	0.4
5	98806	46209	145015	4.8
6	35490	7045	42535	1.4
7	8278	613	8891	0.3
8	23577	5341	28918	1
9	460336	95512	555848	18.5
10	27362	4397	31759	1.1
11	290	0	290	0
12	957	271	1228	0
13	8994	131	9125	0.3
TOTAL	1790475	1214681	3005156	100
GVW/LANE	59.58	40.42	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	0.0053
2	71	76	147	0.8	9e-04
3	138	142	280	1.6	0.0039
4	127	54	181	1	0.82
5	1250	482	1732	9.7	0.36
6	802	122	925	5.2	1.43
7	153	11	164	0.9	1.97
8	402	77	479	2.7	1.03
9	10535	2531	13066	73.5	2.9
10	482	75	558	3.1	2.28
11	12	0	12	0.1	2.34
12	29	5	34	0.2	2.58
13	206	1	207	1.2	3.35
TOTAL	14208	3578	17786	100	19
ESALS/LANE	79.9	20.1	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>
May 2017	441742	14250	435	428251	96.9	13490.9	3.1
Jun 2017	438826	14628	443	425525	97	13301	3
Jul 2017	439624	14181	402	427149	97.2	12475.3	2.8
Aug 2017	605893	19545	618	586728	96.8	19165.5	3.2
Sep 2017	567907	18930	644	548578	96.6	19329.4	3.4
Oct 2017	569972	18386	702	548201	96.2	21771	3.8
Nov 2017	507344	16912	660	487542	96.1	19801.8	3.9
Dec 2017	513763	16573	605	495000	96.3	18762.8	3.7
Jan 2018	490255	15815	599	471697	96.2	18557.6	3.8
Feb 2018	448352	16013	653	430066	95.9	18285.5	4.1
Mar 2018	512513	16533	644	492548	96.1	19965.1	3.9
Apr 2018	517859	17262	753	495274	95.6	22584.9	4.4
TOTAL	6054050	--	--	5836559	--	217491	--
AVERAGE	504504	16586	596	486380	96	18124	4

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>
May 2017	5120	823	5942	1.6
Jun 2017	5445	809	6254	0.6
Jul 2017	4945	730	5675	0.7
Aug 2017	8013	1478	9491	1.1
Sep 2017	7296	1571	8867	1.5
Oct 2017	10395	2096	12491	1.4
Nov 2017	11298	2252	13549	5.2
Dec 2017	11223	2609	13832	8.7
Jan 2018	11608	2729	14337	12.2
Feb 2018	12022	3161	15184	15.1
Mar 2018	13230	3173	16403	7.6
Apr 2018	14271	3586	17857	4.5
TOTAL	114865	--	--	--
AVERAGE	9572	2085	11657	5

Gross Vehicle Weight

<i>Month</i>	<i>GVW WB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>Total GVW Kips</i>
May 2017	1645395	1122207	2767602
Jun 2017	1554529	1047637	2602167
Jul 2017	1734424	1179053	2913477
Aug 2017	1792589	1215750	3008338
Sep 2017	1368815	782424	2151239
Oct 2017	1328916	819795	2148711
Nov 2017	1277397	780242	2057640
Dec 2017	1778497	1291716	3070213
Jan 2018	1662343	1234848	2897191
Feb 2018	1813979	1269402	3083381
Mar 2018	1690562	1154286	2844848
Apr 2018	1689383	1187534	2876918
TOTAL	19336830	13084894	32421724
AVERAGE	1611402	1090408	2701810

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>
May 2017	702	0.2	5.2	24	11
Jun 2017	751	0.2	5.7	14	8
Jul 2017	702	0.2	5.8	13	9
Aug 2017	1056	0.2	5.5	45	31
Sep 2017	838	0.1	4.4	59	39
Oct 2017	1742	0.3	8.1	79	37
Nov 2017	2412	0.5	12.3	229	25
Dec 2017	2523	0.5	13.5	349	29
Jan 2018	2708	0.6	14.6	420	36
Feb 2018	3040	0.7	16.6	565	78
Mar 2018	3191	0.6	16.1	388	45
Apr 2018	3374	0.7	15	242	23
TOTAL	23039	--	--	2427	371
AVERAGE	1919.9	0.4	10.2	202.2	30.9

Freight

<i>Month</i>	<i>WB Freight Tons</i>
May 2017	79220
Jun 2017	81236
Jul 2017	74610
Aug 2017	121047
Sep 2017	116647
Oct 2017	156411
Nov 2017	153141
Dec 2017	146186
Jan 2018	144984
Feb 2018	153149
Mar 2018	171392
Apr 2018	193752
TOTAL	1591776
AVERAGE	132648