

DECEMBER 2019



**WIM #32
US 52, MP 66.0
ORONOCO, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #32 is located on US 52 near Oronoco in Olmsted county.

System Operation

WIM #32 was operational for the entire month of December 2019. Volume was computed using all monthly data.

System Calibration

WIM #32 was most recently calibrated on 2019-06-06. Table 1 summarizes the front axle weights of class 9s by lane ¹. 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: 416454 | Passenger Vehicles: 383235 | Heavy Commercial Vehicles: 33219

Monthly Average Daily Traffic (MADT): 29747 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 1072

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. NB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Mondays. SB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Mondays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), NB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, SB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 03 PM and 05 PM, while volume going SB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

Overweight HCVs

Volume trends. Of a total of 33219 HCVs, 6076 of them were overweight ³. These overweight HCVs contributed to 0.7% of total monthly volume, and 8.5% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Thursdays, with lowest volumes reported on Saturdays. 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, with 61.6% of all overweight vehicles traveling NB 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 June.

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 ,146 NB vehicles exceeded 88,000 pounds (61 vehicles were Class 10's; 51 vehicles were Class 9's). Of vehicles traveling SB,

82 NB vehicles exceeded 88,000 pounds (30 vehicles were Class 9's; 23 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from December 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in December 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling NB, while there were more fully_loaded Class 9's than empty traveling SB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the NB direction. In the SB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 585992 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (51.3%) than SB (48.7%). See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 55X13 (a box culvert) is approximately 1/3 of a mile north of WIM #32, and Bridge No. 8960 (a box culvert) is approximately 1 ¾ miles south of WIM #32. WIM #32 recorded a total of 416454 vehicles with a combined GVW of 6546349 kips (1 kip = 1,000 pounds = 0.5 tons) in December 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 50515 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 51.6% of all ESALs were recorded NB while 48.4% was observed SB. In particular, 76% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 35% 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:

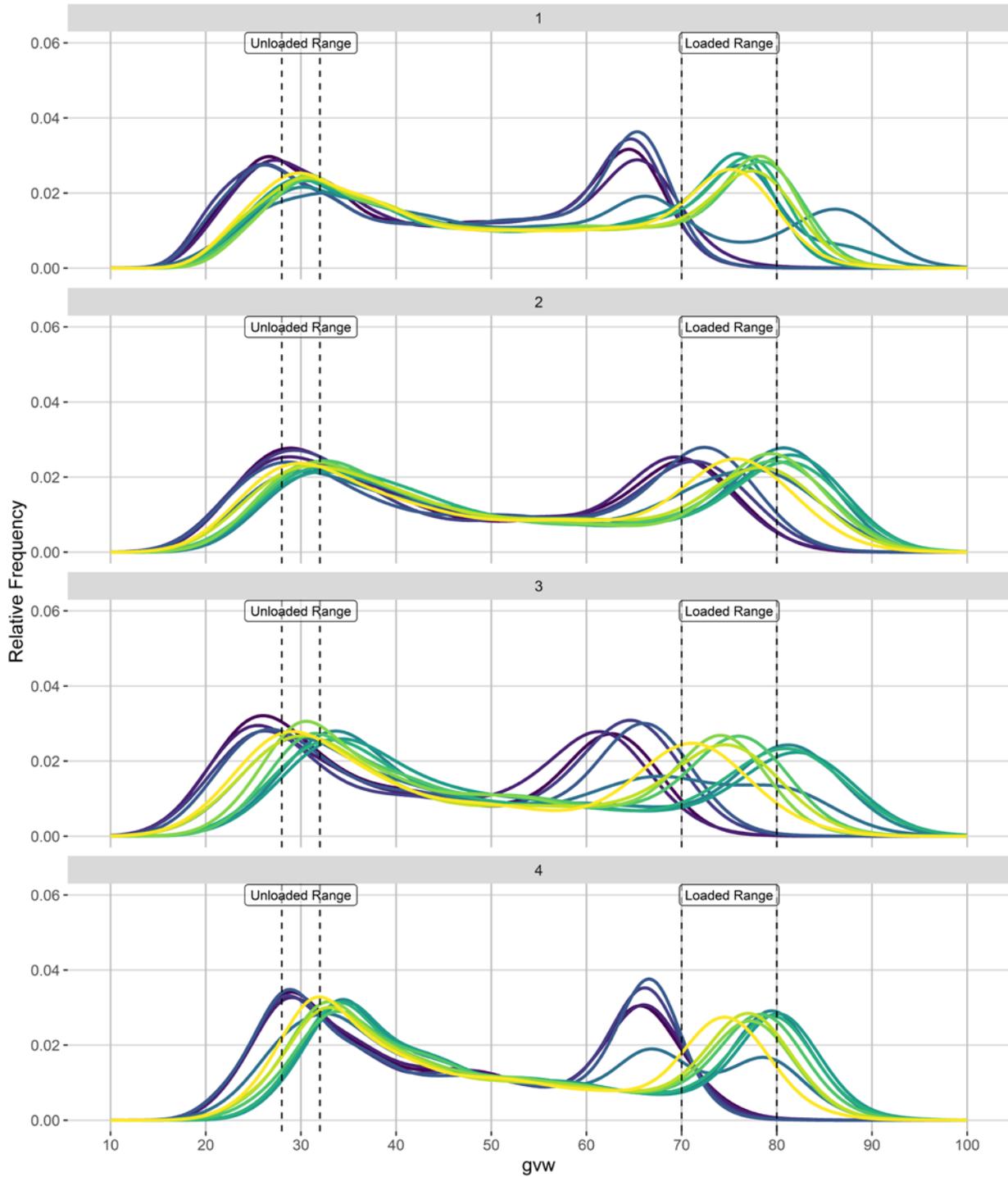
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

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.

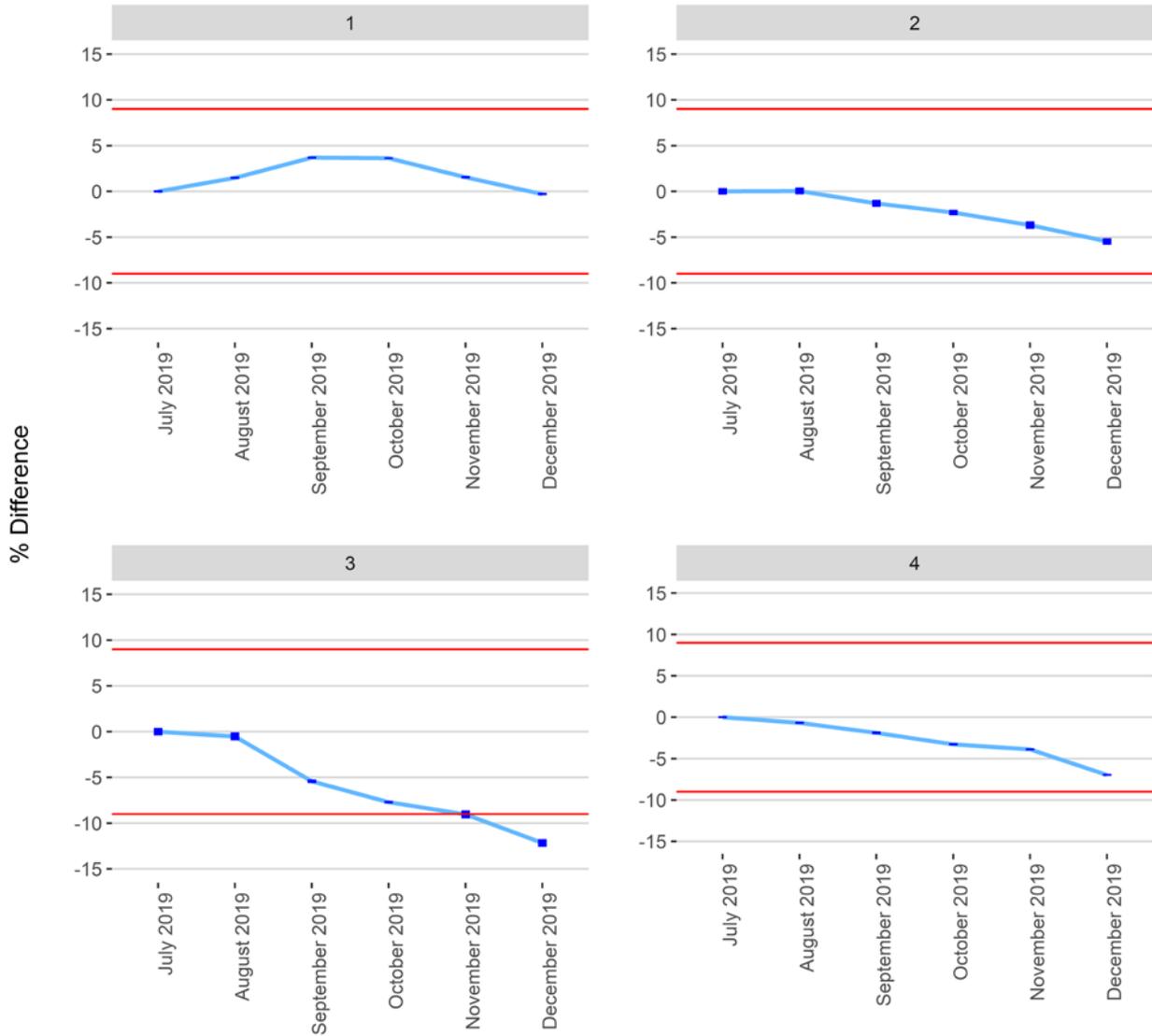
Figure 1 - Monthly Class 9 GVW Histogram



Time	January 2019	April 2019	July 2019	October 2019
	February 2019	May 2019	August 2019	November 2019
	March 2019	June 2019	September 2019	December 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

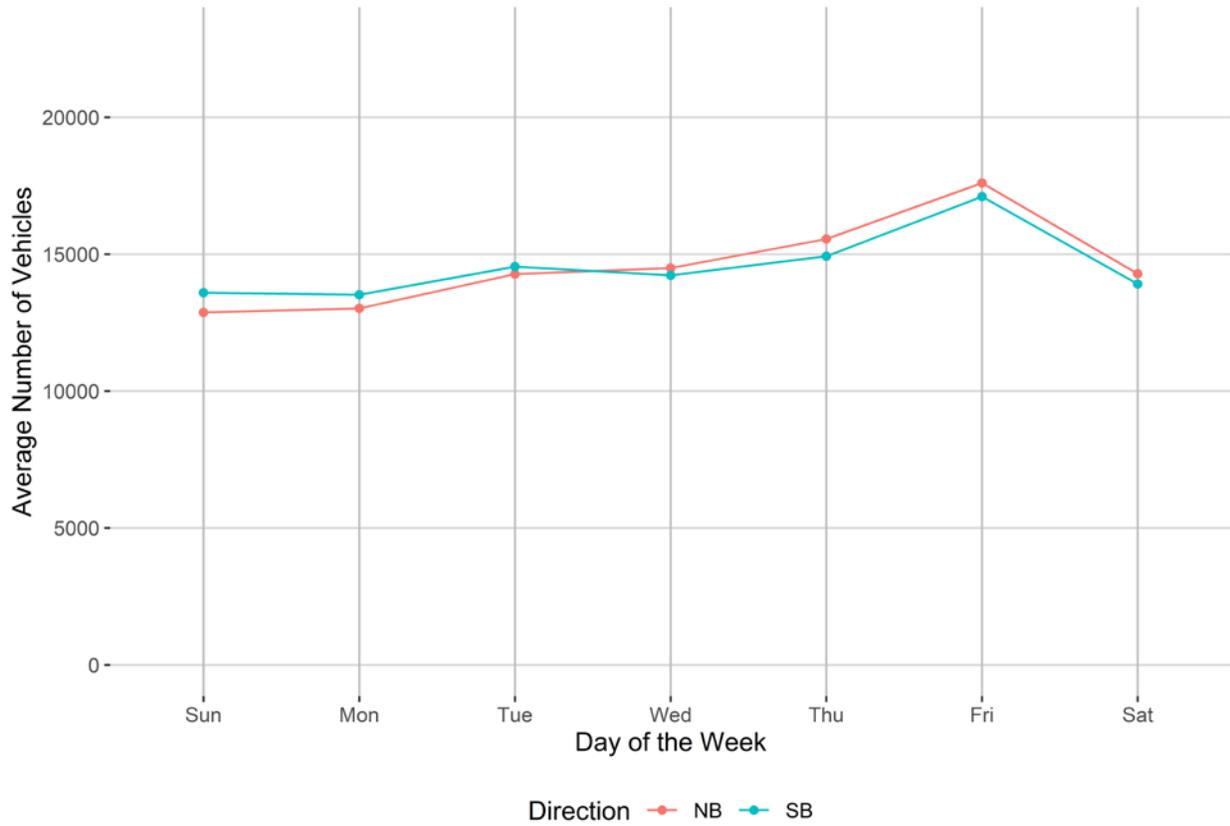


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

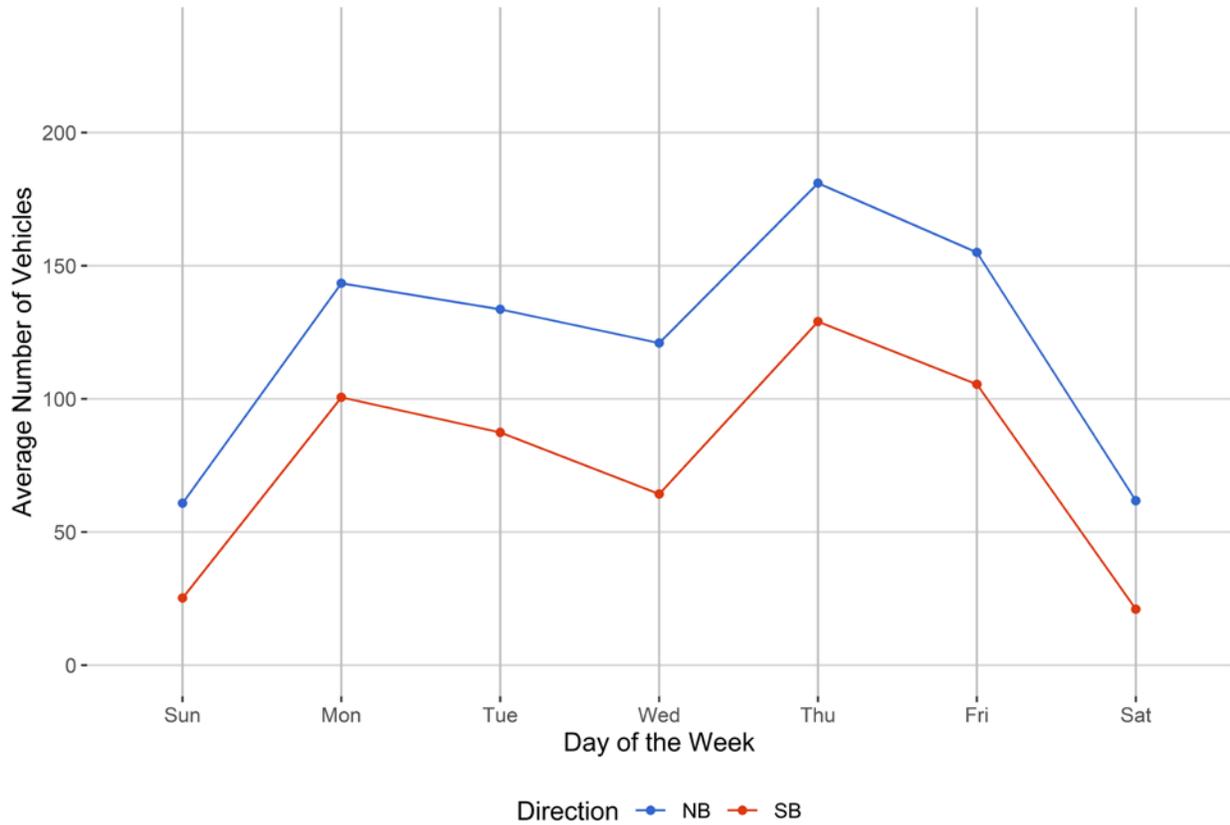


Figure 4 - Passenger Vehicles vs. Hour of the Day

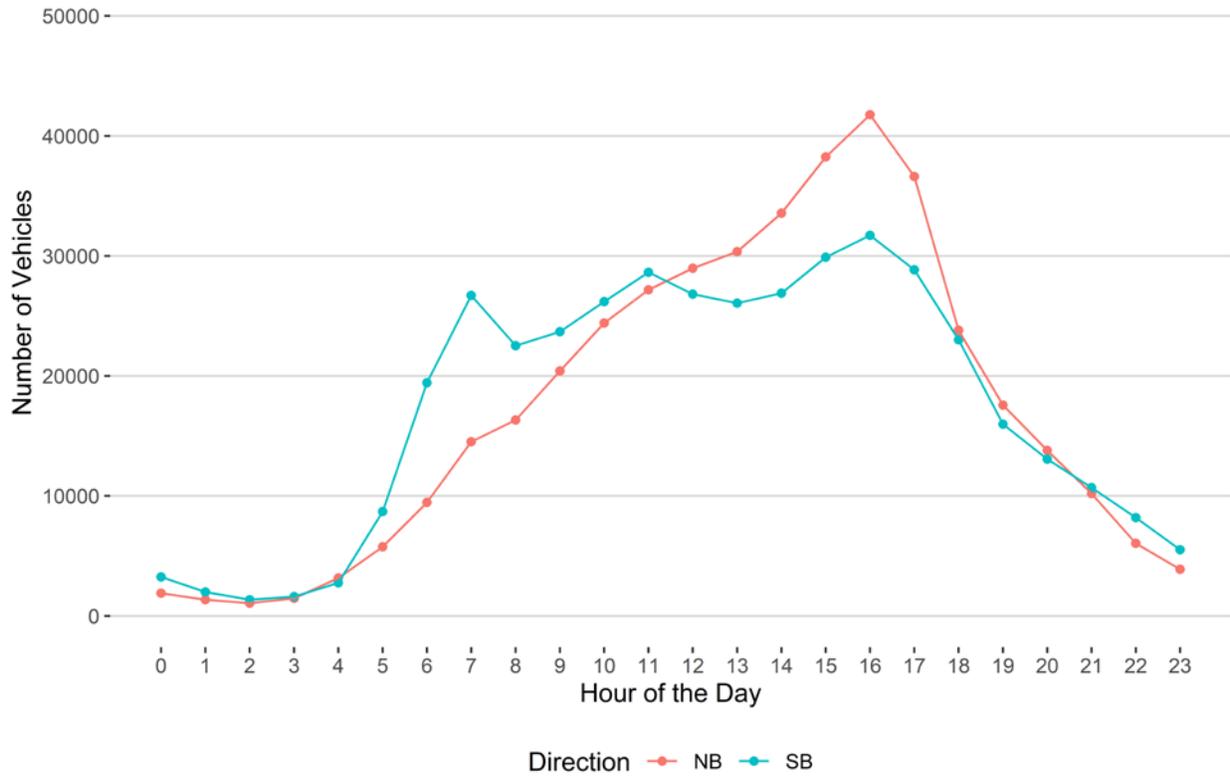


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

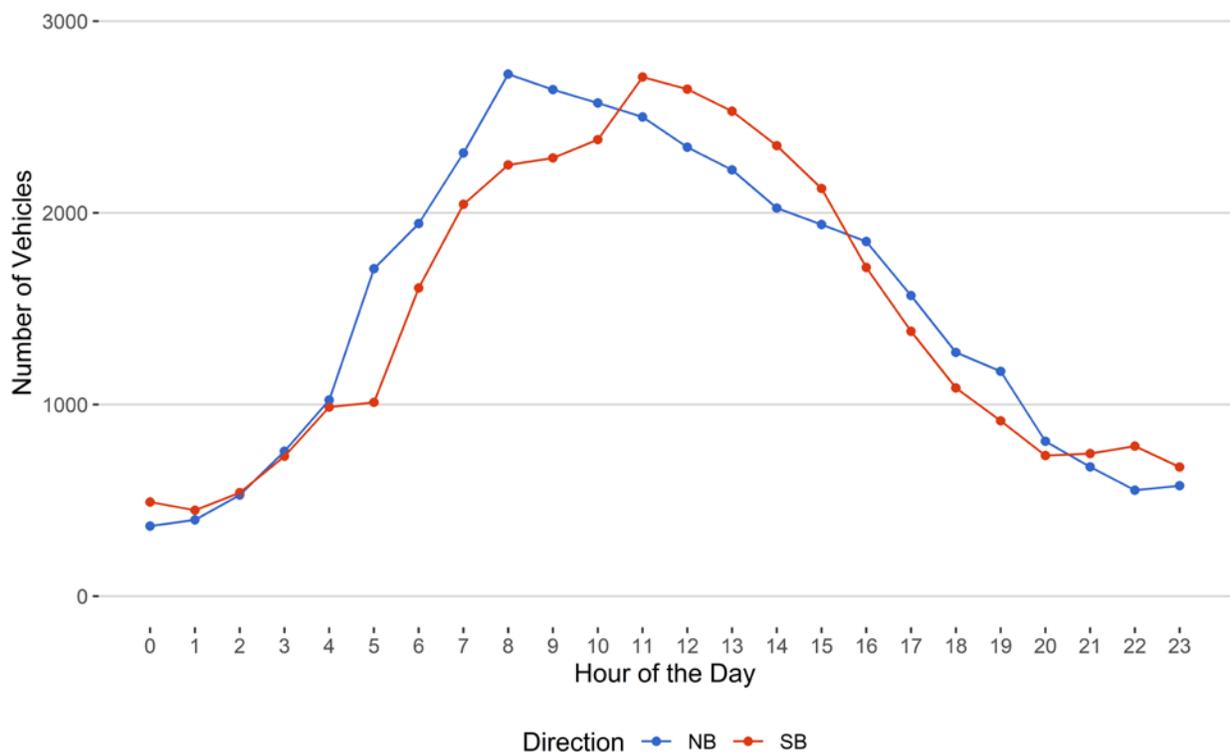


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

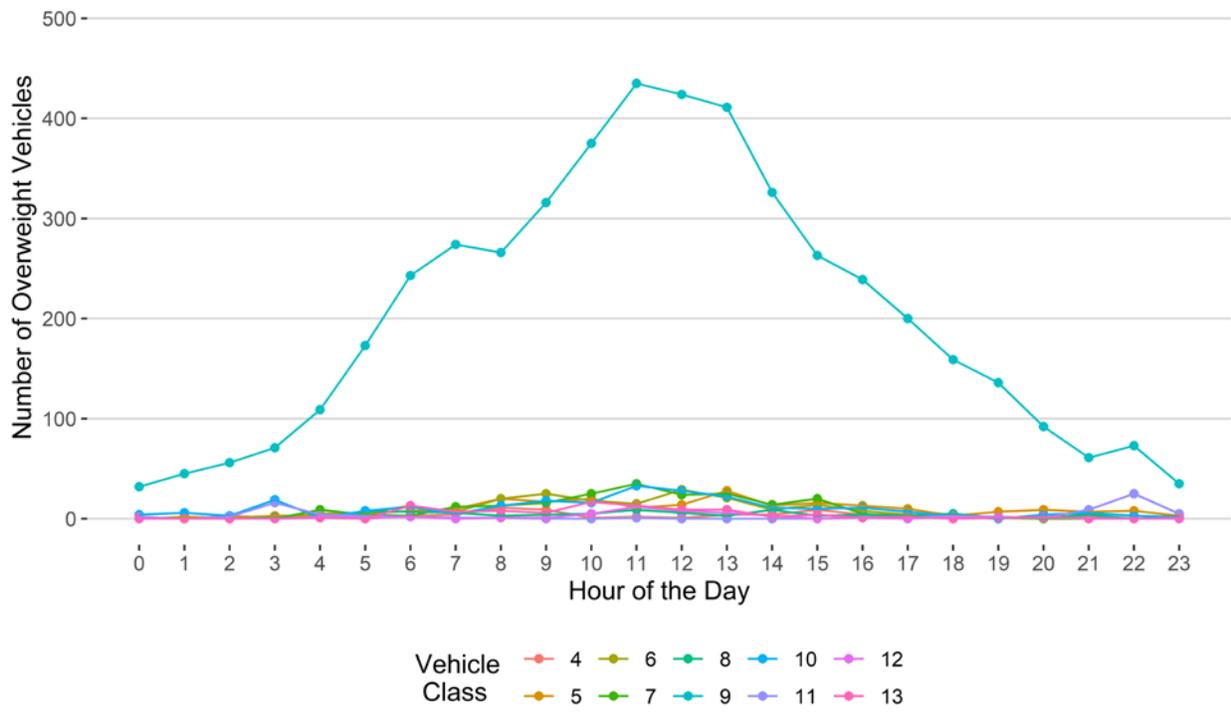


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

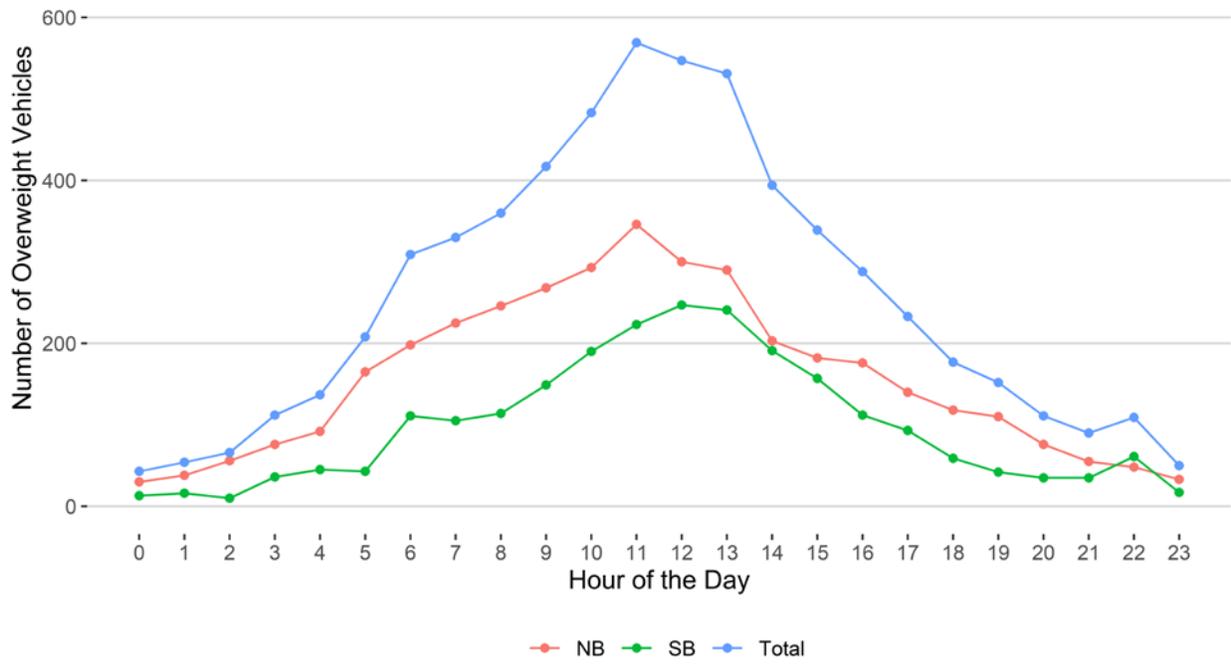
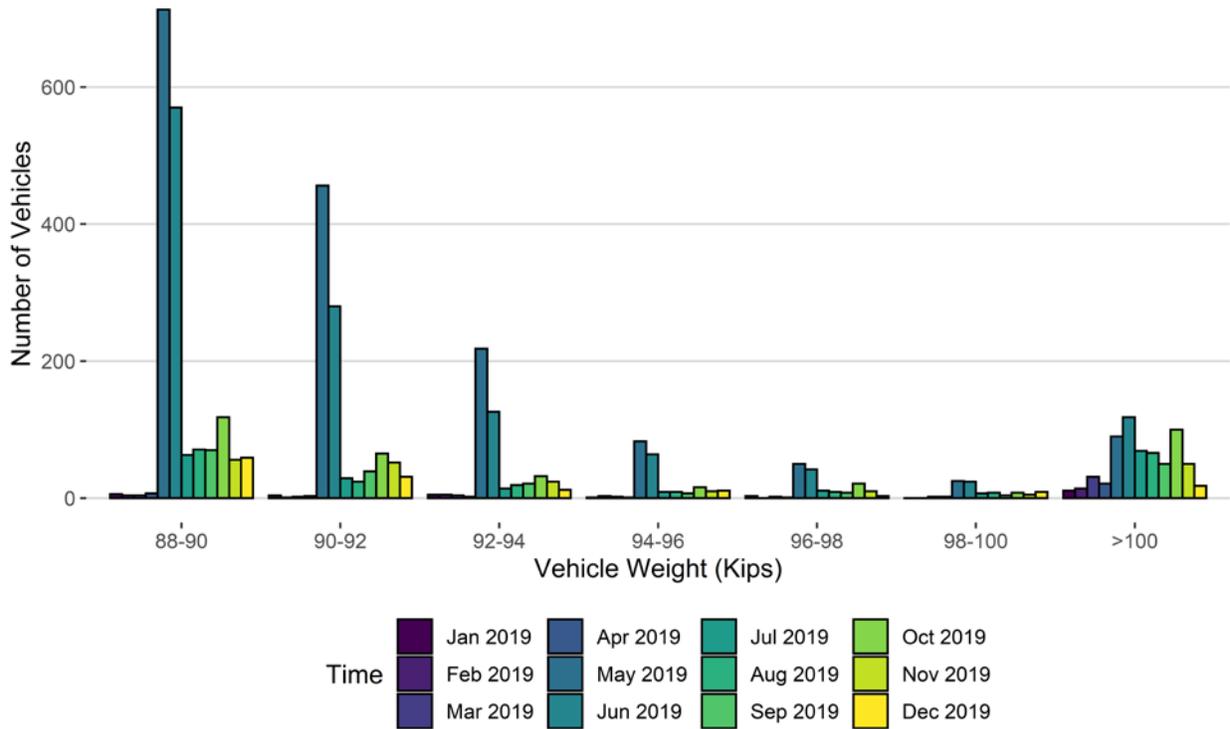
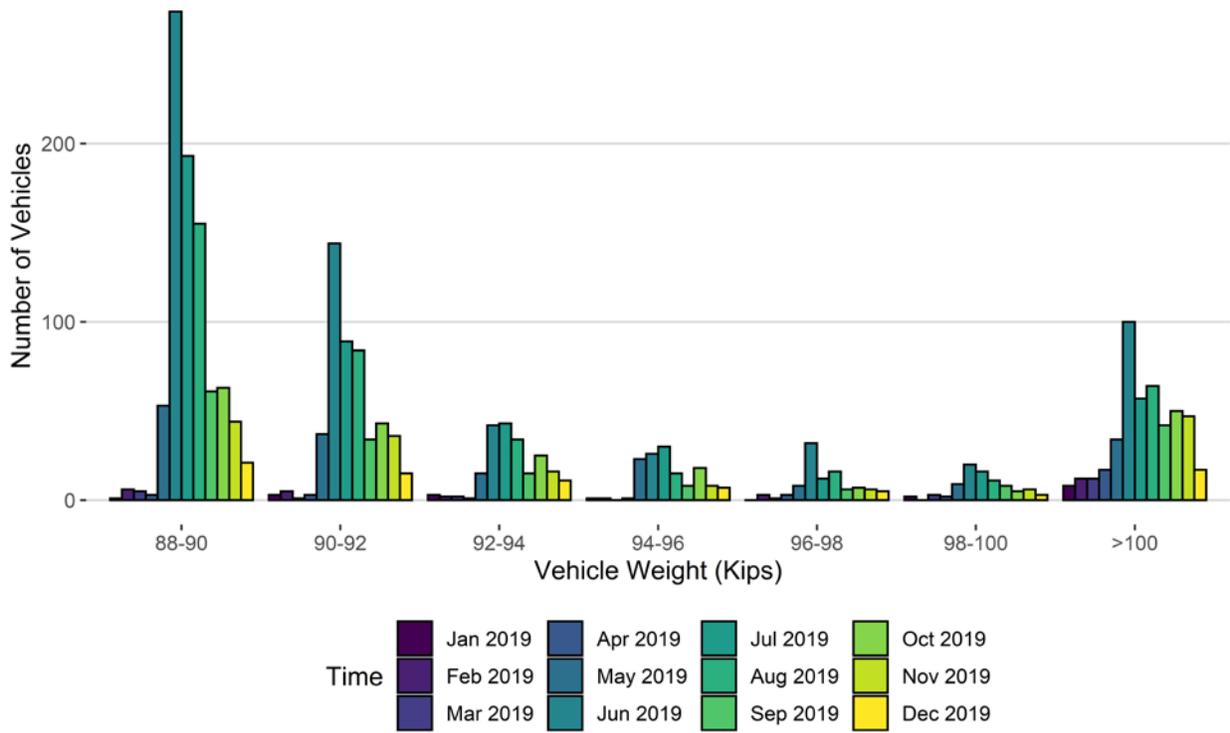


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	6	4	4	7	713	570	63	71	70	118	56	59
90-92	4	1	2	3	456	280	29	24	39	65	52	31
92-94	5	5	4	2	218	126	14	19	21	32	24	12
94-96	1	3	2	1	83	64	9	9	7	16	10	11
96-98	3	0	2	1	50	42	11	9	8	21	10	3
98-100	0	0	2	2	25	24	7	8	4	8	5	9
>100	11	14	31	21	90	118	69	66	50	100	50	18
Total	30	27	47	37	1635	1224	202	206	199	360	207	143

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



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	1	6	5	3	53	274	193	155	61	63	44	21
90-92	3	5	1	3	37	144	89	84	34	43	36	15
92-94	3	2	2	1	15	42	43	34	15	25	16	11
94-96	1	1	0	1	23	26	30	15	8	18	8	7
96-98	0	3	1	3	8	32	12	16	6	7	6	5
98-100	2	0	3	2	9	20	16	11	8	5	6	3
>100	8	12	12	17	34	100	57	64	42	50	47	17
Total	18	29	24	30	179	638	440	379	174	211	163	79

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

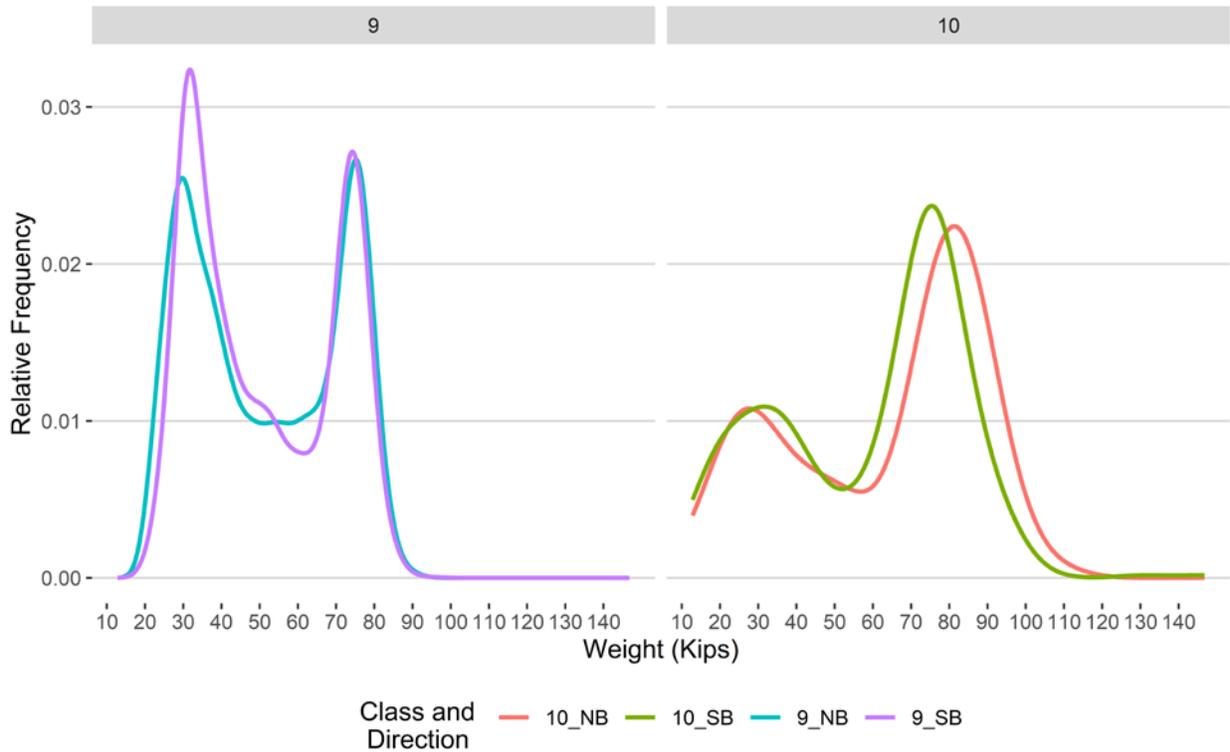


Figure 9 - Freight Percentage by Direction and Class

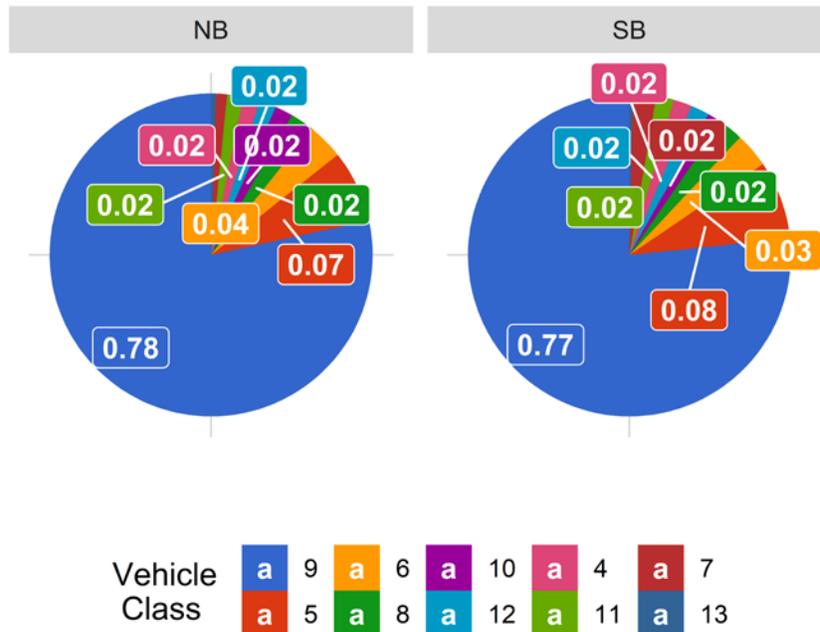


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

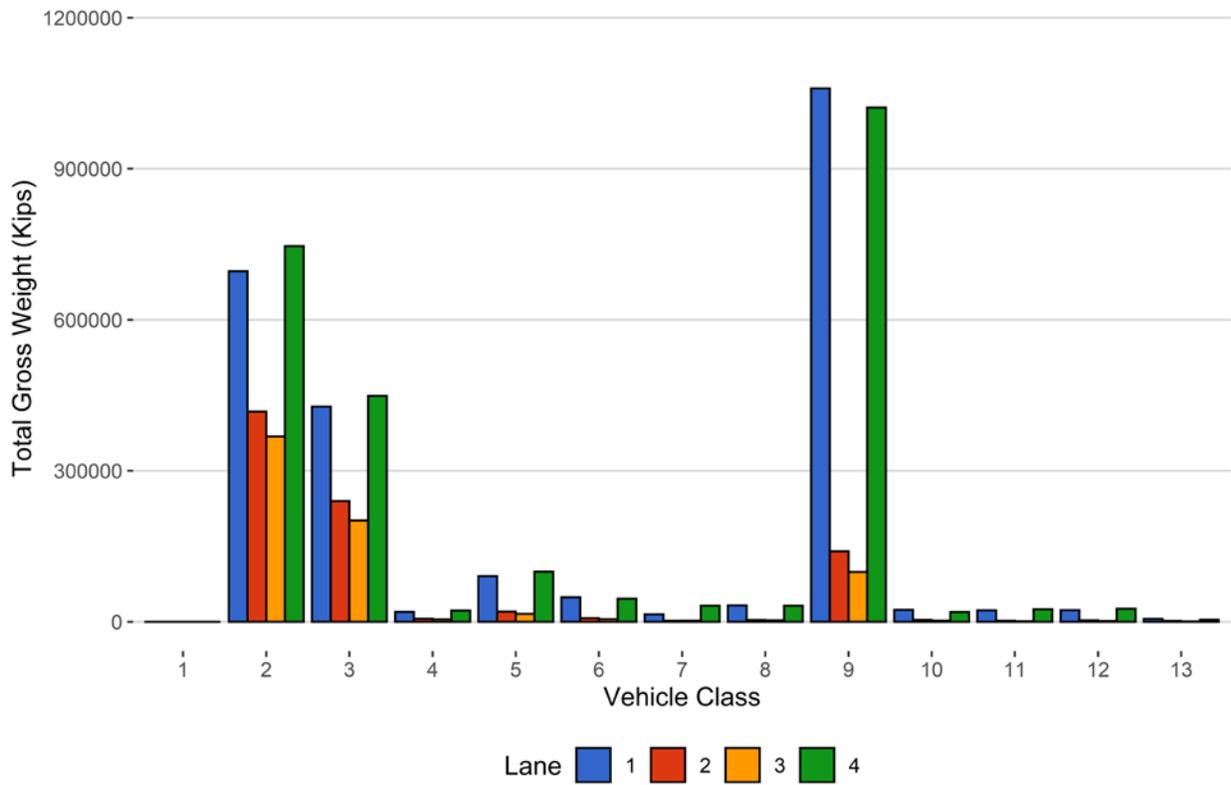


Figure 11 - Total Gross Vehicle Weight t

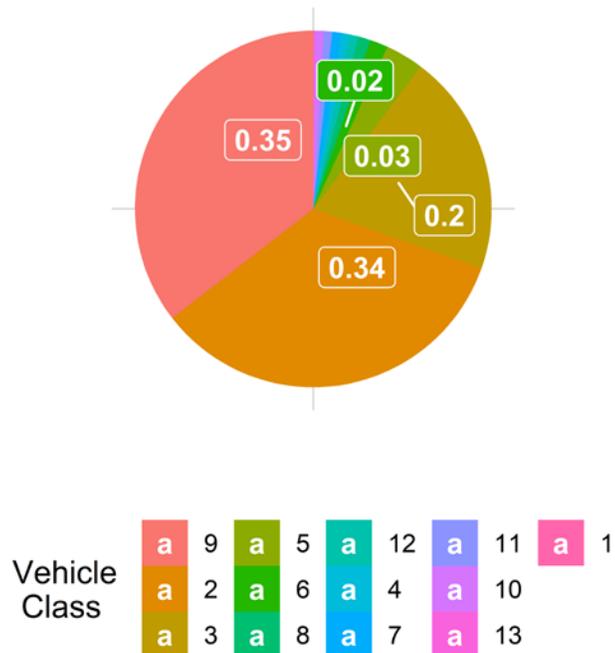


Figure 12 - Total ESALs by Class and Lane

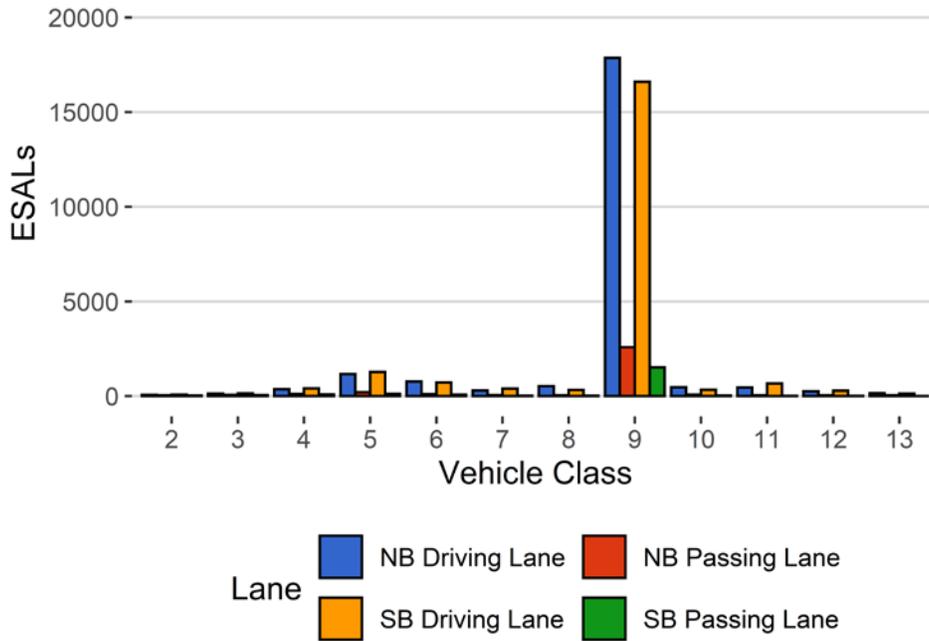


Figure 13 - ESALs by Class

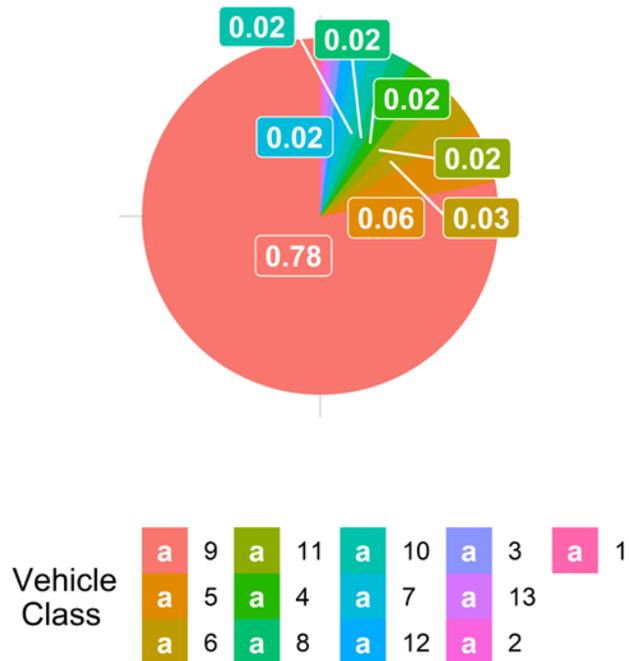


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 3 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 4 (kips)</i>	<i>Front Axle +/- 9%</i>
July 2019	10.23	0.00	11.64	0.00	11.83	0.00	11.75	0.00
August 2019	10.38	1.48	11.65	0.04	11.77	-0.52	11.67	-0.68
September 2019	10.61	3.69	11.49	-1.31	11.19	-5.43	11.53	-1.89
October 2019	10.60	3.63	11.37	-2.31	10.92	-7.71	11.36	-3.28
November 2019	10.39	1.54	11.21	-3.69	10.76	-9.04	11.29	-3.89
December 2019	10.20	-0.29	11.01	-5.47	10.39	-12.16	10.93	-6.97

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	8881	275296	66.1	0	0
3	3482	107936	25.9	0	0
4	24	748	0.2	67	1.1
5	230	7115	1.7	231	3.8
6	56	1730	0.4	202	3.3
7	12	372	0.1	209	3.4
8	35	1078	0.3	85	1.4
9	674	20886	5	4814	79.2
10	12	370	0.1	244	4
11	13	417	0.1	80	1.3
12	14	438	0.1	47	0.8
13	2	64	0	97	1.6
TOTAL	13434	416454	100	6076	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>
2019-12-19	Thursday	07:00:59	10	SB	4	146.79
2019-12-13	Friday	02:51:08	9	NB	1	136.25
2019-12-19	Thursday	03:32:04	10	SB	4	130.84
2019-12-20	Friday	02:57:52	9	NB	1	121.7
2019-12-23	Monday	14:38:53	10	NB	1	111.63
2019-12-27	Friday	17:49:39	10	NB	1	111.03
2019-12-30	Monday	11:10:25	10	NB	1	108.84
2019-12-17	Tuesday	03:15:39	9	NB	1	108.74
2019-12-11	Wednesday	23:07:32	10	NB	1	102.86
2019-12-03	Tuesday	12:32:36	10	SB	4	102.37

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	NB	15	775	83	10.7	24374	1066	6997
5	NB	8	7631	850	11.1	104516	6219	25134
6	NB	19	1975	429	21.7	48644	7032	9635
7	NB	11.5	260	0	0	16922	0	6966
8	NB	31	1182	697	59	19186	16787	2076
9	NB	33	23198	5938	25.6	1034513	164913	232467
10	NB	33.5	435	91	20.9	25337	2214	6906
11	NB	36.5	462	25	5.4	23769	860	3909
12	NB	36.5	475	59	12.4	23937	2024	4376
13	NB	31.5	86	0	0	7260	0	2275
TOTAL	****	****	36479	8172	****	1328458	****	300742
<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	SB	15	839	88	10.5	26127	1140	7431
5	SB	8	7714	938	12.2	108243	6790	27018
6	SB	19	1757	380	21.6	44419	6428	9128
7	SB	11.5	542	0	0	34221	0	13994
8	SB	31	1143	597	52.2	20166	14642	1620
9	SB	33	21849	5213	23.9	967946	152421	209479
10	SB	33.5	364	77	21.2	19830	1801	5108
11	SB	36.5	438	20	4.6	25040	650	4892
12	SB	36.5	469	23	4.9	26379	808	5050
13	SB	31.5	53	0	0	4731	0	1531
TOTAL	****	****	35168	7336	****	1277104	****	285250
GRAND TOTAL	****	****	71647	15508	318	2605562	385795	585992

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>NB Driving Lane</i>	<i>NB Passing Lane</i>	<i>SB Passing Lane</i>	<i>SB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>
1	4	0	0	2	6	0
2	696607	417644	368339	746020	2228610	34.1
3	427613	239803	201409	448904	1317729	20.2
4	19474	5967	4812	22454	52707	0.8
5	90478	20258	15445	99588	225768	3.5
6	48515	7161	5147	45700	106524	1.6
7	14799	2123	2352	31869	51143	0.8
8	32463	3511	2812	31997	70782	1.1
9	1059603	139823	98801	1021566	2319794	35.5
10	23666	3884	2337	19294	49182	0.8
11	22593	2036	880	24810	50319	0.8
12	22949	3011	1358	25829	53148	0.8
13	5608	1651	455	4276	11991	0.2
TOTAL	2464373	846871	704147	2522311	6537702	100
GVW/LANE	37.69	12.95	10.77	38.58	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>NB Driving Lane</i>	<i>NB Passing Lane</i>	<i>SB Passing Lane</i>	<i>SB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0	0	0.1429
2	69	44	35	78	226	0.46	8e-04
3	138	69	51	145	404	0.82	0.0035
4	367	117	86	411	981	1.99	1.22
5	1166	205	120	1279	2770	5.61	0.36
6	770	108	70	723	1670	3.38	0.9
7	298	52	22	396	768	1.56	1.91
8	532	39	21	330	921	1.87	0.79
9	17864	2580	1516	16602	38561	78.15	1.71
10	466	74	37	336	913	1.85	2.27
11	462	41	13	668	1184	2.4	2.61
12	256	40	14	290	600	1.22	1.27
13	153	44	9	140	345	0.7	4.63
TOTAL	22540	3413	1993	21397	49343	100	18
ESALS/LANE	45.7	6.9	4	43.4	100	-	-

Table 7 Site Summary: Volume and Vehicle Class

Month	Total Volume	Monthly ADT	Monthly HCAD T	Passenger Vehicles	Passenger Vehicles %	Heavy Commercial Vehicles	Heavy Commercial Vehicles %	Heavy Commercial Vehicles in Driving Lane %	Heavy Commercial Vehicles in Passing Lane %
Jan 2019	786295	25364	2059	722455	91.9	63839.9	8.1	88.7	11.3
Feb 2019	682508	24375	2079	624284	91.5	58224	8.5	82.2	17.8
Mar 2019	904406	29174	2268	834104	92.2	70302.3	7.8	88.7	11.3
Apr 2019	922175	30739	2481	847749	91.9	74425.7	8.1	88.3	11.7
May 2019	1039153	33329	2670	956381	92	82771.9	8	87.5	12.5
Jun 2019	1022960	34099	2622	944302	92.3	78658.4	7.7	86.8	13.2
Jul 2019	1058475	34221	2702	974717	92.1	83757.7	7.9	87.2	12.8
Aug 2019	1096548	35208	2723	1012139	92.3	84409.1	7.7	88	12
Sep 2019	978335	32323	2587	900716	92.1	77619.2	7.9	70.3	29.7
Oct 2019	1014552	32808	2707	930636	91.7	83916.5	8.3	69.5	30.5
Nov 2019	928048	30742	2455	854402	92.1	73645.7	7.9	88.9	11.1
Dec 2019	416454	29747	1072	383235	92	33219.2	8	87.8	12.2
TOTAL	10849909	-	-	9985120	-	864790	-	-	-
AVERAGE	904159	31011	2369	832093	92	72066	8	84	16

###ESALS

Month	ESALS NB Passing Lane	ESALS NB Driving Lane	ESALS SB Driving Lane	ESALS SB Passing Lane	Total ESALS	Driving Lane ESALS %	Passing Lane ESALS %	Pavement Life Decrease Months
Jan 2019	10858	2006	1055	11960	25880	88	12	0.3
Feb 2019	8685	2828	1545	10833	23891	82	18	0.3
Mar 2019	12211	2429	1320	13607	29567	87	13	0.1
Apr 2019	13454	2771	1525	14186	31936	87	13	0
May 2019	32259	4042	3006	23513	62819	89	11	21.3

Jun 2019	53625	10086	7472	58409	129592	86	14	3.4
Jul 2019	25138	4916	4146	32194	66394	86	14	4.4
Aug 2019	27967	4501	3840	31466	67774	88	12	3.9
Sep 2019	28842	3734	12568	14341	59485	73	27	2.5
Oct 2019	45318	5748	18129	19409	88604	73	27	3.2
Nov 2019	25358	3182	2270	24877	55688	90	10	3.8
Dec 2019	22646	3425	2996	21448	50515	87	13	2.4
TOTAL	306362	49669	59872	276243	692145	-	-	-
AVERAGE	25530	4139	4989	23020	57679	85	15	4

###Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Passing Lane</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Passing Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Jan 19	1876590	646522	520347	1994371	5037829
Feb 19	1423377	652606	530116	1737913	4344012
Mar 19	2086856	798781	620139	2233229	5739005
Apr 19	2203311	844134	673418	2294631	6015495
May 19	2887575	1038509	896554	2762671	7585308
Jun 19	5370351	2138820	1938350	5817580	15265101
Jul 19	2756663	1092970	1018131	3103868	7971633
Aug 19	2918571	1091245	1004179	3150967	8164962
Sep 19	2762888	929295	1822629	1612644	7127456
Oct 19	4231861	1378634	2741559	2296074	10648128
Nov 19	2542992	843130	742994	2613320	6742436
Dec 19	2468575	848039	704753	2524982	6546349
TOTAL	33529611	12302684	13213169	32142250	91187713
AVERAGE	2794134	1025224	1101097	2678521	7598976

###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	575	0.1	0.9	48	21
Feb 2019	794	0.1	1.4	56	26
Mar 2019	591	0.1	0.9	71	48
Apr 2019	563	0.1	0.8	70	42
May 2019	9712	1	11.9	1831	162
Jun 2019	22320	1.1	14.5	1866	262
Jul 2019	11264	1.1	13.7	645	150
Aug 2019	11662	1.1	14.1	585	149
Sep 2019	10051	1.1	13.4	382	112

Oct 2019	13708	1	11.8	574	166
Nov 2019	8705	1	12	382	117
Dec 2019	6109	0.7	8.5	228	52
TOTAL	96054	-	-	6738	1307
AVERAGE	8004.5	0.7	8.7	561.5	108.9

###Freight

<i>Month</i>	<i>NB Freight Tons</i>	<i>SB Freight Tons</i>	<i>Total Freight</i>	<i>NB Freight %</i>	<i>SB Freight %</i>
Jan 2019	191437	189886	381323	50.2	49.8
Feb 2019	161646	180700	342346	47.2	52.8
Mar 2019	217306	218688	435994	49.8	50.2
Apr 2019	239111	230147	469258	51	49
May 2019	377156	315573	692729	54.4	45.6
Jun 2019	693719	700129	1393849	49.8	50.2
Jul 2019	346328	382396	728724	47.5	52.5
Aug 2019	363149	374052	737201	49.3	50.7
Sep 2019	356729	300943	657672	54.2	45.8
Oct 2019	559175	434949	994124	56.2	43.8
Nov 2019	315384	305142	620526	50.8	49.2
Dec 2019	300742	285250	585992	51.3	48.7
TOTAL	4121882	3917855	8039737	-	-
AVERAGE	343490.2	326487.9	669978	51	49