

APRIL 2018



**WIM #48
CSAH 5,
MP 15.05
STORDEN, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #48 is located on CSAH 5 near Storden in Cottonwood county.

System Operation

WIM #48 was operational for the entire month of April 2018. Volume was computed using all monthly data.

System Calibration

WIM #48 was most recently calibrated on 2016-12-21. 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 lane 2 but not 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: 10062 | Passenger Vehicles: 8635 | Heavy Commercial Vehicles: 1427

Monthly Average Daily Traffic (MADT): 335 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 48

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 Tuesdays (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 07 AM 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 07 AM 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 1427 HCVs, 419 of them were overweight³. These overweight HCVs contributed to 4.4% of total monthly volume, and 31.3% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Saturdays. SB overweight vehicles tended to reach highest volumes on Tuesdays, with lowest volumes reported on Saturdays. See Figure 3 .

The top two overweight violators by class were the class 9 and class 13 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 62.3% of all overweight vehicles traveling SB 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 April.

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 ,105 NB vehicles exceeded 88,000 pounds (69 vehicles were Class 9's; 28 vehicles were Class 13's). Of vehicles traveling SB,

144 NB vehicles exceeded 88,000 pounds (93 vehicles were Class 9's; 28 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from April 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in April 2018. Data suggests that there were greater numbers of empty Class 9's than fully_loaded Class 9's traveling NB, while there were more empty Class 9's than fully_loaded 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 15130 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (58.6%) than NB (41.4%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 97506 (a precast box culvert) is approximately 1.3 miles north of WIM #48. Bridge No. 97666 (a precast box culvert) is approximately .45 miles south of WIM #48. WIM #48 recorded a total of 10062 vehicles with a combined GVW of 111139 kips (1 kip = 1,000 pounds = 0.5 tons) in April 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 1747 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 58.6% of all ESALs were recorded SB while 41.4% was observed NB. In particular, 72% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 39% 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).

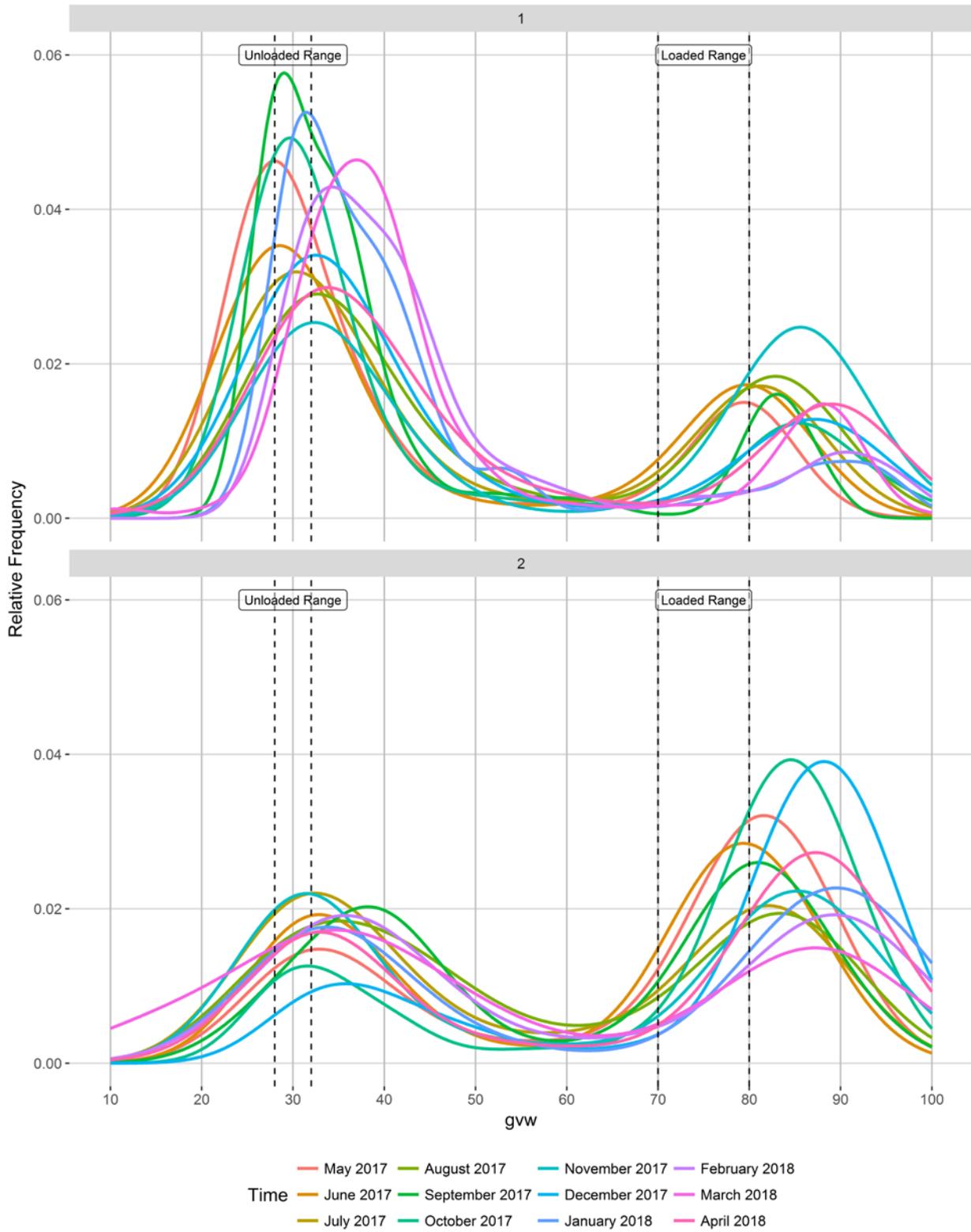
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

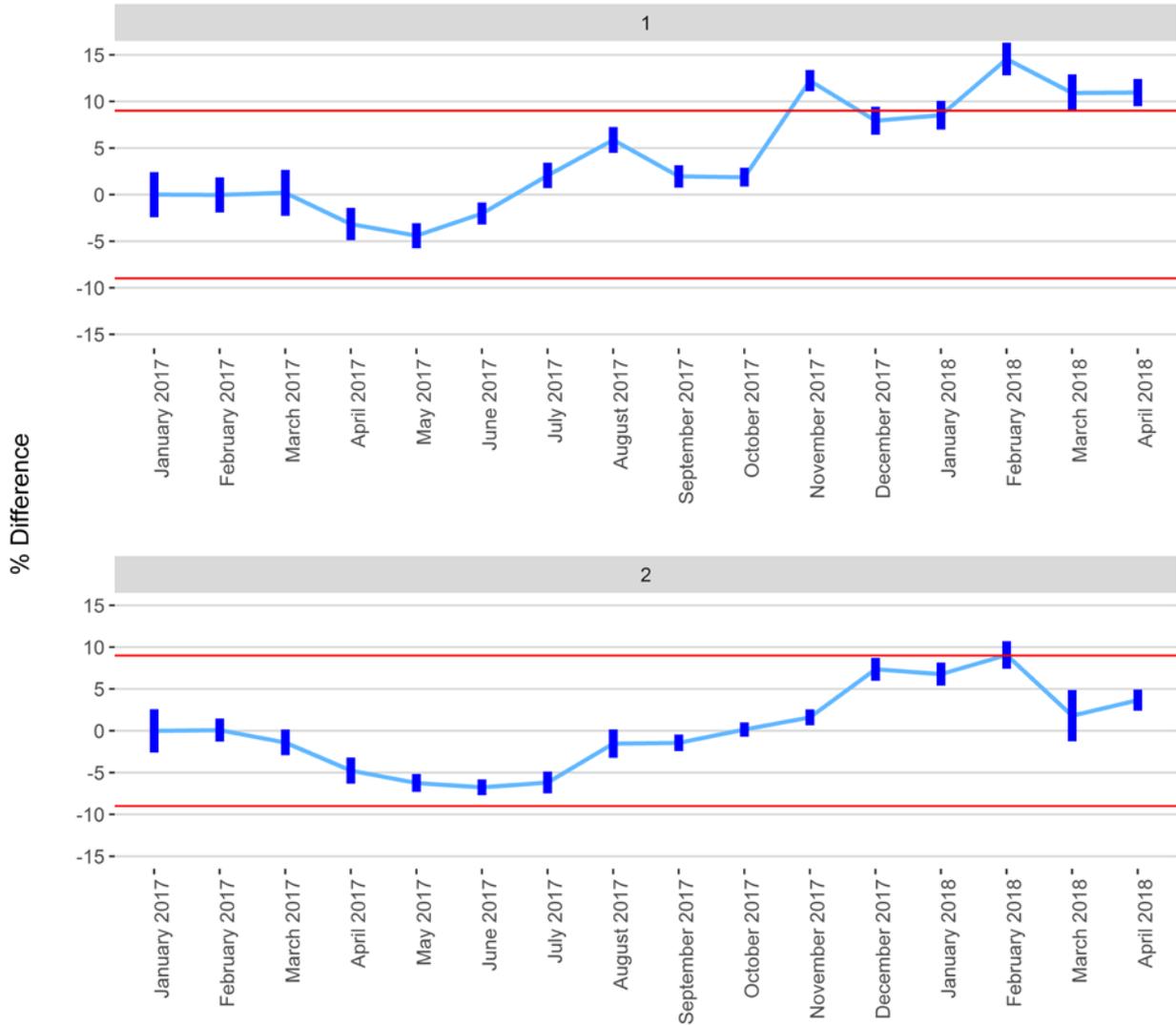
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

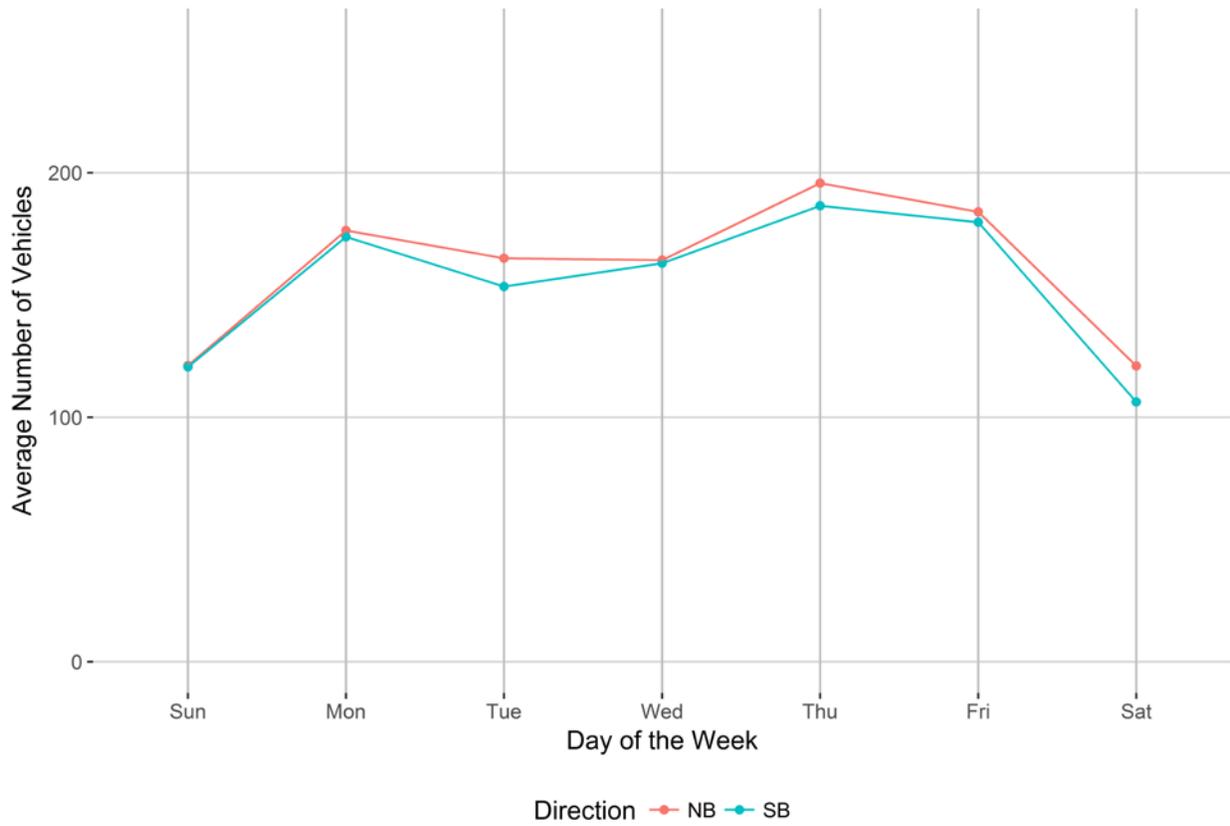


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

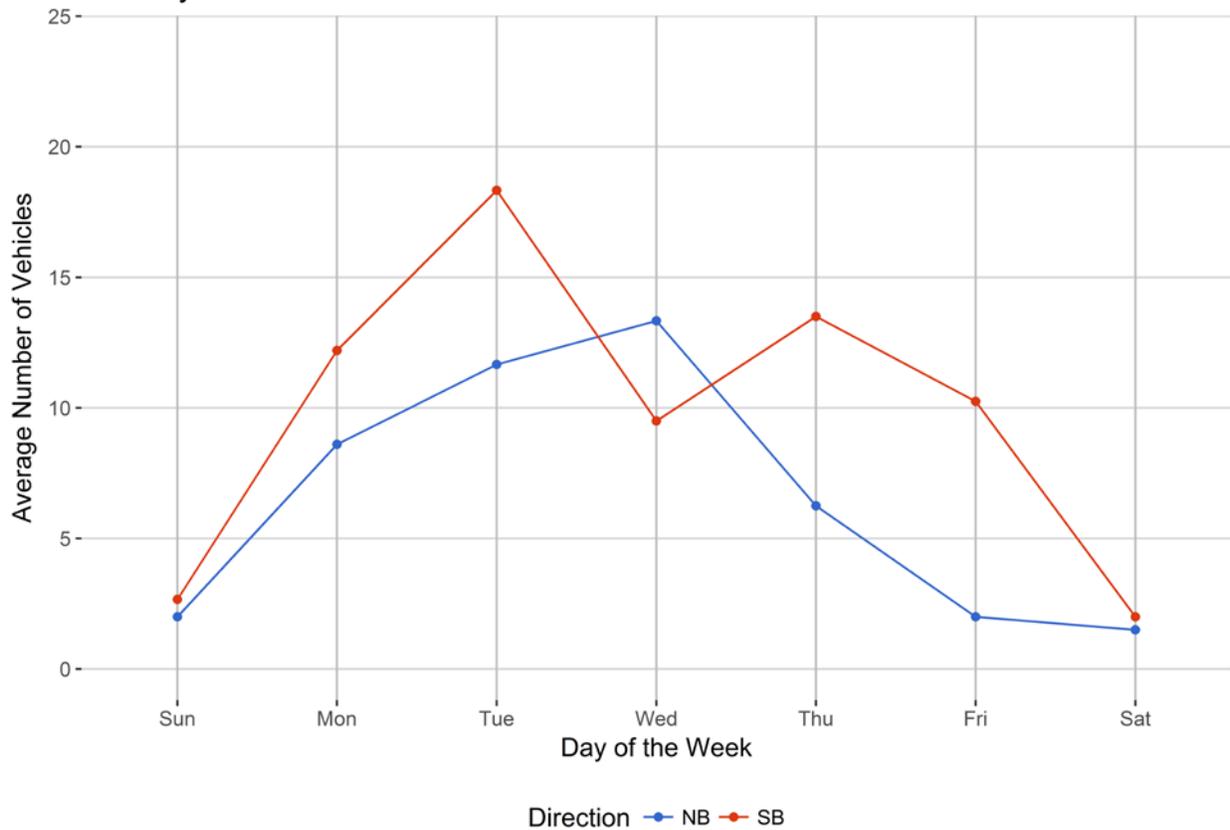


Figure 4 - Passenger Vehicles vs. Hour of the Day

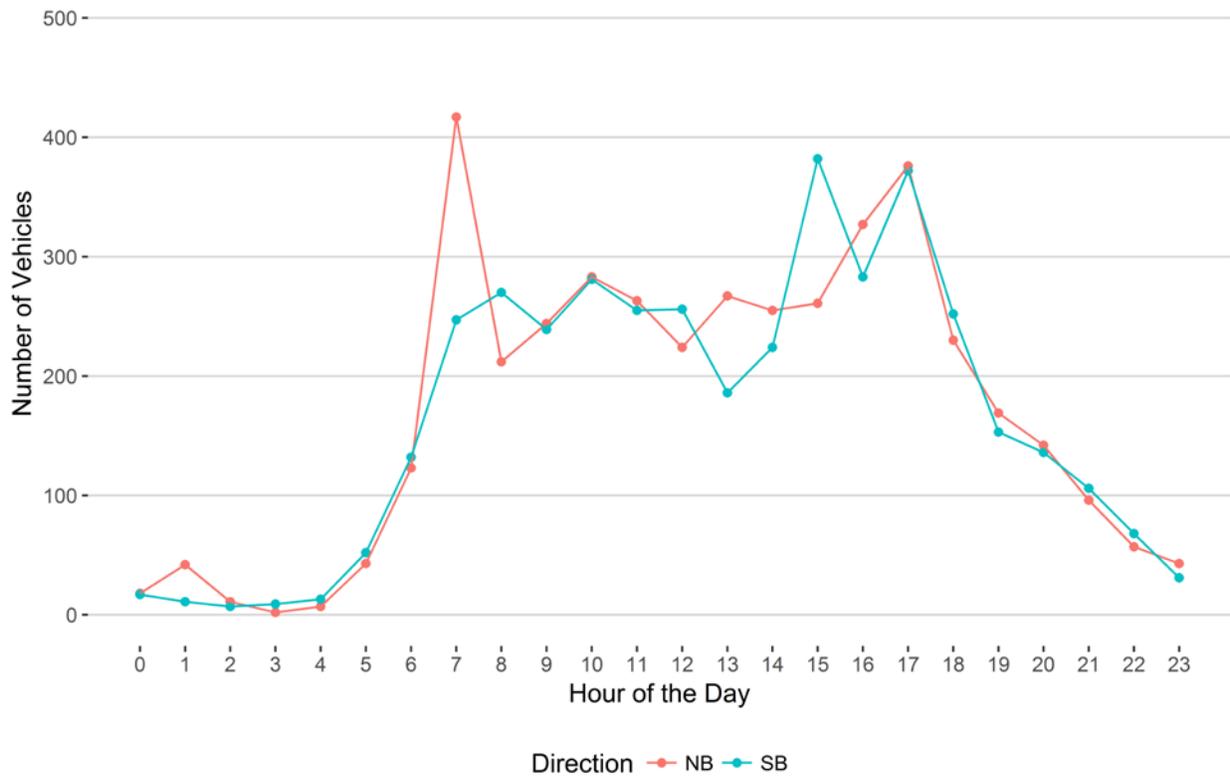


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

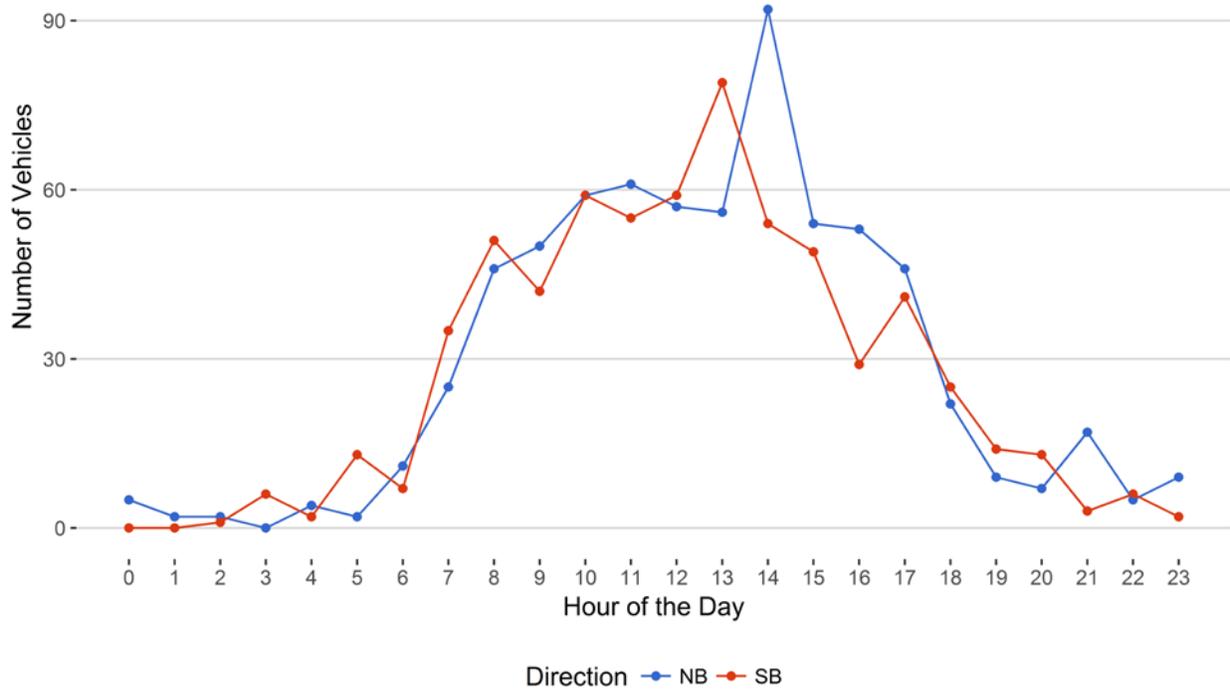


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

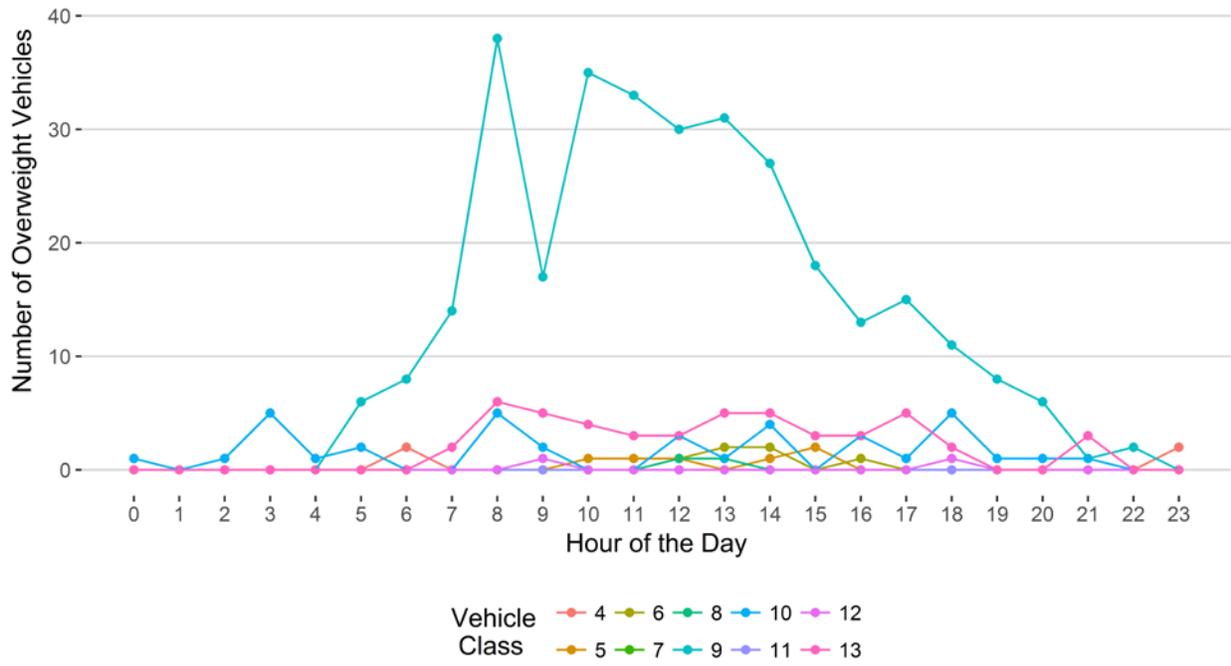


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

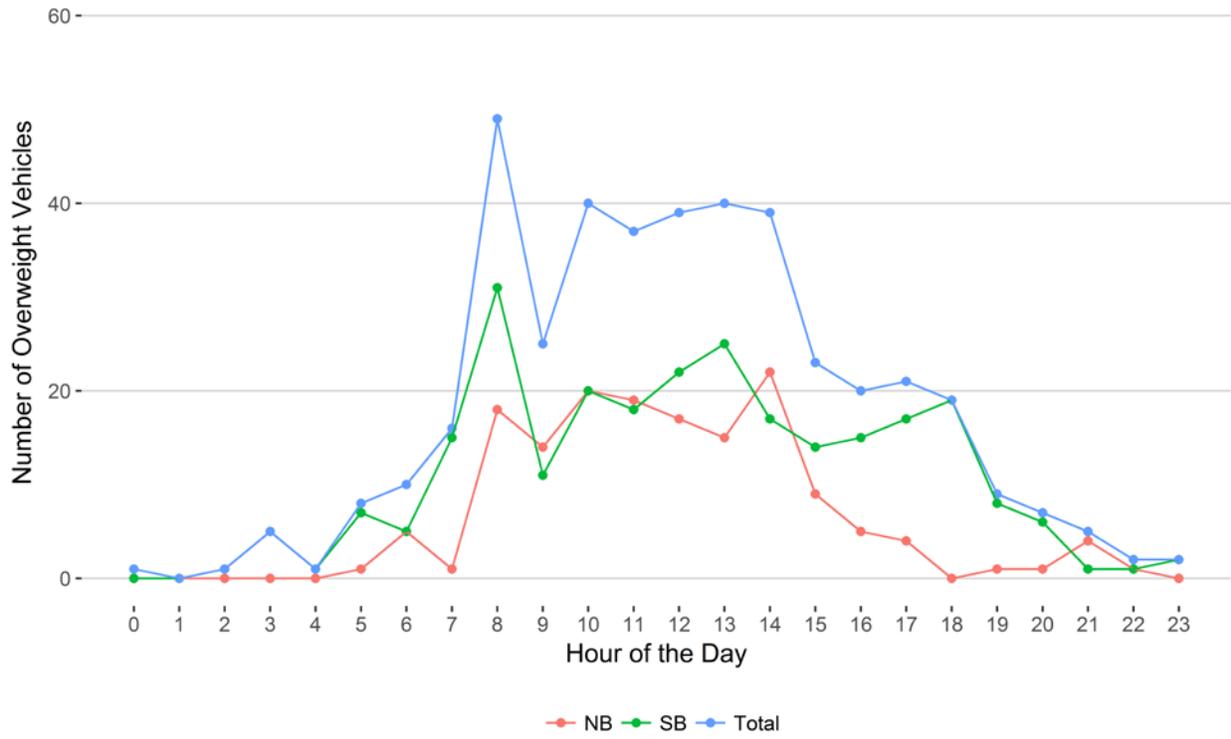
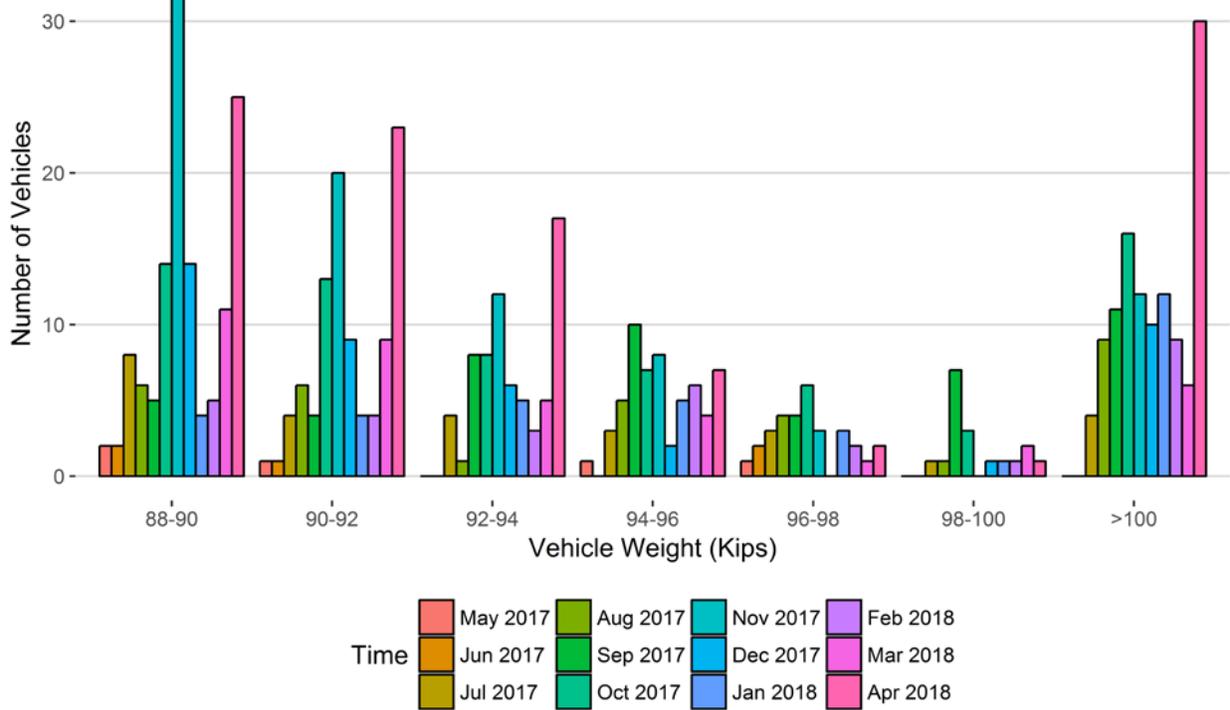
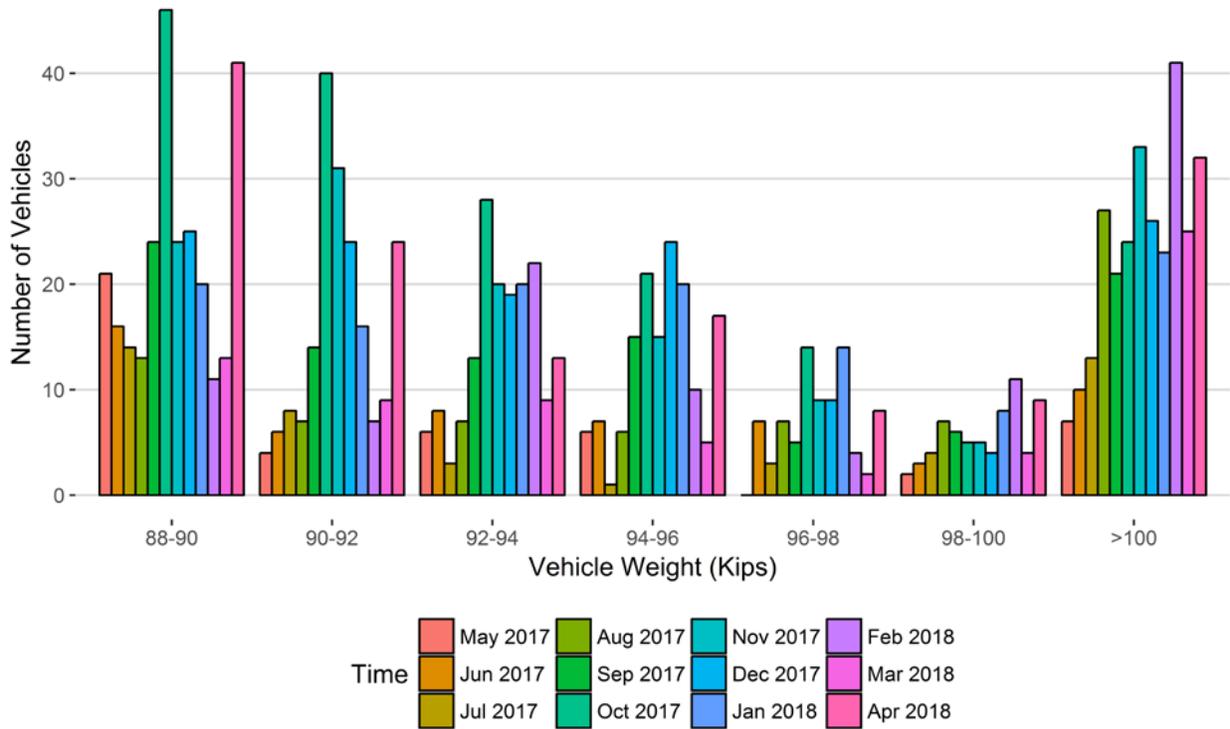


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018
88-90	2	2	8	6	5	14	32	14	4	5	11	25
90-92	1	1	4	6	4	13	20	9	4	4	9	23
92-94	0	0	4	1	8	8	12	6	5	3	5	17
94-96	1	0	3	5	10	7	8	2	5	6	4	7
96-98	1	2	3	4	4	6	3	0	3	2	1	2
98-100	0	0	1	1	7	3	0	1	1	1	2	1
>100	0	0	4	9	11	16	12	10	12	9	6	30
Total	5	5	27	32	49	67	87	42	34	30	38	105

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



Vehicle Weights (Kips)	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018
88-90	21	16	14	13	24	46	24	25	20	11	13	41
90-92	4	6	8	7	14	40	31	24	16	7	9	24
92-94	6	8	3	7	13	28	20	19	20	22	9	13
94-96	6	7	1	6	15	21	15	24	20	10	5	17
96-98	0	7	3	7	5	14	9	9	14	4	2	8
98-100	2	3	4	7	6	5	5	4	8	11	4	9
>100	7	10	13	27	21	24	33	26	23	41	25	32
Total	46	57	46	74	98	178	137	131	121	106	67	144

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

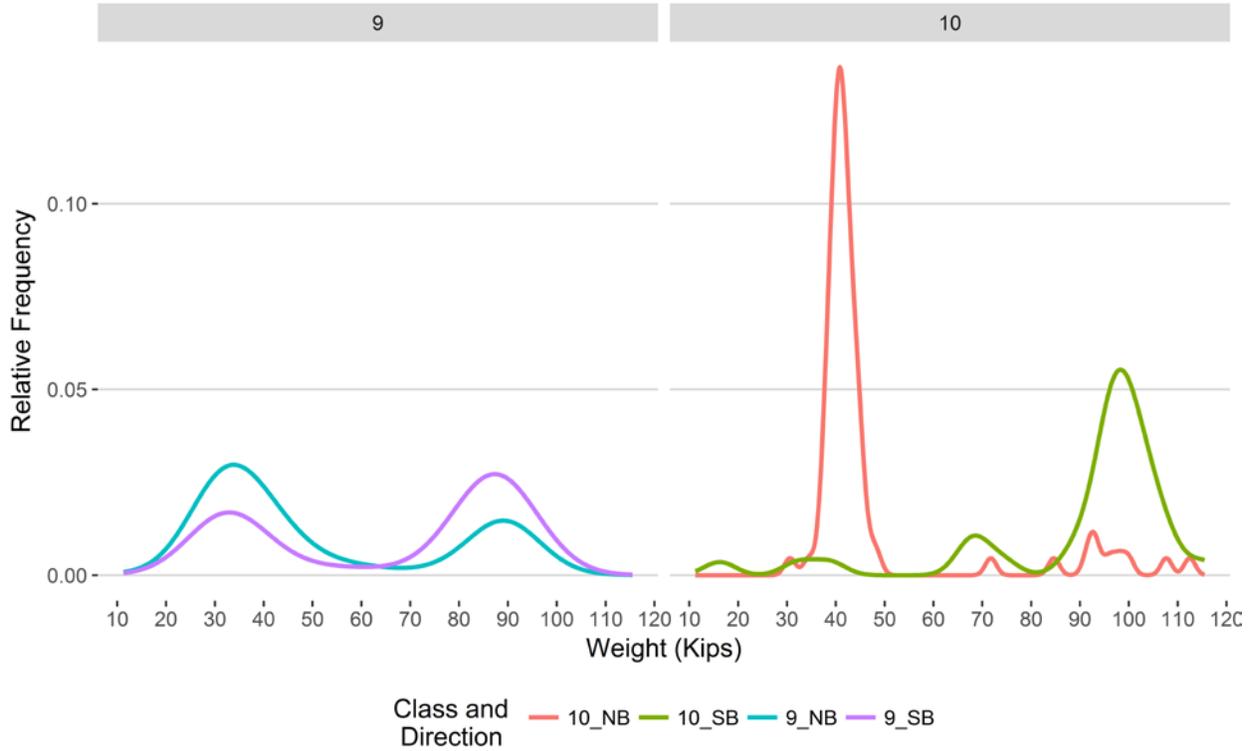


Figure 9 - Freight Percentage by Direction and Class

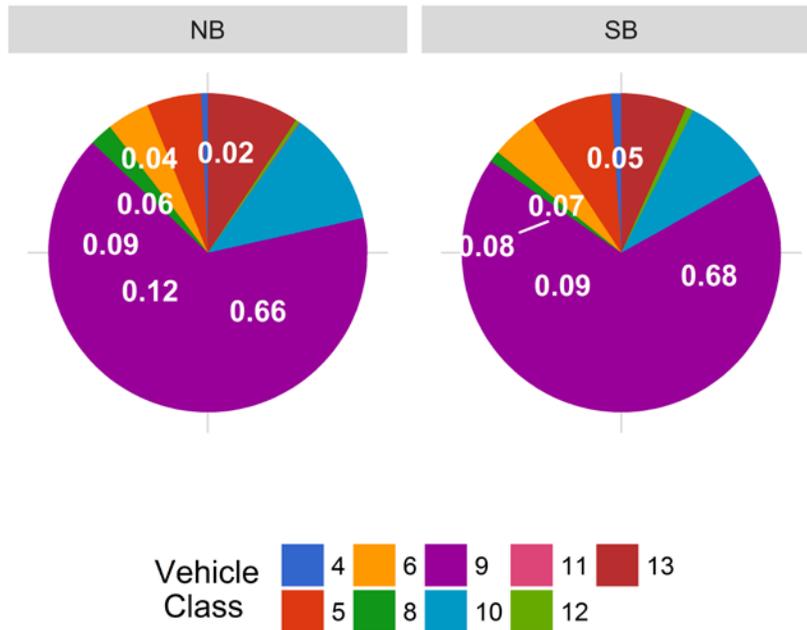


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

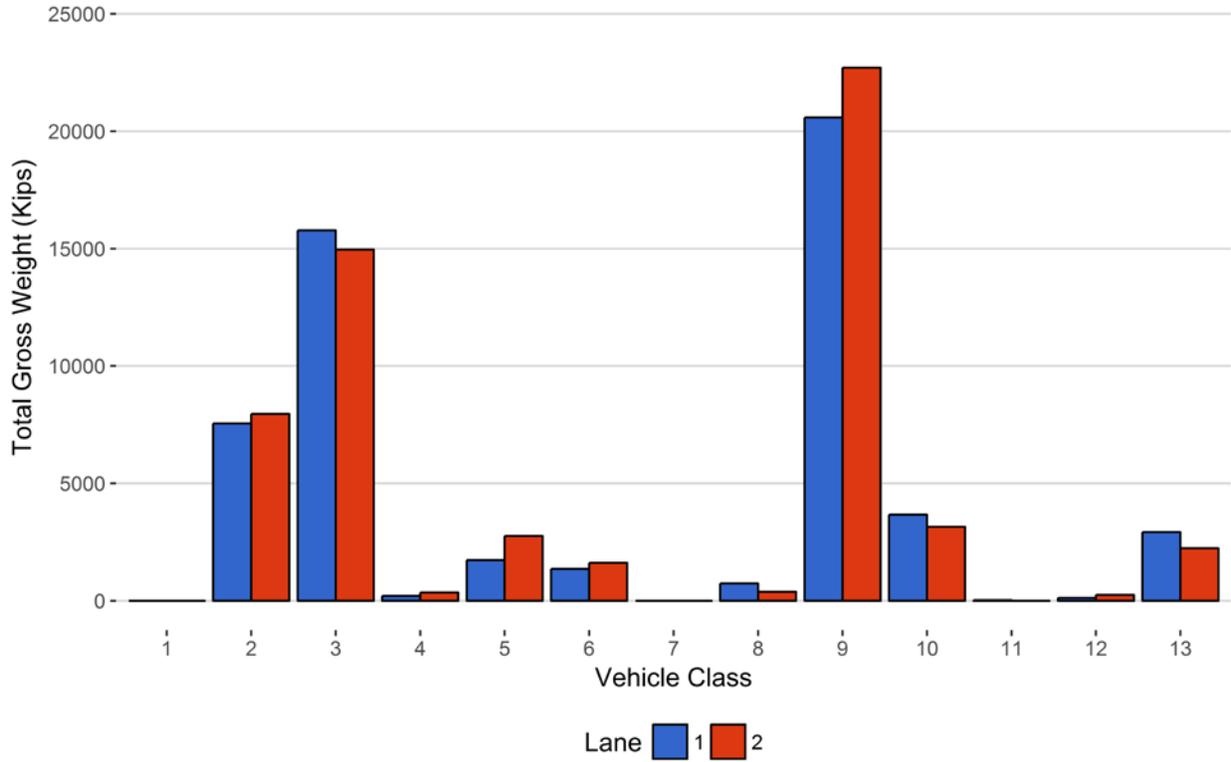


Figure 11 - Total Gross Vehicle Weight I

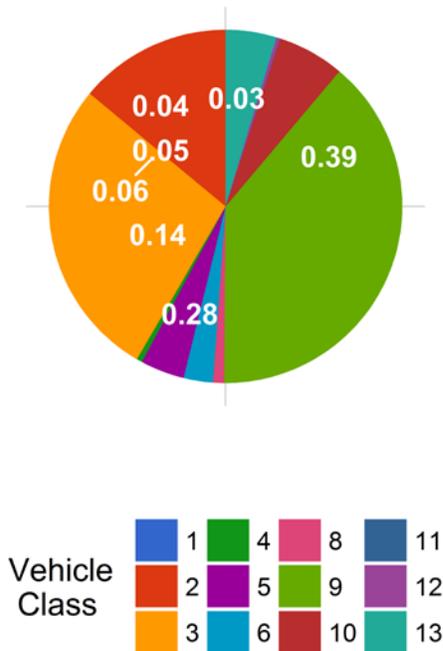


Figure 12 - Total ESALs by Class and Lane

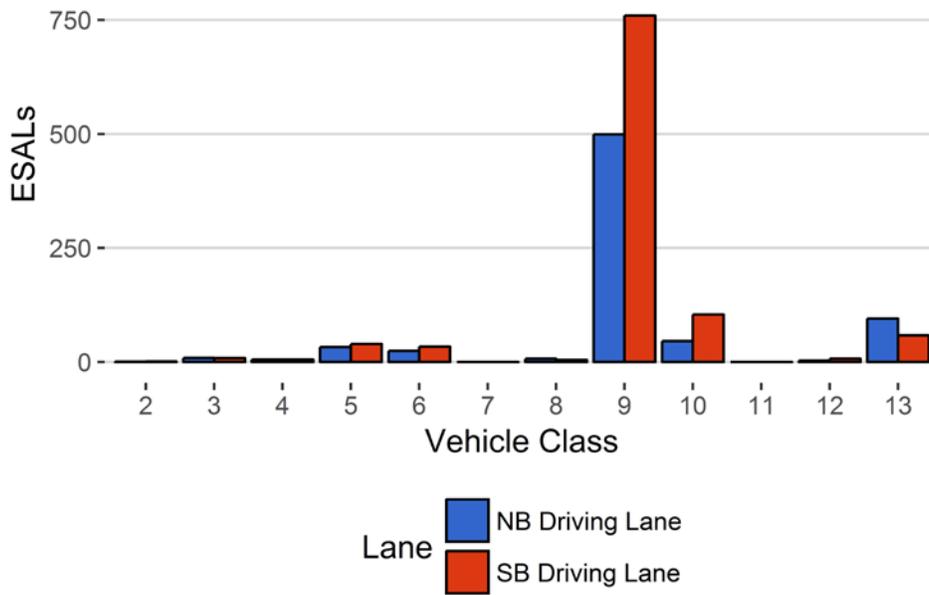


Figure 13 - ESALs by Class

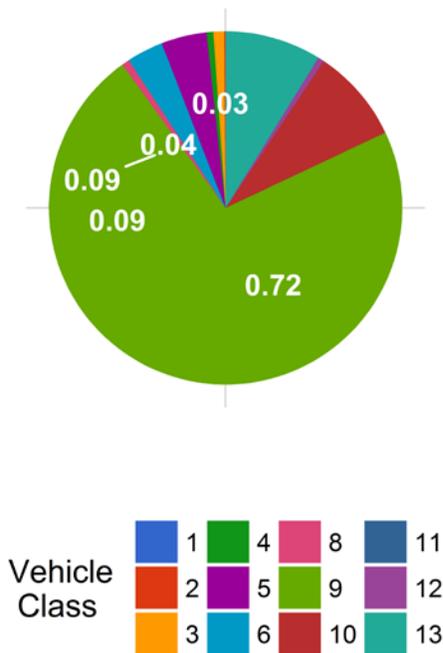


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
January 2017	10.45	0.00	11.43	0.00
February 2017	10.44	-0.03	11.44	0.08
March 2017	10.47	0.20	11.27	-1.40
April 2017	10.12	-3.16	10.89	-4.76
May 2017	9.99	-4.40	10.72	-6.24
June 2017	10.24	-2.03	10.66	-6.76
July 2017	10.66	2.06	10.73	-6.18
August 2017	11.06	5.87	11.26	-1.53
September 2017	10.65	1.96	11.27	-1.44
October 2017	10.64	1.87	11.45	0.15
November 2017	11.73	12.23	11.62	1.61
December 2017	11.28	7.94	12.28	7.36
January 2018	11.34	8.53	12.21	6.78
February 2018	11.97	14.56	12.47	9.06
March 2018	11.59	10.91	11.64	1.80
April 2018	11.59	10.95	11.85	3.66

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	127	3818	37.9	0	0
3	160	4813	47.8	0	0
4	1	20	0.2	4	1
5	10	308	3.1	6	1.4
6	3	96	1	6	1.4
7	0	0	0	0	0
8	1	35	0.3	2	0.5
9	26	790	7.9	313	74.7
10	4	118	1.2	37	8.8
11	0	1	0	0	0
12	0	6	0.1	2	0.5
13	2	52	0.5	49	11.7
TOTAL	335	10062	100	419	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>
2018-04-08	Sunday	16:17:44	10	SB	2	116.1
2018-04-25	Wednesday	08:18:41	10	SB	2	115.53
2018-04-02	Monday	14:29:26	10	NB	1	112.46
2018-04-09	Monday	19:17:00	10	SB	2	108.74
2018-04-17	Tuesday	12:47:42	10	NB	1	107.67
2018-04-12	Thursday	16:15:45	10	SB	2	106.96
2018-04-12	Thursday	19:14:16	9	NB	1	105.83
2018-04-01	Sunday	18:59:48	10	SB	2	105.71
2018-04-13	Friday	08:15:22	10	SB	2	104.04
2018-04-18	Wednesday	10:58:28	10	NB	1	103.75

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	6	0	0	211	0	60
5	NB	8	113	4	3.5	1700	30	414
6	NB	19	45	5	11.1	1274	83	257
8	NB	31	22	3	13.6	677	64	44
9	NB	33	400	121	30.2	16984	3601	3889
10	NB	33.5	76	1	1.3	3632	31	560
11	NB	36.5	1	1	100	0	25	0
12	NB	36.5	3	2	66.7	79	46	21
13	NB	31.5	28	0	0	2928	0	1023
TOTAL	****	****	694	137	****	27484	****	6268
<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	13	2	15.4	328	23	82
5	SB	8	176	9	5.1	2691	67	677
6	SB	19	45	4	8.9	1546	72	384
8	SB	31	11	3	27.3	315	70	34
9	SB	33	341	67	19.6	20700	2011	5829
10	SB	33.5	35	2	5.7	3101	49	998
12	SB	36.5	3	0	0	253	0	72
13	SB	31.5	21	0	0	2238	0	788
TOTAL	****	****	645	87	****	31172	****	8863
GRAND TOTAL	****	****	1339	224	308	58656	6173	15130

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>
1	2	1	3	0
2	7551	7958	15509	14
3	15780	14955	30735	27.7
4	211	352	562	0.5
5	1731	2758	4488	4
6	1357	1618	2975	2.7
8	741	385	1127	1
9	20585	22711	43296	39
10	3663	3150	6812	6.1
11	25	0	25	0
12	125	253	378	0.3
13	2928	2238	5165	4.7
TOTAL	54698	56378	111076	100
GVW/LANE	49.24	50.76	100	0.09

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.25
2	1	1	2	0.1	0.0018
3	9	8	17	1	0.0085
4	5	6	11	0.6	1.15
5	33	40	73	4.2	0.53
6	25	34	58	3.3	1.31
8	7	5	12	0.7	0.81
9	499	759	1258	72.1	3.46
10	46	104	150	8.6	2.64
11	0	0	0	0	0.93
12	3	7	10	0.6	1.81
13	95	58	154	8.8	5.31
TOTAL	723	1022	1746	100	18
ESALS/LANE	41.4	58.5	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>
May 2017	13129	424	50	11582	88.2	1547	11.8
Jun 2017	12884	430	62	11025	85.6	1858.7	14.4
Jul 2017	12346	398	50	10803	87.5	1543.1	12.5
Aug 2017	11998	387	44	10631	88.6	1366.8	11.4
Sep 2017	12700	423	55	11064	87.1	1636.5	12.9
Oct 2017	13498	435	74	11202	83	2295.5	17
Nov 2017	12370	412	64	10464	84.6	1905.8	15.4
Dec 2017	10135	327	36	9031	89.1	1103.7	10.9
Jan 2018	9405	303	40	8154	86.7	1251.5	13.3
Feb 2018	8430	301	37	7386	87.6	1043.9	12.4
Mar 2018	9969	322	35	8878	89.1	1091.2	10.9
Apr 2018	10062	335	48	8635	85.8	1427.4	14.2
TOTAL	136926	--	--	118855	--	18071	--
AVERAGE	11410	375	50	9905	87	1506	13

ESALS

<i>Month</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
May 2017	489	879	1369	15.4
Jun 2017	682	1058	1740	14.6
Jul 2017	645	705	1350	16.2
Aug 2017	581	743	1325	23.9
Sep 2017	553	1065	1618	32.6
Oct 2017	948	2092	3040	31.3
Nov 2017	1287	1355	2642	43.3
Dec 2017	457	962	1419	65.7
Jan 2018	425	909	1334	73.5
Feb 2018	346	747	1093	68.9
Mar 2018	402	520	922	56.5
Apr 2018	724	1023	1747	55.4
TOTAL	7539	--	--	--
AVERAGE	628	1005	1633	41

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
May 2017	41930	48655	90585
Jun 2017	37098	43044	80142
Jul 2017	43050	42310	85360
Aug 2017	54740	56400	111139
Sep 2017	56104	62800	118905
Oct 2017	64178	69477	133655
Nov 2017	57644	58281	115925
Dec 2017	54657	54121	108778
Jan 2018	57117	68759	125876
Feb 2018	68560	88970	157531
Mar 2018	71826	70084	141910
Apr 2018	42975	50948	93923
TOTAL	649879	713849	1363728
AVERAGE	54157	59487	113644

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>
May 2017	362	2.9	24.4	51	9
Jun 2017	433	3.6	24.4	62	13
Jul 2017	342	2.9	23	73	22
Aug 2017	355	3.1	26.8	106	44
Sep 2017	430	3.6	27.3	147	45
Oct 2017	756	6.1	35.3	245	48
Nov 2017	669	5.8	37.4	224	50
Dec 2017	324	3.4	31.4	173	41
Jan 2018	281	3.2	24.1	155	44
Feb 2018	225	2.9	23.1	136	62
Mar 2018	202	2.2	19.6	105	37
Apr 2018	419	4.4	31.2	249	72
TOTAL	4798	--	--	1726	487
AVERAGE	399.8	3.7	27.3	143.8	40.6

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>
May 2017	5141	8302	13443	38.2	61.8
Jun 2017	7334	10263	17597	41.7	58.3
Jul 2017	6266	7022	13288	47.2	52.8
Aug 2017	5751	6892	12643	45.5	54.5
Sep 2017	5415	10372	15787	34.3	65.7
Oct 2017	7488	16992	24481	30.6	69.4
Nov 2017	10635	10985	21620	49.2	50.8
Dec 2017	3645	7789	11434	31.9	68.1
Jan 2018	3514	7144	10657	33	67
Feb 2018	3205	6254	9460	33.9	66.1
Mar 2018	3533	4672	8204	43.1	56.9
Apr 2018	6268	8863	15130	41.4	58.6
TOTAL	68194	105551	173744	--	--
AVERAGE	5682.8	8795.9	14478.7	39.2	60.8