

JULY 2018



**WIM #30
MN 61, MP 16.3
TWO HARBORS,
MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #30 is located on MN 61 near Two Harbors in Lake county.

System Operation

WIM #30 was operational for the entire month of July 2018. Volume was computed using all monthly data.

System Calibration

WIM #30 was most recently calibrated on 2017-01-20. 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: 350547 | Passenger Vehicles: 332764 | Heavy Commercial Vehicles: 17783

Monthly Average Daily Traffic (MADT): 11308 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 574

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 Sundays. SB vehicles typically reached highest volume levels on Sundays, with lowest volumes reported on Wednesdays (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 02 PM and 04 PM. Similarly, SB PVs peaked in volume between 12 PM and 04 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 02 PM and 04 PM, while volume going SB peaked between 12 PM 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 17783 HCVs, 2374 of them were overweight³. These overweight HCVs contributed to 0.7% of total monthly volume, and 13.4% 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 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, with 61.4% 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 March.

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 ,355 NB vehicles exceeded 88,000 pounds (220 vehicles were Class 9's; 98 vehicles were Class 10's). Of vehicles traveling SB,

345 NB vehicles exceeded 88,000 pounds (276 vehicles were Class 10's; 32 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from July 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in July 2018. 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 empty Class 10's than fully_loaded traveling in the NB direction. In the SB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 130627 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (55.3%) than SB (44.7%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridges No. 9341 and No. 9339, which are respectively on the NB and SB side of MN 61, are approximately 1.5 miles north of WIM #30. Bridge No. 9333 (a box culvert) is approximately 1.8 miles south of WIM #30. WIM #30 recorded a total of 350547 vehicles with a combined GVW of 2272204 kips (1 kip = 1,000 pounds = 0.5 tons) in July 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 13065 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 57.4% of all ESALs were recorded NB while 42.6% was observed SB. In particular, 50% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 13% 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).

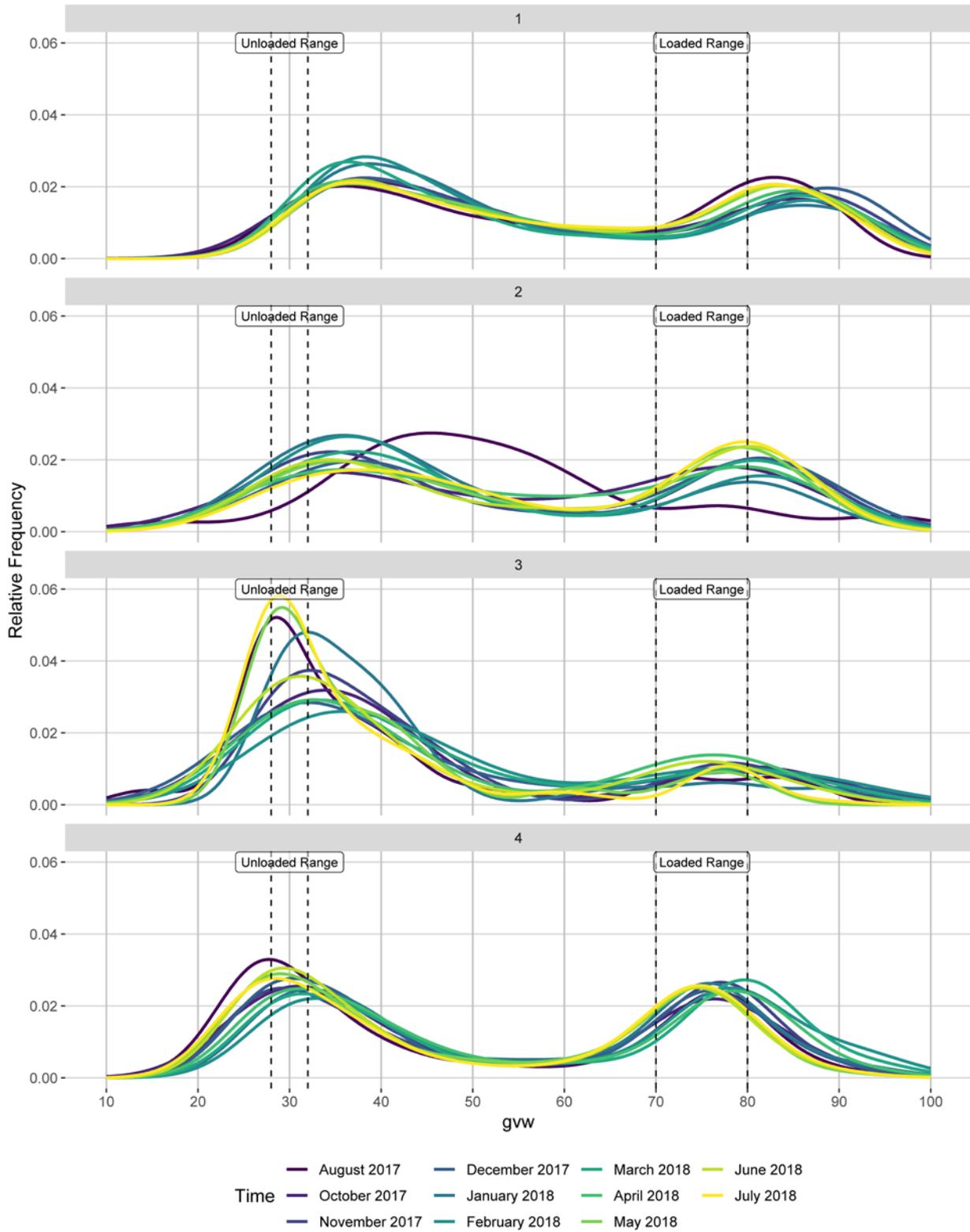
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

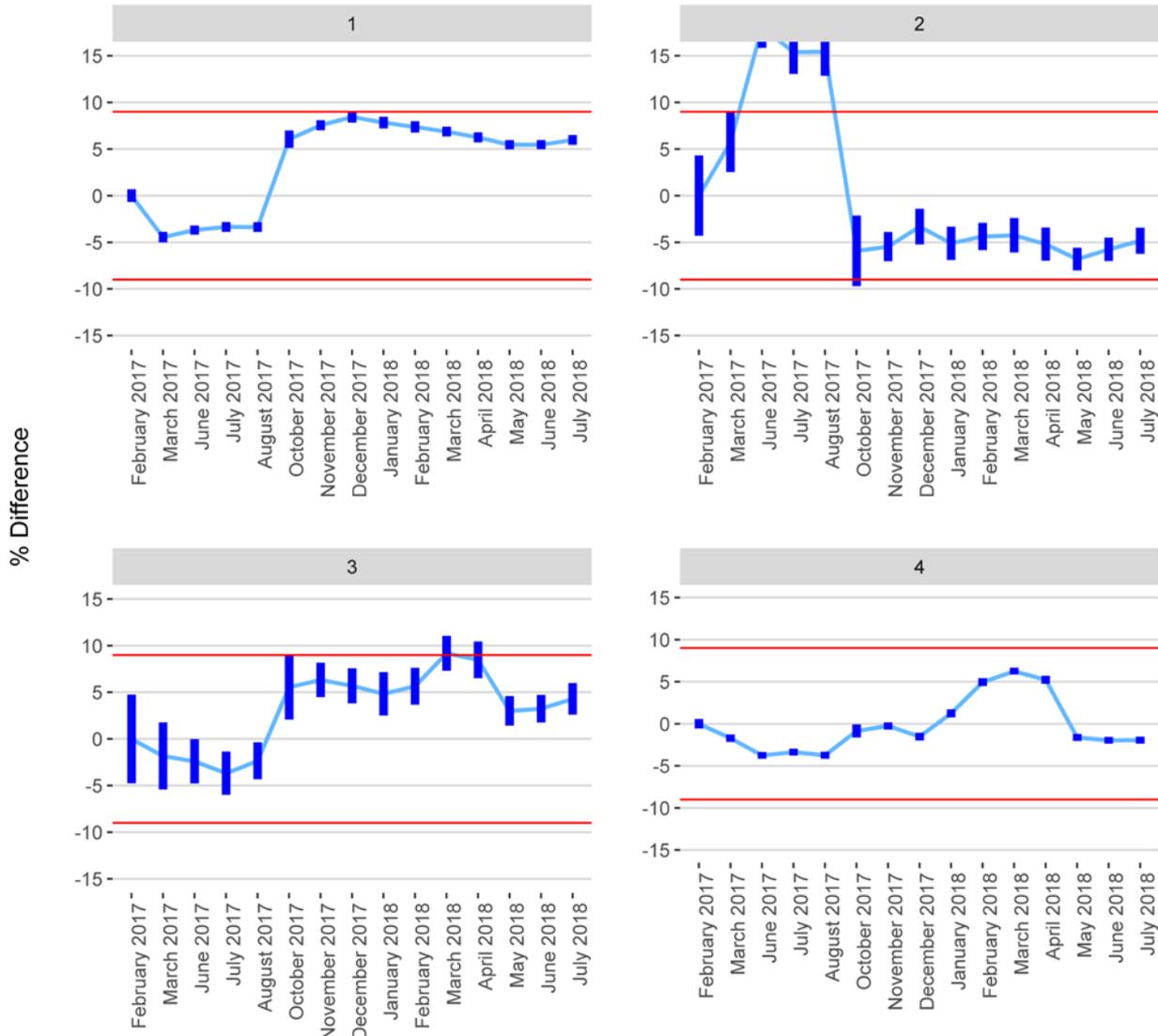
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

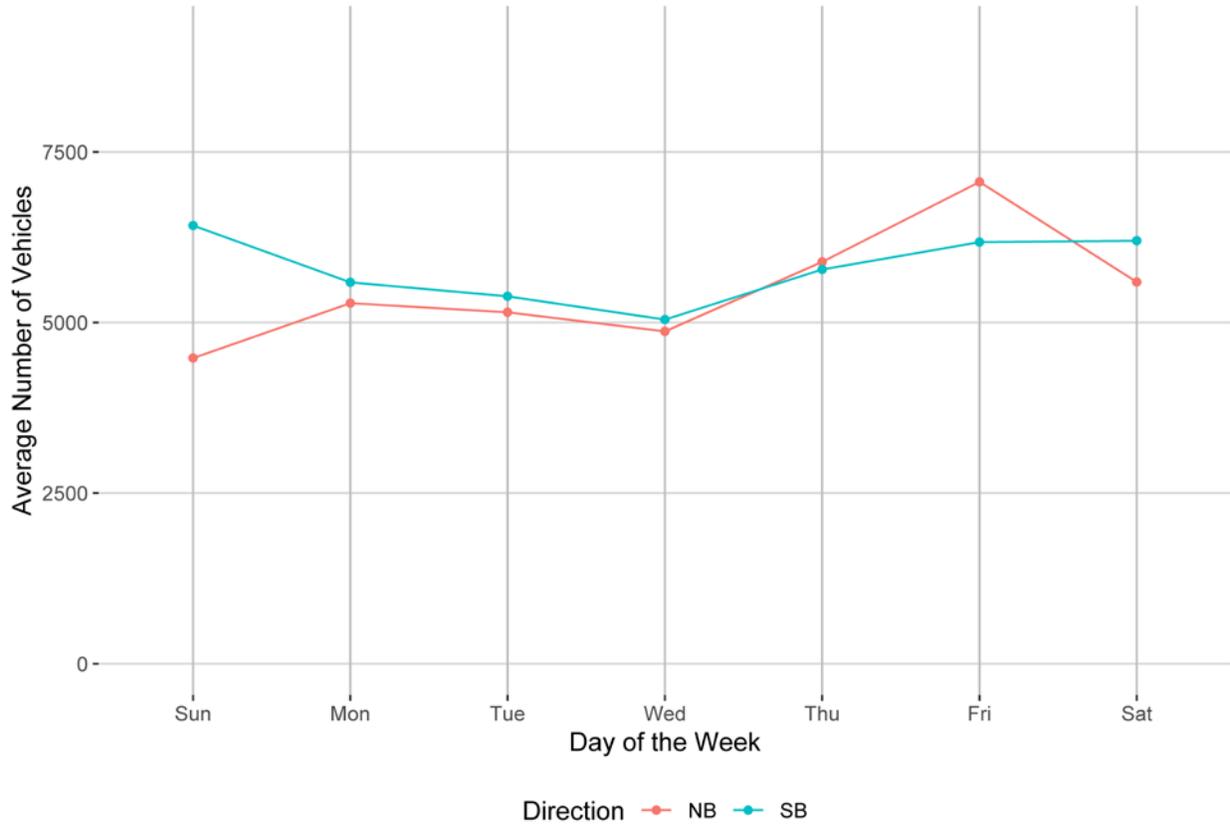


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

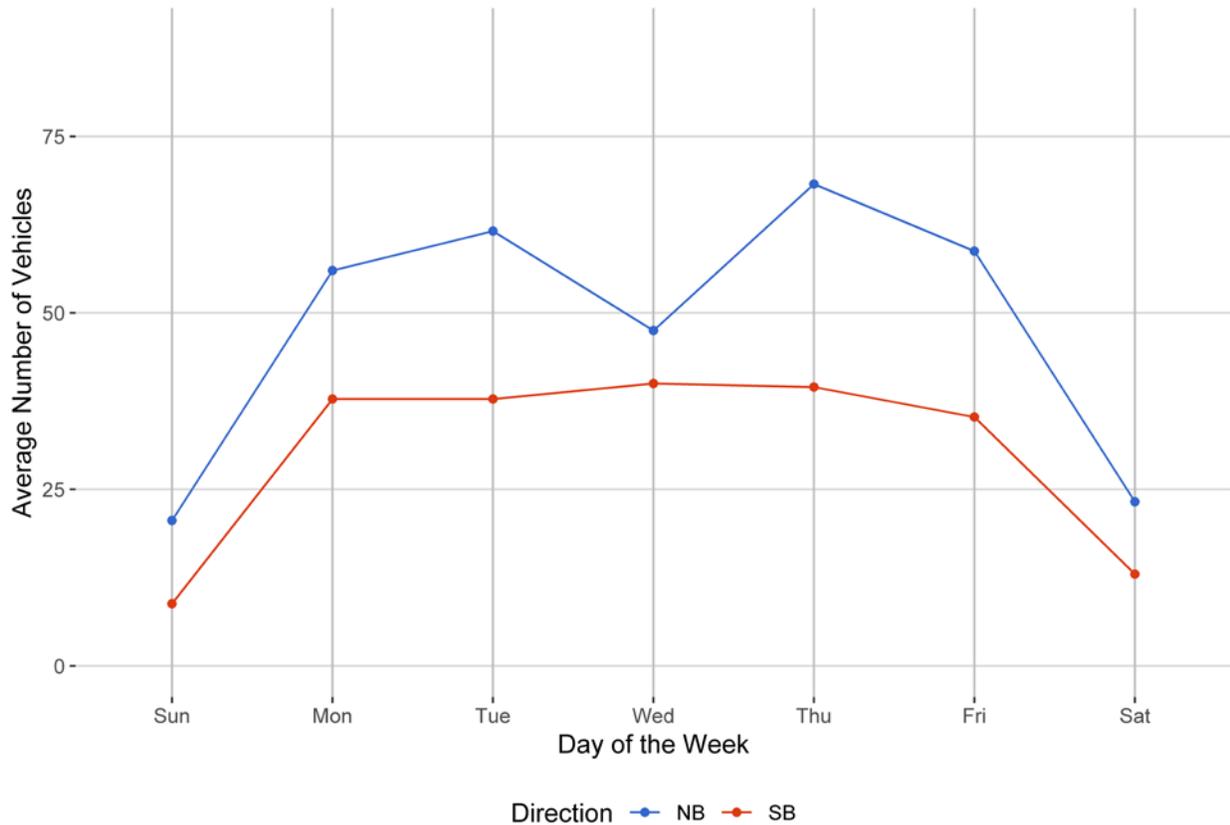


Figure 4 - Passenger Vehicles vs. Hour of the Day

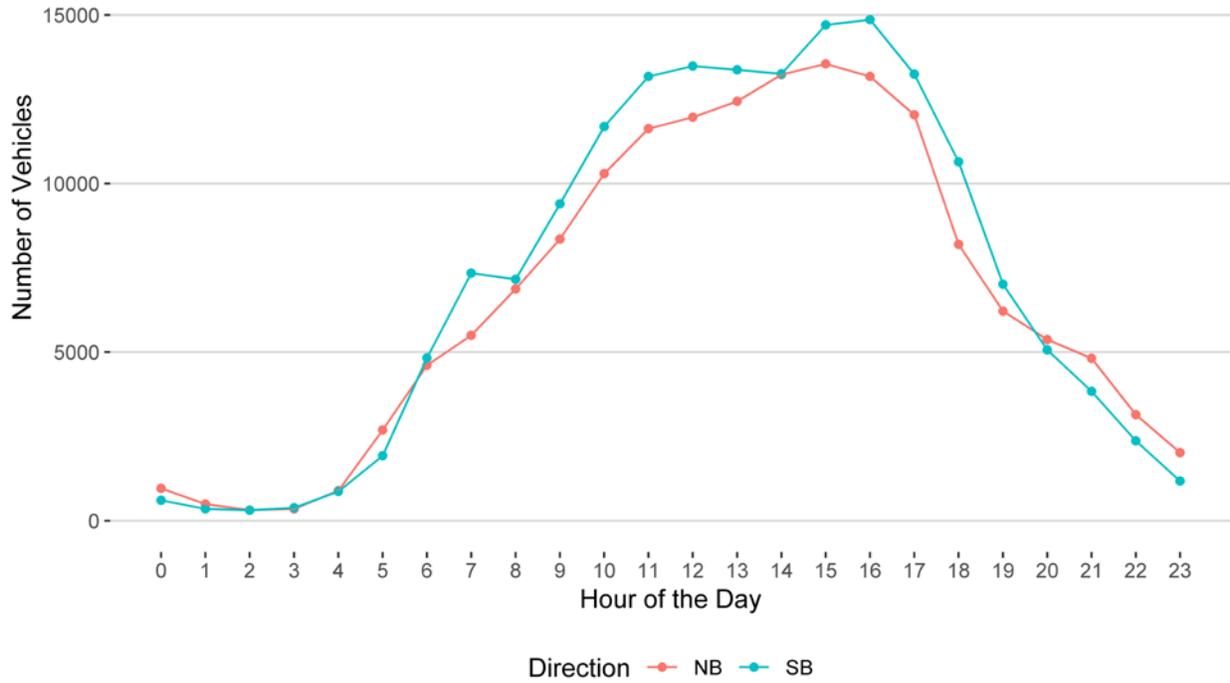


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

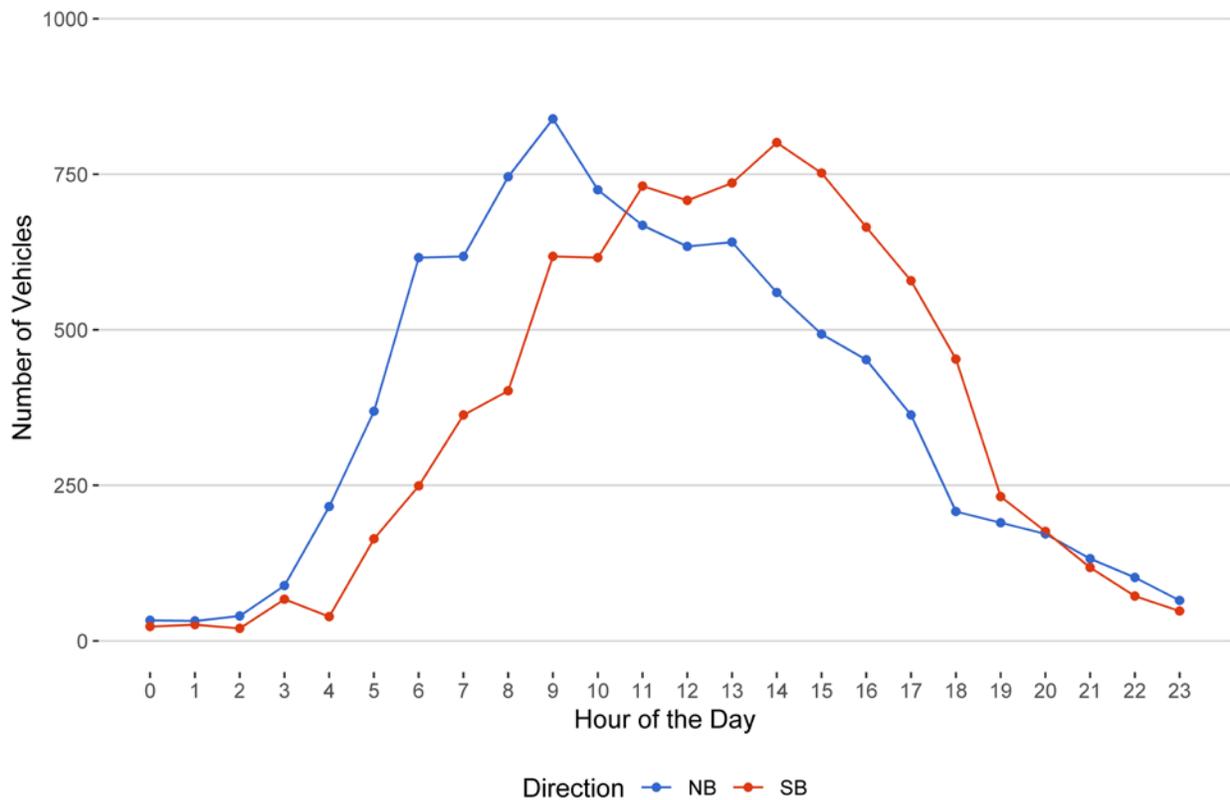


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

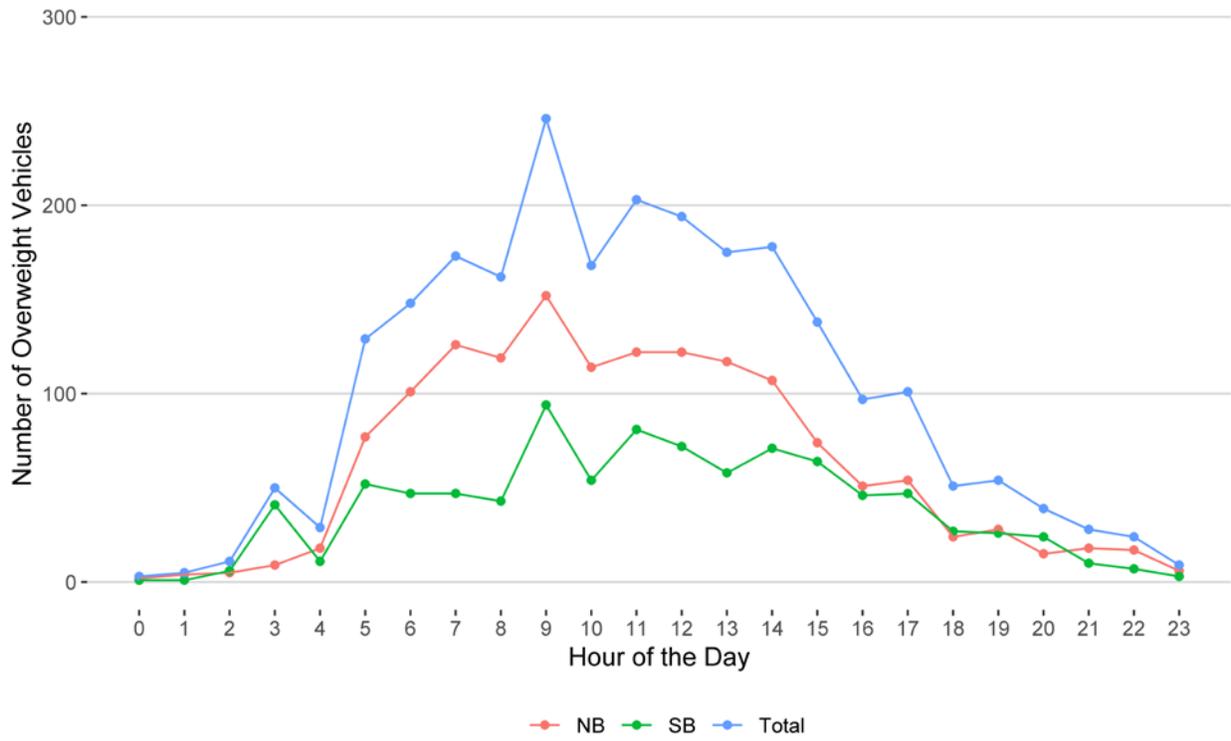
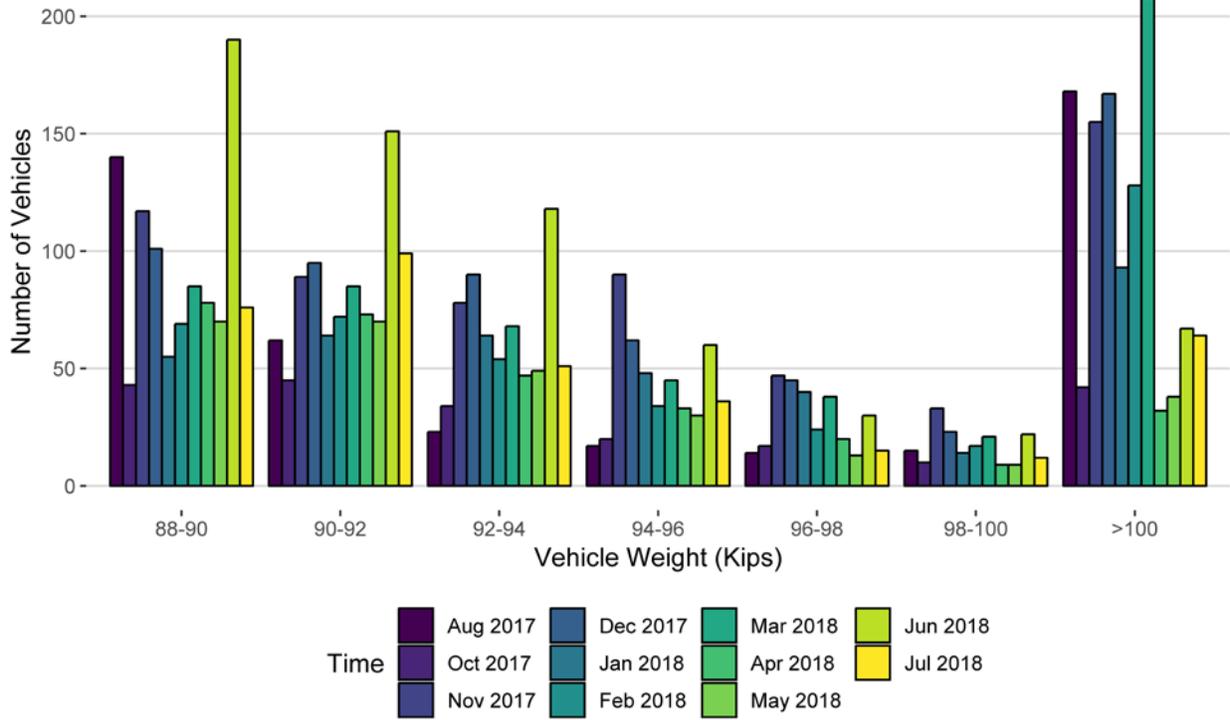
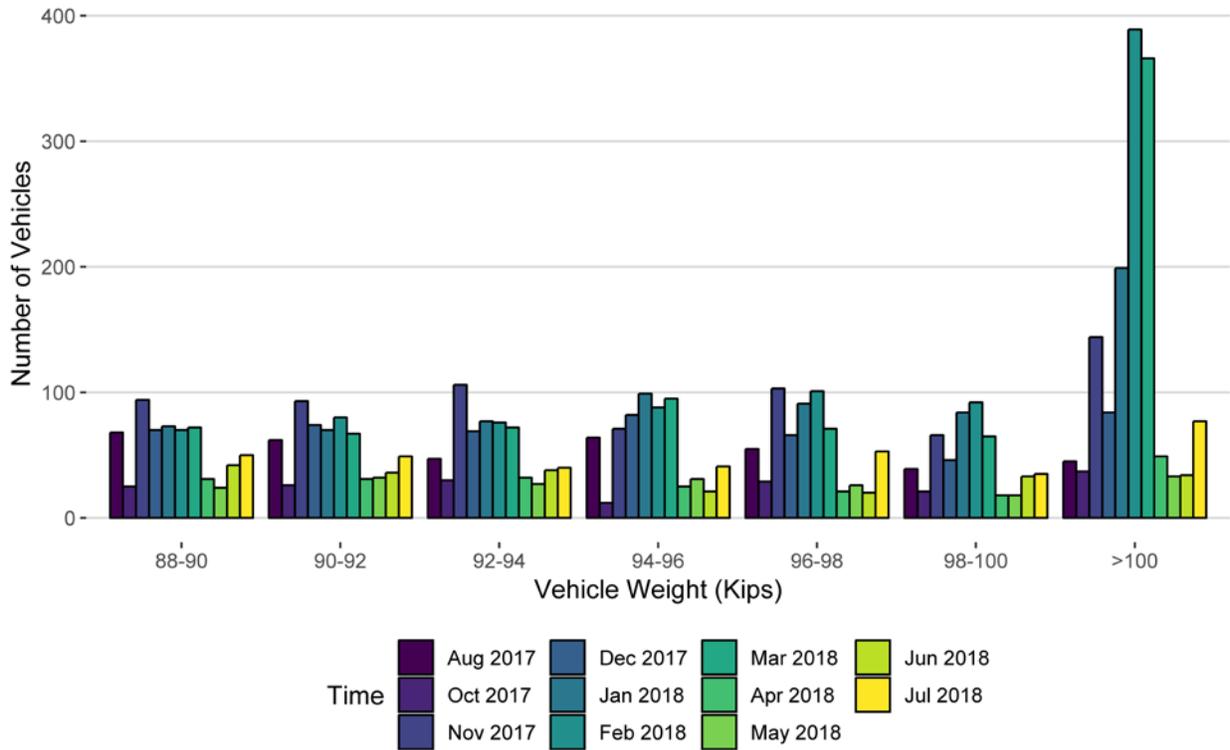


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Aug 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018
88-90	140	43	117	101	55	69	85	78	70	190	76
90-92	62	45	89	95	64	72	85	73	70	151	99
92-94	23	34	78	90	64	54	68	47	49	118	51
94-96	17	20	90	62	48	34	45	33	30	60	36
96-98	14	17	47	45	40	24	38	20	13	30	15
98-100	15	10	33	23	14	17	21	9	9	22	12
>100	168	42	155	167	93	128	208	32	38	67	64
Total	439	211	609	583	378	398	550	292	279	638	353

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



Vehicle Weights (Kips)	Aug 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018
88-90	68	25	94	70	73	70	72	31	24	42	50
90-92	62	26	93	74	70	80	67	31	32	36	49
92-94	47	30	106	69	77	76	72	32	27	38	40
94-96	64	12	71	82	99	88	95	25	31	21	41
96-98	55	29	103	66	91	101	71	21	26	20	53
98-100	39	21	66	46	84	92	65	18	18	33	35
>100	45	37	144	84	199	389	366	49	33	34	77
Total	380	180	677	491	693	896	808	207	191	224	345

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

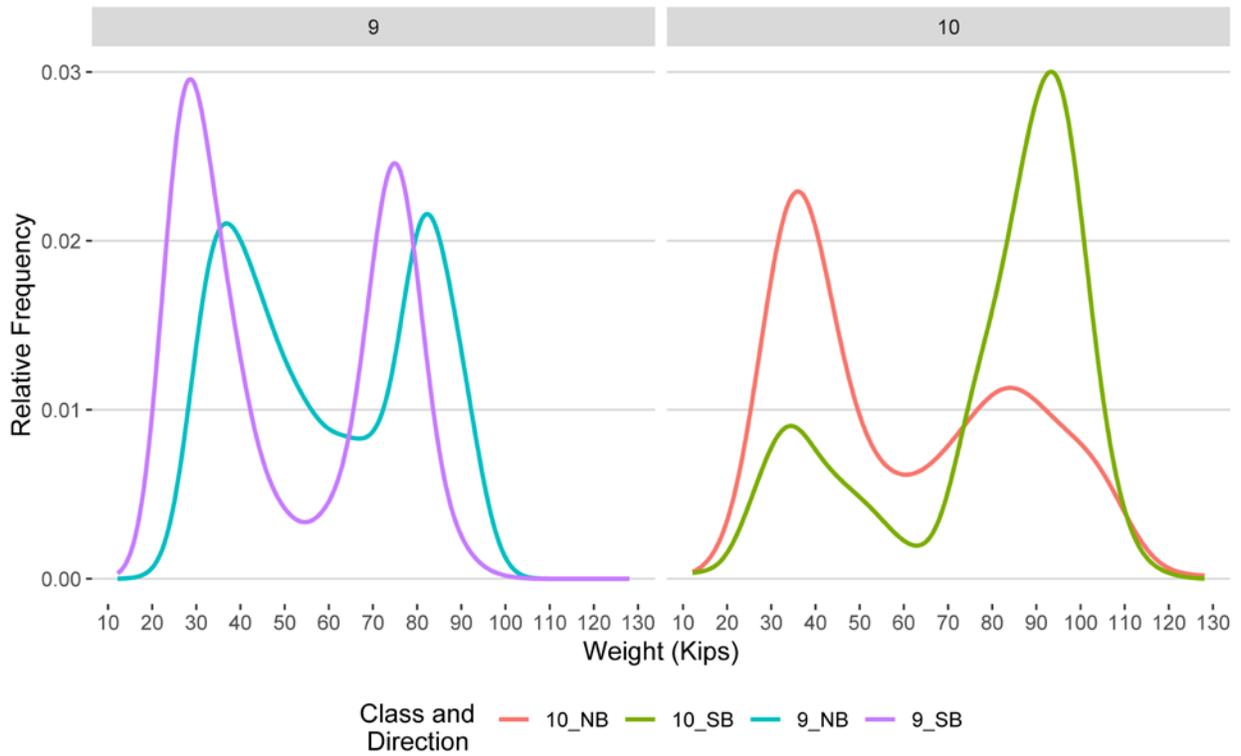


Figure 9 - Freight Percentage by Direction and Class

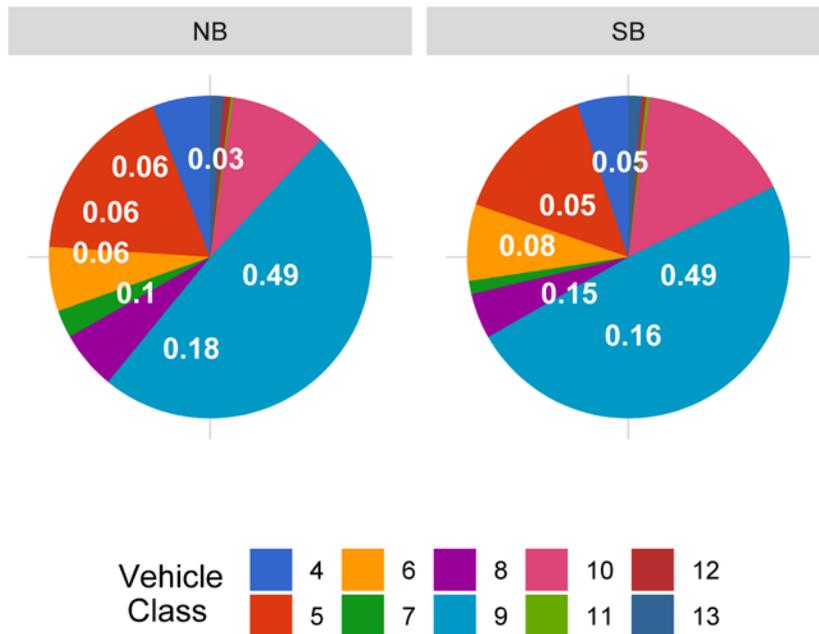


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

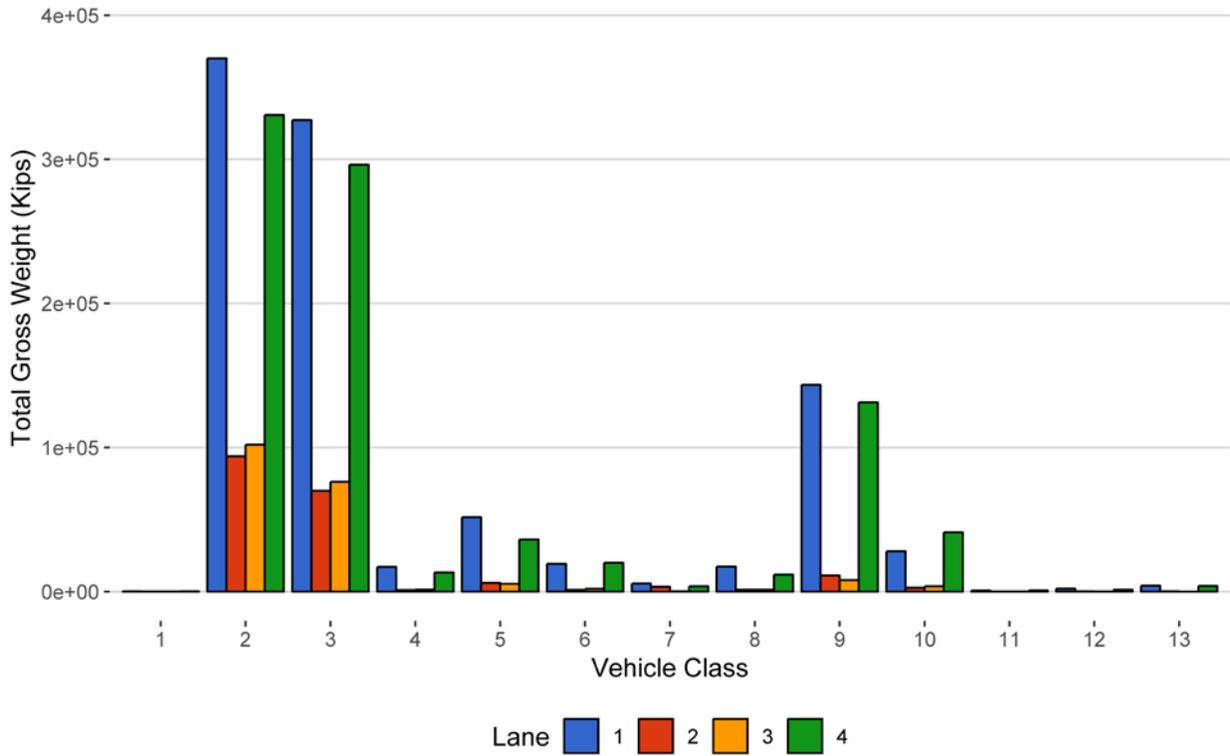


Figure 11 - Total Gross Vehicle Weight t

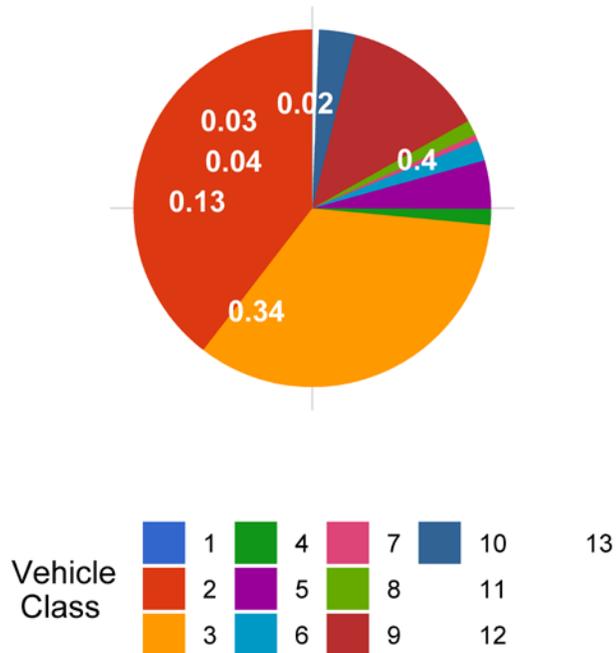


Figure 12 - Total ESALs by Class and Lane

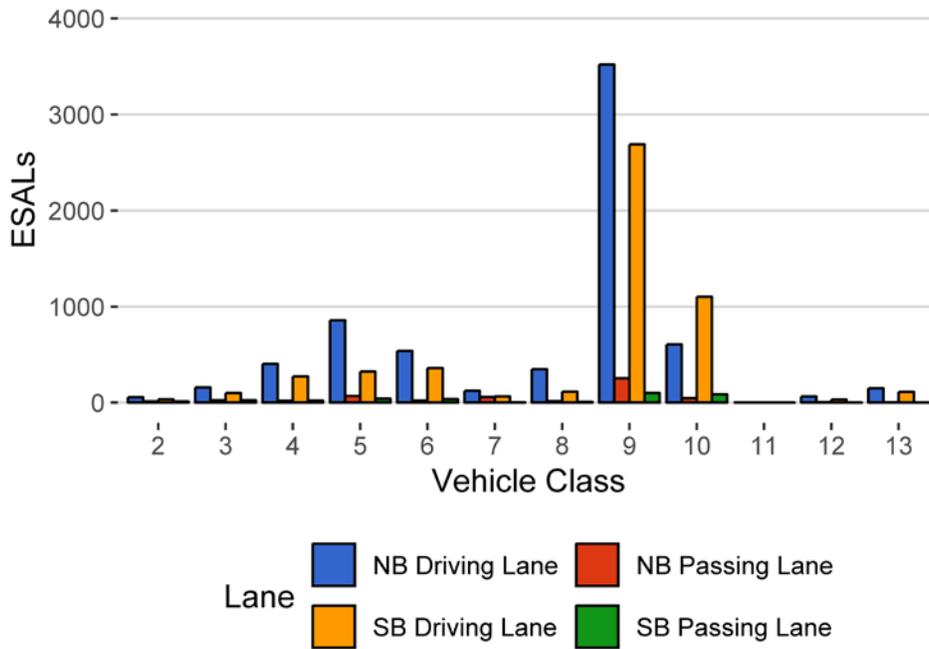


Figure 13 - ESALs by Class

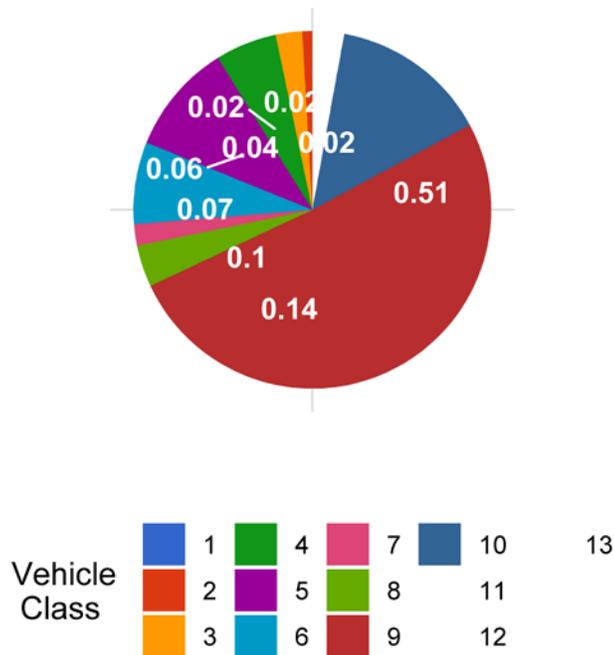


Table 1 Class 9 Front Axle Weight by Lane

<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>
February 2017	11.62	0.00	12.12	0.00	10.33	0.00	11.31	0.00
March 2017	11.10	-4.45	12.82	5.74	10.14	-1.83	11.11	-1.71
June 2017	11.19	-3.68	14.31	18.03	10.08	-2.40	10.88	-3.75
July 2017	11.23	-3.35	13.99	15.41	9.95	-3.68	10.93	-3.36
August 2017	11.23	-3.36	13.99	15.43	10.09	-2.35	10.89	-3.73
October 2017	12.32	6.06	11.40	-5.91	10.91	5.55	11.21	-0.85
November 2017	12.49	7.54	11.46	-5.46	10.99	6.32	11.28	-0.25
December 2017	12.60	8.45	11.72	-3.32	10.92	5.69	11.14	-1.52
January 2018	12.53	7.84	11.50	-5.10	10.83	4.84	11.45	1.24
February 2018	12.47	7.38	11.59	-4.37	10.92	5.64	11.87	4.95
March 2018	12.41	6.87	11.61	-4.25	11.28	9.19	12.01	6.26
April 2018	12.34	6.25	11.49	-5.19	11.21	8.47	11.90	5.24
May 2018	12.25	5.47	11.30	-6.81	10.64	3.00	11.12	-1.61
June 2018	12.25	5.47	11.42	-5.75	10.67	3.24	11.08	-1.97
July 2018	12.31	5.98	11.54	-4.83	10.78	4.29	11.09	-1.94

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	9	278	0.1	0	0
2	7042	218304	62.3	0	0
3	3683	114182	32.6	0	0
4	39	1198	0.3	126	5.3
5	231	7158	2	133	5.6
6	41	1257	0.4	167	7
7	7	225	0.1	81	3.4
8	40	1254	0.4	67	2.8
9	174	5380	1.5	1165	49.1
10	35	1095	0.3	540	22.7
11	3	89	0	0	0
12	2	51	0	25	1.1
13	3	78	0	70	2.9
TOTAL	11308	350547	100	2374	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>
2018-07-10	Tuesday	06:15:08	10	NB	1	128.07
2018-07-31	Tuesday	18:51:17	10	NB	1	119.25
2018-07-04	Wednesday	06:56:28	10	SB	4	117.21
2018-07-26	Thursday	06:01:25	10	SB	4	116.07
2018-07-20	Friday	06:59:21	10	NB	1	114.85
2018-07-31	Tuesday	05:53:39	10	SB	4	111.78
2018-07-06	Friday	05:41:16	10	SB	4	110.43
2018-07-11	Wednesday	05:51:33	10	SB	4	109.76
2018-07-02	Monday	15:24:02	10	SB	4	109.42
2018-07-17	Tuesday	05:35:27	10	SB	4	109.38

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	623	35	5.6	17710	471	4445
5	NB	8	3835	202	5.3	56127	1492	13532
6	NB	19	534	10	1.9	20219	170	5132
7	NB	11.5	140	0	0	8781	0	3586
8	NB	31	667	386	57.9	11897	6686	1593
9	NB	33	2585	253	9.8	146880	7680	34962
10	NB	33.5	513	85	16.6	28069	2618	6865
11	NB	36.5	38	38	100	0	821	0
12	NB	36.5	30	3	10	2134	70	574
13	NB	31.5	38	0	0	4235	0	1519
TOTAL	****	****	9003	1012	****	296052	****	72207
<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	567	111	19.6	13242	1411	3201
5	SB	8	3274	717	21.9	36398	5100	7971
6	SB	19	714	56	7.8	20884	957	4191
7	SB	11.5	83	1	1.2	3731	11	1394
8	SB	31	578	475	82.2	3828	9161	317
9	SB	33	2758	981	35.6	112384	26911	26871
10	SB	33.5	574	47	8.2	43439	1341	12892
11	SB	36.5	50	50	100	0	931	0
12	SB	36.5	21	7	33.3	1088	168	289
13	SB	31.5	39	0	0	3815	0	1293
TOTAL	****	****	8658	2445	****	238808	****	58420
GRAND TOTAL	****	****	17661	3457	517	534860	66001	130627

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	134	37	24	159	353	0
2	370124	93811	101977	330818	896730	39.5
3	327179	69912	76209	296300	769601	33.9
4	17146	1034	1407	13246	32834	1.4
5	51626	5994	5305	36192	99117	4.4
6	19269	1120	1882	19959	42231	1.9
7	5522	3259	138	3604	12523	0.6
8	17352	1231	1259	11729	31572	1.4
9	143397	11162	7914	131381	293854	13
10	28014	2673	3648	41132	75467	3.3
11	747	74	85	846	1751	0.1
12	2036	169	35	1221	3461	0.2
13	4066	169	0	3815	8050	0.4
TOTAL	986613	190646	199883	890403	2267545	100
GVW/LANE	43.51	8.41	8.81	39.27	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	0.0036
2	56	12	12	35	116	0.9	0.0011
3	159	25	25	100	309	2.39	0.0055
4	404	19	21	273	718	5.56	1.21
5	858	69	42	323	1292	10.02	0.37
6	539	22	37	359	957	7.41	1.54
7	124	58	3	64	250	1.93	2.21
8	348	15	9	115	487	3.78	0.79
9	3520	255	100	2690	6564	50.87	2.46
10	606	48	86	1102	1842	14.27	3.38
11	1	0	0	1	2	0.01	0.15
12	64	5	0	32	101	0.78	3.41
13	151	3	0	113	266	2.06	6.09
TOTAL	6830	530	335	5208	12903	100	22
ESALS/LANE	52.9	4.1	2.6	40.4	100	-	-

Table 7 Site Summary: Volume and Vehicle Class

<i>Month</i>	<i>Total Volume</i>	<i>Monthly ADT</i>	<i>Monthly HCAD T</i>	<i>Passenger Vehicles</i>	<i>Passenger Vehicles %</i>	<i>Heavy Commercial Vehicles</i>	<i>Heavy Commercial Vehicles %</i>	<i>Heavy Commercial Vehicles in Driving Lane %</i>	<i>Heavy Commercial Vehicles in Passing Lane %</i>
Aug 2017	350278	11299	800	325471	92.9	24806.8	7.1	75.2	24.8
Oct 2017	79225	7922	171	73909	93.3	5315.5	6.7	91.8	8.2
Nov 2017	214234	7141	488	199588	93.2	14646	6.8	92.7	7.3
Dec 2017	210731	6798	402	198277	94.1	12454.1	5.9	93.2	6.8
Jan 2018	203332	6559	416	190447	93.7	12885.2	6.3	94.4	5.6
Feb 2018	187761	6706	445	175314	93.4	12446.9	6.6	93.7	6.3
Mar 2018	227467	7338	458	213260	93.8	14206.9	6.2	93.5	6.5
Apr 2018	208109	6937	390	196423	94.4	11686.2	5.6	93.5	6.5
May 2018	275473	8886	486	260406	94.5	15066.6	5.5	91.8	8.2
Jun 2018	306452	10215	626	287683	93.9	18769.5	6.1	90.8	9.2
Jul 2018	350547	11308	574	332764	94.9	17782.9	5.1	90.2	9.8
TOTAL	2613609	-	-	2453542	-	160067	-	-	-
AVERAGE	237601	8283	478	223049	94	14552	6	91	9

ESALS

<i>Month</i>	<i>ESALS NB Passing Lane</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>ESALS SB Passing Lane</i>	<i>Total ESALS</i>	<i>Driving Lane ESALS %</i>	<i>Passing Lane ESALS %</i>	<i>Pavement Life Decrease Months</i>
Aug 2017	6093	1231	310	5649	13284	88	12	24.6
Oct 2017	2404	157	213	1939	4714	92	8	40.8
Nov 2017	6711	379	332	6211	13634	95	5	53.5
Dec 2017	6031	297	262	4744	11333	95	5	62.1
Jan 2018	5226	297	153	5862	11538	96	4	70
Feb 2018	5255	266	317	7250	13089	96	4	91.1
Mar 2018	6638	321	340	7817	15116	96	4	71.8
Apr 2018	4677	226	180	4274	9357	96	4	29.7
May 2018	5870	397	196	4186	10649	94	6	19.6
Jun 2018	8117	587	372	5176	14252	93	7	29.4
Jul 2018	6965	535	336	5229	13065	93	7	23.1
TOTAL	63987	4694	3012	58338	130032	-	-	-
AVERAGE	5817	427	274	5304	11821	94	6	47

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>
Aug 2017	642847	77552	51867	631608	1403875
Oct 2017	612031	73787	60261	626261	1372339
Nov 2017	725128	97474	95556	725911	1644069
Dec 2017	624365	79369	76549	597736	1378018
Jan 2018	805267	135068	123381	716964	1780680
Feb 2018	956809	179159	163542	840328	2139837
Mar 2018	989942	190861	199906	891495	2272204
Apr 2018	735483	162845	184034	862884	1945246
May 2018	246018	34262	43177	241343	564799
Jun 2018	698717	96530	89621	663298	1548165
Jul 2018	675664	81599	69056	602852	1429172
TOTAL	7712270	1208506	1156950	7400680	17478405
AVERAGE	701115	109864	105177	672789	1588946

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>
Aug 2017	2449	0.8	11.7	820	268
Oct 2017	998	1.3	18.8	392	110
Nov 2017	2780	1.3	19	1289	398
Dec 2017	2132	1	17.2	1074	320
Jan 2018	2101	1.1	16.5	1071	390
Feb 2018	2416	1.3	19.6	1294	626
Mar 2018	2872	1.3	20.3	1363	661
Apr 2018	1663	0.8	14.3	499	108
May 2018	1827	0.7	12.2	470	98
Jun 2018	2892	1	15.4	866	157
Jul 2018	2415	0.7	13.6	700	189
TOTAL	24545	-	-	9838	3325
AVERAGE	2231.4	1	16.2	894.4	302.3

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>
Aug 2017	67447	59958	127406	52.9	47.1
Oct 2017	25289	21734	47024	53.8	46.2
Nov 2017	65328	66591	131919	49.5	50.5
Dec 2017	55298	50890	106189	52.1	47.9
Jan 2018	49987	59879	109866	45.5	54.5
Feb 2018	48947	66785	115732	42.3	57.7
Mar 2018	61186	72833	134019	45.7	54.3
Apr 2018	46511	43976	90486	51.4	48.6
May 2018	61664	47687	109351	56.4	43.6
Jun 2018	88451	64157	152607	58	42
Jul 2018	72207	58420	130627	55.3	44.7
TOTAL	642315	612909	1255224	-	-
AVERAGE	58392.3	55719	114111.3	51.2	48.8