

MAY 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 May 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: 275473 | Passenger Vehicles: 260406 | Heavy Commercial Vehicles: 15067

Monthly Average Daily Traffic (MADT): 8886 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 486

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 Tuesdays. 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 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 5's and Class 9's.

Overweight HCVs

Volume trends. Of a total of 15067 HCVs, 1822 of them were overweight³. These overweight HCVs contributed to 0.7% of total monthly volume, and 12.2% 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 Fridays, 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 65.2% 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 ,279 NB vehicles exceeded 88,000 pounds (204 vehicles were Class 9's; 50 vehicles were Class 10's). Of vehicles traveling SB,

191 NB vehicles exceeded 88,000 pounds (143 vehicles were Class 10's; 27 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from May 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in May 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 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 109351 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (56.4%) than SB (43.6%). 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 275473 vehicles with a combined GVW of 1780680 kips (1 kip = 1,000 pounds = 0.5 tons) in May 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 10649 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 58.8% of all ESALs were recorded NB while 41.2% was observed SB. In particular, 57% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 15% 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).

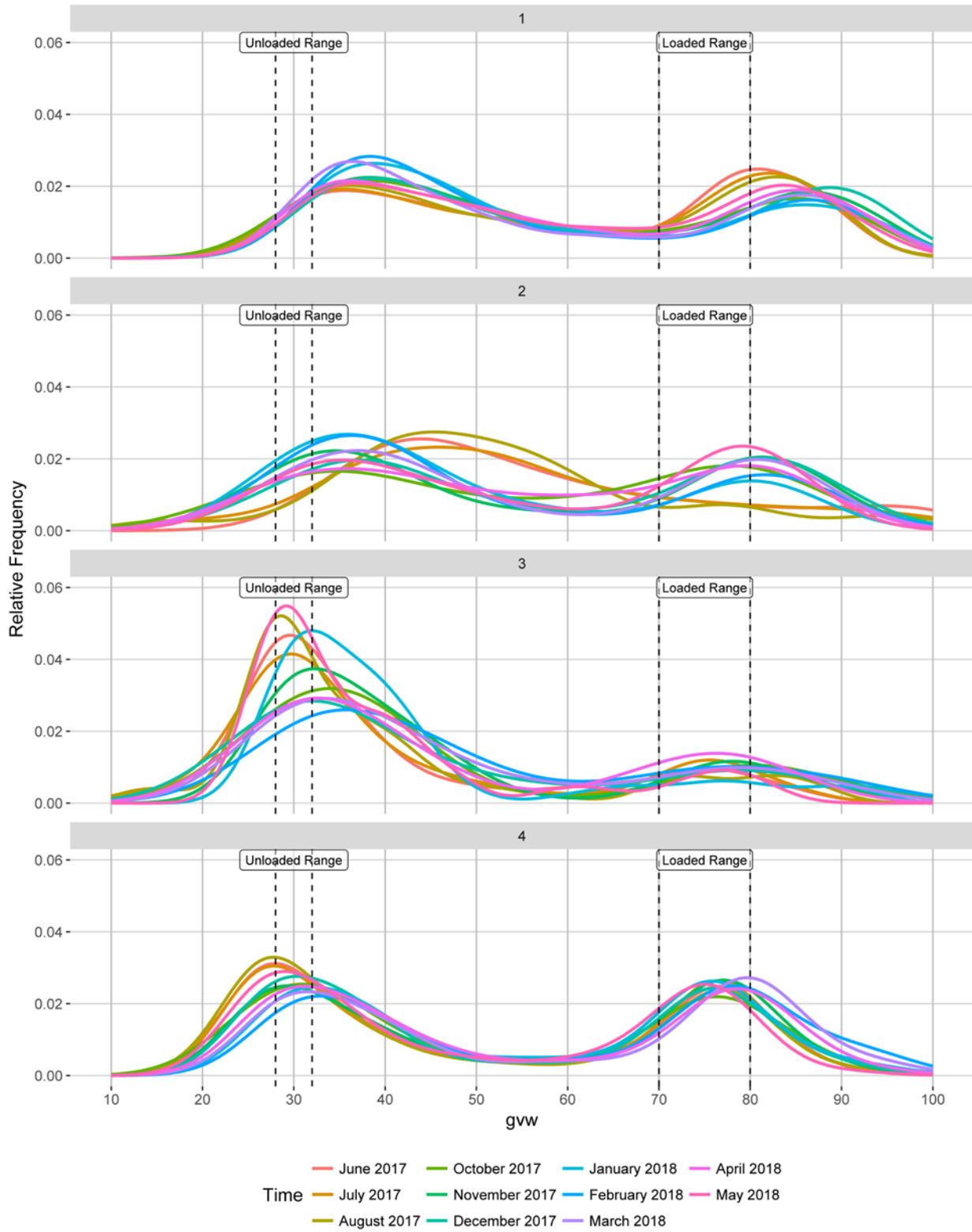
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

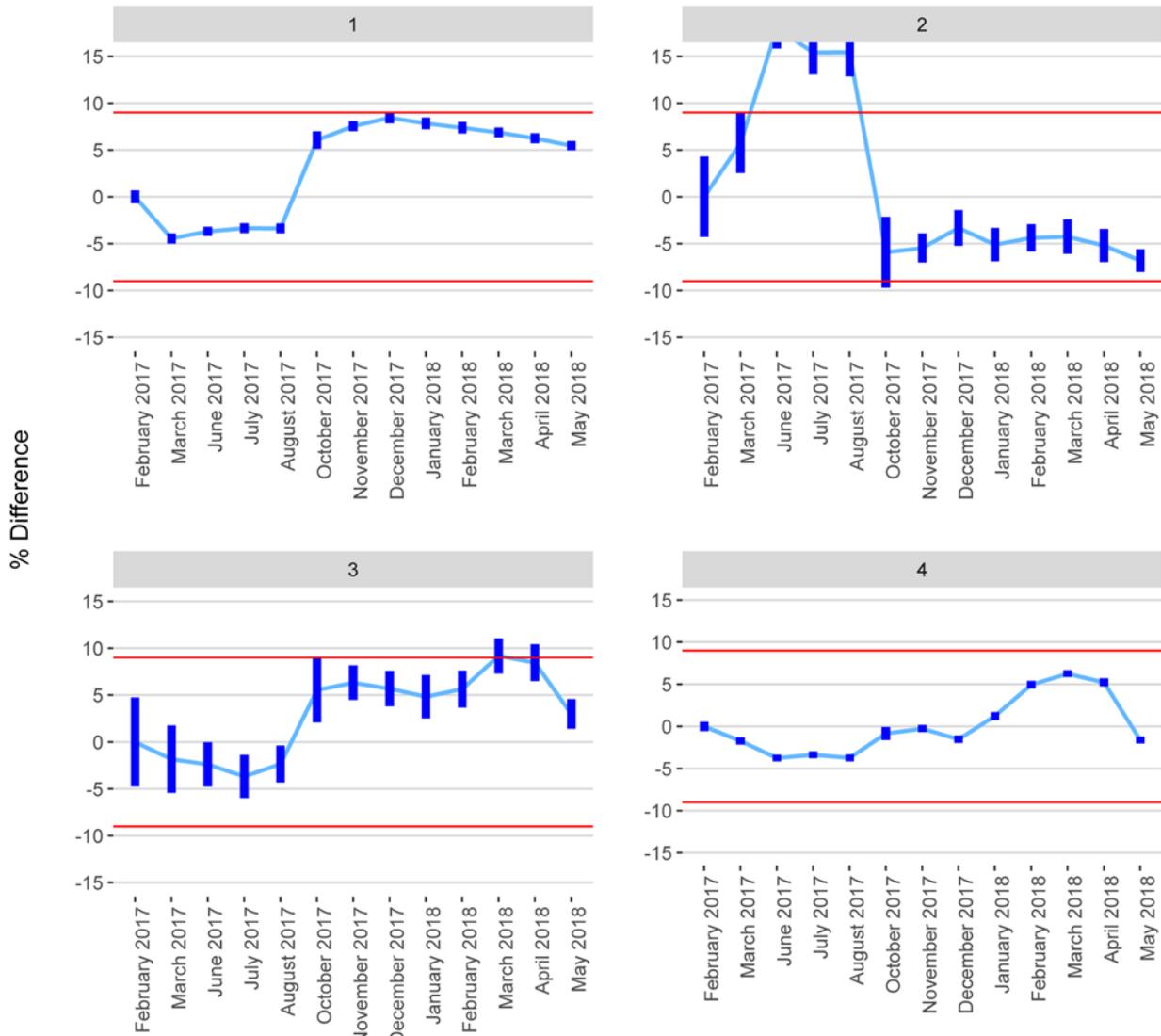
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

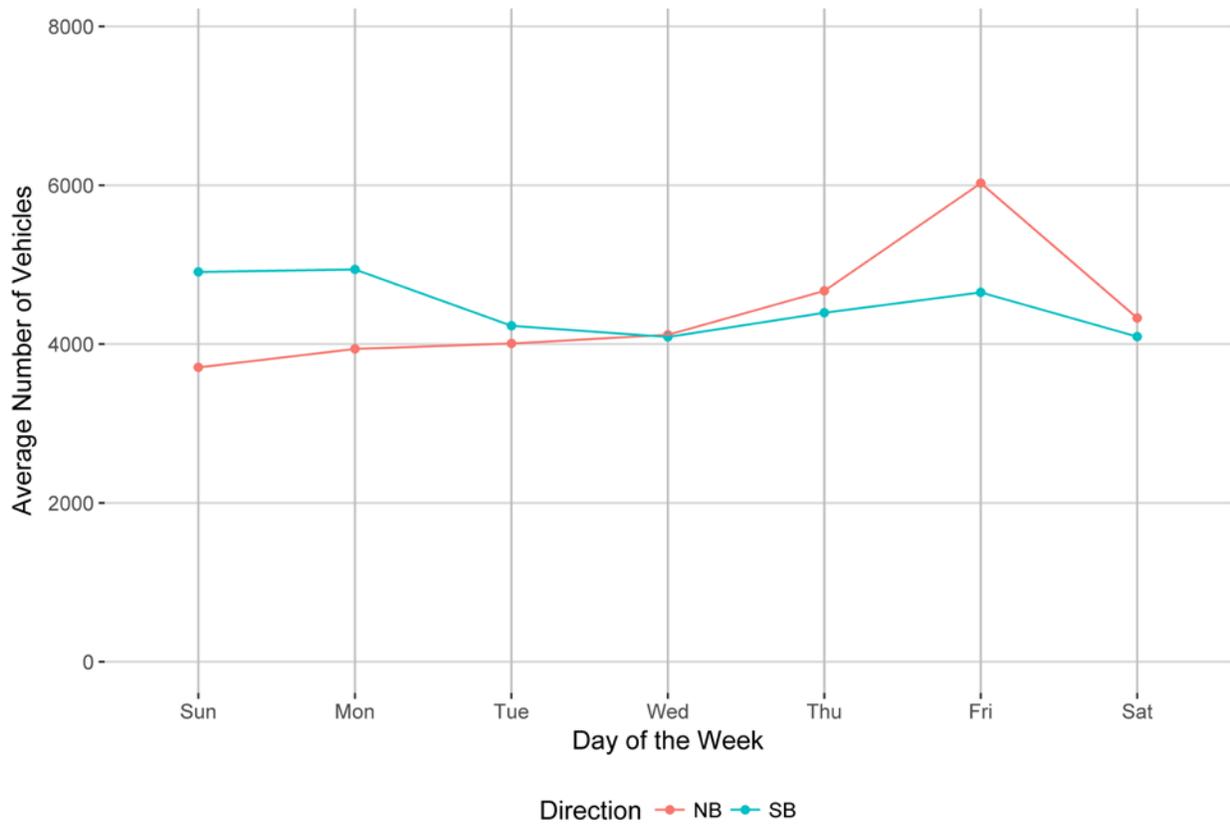


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

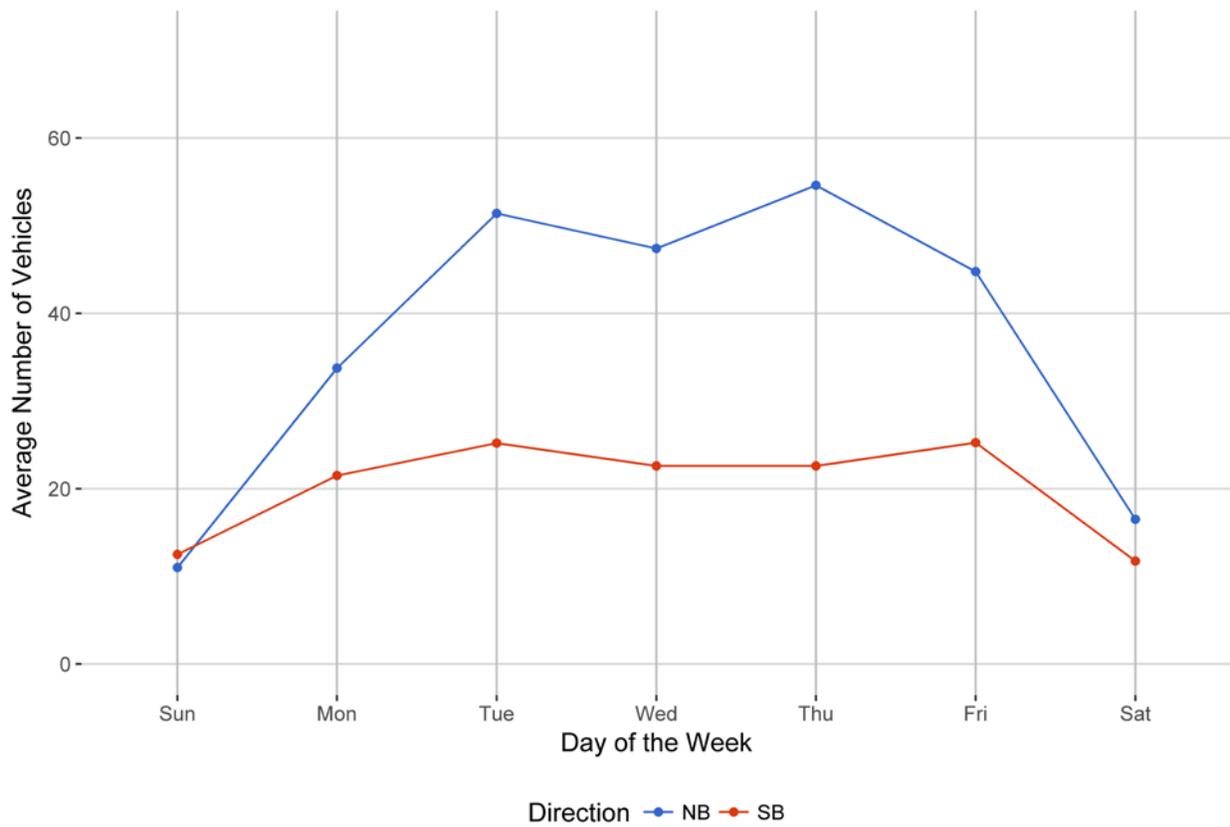


Figure 4 - Passenger Vehicles vs. Hour of the Day

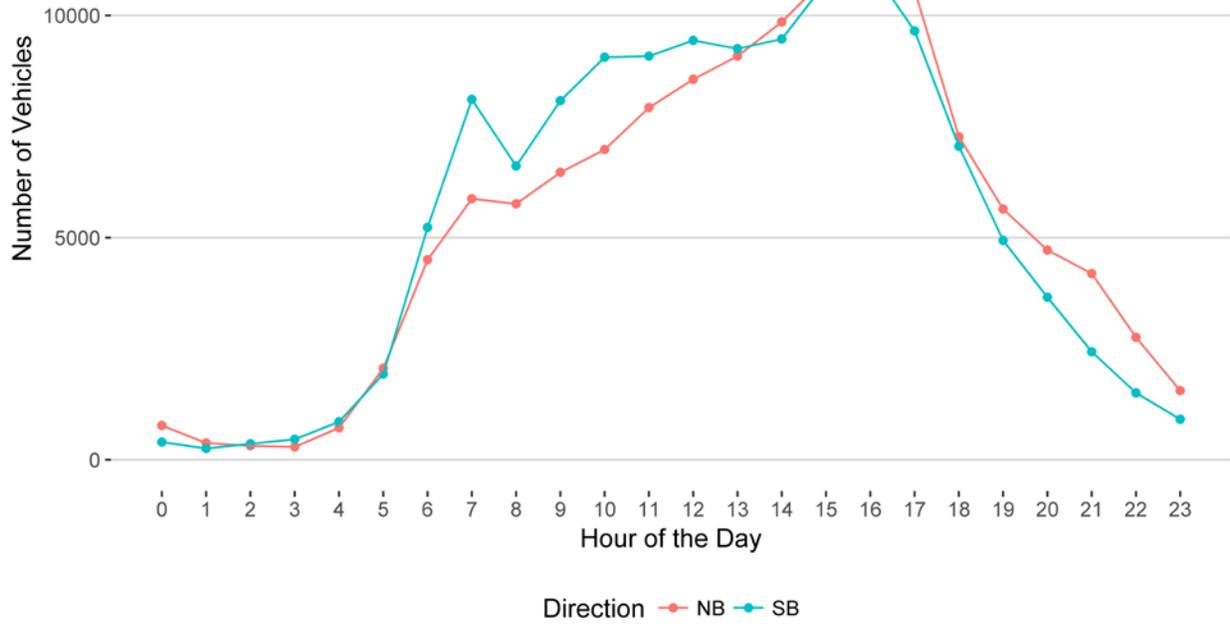


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

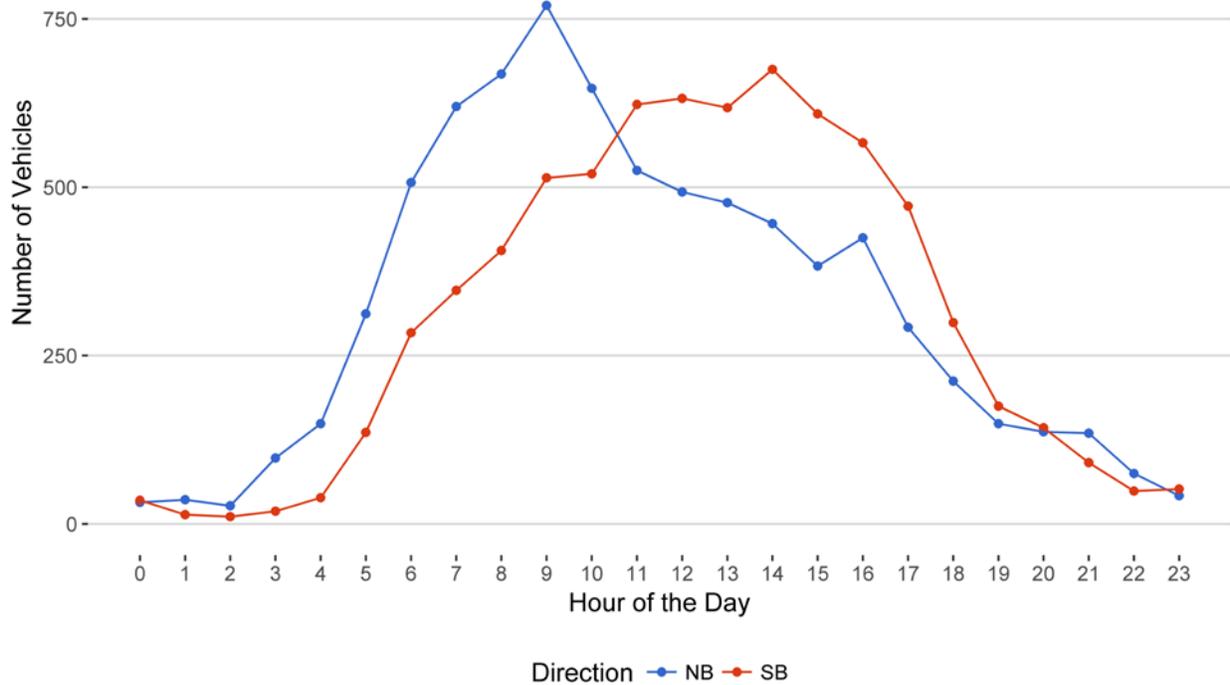


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

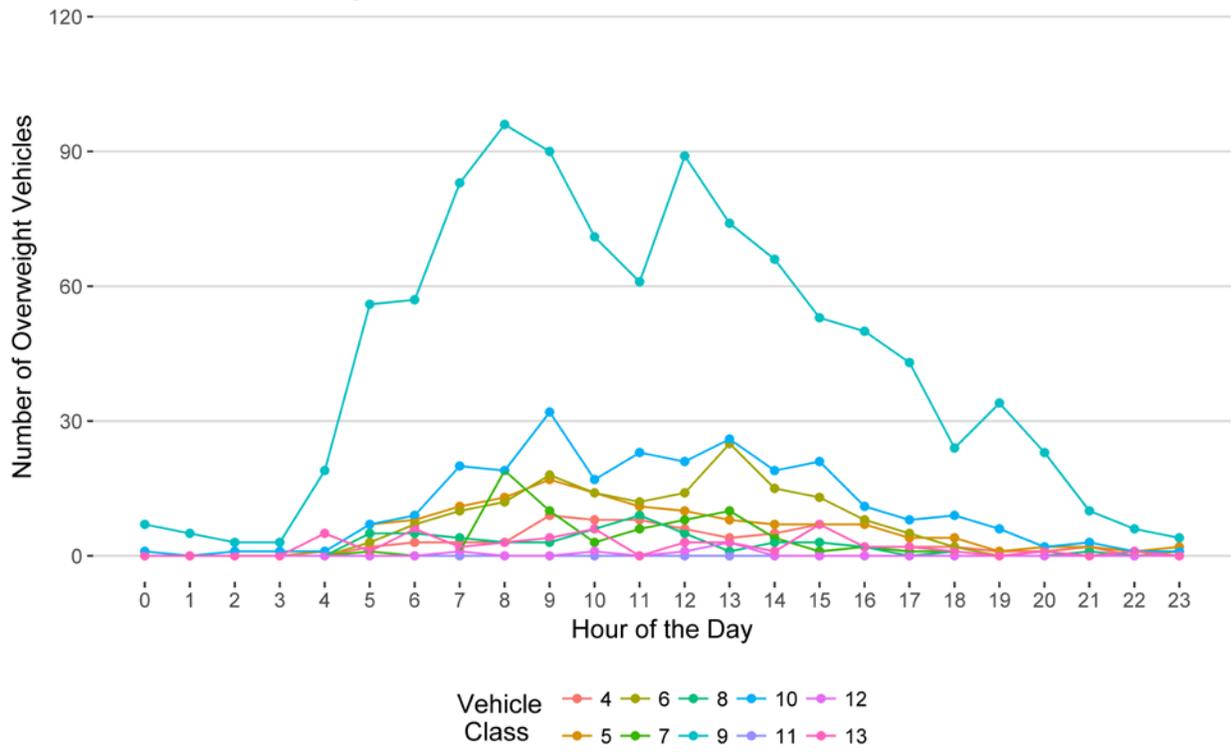


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

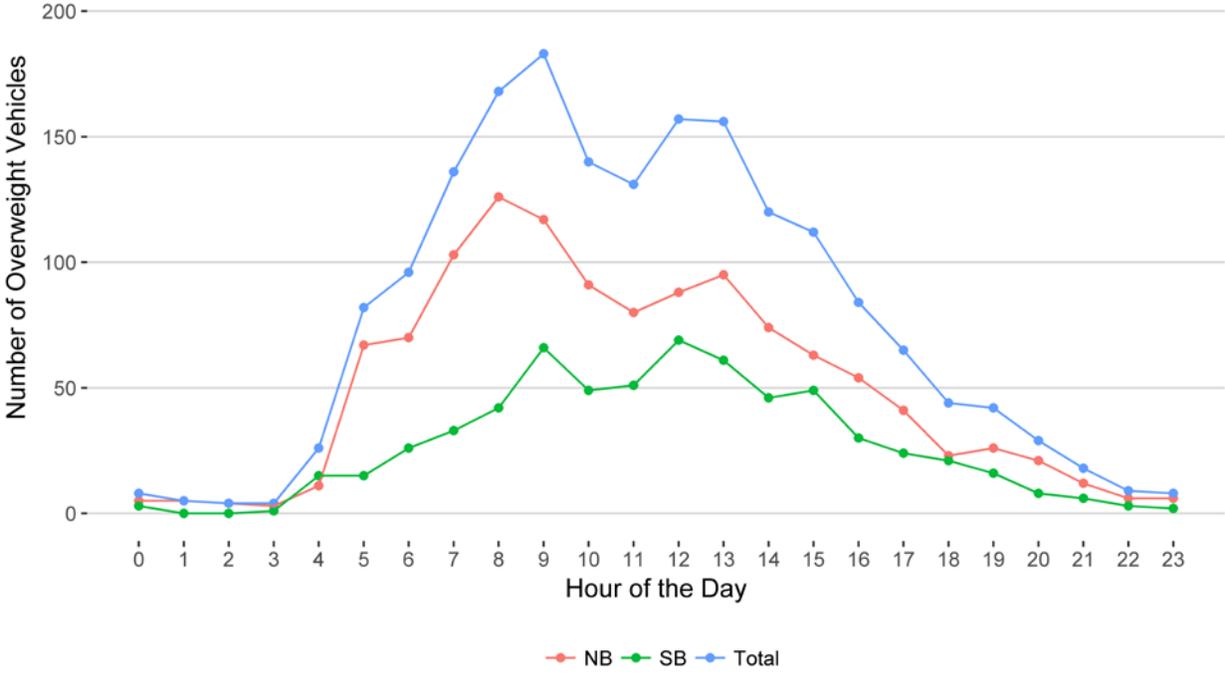
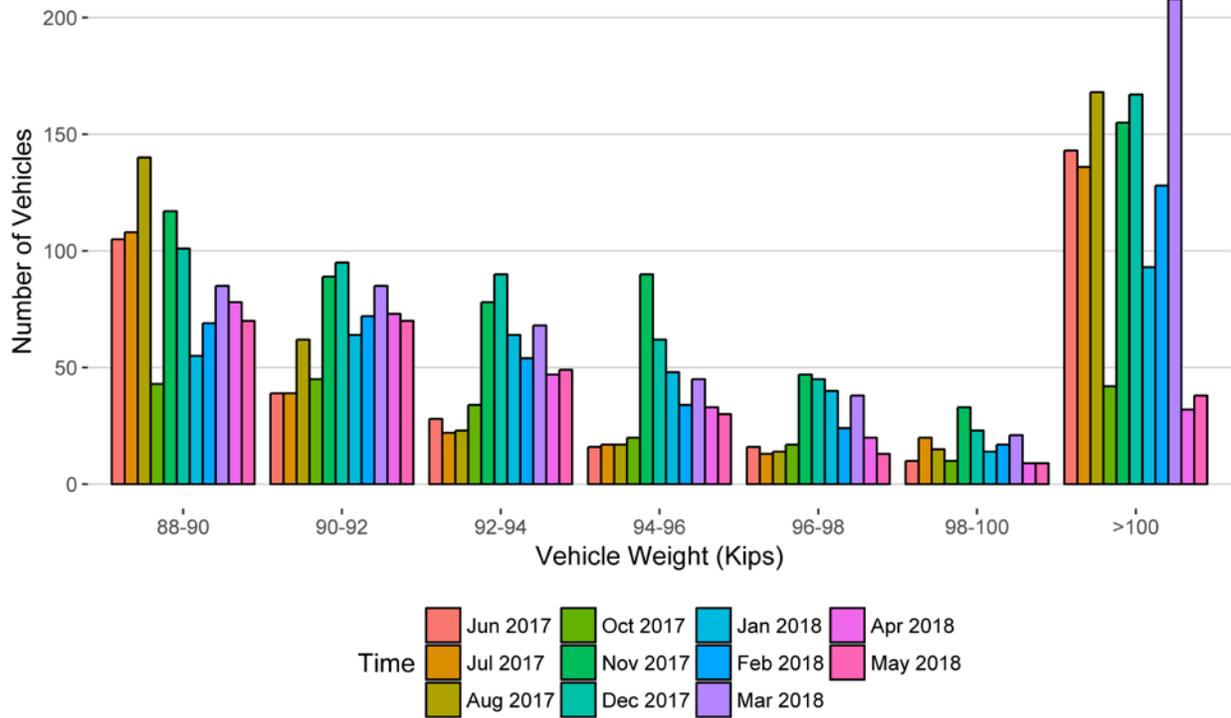
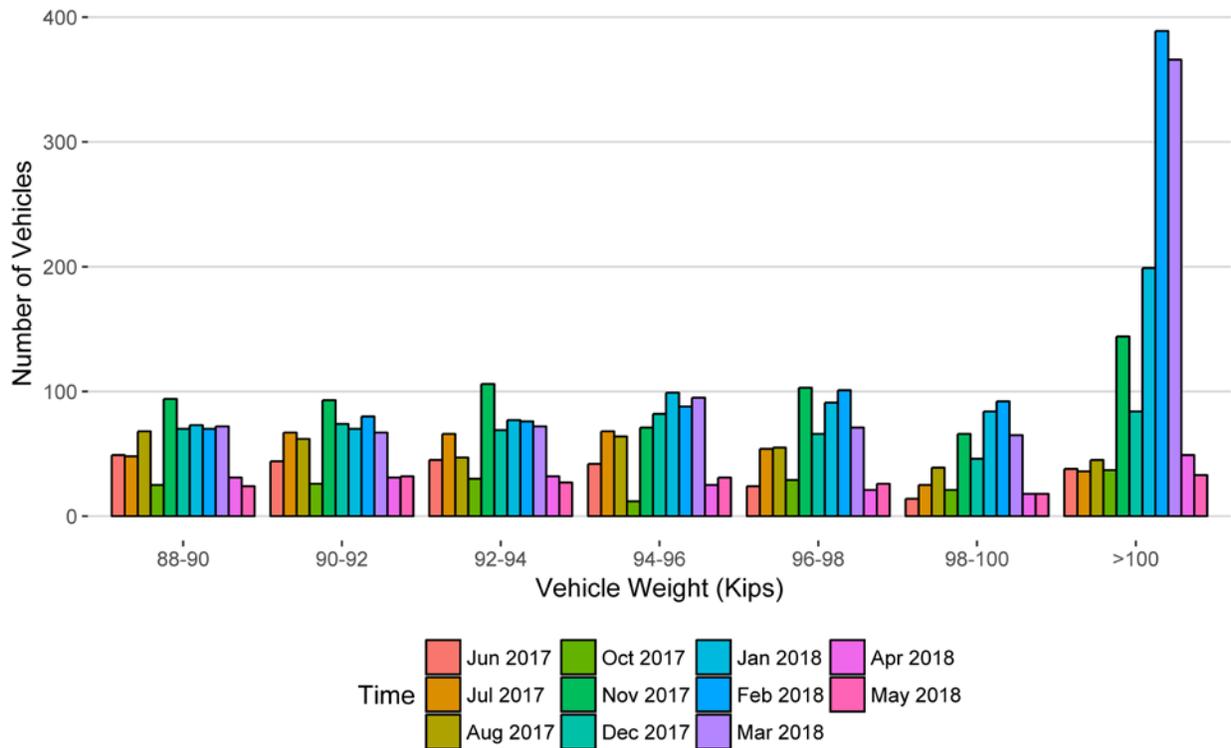


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Jun 2017	Jul 2017	Aug 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018
88-90	105	108	140	43	117	101	55	69	85	78	70
90-92	39	39	62	45	89	95	64	72	85	73	70
92-94	28	22	23	34	78	90	64	54	68	47	49
94-96	16	17	17	20	90	62	48	34	45	33	30
96-98	16	13	14	17	47	45	40	24	38	20	13
98-100	10	20	15	10	33	23	14	17	21	9	9
>100	143	136	168	42	155	167	93	128	208	32	38
Total	357	355	439	211	609	583	378	398	550	292	279

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



Vehicle Weights (Kips)	Jun 2017	Jul 2017	Aug 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018
88-90	49	48	68	25	94	70	73	70	72	31	24
90-92	44	67	62	26	93	74	70	80	67	31	32
92-94	45	66	47	30	106	69	77	76	72	32	27
94-96	42	68	64	12	71	82	99	88	95	25	31
96-98	24	54	55	29	103	66	91	101	71	21	26
98-100	14	25	39	21	66	46	84	92	65	18	18
>100	38	36	45	37	144	84	199	389	366	49	33
Total	256	364	380	180	677	491	693	896	808	207	191

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

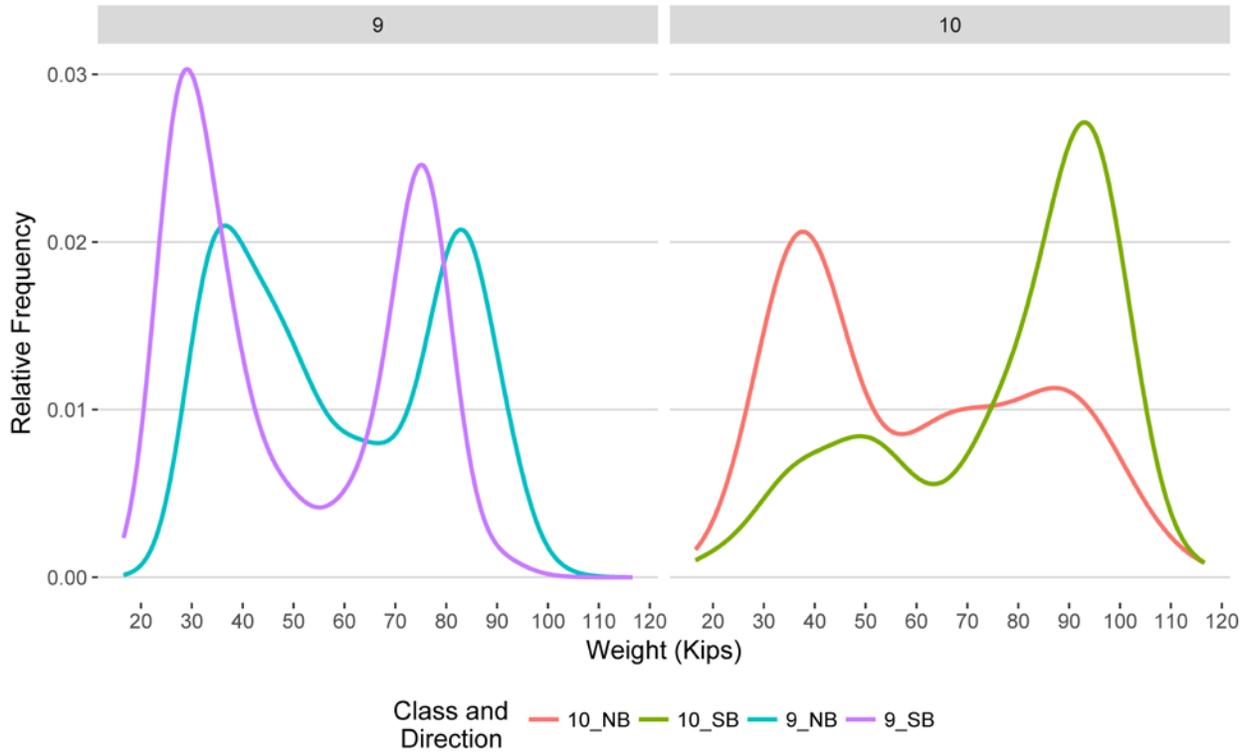


Figure 9 - Freight Percentage by Direction and Class

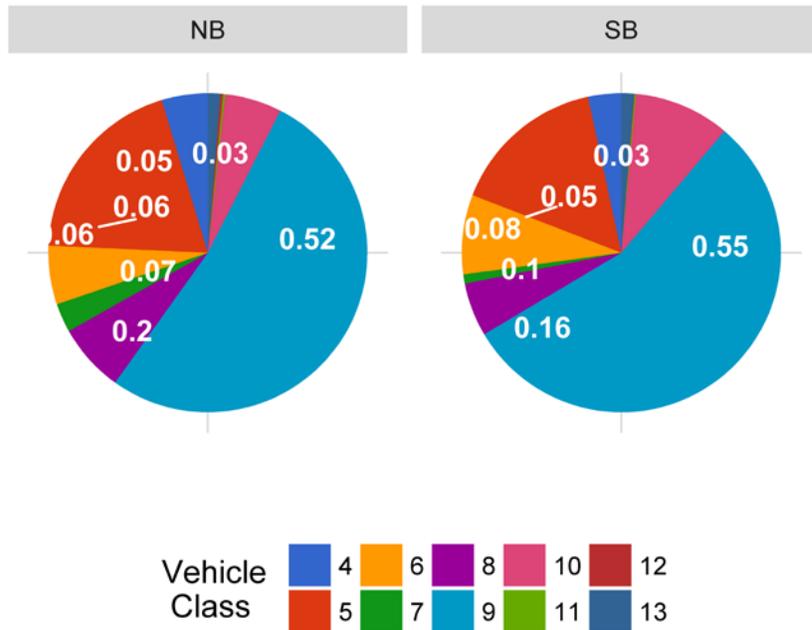


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

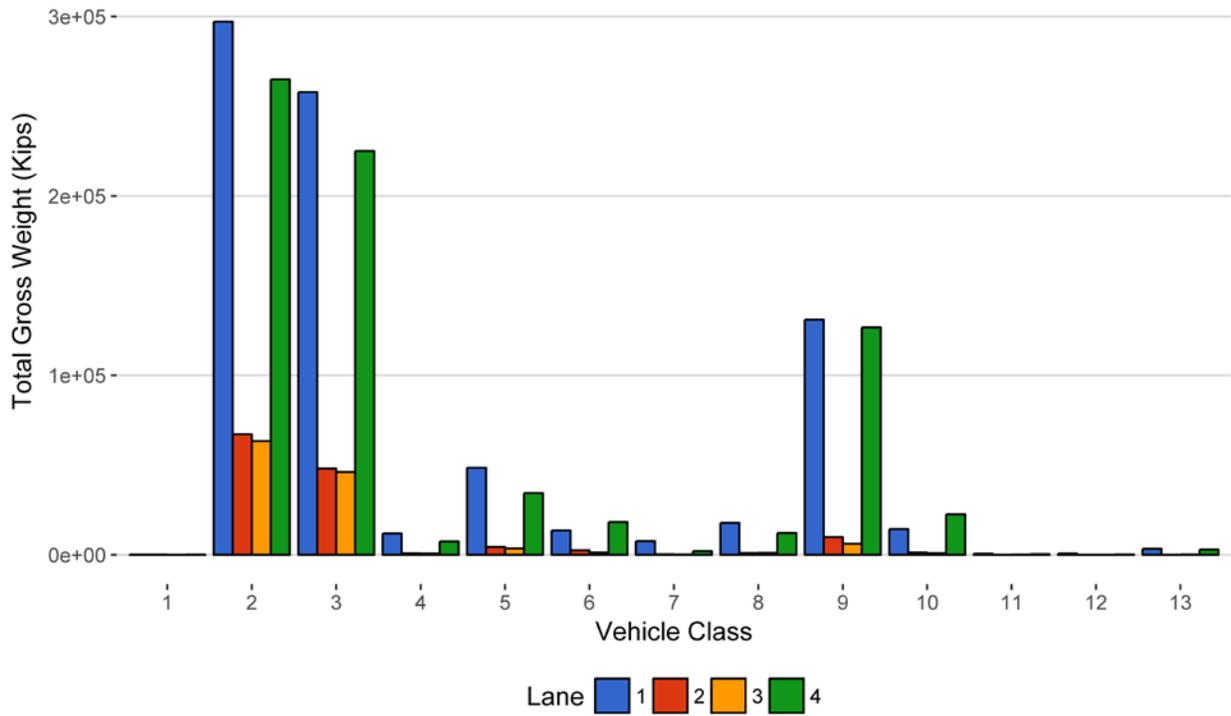


Figure 11 - Total Gross Vehicle Weight I

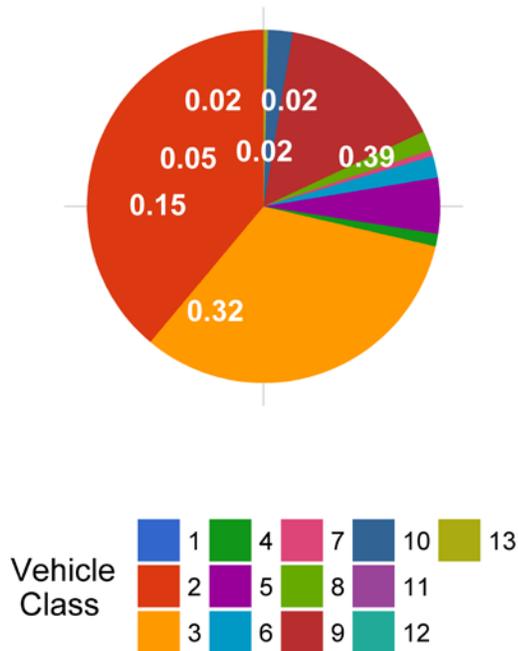


Figure 12 - Total ESALs by Class and Lane

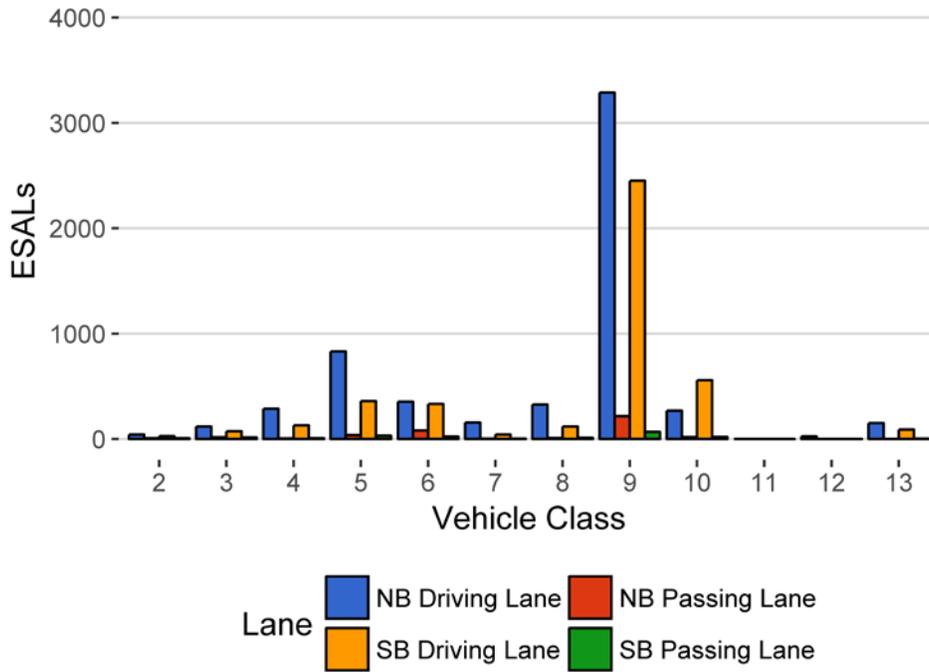


Figure 13 - ESALs by Class

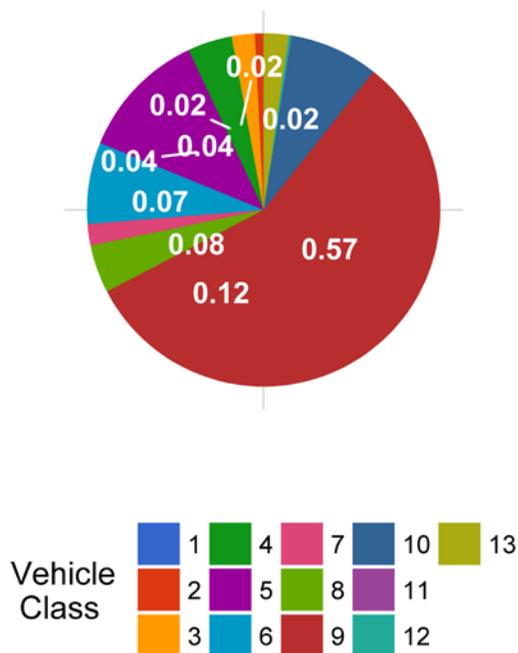


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>	<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

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	5	155	0.1	0	0
2	5543	171826	62.4	0	0
3	2852	88425	32.1	0	0
4	23	728	0.3	68	3.7
5	201	6233	2.3	137	7.5
6	34	1053	0.4	159	8.7
7	6	173	0.1	67	3.7
8	37	1156	0.4	51	2.8
9	162	5036	1.8	1027	56.4
10	18	567	0.2	259	14.2
11	1	46	0	0	0
12	0	13	0	6	0.3
13	2	61	0	48	2.6
TOTAL	8886	275473	100	1822	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>
2018-05-08	Tuesday	20:07:33	10	SB	4	116.63
2018-05-30	Wednesday	08:53:33	10	NB	1	115.54
2018-05-23	Wednesday	16:33:29	10	SB	4	114.53
2018-05-08	Tuesday	06:04:59	10	NB	1	110.69
2018-05-11	Friday	02:16:47	10	NB	1	108.14
2018-05-29	Tuesday	06:58:43	10	NB	1	106.51
2018-05-07	Monday	17:13:28	9	NB	1	106.14
2018-05-26	Saturday	09:05:58	10	NB	1	105.52
2018-05-15	Tuesday	09:09:53	9	NB	1	105.4
2018-05-30	Wednesday	07:03:57	10	SB	4	105.07

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	401	43	10.7	12005	568	3318
5	NB	8	3388	262	7.7	50880	1925	12936
6	NB	19	425	9	2.1	15877	158	3986
7	NB	11.5	128	0	0	7892	0	3210
8	NB	31	625	306	49	12943	5808	1527
9	NB	33	2363	232	9.8	133915	7043	31796
10	NB	33.5	260	34	13.1	14510	1026	3470
11	NB	36.5	28	28	100	0	580	0
12	NB	36.5	10	2	20	651	57	180
13	NB	31.5	29	0	0	3397	0	1242
TOTAL	****	****	7657	916	****	252071	****	61664
<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	323	105	32.5	6717	1339	1723
5	SB	8	2812	574	20.4	33859	4073	7978
6	SB	19	622	32	5.1	18820	556	3805
7	SB	11.5	44	0	0	2237	0	865
8	SB	31	525	409	77.9	4396	8662	400
9	SB	33	2646	920	34.8	107428	25476	25235
10	SB	33.5	304	14	4.6	23004	381	6644
11	SB	36.5	18	18	100	0	339	0
12	SB	36.5	3	2	66.7	49	70	6
13	SB	31.5	32	0	0	3067	0	1030
TOTAL	****	****	7329	2074	****	199577	****	47687
GRAND TOTAL	****	****	14986	2990	554	451648	58063	109351

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	72	31	24	68	195	0
2	297197	67129	63344	265018	692688	38.9
3	257934	48062	46185	225058	577238	32.4
4	11835	738	666	7390	20630	1.2
5	48477	4328	3568	34364	90738	5.1
6	13556	2479	1179	18198	35412	2
7	7610	282	183	2053	10129	0.6
8	17821	930	1003	12055	31809	1.8
9	131102	9856	6164	126740	273862	15.4
10	14329	1207	868	22517	38920	2.2
11	563	18	49	290	919	0.1
12	709	0	0	120	828	0
13	3397	0	147	2920	6465	0.4
TOTAL	804602	135059	123381	716791	1779833	100
GVW/LANE	45.21	7.59	6.93	40.27	100	0.01

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	0.0065
2	42	8	7	28	85	0.8	0.001
3	118	16	15	74	224	2.1	0.0051
4	288	7	9	129	432	4.07	1.2
5	831	36	32	361	1259	11.85	0.41
6	354	81	24	333	792	7.45	1.52
7	156	5	5	43	209	1.97	2.38
8	328	10	12	119	469	4.41	0.82
9	3288	216	68	2452	6023	56.67	2.41
10	269	18	20	558	865	8.14	3.05
11	1	0	0	0	1	0.01	0.23
12	25	0	0	1	26	0.25	2.58
13	150	0	4	89	243	2.29	6.78
TOTAL	5850	397	196	4185	10629	100	21
ESALS/LANE	55	3.7	1.8	39.4	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>
Jun 2017	303289	10110	767	280277	92.4	23012.5	7.6	76.9	23.1
Jul 2017	351544	11340	754	328181	93.4	23363.1	6.6	75.3	24.7
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
TOTAL	2611443	--	--	2441553	--	169890	--	--	--
AVERAGE	237404	8276	507	221959	94	15445	6	88	12

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>
Jun 2017	5791	1165	571	5331	12860	86	14	18.6
Jul 2017	5657	1255	367	5539	12818	87	13	20.6
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
TOTAL	60354	5992	3242	58804	128392	--	--	--
AVERAGE	5487	545	295	5346	11672	93	7	46

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>
Jun 2017	642847	77552	51867	631608	1403875
Jul 2017	612031	73787	60261	626261	1372339
Aug 2017	725128	97474	95556	725911	1644069
Oct 2017	624365	79369	76549	597736	1378018
Nov 2017	805267	135068	123381	716964	1780680
Dec 2017	668090	130691	158883	817641	1775306
Jan 2018	718725	157727	191477	889237	1957166
Feb 2018	735483	162845	184034	862884	1945246
Mar 2018	246018	34262	43177	241343	564799
Apr 2018	698717	96530	89621	663298	1548165
May 2018	675664	81599	69056	602852	1429172
TOTAL	7152334	1126903	1143863	7375735	16798835
AVERAGE	650212	102446	103988	670521	1527167

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>
Jun 2017	2304	0.9	11.6	613	205
Jul 2017	2347	0.8	11.7	723	221
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
TOTAL	23889	--	--	9608	3405
AVERAGE	2171.7	1	15.7	873.5	309.5

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>
Jun 2017	64202	60259	124461	51.6	48.4
Jul 2017	63358	60634	123992	51.1	48.9
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
TOTAL	609217	611227	1220444	--	--
AVERAGE	55383.4	55566.1	110949.4	50.2	49.8