

FEBRUARY 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 February 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: 20016 | Passenger Vehicles: 14520 | Heavy Commercial Vehicles: 5496

Monthly Average Daily Traffic (MADT): 715 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 196

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 Thursdays, with lowest volumes reported on Mondays. 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 07 AM 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 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 14's.

Overweight HCVs

Volume trends. Of a total of 5496 HCVs, 164 of them were overweight³. These overweight HCVs contributed to 0.9% of total monthly volume, and 3.2% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Fridays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Fridays, 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 65.5% of all overweight vehicles traveling EB 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 ,69 EB vehicles exceeded 88,000 pounds (66 vehicles were Class 10's; 2 vehicles were Class 9's). Of vehicles traveling WB,

24 EB vehicles exceeded 88,000 pounds (17 vehicles were Class 10's; 6 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from February 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in February 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 empty class 10 vehicles.

Freight Totals. A total of 11438 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (63%) than WB (37%). 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 20016 vehicles with a combined GVW of 147409 kips (1 kip = 1,000 pounds = 0.5 tons) in February 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 1010 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 56.3% of all ESALs were recorded EB while 43.7% was observed WB. In particular, 31% of all ESALs were generated by the Class 10's (Class 10's were also responsible for generating 7% 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).

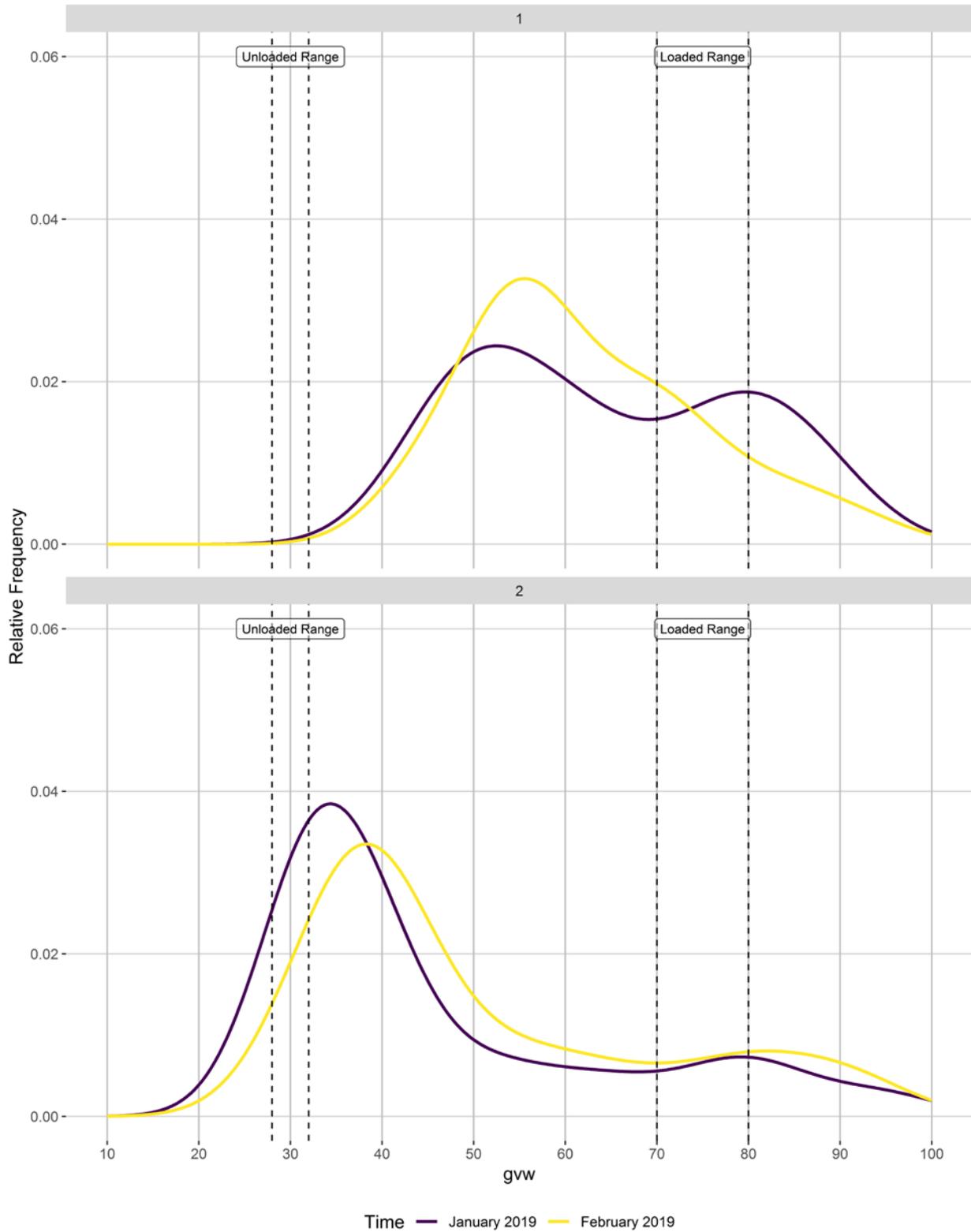
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

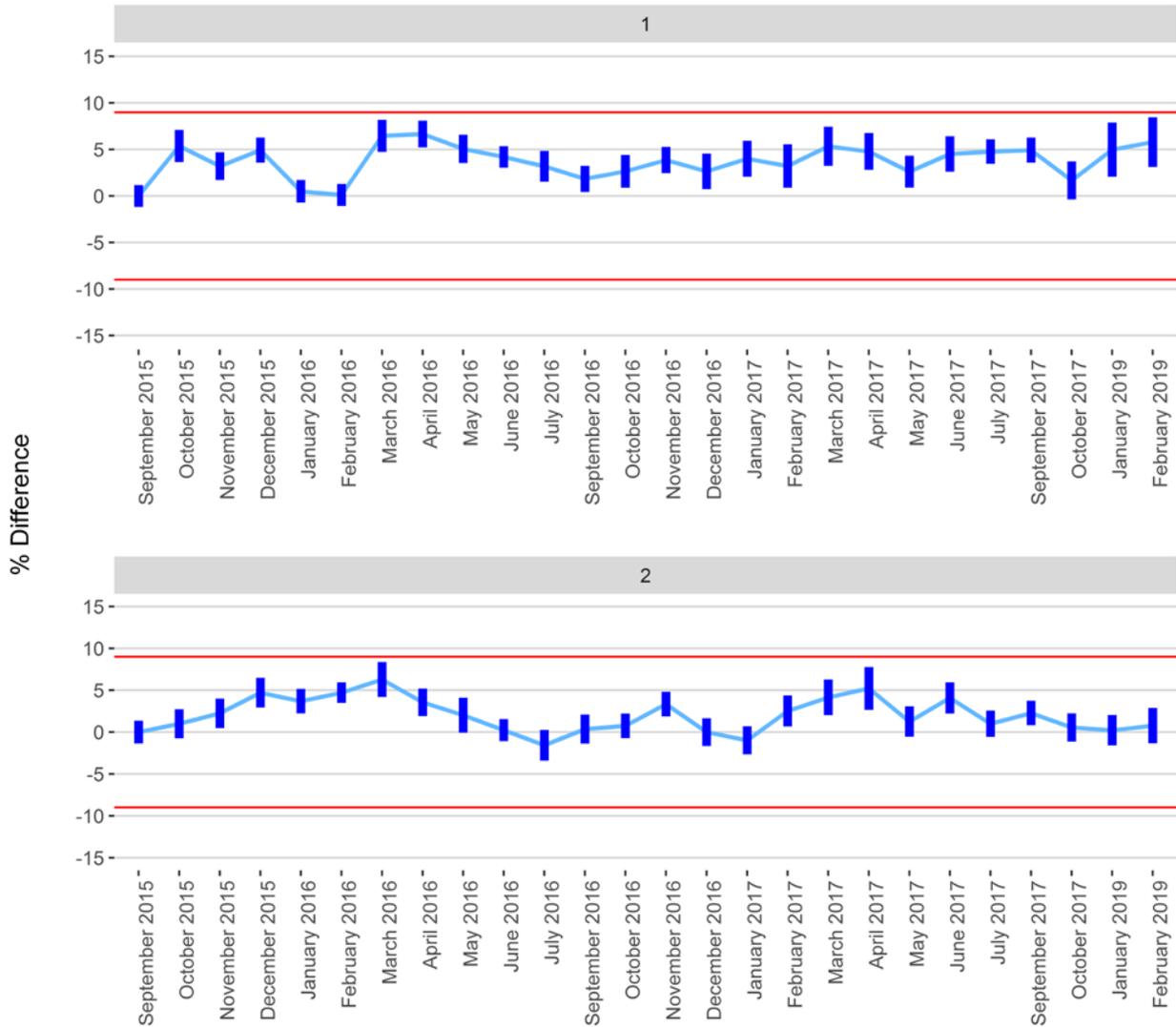
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

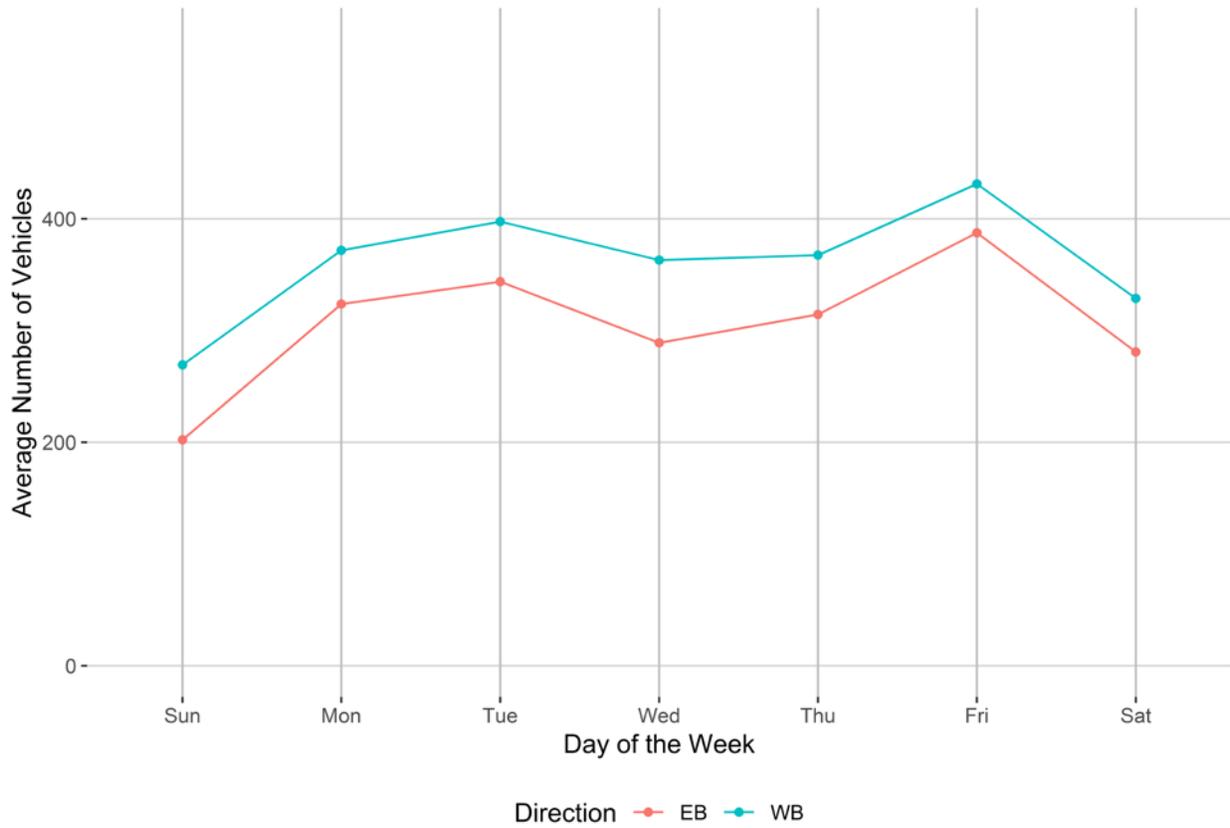


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

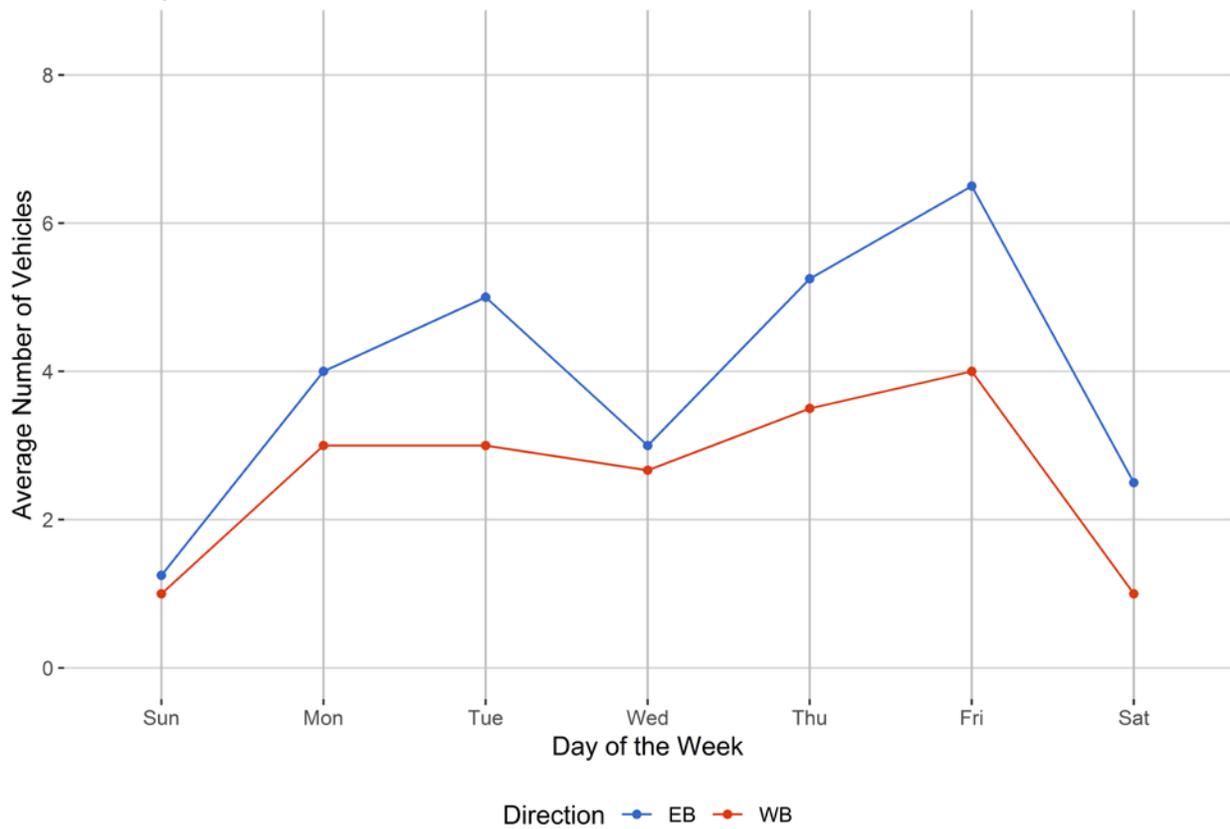


Figure 4 - Passenger Vehicles vs. Hour of the Day

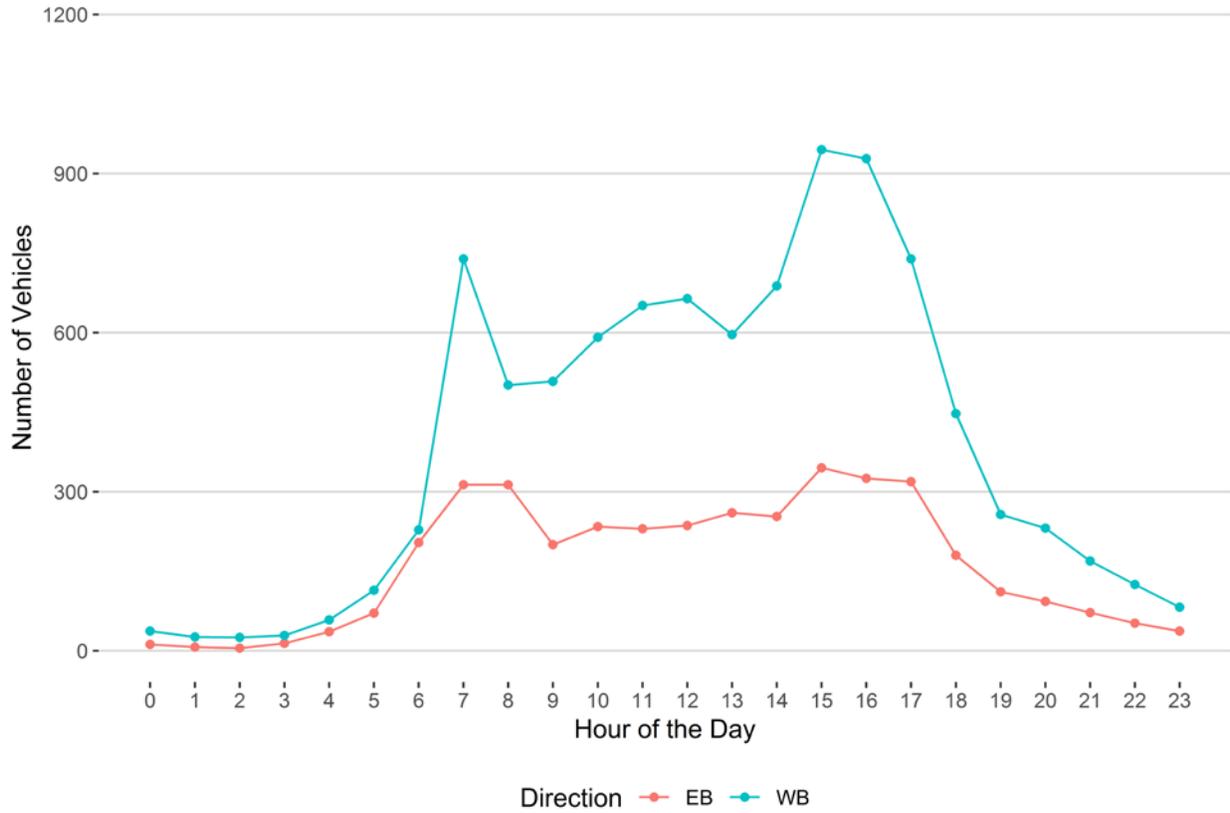


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

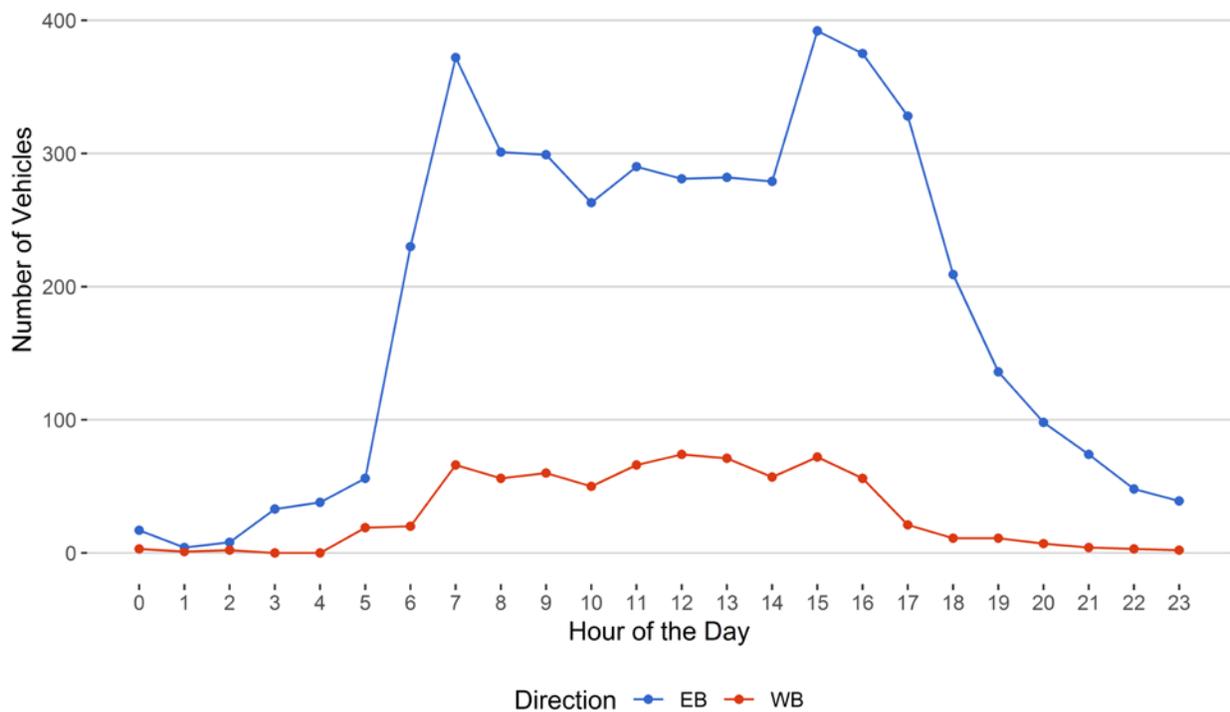


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

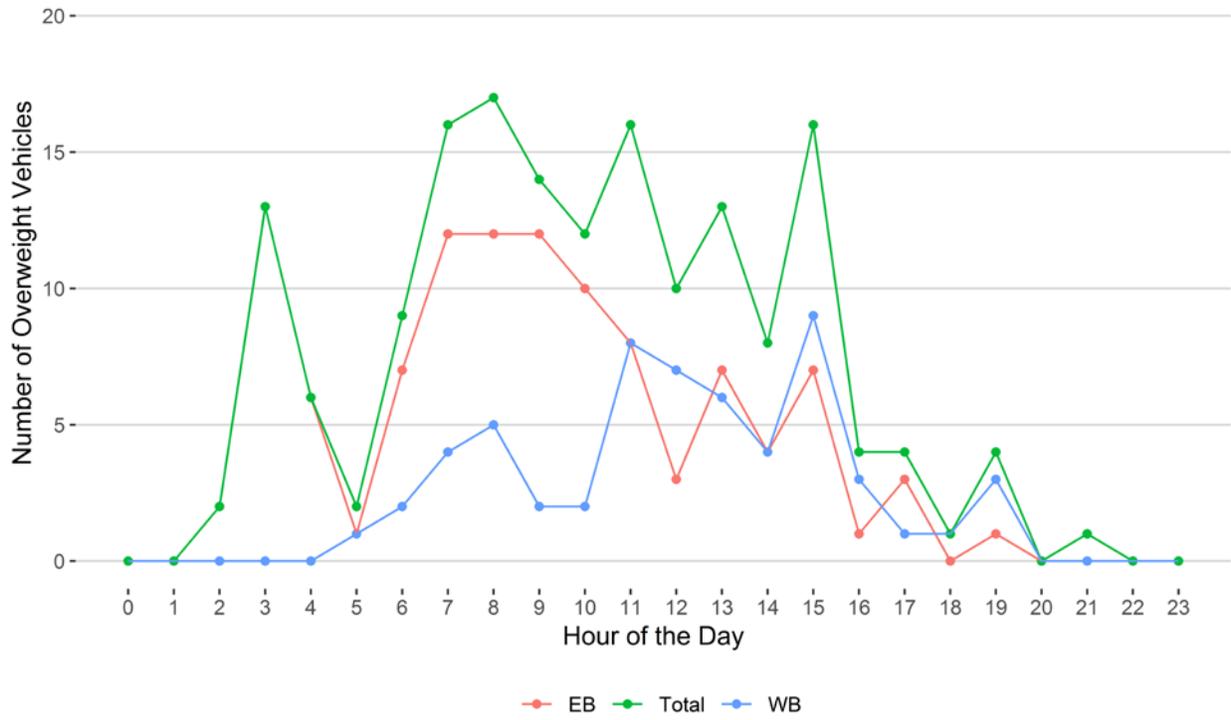
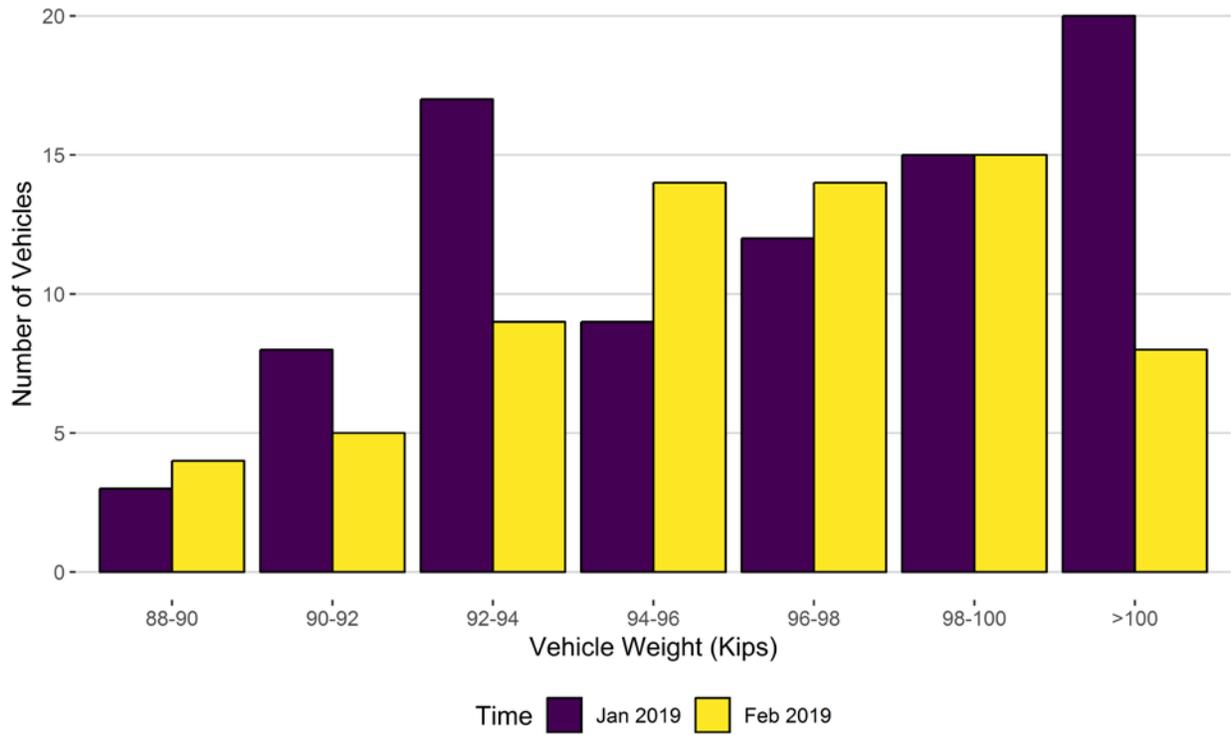
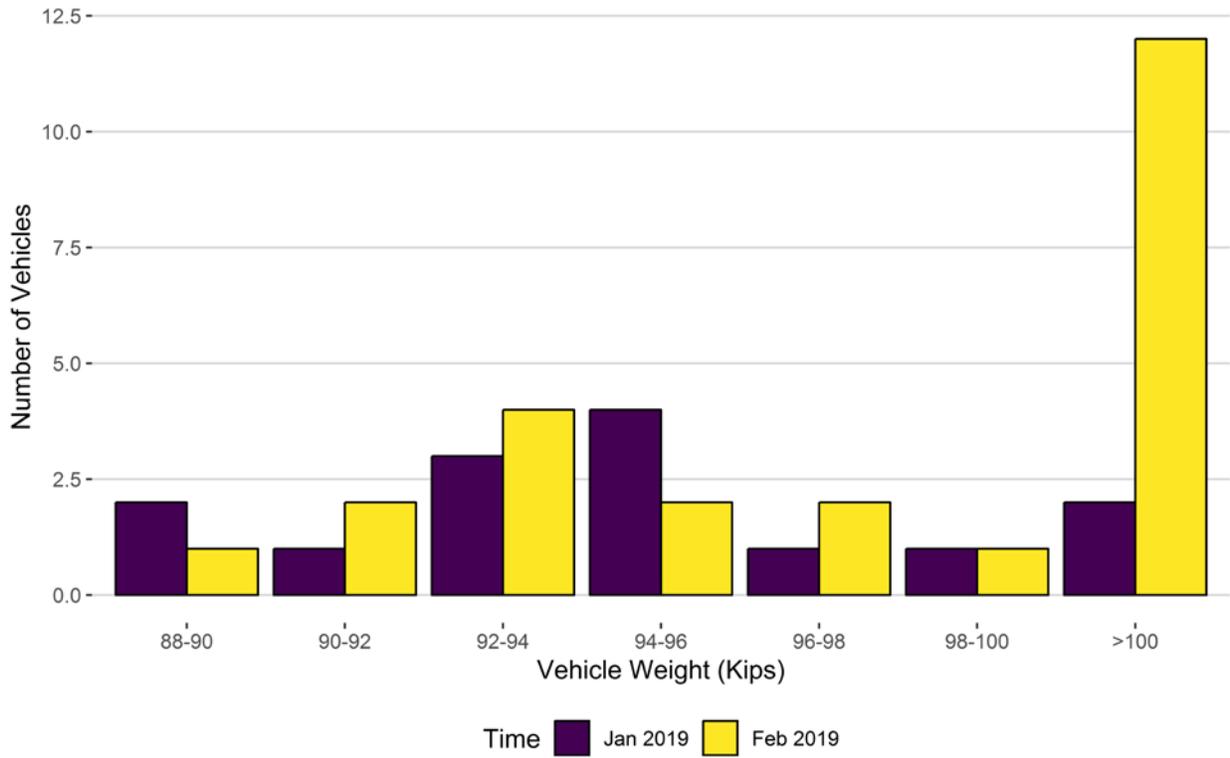


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Jan 2019</i>	<i>Feb 2019</i>
88-90	3	4
90-92	8	5
92-94	17	9
94-96	9	14
96-98	12	14
98-100	15	15
>100	20	8
Total	84	69

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



<i>Vehicle Weights (Kips)</i>	<i>Jan 2019</i>	<i>Feb 2019</i>
88-90	2	1
90-92	1	2
92-94	3	4
94-96	4	2
96-98	1	2
98-100	1	1
>100	2	12
Total	14	24

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

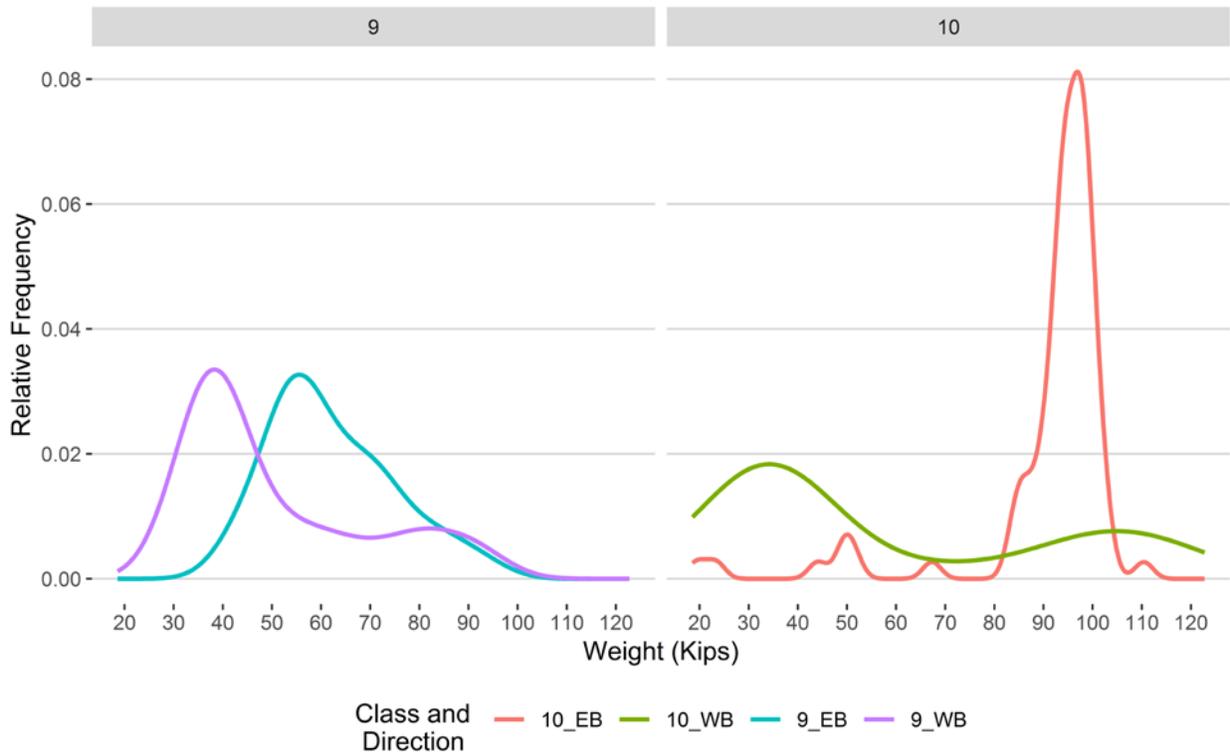


Figure 9 - Freight Percentage by Direction and Class

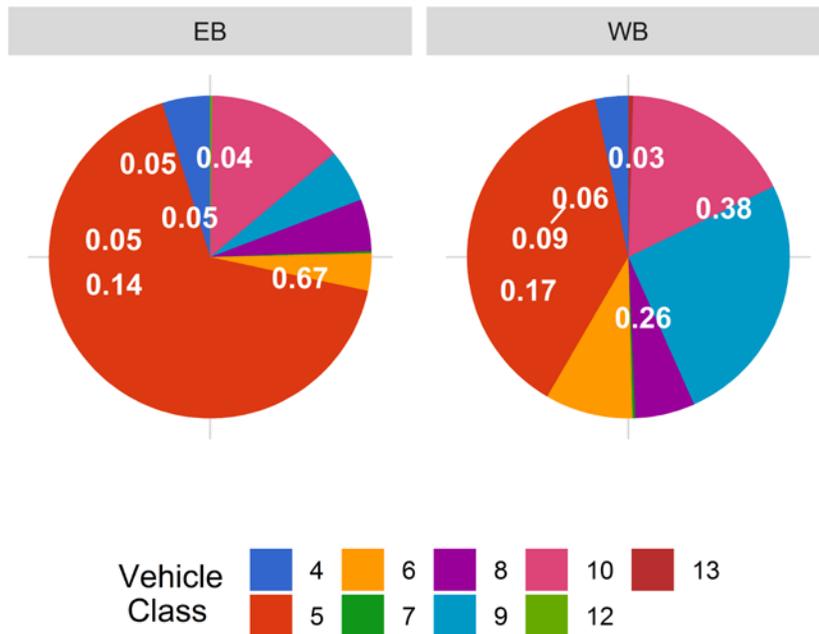


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

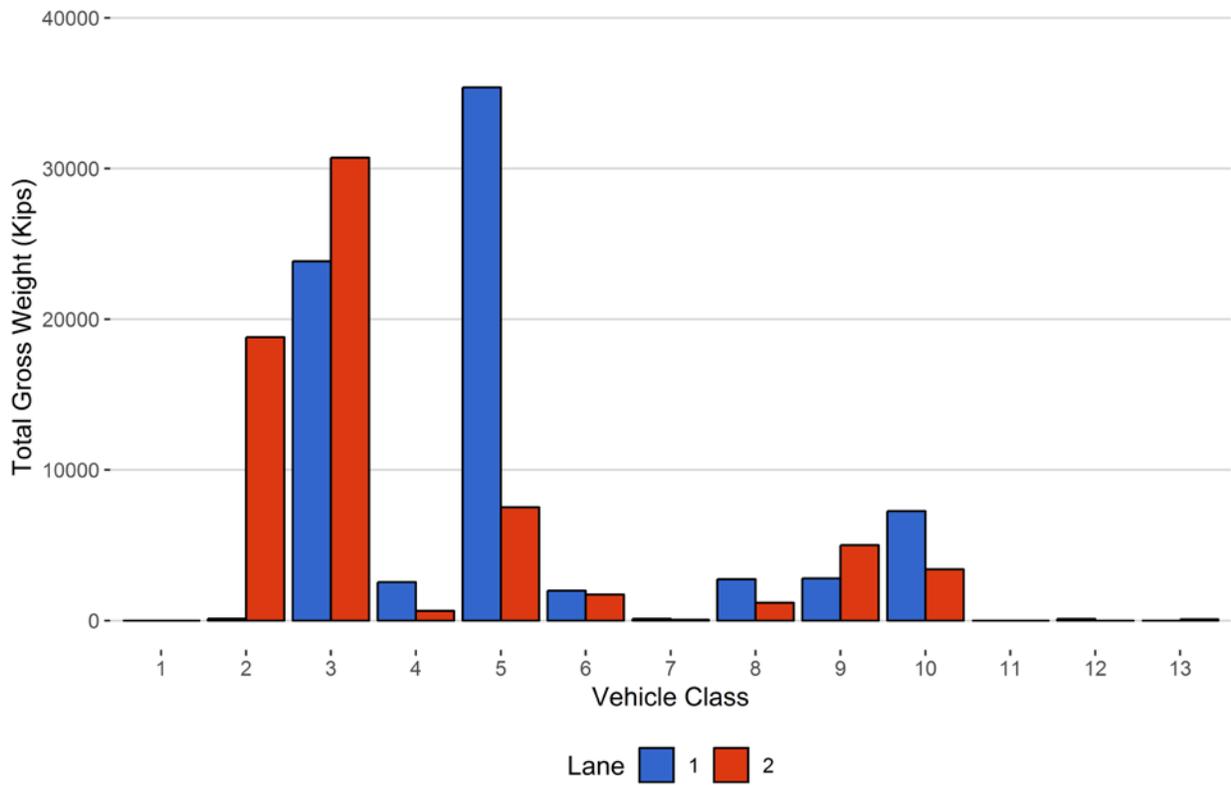


Figure 11 - Total Gross Vehicle Weight t

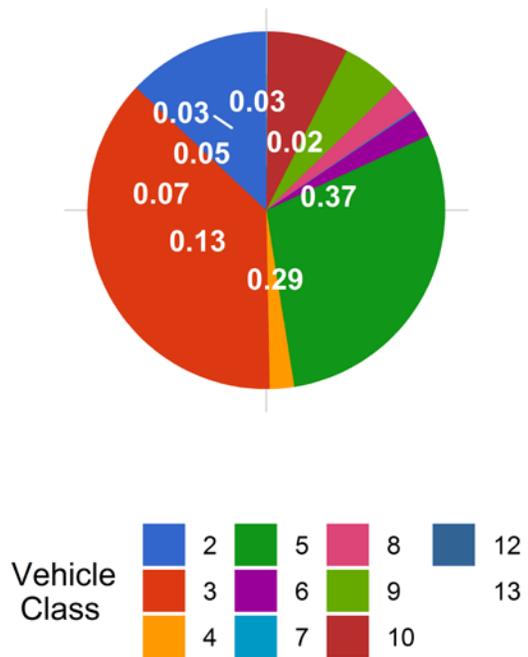


Figure 12 - Total ESALs by Class and Lane

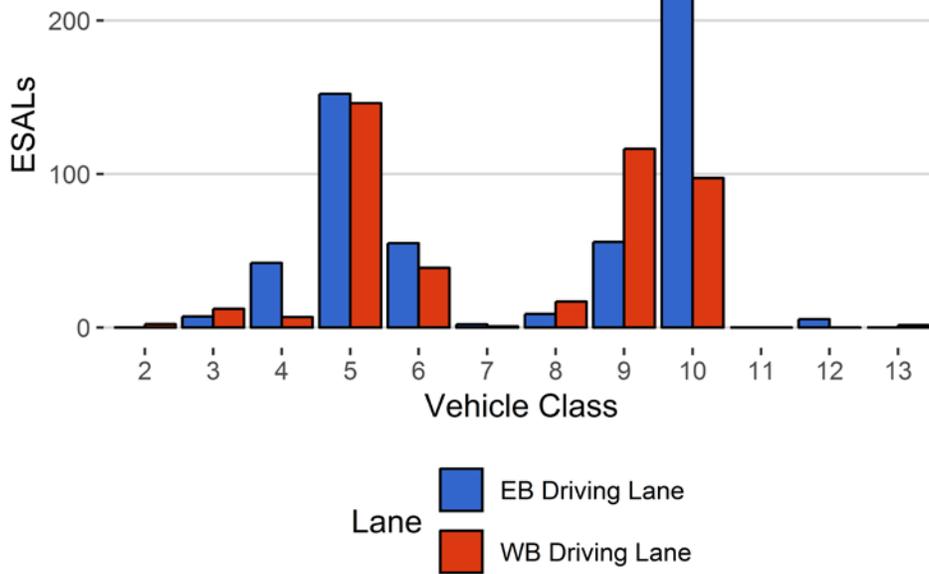


Figure 13 - ESALs by Class

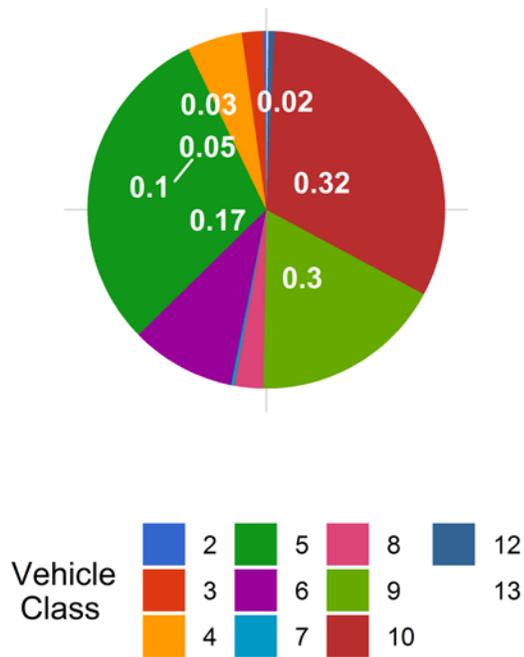


Table 1 Class 9 Front Axle Weight by Lane

<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
January 2019	11.03	4.97	10.71	0.22
February 2019	11.12	5.79	10.77	0.77

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	191	5336	26.7	0	0
3	328	9184	45.9	0	0
4	5	145	0.7	1	0.6
5	169	4732	23.6	24	14.6
6	3	98	0.5	21	12.8
7	0	3	0	2	1.2
8	8	216	1.1	2	1.2
9	5	153	0.8	21	12.8
10	5	147	0.7	91	55.5
11	0	0	0	0	0
12	0	1	0	1	0.6
13	0	1	0	1	0.6
TOTAL	715	20016	100	164	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>
2019-02-15	Friday	13:55:12	10	WB	2	122.77
2019-02-11	Monday	07:46:58	10	WB	2	115.26
2019-02-11	Monday	11:10:55	10	WB	2	114.82
2019-02-04	Monday	11:31:28	10	WB	2	113.77
2019-02-26	Tuesday	16:41:35	10	WB	2	112.66
2019-02-05	Tuesday	15:58:56	10	WB	2	110.74
2019-02-22	Friday	15:40:31	10	WB	2	110.51
2019-02-04	Monday	09:00:03	10	EB	1	110.4
2019-02-19	Tuesday	17:13:04	10	WB	2	106.69
2019-02-21	Thursday	16:14:05	10	WB	2	105.69

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	111	1	0.9	2536	15	443
5	EB	8	4003	2265	56.6	20123	15270	3110
6	EB	19	46	0	0	1985	0	556
7	EB	11.5	2	0	0	116	0	46
8	EB	31	164	151	92.1	509	2236	53
9	EB	33	45	0	0	2800	0	657
10	EB	33.5	80	2	2.5	7219	43	2303
12	EB	36.5	1	0	0	113	0	38
TOTAL	****	****	4452	2419	****	35401	****	7206
<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	26	6	23.1	571	76	136
5	WB	8	460	36	7.8	7256	263	1932
6	WB	19	46	1	2.2	1711	15	428
7	WB	11.5	1	0	0	55	0	22
8	WB	31	40	17	42.5	861	316	74
9	WB	33	99	7	7.1	4783	223	874
10	WB	33.5	59	15	25.4	2946	454	736
13	WB	31.5	1	0	0	93	0	31
TOTAL	****	****	732	82	****	18276	****	4232
GRAND TOTAL	****	****	5184	2501	260	53677	18911	11438

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	131	18806	18937	13
3	23848	30726	54573	37.4
4	2551	647	3198	2.2
5	35394	7519	42912	29.4
6	1985	1727	3712	2.5
7	116	55	171	0.1
8	2745	1176	3921	2.7
9	2800	5006	7806	5.3
10	7262	3400	10661	7.3
12	113	0	113	0.1
13	0	93	93	0.1
TOTAL	76943	69155	146098	100
GVW/LANE	52.67	47.33	100	0.07

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	2	2	0.2	0.0015
3	7	12	20	2	0.0051
4	42	7	49	5	0.76
5	152	146	298	30.2	0.14
6	55	39	94	9.5	2.08
7	2	1	3	0.3	1.34
8	9	17	26	2.6	0.3
9	56	116	172	17.4	2.42
10	220	97	318	32.1	4.55
12	6	0	6	0.6	1.82
13	0	2	2	0.2	1.18
TOTAL	549	440	989	100	15
ESALS/LANE	55.5	44.5	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>
Jan 2019	22033	711	185	16286	73.9	5747.4	26.1
Feb 2019	20016	715	196	14520	72.5	5495.9	27.5
TOTAL	42049	-	-	30806	-	11243	-
AVERAGE	21024	713	190	15403	73	5622	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>
Jan 2019	666	412	1078	66.1
Feb 2019	569	442	1010	60.5
TOTAL	1235	-	-	-
AVERAGE	617	427	1044	63

Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Jan 2019	86693	76018	162711
Feb 2019	78141	69268	147409
TOTAL	164834	145286	310120
AVERAGE	82417	72643	155060

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>
Jan 2019	174	0.8	3.1	98	38
Feb 2019	168	0.9	3.1	93	36
TOTAL	342	-	-	191	74
AVERAGE	171	0.8	3.1	95.5	37

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>
Jan 2019	8077	4108	12185	66.3	33.7
Feb 2019	7206	4232	11438	63	37
TOTAL	15283	8340	23623	-	-
AVERAGE	7641.6	4170	11811.6	64.6	35.4