APRIL 2018

WIM #59/61
I-90,
MP 276.8
DRESBACH,
MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #59 is located on I-90 near Dresbach in Winona county.

System Operation

WIM #59 was operational for the entire month of April 2018. Volume was computed using all monthly data.

System Calibration

WIM #59 was most recently calibrated on 2016-12-20. 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: 637163 | Passenger Vehicles: 539170 | Heavy Commercial Vehicles: 97993

Monthly Average Daily Traffic (MADT): 21239 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 3266

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 Fridays, with lowest volumes reported on Tuesdays. WB 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), EB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, WB PVs peaked in volume between 03 PM and 05 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 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 97993 HCVs, 19588 of them were overweight [3]. These overweight HCVs contributed to 3.2% of total monthly volume, and 20.4% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Saturdays. WB overweight vehicles tended to reach highest volumes on Thursdays, with lowest volumes reported on Sundays. See Figure 3 . The top two overweight violators by class were the class 9 and class 11 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 74.4% of all overweight vehicles traveling WB 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 report [4].
Using normal load limits ,964 EB vehicles exceeded 88,000 pounds (900 vehicles were Class 9's; 34 vehicles were Class 10's). Of vehicles traveling WB,

3346 EB vehicles exceeded 88,000 pounds (3219 vehicles were Class 9's; 52 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 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 fully_loaded class 10 vehicles.

Freight Totals. A total of 1144265 tons of freight was recorded to have crossed the WIM. More freight was shipped WB (56.9%) than EB (43.1%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 85802 and 85801 (Prestressed Beam Span) are approximately .02 miles east of WIM #59. Bridge No. 85849 and 85850 (Continuous Steel Beam Span) are appoximately .3 miles west of WIM #59. WIM #59 recorded a total of 637163 vehicles with a combined GVW of 7553332 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 112047 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 61.8% of all ESALs were recorded WB while 38.2% was observed EB. In particular, 88% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 59% 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

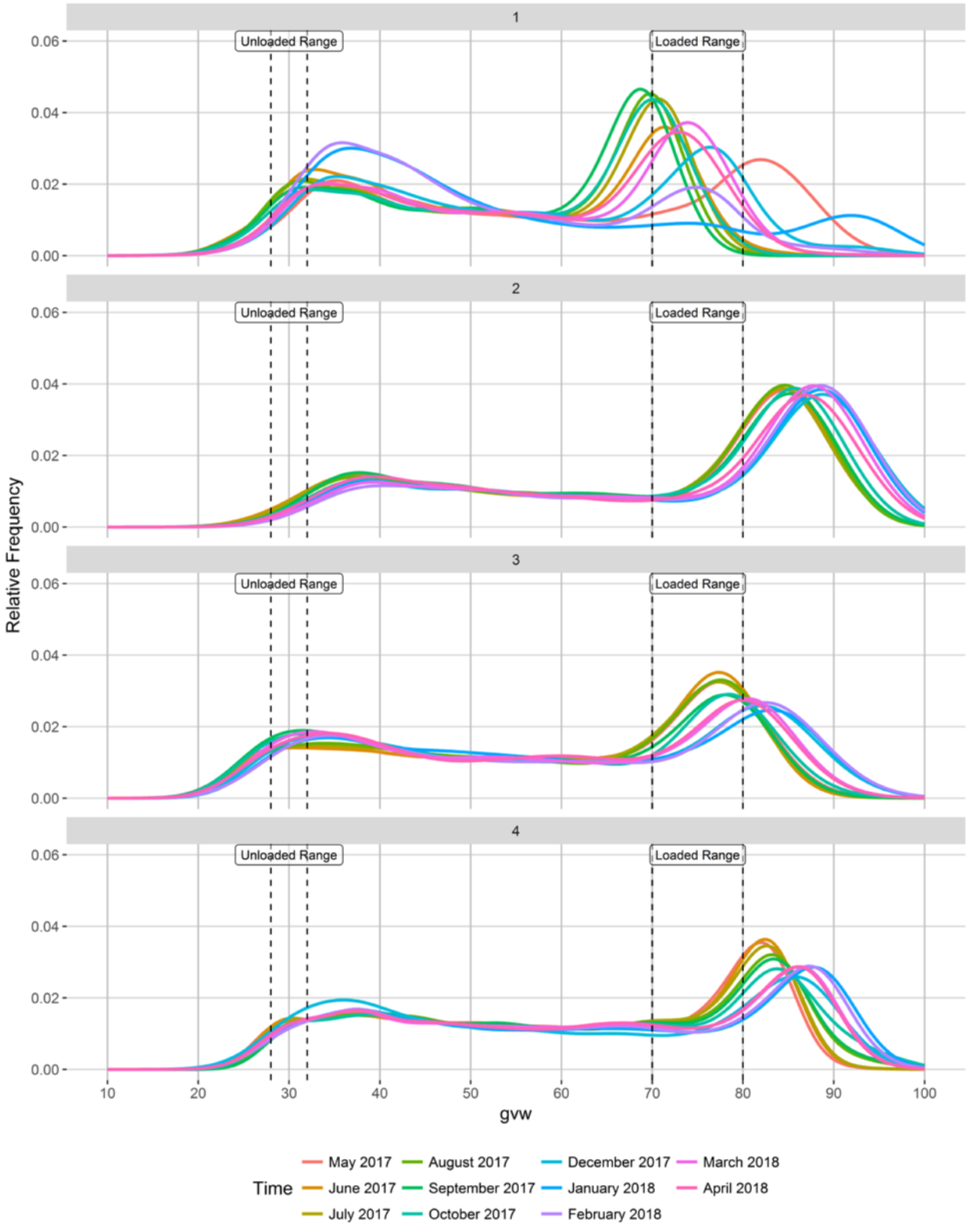
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [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

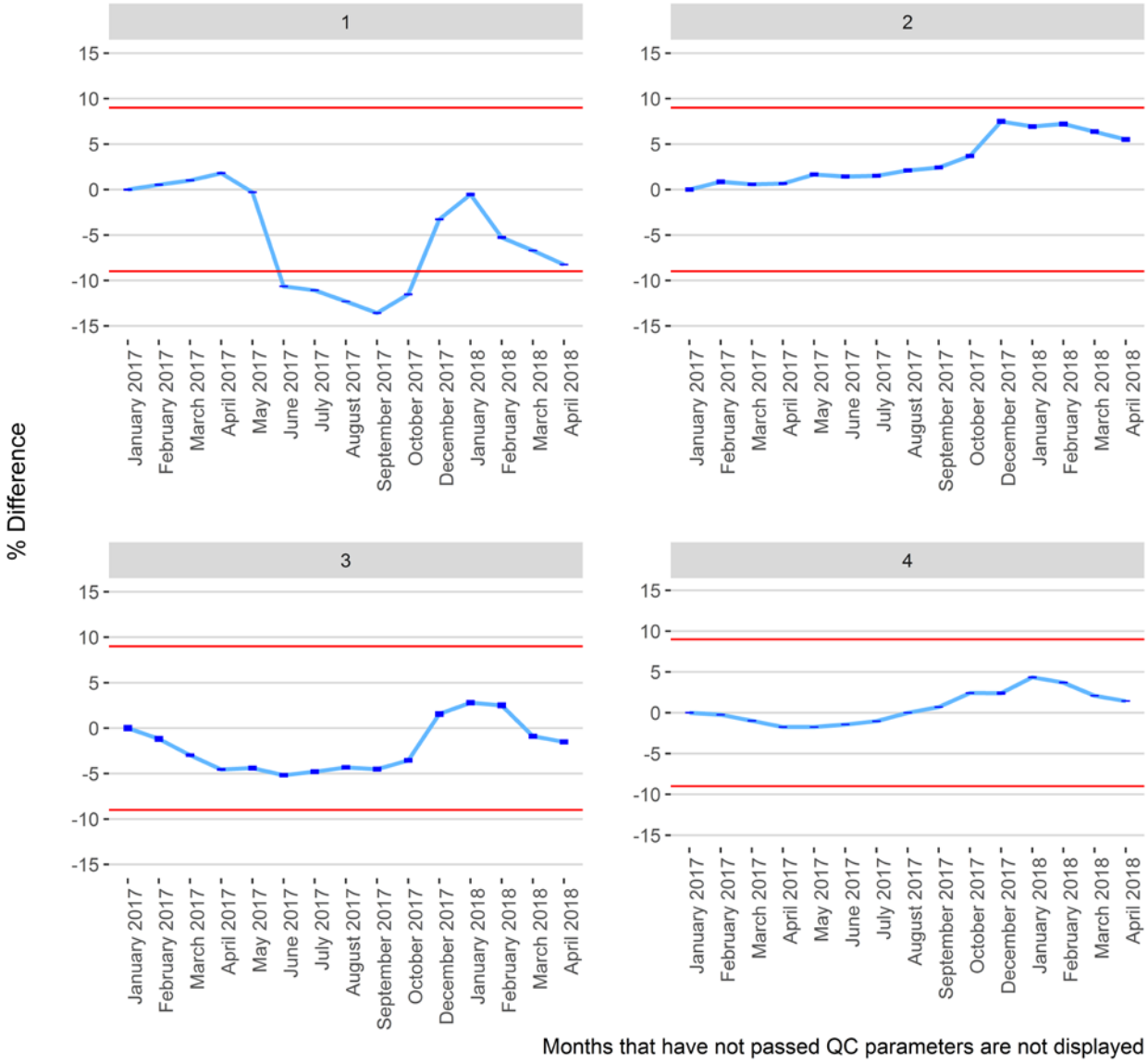
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

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

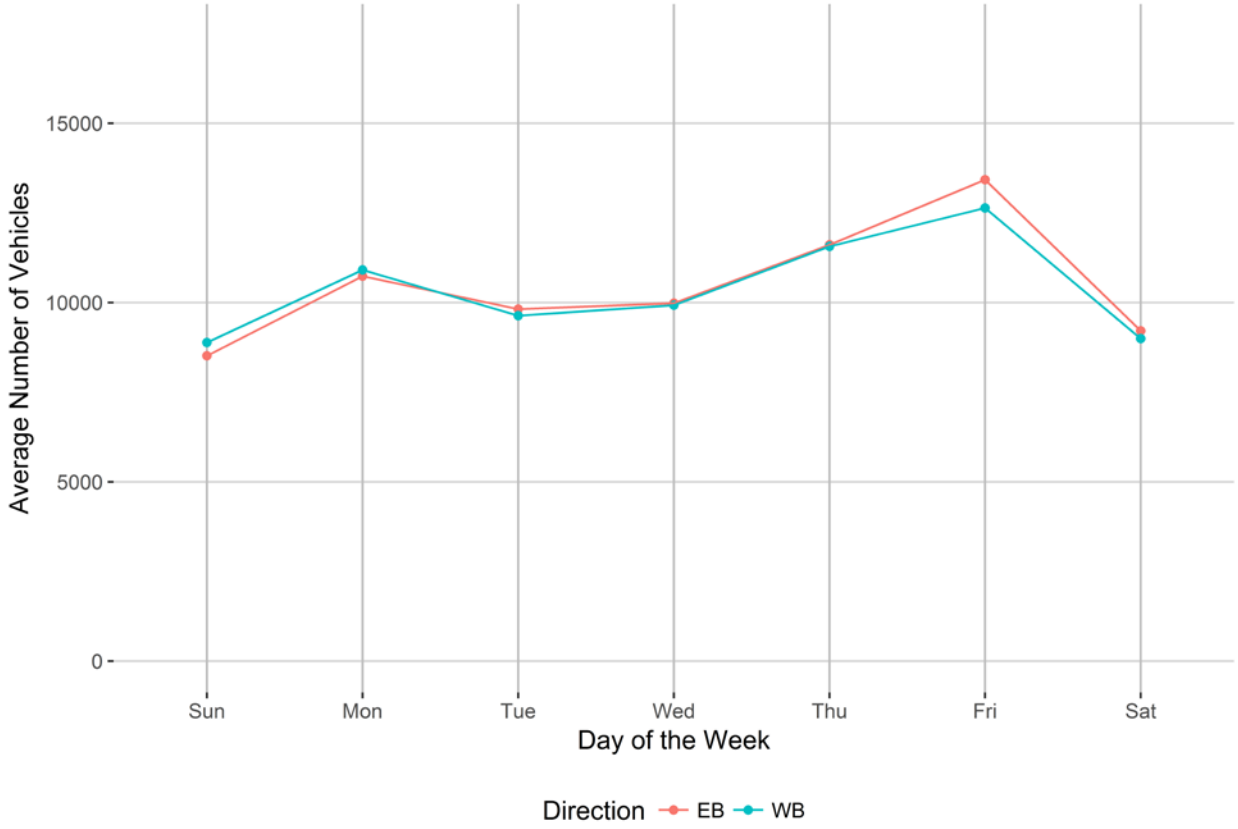


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

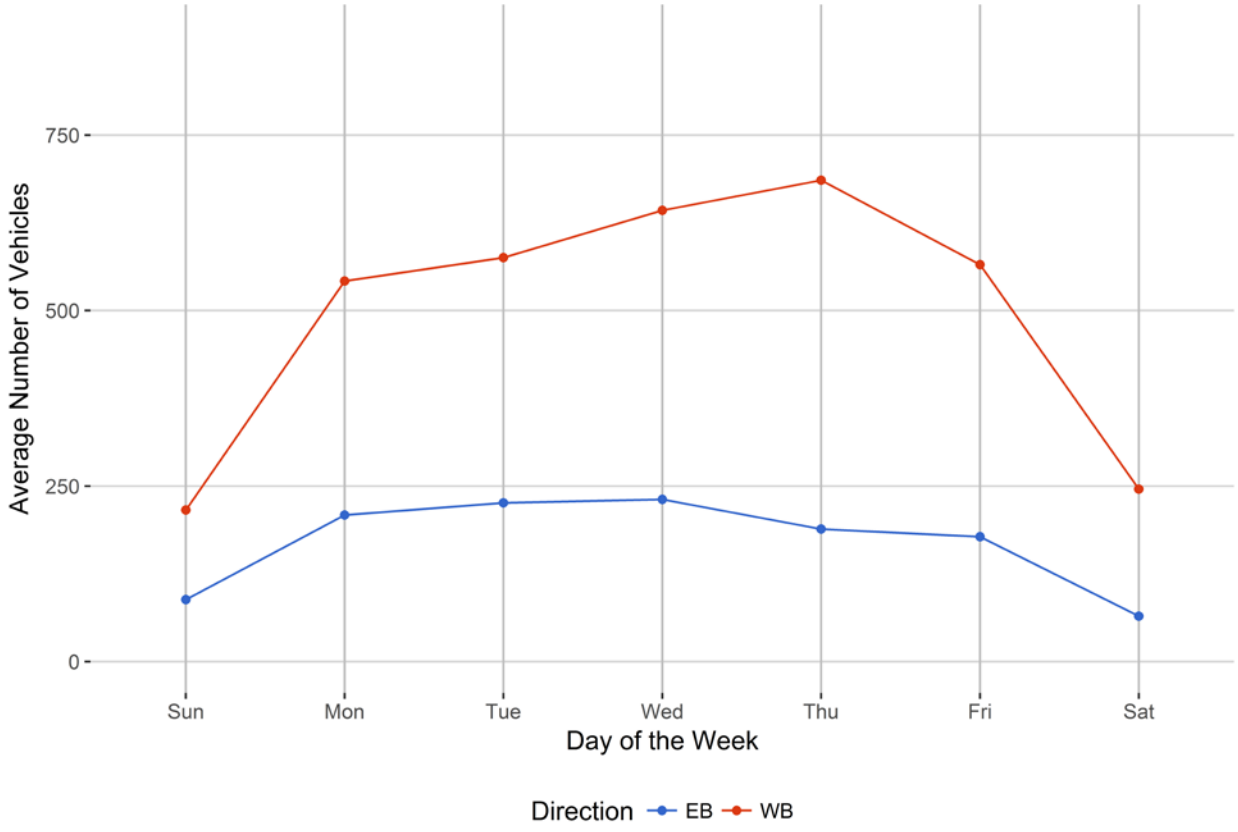


Figure 4 - Passenger Vehicles vs. Hour of the Day

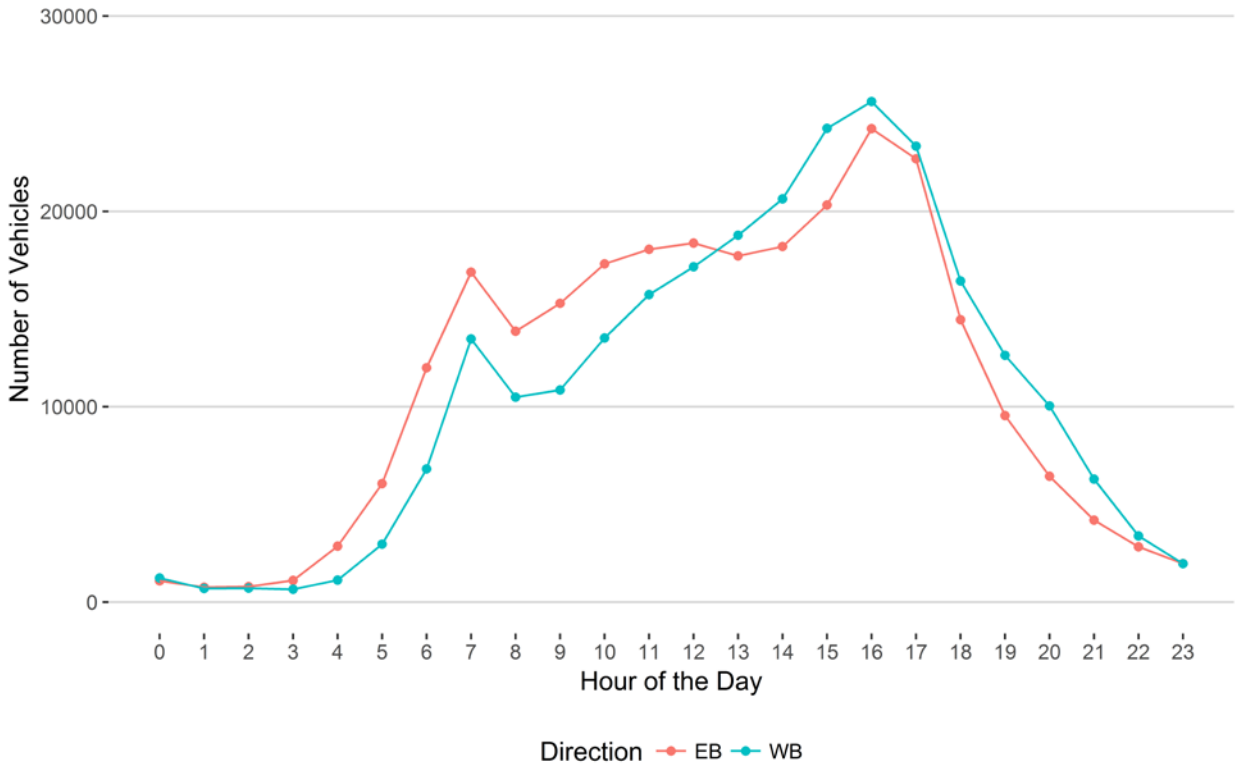


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

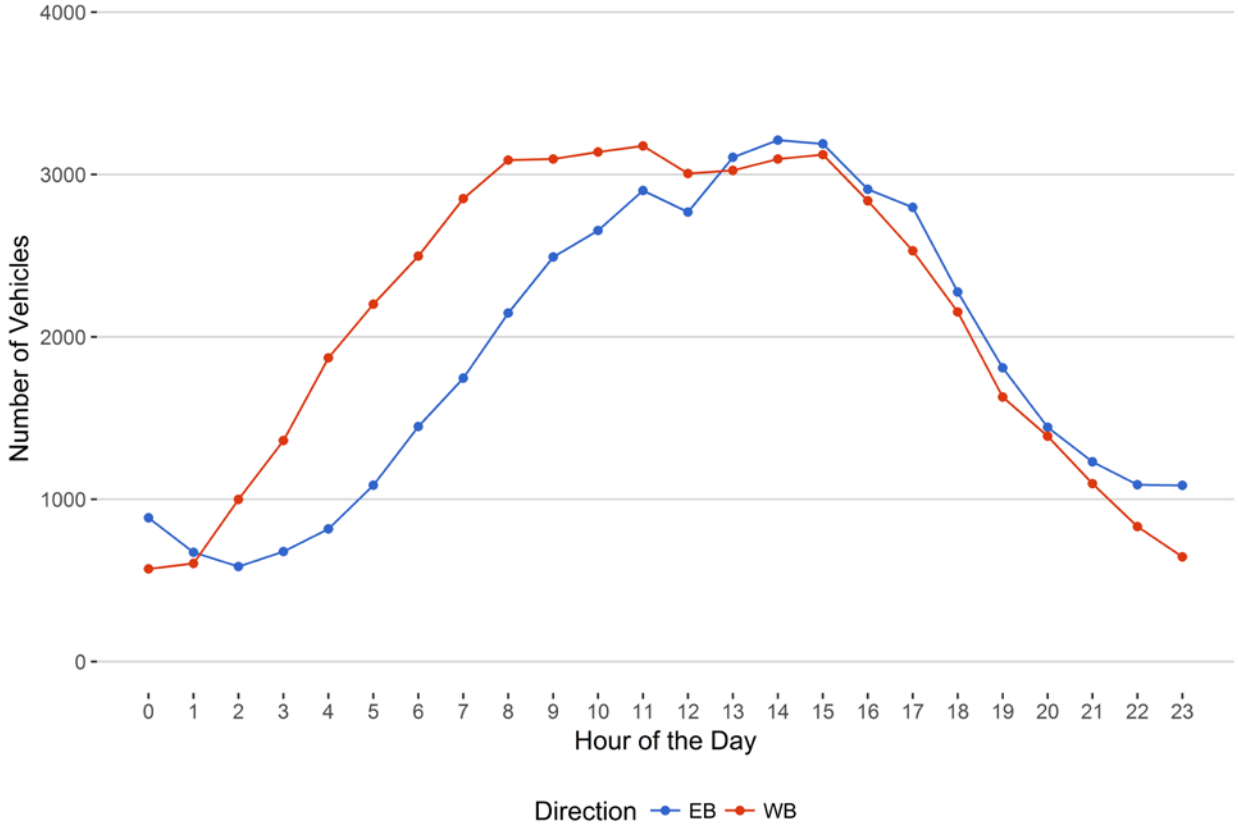


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

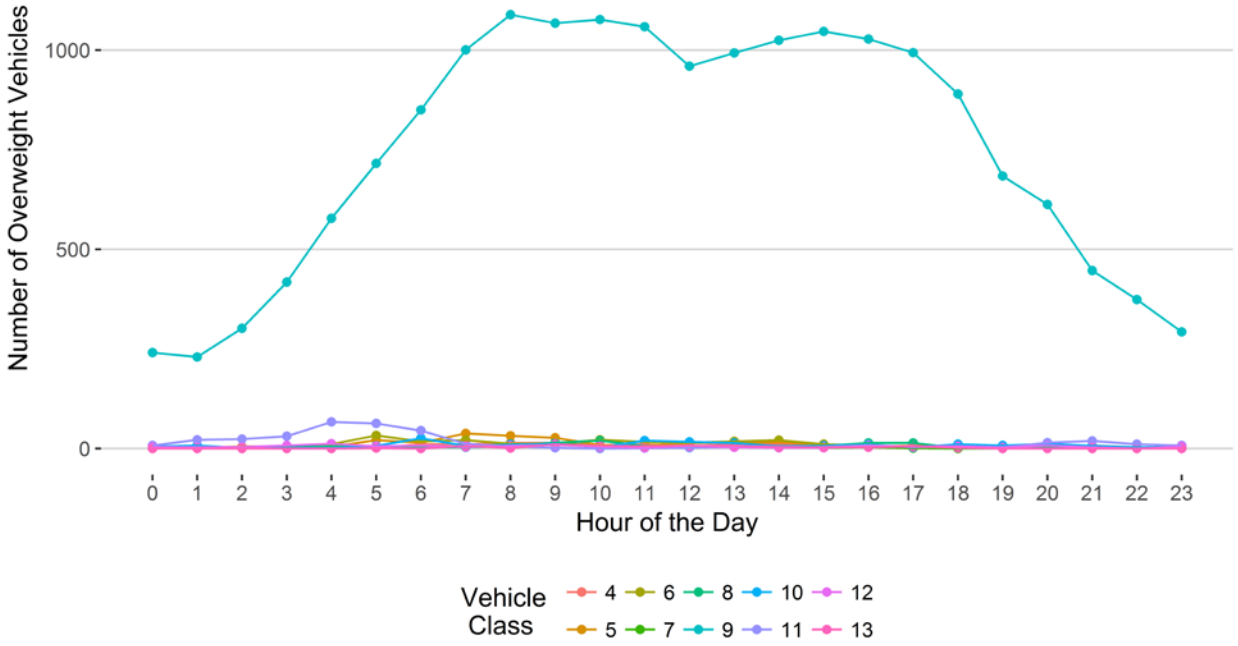
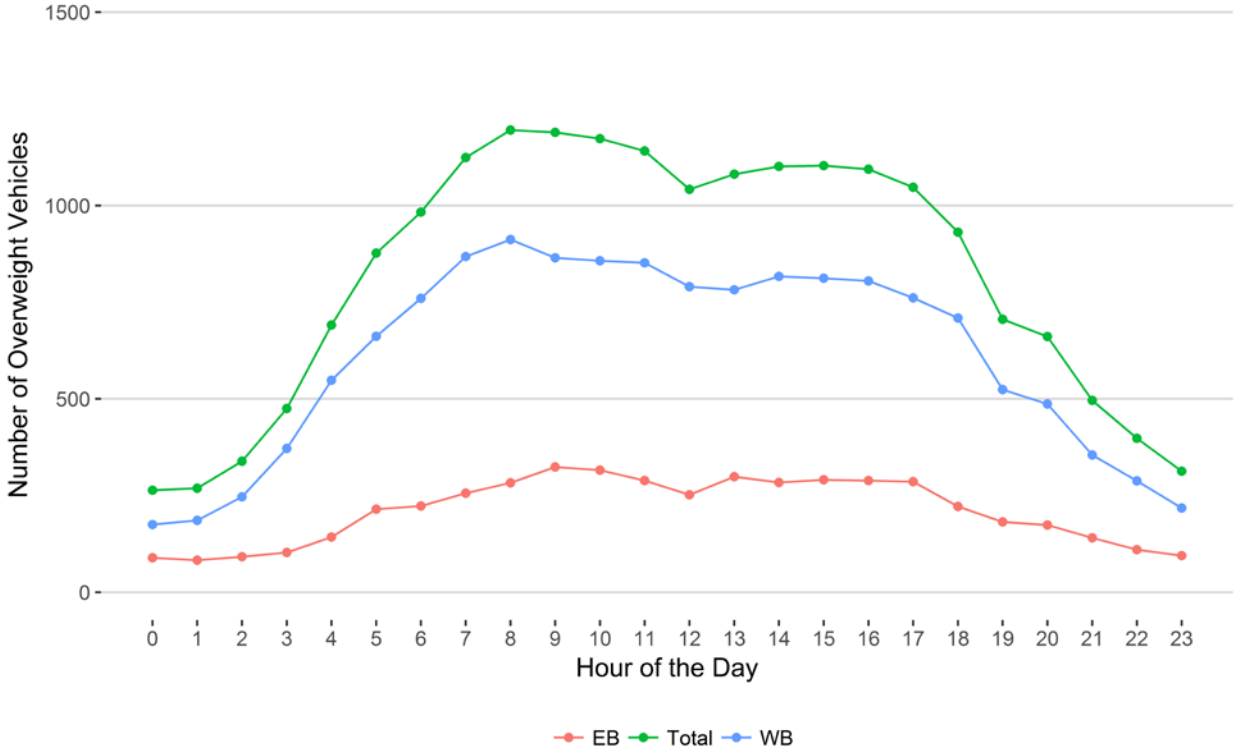
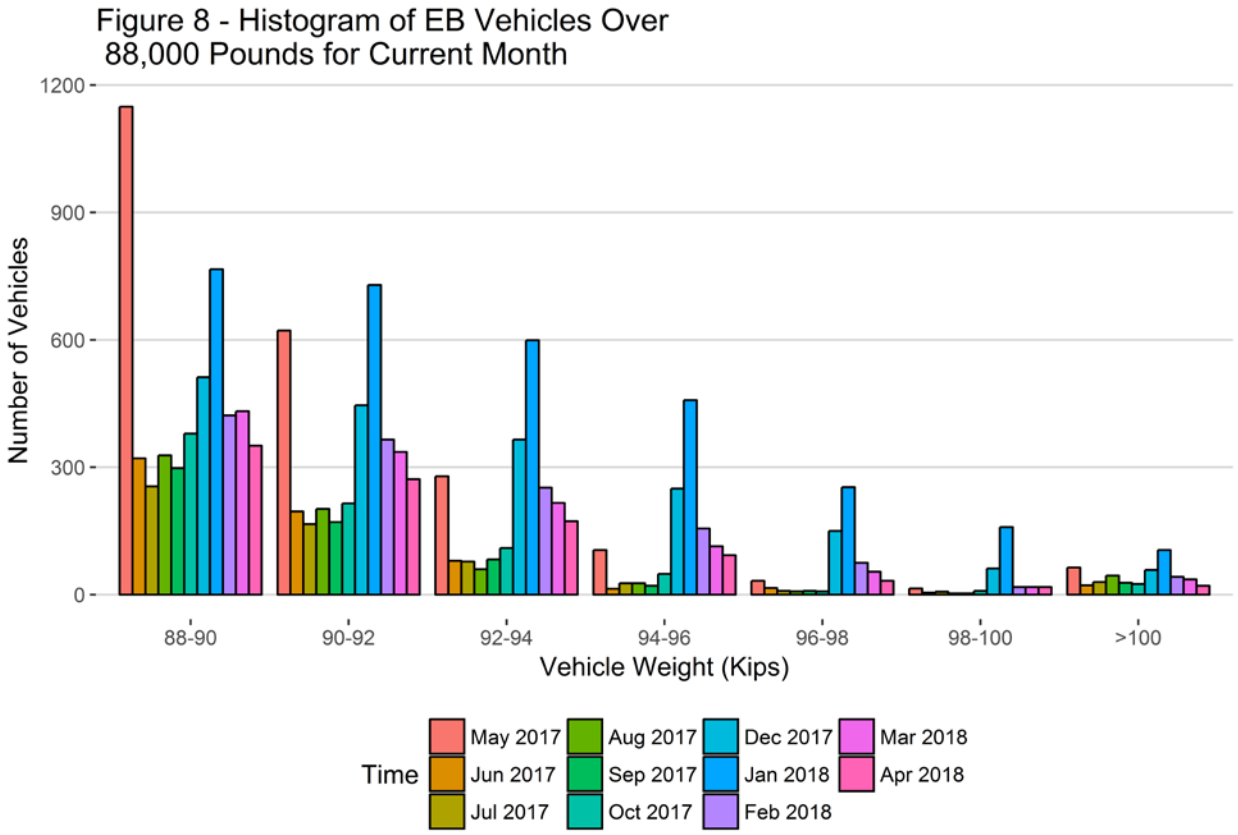


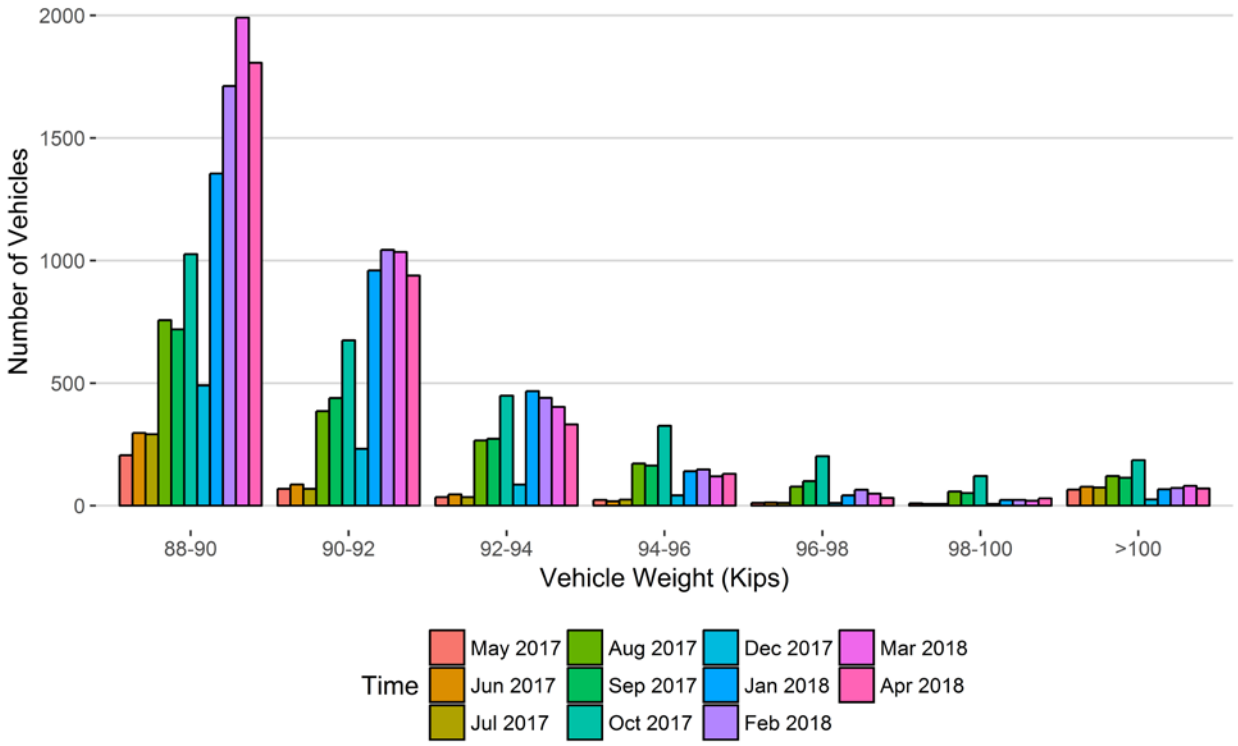
Figure 7 - Overweight Vehicles by Direction
Hour of the Day





Vehicle Weights (Kips)	*May 2017*	*Jun 2017*	*Jul 2017*	*Aug 2017*	*Sep 2017*	*Oct 2017*	*Dec 2017*	*Jan 2018*	*Feb 2018*	*Mar 2018*	*Apr 2018*
88-90	1149	321	255	328	298	379	512	766	422	432	351
90-92	622	196	166	202	171	215	446	729	365	336	272
92-94	279	80	78	60	83	110	365	599	252	216	173
94-96	105	14	27	27	21	49	250	458	156	114	93
96-98	33	16	9	8	9	8	150	253	75	54	33
98-100	15	5	7	3	3	9	62	159	18	18	18
>100	64	22	30	45	28	25	58	105	42	36	21
Total	2267	654	572	673	613	795	1843	3069	1330	1206	961

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



Vehicle Weights (Kips)	*May 2017*	*Jun 2017*	*Jul 2017*	*Aug 2017*	*Sep 2017*	*Oct 2017*	*Dec 2017*	*Jan 2018*	*Feb 2018*	*Mar 2018*	*Apr 2018*
88-90	206	297	292	757	719	1026	491	1355	1712	1991	1807
90-92	69	87	69	386	439	675	232	960	1044	1035	939
92-94	35	46	35	266	273	449	86	467	440	403	332
94-96	24	18	25	172	164	326	42	141	148	120	130
96-98	12	13	12	78	100	202	11	42	65	49	32
98-100	10	7	7	58	52	121	7	24	24	20	30
>100	66	77	74	121	114	186	26	67	72	81	70
Total	422	545	514	1838	1861	2985	895	3056	3505	3699	3340

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

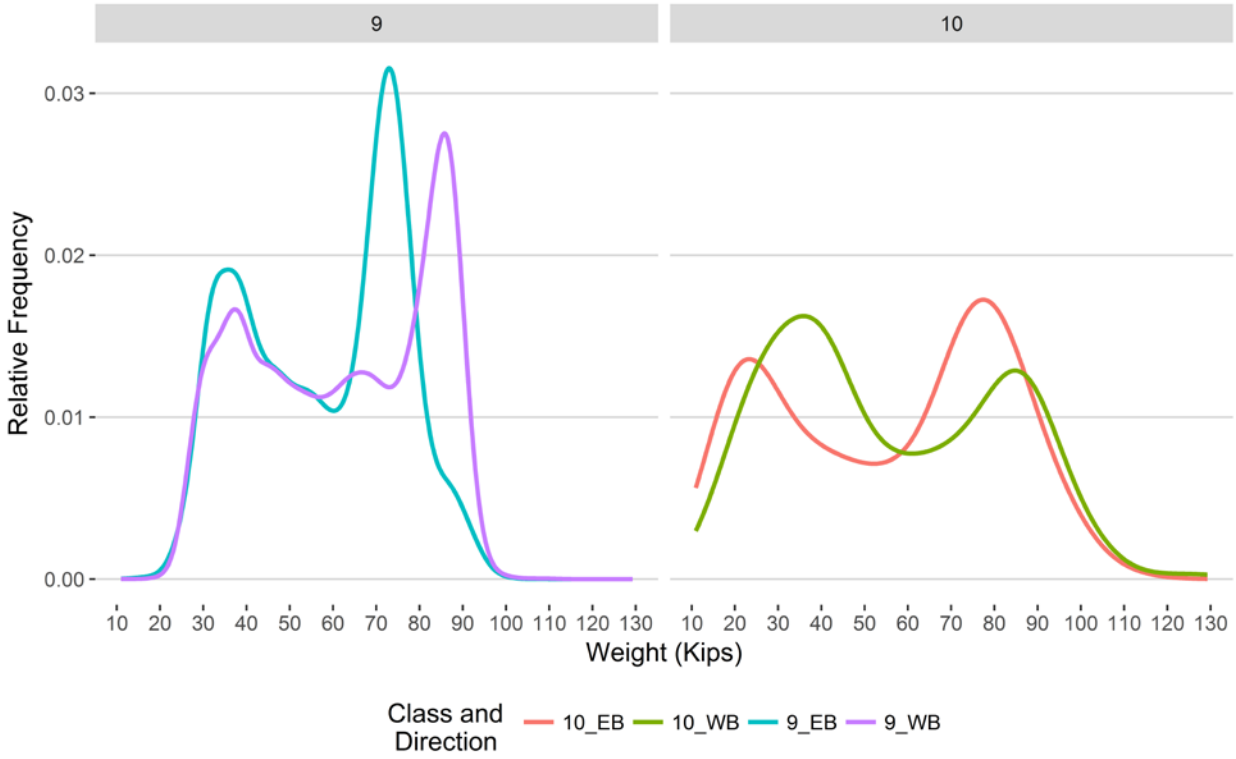


Figure 9 - Freight Percentage by Direction and Class

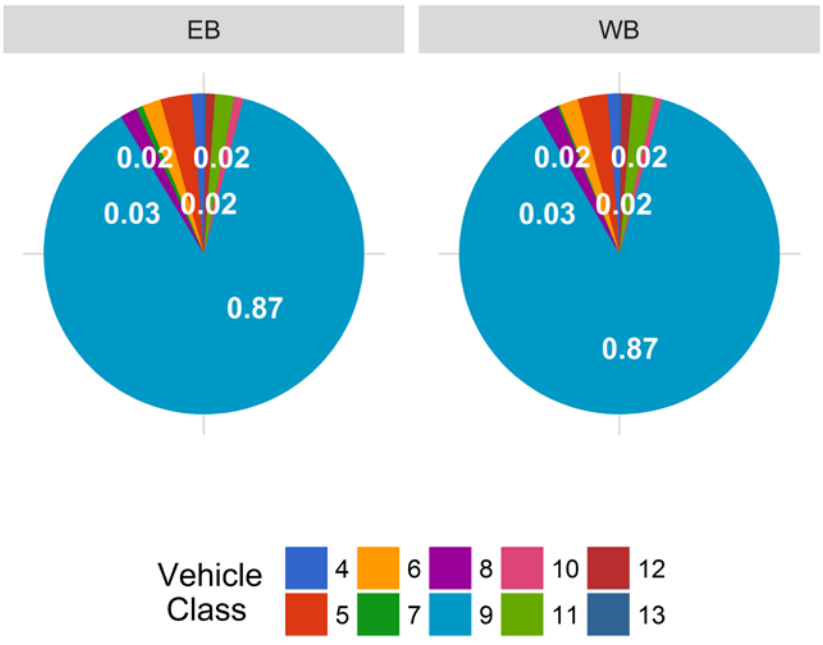


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

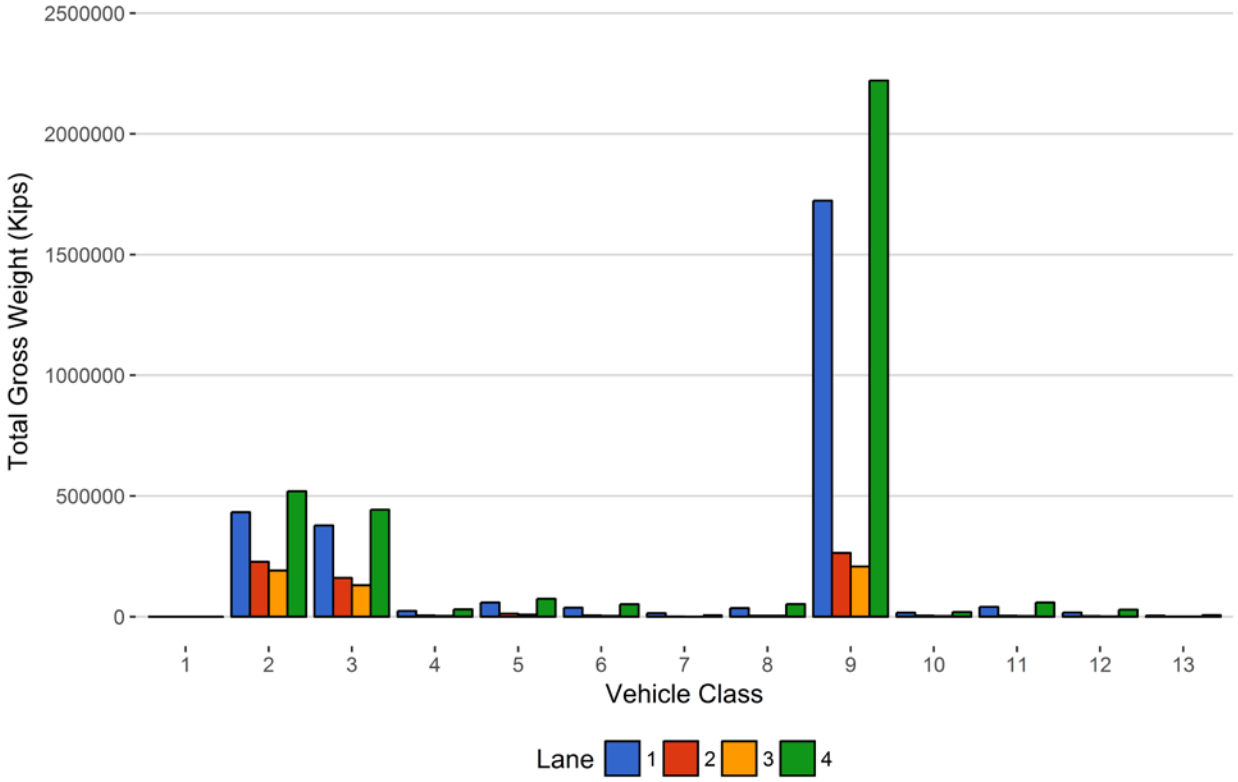


Figure 11 - Total Gross Vehicle Weight I

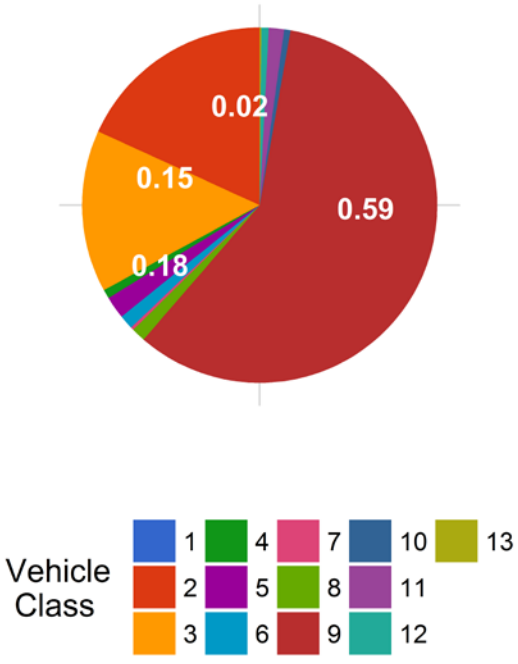


Figure 12 - Total ESALs by Class and Lane

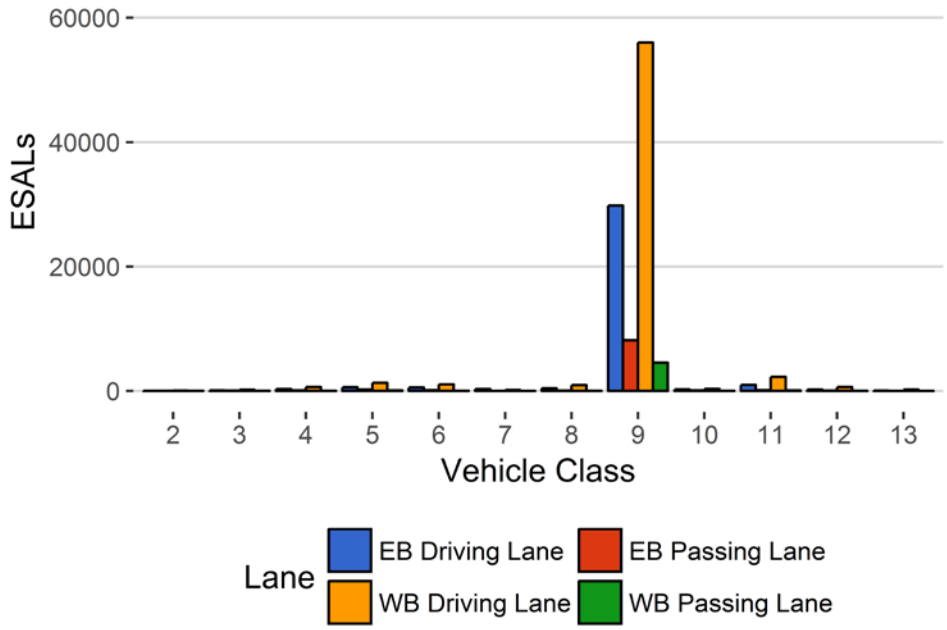


Figure 13 - ESALs by Class

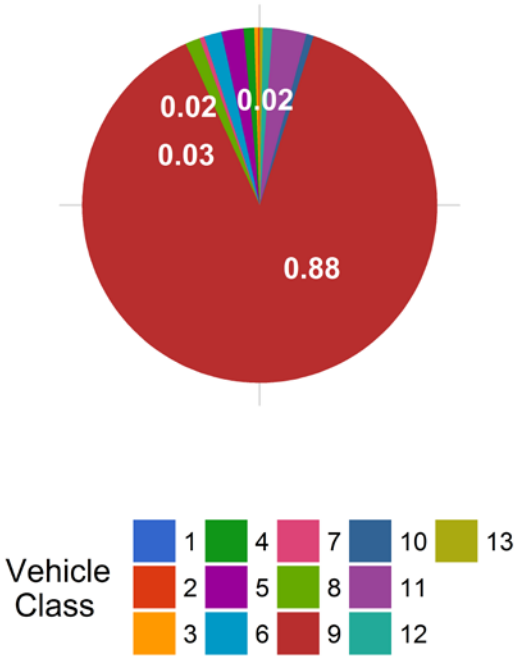


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*	*Lane 3 (Kips)*	*Front Axle +/- 9%*	*Lane 4 (kips)*	*Front Axle +/- 9%*
January 2017	11.32	0.00	12.24	0.00	12.06	0.00	11.96	0.00
February 2017	11.38	0.53	12.34	0.86	11.92	-1.18	11.93	-0.24
March 2017	11.43	1.01	12.31	0.58	11.71	-2.97	11.84	-0.98
April 2017	11.52	1.80	12.32	0.66	11.52	-4.55	11.75	-1.74
May 2017	11.29	-0.29	12.44	1.67	11.53	-4.39	11.75	-1.74
June 2017	10.11	-10.64	12.42	1.43	11.44	-5.18	11.79	-1.43
July 2017	10.07	-11.07	12.43	1.51	11.49	-4.78	11.84	-1.04
August 2017	9.93	-12.30	12.50	2.10	11.54	-4.33	11.96	0.00
September 2017	9.78	-13.58	12.54	2.43	11.52	-4.51	12.04	0.71
October 2017	10.01	-11.53	12.69	3.70	11.64	-3.54	12.25	2.42
December 2017	10.95	-3.27	13.16	7.50	12.25	1.55	12.25	2.40
January 2018	11.26	-0.54	13.09	6.93	12.40	2.80	12.48	4.35
February 2018	10.72	-5.27	13.12	7.22	12.37	2.50	12.40	3.70
March 2018	10.56	-6.70	13.02	6.37	11.96	-0.89	12.21	2.08
April 2018	10.39	-8.25	12.91	5.51	11.88	-1.52	12.13	1.44

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
1	4	110	0	0	0
2	11751	352517	55.3	0	0
3	6218	186542	29.3	0	0
4	75	2250	0.4	153	0.8
5	364	10918	1.7	255	1.3
6	108	3244	0.5	240	1.2
7	12	354	0.1	69	0.4
8	95	2852	0.4	137	0.7
9	2501	75042	11.8	17977	91.8
10	26	786	0.1	204	1
11	55	1648	0.3	365	1.9
12	26	769	0.1	122	0.6
13	4	130	0	66	0.3
TOTAL	**21239**	**637163**	**100**	**19588**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2018-04-18	Wednesday	11:42:17	10	WB	4	129.3
2018-04-11	Wednesday	11:04:02	10	WB	4	124.54
2018-04-16	Monday	09:12:27	10	EB	1	119.55
2018-04-07	Saturday	05:26:27	10	EB	1	119.49
2018-04-01	Sunday	05:29:09	10	EB	1	118.6
2018-04-05	Thursday	03:59:41	10	EB	1	118.16
2018-04-19	Thursday	03:58:55	10	EB	1	117.8
2018-04-04	Wednesday	09:17:29	10	EB	1	117.23
2018-04-15	Sunday	04:20:35	9	EB	1	117.22
2018-04-08	Sunday	05:43:06	10	EB	1	116.81

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	EB	15	1078	166	15.4	26365	2126	6343
5	EB	8	5276	1017	19.3	64259	7117	15093
6	EB	19	1480	367	24.8	36725	6095	7789
7	EB	11.5	250	0	0	15410	0	6267
8	EB	31	1215	513	42.2	27744	11636	2991
9	EB	33	34227	3612	10.6	1880955	106579	435330
10	EB	33.5	374	109	29.1	18610	2468	4866
11	EB	36.5	742	43	5.8	42926	1467	8706
12	EB	36.5	326	11	3.4	19534	306	4018
13	EB	31.5	66	2	3	5152	45	1568
TOTAL	****	****	**45034**	**5840**	****	**2137680**	****	**492972**
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	WB	15	1123	136	12.1	31431	1775	8313
5	WB	8	5404	445	8.2	79835	3213	20082
6	WB	19	1693	142	8.4	51961	2497	11246
7	WB	11.5	96	0	0	5987	0	2441
8	WB	31	1575	562	35.7	42313	13998	5455
9	WB	33	39177	3731	9.5	2319130	109627	574706
10	WB	33.5	395	100	25.3	19531	2551	4824
11	WB	36.5	870	4	0.5	61084	129	14738
12	WB	36.5	426	1	0.2	29800	27	7144
13	WB	31.5	61	0	0	6609	0	2344
TOTAL	****	****	**50820**	**5121**	****	**2647683**	****	**651293**
GRAND TOTAL	****	****	**95854**	**10961**	**254**	**4785363**	**271655**	**1144265**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*EB Driving Lane*	*EB Passing Lane*	*WB Passing Lane*	*WB Driving Lane*	*Total*	*Percentage*
1	49	30	18	26	123	0
2	433009	227464	191277	519719	1371469	18.2
3	378165	160942	130702	443082	1112891	14.8
4	23529	4963	2933	30273	61698	0.8
5	58592	12784	8568	74480	154424	2
6	37672	5149	3014	51445	97279	1.3
7	14673	737	190	5797	21397	0.3
8	35402	3978	3844	52466	95691	1.3
9	1723459	264074	207686	2221071	4416291	58.6
10	16957	4121	2731	19351	43160	0.6
11	40544	3850	2347	58866	105607	1.4
12	17580	2259	1147	28680	49666	0.7
13	4500	697	466	6143	11806	0.2
TOTAL	**2784131**	**691047**	**554923**	**3511400**	**7541500**	**100**
GVW/LANE	**36.92**	**9.16**	**7.36**	**46.56**	**100**	**0**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*EB Driving Lane*	*EB Passing Lane*	*WB Passing Lane*	*WB Driving Lane*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0	0	0.0092
2	38	33	28	66	164	0.15	0.001
3	102	64	52	181	399	0.36	0.0044
4	313	92	40	629	1074	0.96	0.98
5	598	212	111	1322	2243	2.01	0.42
6	550	120	48	1069	1787	1.6	1.13
7	315	22	3	152	492	0.44	2.81
8	441	72	46	927	1486	1.33	1.07
9	29806	8144	4556	56000	98506	88.23	2.68
10	246	98	43	355	743	0.67	1.92
11	956	136	96	2278	3466	3.1	4.28
12	232	58	24	638	953	0.85	2.51
13	75	18	14	225	332	0.3	4.84
TOTAL	**33673**	**9068**	**5061**	**63842**	**111644**	**100**	**23**
ESALS/LANE	**30.2**	**8.1**	**4.5**	**57.2**	**100**	**--**	**--**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*	*Heavy Commercial Vehicles in Driving Lane %*	*Heavy Commercial Vehicles in Passing Lane %*
May 2017	731825	23607	3667	618140	84.5	113685.5	15.5	88.5	11.5
Jun 2017	787202	26240	3845	671842	85.3	115359.8	14.7	87.6	12.4
Jul 2017	793741	25604	3569	683116	86.1	110625.4	13.9	87.8	12.2
Aug 2017	804859	25963	3913	683559	84.9	121300.1	15.1	88.2	11.8
Sep 2017	726392	24213	3236	629322	86.6	97070.4	13.4	87.1	12.9
Oct 2017	719949	23224	2883	630576	87.6	89373.1	12.4	84.9	15.1
Dec 2017	608685	19635	1976	547421	89.9	61264.3	10.1	81.9	18.1
Jan 2018	545214	17588	1886	486743	89.3	58471.1	10.7	80.9	19.1
Feb 2018	519118	18540	2213	457150	88.1	61967.9	11.9	84.8	15.2
Mar 2018	672594	21697	3246	571963	85	100631.3	15	89.4	10.6
Apr 2018	637163	21239	3266	539170	84.6	97993.1	15.4	89.6	10.4
TOTAL	**7546742**	**--**	**--**	**6519002**	**--**	**1027742**	**--**	**--**	**--**
AVERAGE	**686067**	**22505**	**3064**	**592637**	**87**	**93431**	**13**	**86**	**14**

ESALs

Month	*ESALS EB Passing Lane*	*ESALS EB Driving Lane*	*ESALS WB Driving Lane*	*ESALS WB Passing Lane*	*Total ESALS*	*Driving Lane ESALS %*	*Passing Lane ESALS %*	*Pavement Life Decrease Months*
May 2017	53277	10973	5355	62162	131767	88	12	2.9
Jun 2017	29143	11749	5847	65483	112222	84	16	3.1
Jul 2017	32412	10936	5392	58059	106799	85	15	3.6
Aug 2017	33618	11934	5771	69776	121098	85	15	12.8
Sep 2017	21056	9854	4941	62745	98597	85	15	14.4
Oct 2017	17870	10341	5631	60500	94342	83	17	25.9
Dec 2017	32042	9829	5415	21039	68325	78	22	11.1
Jan 2018	19672	10910	5796	35694	72073	77	23	37.1
Feb 2018	11994	9787	5059	45812	72652	80	20	31.6
Mar 2018	36022	10271	5273	66550	118116	87	13	23.4
Apr 2018	33699	9080	5070	64198	112047	87	13	21.8
TOTAL	**320805**	**115663**	**59551**	**612019**	**1108038**	**--**	**--**	**--**
AVERAGE	**29164**	**10515**	**5414**	**55638**	**100731**	**84**	**16**	**17**

Gross Vehicle Weight

Month	*GVW EB Passing Lane*	*GVW EB Driving Lane*	*GVW WB Passing Lane*	*GVW WB Driving Lane*	*Total GVW Kips*
May 2017	1766773	670355	515044	1948965	4901137
Jun 2017	1548618	606656	457410	2455684	5068368
Jul 2017	2931469	759060	586267	3650504	7927301
Aug 2017	2785677	692032	555620	3520002	7553332
Sep 2017	3360608	864935	637411	3843661	8706616
Oct 2017	2952550	967704	732361	4032996	8685611
Dec 2017	3159815	956636	735948	3732726	8585126
Jan 2018	3303649	990874	745014	4084406	9123942
Feb 2018	2281938	844722	639059	3699998	7465716
Mar 2018	1844438	851013	680855	3359518	6735824
Apr 2018	2602727	725139	571128	1034431	4933426
TOTAL	**28538265**	**8929126**	**6856116**	**35362891**	**79686398**
AVERAGE	**2594388**	**811739**	**623283**	**3214808**	**7244218**

Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
May 2017	27913	3.9	25	2709	160
Jun 2017	19465	2.5	17.2	1210	117
Jul 2017	16898	2.2	15.5	1096	125
Aug 2017	19320	2.5	16.3	2517	230
Sep 2017	16680	2.4	17.8	2488	208
Oct 2017	16692	2.6	19.2	3826	354
Dec 2017	10576	2	15.9	2771	163
Jan 2018	14410	2.9	22.6	6149	364
Feb 2018	14486	3	22.6	4842	158
Mar 2018	20928	3.2	21	4910	155
Apr 2018	19693	3.2	20.4	4310	139
TOTAL	**197061**	**--**	**--**	**36828**	**2173**
AVERAGE	**17914.6**	**2.8**	**19.4**	**3348**	**197.5**

Freight

Month	*EB Freight Tons*	*WB Freight Tons*	*Total Freight*	*EB Freight %*	*WB Freight %*
May 2017	640310	701589	1341898	47.7	52.3
Jun 2017	496712	733003	1229716	40.4	59.6
Jul 2017	537419	650628	1188047	45.2	54.8
Aug 2017	575347	742535	1317881	43.7	56.3
Sep 2017	391097	664771	1055867	37	63
Oct 2017	337732	622525	960257	35.2	64.8
Dec 2017	444244	175532	619776	71.7	28.3
Jan 2018	278786	364384	643170	43.3	56.7
Feb 2018	224800	462615	687414	32.7	67.3
Mar 2018	524835	672213	1197049	43.8	56.2
Apr 2018	492972	651293	1144265	43.1	56.9
TOTAL	**4944254**	**6441087**	**11385341**	**--**	**--**
AVERAGE	**449477.6**	**585553.4**	**1035031**	**44**	**56**