

APRIL 2018



**WIM #44
CSAH 1, MP 8.1
MANHATTAN
BEACH, MN**

**MONTHLY
REPORT**



Your Destination... Our Priority



WIM Site Location

WIM #44 is located on CSAH 1 near Manhattan Beach in Crow Wing county.

System Operation

WIM #44 was operational for the entire month of April 2018. Volume was computed using all monthly data.

System Calibration

WIM #44 was most recently calibrated on 2015-08-10. 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 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: 24702 | Passenger Vehicles: 18109 | Heavy Commercial Vehicles: 6593

Monthly Average Daily Traffic (MADT): 823 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 220

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 Sundays, with lowest volumes reported on Thursdays. 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 02 PM and 04 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 02 PM and 04 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 5's and Class 8's.

Overweight HCVs

Volume trends. Of a total of 6593 HCVs, 78 of them were overweight ³. These overweight HCVs contributed to 0.3% of total monthly volume, and 1.2% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on NAs. WB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on Saturdays. See Figure 3 .

The top two overweight violators by class were the class 10 and class 5 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 51.8% 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 ,19 EB vehicles exceeded 88,000 pounds (16 vehicles were Class 10's; 3 vehicles were Class 9's). Of vehicles traveling WB,

9 EB vehicles exceeded 88,000 pounds (4 vehicles were Class 10's; 4 vehicles were Class 12'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 9s and 10s in April 2018. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling EB, while there were more fully_loaded Class 9's than empty 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 11144 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (53.4%) than WB (46.6%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 95425 (a precast pipe arch) is approximately 3.45 miles south west from WIM #44. Bridge No. 95426 (a precast pipe arch) is approximately .08 miles sw of WIM #44. WIM #44 recorded a total of 24702 vehicles with a combined GVW of 174122 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 866 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 52.4% of all ESALs were recorded EB while 47.6% was observed WB. In particular, 41% of all ESALs were generated by the Class 5's (Class 5's were also responsible for generating 31% 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).

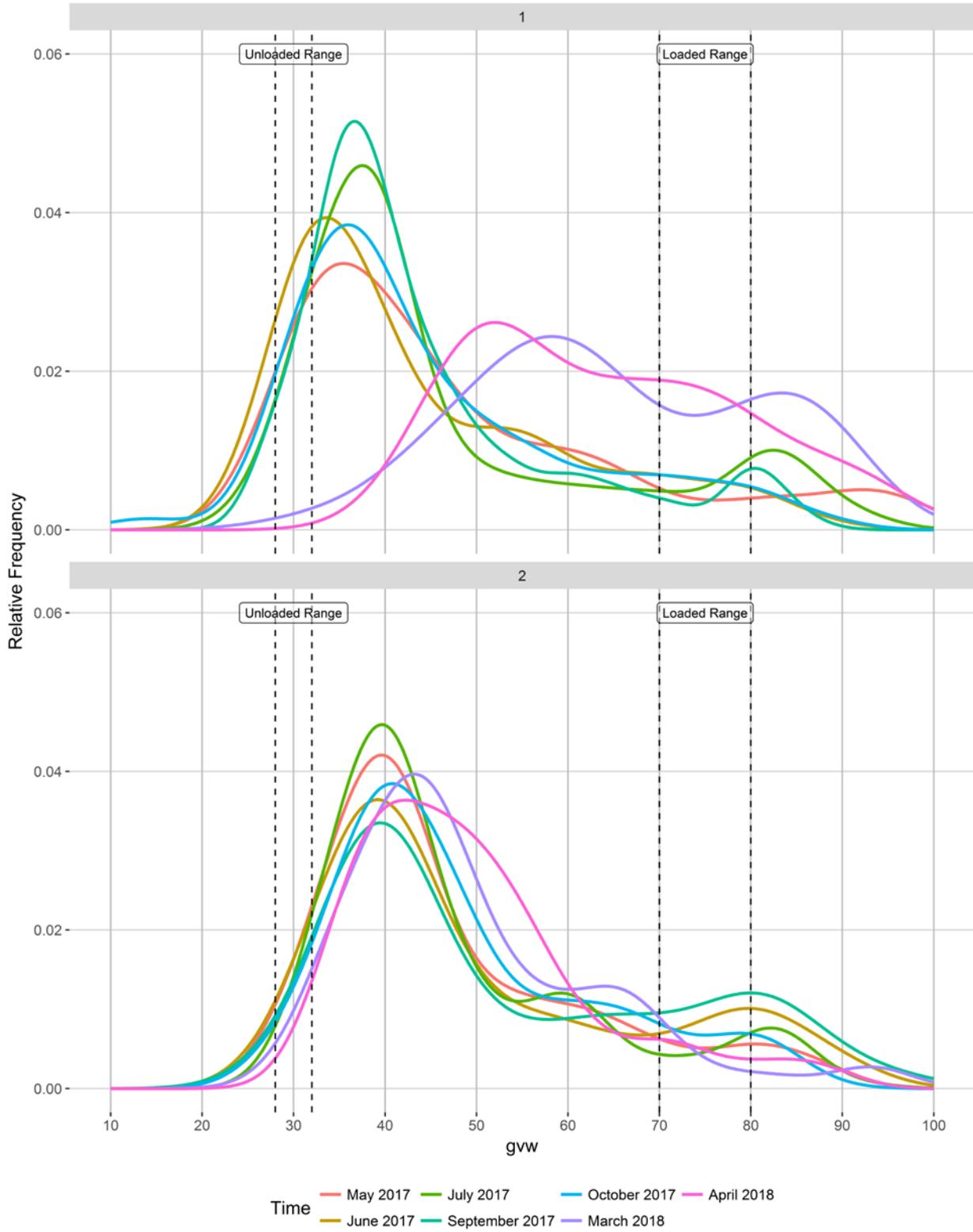
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

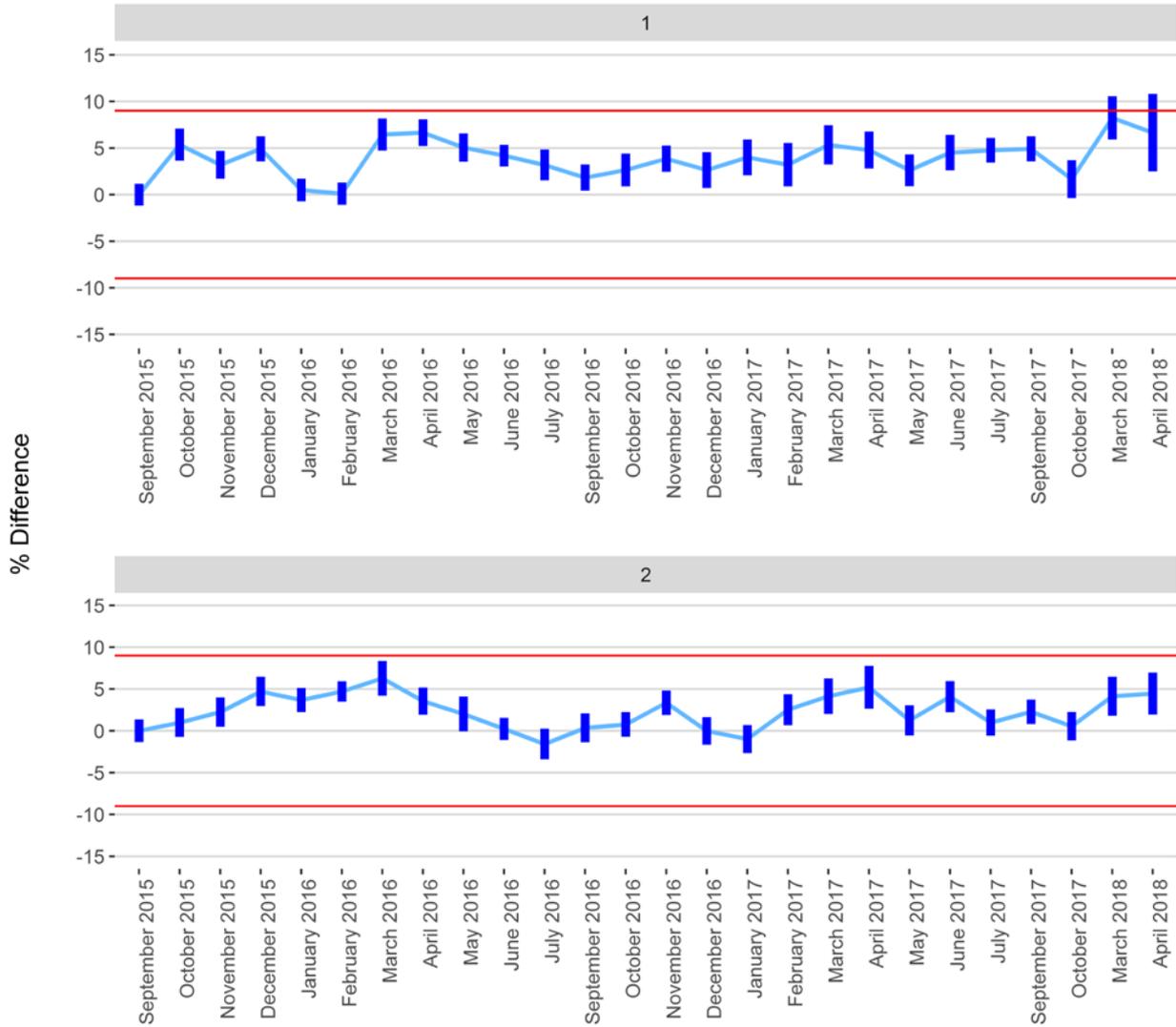
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Figure 1 - Monthly Class 9 GVW Histogram



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

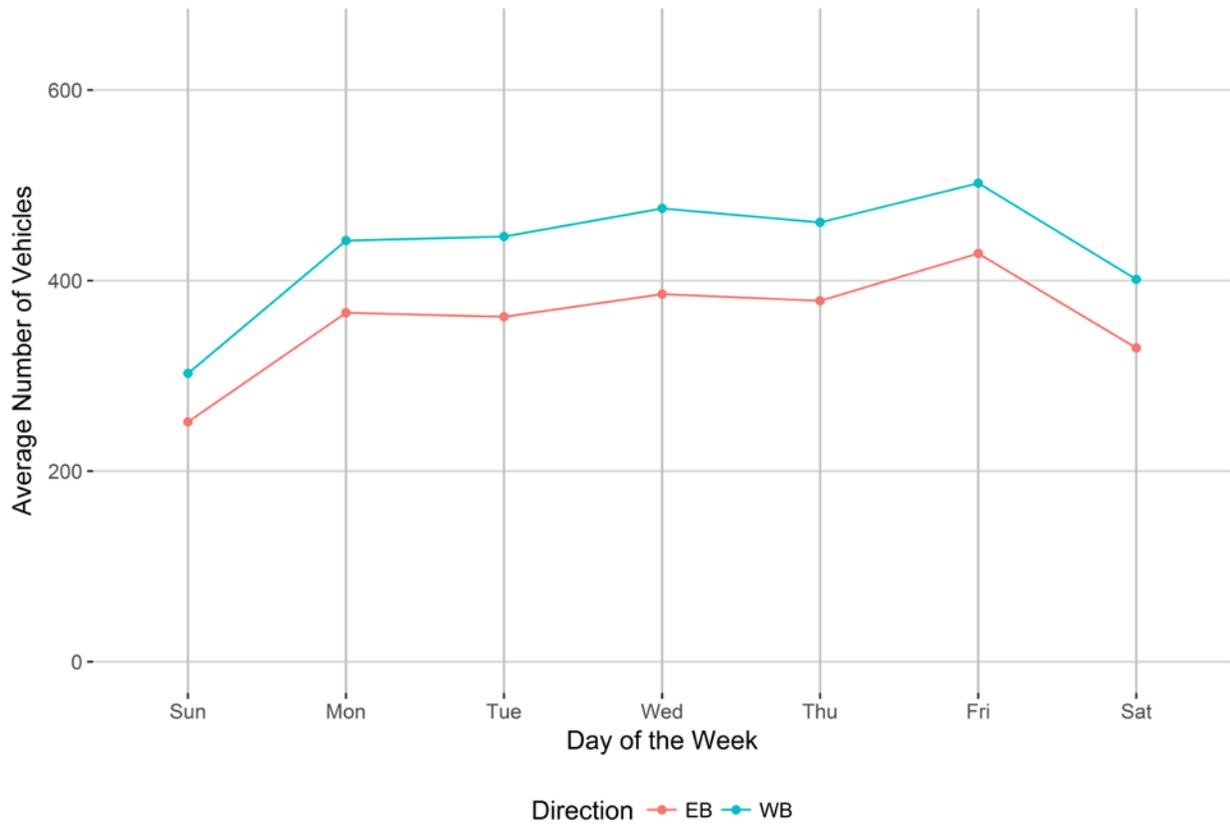


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

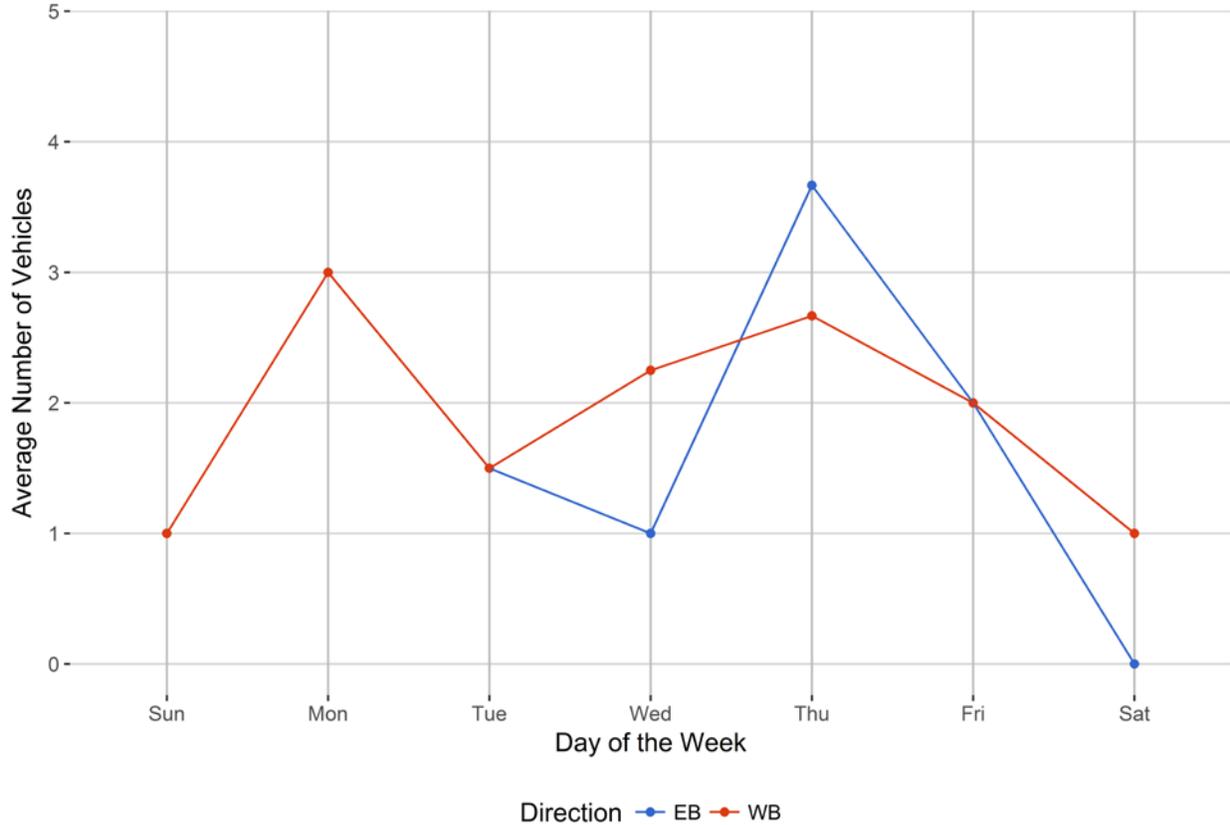


Figure 4 - Passenger Vehicles vs. Hour of the Day

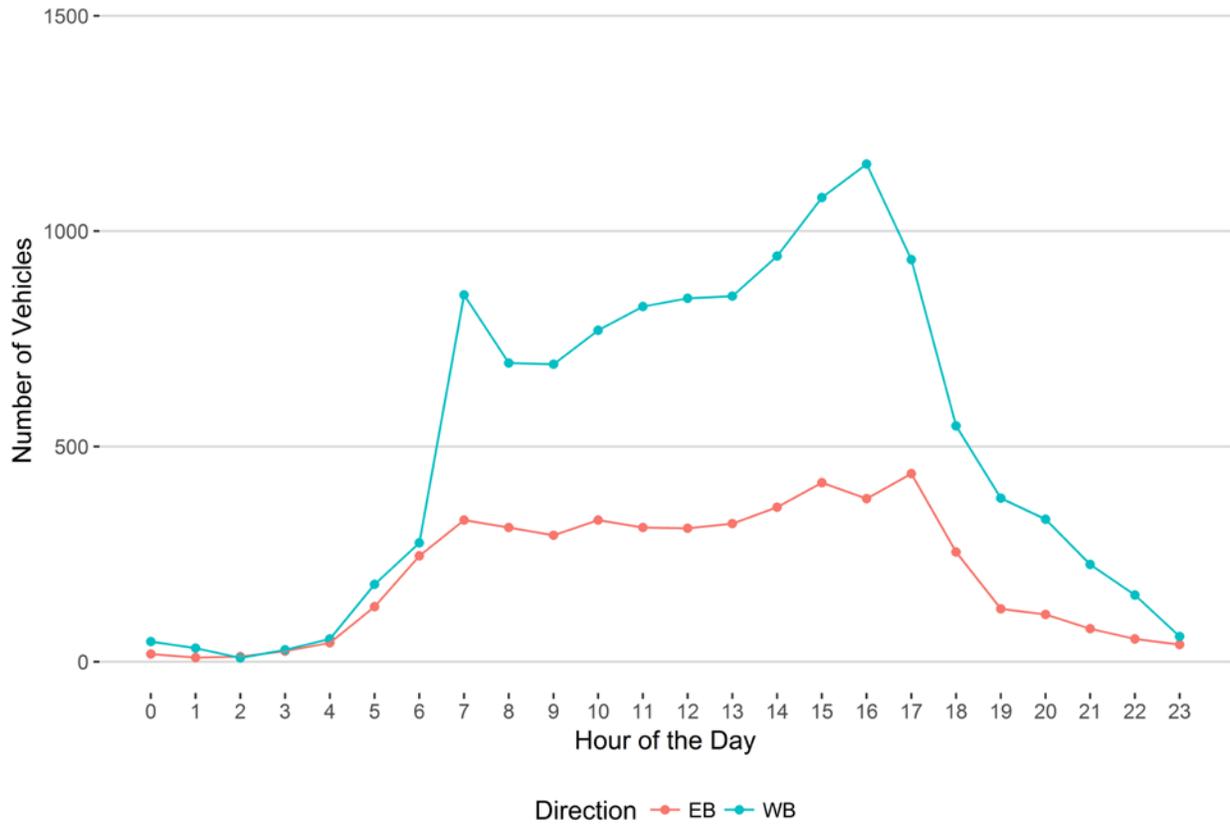


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

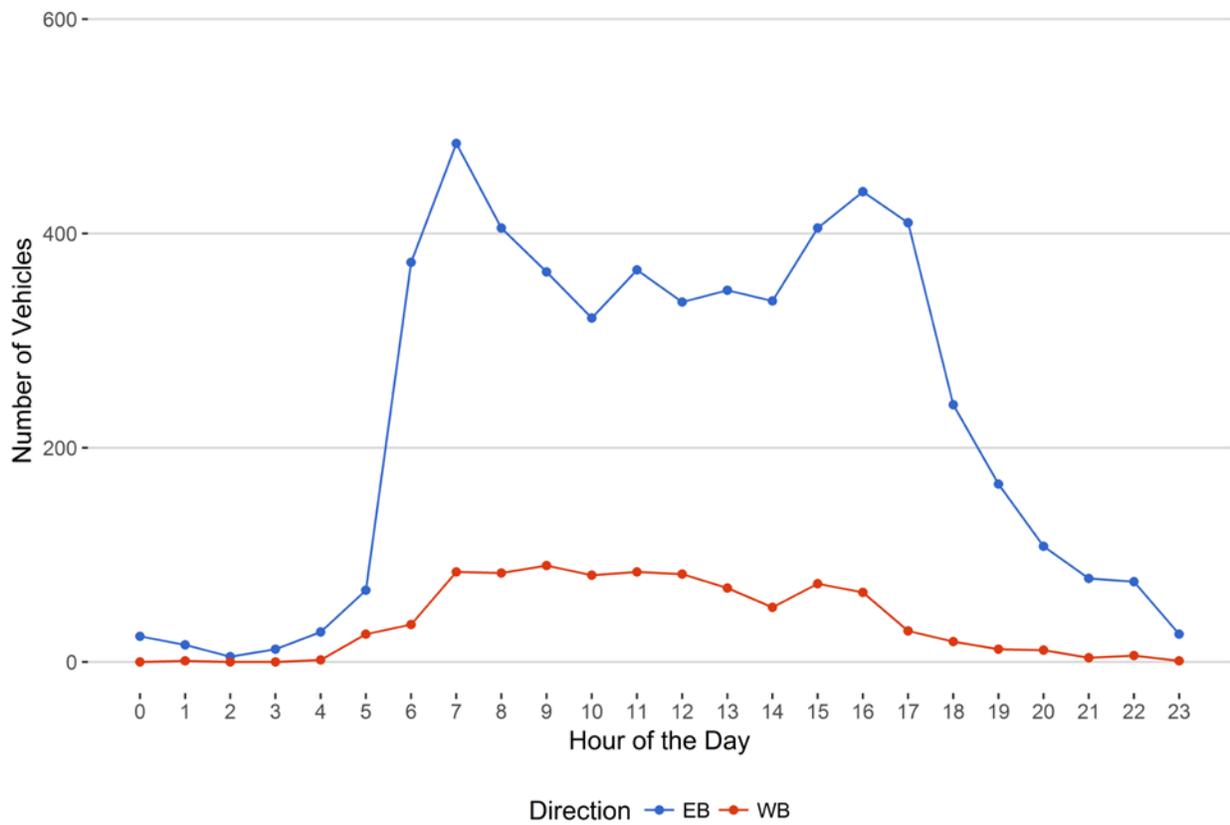


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

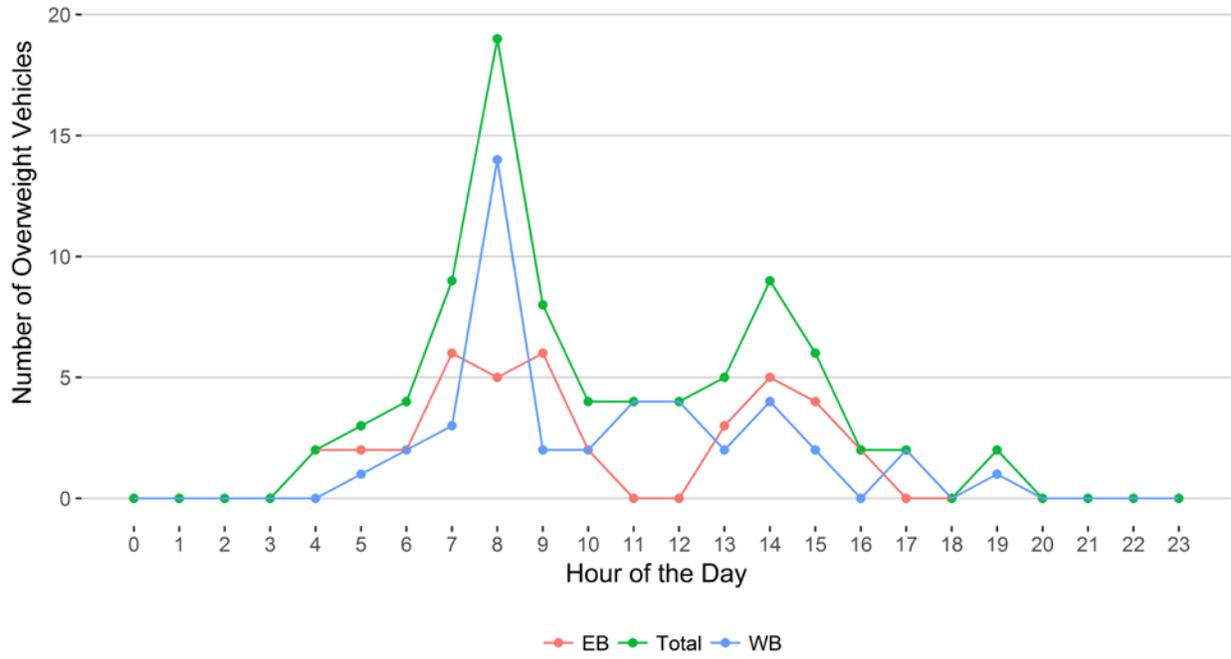
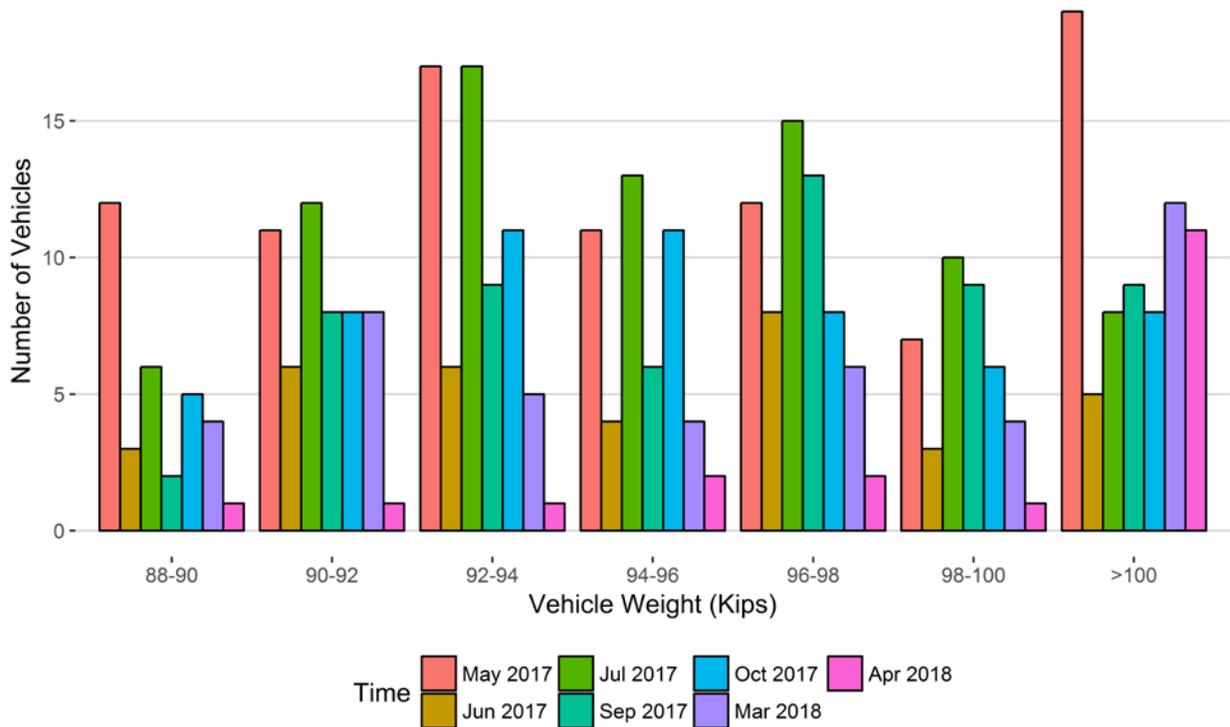
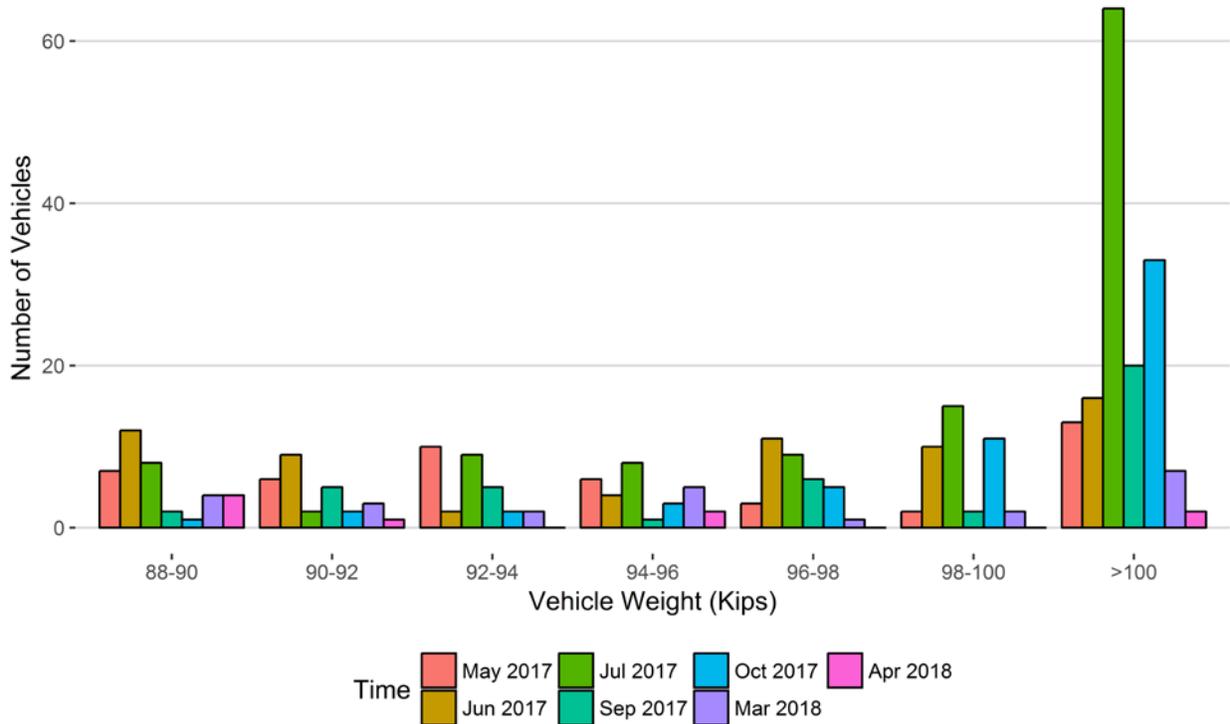


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>May 2017</i>	<i>Jun 2017</i>	<i>Jul 2017</i>	<i>Sep 2017</i>	<i>Oct 2017</i>	<i>Mar 2018</i>	<i>Apr 2018</i>
88-90	12	3	6	2	5	4	1
90-92	11	6	12	8	8	8	1
92-94	17	6	17	9	11	5	1
94-96	11	4	13	6	11	4	2
96-98	12	8	15	13	8	6	2
98-100	7	3	10	9	6	4	1
>100	19	5	8	9	8	12	11
Total	89	35	81	56	57	43	19

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



Vehicle Weights (Kips)	May 2017	Jun 2017	Jul 2017	Sep 2017	Oct 2017	Mar 2018	Apr 2018
88-90	7	12	8	2	1	4	4
90-92	6	9	2	5	2	3	1
92-94	10	2	9	5	2	2	0
94-96	6	4	8	1	3	5	2
96-98	3	11	9	6	5	1	0
98-100	2	10	15	2	11	2	0
>100	13	16	64	20	33	7	2
Total	47	64	115	41	57	24	9

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

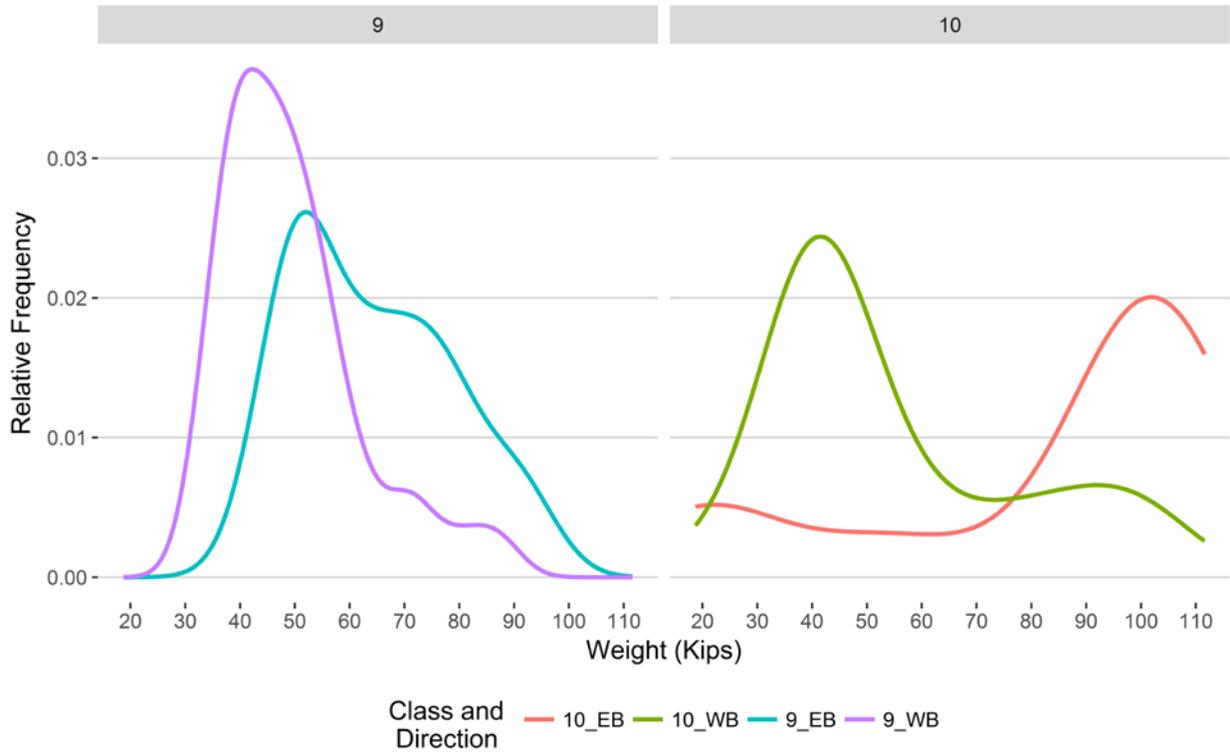


Figure 9 - Freight Percentage by Direction and Class

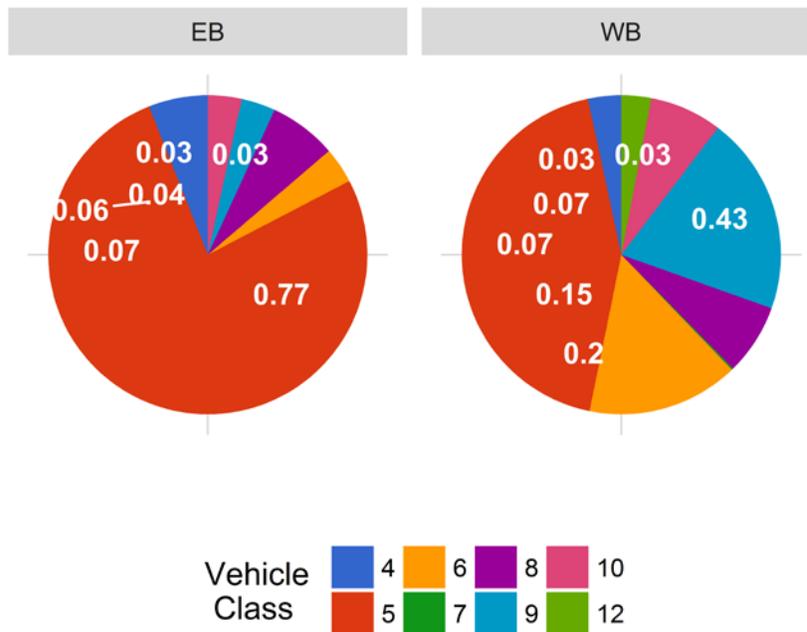


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

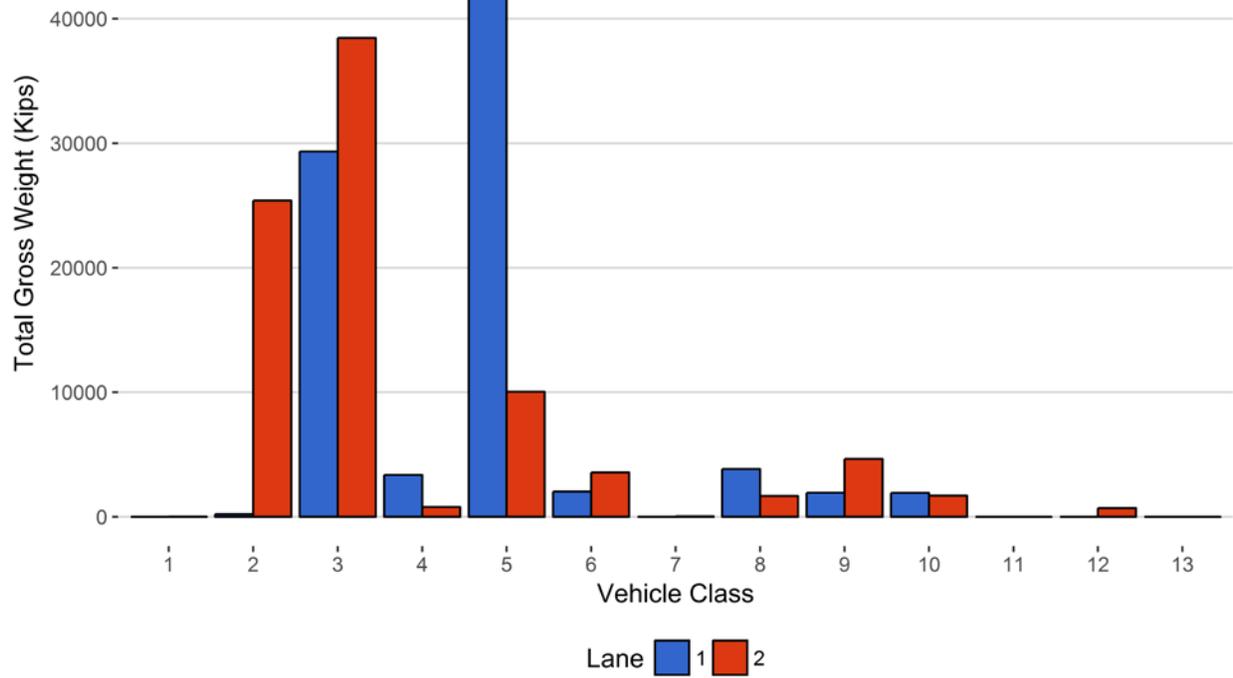


Figure 11 - Total Gross Vehicle Weight I

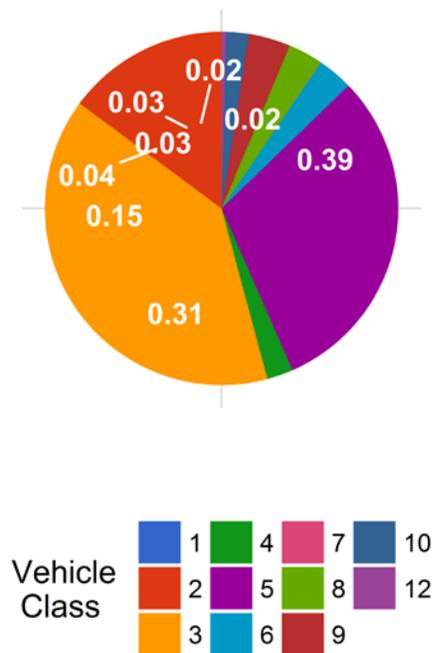


Figure 12 - Total ESALs by Class and Lane

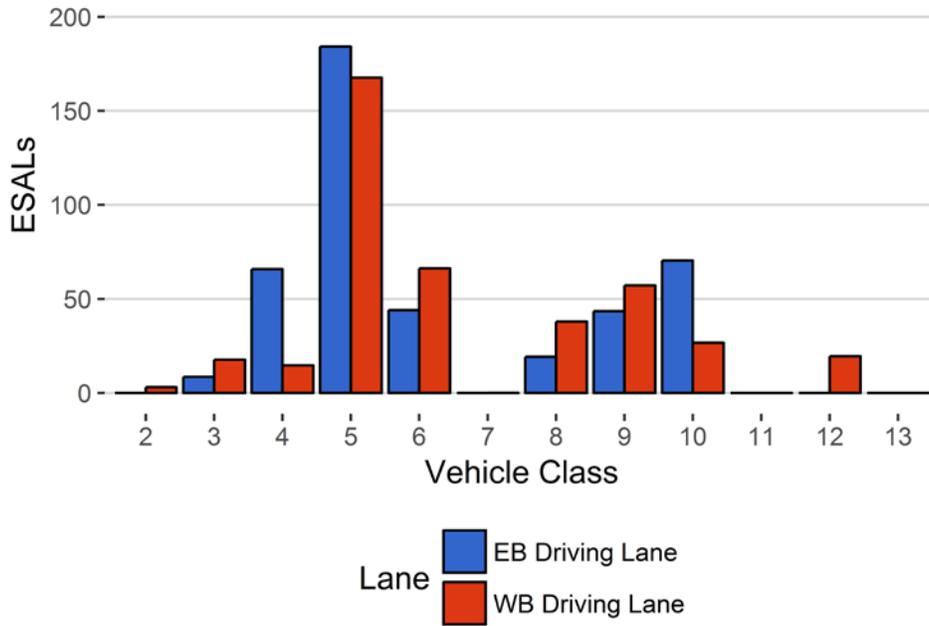


Figure 13 - ESALs by Class

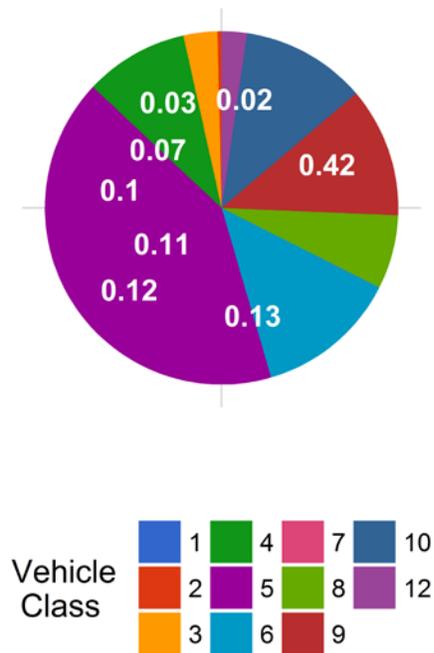


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
September 2015	10.51	0.00	10.69	0.00
October 2015	11.07	5.36	10.79	0.99
November 2015	10.85	3.20	10.93	2.24
December 2015	11.03	4.92	11.19	4.71
January 2016	10.56	0.50	11.08	3.69
February 2016	10.52	0.10	11.19	4.71
March 2016	11.19	6.46	11.36	6.28
April 2016	11.21	6.66	11.07	3.55
May 2016	11.04	5.06	10.90	2.02
June 2016	10.95	4.18	10.71	0.24
July 2016	10.84	3.19	10.52	-1.58
September 2016	10.70	1.83	10.72	0.36
October 2016	10.79	2.64	10.77	0.75
November 2016	10.92	3.86	11.04	3.35
December 2016	10.79	2.64	10.69	0.00
January 2017	10.93	4.00	10.58	-0.98
February 2017	10.85	3.21	10.96	2.52
March 2017	11.07	5.33	11.13	4.15
April 2017	11.01	4.78	11.24	5.21
May 2017	10.78	2.61	10.82	1.25
June 2017	10.98	4.51	11.12	4.08
July 2017	11.01	4.77	10.79	0.99
September 2017	11.03	4.93	10.93	2.27
October 2017	10.68	1.65	10.74	0.55
March 2018	11.38	8.24	11.13	4.13
April 2018	11.21	6.66	11.16	4.45

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	3	0	0	0
2	235	7037	28.5	0	0
3	369	11069	44.8	0	0
4	6	173	0.7	2	2.6
5	193	5777	23.4	18	23.1
6	5	156	0.6	9	11.5
7	0	1	0	0	0
8	10	293	1.2	6	7.7
9	4	129	0.5	11	14.1
10	2	56	0.2	24	30.8
11	0	0	0	0	0
12	0	8	0	8	10.3
13	0	0	0	0	0
TOTAL	823	24702	100	78	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>
2018-04-12	Thursday	07:37:55	10	EB	1	111.62
2018-04-12	Thursday	08:21:16	10	EB	1	110.53
2018-04-19	Thursday	06:55:30	10	EB	1	106.3
2018-04-19	Thursday	04:52:09	10	EB	1	105.94
2018-04-18	Wednesday	14:53:46	10	WB	2	105.7
2018-04-12	Thursday	08:48:24	10	EB	1	104.98
2018-04-19	Thursday	06:55:47	10	EB	1	104.23
2018-04-18	Wednesday	14:28:20	10	EB	1	103.85
2018-04-20	Friday	15:23:04	10	EB	1	103.06
2018-04-12	Thursday	07:37:20	10	EB	1	102.39

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	141	2	1.4	3334	24	625
5	EB	8	4957	2965	59.8	23270	19556	3667
6	EB	19	53	0	0	2029	0	511
8	EB	31	228	214	93.9	605	3227	86
9	EB	33	30	0	0	1926	0	468
10	EB	33.5	23	4	17.4	1826	86	595
TOTAL	****	****	5432	3185	****	32990	****	5951
<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	25	1	4	764	14	202
5	WB	8	598	50	8.4	9668	376	2642
6	WB	19	97	2	2.1	3521	37	858
7	WB	11.5	1	0	0	38	0	13
8	WB	31	54	25	46.3	1232	431	167
9	WB	33	94	1	1.1	4614	32	772
10	WB	33.5	31	1	3.2	1674	19	335
12	WB	36.5	8	0	0	701	0	205
TOTAL	****	****	908	80	****	22212	****	5193
GRAND TOTAL	****	****	6340	3265	238	55202	23801	11144

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	4	4	0
2	215	25399	25614	14.9
3	29338	38458	67795	39.3
4	3358	778	4135	2.4
5	42826	10044	52870	30.7
6	2029	3558	5587	3.2
7	0	38	38	0
8	3832	1663	5495	3.2
9	1926	4645	6571	3.8
10	1912	1693	3605	2.1
12	0	701	701	0.4
TOTAL	85436	86980	172416	100
GVW/LANE	49.55	50.45	100	0.06

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	0.25
2	0	3	3	0.4	0.0014
3	8	18	26	3.1	0.0055
4	66	15	80	9.5	1.03
5	184	168	352	41.5	0.13
6	44	66	110	13	1.54
7	0	0	0	0	0.9
8	19	38	57	6.8	0.45
9	44	57	101	11.9	1.67
10	70	27	97	11.5	3.37
12	0	20	20	2.3	2.67
TOTAL	436	411	847	100	12
ESALS/LANE	51.5	48.5	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	36813	1188	93	33921	92.1	2891.8	7.9
Jun 2017	39195	1306	100	36191	92.3	3004.1	7.7
Jul 2017	44467	1434	115	40917	92	3550.3	8
Sep 2017	35473	1182	92	32700	92.2	2773	7.8
Oct 2017	31525	1017	95	28567	90.6	2957.8	9.4
Mar 2018	23847	769	208	17402	73	6445	27
Apr 2018	24702	823	220	18109	73.3	6593	26.7
TOTAL	236022	--	--	207807	--	28215	--
AVERAGE	33717	1103	132	29687	87	4031	13

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>
May 2017	978	1012	1990	19.5
Jun 2017	752	1070	1821	25.9
Jul 2017	1643	1291	2934	25.4
Sep 2017	877	1083	1959	22.1
Oct 2017	909	1075	1983	29.6
Mar 2018	618	539	1157	40.2
Apr 2018	454	413	866	31.3
TOTAL	6229	--	--	--
AVERAGE	890	926	1816	28

Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
May 2017	89941	88487	178428
Jun 2017	87071	87050	174122
Jul 2017	128367	143432	271799
Sep 2017	126323	154528	280851
Oct 2017	146289	177523	323812
Mar 2018	121395	140110	261505
Apr 2018	116073	133692	249765
TOTAL	815460	924823	1740283
AVERAGE	116494	132118	248612

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	361	1	12.6	136	41
Jun 2017	317	0.8	10.6	99	34
Jul 2017	640	1.5	18.9	196	97
Sep 2017	323	0.9	11.5	98	40
Oct 2017	344	1.1	10.3	115	58
Mar 2018	156	0.7	2.4	67	25
Apr 2018	83	0.4	1.3	28	14
TOTAL	2224	--	--	739	309
AVERAGE	317.7	0.9	9.7	105.6	44.1

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>
May 2017	10567	11297	21864	48.3	51.7
Jun 2017	8485	11479	19964	42.5	57.5
Jul 2017	14839	13532	28371	52.3	47.7
Sep 2017	9454	10945	20399	46.3	53.7
Oct 2017	10009	11716	21725	46.1	53.9
Mar 2018	7741	6003	13744	56.3	43.7
Apr 2018	5951	5193	11144	53.4	46.6
TOTAL	67046	70165	137211	--	--
AVERAGE	9578	10023.5	19601.5	49.3	50.7