

MARCH 2019



**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 March 2019. 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: 21799 | Passenger Vehicles: 15856 | Heavy Commercial Vehicles: 5943

Monthly Average Daily Traffic (MADT): 703 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 192

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 Fridays, with lowest volumes reported on Saturdays. 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 03 PM and 05 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 03 PM and 05 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 5943 HCVs, 116 of them were overweight³. These overweight HCVs contributed to 0.6% of total monthly volume, and 2% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Thursdays. WB overweight vehicles tended to reach highest volumes on Tuesdays, with lowest volumes reported on Mondays. 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 50.4% 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 report⁴.

Using normal load limits ,16 EB vehicles exceeded 88,000 pounds (13 vehicles were Class 10's; 3 vehicles were Class 9's). Of vehicles traveling WB,

25 EB vehicles exceeded 88,000 pounds (22 vehicles were Class 10's; 2 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from March 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in March 2019. 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 fully_loaded Class 10's than empty traveling in the EB direction. In the WB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 10075 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (56%) than WB (44%). 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 21799 vehicles with a combined GVW of 156665 kips (1 kip = 1,000 pounds = 0.5 tons) in March 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 854 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 52.9% of all ESALs were recorded WB while 47.1% was observed EB. In particular, 35% of all ESALs were generated by the Class 5's (Class 5's were also responsible for generating 30% 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).

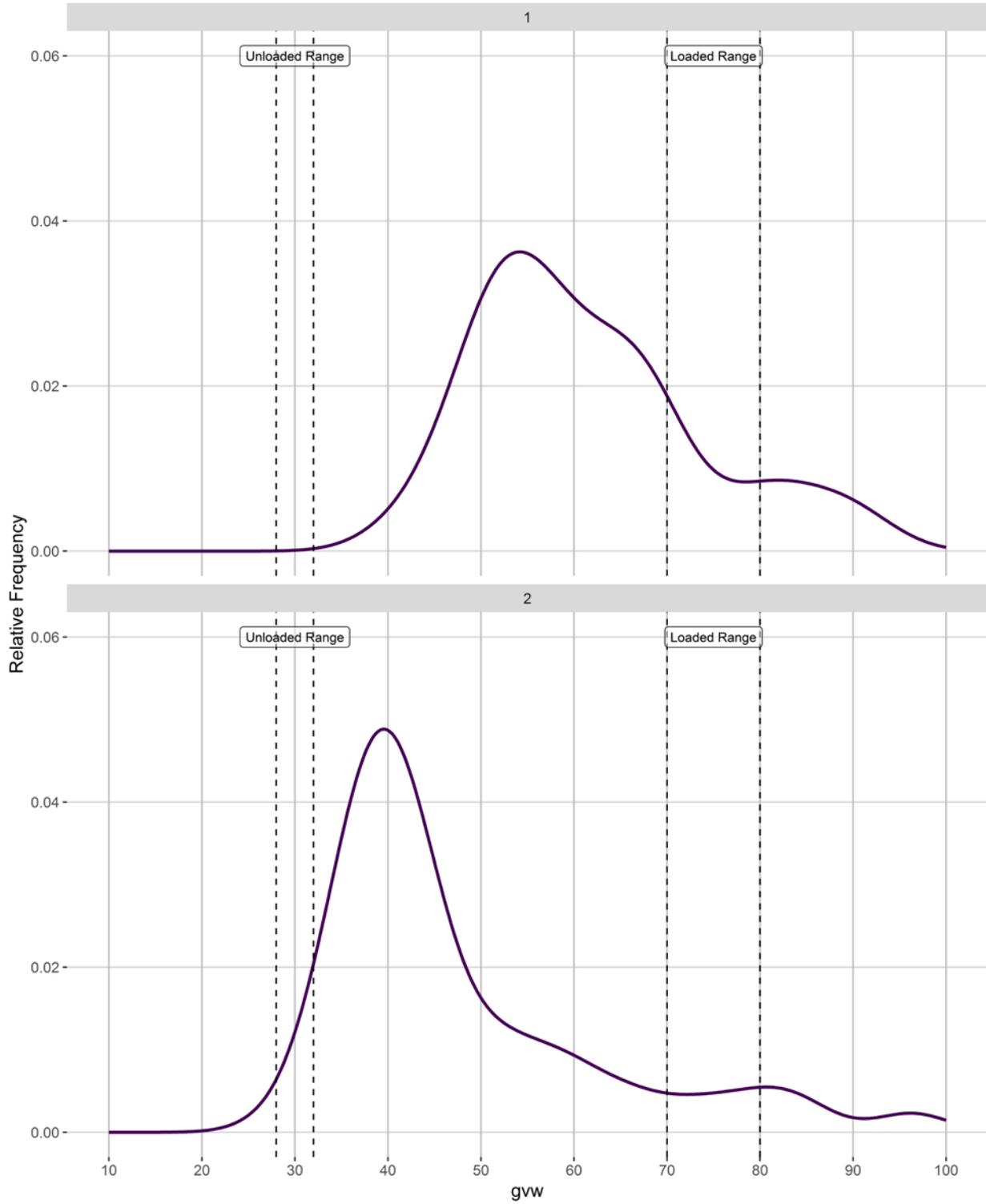
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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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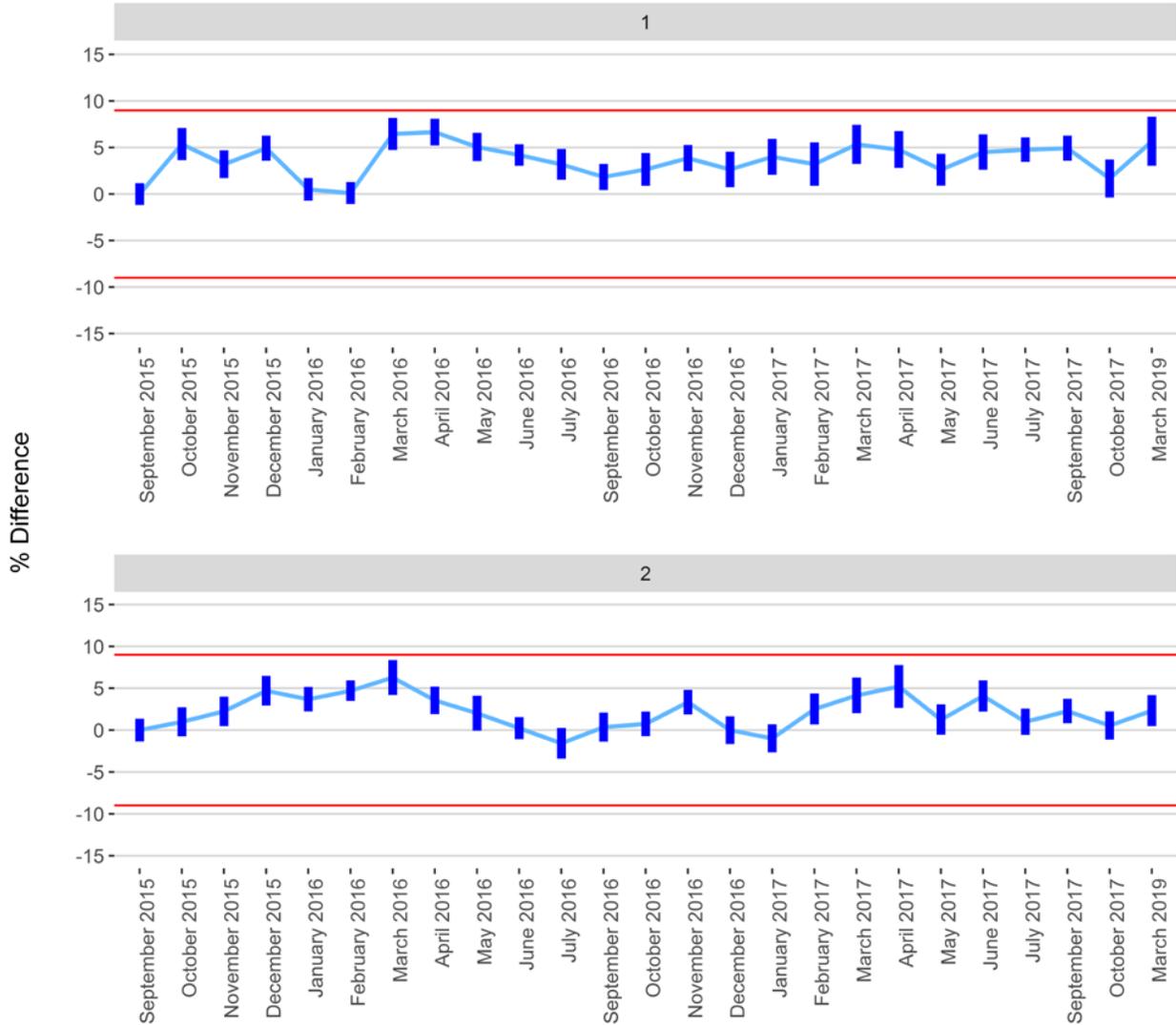
Figure 1 - Monthly Class 9 GVW Histogram



Time — March 2019

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

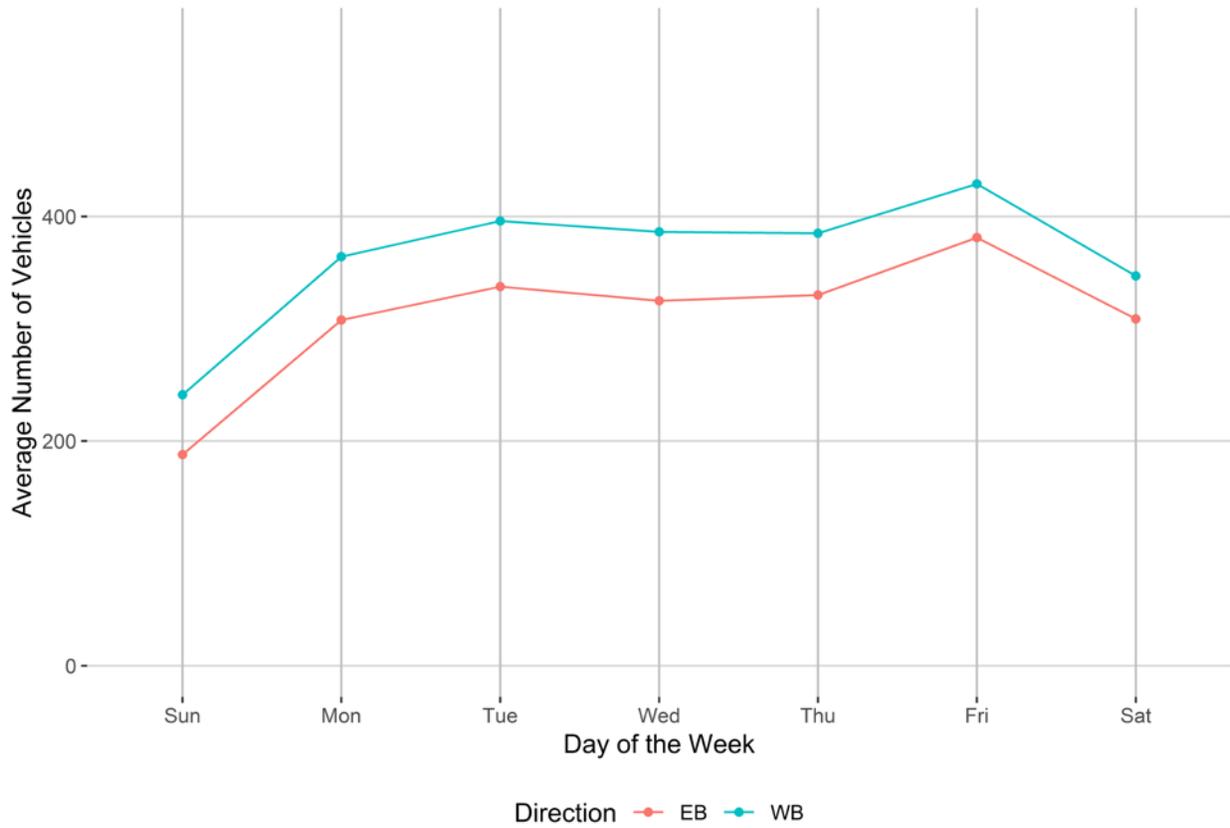


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

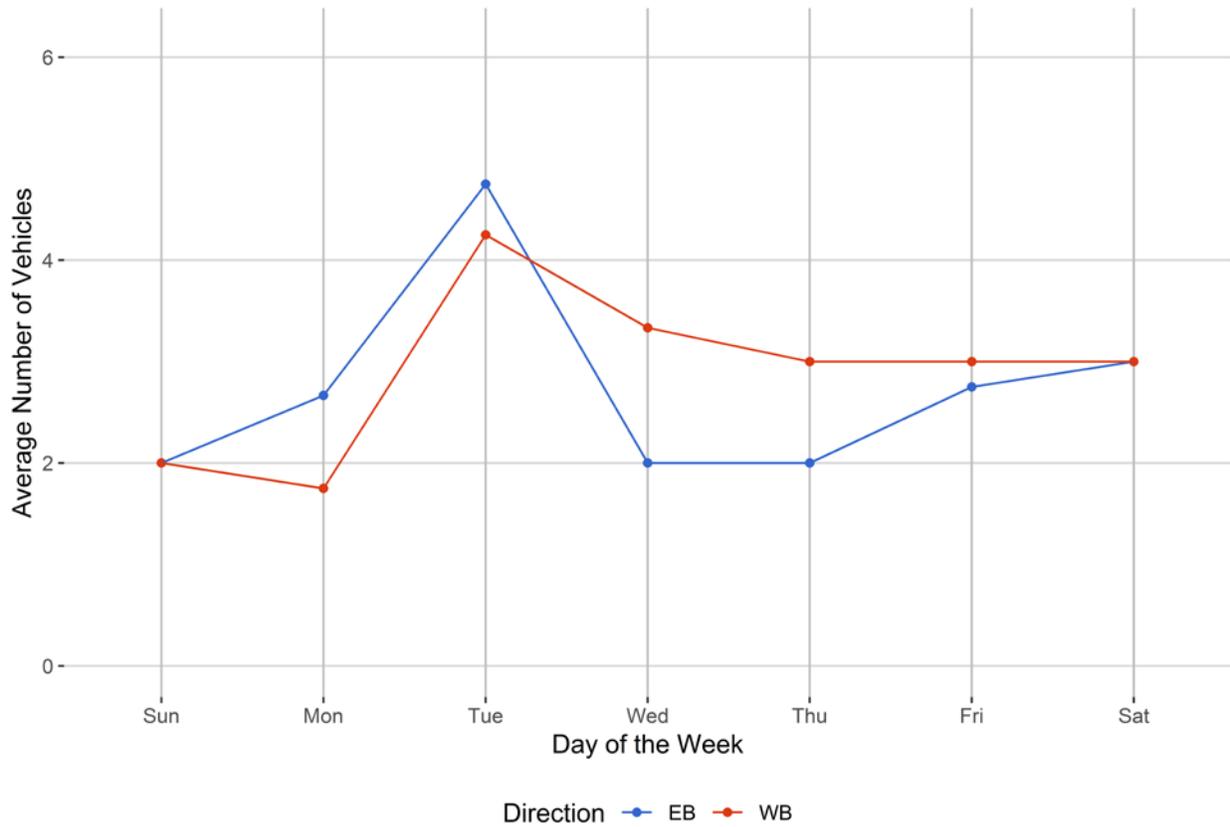


Figure 4 - Passenger Vehicles vs. Hour of the Day

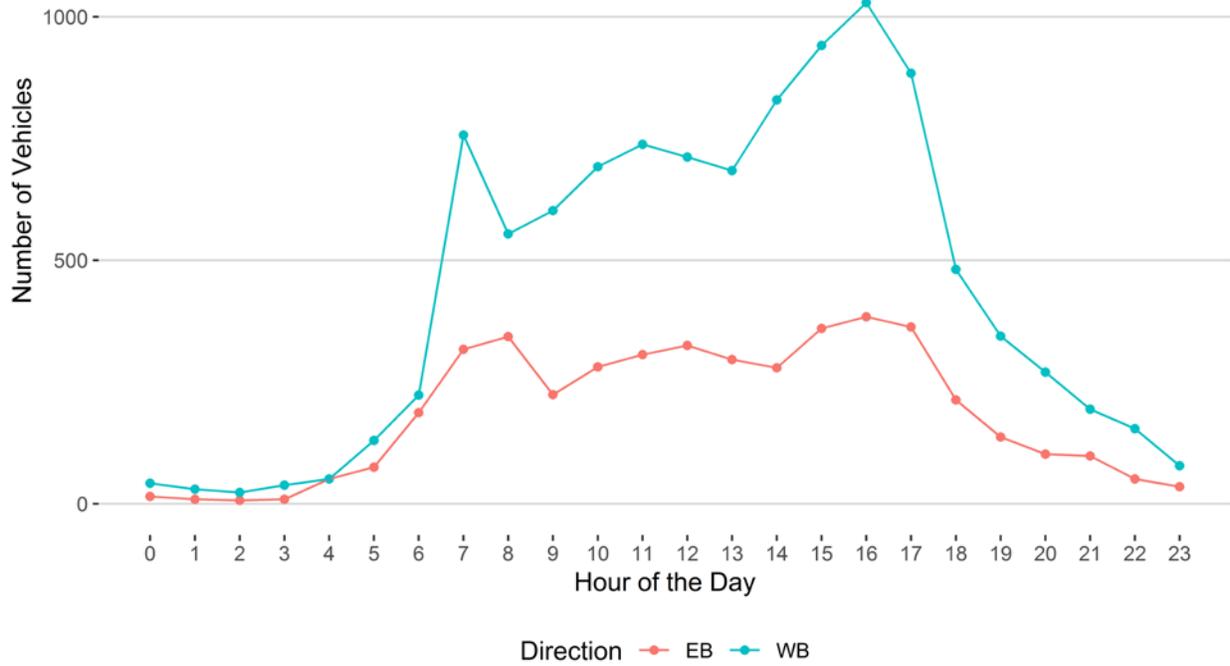


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

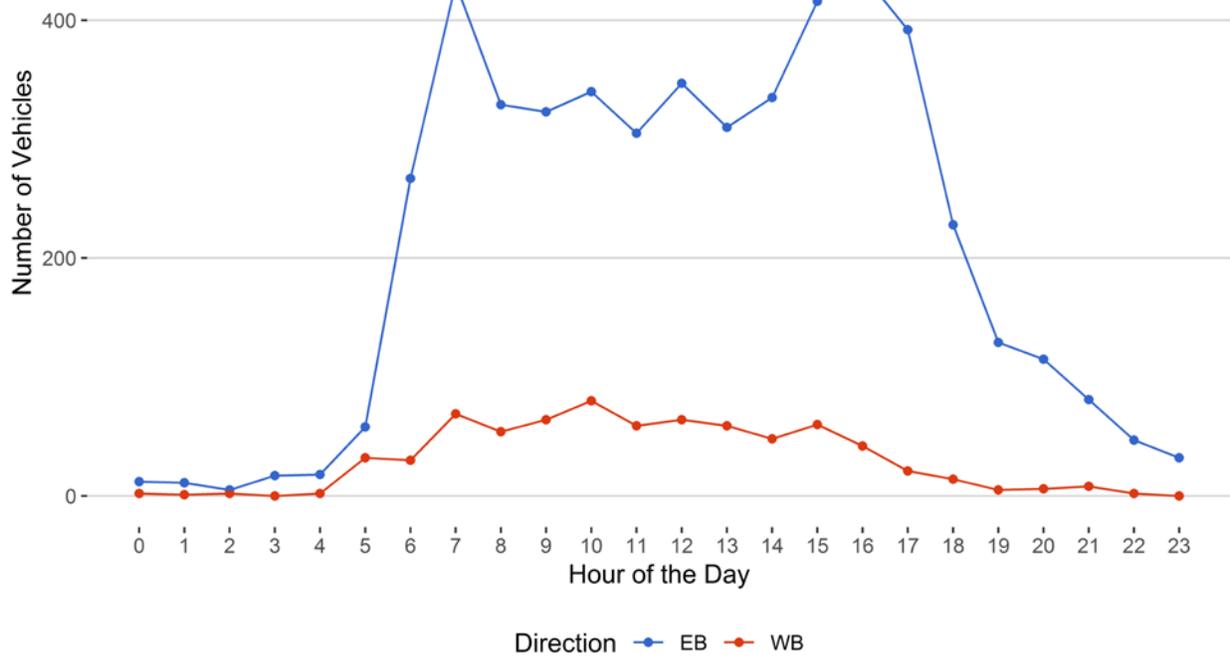


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

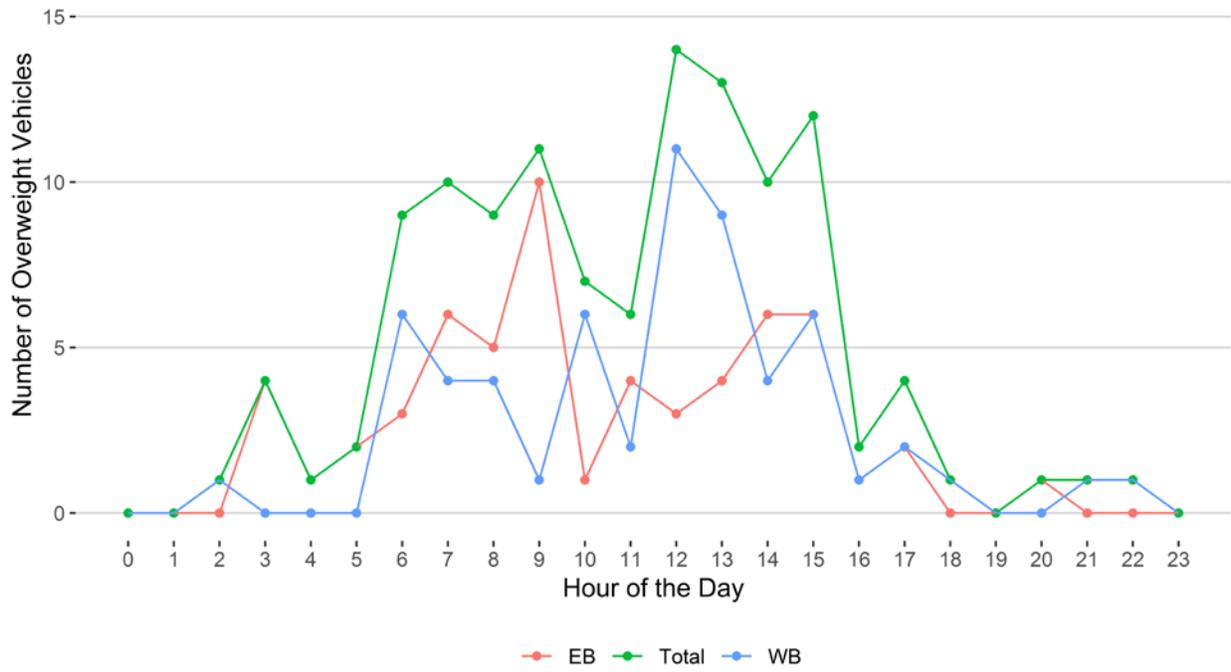
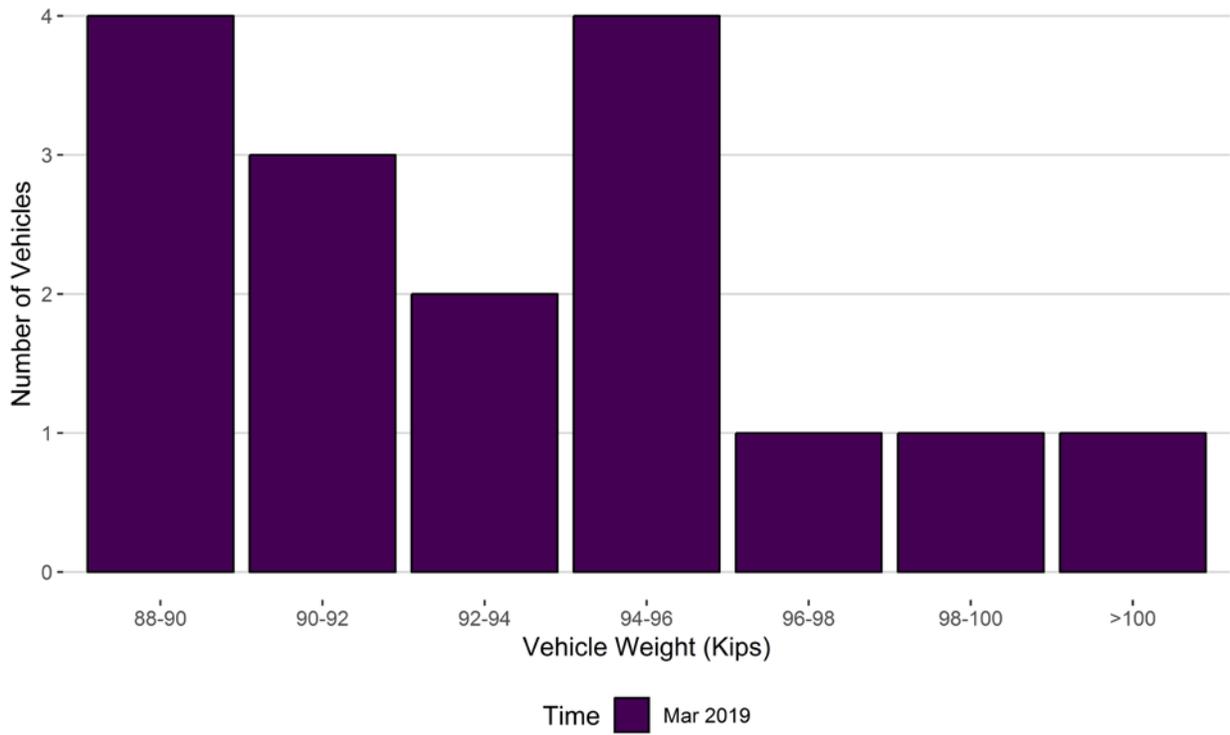
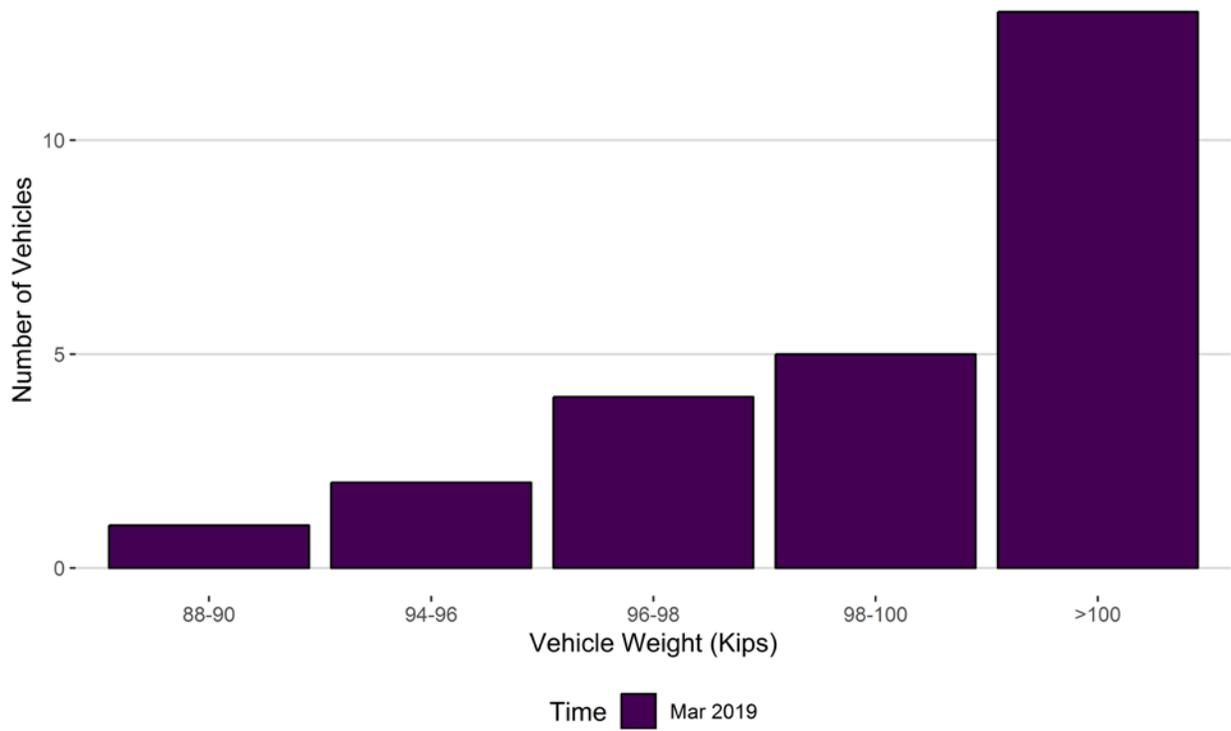


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Mar 2019</i>
88-90	4
90-92	3
92-94	2
94-96	4
96-98	1
98-100	1
>100	1
Total	16

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



<i>Vehicle Weights (Kips)</i>	<i>Mar 2019</i>
88-90	1
94-96	2
96-98	4
98-100	5
>100	13
Total	25

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

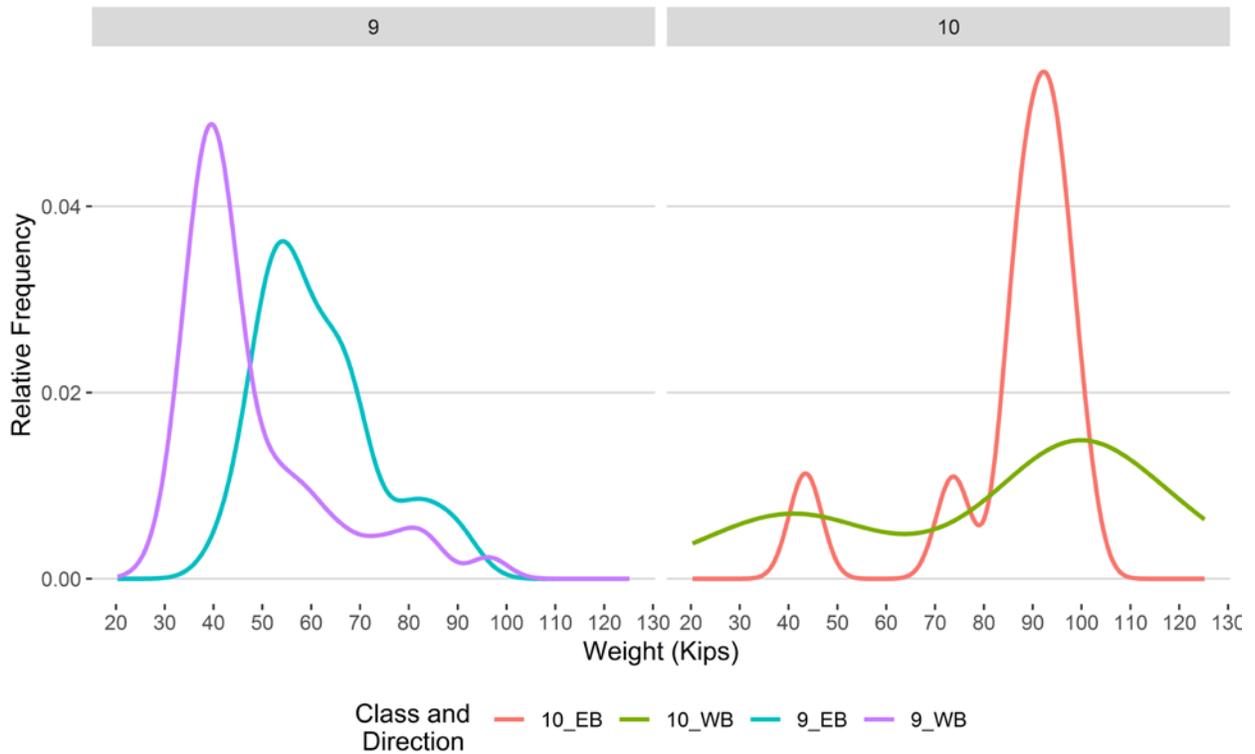


Figure 9 - Freight Percentage by Direction and Class

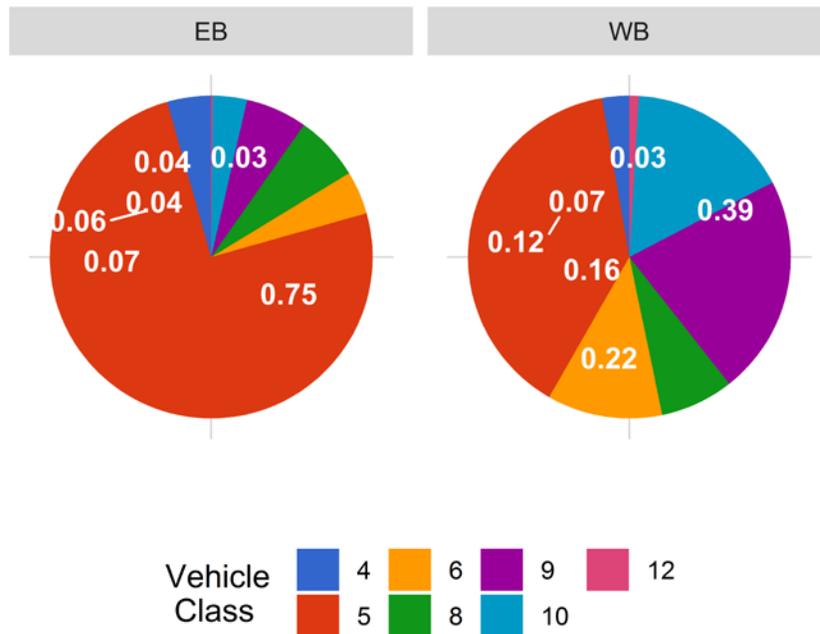


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

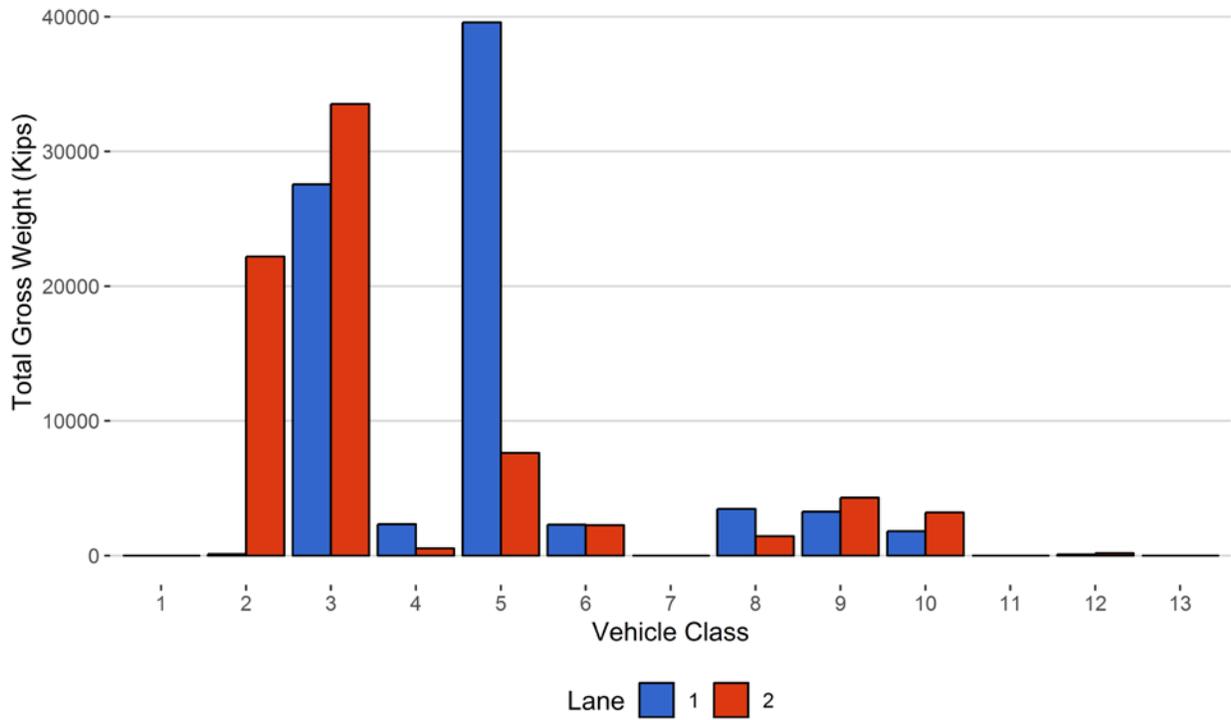


Figure 11 - Total Gross Vehicle Weight by

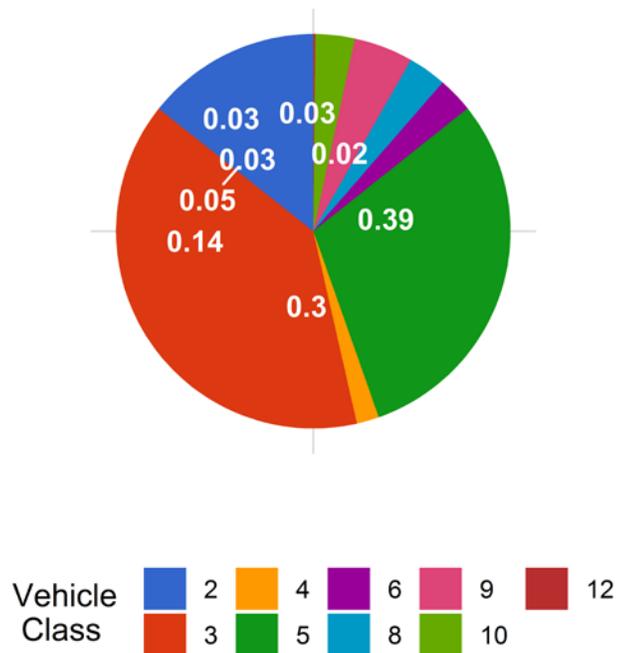


Figure 12 - Total ESALs by Class and Lane

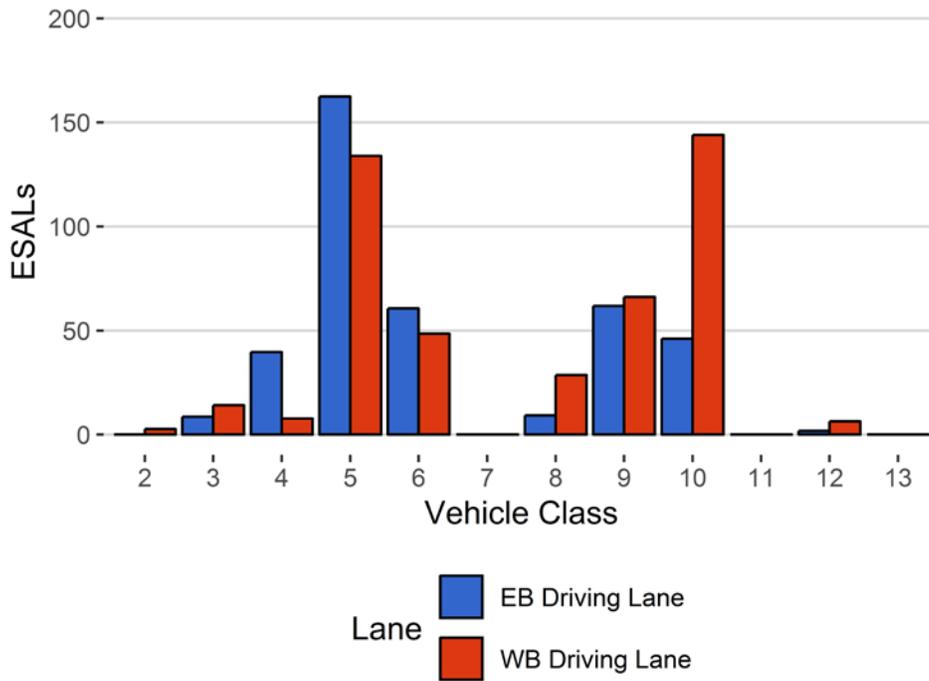


Figure 13 - ESALs by Class

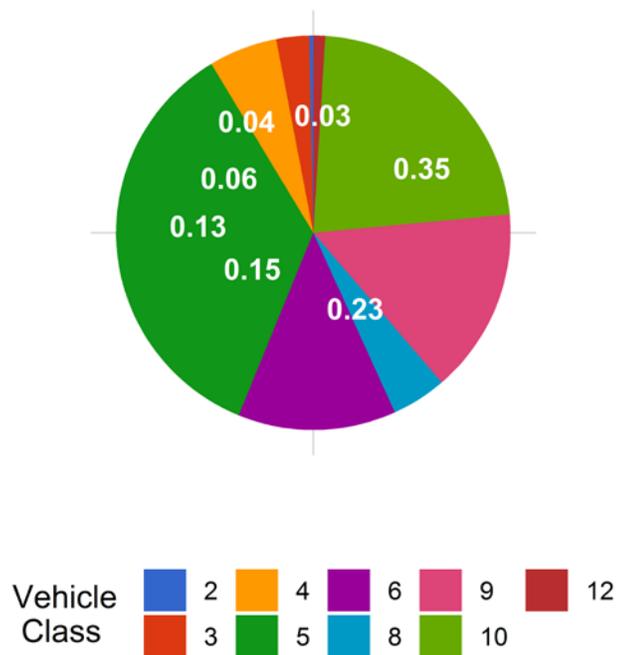


Table 1 Class 9 Front Axle Weight by Lane

<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 2019	11.10	5.66	10.93	2.33

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	0	0	0	0
2	190	5877	27	0	0
3	322	9979	45.8	0	0
4	4	126	0.6	1	0.9
5	168	5210	23.9	34	29.3
6	4	120	0.5	16	13.8
7	0	0	0	0	0
8	9	273	1.3	4	3.4
9	5	149	0.7	15	12.9
10	2	62	0.3	43	37.1
11	0	0	0	0	0
12	0	3	0	3	2.6
13	0	0	0	0	0
TOTAL	703	21799	100	116	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>
2019-03-09	Saturday	13:15:24	10	WB	2	125.18
2019-03-09	Saturday	08:57:18	10	WB	2	123.19
2019-03-09	Saturday	08:57:38	10	WB	2	123.03
2019-03-15	Friday	12:27:06	10	WB	2	121.31
2019-03-05	Tuesday	18:02:27	10	WB	2	117.95
2019-03-13	Wednesday	07:36:03	10	WB	2	108.94
2019-03-18	Monday	15:47:11	10	WB	2	106.76
2019-03-15	Friday	10:25:00	10	WB	2	105.32
2019-03-15	Friday	14:11:39	10	WB	2	104.88
2019-03-07	Thursday	12:17:21	10	WB	2	103.28

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	99	0	0	2327	0	421
5	EB	8	4544	2580	56.8	22150	17432	3219
6	EB	19	54	0	0	2284	0	629
8	EB	31	215	203	94.4	469	2992	48
9	EB	33	53	0	0	3258	0	754
10	EB	33.5	21	0	0	1802	0	549
12	EB	36.5	1	0	0	84	0	24
TOTAL	****	****	4987	2783	****	32374	****	5645
<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	22	3	13.6	491	41	103
5	WB	8	463	61	13.2	7167	445	1975
6	WB	19	61	3	4.9	2206	49	552
8	WB	31	47	19	40.4	1097	339	114
9	WB	33	90	5	5.6	4138	158	667
10	WB	33.5	39	3	7.7	3134	71	964
12	WB	36.5	2	0	0	182	0	55
TOTAL	****	****	724	94	****	18415	****	4430
GRAND TOTAL	****	****	5711	2877	237	50789	21526	10075

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>
2	108	22196	22304	14.3
3	27554	33522	61076	39.2
4	2327	532	2859	1.8
5	39582	7612	47193	30.3
6	2284	2254	4538	2.9
8	3461	1435	4896	3.1
9	3258	4296	7554	4.9
10	1802	3205	5007	3.2
12	84	182	267	0.2
TOTAL	80461	75234	155695	100
GVW/LANE	51.68	48.32	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>
2	0	3	3	0.3	0.0015
3	9	14	23	2.7	0.0053
4	40	8	47	5.6	0.84
5	162	134	296	35.2	0.13
6	61	48	109	13	1.96
8	9	29	38	4.5	0.33
9	62	66	128	15.2	1.84
10	46	144	190	22.6	5.9
12	2	6	8	1	1.95
TOTAL	390	452	843	100	13
ESALS/LANE	46.3	53.6	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>
Mar 2019	21799	703	192	15856	72.7	5943	27.3
TOTAL	21799	-	-	15856	-	5943	-
AVERAGE	21799	703	192	15856	73	5943	27

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>
Mar 2019	402	452	854	66.8
TOTAL	402	-	-	-
AVERAGE	402	452	854	67

Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Mar 2019	81349	75316	156665
TOTAL	81349	75316	156665
AVERAGE	81349	75316	156665

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>
Mar 2019	119	0.6	2	41	20
TOTAL	119	-	-	41	20
AVERAGE	119	0.6	2	41	20

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>
Mar 2019	5645	4430	10075	56	44
TOTAL	5645	4430	10075	-	-
AVERAGE	5645.2	4430	10075.1	56	44