Final Report

to the

Florida Department of Transportation
Research Office

on Project

Heavy Vehicle Effects on Florida Freeways and Multilane Highways

FDOT Contract BDK77 977-15 (UF Project 00093817)

October 2013

University of Florida
Transportation Research Center
Department of Civil and Coastal Engineering

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SI (MODERN METRIC) CONVERSION FACTORS

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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16. Abstract

The Florida Department of Transportation's (FDOT) primary guide for conducting highway capacity and level of service analyses from planning through design is the Transportation Research Board's Highway Capacity Manual (HCM). FDOT's FREEPLAN and HIGHPLAN software programs utilize truck passenger car equivalency (PCE) values from the HCM to account for the effects of trucks on traffic flow operations. The PCE values in the HCM used for freeways and multilane highways are based on a study performed in the mid-1990s. Since that time, commercial truck performance technologies have changed. Furthermore, loading conditions are considerably different today, given the tremendous growth in freight movement. Additionally, the PCE values developed in that study were based strictly on simulation and a now outdated version of CORSIM (5.0). And finally, the PCE values taken from that study for inclusion in the HCM correspond to just a single "typical" truck (although the study considered multiple categories of trucks), which may not be representative of a typical truck in Florida, and accounting for just a single truck type may lead to considerable error in level of service results in some situations. Therefore, the objective of this project was to develop PCE values appropriate for commercial truck conditions on Florida freeways and multilane highways. The most prevalent truck types on Florida freeways and multilane highways were determined to be single unit, intermediate/interstate semi-tractor+trailer, and semi-tractor+double- trailer trucks. The CORSIM-NG simulation program was utilized to generate the traffic stream data for this study, as this program incorporates a more detailed truck acceleration model than other available simulation tools. In order to develop the PCE values, the methodology introduced into the literature by Sumner et al. was used. This methodology has also been utilized by others (e.g., Webster and Elefteriadou). Once the PCE calculations were run and the values were obtained for the three heavy vehicle types of interest, it was observed that PCE values generally increase with increases in proportion of grade, length of grade, traffic demand, free-flow-speed, and proportion of heavy vehicles. Conversely, the PCE values generally decrease as the number of lanes increases. Although it is difficult to directly compare the PCE values from this study to those of the HCM 2010 because the HCM values are much more generalized, for the same input conditions the PCE values from this study are generally slightly lower, which is largely due to the higher power-to-weight ratios of the trucks used in this study and the more detailed vehicle dynamics modeling.

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EXECUTIVE SUMMARY

The Florida Department of Transportation's (FDOT) primary guide for conducting highway capacity and level of service analyses from planning through design is the Highway Capacity Manual (HCM). Therefore, FDOT's FREEPLAN and HIGHPLAN software programs utilize truck passenger car equivalency (PCE) values from the HCM to account for the effects of trucks on traffic flow operations on freeway and highway facilities. The PCE values in the HCM used for freeways and multilane highways are based on a study performed in the mid-1990s by Webster and Elefteriadou (1999). Since that time, commercial truck performance technologies have changed. Furthermore, loading conditions are considerably different today given the tremendous growth in freight movement. Additionally, the PCE values developed in that study were based strictly on simulation and a now outdated version of CORSIM (5.0). And finally, the PCE values taken from that study for inclusion in the HCM correspond to just a single "typical" truck (although the study considered multiple categories of trucks), which may not be representative of a typical truck in Florida, and accounting for just a single truck type may lead to considerable error in level of service results in some situations. Therefore, the objective of this project was to develop truck PCE values appropriate for commercial truck conditions on Florida freeways and multilane highways.

The initial step of the data collection procedure was to obtain information on physical and powertrain characteristics for Mack, Peterbilt, Volvo, and Kenworth brand commercial heavy vehicles in order to become familiar with the current available truck fleets. In addition, FDOT provided data from 24 Weigh-in-Motion (WIM) stations that are located on Florida freeways and multilane highways, for years 2008-2010, and part of 2011. Using these data, the research team was able to obtain AADT, truck classification, total truck volume, and typical weight loadings for each of the 24 WIM stations per area type (rural, urban) and facility type (freeway, multilane highway). Per these data, it was determined that four truck types were most prevalent in the Florida traffic stream, namely,

- Classes 5&6 combined under Single Unit Truck (Small Truck),
- Class 8 as Intermediate Semi-tractor+trailer (Medium Truck),
- Class 9 as Interstate Semi-tractor+trailer (Medium Truck), and
- Classes 11&12 combined under Semi-tractor+double-trailer (Large Truck).

Once the most prevalent truck types in the Florida highway network traffic stream were determined, the initial step to develop PCE values was to generate the new truck acceleration profile curves that would be introduced into the traffic simulation program CORSIM-NG. The research team came up with a methodology to calculate new acceleration vs. speed curves for the four truck types using the Al Kaisy et al. (2005) methodology. In order to validate the acceleration values calculated by this methodology, the research team used the simulation program TruckSim as the reference for truck acceleration performance. TruckSim provides detailed simulation of individual trucks, based on mathematical models of the truck's powertrain (engine, transmission) and physical characteristics. The truck acceleration performance in CORSIM-NG was compared to that in TruckSim. As a result of this comparison, the research team realized the need to implement a more sophisticated truck acceleration model than the one provided in the Al Kaisy et al. methodology. Ultimately, a truck acceleration modeling process was incorporated into CORSIM-NG that utilized a comprehensive vehicle dynamics approach.

An additional advantage to this approach is that transmission gear shifts are explicitly modeled. This leads to more accurate truck acceleration values because available engine power is linked to engine speed, which can vary as a function of transmission gear. Other models generally assume that peak engine power is available at all times.

As for the determination of the Florida truck PCE values, multiple approaches were considered in order to determine the most suitable methodology and experimental design. Per the literature review conducted, it was determined that the methods used in the Webster and Elefteriadou study (1999), which were based on Sumner et al.'s approach (1984), are most consistent with the HCM methodology. This methodology defines equivalence in terms of the measure density, since this measure is used to define level of service for freeways and multilane highways.

Once the experimental design was executed, which resulted in a total of 311,040 simulation runs, the chosen PCE calculation methodology was applied to determine the PCE values for each specific truck class. From these PCE values, a regression analysis was used to develop equations to estimate the PCE values for each truck type as a function of several explanatory variables. From the analysis, it was determined that there was not much difference in the PCE values between Class 8 and Class 9 trucks. Although they have different average load conditions, their drivetrain and physical characteristics are very similar. And given that Class 9 trucks are much more prevalent in the traffic streams of freeways and multilane highways than Class 8 trucks, it was decided to use just three separate truck categories for the purposes of PCEs, for which Class 9 would represent the 'medium' truck category. Equations i through iii are the resulting PCE estimation equations from this study. They correspond to Single Unit Trucks (Small), Semi-tractor+trailer trucks (Medium), and Semi-tractor+double-trailer trucks (Large), respectively. It should be noted that all calculated PCE values using the below equations should be rounded to the nearest hundredth.

$$PCE_{ST} = 0.966 + 0.0000154 \times (\text{Min}(SegLen \times Prop.\ Grade, 300))^2 - 0.000101 \times (\text{Min}(SegLen \times Prop.\ Grade, 300)) + 0.0037 \times \text{Max}(FFS, 66) - 0.0801 \times NumLanes + 1.21 \times Prop.\ Small\ Trucks + 0.0031 \times \text{Max}(Flow\ Rate, 100) \times Prop.\ Small\ Trucks \quad \textbf{[i]}$$

$$PCE_{MT} = 1.095 + 0.0000165 \times (\text{Min}(SegLen \times Prop.\ Grade, 300))^2 - 0.000105 \times (\text{Min}(SegLen \times Prop.\ Grade, 300)) + 0.00255 \times \text{Max}(FFS, 66) - 0.07774 \times NumLanes + 2.148 \times Prop.\ Medium\ Trucks + 0.00244 \times \text{Max}(Flow\ Rate, 100) \times Prop.\ Medium\ Trucks \quad \textbf{[ii]}$$

$$PCE_{LT} = 1.246 + 0.0000171 \times (\text{Min}(SegLen \times Prop.\ Grade, 300))^2 - 0.0000335 \times (\text{Min}(SegLen \times Prop.\ Grade, 300)) + 0.00264 \times \text{Max}(FFS, 66) - 0.10316 \times NumLanes + 1.98 \times Prop.\ Large\ Trucks + 0.00401 \times \text{Max}(Flow\ Rate, 100) \times Prop.\ Large\ Trucks \quad \textbf{[iii]}$$

where

SegLen	=	Segment/Link length in ft.
Prop. Grade	=	Proportion of grade (i.e., % grade/100)
FFS	=	Free-flow-speed in ft/s
NumLanes	=	Number of lanes in analysis direction
Prop. Small Trucks	=	Proportion of single unit trucks in traffic stream (i.e., % ST/100)
Prop. Medium Trucks	=	Proportion of medium trucks in traffic stream (i.e., % MT/100)
Prop. Large Trucks	=	Proportion of large trucks in traffic stream (i.e., % LT/100)
Flow rate	=	Measured volume in veh/h/ln

These equations provide the ability to estimate PCE values as a function of several explanatory variables, and at a much finer resolution than those provided in the HCM in a tabular format. Although the equations are incorporated in the FREEPLAN and HIGHPLAN software, as opposed to a table implementation, the next three tables (Table ES-1 through Table ES-3) are presented just to give a general comparison of some of the PCE values calculated by the above equations and the "corresponding" PCE values in the HCM 2010. The specific demand, number of lanes, and FFS value used to obtain these table values, in addition to the variable values shown in the tables, were as follows:

- 1200 veh/h/ln
- 3 lanes in analysis direction
- 65 mi/h (95.33 ft/s)

Table ES-1. PCE Comparison Table for Single Unit Trucks

Upgrade (%)	Length (mi)	PCE Calculation Source	Proportion of Trucks and Buses							
			2%	4%	5%	6%	8%	10%	15%	20%
≤2	All	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. i	1.18	1.28	1.32	1.37	1.47	1.57	1.82	2.06
>2-3	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. i	1.20	1.30	1.35	1.39	1.49	1.59	1.84	2.08
	>0.25-0.50	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. i	1.27	1.36	1.41	1.46	1.56	1.66	1.91	2.15
	>0.50-0.75	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. i	1.38	1.48	1.53	1.58	1.68	1.78	2.02	2.27
	>0.75-1.00	HCM	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50
		Eq. i	1.55	1.65	1.70	1.74	1.84	1.94	2.19	2.43
>3-4	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. i	1.21	1.31	1.36	1.41	1.51	1.61	1.86	2.10
	>0.25-0.50	HCM	2.00	2.00	2.00	2.00	2.00	2.00	1.50	1.50
		Eq. i	1.34	1.44	1.49	1.54	1.63	1.73	1.98	2.23
	>0.50-0.75	HCM	2.50	2.50	2.00	2.00	2.00	2.00	2.00	2.00
		Eq. i	1.55	1.65	1.70	1.74	1.84	1.94	2.19	2.43
	>0.75-1.00	HCM	3.00	3.00	2.50	2.50	2.50	2.50	2.00	2.00
		Eq. i	1.84	1.94	1.99	2.04	2.14	2.24	2.48	2.73
>4-5	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. i	1.24	1.34	1.39	1.43	1.53	1.63	1.88	2.12
	>0.25-0.50	HCM	3.00	2.50	2.50	2.50	2.00	2.00	2.00	2.00
		Eq. i	1.43	1.53	1.58	1.63	1.73	1.83	2.07	2.32
	>0.50-0.75	HCM	3.50	3.00	3.00	3.00	2.50	2.50	2.50	2.50
		Eq. i	1.76	1.86	1.91	1.96	2.06	2.16	2.40	2.65
	>0.75-1.00	HCM	4.00	3.50	3.50	3.50	3.00	3.00	3.00	3.00
		Eq. i	2.22	2.32	2.37	2.42	2.52	2.62	2.86	3.11
>5-6	0.00-0.25	HCM	2.00	2.00	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. i	1.27	1.36	1.41	1.46	1.56	1.66	1.91	2.15
	>0.25-0.50	HCM	4.50	4.00	3.50	3.00	2.50	2.50	2.50	2.50
		Eq. i	1.55	1.65	1.70	1.74	1.84	1.94	2.19	2.43
	>0.50-0.75	HCM	5.00	4.50	4.00	3.50	3.00	3.00	3.00	3.00
		Eq. i	2.02	2.12	2.17	2.22	2.32	2.42	2.66	2.91
	>0.75-1.00	HCM	5.50	5.00	4.50	4.00	3.00	3.00	3.00	3.00
		Eq. i	2.53	2.63	2.68	2.73	2.83	2.93	3.17	3.42

Table ES-2. PCE Comparison Table for Semi-tractor+Trailer Trucks

Upgrade (%)	Length (mi)	PCE Calculation Source	Proportion of Trucks and Buses							
			2%	4%	5%	6%	8%	10%	15%	20%
≤2	All	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. ii	1.21	1.31	1.36	1.41	1.51	1.61	1.87	2.12
>2-3	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. ii	1.23	1.33	1.38	1.43	1.53	1.63	1.89	2.14
	>0.25-0.50	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. ii	1.30	1.40	1.45	1.50	1.61	1.71	1.96	2.22
	>0.50-0.75	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. ii	1.43	1.53	1.58	1.63	1.73	1.83	2.09	2.34
	>0.75-1.00	HCM	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50
		Eq. ii	1.60	1.71	1.76	1.81	1.91	2.01	2.26	2.52
>3-4	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. ii	1.25	1.35	1.40	1.45	1.55	1.65	1.91	2.16
	>0.25-0.50	HCM	2.00	2.00	2.00	2.00	2.00	2.00	1.50	1.50
		Eq. ii	1.38	1.48	1.53	1.58	1.68	1.79	2.04	2.29
	>0.50-0.75	HCM	2.50	2.50	2.00	2.00	2.00	2.00	2.00	2.00
		Eq. ii	1.60	1.71	1.76	1.81	1.91	2.01	2.26	2.52
	>0.75-1.00	HCM	3.00	3.00	2.50	2.50	2.50	2.50	2.00	2.00
		Eq. ii	1.92	2.02	2.07	2.12	2.22	2.33	2.58	2.83
>4-5	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. ii	1.27	1.37	1.42	1.47	1.58	1.68	1.93	2.19
	>0.25-0.50	HCM	3.00	2.50	2.50	2.50	2.00	2.00	2.00	2.00
		Eq. ii	1.48	1.58	1.63	1.68	1.78	1.89	2.14	2.39
	>0.50-0.75	HCM	3.50	3.00	3.00	3.00	2.50	2.50	2.50	2.50
		Eq. ii	1.83	1.93	1.98	2.04	2.14	2.24	2.49	2.75
	>0.75-1.00	HCM	4.00	3.50	3.50	3.50	3.00	3.00	3.00	3.00
		Eq. ii	2.33	2.43	2.48	2.53	2.63	2.73	2.99	3.24
>5-6	0.00-0.25	HCM	2.00	2.00	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. ii	1.30	1.40	1.45	1.50	1.61	1.71	1.96	2.22
	>0.25-0.50	HCM	4.50	4.00	3.50	3.00	2.50	2.50	2.50	2.50
		Eq. ii	1.60	1.71	1.76	1.81	1.91	2.01	2.26	2.52
	>0.50-0.75	HCM	5.00	4.50	4.00	3.50	3.00	3.00	3.00	3.00
		Eq. ii	2.11	2.21	2.27	2.32	2.42	2.52	2.77	3.03
	>0.75-1.00	HCM	5.50	5.00	4.50	4.00	3.00	3.00	3.00	3.00
		Eq. ii	2.66	2.76	2.81	2.86	2.96	3.07	3.32	3.57

Table ES-3. PCE Comparison Table for Semi-tractor+Double-trailer Trucks

Upgrade (%)	Length (mi)	PCE Calculation Source	Proportion of Trucks and Buses							
			2%	4%	5%	6%	8%	10%	15%	20%
≤2	All	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. iii	1.32	1.46	1.53	1.60	1.73	1.87	2.21	2.55
>2-3	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. iii	1.35	1.49	1.55	1.62	1.76	1.89	2.23	2.57
	>0.25-0.50	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. iii	1.43	1.56	1.63	1.70	1.84	1.97	2.31	2.65
	>0.50-0.75	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. iii	1.56	1.70	1.77	1.83	1.97	2.10	2.44	2.78
	>0.75-1.00	HCM	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50
		Eq. iii	1.75	1.88	1.95	2.02	2.16	2.29	2.63	2.97
>3-4	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. iii	1.37	1.51	1.57	1.64	1.78	1.91	2.25	2.59
	>0.25-0.50	HCM	2.00	2.00	2.00	2.00	2.00	2.00	1.50	1.50
		Eq. iii	1.51	1.65	1.71	1.78	1.92	2.05	2.39	2.73
	>0.50-0.75	HCM	2.50	2.50	2.00	2.00	2.00	2.00	2.00	2.00
		Eq. iii	1.75	1.88	1.95	2.02	2.16	2.29	2.63	2.97
	>0.75-1.00	HCM	3.00	3.00	2.50	2.50	2.50	2.50	2.00	2.00
		Eq. iii	2.08	2.22	2.28	2.35	2.49	2.62	2.96	3.30
>4-5	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. iii	1.40	1.53	1.60	1.67	1.80	1.94	2.28	2.62
	>0.25-0.50	HCM	3.00	2.50	2.50	2.50	2.00	2.00	2.00	2.00
		Eq. iii	1.62	1.75	1.82	1.89	2.03	2.16	2.50	2.84
	>0.50-0.75	HCM	3.50	3.00	3.00	3.00	2.50	2.50	2.50	2.50
		Eq. iii	1.99	2.12	2.19	2.26	2.40	2.53	2.87	3.21
	>0.75-1.00	HCM	4.00	3.50	3.50	3.50	3.00	3.00	3.00	3.00
		Eq. iii	2.51	2.64	2.71	2.78	2.91	3.05	3.39	3.73
>5-6	0.00-0.25	HCM	2.00	2.00	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. iii	1.43	1.56	1.63	1.70	1.84	1.97	2.31	2.65
	>0.25-0.50	HCM	4.50	4.00	3.50	3.00	2.50	2.50	2.50	2.50
		Eq. iii	1.75	1.88	1.95	2.02	2.16	2.29	2.63	2.97
	>0.50-0.75	HCM	5.00	4.50	4.00	3.50	3.00	3.00	3.00	3.00
		Eq. iii	2.28	2.42	2.49	2.55	2.69	2.82	3.16	3.50
	>0.75-1.00	HCM	5.50	5.00	4.50	4.00	3.00	3.00	3.00	3.00
		Eq. iii	2.85	2.99	3.06	3.12	3.26	3.40	3.74	4.08

In addition to the above tables, Table ES-4 presents the PCE values obtained for each truck type for level, rolling, and mountainous terrain. The other variables values, in addition to the variable values shown in the table that these PCE values are based on, are given in Table ES-5.

Table ES-4. PCE Comparison by Terrain Type

Vehicle	Link Length (ft)	PCE by Type of Terrain					
		Level		Rolling		Mountainous	
		2-lanes	3-lanes	2-lanes	3-lanes	2-lanes	3-lanes
Single Unit Trucks	2640	1.41	1.32	1.81	1.73	2.48	2.40
	5280	1.41	1.32	2.32	2.24	3.17	3.09
Semi-tractor+trailer Trucks	2640	1.44	1.36	1.86	1.79	2.60	2.52
	5280	1.44	1.36	2.40	2.33	3.34	3.26
Semi-tractor+double-trailer trucks	2640	1.63	1.53	2.16	2.05	3.01	2.90
	5280	1.63	1.53	2.73	2.62	3.78	3.68

Table ES-5. Terrain Type Specific Input Values

Input Values	Level	Rolling	Mountainous
Prop. Specific Truck Type	0.05	0.10	0.15
Free-Flow-Speed (ft/s)	95.33	95.33	73.33
Prop. Grade	0.00	0.04	0.08
Flow Rate (veh/h/ln)	1200		

FREEPLAN and HIGHPLAN still maintain support for the use of the generalized terrain categories by applying the PCE estimation equations by assuming the grade proportions shown in the above table, grade lengths of 2640 ft for 'rolling' terrain and 5280 ft for 'mountainous' terrain, and using the values specified by the analysis for the other variables in the equations.

Although it is difficult to directly compare the PCE values from this study to those of the HCM 2010 because the HCM values are much more generalized, for similar input conditions the PCE values from this study are generally slightly lower, which is largely due to the higher power-to-weight ratios of the trucks used in this study and the more detailed vehicle dynamics modeling.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The Florida Department of Transportation's (FDOT) primary guide for conducting highway capacity and level of service analyses from planning through design is the Highway Capacity Manual (HCM). Therefore, FDOT's FREEPLAN and HIGHPLAN software programs utilize truck passenger car equivalency (PCE) values from the HCM to account for the effects of trucks on traffic flow operations. However, the PCE values in the HCM used for freeways and multilane highways are based on a study performed by Webster and Elefteriadou (1999) in the mid-1990s.

Since that time, not only have the commercial truck performance technologies changed, but also the loading conditions are considerably different today, given the tremendous growth in freight movement. Additionally, the PCE values developed in that study were based strictly on simulation and a now outdated version of CORSIM (5.0). And finally, the PCE values taken from that study for inclusion in the HCM correspond to just a single "typical" truck (although the study considered multiple categories of trucks), which may not be representative of a typical truck in Florida, and accounting for just a single truck type may lead to considerable error in level of service results in some situations.

Therefore, the FDOT sponsored this project to investigate the current commercial truck fleet characteristics in Florida and to develop truck PCE values appropriate for the commercial truck conditions on Florida freeways and multilane highways.

LITERATURE REVIEW

The first step that the research team took to develop truck PCE values was to do an extensive literature review in order to get familiar with all different PCE calculation methodologies. The first methodology to be considered was calculating PCE values based on flow rate and density. Webster and Elefteriadou (1999) estimated truck passenger car equivalents (PCE) using simulation and based their calculations on density. The authors suggested that traffic density is a good indicator of the driver's freedom to maneuver and proximity to other vehicles and most importantly is consistent with the measure of effectiveness (MOE) for freeways used in the Highway Capacity Manual (HCM).

The authors used the PCE estimation technique developed by Sumner et al. (1984), which is also based on traffic density as its MOE. The initial step is to generate a flow vs. density curve by simulating a passenger car only traffic stream at nine different flow rates spread evenly between 0 vehicles per hour per lane (veh/h/ln) and capacity. The second step is generating a similar flow vs. density curve but this time using the typical vehicle mix, including passenger cars and trucks. The third step is to replace a certain number of passenger cars, Δp, of 5%, with an equal number of the subject truck. Then the fourth step is to simulate the operations of this traffic mix at a selected traffic flow rate, q_s, and obtain the resultant traffic density, which is Point C in Figure 1.

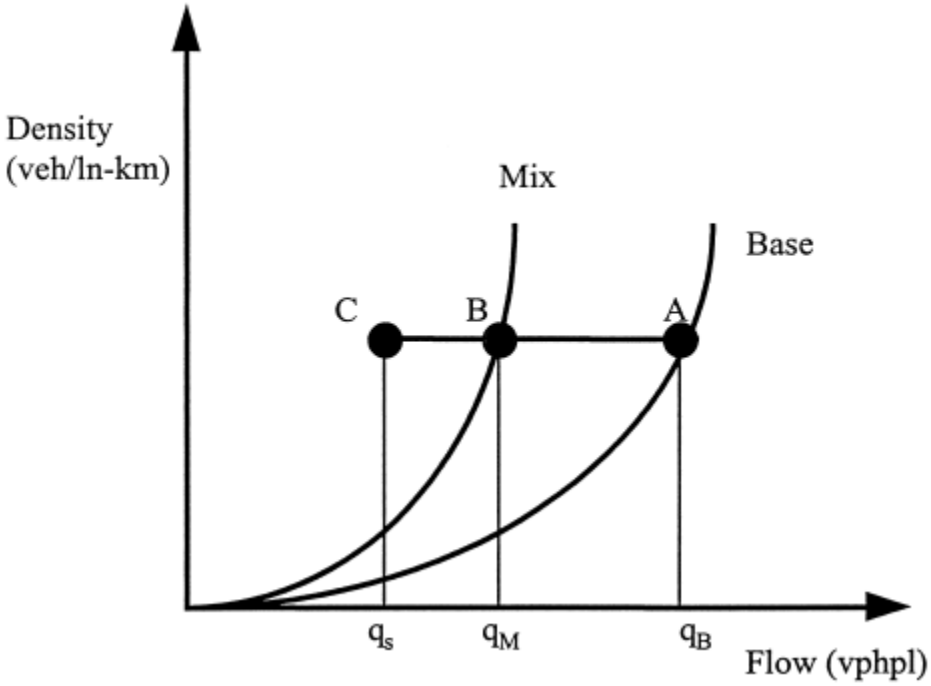

Figure 1. Illustration of Flow-Density Relationship for PCE Calculation Methodology per Sumner et al. (1984)
Figure reproduced from Webster and Elefteriadou (1999)

The fifth step is to draw a horizontal line from Point C to intersect with the mix traffic curve at Point B so that the value of q_m is obtained. The final step is to use equation $\boldsymbol{PCEs} = \frac{\mathbf{1}}{\Delta \boldsymbol{p}}\left[\frac{\boldsymbol{q_B}}{\boldsymbol{q_S}} - \frac{\boldsymbol{q_B}}{\boldsymbol{q_M}}\right] + \mathbf{1}$ [1 in order to calculate the PCEs for each subject vehicle.

$$\boldsymbol{PCEs} = \frac{\mathbf{1}}{\Delta \boldsymbol{p}}\left[\frac{\boldsymbol{q_B}}{\boldsymbol{q_S}} - \frac{\boldsymbol{q_B}}{\boldsymbol{q_M}}\right] + \mathbf{1} \qquad \textbf{[1]}$$

The simulated freeway section that was used by the authors is depicted in Figure 2.

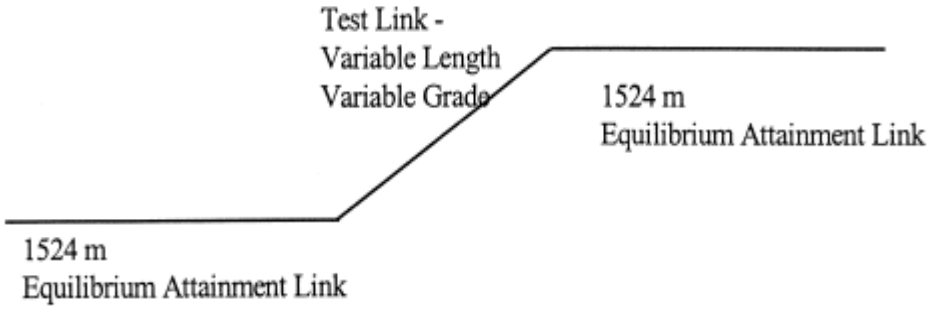

Figure 2. Webster and Elefteriadou Experimental Roadway Configuration

The authors generated several PCE tables for different types of heavy vehicles and concluded by stating that the PCEs tend to increase with traffic flow, free flow speed, and grade/length of grade. In addition, PCEs tend to decrease with an increase in truck percentage and number of lanes.

The methods used in this paper agree the most with the HCM methodology since it is more logical to base PCEs on density for freeway operational analysis because density is the performance measure used to define LOS (i.e., service measure) for freeways in the HCM.

Werner and Morrall (1976) looked at calculating PCE values based on capacity and headway. The authors estimated trucks, buses and recreational vehicle PCEs, however their paper mainly discusses the effects that recreational vehicles (RVs) have on highway capacity. In addition, they discussed the methods referred to in the 1965 HCM for determining PCEs and how the new PCEs should be used for typical highway capacity computations. The authors state that the results obtained in their study strongly indicated that the 1965 HCM PCE speed curves and adjustment factors in the 1965 HCM require refinement, particularly at slower speeds. Therefore, the authors offered a revised set of values by applying basic traffic engineering relationships. The methods used in Werner and Morrall's paper were not chosen for calculating PCE values for this project because the authors mainly deal with the older HCM methodology of calculating PCEs based on speed curves, whereas the current HCM methodology to calculate LOS is based on density.

Al Kaisy et al. (2002) investigated the hypothesis that the effect of heavy vehicles on traffic during congestion is greater than their effect under saturated conditions. The authors developed a new approach to derive PCEs using queue discharge flow (QDF) capacity as the equivalency criterion. The sites that were used for this research were an entrance ramp merge area and a long-term freeway construction zone. However, the method used in this paper was

not chosen for calculating the PCE values for this project since the research team was not interested in a queue discharge scenario, but normal traffic operation conditions.

Van Aerde and Yagar (1983) derived PCE values using a speed reduction method that was based on relative rates of speed reduction for each type of vehicle traveling in the main direction and for all vehicles in the opposing direction. The analysis of their data suggested that a general speed-volume curve shape consisted of two distinct parts: a linear section depicting normal operating conditions and a nonlinear section depicting breakdown in flow as the capacity is approached. Therefore, the authors focused on the linear section of the speed volume curve since it mainly represents the entire range of practical operating volumes.

A linear approximation was found by the authors to fit the data for each of the 10th, 50th and 90th speed percentiles and a multiple linear regression model was structured in equation $\boldsymbol{Percentile\ Speed = Free\ Flow\ Speed + (C1 \times \#\ cars) + (C2 \times \#\ trucks) + (C3 \times \#\ RV) + (C4 \times \#\ other\ vehicles) + (C5 \times \#\ opposing\ vehicles)}$ [2:

$$\boldsymbol{Percentile\ Speed = Free\ Flow\ Speed + (C1 \times \#\ cars) + (C2 \times \#\ trucks) + (C3 \times \#\ RV) + (C4 \times \#\ other\ vehicles) + (C5 \times \#\ opposing\ vehicles)} \quad \textbf{[2]}$$

Using this multiple linear regression model, the free flow speed and the speed reduction coefficients C1-C5 were estimated. The authors suggested that C1-C5 indicated the relative sizes of speed reductions for each vehicle type. The final PCE values for each vehicle type were calculated by using equation 2, where Cn is the coefficient for the vehicle type that you are trying to calculate the corresponding PCE for.

$$PCE_n = \frac{Cn}{C1} \quad \textbf{[3]}$$

The Van Aerde and Yagar paper, similar to the papers that were published in the early 1980s, estimates the PCEs by mainly using speed relationships. However, even though the HCM methodology was tailored for speed relationships in its earlier versions, the current HCM MOE to calculate LOS is density. Therefore, this methodology was not chosen to be the PCE estimation methodology for this project.

Cunagin and Messer (1983) calculated PCE values by using ratio of delay experienced by pc due to non-pc to the delay by a pc due to other pc. In addition, the authors used speed distributions, traffic volume and vehicle type to come up with the PCE. It should be noted that, similar to the early 1980s' papers, the PCE values were mainly derived from vehicle speed.

Another methodology was introduced by Fan (1990), for which the author used data that was obtained from a Singapore expressway. Fan focused on *v/c* ratios that are higher than 0.67, therefore congested traffic data was used rather than uncongested. The author then estimated the PCEs by using a multiple linear regression model that multiplies the observed flow by the v/c ratios. This paper used *v/c* ratios to estimate the PCE values on an island expressway with 50 km/h speed limit. Not only the location of the data is not representative of the Florida freeway conditions, but also the used MOE (*v/c* ratio) is not very agreeable with the HCM methodology that mainly focuses on density as its main MOE to calculate LOS.

Sumner et al. (1984) generated a methodology to calculate PCE values between consecutive signalized intersections on urban arterial roads using NETSIM to obtain vehicle hours. However, for the purposes of this project, signalized intersection PCE estimation methodologies could not be used. Therefore, this methodology was not selected to estimate the PCE values for this project.

Van Aerde and Yagar (1983) also looked at deriving PCE values using a platoon leadership and follower creation. The authors used the radar-platoon technique for their data collection efforts. However, a reviewer of their original publication criticized this method since it is very sensitive to the definition of what headway separation constitutes a different platoon. The authors replied by stating that they gathered a group of people from different backgrounds and there was unanimous agreement where the platoons started and ended for their study. However, this methodology does not agree with the current HCM LOS calculation MOEs, and does not give any indication of density since it only looks at the platoon formation aspect.

Keller and Saklas (1984) looked at travel time to estimate PCE values. More specifically, the authors used signal timing for urban arterial networks in order to calculate the PCE values. However, since the focus of our project is freeways, this methodology was not chosen to estimate the PCEs for this project.

DATA COLLECTION

Truck Classification and AADT Data

In order to obtain information on the current commercial truck fleet in Florida freeways and multilane highways, the research team obtained physical and power characteristics for Mack, Peterbilt, Volvo, and Kenworth brand commercial trucks. For the Mack brand, physical and power characteristics for models Pinnacle and Titan were obtained. For the Peterbilt brand, physical and power characteristics for models 386, 388, and 587 were obtained. For the Volvo brand, the physical and power characteristics for models VN 630, 780, and VNL 430 were obtained. Lastly, for the Kenworth brand, physical and power characteristics for models T700, T800, and W900 were obtained. Table 1 summarizes the common engine characteristics of these truck types.

Table 1. Heavy Vehicle Fleet Common Engine Characteristics (HP and Torque)

Heavy Vehicle Brand	Typical Engine Type	Horsepower (hp)	Torque (ft-lb)
Mack-Pinnacle	MP 7 MP 8	325-405 415-505	1260-1560 1460-1760
Mack-Titan	MP10 MCruise	515-605	1860-2060
Peterbilt 386	Paccar MX	385-485	1450-1750
Peterbilt 388	Cummins ISX15	400-600	1450-1850
Peterbilt 587	Cummins ISX15	400-600	1450-1850
Volvo 630	Volvo D13	375-500	1450-1750
Volvo 780	Volvo D16	500-550	1450-1850
Volvo 430L	Volvo D11	325-405	1250-1450
Kenworth T-700	Paccar MX	385-485	1450-1750
Kenworth T-800	Cummins ISX15	400-600	1450-1850
Kenworth W-900	Cummins ISX15	400-600	1450-1850

In addition, to obtain truck classification data from Florida freeways and highways, Mr. Richard Reel of FDOT's Statistics Office provided a list of 24 Active Permanent Weigh-in-Motion (WIM) Stations that are located on Florida freeways and highways. In addition, Mr. Reel also supplied the research team with a DVD that contains the 2010 FDOT Florida Traffic Information so that data on AADT, total truck volume, truck classes, and corresponding volumes for each of the 24 WIM stations for the years 2008, 2009, and 2010 could be obtained. These data were

organized in tables (two data tables per page for each WIM station) and are shown in Table 14 through Table 61 in Appendix A.
Using these data, Table 2 provides the overall truck classification history. In addition,

Table 3-Table 6 represent the truck classification history based on area type and roadway type.

Table 2. Overall Truck Classification History as % of Truck AADT

Truck Class #	Total Volume Per Truck Class	% of AADT
5	26326	25.36%
6	6354	6.12%
7	1092	1.05%
8	10456	10.07%
9	55446	53.41%
10	605	0.58%
11	2159	2.08%
12	1100	1.06%
13	275	0.26%
TOTAL %		100.00%

Table 3. Urban/Freeway Truck Classification History as % of Truck AADT

Truck Class #	Total Volume Per Truck Class	% of AADT
5	15089	28.62%
6	3500	6.64%
7	671	1.27%
8	5883	11.16%
9	25482	48.33%
10	335	0.64%
11	1118	2.12%
12	470	0.89%
13	172	0.33%
TOTAL %		100.00%

Table 4. Urban/Multilane Highway Truck Classification History as % of Truck AADT

Truck Class #	Total Volume Per Truck Class	% of AADT
5	2976	33.57%
6	1481	16.71%
7	314	3.54%
8	910	10.27%
9	3094	34.91%
10	41	0.46%
11	24	0.27%
12	13	0.15%
13	11	0.12%
TOTAL %		100.00%

Table 5. Rural/Freeway Truck Classification History as % of Truck AADT

Truck Class #	Total Volume Per Truck Class	% of AADT
5	5122	17.03%
6	791	2.63%
7	45	0.15%
8	2407	8.00%
9	20100	66.83%
10	173	0.58%
11	862	2.87%
12	532	1.77%
13	46	0.15%
TOTAL %		100.00%

Table 6. Rural/Multilane Highway Truck Classification History as % of Truck AADT

Truck Class #	Total Volume Per Truck Class	% of AADT
5	3139	25.83%
6	582	4.79%
7	62	0.51%
8	1256	10.34%
9	6770	55.72%
10	56	0.46%
11	155	1.28%
12	85	0.70%
13	46	0.38%
TOTAL %		100.00%

From Table 2 through Table 6, it was determined that truck classifications 5, 6, 8, 9, 11 and 12 are the most prevalent truck types on Florida multilane highways and freeways. Considering the truck characteristics and the similarities between some of these truck types, four truck classes were generated, namely, Classes 5&6 combined under Single Unit Truck, Class 8 as Intermediate Semi-trailer, Class 9 as Interstate Semi-trailer, and Classes 11&12 combined under Double-Bottom Trailer. Figure 3. FHWA Vehicle presents the FHWA Vehicle Classification scheme and the corresponding vehicle class numbers used in this report.

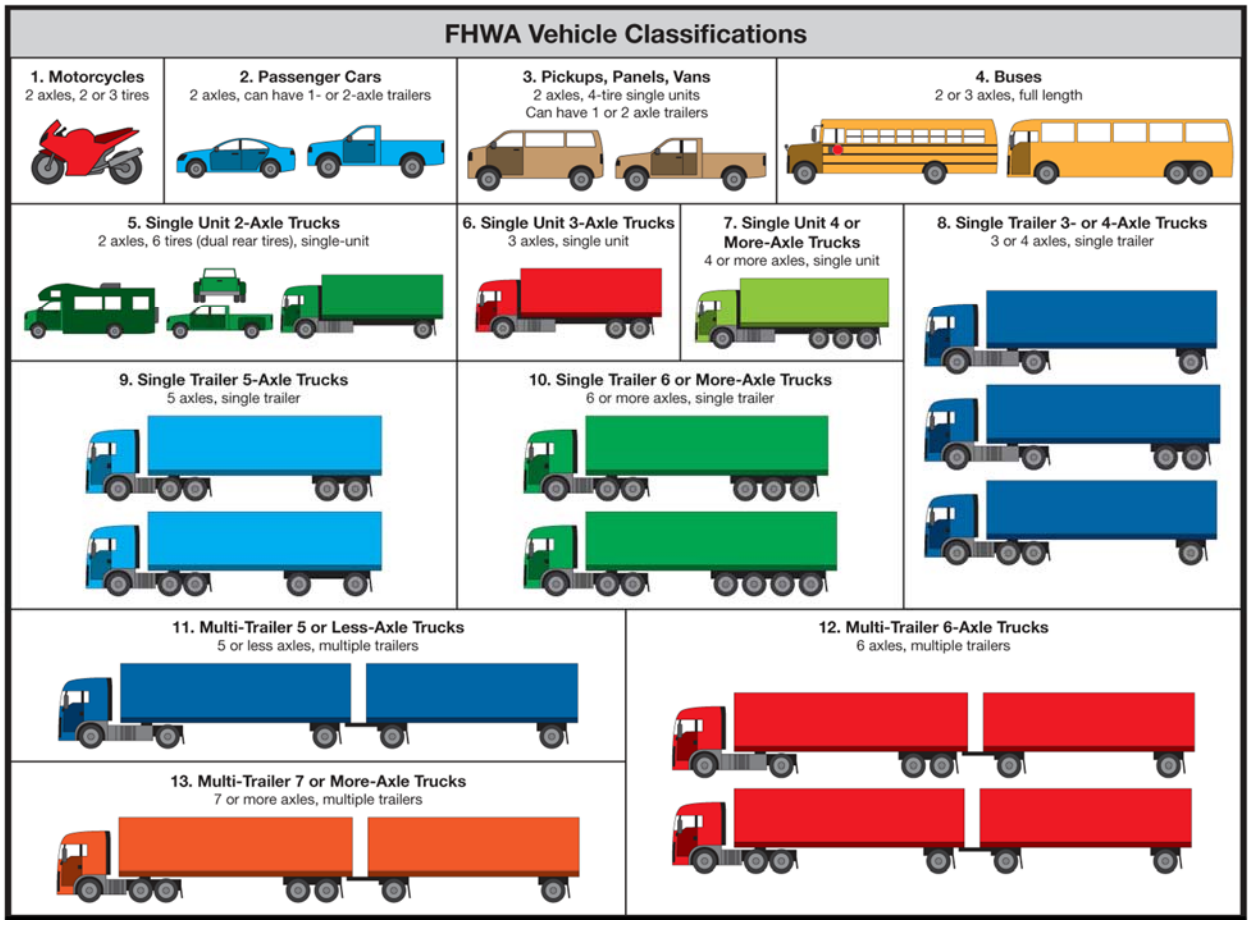

Figure 3. FHWA Vehicle Classifications

Truck Characteristics Data

In addition to the truck classification and AADT data obtained using the 2010 FDOT Florida Traffic Information DVD, the truck characteristics data such as weight loadings, length of truck, speed of truck, etc. were obtained by processing and analyzing the data obtained from the 24 weigh-in-motion (WIM) stations throughout the state. These data were obtained in raw WIM data format for the past 3 years from Mr. Richard Reel of FDOT. In order to obtain this data, the raw data needed to be processed by the research team. The first step in the processing of the files was to use the PAT software program to convert the original binary files into ASCII format. This step is necessary since the PAT software is proprietary and the organization of the data in the original binary files is not published. The next step was to process the ASCII files to obtain various statistics for each station such as speed for each class, average speed for all classes, weight for each class, average weight for all classes, frequency for each class, etc. Since there is a very large number of data files that need to be processed (approximately 44,000, for 4 years of data across 24 WIM stations), a custom WIM data-processing program was developed in the C# programming environment to automate this process. This program has capabilities such as choosing a specific data folder, moving selected folders to a new folder, renaming the files of interest for analysis purposes and reading/processing the WIM files to produce results. In

addition, once the files are analyzed, the program has the capability of allowing the user to select the WIM stations of interest, either one by one or in groups. Also, the program can distinguish between WIM stations by area and facility type and can aggregate results for full day or time of day analysis. Figure 11 and Figure 12 in Appendix B present the control windows for all of these capabilities of the C# data processing program.

Making full use of the capabilities of this program, two categories of results were obtained, namely, Full Day and Time of Day [Morning Peak (6-9 am), Mid-Day (11 am-1 pm) and Evening Peak (4-7 pm)] so that the effects of full day versus time of day could be observed. In addition, the results were further divided by area type into Urban and Rural as well as by facility type into Multilane Highway and Freeway. The results obtained are summarized in Table 62 through Table 81 under Appendix C.

The data in these tables represent the field conditions on Florida multilane highways and freeways, and the values presented in these tables were used for generating the four heavy vehicle types and their characteristics during simulation modeling as described under the research approach section.

RESEARCH APPROACH

Simulation Platform

In order to obtain the analysis data, the research team used traffic simulation due to the fact that collecting field data for the varying levels of all the desired study parameters (roadway and traffic) would be an extremely expensive and time consuming approach. Instead, the traffic stream data were obtained through simulation.

At the UF-TRC, CORSIM is typically the simulation tool of choice. However, the current version of CORSIM (6.3) was not used in this study because it was felt that the simplistic method of determining maximum truck acceleration values (a lookup table with acceleration based simply on velocity, in course intervals of 10 ft/s) would not be sufficient for this study. Furthermore, the relationship between these table values and the grade adjustment factor is convoluted, at best; thus, making it difficult to ensure that effect of grade on acceleration is being properly accounted for. Unfortunately, the software architecture of the current version of CORSIM is also not amenable to implementing a more comprehensive, and accurate, vehicle acceleration model.

Therefore, a completely new version of CORSIM, referred to as CORSIM Next Generation (CORSIM-NG), which has been under development for the past couple of years, led by Dr. Washburn, but not yet publicly available, was utilized for this project. CORSIM-NG is a micro-simulation tool that employs state-of-the-art software architecture. This architecture is object-oriented and built on the C# / .NET framework programming model, which allows for a high level of extensibility and modularity. The new architecture also supports a high level of fidelity with respect to temporal and spatial modeling resolution.

Much of the vehicle-movement logic in CORSIM-NG is the same as that employed in CORSIM 6 (the current publicly available version of CORSIM), with the following exceptions:

- CORSIM-NG uses the Modified Pitt car-following model (Cohen, 2002) as opposed to CORSIM 6's Pitt car-following model.
- The discretionary lane-changing logic has been enhanced by adding logic to bias (but not restrict) slower moving vehicles to the right-side lanes. For example, for a 3-lane roadway, the slowest vehicles in the traffic stream will generally be in the far-right lane, the fastest vehicles will be in the far-left lane, and "average" speed vehicles will be in the middle lane. However, unlike a lane restriction scenario, any of these vehicles can still use other lanes, which might happen temporarily for conducting passing maneuvers. This logic particularly comes into play for the truck vehicle types on grades. The trucks generally have somewhat lower desired speeds than the passenger cars, so they are more likely to be in the right- or middle-lane (of a 3-lane roadway) than in the left lane, but regardless of which lane they are initially in, as they begin to lose speed on a grade, they will look to move to the right-side lanes. For a smaller truck type (e.g., the single-unit truck) on a moderate grade, it still may be able to maintain its desired speed and therefore will not be biased toward the right-side lanes.

Some other notable differences between CORSIM-NG and CORSIM 6 include:

- A 0.1-second simulation time resolution instead of 1 second for CORSIM 6.

- Explicit modeling of vehicle paths from system entry to system exit. CORSIM 6 does not explicitly model vehicle movements through an intersection area--the animation component of CORSIM 6, TrafVu, interpolates vehicle positions through the intersection areas based on estimated intersection vehicle entry and exit times from CORSIM 6.

In general, because of the object-oriented architecture of CORSIM-NG, there are many more possibilities of what we can model versus CORSIM 6, as well as model the same things that CORSIM 6 is currently capable of modeling, but with greater detail and accuracy. As one example, in CORSIM-NG vehicles and drivers are separate objects, whereas in CORSIM 6, there is a driver type property that is integral to the vehicle definition. By having separate vehicle and driver objects, there is much more flexibility in the properties that can be assigned to both and how the two objects can be coupled together.

One of the key features of CORSIM-NG is the ability to model individual vehicle characteristics and dynamics in great detail, which was specifically used for this project to model truck characteristics and dynamics to replicate their behavior in the traffic stream.

Additionally, passenger car and truck characteristics data such as vehicle height, vehicle width, vehicle length, vehicle's wheel radius, engine power, engine torque, transmission gear ratios, etc. were also obtained by the research team and incorporated into the CORSIM-NG simulation program to ensure accurate representation of the real vehicles in the simulation process. These data are summarized in Table 7.

Table 7. Vehicle Characteristics Data

	Passenger Car	Single Unit Truck	Intermediate Semi-Trailer	Interstate Semi-Trailer	Semi-tractor+double-trailer
Vehicle Height (ft)	4.46	10.00	10.00	10.00	10.00
Vehicle Width (ft)	5.74	7.00	8.00	8.00	8.00
Vehicle Length (ft)	16.00	29.00	55.00	68.50	74.60
Vehicle Weight (lb)	3060	25,000	37,000	53,000	55,000
Maximum Torque (lb-ft)	139	660	1650	1650	1650
Maximum Power (hp)	197	300	485	485	485
Wheel Radius (ft)	1.03	1.66	1.66	1.66	1.66
Differential Gear Ratio	4.77	4.40	3.50	3.50	3.50
Transmission Gear Ratios					
Gear 1	3.27	7.59	11.06	11.06	11.06
Gear 2	2.13	5.06	8.20	8.20	8.20
Gear 3	1.52	3.38	6.06	6.06	6.06
Gear 4	1.15	2.25	4.49	4.49	4.49
Gear 5	0.92	1.50	3.32	3.32	3.32
Gear 6	0.66	1.0	2.46	2.46	2.46
Gear 7	N/A	0.75	1.82	1.82	1.82
Gear 8	N/A	N/A	1.35	1.35	1.35
Gear 9	N/A	N/A	1.00	1.00	1.00
Gear 10	N/A	N/A	0.74	0.74	0.74

New Truck Acceleration Curves

In order to develop the Florida truck PCE values, the initial step was to generate the new truck acceleration profile curves that would be introduced into CORSIM-NG for the simulation of Florida traffic conditions. This way the performance characteristics of the current Florida truck fleet would be represented in the PCE calculations. Several different methods for determining vehicle acceleration capabilities have been proposed in the literature. The research team evaluated three different methods briefly described as follows.

The first method relies on detailed calculations for engine-generated tractive effort and maximum tractive effort (maximum force that can be handled at the tire-pavement interface). This approach also requires detailed information on engine performance (power and torque) and transmission configuration (number of gears and gear ratios). For heavy vehicles, the engine-generated tractive effort (as opposed to maximum tractive effort) is almost always the controlling factor for acceleration. In addition to these forces, various resistance forces are also considered, since they counteract the tractive effort generated by the engine. These resistance forces are aerodynamic, rolling, and grade resistance. This first method (labeled as HP-Torque) is based on formulas as outlined in textbooks by Mannering and Washburn (2012) and Wong (2008). In these formulations, Paccar MX engines with a HP-Torque rating of 480 HP and 1650 lb-ft were used for Intermediate/Interstate Semi-trailers and Double-Bottom Trailers. In addition, Paccar PX-6 300 engines with a HP-Torque rating of 300 HP and 660 lb-ft were used for Single-Unit trucks. The second method (labeled as Al-Kaisy/Rakha) uses formulas as outlined in Al Kaisy et al. (2005). These formulas are generally consistent with the conceptual approach used in the first method, but incorporate some simplifying assumptions to reduce the computational effort. The third method (labeled as TSPM) uses the same methodology as highlighted in St. John and Kobett (1978). Again, this methodology is generally consistent with the conceptual approach in method 1 but uses some simplifying assumptions, but does consider an additional factor not used in either method 1 or 2 (namely, the effect of gear-shift time).

After these three different methods were evaluated, the research team generated two sets of acceleration vs. speed curves so that a comparison between the three methodologies could be obtained. The first set was developed for level grades and the second set for 5 % grades. These acceleration versus speed curves are depicted in Figure 13 through Figure 20 in Appendix D.

By analysis of these curves, it was determined that the results obtained by using this second method were the most reasonable set. In addition, these results were found to be a good compromise between accuracy and computational effort when compared to the other two models. Therefore, this methodology (Al Kaisy et. al. 2005) was chosen for the acceleration profile calculations and was incorporated into CORSIM-NG.

TruckSim

As a part of the data collection, the research team originally intended to collect data at one or more WIM stations on non-level terrain. However, via conversations with Mr. Richard Reel (FDOT Statistics Office), it was determined that all of the WIM stations, as well as all permanent count stations, in Florida are located on level, or very nearly level, terrain sites.

As an alternative approach, the research team obtained a copy of the TruckSim software program to help with the task of determining truck acceleration performance on grades. TruckSim provides detailed simulation of individual trucks, based on mathematical models of the truck's powertrain (engine, transmission) and physical characteristics. TruckSim was used to

determine the acceleration capabilities of a truck on varying grades and this information was used to validate the truck acceleration calculation methodology results as discussed under the previous section. With this software, it allowed us the opportunity to further evaluate the truck acceleration curves previously developed.

Figure 4 through Figure 7 depict some of the main control windows in TruckSim as well as the results that could be obtained.

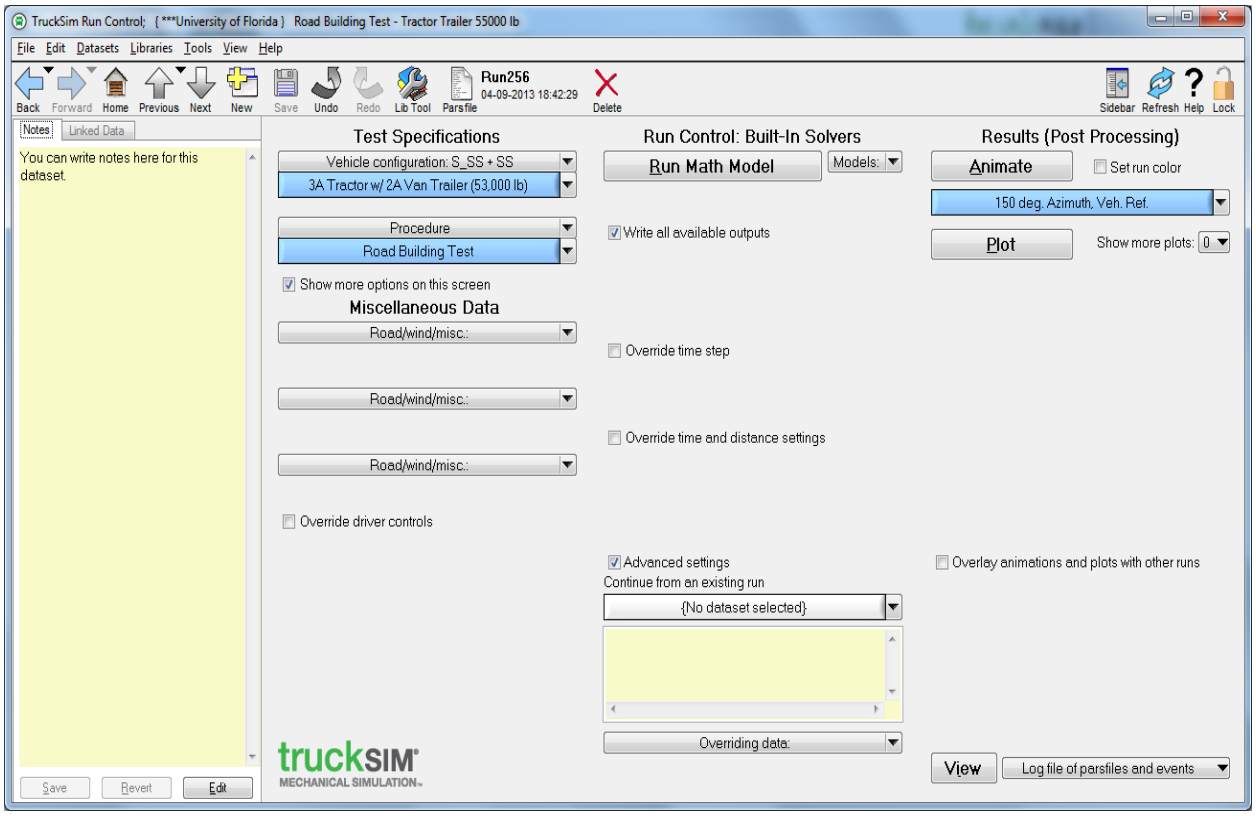

Figure 4. TruckSim Run Control Window

Through the run control window, the user can select the heavy vehicle configuration that they want to analyze. In addition, the procedure/test that wants to be analyzed is also set from this window by changing the roadway attributes, such as segment length, segment grade, etc.

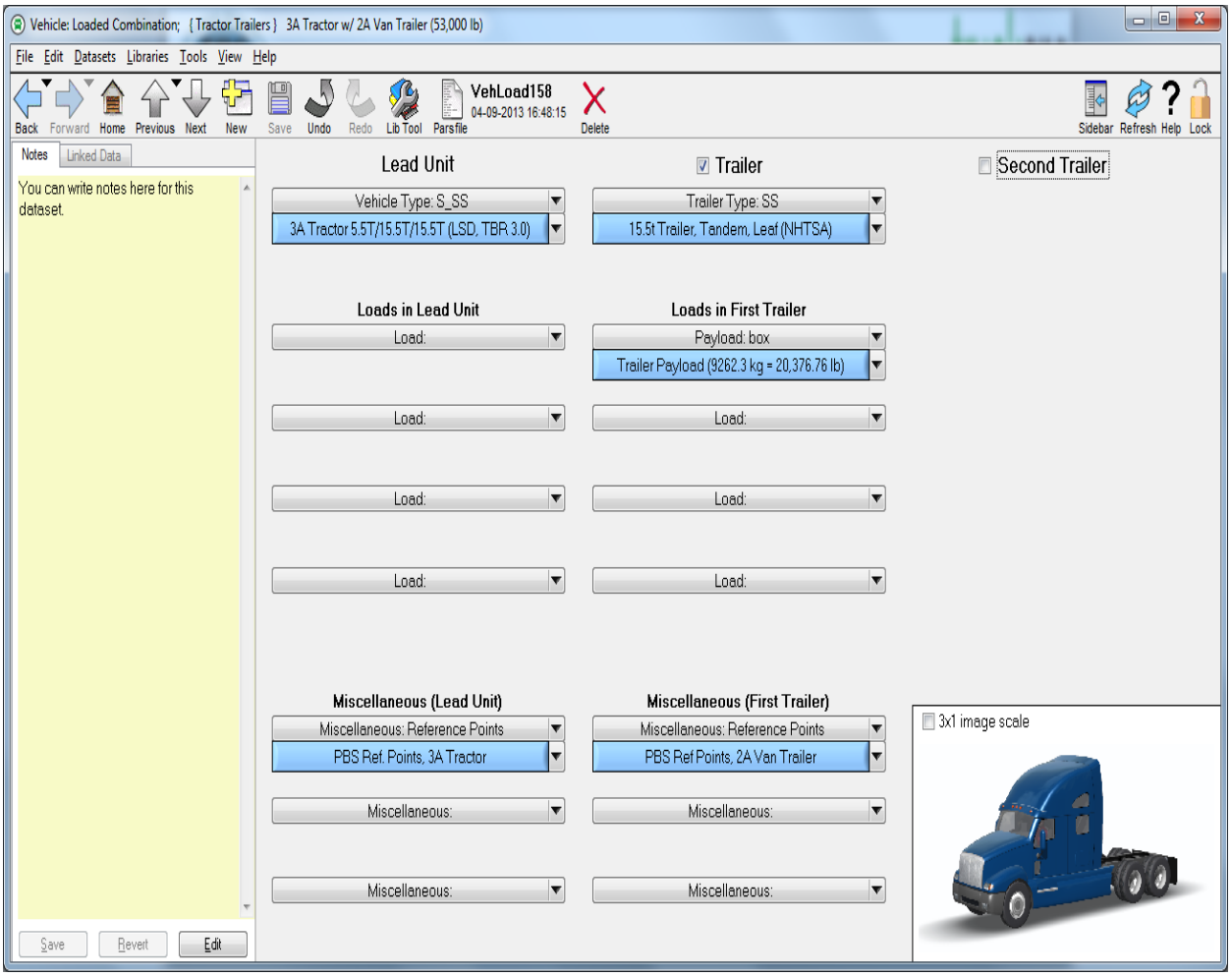

Figure 5. TruckSim Vehicle Attributes Window

Through the usage of the TruckSim vehicle attributes window, the user can specify the heavy vehicle that they want to analyze, as well as the trailers and payloads that are associated with this specific heavy vehicle.

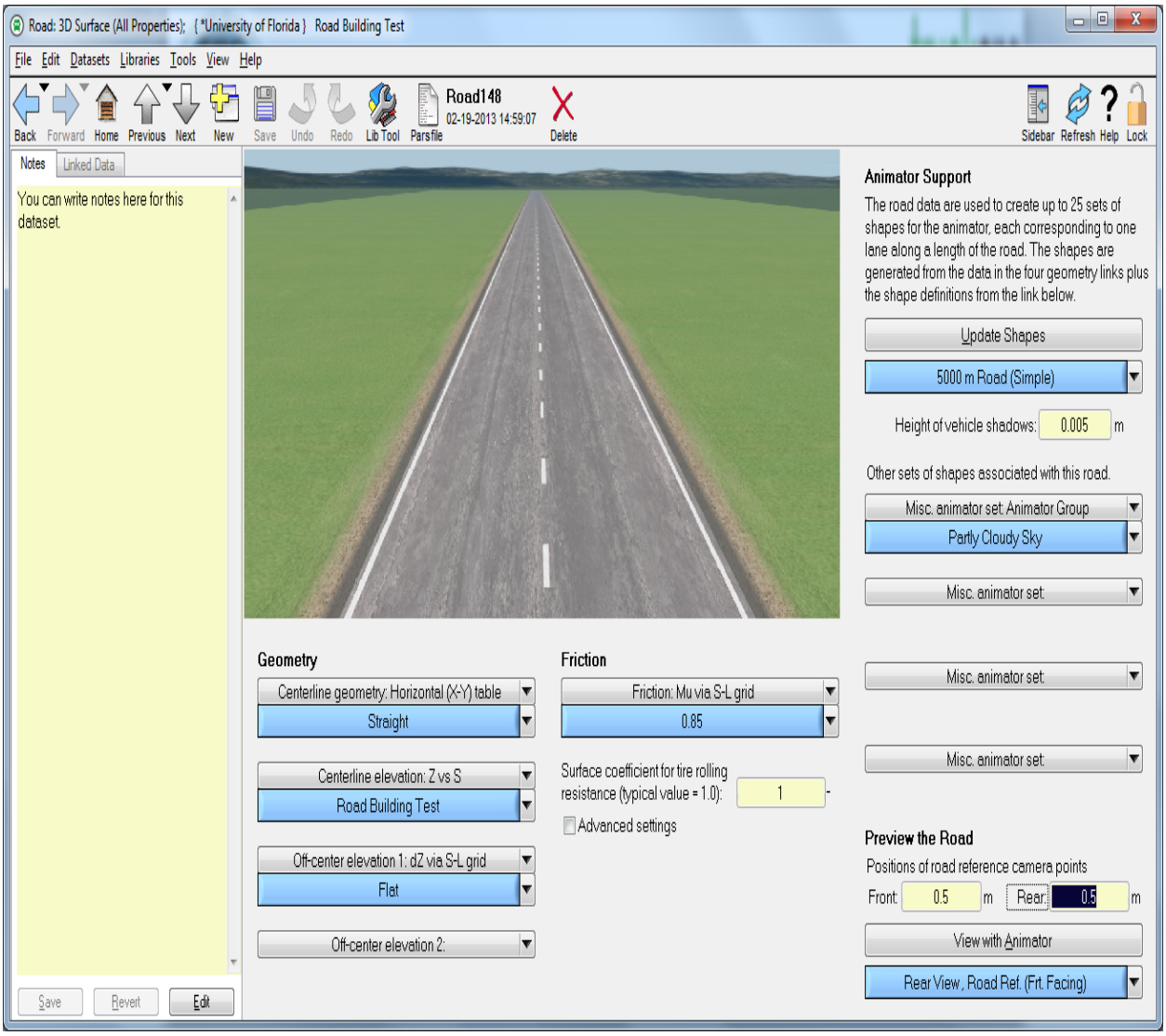

Figure 6. TruckSim Roadway Geometry Window

By utilizing the TruckSim roadway geometry window, the user has the ability to set the type of roadway characteristics for their analyses, including grade, length, etc.

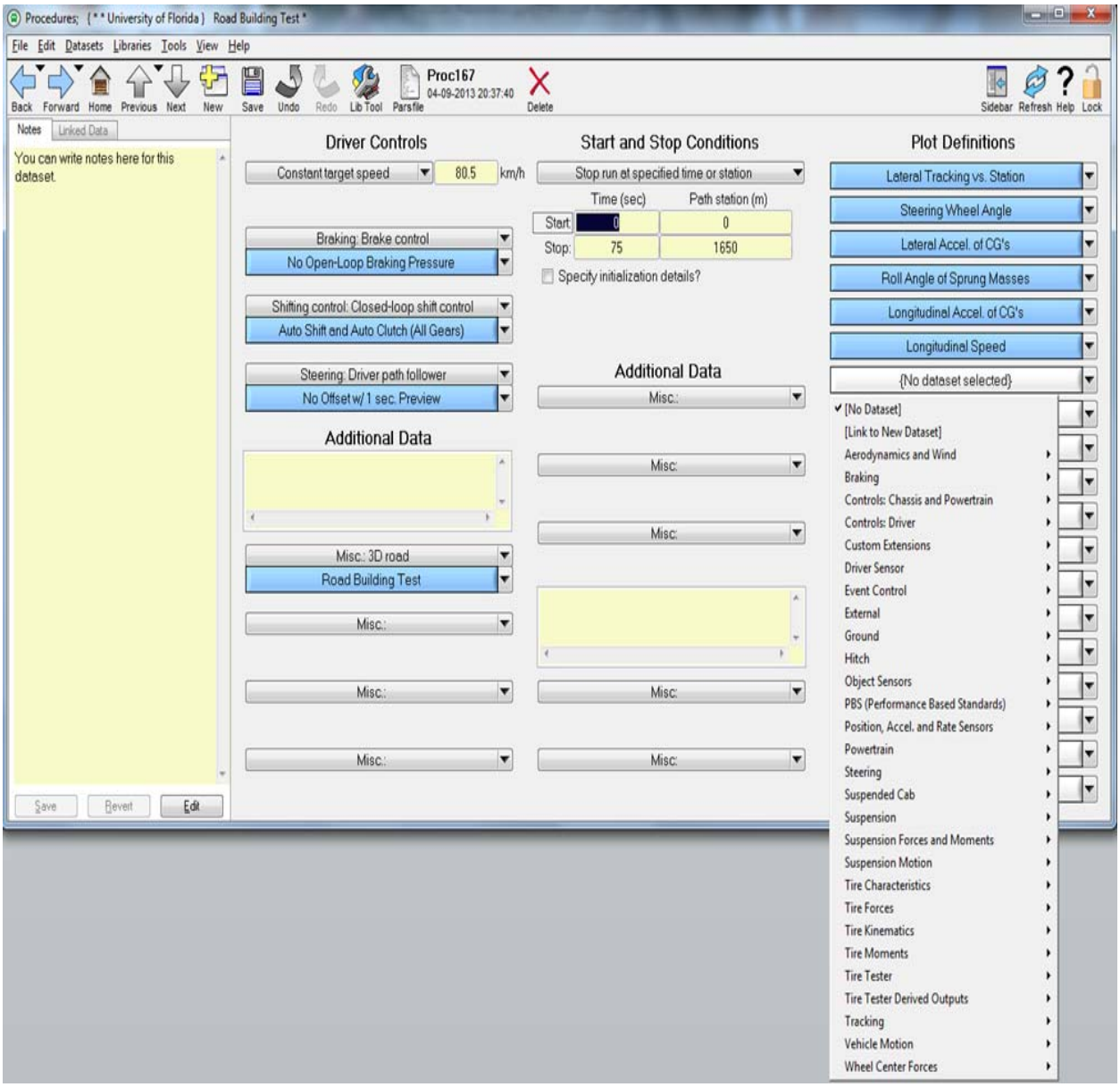

Figure 7. TruckSim Plot Outputs Window

The user can specify the plots that they would like to use in their analyses and get the TruckSim outputs accordingly. In addition, all of the plot outputs are available to be saved as a text file to the users discretion.

At this point the research team ran tests with Single Unit, Intermediate Semi-trailer, Interstate Semi-trailer and Semi-tractor+double-trailer trucks both using the revised CORSIM-NG and TruckSim. The tests that were run were to compare the acceleration and velocity outputs and have a close matchup so that the revised CORSIM-NG results could be validated before starting the PCE calculations. Segment lengths of 1320, 1760, and 2640 were utilized for different grades such as 3, 6, and 9 %. Figure 21 through Figure 30 in Appendix E present the results that were obtained by these test runs.

By examining the TruckSim and revised CORSIM-NG acceleration and velocity results for the heavy vehicles of interest, which facilitated a more detailed analysis than the general acceleration curves initially developed, it was determined that the differences between the two sets of results were larger than desired. These differences were largely due to the fact that the Al-Kaisy/Rakha acceleration model does not take into account the gear shifting characteristics of heavy vehicles, whereas the TruckSim model does. This causes inconsistencies between the velocities of the two models and therefore will affect the traffic streams generated by either of these models differently. At this point, it was decided that accounting for gear shifting was a significant enough factor that it should be accounted for in the truck acceleration calculation model. Another limitation that arises from ignoring transmission gear changes is that it is assumed that peak engine power is always available, which is often not the case; thus, acceleration values from the simplified model tend to be more optimistic than those obtained from a model that considers gear shifts.

Therefore, the research team decided to revise the heavy vehicle acceleration calculation model to account for the gear shifting capabilities of heavy vehicles. For this effort, the research team calculated gear changing speeds for the passenger car and the four truck types of interest using vehicle dynamics equations from Mannering and Washburn (2012). In addition, the research team obtained typical transmission gear ratios for these vehicles using transmission information from Wong (2008) and the Internet (Refs. 18-20).

The approach used to model vehicle acceleration in CORSIM-NG is based on the vehicle performance theory and equations given in *Principles of Highway Engineering and Traffic Analysis* (Mannering and Washburn, 2012). An overview of this approach is given here.

The approach at its most basic level determines acceleration through the fundamental equation relating tractive force to resistance forces, as follows.

$$F = ma + R_a + R_{rl} + R_g \quad \textbf{[4]}$$

The tractive force, F, referred to here as available tractive effort, is taken as the lesser of maximum tractive effort and engine-generated tractive effort. Maximum tractive effort is a function of several of the vehicle's physical characteristics (such as wheelbase, center of gravity, and weight) and the roadway coefficient of road adhesion. Maximum tractive effort represents the amount of longitudinal force that can be accommodated by the tire-pavement interface. Engine-generated tractive effort is a function of engine torque, transmission and differential gearing, and drive wheel radius. For vehicles with low power-to-weight ratios, such as commercial trucks, maximum tractive effort is very rarely the governing condition. Thus, the acceleration calculations for trucks in CORSIM-NG are based on engine-generated tractive effort.

The major resistance forces are aerodynamic, rolling, and grade. The equation for determining aerodynamic resistance is

$$R_a = \frac{\rho}{2} C_D A_f V^2 \quad \textbf{[5]}$$

where

R_a = aerodynamic resistance in lb,

ρ = air density in slugs/ft^3,
C_D = coefficient of drag (unitless),
Af = frontal area of the vehicle (projected area of the vehicle in the direction of travel) in ft^2, and
V = speed of the vehicle in ft/s.

The coefficient of rolling resistance for road vehicles operating on paved surfaces is approximated as

$$f_{rl} = 0.01\left(1 + \frac{V}{147}\right) \quad \textbf{[6]}$$

where

f_{rl} = coefficient of rolling resistance (unitless), and
V = vehicle speed in ft/s.

The rolling resistance, in lb, is simply the coefficient of rolling resistance multiplied by W cos θg, the vehicle weight acting normal to the roadway surface. For most highway applications θg is very small, so it can be assumed that cos $\theta_g = 1$, giving the equation for rolling resistance (R_{rl}) as

$$R_{rl} = f_{rl} W \quad \textbf{[7]}$$

Grade resistance is simply the gravitational force (the component parallel to the roadway) acting on the vehicle. The expression for grade resistance (Rg) is

$$R_g = W \sin\theta_g \quad \textbf{[8]}$$

As in the development of the rolling resistance formula, highway grades are usually very small, so sin $\theta_g \cong$ tan θ_g. Thus, grade resistance is calculated as

$$R_g \cong W \tan\theta_g = WG \quad \textbf{[9]}$$

where

G = grade, defined as the vertical rise per some specified horizontal distance in ft/ft.

Grades are generally specified as percentages for ease of understanding. Thus a roadway that rises 5 ft vertically per 100 ft horizontally ($G = 0.05$ and $\theta g = 2.86°$) is said to have a 5% grade.

The relationship between vehicle speed and engine speed is

$$V = \frac{2\pi r n_e (1-i)}{\varepsilon_0} \quad \textbf{[10]}$$

where

V = vehicle speed in ft/s,
n_e = engine speed in crankshaft revolutions per second,
i = slippage of the drive axle, and
ε_0 = overall gear reduction ratio

The overall gear reduction ratio is a function of the differential gear ratio and the transmission gear ratio, which is a function of the selected transmission gear for the running speed. This equation can be rearranged to solve for engine speed given the current vehicle speed (if vehicle speed is zero, engine speed is a function of throttle input).

With the calculated engine speed, the torque being produced by the engine can be determined from the torque-engine speed relationship. For example, assuming an engine speed of 2000 revolutions/min with the torque-engine speed relationship (Paccar PX-7 Engine) shown in Figure 8 (Ref. 21), the resulting torque is 660 ft-lb. In addition, Figure 9 shows the torque-engine speed relationship for a Paccar MX-13 engine (Ref. 22).

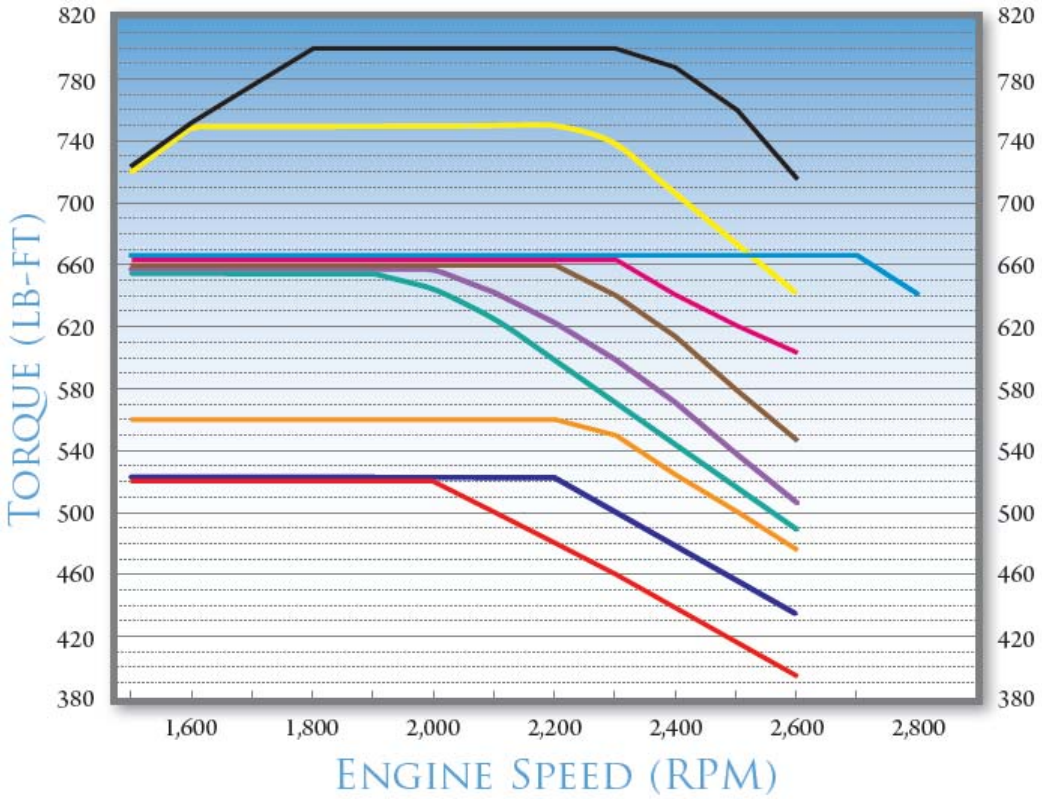

Figure 8. Torque-Engine Speed Curve for a Paccar PX-7 Engine

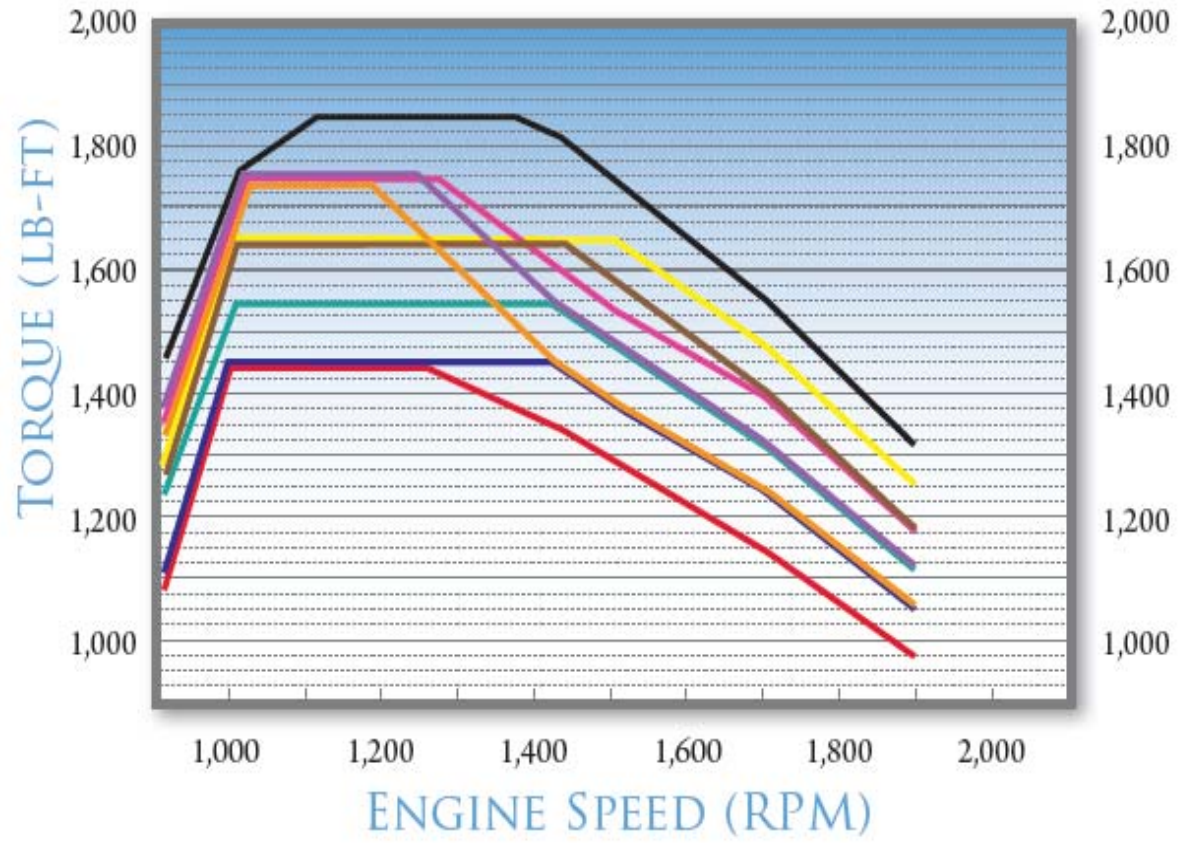

Figure 9. Torque-Engine Speed Curve for a Paccar MX-13 Engine

Power is the rate of engine work, expressed in horsepower (hp), and is related to the engine's torque by the following equation:

$$\text{hp}_e = \frac{2\pi M_e n_e}{550} \qquad \textbf{[11]}$$

where

hp_e = engine-generated horsepower (1 horsepower equals 550 ft-lb/s),
M_e = engine torque in ft-lb, and
n_e = engine speed in crankshaft revolutions per second.

The engine-generated tractive effort reaching the drive wheels is given as

$$F_e = \frac{M_e \varepsilon_0 \eta_d}{r} \qquad \textbf{[12]}$$

where

F_e = engine-generated tractive effort reaching the drive wheels in lb,
M_e = engine torque in ft-lb,
ε_0 = overall gear reduction ratio,
η_d = mechanical efficiency of the drivetrain, and
r = radius of the drive wheels in ft.

Note that since torque and horsepower are directly related, if only a power-engine speed relationship is available, this can be converted to a torque-engine speed relationship through equation 10.

For determining vehicle acceleration, equation $F = ma + R_a + R_{rl} + R_g$ **[4** is rearranged and an additional term, γ_m, to account for the inertia of the vehicle's rotating parts that must be overcome during acceleration, is included.

$$a = \frac{F - \sum R}{\gamma_m m} \quad \textbf{[13]}$$

γ_m, referred to as the mass factor, is approximated as

$$\gamma_m = 1.04 + 0.0025\varepsilon_0^2 \quad \textbf{[14]}$$

An example application of this approach is given in Appendix F.

Once these data were coded into CORSIM-NG, the simulations were run again to ensure that the desired gear changes were observed. Figure 31 through Figure 42 in Appendix G depict the gear change capable CORSIM-NG versus TruckSim results that were obtained in these runs.

These results show that by introducing the gear changing capabilities of the vehicles into CORSIM-NG, the acceleration performance of trucks modeled in CORSIM-NG match much more closely to TruckSim. The research team was satisfied with the level of accuracy of truck acceleration modeling with the more comprehensive dynamics modeling approach, and moved forward with executing the experimental design at this point.

PCE Calculation Methodology

As discussed under the literature review section, the research team looked at multiple methodologies in order to determine the most suitable calculation approach and experimental design to develop the Florida truck PCE values. Nine separate methodologies were analyzed and per the literature review conducted, it was determined that the methods used in the Webster and Elefteriadou paper (1999) are the most consistent with the HCM methodology. A primary reason for this is because density is the performance measure used to define LOS for freeway operations in the HCM. Therefore, the research team elected to choose this methodology for calculating the PCE values. The roadway configuration aspect of the experimental design that was used in this study is depicted in Figure 10.

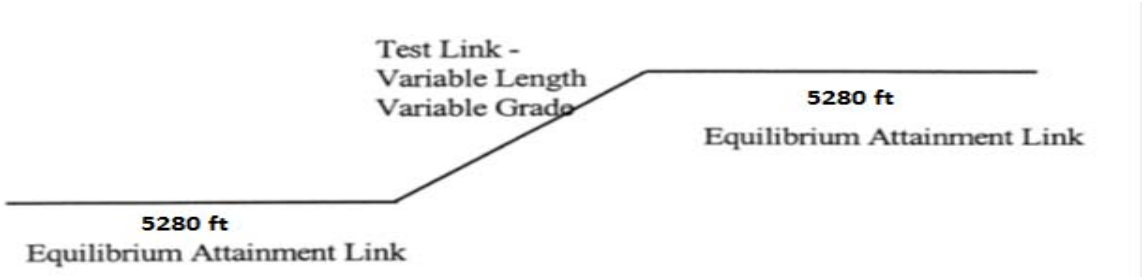

Figure 10. Roadway Configuration used for Experimental Design Simulation Runs

Once this experimental roadway configuration was set up in the CORSIM-NG program, the following variables in Table 8 were used to calculate the final PCE values for this study.

Table 8. Variables used for Experimental Design Simulation Runs

Variable	Link Length (ft)
Number of lanes in analysis direction	2-lanes
	3-lanes
Roadway Grade	Level
	3%
	6%
Free-Flow-Speed (mi/h)	55
	65
	75
Segment Length (ft)	1320
	2640
	3960
	5280
HV Percentage	5%
	10%
	15%
	20%

It was determined that six replications of each simulation scenario would be sufficient to provide a 95% confidence interval (CI) for the obtained density values.

RESULTS

Once the experimental design was executed, which resulted in a total of 311,040 simulation runs, the chosen PCE calculation methodology was applied to determine the PCE values for each specific truck class. From these PCE values, a regression analysis was used to develop equations to estimate the PCE values for each truck type as a function of several explanatory variables. From the analysis, it was determined that there was not much difference in the PCE values between Class 8 and Class 9 trucks. Although they have different average load conditions, their drivetrain and physical characteristics are very similar. And given that Class 9 trucks are much more prevalent in the traffic streams of freeways and multilane highways than Class 8 trucks, it was decided to use just three separate truck categories for the purposes of PCEs, for which Class 9 would represent the 'medium' truck category. Equations 14 through 16 are the resulting PCE estimation equations from this study. They correspond to Single Unit Trucks (Small), Semi-tractor+trailer trucks (Medium), and Semi-tractor+double-trailer trucks (Large), respectively. It should be noted that all calculated PCE values using the below equations should be rounded to the nearest hundredth.

$$PCE_{ST} = 0.966 + 0.0000154 \times (\text{Min}(SegLen \times Prop.\ Grade, 300))^2 - 0.000101 \times (\text{Min}(SegLen \times Prop.\ Grade, 300)) + 0.0037 \times \text{Max}(FFS, 66) - 0.0801 \times NumLanes + 1.21 \times Prop.\ Small\ Trucks + 0.0031 \times \text{Max}(Flow\ Rate, 100) \times Prop.\ Small\ Trucks \quad \textbf{[15]}$$

$$\boldsymbol{PCE_{MT} = 1.095 + 0.0000165 \times (\text{Min}(SegLen \times Prop.\ Grade, 300))^2 - 0.000105 \times (\text{Min}(SegLen \times Prop.\ Grade, 300)) + 0.00255 \times \text{Max}(FFS, 66) - 0.07774 \times NumLanes + 2.148 \times Prop.\ Medium\ Trucks + 0.00244 \times \text{Max}(Flow\ Rate, 100) \times Prop.\ Medium\ Trucks} \quad \textbf{[16]}$$

$$\boldsymbol{PCE_{LT} = 1.246 + 0.0000171 \times (\text{Min}(SegLen \times Prop.\ Grade, 300))^2 - 0.0000335 \times (\text{Min}(SegLen \times Prop.\ Grade, 300)) + 0.00264 \times \text{Max}(FFS, 66) - 0.10316 \times NumLanes + 1.98 \times Prop.\ Large\ Trucks + 0.00401 \times \text{Max}(Flow\ Rate, 100) \times Prop.\ Large\ Trucks} \quad \textbf{[17]}$$

where

SegLen	=	Segment/Link length in ft.
Prop. Grade	=	Proportion of grade (i.e., % grade/100)
FFS	=	Free-flow-speed in ft/s
NumLanes	=	Number of lanes in analysis direction
Prop. Small Trucks	=	Proportion of single unit trucks in traffic stream (i.e., % ST/100)
Prop. Medium Trucks	=	Proportion of medium trucks in traffic stream (i.e., % MT/100)
Prop. Large Trucks	=	Proportion of large trucks in traffic stream (i.e., % LT/100)
Flow rate	=	Measured volume in veh/h/ln

All of the variables in these three PCE models are statistically significant at a 95% CI, with respective adjusted R^2 values of 0.7194, 0.7170, and 0.7195. Furthermore, the signs of all the model variables are logical.

The PCE values increase as the magnitude of the grade increases and/or the length of the grade. These two variables are included in the model as an interaction term because it is the combined effect of these two variables that are important (e.g., the length of the segment is not important if the grade is level). Furthermore, the impact of this interaction on truck performance is not strictly linear; thus, the polynomial form (squared and linear terms). Although the sign of the squared term is positive and the sign of the linear term is negative, the overall effect of this interaction will be positive. Eventually, if the grade is steep enough, or the grade is long enough, a truck may reach its crawl speed, which will create a limit point of the impact of the truck's performance on the traffic stream operations. It should be noted that the research team did not account for truck performance/roadway combinations that could lead to a truck not being able to at least maintain a crawl speed up the grade. Through testing of different truck types and different percent grade/length of grade combinations, an approximate value of the product of grade length and grade proportion where trucks reached their crawl speed was identified. This value is 300 and is accounted for in the PCE equations through the minimum function.

The PCE values increase with an increase in free-flow-speed. This makes sense since as the free-flow-speed increases, finding acceptable gaps becomes for lane changing maneuvers becomes more difficult. Note that the minimum free-flow that should be used in these equations is 45 mi/h (66 ft/s).

The PCE values decrease with the number of lanes. This result was as expected since with fewer lanes available for the passenger cars to make a passing maneuver, the impact of trucks on the traffic stream increases.

The PCE values increase with the proportion of trucks. This result is counter to the values in the HCM 2010, where the PCE values decrease with increasing truck percentage. The HCM explains this relationship as being due to the tendency of truck drivers to form platoons with one another in the traffic stream and that this platooning effect reduces the relative impact of each truck. This in fact may be true; however, CORSIM-NG does not employ logic to form platoons between multiple trucks in the traffic stream, although some of this did occur through the lane biasing based on speed logic discussed earlier. It should be noted that the previous version of CORSIM that was used to develop the PCE values that are in the HCM 2010 also did not have the platooning logic. This supposed platooning phenomenon is an area that should be studied further, and if it truly exists, the CORSIM-NG logic could be modified accordingly. For now, the research team is comfortable with the relationship between the PCE values and truck percentages as given by the above PCE models.

The effect of proportion of trucks on PCE is also captured through an interaction term with the traffic flow rate. This effect is also positive; that is, as the flow rate increases and/or the proportion of trucks increases, the PCE will increase. This term essentially reflects the impact that the number of trucks on the roadway will have on traffic stream operations. In other words, a high truck percent by itself may not have much impact on traffic stream operations if the overall traffic level is low. Note that the minimum flow rate that should be used in these equations is 100 veh/h/ln.

These equations provide the ability to estimate PCE values as a function of several explanatory variables, and at a much finer resolution than those provided in the HCM in a tabular format. Although the equations are incorporated in the FREEPLAN and HIGHPLAN software, as opposed to a table implementation, the next three tables (Table 9 through Table 11)) are presented just to give a general comparison of some of the PCE values calculated by the above equations and the "corresponding" PCE values in the HCM 2010. The specific demand, number of lanes, and FFS values used to obtain these table values, in addition to the variable values shown in the tables, were as follows

- 1200 veh/h/ln,
- 3 lanes in analysis direction
- 65 mi/h (95.33 ft/s)

Table 9. PCE Comparison Table for Single Unit Trucks

Upgrade (%)	Length (mi)	PCE Calculation Source	Proportion of Trucks and Buses							
			2%	4%	5%	6%	8%	10%	15%	20%
≤2	All	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 15	1.18	1.28	1.32	1.37	1.47	1.57	1.82	2.06
>2-3	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 15	1.20	1.30	1.35	1.39	1.49	1.59	1.84	2.08
	>0.25-0.50	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 15	1.27	1.36	1.41	1.46	1.56	1.66	1.91	2.15
	>0.50-0.75	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 15	1.38	1.48	1.53	1.58	1.68	1.78	2.02	2.27
	>0.75-1.00	HCM	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50
		Eq. 15	1.55	1.65	1.70	1.74	1.84	1.94	2.19	2.43
>3-4	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 15	1.21	1.31	1.36	1.41	1.51	1.61	1.86	2.10
	>0.25-0.50	HCM	2.00	2.00	2.00	2.00	2.00	2.00	1.50	1.50
		Eq. 15	1.34	1.44	1.49	1.54	1.63	1.73	1.98	2.23
	>0.50-0.75	HCM	2.50	2.50	2.00	2.00	2.00	2.00	2.00	2.00
		Eq. 15	1.55	1.65	1.70	1.74	1.84	1.94	2.19	2.43
	>0.75-1.00	HCM	3.00	3.00	2.50	2.50	2.50	2.50	2.00	2.00
		Eq. 15	1.84	1.94	1.99	2.04	2.14	2.24	2.48	2.73
>4-5	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 15	1.24	1.34	1.39	1.43	1.53	1.63	1.88	2.12
	>0.25-0.50	HCM	3.00	2.50	2.50	2.50	2.00	2.00	2.00	2.00
		Eq. 15	1.43	1.53	1.58	1.63	1.73	1.83	2.07	2.32
	>0.50-0.75	HCM	3.50	3.00	3.00	3.00	2.50	2.50	2.50	2.50
		Eq. 15	1.76	1.86	1.91	1.96	2.06	2.16	2.40	2.65
	>0.75-1.00	HCM	4.00	3.50	3.50	3.50	3.00	3.00	3.00	3.00
		Eq. 15	2.22	2.32	2.37	2.42	2.52	2.62	2.86	3.11
>5-6	0.00-0.25	HCM	2.00	2.00	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 15	1.27	1.36	1.41	1.46	1.56	1.66	1.91	2.15
	>0.25-0.50	HCM	4.50	4.00	3.50	3.00	2.50	2.50	2.50	2.50
		Eq. 15	1.55	1.65	1.70	1.74	1.84	1.94	2.19	2.43
	>0.50-0.75	HCM	5.00	4.50	4.00	3.50	3.00	3.00	3.00	3.00
		Eq. 15	2.02	2.12	2.17	2.22	2.32	2.42	2.66	2.91
	>0.75-1.00	HCM	5.50	5.00	4.50	4.00	3.00	3.00	3.00	3.00
		Eq. 15	2.53	2.63	2.68	2.73	2.83	2.93	3.17	3.42

Table 10. PCE Comparison Table for Semi-tractor+Trailer Trucks

Upgrade (%)	Length (mi)	PCE Calculation Source	Proportion of Trucks and Buses							
			2%	4%	5%	6%	8%	10%	15%	20%
≤2	All	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 16	1.21	1.31	1.36	1.41	1.51	1.61	1.87	2.12
>2-3	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 16	1.23	1.33	1.38	1.43	1.53	1.63	1.89	2.14
	>0.25-0.50	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 16	1.30	1.40	1.45	1.50	1.61	1.71	1.96	2.22
	>0.50-0.75	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 16	1.43	1.53	1.58	1.63	1.73	1.83	2.09	2.34
	>0.75-1.00	HCM	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50
		Eq. 16	1.60	1.71	1.76	1.81	1.91	2.01	2.26	2.52
>3-4	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 16	1.25	1.35	1.40	1.45	1.55	1.65	1.91	2.16
	>0.25-0.50	HCM	2.00	2.00	2.00	2.00	2.00	2.00	1.50	1.50
		Eq. 16	1.38	1.48	1.53	1.58	1.68	1.79	2.04	2.29
	>0.50-0.75	HCM	2.50	2.50	2.00	2.00	2.00	2.00	2.00	2.00
		Eq. 16	1.60	1.71	1.76	1.81	1.91	2.01	2.26	2.52
	>0.75-1.00	HCM	3.00	3.00	2.50	2.50	2.50	2.50	2.00	2.00
		Eq. 16	1.92	2.02	2.07	2.12	2.22	2.33	2.58	2.83
>4-5	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 16	1.27	1.37	1.42	1.47	1.58	1.68	1.93	2.19
	>0.25-0.50	HCM	3.00	2.50	2.50	2.50	2.00	2.00	2.00	2.00
		Eq. 16	1.48	1.58	1.63	1.68	1.78	1.89	2.14	2.39
	>0.50-0.75	HCM	3.50	3.00	3.00	3.00	2.50	2.50	2.50	2.50
		Eq. 16	1.83	1.93	1.98	2.04	2.14	2.24	2.49	2.75
	>0.75-1.00	HCM	4.00	3.50	3.50	3.50	3.00	3.00	3.00	3.00
		Eq. 16	2.33	2.43	2.48	2.53	2.63	2.73	2.99	3.24
>5-6	0.00-0.25	HCM	2.00	2.00	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 16	1.30	1.40	1.45	1.50	1.61	1.71	1.96	2.22
	>0.25-0.50	HCM	4.50	4.00	3.50	3.00	2.50	2.50	2.50	2.50
		Eq. 16	1.60	1.71	1.76	1.81	1.91	2.01	2.26	2.52
	>0.50-0.75	HCM	5.00	4.50	4.00	3.50	3.00	3.00	3.00	3.00
		Eq. 16	2.11	2.21	2.27	2.32	2.42	2.52	2.77	3.03
	>0.75-1.00	HCM	5.50	5.00	4.50	4.00	3.00	3.00	3.00	3.00
		Eq. 16	2.66	2.76	2.81	2.86	2.96	3.07	3.32	3.57

Table 11. PCE Comparison Table for Semi-tractor+Double-trailer Trucks

Upgrade (%)	Length (mi)	PCE Calculation Source	Proportion of Trucks and Buses							
			2%	4%	5%	6%	8%	10%	15%	20%
≤2	All	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 17	1.32	1.46	1.53	1.60	1.73	1.87	2.21	2.55
>2-3	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 17	1.35	1.49	1.55	1.62	1.76	1.89	2.23	2.57
	>0.25-0.50	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 17	1.43	1.56	1.63	1.70	1.84	1.97	2.31	2.65
	>0.50-0.75	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 17	1.56	1.70	1.77	1.83	1.97	2.10	2.44	2.78
	>0.75-1.00	HCM	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50
		Eq. 17	1.75	1.88	1.95	2.02	2.16	2.29	2.63	2.97
>3-4	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 17	1.37	1.51	1.57	1.64	1.78	1.91	2.25	2.59
	>0.25-0.50	HCM	2.00	2.00	2.00	2.00	2.00	2.00	1.50	1.50
		Eq. 17	1.51	1.65	1.71	1.78	1.92	2.05	2.39	2.73
	>0.50-0.75	HCM	2.50	2.50	2.00	2.00	2.00	2.00	2.00	2.00
		Eq. 17	1.75	1.88	1.95	2.02	2.16	2.29	2.63	2.97
	>0.75-1.00	HCM	3.00	3.00	2.50	2.50	2.50	2.50	2.00	2.00
		Eq. 17	2.08	2.22	2.28	2.35	2.49	2.62	2.96	3.30
>4-5	0.00-0.25	HCM	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 17	1.40	1.53	1.60	1.67	1.80	1.94	2.28	2.62
	>0.25-0.50	HCM	3.00	2.50	2.50	2.50	2.00	2.00	2.00	2.00
		Eq. 17	1.62	1.75	1.82	1.89	2.03	2.16	2.50	2.84
	>0.50-0.75	HCM	3.50	3.00	3.00	3.00	2.50	2.50	2.50	2.50
		Eq. 17	1.99	2.12	2.19	2.26	2.40	2.53	2.87	3.21
	>0.75-1.00	HCM	4.00	3.50	3.50	3.50	3.00	3.00	3.00	3.00
		Eq. 17	2.51	2.64	2.71	2.78	2.91	3.05	3.39	3.73
>5-6	0.00-0.25	HCM	2.00	2.00	1.50	1.50	1.50	1.50	1.50	1.50
		Eq. 17	1.43	1.56	1.63	1.70	1.84	1.97	2.31	2.65
	>0.25-0.50	HCM	4.50	4.00	3.50	3.00	2.50	2.50	2.50	2.50
		Eq. 17	1.75	1.88	1.95	2.02	2.16	2.29	2.63	2.97
	>0.50-0.75	HCM	5.00	4.50	4.00	3.50	3.00	3.00	3.00	3.00
		Eq. 17	2.28	2.42	2.49	2.55	2.69	2.82	3.16	3.50
	>0.75-1.00	HCM	5.50	5.00	4.50	4.00	3.00	3.00	3.00	3.00
		Eq. 17	2.85	2.99	3.06	3.12	3.26	3.40	3.74	4.08

In addition to the above tables, Table 12 presents the PCE values obtained for each truck type for level, rolling, and mountainous terrain. The other variables values, in addition to the variable values shown in the table that these PCE values are based on, are given in Table 13.

Table 12. PCE Comparison by Terrain Type

Vehicle	Link Length (ft)	PCE by Type of Terrain					
		Level		Rolling		Mountainous	
		2-lanes	3-lanes	2-lanes	3-lanes	2-lanes	3-lanes
Single Unit Truck	2640	1.41	1.32	1.81	1.73	2.48	2.40
	5280	1.41	1.32	2.32	2.24	4.52	4.44
Intermediate/Interstate Semi-Trailer	2640	1.44	1.36	1.86	1.79	2.60	2.52
	5280	1.44	1.36	2.40	2.33	4.79	4.71
Double-Bottom Trailer	2640	1.63	1.53	2.16	2.05	3.01	2.90
	5280	1.63	1.53	2.73	2.62	5.29	5.19

Table 13. Terrain Type Specific Input Values

Input Values	Level	Rolling	Mountainous
Prop. Specific Truck Type	0.05	0.10	0.15
FFS (ft/s)	95.33	95.33	73.33
Prop. Grade	0.00	0.04	0.08
Flow Rate (veh/h/ln)	1200		

FREEPLAN and HIGHPLAN still maintain support for the use of the generalized terrain categories by applying the PCE estimation equations by assuming the grade proportions shown in the above table, grade lengths of 2640 ft for 'rolling' terrain and 5280 ft for 'mountainous' terrain, and using the values specified by the analysis for the other variables in the equations.

Although it is difficult to directly compare the PCE values from this study to those of the HCM 2010 because the HCM values are much more generalized, for similar input conditions the PCE values from this study are generally slightly lower, which is largely due to the higher power-to-weight ratios of the trucks used in this study and the more detailed vehicle dynamics modeling.

SUMMARY

Florida freeway and multilane highway truck fleet characteristics were determined from a detailed analysis of numerous weigh-in-motion stations located throughout the State. This information was used to determine the appropriate truck classifications, and their loading conditions, to use for developing PCE values applicable to Florida roadway conditions.

The CORSIM-NG program was used to provide simulated traffic stream data. A comprehensive truck acceleration model was incorporated into CORSIM-NG and validated with the TruckSim software program.

Using the traffic stream data generated by CORSIM-NG through the experimental design, the research team estimated PCE values for basic freeway/multilane highway segments with varying lengths, grades, percent heavy vehicles, number of directional lanes, free-flow speed, and flow rates.

After the PCE values are obtained, three PCE estimation models were developed, one for each of the small, medium, and large truck types as described in this study. The research team feels that the model forms, variable signs, and predicted PCE values are all reasonable.

Finally, the LOSPLAN software, specifically FREEPLAN and HIGHPLAN (the multilane highway component), was revised to reflect the results of this project.

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APPENDIX A - WIM Station Site Data

Table 14. WIM Station 57-0291 Site Data

Site Data		
WIM SITE	Number	Name
0219	57	Okaloosa

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	584	4.21	13290	95.79	365	2.63	215	1.55	4	0.03	13874
2009	586	4.1	13709	95.9	373	2.61	209	1.46	4	0.03	14295
2010	579	3.98	13978	96.02	376	2.58	201	1.38	3	0.02	14557

Table 15. WIM Station 57-0291 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
0219	57	Okaloosa

Truck Class	Volume	% of AADT
5	267	1.84
6	74	0.51
7	24	0.16
8	94	0.65
9	104	0.71
10	3	0.02
11	3	0.02
12	0	0
13	0	0
Total	569	3.91

Table 16. WIM Station 54-9901 Site Data

Site Data		
WIM SITE	Number	Name
9901	54	Jefferson

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	5868	25.38	17252	74.62	883	3.82	4754	20.56	231	1	23120
2009	5115	21.01	19230	78.99	896	3.68	4037	16.58	183	0.75	24345
2010	5318	21.07	19923	78.93	866	3.43	4263	16.89	189	0.75	25241

Table 17. WIM Station 54-9901 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9901	54	Jefferson
Truck Class	Volume	% of AADT
5	658	2.61
6	120	0.48
7	5	0.02
8	314	1.24
9	3926	15.54
10	27	0.11
11	120	0.48
12	59	0.23
13	9	0.04
Total	5238	20.75

Table 18. WIM Station 26-9904 Site Data

Site Data		
WIM SITE	Number	Name
9904	26	Alachua

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	13274	22.04	46951	77.96	2686	4.46	9925	16.48	662	1.1	60225
2009	11120	18.16	50111	81.84	2082	3.4	8511	13.9	527	0.86	61231
2010	10918	17.79	50449	82.21	2259	3.68	8138	13.26	522	0.85	61367

Table 19. WIM Station 26-9904 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9904	26	Alachua
Truck Class	Volume	% of AADT
5	1854	3.02
6	208	0.34
7	24	0.04
8	749	1.22
9	7347	11.97
10	45	0.07
11	301	0.49
12	206	0.34
13	15	0.02
Total	10749	17.51

Table 20. WIM Station 72-9905 Site Data

Site Data		
WIM SITE	Number	Name
9905	72	Duval

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	11653	13.9	72189	86.1	2767	3.3	8442	10.07	444	0.53	83842
2009	10628	12.51	74316	87.49	2481	2.92	7765	9.14	382	0.45	84944
2010	10716	12.21	77055	87.79	2431	2.77	7890	8.99	395	0.45	87771

Table 21. WIM Station 72-9905 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9905	72	Duval
Truck Class	Volume	% of AADT
5	1826	2.08
6	441	0.5
7	21	0.02
8	932	1.06
9	6896	7.86
10	61	0.07
11	270	0.31
12	105	0.12
13	16	0.02
Total	10568	12.04

Table 22. WIM Station 79-9906 Site Data

Site Data		
WIM SITE	Number	Name
9906	79	Volusia

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	7916	8.55	84662	91.45	3250	3.51	4407	4.76	259	0.28	92578
2009	7790	8.23	86874	91.77	3228	3.41	4335	4.58	227	0.24	94664
2010	7525	7.89	87844	92.11	2918	3.06	4368	4.58	238	0.25	95369

Table 23. WIM Station 79-9906 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9906	79	Volusia
Truck Class	Volume	% of AADT
5	2355	2.47
6	350	0.37
7	49	0.05
8	620	0.65
9	3716	3.9
10	31	0.03
11	151	0.16
12	75	0.08
13	9	0.01
Total	7356	7.72

Table 24. WIM Station 46-9907 Site Data

Site Data		
WIM SITE	Number	Name
9907	46	Bay

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	1370	9.43	13158	90.57	545	3.75	818	5.63	7	0.05	14528
2009	1500	10.11	13335	89.89	616	4.15	877	5.91	7	0.05	14835
2010	1468	10.31	12770	89.69	592	4.16	867	6.09	9	0.06	14238

Table 25. WIM Station 46-9907 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9907	46	Bay
Truck Class	Volume	% of AADT
5	458	3.22
6	87	0.61
7	8	0.06
8	242	1.7
9	618	4.34
10	7	0.05
11	6	0.04
12	2	0.01
13	2	0.01
Total	1430	10.04

Table 26. WIM Station 34-9909 Site Data

Site Data		
WIM SITE	Number	Name
9909	34	Levy

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	988	7.8	11673	92.2	470	3.71	510	4.03	8	0.06	12661
2009	900	7.31	11413	92.69	430	3.49	438	3.56	32	0.26	12313
2010	878	7.1	11486	92.9	404	3.27	438	3.54	36	0.29	12364

Table 27. WIM Station 34-9909 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9909	34	Levy
Truck Class	Volume	% of AADT
5	338	2.75
6	48	0.39
7	3	0.02
8	146	1.18
9	289	2.34
10	3	0.02
11	2	0.02
12	5	0.04
13	29	0.23
Total	863	6.99

Table 28. WIM Station 97-9913 Site Data

Site Data		
WIM SITE	Number	Name
9913	97	Turnpike

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										39784
2009	3869	4.04	34976	90.04	1569	4.04	1958	5.04	342	0.88	38845
2010	3967	4.01	34850	89.78	1557	4.01	2077	5.35	334	0.86	38817

Table 29. WIM Station 97-9913 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9913	97	Turnpike
Truck Class	Volume	% of AADT
5	1244	3.21
6	145	0.37
7	15	0.04
8	377	0.97
9	1686	4.34
10	17	0.04
11	160	0.41
12	92	0.24
13	83	0.21
Total	3819	9.83

Table 30. WIM Station 72-9914 Site Data

Site Data		
WIM SITE	Number	Name
9914	72	Duval

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	9843	14.48	58118	85.52	3501	5.15	5927	8.72	415	0.61	67961
2009	8566	13.01	57266	86.99	3088	4.69	5122	7.78	356	0.54	65832
2010	8290	12.73	56835	87.27	2866	4.4	5073	7.79	352	0.54	65125

Table 31. WIM Station 72-9914 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9914	72	Duval
Truck Class	Volume	% of AADT
5	1825	2.8
6	913	1.4
7	23	0.04
8	605	0.93
9	4410	6.77
10	59	0.09
11	271	0.42
12	65	0.1
13	11	0.02
Total	8182	12.57

Table 32. WIM Station 48-9916 Site Data

Site Data		
WIM SITE	Number	Name
9916	48	Escambia

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	1667	5.42	29091	94.58	840	2.73	797	2.59	31	0.1	30758
2009	1873	5.97	29486	94.03	1016	3.24	828	2.64	28	0.09	31359
2010	1990	6.31	29545	93.69	1041	3.3	918	2.91	32	0.1	31535

Table 33. WIM Station 48-9916 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9916	48	Escambia
Truck Class	Volume	% of AADT
5	732	2.32
6	264	0.84
7	29	0.09
8	192	0.61
9	713	2.26
10	14	0.04
11	19	0.06
12	9	0.03
13	2	0.01
Total	1974	6.26

Table 34. WIM Station 70-9919 Site Data

Site Data		
WIM SITE	Number	Name
9919	70	Brevard

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										39500
2009	No data available for 2009										N/A
2010	No data available for 2010										N/A

Table 35. WIM Station 70-9919 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9919	70	Brevard

Truck Class	Volume	% of AADT
5	No data available	
6	No data available	
7	No data available	
8	No data available	
9	No data available	
10	No data available	
11	No data available	
12	No data available	
13	No data available	
Total	No data available	

Table 36. WIM Station 72-9923 Site Data

Site Data		
WIM SITE	Number	Name
9923	72	Duval

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										N/A
2009	8635	14.27	51880	85.73	1936	3.2	6433	10.63	266	0.44	60515
2010	9308	15.22	51852	84.78	2012	3.29	6978	11.41	318	0.52	61160

Table 37. WIM Station 72-9923 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9923	72	Duval
Truck Class	Volume	% of AADT
5	1520	2.49
6	336	0.55
7	10	0.02
8	554	0.91
9	6342	10.37
10	82	0.13
11	184	0.3
12	117	0.19
13	18	0.03
Total	9163	14.99

Table 38. WIM Station 10-9926 Site Data

Site Data		
WIM SITE	Number	Name
9926	10	Hillsborough

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										132630
2009	9548	7.22	122678	92.78	3875	2.93	5554	4.2	119	0.09	132226
2010	9634	7.32	121979	92.68	3751	2.85	5751	4.37	132	0.1	131613

Table 39. WIM Station 10-9926 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9926	10	Hillsborough
Truck Class	Volume	% of AADT
5	3001	2.28
6	508	0.39
7	98	0.07
8	1779	1.35
9	3868	2.94
10	101	0.08
11	82	0.06
12	33	0.03
13	19	0.01
Total	9489	7.21

Table 40. WIM Station 16-9927 Site Data

Site Data		
WIM SITE	Number	Name
9927	16	Polk

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	2182	14.5	12867	85.5	778	5.17	1395	9.27	9	0.06	15049
2009	1961	13.04	13080	86.96	693	4.61	1260	8.38	8	0.05	15041
2010	1966	13.25	12873	86.75	686	4.62	1276	8.6	4	0.03	14839

Table 41. WIM Station 16-9927 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9927	16	Polk
Truck Class	Volume	% of AADT
5	448	3.02
6	201	1.35
7	9	0.06
8	192	1.29
9	1082	7.29
10	3	0.02
11	0	0
12	2	0.01
13	3	0.02
Total	1940	13.06

Table 42. WIM Station 79-9929 Site Data

Site Data		
WIM SITE	Number	Name
9929	79	Volusia

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	522	4.41	11321	95.59	397	3.35	126	1.06	0	0	11843
2009	462	3.96	11204	96.04	356	3.05	105	0.9	1	0.01	11666
2010	461	4.03	10979	95.97	345	3.02	113	0.99	2	0.02	11440

Table 43. WIM Station 79-9929 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9929	79	Volusia
Truck Class	Volume	% of AADT
5	292	2.55
6	34	0.3
7	3	0.03
8	91	0.8
9	19	0.17
10	2	0.02
11	0	0
12	0	0
13	2	0.02
Total	443	3.89

Table 44. WIM Station 97-9931 Site Data

Site Data		
WIM SITE	Number	Name
9931	97	Turnpike

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										35858
2009	5406	15.04	30535	84.96	1463	4.07	3512	9.77	431	1.2	35941
2010	5622	15.1	31613	84.9	1545	4.15	3671	9.86	406	1.09	37235

Table 45. WIM Station 97-9931 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9931	97	Turnpike
Truck Class	Volume	% of AADT
5	1242	3.34
6	159	0.43
7	8	0.02
8	758	2.04
9	2890	7.76
10	21	0.03
11	239	0.64
12	162	0.44
13	5	0.01
Total	5484	14.71

Table 46. WIM Station 97-9933 Site Data

Site Data		
WIM SITE	Number	Name
9933	97	Turnpike

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										73500
2009	2888	3.7	75159	96.3	1866	2.39	960	1.23	62	0.08	78047
2010	2883	3.63	76539	96.37	1898	2.39	921	1.16	64	0.08	79422

Table 47. WIM Station 97-9933 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9933	97	Turnpike
Truck Class	Volume	% of AADT
5	1547	1.95
6	213	0.27
7	61	0.08
8	296	0.37
9	618	0.78
10	10	0.01
11	30	0.04
12	20	0.03
13	4	0.01
Total	2799	3.54

Table 48. WIM Station 97-9934 Site Data

Site Data		
WIM SITE	Number	Name
9934	97	Turnpike

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	5937	7.36	74720	92.64	3452	4.28	2380	2.95	105	0.13	80657
2009	5193	6.45	75309	93.55	3019	3.75	2069	2.57	105	0.13	80502
2010	5164	6.19	78247	93.81	2895	3.47	2152	2.58	117	0.14	83411

Table 49. WIM Station 97-9934 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9934	97	Turnpike
Truck Class	Volume	% of AADT
5	1786	2.14
6	632	0.76
7	387	0.46
8	587	0.7
9	1544	1.85
10	26	0.03
11	58	0.07
12	36	0.04
13	21	0.03
Total	5077	6.08

Table 50. WIM Station 29-9936 Site Data

Site Data		
WIM SITE	Number	Name
9936	29	Columbia

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										20000
2009	4493	22.31	15647	77.69	691	3.43	3619	17.97	183	0.91	20140
2010	4759	23.24	15717	76.76	674	3.29	3893	19.01	192	0.94	20476

Table 51. WIM Station 29-9936 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9936	29	Columbia
Truck Class	Volume	% of AADT
5	506	2.47
6	88	0.43
7	3	0.01
8	346	1.69
9	3521	17.2
10	25	0.12
11	138	0.67
12	47	0.23
13	8	0.04
Total	4682	22.86

Table 52. WIM Station 58-9937 Site Data

Site Data		
WIM SITE	Number	Name
9937	58	Santa Rosa

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										12600
2009	570	4.43	12292	95.57	570	4.43	386	3	8	0.06	12862
2010	549	4.29	12251	95.71	549	4.29	380	2.97	8	0.06	12800

Table 53. WIM Station 58-9937 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9937	58	Santa Rosa
Truck Class	Volume	% of AADT
5	320	2.5
6	46	0.36
7	8	0.06
8	81	0.63
9	78	0.61
10	3	0.02
11	2	0.02
12	2	0.02
13	2	0.02
Total	542	4.24

Table 54. WIM Station 50-9940 Site Data

Site Data		
WIM SITE	Number	Name
9940	50	Gadsden

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	488	5.91	7778	94.09	223	2.7	265	3.21	0	0	8266
2009	No data available for 2009										7600
2010	544	6.77	7497	93.23	274	3.41	269	3.35	1	0.01	8041

Table 55. WIM Station 50-9940 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9940	50	Gadsden
Truck Class	Volume	% of AADT
5	225	2.8
6	38	0.47
7	3	0.04
8	74	0.92
9	194	2.41
10	2	0.02
11	0	0
12	0	0
13	1	0.01
Total	537	6.67

Table 56. WIM Station 87-9947 Site Data

Site Data		
WIM SITE	Number	Name
9947	87	Miami-Dade

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										N/A
2009	No data available for 2009										32783
2010	4605	14.12	28006	85.88	2854	8.75	1738	5.33	13	0.04	32611

Table 57. WIM Station 87-9947 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9947	87	Miami-Dade
Truck Class	Volume	% of AADT
5	1504	4.61
6	982	3.01
7	273	0.84
8	435	1.33
9	1280	3.93
10	22	0.07
11	5	0.02
12	2	0.01
13	4	0.01
Total	4507	13.83

Table 58. WIM Station 16-9948 Site Data

Site Data		
WIM SITE	Number	Name
9948	16	Polk

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										N/A
2009	3107	13.94	19183	86.06	1099	4.93	1964	8.81	45	0.2	22290
2010	3040	13.71	19138	86.29	1120	5.05	1878	8.47	42	0.19	22178

Table 59. WIM Station 16-9948 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9948	16	Polk
Truck Class	Volume	% of AADT
5	873	3.94
6	169	0.76
7	11	0.05
8	305	1.38
9	1561	7.04
10	11	0.05
11	22	0.1
12	17	0.08
13	3	0.01
Total	2972	13.41

Table 60. WIM Station 48-9949 Site Data

Site Data		
WIM SITE	Number	Name
9949	48	Escambia

Year	Total Truck Volume		Passenger Cars		Single Unit Trucks		Combo Trailer Trucks		Multi-Trailer Trucks		Total AADT
	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	Volume	% of AADT	
2008	No data available for 2008										N/A
2009	No data available for 2009										N/A
2010	5551	12.01	40684	87.99	1937	4.19	3462	7.49	153	0.33	46235

Table 61. WIM Station 48-9949 Site Data per Truck Class

Site Data per Truck Class		
WIM SITE	Number	Name
9949	48	Escambia
Truck Class	Volume	% of AADT
5	1505	3.26
6	298	0.65
7	17	0.04
8	687	1.49
9	2744	5.94
10	30	0.06
11	96	0.21
12	44	0.1
13	9	0.02
Total	5430	11.77

APPENDIX B - Custom WIM Station Data Processor Control Windows

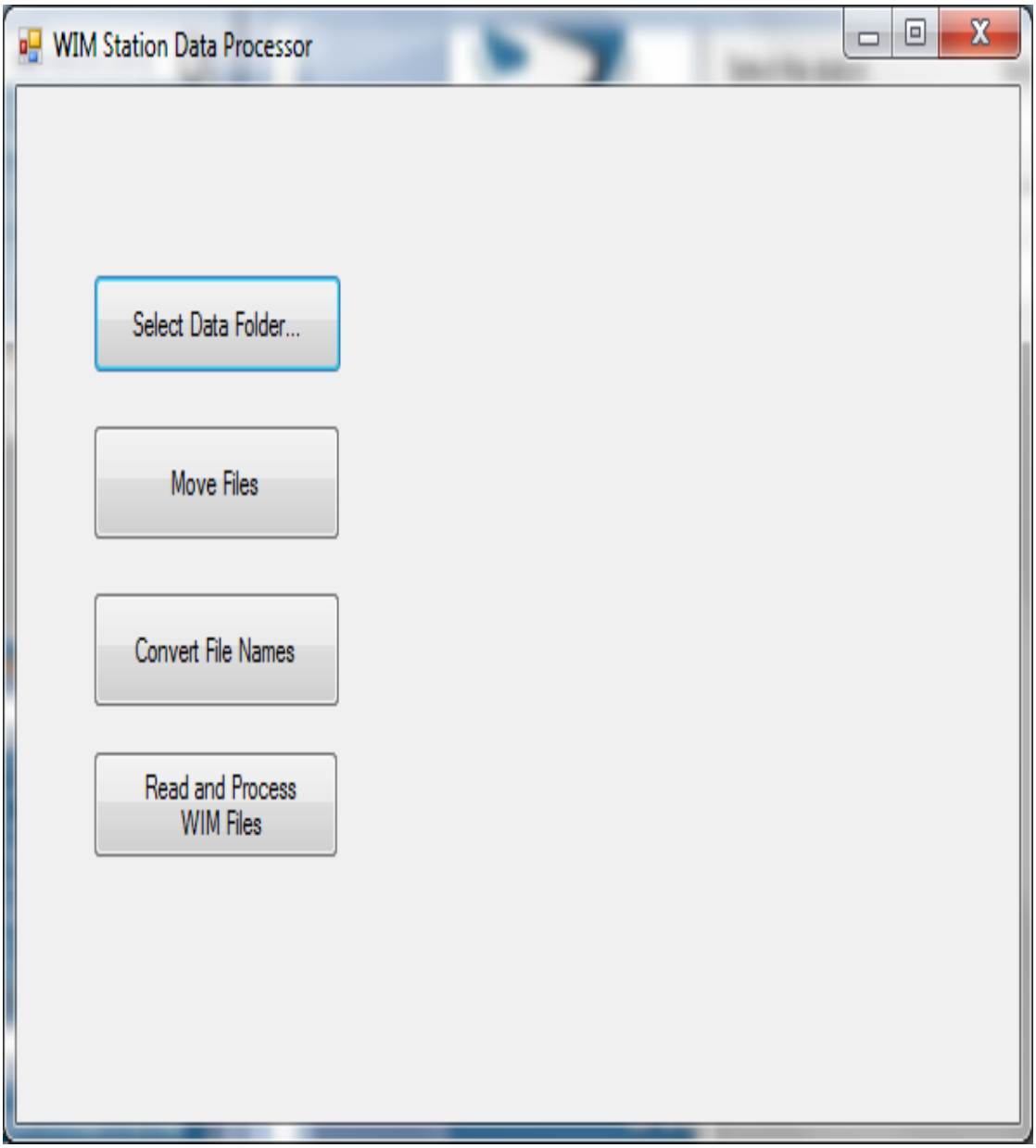

Figure 11. Control Window for Data File Manipulation

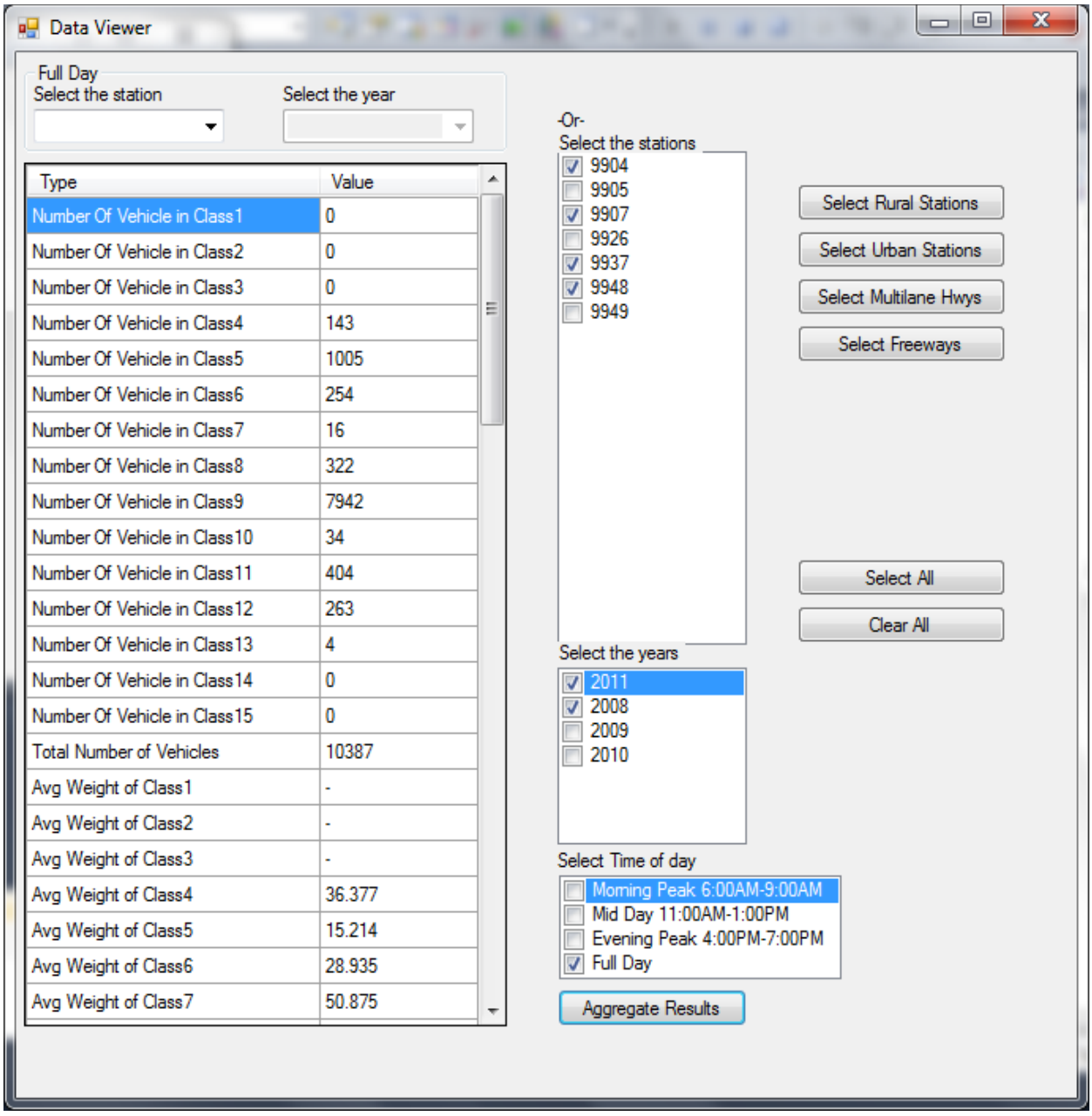

Figure 12. Control Window for Data Processor

APPENDIX C - Truck Characteristics Results

Table 62. Truck Characteristics Results – Year 2008 – Urban Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	158380	30567	9412	23107
Number Of Vehicle in Class5	2918200	571190	194292	466929
Number Of Vehicle in Class6	1387521	289196	115775	130237
Number Of Vehicle in Class7	291650	77969	27206	9644
Number Of Vehicle in Class8	887198	173944	57124	108365
Number Of Vehicle in Class9	7504628	1049607	451856	959193
Number Of Vehicle in Class10	64488	11130	5247	9075
Number Of Vehicle in Class11	339054	39130	3737	24827
Number Of Vehicle in Class12	106493	13097	2253	7248
Number Of Vehicle in Class13	32508	2850	1569	6521
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	13690120	2258680	868471	1745146
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	27.021	26.783	27.033	27.563
Avg Weight of Class5	14.498	15.014	14.626	13.487
Avg Weight of Class6	31.385	33.218	32.707	27.643
Avg Weight of Class7	65.046	65.486	64.952	63.681
Avg Weight of Class8	37.758	40.132	37.259	33.997
Avg Weight of Class9	51.420	51.814	49.251	51.373
Avg Weight of Class10	61.722	62.261	62.819	60.557
Avg Weight of Class11	53.893	51.534	51.610	54.057
Avg Weight of Class12	54.036	53.800	56.323	52.981
Avg Weight of Class13	73.024	79.688	82.893	66.492
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	40.823	39.454	38.933	38.288
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0116	0.0135	0.0108	0.0132
Percent Vehicles in Class5	0.2132	0.2529	0.2237	0.2676
Percent Vehicles in Class6	0.1014	0.1280	0.1333	0.0746

Percent Vehicles in Class7	0.0213	0.0345	0.0313	0.0055
Percent Vehicles in Class8	0.0648	0.0770	0.0658	0.0621
Percent Vehicles in Class9	0.5482	0.4647	0.5203	0.5496
Percent Vehicles in Class10	0.0047	0.0049	0.0060	0.0052
Percent Vehicles in Class11	0.0248	0.0173	0.0043	0.0142
Percent Vehicles in Class12	0.0078	0.0058	0.0026	0.0042
Percent Vehicles in Class13	0.0024	0.0013	0.0018	0.0037
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	65.397	64.661	66.271	64.312
Avg Speed in Class5	65.314	65.028	65.232	65.091
Avg Speed in Class6	62.501	62.123	62.657	62.226
Avg Speed in Class7	58.960	58.597	59.343	58.525
Avg Speed in Class8	63.548	63.122	63.426	62.986
Avg Speed in Class9	64.930	64.162	64.997	64.374
Avg Speed in Class10	65.628	64.994	65.832	64.948
Avg Speed in Class11	63.772	63.667	63.753	63.317
Avg Speed in Class12	66.095	65.509	67.225	66.126
Avg Speed in Class13	65.811	64.279	61.913	65.625
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	64.540	63.858	64.471	64.286
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.229	40.136	39.726	40.830
Avg Length by Class5	28.371	28.313	28.580	27.860
Avg Length by Class6	29.407	29.567	29.581	29.224
Avg Length by Class7	27.427	27.742	27.207	27.613
Avg Length by Class8	56.597	54.708	55.504	58.675
Avg Length by Class9	68.371	67.426	68.110	69.164
Avg Length by Class10	72.791	72.407	72.552	73.201
Avg Length by Class11	75.031	74.829	75.137	75.172
Avg Length by Class12	78.433	78.219	80.339	80.156
Avg Length by Class13	93.371	92.994	95.241	92.408
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 63. Truck Characteristics Results – Year 2008 – Rural Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	91791	14174	5004	14181
Number Of Vehicle in Class5	1418709	291437	96773	240021
Number Of Vehicle in Class6	415019	97843	29640	49533
Number Of Vehicle in Class7	70682	24624	6424	3221
Number Of Vehicle in Class8	493695	92272	31029	57837
Number Of Vehicle in Class9	8186241	994000	466700	1219773
Number Of Vehicle in Class10	48073	7914	3758	7843
Number Of Vehicle in Class11	277638	31770	7503	20128
Number Of Vehicle in Class12	141866	14658	3938	10723
Number Of Vehicle in Class13	14592	2131	1256	2734
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	11158306	1570823	652025	1625994
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	30.275	28.489	29.298	30.323
Avg Weight of Class5	14.174	15.104	14.115	13.412
Avg Weight of Class6	28.946	31.323	29.538	26.935
Avg Weight of Class7	63.718	63.896	63.964	60.262
Avg Weight of Class8	38.800	38.774	38.172	37.205
Avg Weight of Class9	54.284	54.421	51.702	54.798
Avg Weight of Class10	63.478	63.102	65.283	63.315
Avg Weight of Class11	53.825	54.535	53.354	52.298
Avg Weight of Class12	55.593	56.960	58.527	55.283
Avg Weight of Class13	87.150	96.046	87.116	84.017
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	47.507	44.810	44.627	47.074
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0082	0.0090	0.0077	0.0087
Percent Vehicles in Class5	0.1271	0.1855	0.1484	0.1476
Percent Vehicles in Class6	0.0372	0.0623	0.0455	0.0305

Percent Vehicles in Class7	0.0063	0.0157	0.0099	0.0020
Percent Vehicles in Class8	0.0442	0.0587	0.0476	0.0356
Percent Vehicles in Class9	0.7336	0.6328	0.7158	0.7502
Percent Vehicles in Class10	0.0043	0.0050	0.0058	0.0048
Percent Vehicles in Class11	0.0249	0.0202	0.0115	0.0124
Percent Vehicles in Class12	0.0127	0.0093	0.0060	0.0066
Percent Vehicles in Class13	0.0013	0.0014	0.0019	0.0017
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	67.079	64.181	67.858	67.344
Avg Speed in Class5	66.831	66.102	66.546	67.168
Avg Speed in Class6	64.727	63.332	64.536	65.803
Avg Speed in Class7	62.232	62.041	62.107	62.581
Avg Speed in Class8	65.790	64.912	65.447	66.201
Avg Speed in Class9	66.764	66.435	66.891	66.831
Avg Speed in Class10	67.705	66.638	67.648	68.218
Avg Speed in Class11	64.316	64.471	65.112	64.434
Avg Speed in Class12	66.260	66.473	68.212	66.756
Avg Speed in Class13	66.487	65.596	66.271	66.931
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.564	65.962	66.615	66.800
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	38.736	39.566	38.487	39.203
Avg Length by Class5	27.895	27.836	28.003	27.522
Avg Length by Class6	29.955	29.718	30.096	29.890
Avg Length by Class7	27.778	27.385	27.707	28.137
Avg Length by Class8	57.551	55.355	56.829	59.075
Avg Length by Class9	68.475	67.634	68.337	68.905
Avg Length by Class10	72.773	72.405	72.826	73.147
Avg Length by Class11	74.262	73.719	73.370	74.603
Avg Length by Class12	78.264	78.489	80.600	80.316
Avg Length by Class13	87.882	86.554	87.323	88.564
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 64. Truck Characteristics Results – Year 2008 – Multilane Highways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	63316	12524	3252	9208
Number Of Vehicle in Class5	965795	233329	68819	157478
Number Of Vehicle in Class6	397368	103119	31837	37788
Number Of Vehicle in Class7	76869	25290	7336	2978
Number Of Vehicle in Class8	330583	71433	22378	37650
Number Of Vehicle in Class9	3439586	491597	208672	491163
Number Of Vehicle in Class10	24024	4584	1976	3565
Number Of Vehicle in Class11	79520	11347	3000	5769
Number Of Vehicle in Class12	37998	3405	833	3362
Number Of Vehicle in Class13	4791	823	388	756
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	5419850	957451	348491	749717
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	30.747	27.554	30.500	30.751
Avg Weight of Class5	14.832	15.705	14.786	13.655
Avg Weight of Class6	32.012	33.570	33.682	27.973
Avg Weight of Class7	64.851	64.289	64.940	63.566
Avg Weight of Class8	40.539	39.629	39.648	39.528
Avg Weight of Class9	53.549	53.409	51.530	53.647
Avg Weight of Class10	63.325	60.797	66.665	62.552
Avg Weight of Class11	54.258	54.312	54.412	52.192
Avg Weight of Class12	54.591	55.040	61.778	52.446
Avg Weight of Class13	88.024	84.391	91.687	86.625
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	44.263	41.084	42.146	43.061
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.012	0.013	0.009	0.012
Percent Vehicles in Class5	0.178	0.244	0.197	0.210
Percent Vehicles in Class6	0.073	0.108	0.091	0.050

Percent Vehicles in Class7	0.014	0.026	0.021	0.004
Percent Vehicles in Class8	0.061	0.075	0.064	0.050
Percent Vehicles in Class9	0.635	0.513	0.599	0.655
Percent Vehicles in Class10	0.004	0.005	0.006	0.005
Percent Vehicles in Class11	0.015	0.012	0.009	0.008
Percent Vehicles in Class12	0.007	0.004	0.002	0.004
Percent Vehicles in Class13	0.001	0.001	0.001	0.001
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	62.849	59.582	63.541	62.733
Avg Speed in Class5	59.518	60.068	59.316	60.279
Avg Speed in Class6	58.070	58.330	58.004	58.921
Avg Speed in Class7	59.475	60.008	59.301	59.146
Avg Speed in Class8	62.506	61.768	61.916	62.918
Avg Speed in Class9	63.663	62.333	63.510	64.455
Avg Speed in Class10	63.918	62.367	64.012	65.189
Avg Speed in Class11	62.393	63.521	65.822	63.893
Avg Speed in Class12	65.095	63.601	68.015	66.093
Avg Speed in Class13	64.227	63.250	63.452	64.776
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	62.368	61.230	62.022	63.186
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	37.492	39.105	36.950	37.809
Avg Length by Class5	27.131	27.614	27.066	26.495
Avg Length by Class6	28.726	29.037	28.844	28.324
Avg Length by Class7	27.506	27.211	27.390	27.702
Avg Length by Class8	54.890	53.669	54.227	56.423
Avg Length by Class9	65.128	65.030	65.099	65.273
Avg Length by Class10	71.296	71.225	71.358	71.718
Avg Length by Class11	71.895	71.658	70.262	71.422
Avg Length by Class12	76.283	75.342	76.884	78.033
Avg Length by Class13	88.614	88.181	88.337	89.415
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 65. Truck Characteristics Results – Year 2008 – Freeways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	186855	32217	11164	28080
Number Of Vehicle in Class5	3371114	629298	222246	549472
Number Of Vehicle in Class6	1405172	283920	113578	141982
Number Of Vehicle in Class7	285463	77303	26294	9887
Number Of Vehicle in Class8	1050310	194783	65775	128552
Number Of Vehicle in Class9	12251283	1552010	709884	1687803
Number Of Vehicle in Class10	88537	14460	7029	13353
Number Of Vehicle in Class11	537172	59553	8240	39186
Number Of Vehicle in Class12	210361	24350	5358	14609
Number Of Vehicle in Class13	42309	4158	2437	8499
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	19428576	2872052	1172005	2621423
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	27.357	27.234	27.038	27.911
Avg Weight of Class5	14.266	14.800	14.354	13.406
Avg Weight of Class6	30.487	32.437	31.606	27.308
Avg Weight of Class7	64.770	65.372	64.713	62.602
Avg Weight of Class8	37.372	39.673	36.877	33.820
Avg Weight of Class9	52.736	52.979	50.192	53.187
Avg Weight of Class10	62.241	63.185	63.055	61.644
Avg Weight of Class11	53.804	52.605	52.178	53.428
Avg Weight of Class12	54.986	55.529	57.095	54.794
Avg Weight of Class13	76.198	87.141	83.669	70.338
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	43.702	41.840	41.145	42.373
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.010	0.011	0.010	0.011
Percent Vehicles in Class5	0.174	0.219	0.190	0.210
Percent Vehicles in Class6	0.072	0.099	0.097	0.054

Percent Vehicles in Class7	0.015	0.027	0.022	0.004
Percent Vehicles in Class8	0.054	0.068	0.056	0.049
Percent Vehicles in Class9	0.631	0.540	0.606	0.644
Percent Vehicles in Class10	0.005	0.005	0.006	0.005
Percent Vehicles in Class11	0.028	0.021	0.007	0.015
Percent Vehicles in Class12	0.011	0.008	0.005	0.006
Percent Vehicles in Class13	0.002	0.001	0.002	0.003
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	67.087	66.424	67.777	66.361
Avg Speed in Class5	67.613	67.365	67.637	67.377
Avg Speed in Class6	64.411	63.918	64.452	64.354
Avg Speed in Class7	59.632	59.232	60.030	59.659
Avg Speed in Class8	64.930	64.467	64.893	64.452
Avg Speed in Class9	66.511	66.197	66.679	66.127
Avg Speed in Class10	67.220	66.727	67.315	66.804
Avg Speed in Class11	64.257	64.124	64.238	63.806
Avg Speed in Class12	66.387	66.356	67.827	66.596
Avg Speed in Class13	66.223	65.158	63.914	66.120
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.308	65.885	66.392	66.160
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.423	40.286	39.980	40.999
Avg Length by Class5	28.526	28.351	28.797	28.104
Avg Length by Class6	29.761	29.812	29.922	29.696
Avg Length by Class7	27.493	27.802	27.278	27.757
Avg Length by Class8	57.582	55.395	56.563	59.515
Avg Length by Class9	69.351	68.318	69.145	70.109
Avg Length by Class10	73.187	72.780	73.034	73.565
Avg Length by Class11	75.098	74.841	75.303	75.432
Avg Length by Class12	78.707	78.783	81.068	80.762
Avg Length by Class13	92.016	90.646	92.259	91.438
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 66. Truck Characteristics Results – Year 2009 – Urban Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	212610	40932	12364	31192
Number Of Vehicle in Class5	3935286	753794	261757	637394
Number Of Vehicle in Class6	1518438	320153	124673	144929
Number Of Vehicle in Class7	315508	90634	28398	8091
Number Of Vehicle in Class8	1311644	223116	82803	173939
Number Of Vehicle in Class9	8478699	1200714	513778	1083755
Number Of Vehicle in Class10	68895	12659	5519	9869
Number Of Vehicle in Class11	379608	43179	3542	21474
Number Of Vehicle in Class12	130343	15602	2191	6195
Number Of Vehicle in Class13	22494	2553	1512	3262
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	16373525	2703336	1036537	2120100
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	27.107	26.742	27.040	27.184
Avg Weight of Class5	14.489	15.046	14.527	13.492
Avg Weight of Class6	30.630	32.439	31.969	26.751
Avg Weight of Class7	65.682	66.429	65.397	62.518
Avg Weight of Class8	38.310	39.873	37.268	35.791
Avg Weight of Class9	51.195	51.300	48.871	51.602
Avg Weight of Class10	61.249	61.165	61.755	60.611
Avg Weight of Class11	54.709	52.420	52.178	54.627
Avg Weight of Class12	55.753	55.471	57.741	55.232
Avg Weight of Class13	88.743	92.018	86.950	81.602
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	39.612	38.276	37.585	36.960
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0130	0.0151	0.0119	0.0147
Percent Vehicles in Class5	0.2403	0.2788	0.2525	0.3006
Percent Vehicles in Class6	0.0927	0.1184	0.1203	0.0684

Percent Vehicles in Class7	0.0193	0.0335	0.0274	0.0038
Percent Vehicles in Class8	0.0801	0.0825	0.0799	0.0820
Percent Vehicles in Class9	0.5178	0.4442	0.4957	0.5112
Percent Vehicles in Class10	0.0042	0.0047	0.0053	0.0047
Percent Vehicles in Class11	0.0232	0.0160	0.0034	0.0101
Percent Vehicles in Class12	0.0080	0.0058	0.0021	0.0029
Percent Vehicles in Class13	0.0014	0.0009	0.0015	0.0015
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	65.753	64.976	66.440	64.754
Avg Speed in Class5	65.310	65.093	65.168	65.178
Avg Speed in Class6	61.605	61.234	61.701	61.614
Avg Speed in Class7	57.734	57.185	58.309	58.290
Avg Speed in Class8	64.091	63.561	63.993	63.423
Avg Speed in Class9	64.445	63.756	64.452	63.895
Avg Speed in Class10	65.324	64.935	65.530	64.634
Avg Speed in Class11	64.053	64.170	63.933	63.493
Avg Speed in Class12	65.993	65.423	67.306	65.843
Avg Speed in Class13	63.420	62.859	63.239	61.997
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	64.255	63.633	64.129	64.080
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.079	40.113	39.611	40.556
Avg Length by Class5	28.503	28.505	28.631	27.999
Avg Length by Class6	29.219	29.264	29.473	29.133
Avg Length by Class7	27.428	27.507	27.388	28.001
Avg Length by Class8	59.637	57.320	59.180	60.891
Avg Length by Class9	67.544	66.644	67.721	68.313
Avg Length by Class10	72.542	72.104	72.556	72.920
Avg Length by Class11	74.285	74.027	74.556	74.717
Avg Length by Class12	77.673	77.149	79.364	79.019
Avg Length by Class13	100.895	96.306	98.919	100.865
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 67. Truck Characteristics Results – Year 2009 – Rural Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	139705	20439	7093	22792
Number Of Vehicle in Class5	1711280	274137	115818	290435
Number Of Vehicle in Class6	460520	81801	32172	59350
Number Of Vehicle in Class7	44811	12193	3734	2044
Number Of Vehicle in Class8	510798	82358	31297	63004
Number Of Vehicle in Class9	10229994	1178350	566501	1568483
Number Of Vehicle in Class10	64428	9516	4824	10756
Number Of Vehicle in Class11	372532	45015	9799	27589
Number Of Vehicle in Class12	191842	21687	5814	14440
Number Of Vehicle in Class13	15344	2168	1192	2501
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	13741254	1727664	778244	2061394
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	29.839	28.414	29.658	29.212
Avg Weight of Class5	14.372	14.960	14.444	13.550
Avg Weight of Class6	28.923	31.354	29.700	26.511
Avg Weight of Class7	63.741	65.472	64.096	56.898
Avg Weight of Class8	35.935	37.522	34.899	33.476
Avg Weight of Class9	54.623	54.634	52.195	55.166
Avg Weight of Class10	62.620	63.709	64.401	62.219
Avg Weight of Class11	54.434	54.521	54.797	54.171
Avg Weight of Class12	56.598	57.252	59.179	58.673
Avg Weight of Class13	89.498	95.219	90.111	89.518
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	47.931	46.318	45.022	47.619
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0102	0.0118	0.0091	0.0111
Percent Vehicles in Class5	0.1245	0.1587	0.1488	0.1409
Percent Vehicles in Class6	0.0335	0.0473	0.0413	0.0288

Percent Vehicles in Class7	0.0033	0.0071	0.0048	0.0010
Percent Vehicles in Class8	0.0372	0.0477	0.0402	0.0306
Percent Vehicles in Class9	0.7445	0.6820	0.7279	0.7609
Percent Vehicles in Class10	0.0047	0.0055	0.0062	0.0052
Percent Vehicles in Class11	0.0271	0.0261	0.0126	0.0134
Percent Vehicles in Class12	0.0140	0.0126	0.0075	0.0070
Percent Vehicles in Class13	0.0011	0.0013	0.0015	0.0012
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	67.635	65.197	68.298	68.312
Avg Speed in Class5	67.250	66.808	66.963	67.919
Avg Speed in Class6	65.300	64.572	65.214	66.213
Avg Speed in Class7	61.314	61.566	61.261	62.486
Avg Speed in Class8	65.473	65.210	65.307	65.701
Avg Speed in Class9	66.614	66.560	66.740	66.571
Avg Speed in Class10	67.714	67.561	67.759	67.858
Avg Speed in Class11	64.659	65.124	65.536	64.937
Avg Speed in Class12	65.981	66.180	67.854	66.722
Avg Speed in Class13	66.278	65.976	65.894	66.506
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.542	66.352	66.639	66.725
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.364	40.611	40.121	40.470
Avg Length by Class5	28.238	28.286	28.282	27.813
Avg Length by Class6	30.163	30.377	30.383	29.901
Avg Length by Class7	27.881	27.804	27.945	29.057
Avg Length by Class8	57.853	55.986	57.322	59.353
Avg Length by Class9	68.801	68.049	68.617	69.262
Avg Length by Class10	73.452	73.096	73.417	73.787
Avg Length by Class11	73.931	73.755	73.743	74.495
Avg Length by Class12	77.976	78.178	80.064	79.947
Avg Length by Class13	87.273	85.855	87.334	87.431
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 68. Truck Characteristics Results – Year 2009 – Multilane Highways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	71344	13926	3275	10022
Number Of Vehicle in Class5	1148848	208306	82471	179717
Number Of Vehicle in Class6	478146	103237	38187	46072
Number Of Vehicle in Class7	86617	25926	7804	1889
Number Of Vehicle in Class8	288467	52230	20220	34583
Number Of Vehicle in Class9	3171018	424424	188652	448143
Number Of Vehicle in Class10	22717	3782	1846	3427
Number Of Vehicle in Class11	67280	9074	2288	4695
Number Of Vehicle in Class12	33263	2503	757	2655
Number Of Vehicle in Class13	5482	811	398	859
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	5373182	844219	345898	732062
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	28.609	25.614	28.595	29.158
Avg Weight of Class5	14.598	15.351	14.690	13.251
Avg Weight of Class6	31.055	33.169	32.609	25.858
Avg Weight of Class7	65.973	66.096	66.025	62.256
Avg Weight of Class8	37.188	38.880	35.824	33.066
Avg Weight of Class9	52.559	52.060	50.427	52.884
Avg Weight of Class10	61.913	61.448	62.949	61.790
Avg Weight of Class11	53.620	53.161	55.476	53.145
Avg Weight of Class12	53.863	54.457	60.490	52.131
Avg Weight of Class13	81.102	82.677	84.553	82.821
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	41.692	39.962	39.392	40.292
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.013	0.016	0.009	0.014
Percent Vehicles in Class5	0.214	0.247	0.238	0.245
Percent Vehicles in Class6	0.089	0.122	0.110	0.063

Percent Vehicles in Class7	0.016	0.031	0.023	0.003
Percent Vehicles in Class8	0.054	0.062	0.058	0.047
Percent Vehicles in Class9	0.590	0.503	0.545	0.612
Percent Vehicles in Class10	0.004	0.004	0.005	0.005
Percent Vehicles in Class11	0.013	0.011	0.007	0.006
Percent Vehicles in Class12	0.006	0.003	0.002	0.004
Percent Vehicles in Class13	0.001	0.001	0.001	0.001
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	61.155	58.325	61.739	61.086
Avg Speed in Class5	58.512	57.304	58.472	59.786
Avg Speed in Class6	54.837	54.018	54.870	56.118
Avg Speed in Class7	50.874	48.872	51.720	54.259
Avg Speed in Class8	58.328	57.869	57.934	57.824
Avg Speed in Class9	62.093	60.597	61.721	62.903
Avg Speed in Class10	61.779	60.096	61.618	63.034
Avg Speed in Class11	61.646	63.242	65.934	63.593
Avg Speed in Class12	63.480	61.992	66.767	65.190
Avg Speed in Class13	62.265	61.708	62.353	63.088
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	60.288	58.445	59.782	61.437
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	39.391	39.744	38.745	39.567
Avg Length by Class5	27.487	27.869	27.490	26.672
Avg Length by Class6	28.371	28.510	28.685	28.026
Avg Length by Class7	26.451	26.049	26.700	27.528
Avg Length by Class8	55.534	54.628	55.084	57.731
Avg Length by Class9	66.433	65.706	66.251	66.932
Avg Length by Class10	71.991	71.585	72.022	72.407
Avg Length by Class11	73.157	72.958	72.608	73.377
Avg Length by Class12	77.259	76.595	78.403	78.867
Avg Length by Class13	86.953	86.310	86.587	87.439
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 69. Truck Characteristics Results – Year 2009 – Freeways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	280971	47445	16182	43962
Number Of Vehicle in Class5	4497718	819625	295104	748112
Number Of Vehicle in Class6	1500812	298717	118658	158207
Number Of Vehicle in Class7	273702	76901	24328	8246
Number Of Vehicle in Class8	1533975	253244	93880	202360
Number Of Vehicle in Class9	15537675	1954640	891627	2204095
Number Of Vehicle in Class10	110606	18393	8497	17198
Number Of Vehicle in Class11	684860	79120	11053	44368
Number Of Vehicle in Class12	288922	34786	7248	17980
Number Of Vehicle in Class13	32356	3910	2306	4904
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	24741597	3586781	1468883	3449432
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	28.084	27.794	27.873	27.785
Avg Weight of Class5	14.417	14.940	14.448	13.572
Avg Weight of Class6	29.970	31.890	31.148	26.921
Avg Weight of Class7	65.272	66.389	64.996	61.185
Avg Weight of Class8	37.730	39.313	36.789	35.536
Avg Weight of Class9	53.174	53.145	50.654	53.878
Avg Weight of Class10	61.911	62.423	62.998	61.382
Avg Weight of Class11	54.666	53.531	53.817	54.500
Avg Weight of Class12	56.532	56.655	58.607	58.454
Avg Weight of Class13	90.395	95.730	88.998	85.426
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	43.780	41.753	41.100	42.623
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.011	0.013	0.011	0.013
Percent Vehicles in Class5	0.182	0.229	0.201	0.217
Percent Vehicles in Class6	0.061	0.083	0.081	0.046

Percent Vehicles in Class7	0.011	0.021	0.017	0.002
Percent Vehicles in Class8	0.062	0.071	0.064	0.059
Percent Vehicles in Class9	0.628	0.545	0.607	0.639
Percent Vehicles in Class10	0.004	0.005	0.006	0.005
Percent Vehicles in Class11	0.028	0.022	0.008	0.013
Percent Vehicles in Class12	0.012	0.010	0.005	0.005
Percent Vehicles in Class13	0.001	0.001	0.002	0.001
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	67.856	67.023	68.206	67.435
Avg Speed in Class5	67.785	67.646	67.743	67.538
Avg Speed in Class6	64.895	64.642	64.852	64.940
Avg Speed in Class7	60.491	60.682	60.876	60.253
Avg Speed in Class8	65.635	65.271	65.736	65.089
Avg Speed in Class9	66.353	66.133	66.484	66.001
Avg Speed in Class10	67.444	67.288	67.646	66.970
Avg Speed in Class11	64.619	64.819	64.940	64.380
Avg Speed in Class12	66.274	66.141	67.802	66.645
Avg Speed in Class13	64.971	64.826	64.764	64.106
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.387	66.164	66.482	66.222
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.395	40.436	40.010	40.737
Avg Length by Class5	28.662	28.593	28.812	28.246
Avg Length by Class6	29.779	29.830	29.973	29.743
Avg Length by Class7	27.811	28.046	27.694	28.371
Avg Length by Class8	59.814	57.441	59.443	60.952
Avg Length by Class9	68.598	67.695	68.601	69.269
Avg Length by Class10	73.185	72.724	73.161	73.565
Avg Length by Class11	74.203	73.995	74.238	74.720
Avg Length by Class12	77.922	77.830	80.026	79.786
Avg Length by Class13	96.798	92.585	95.059	96.365
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 70. Truck Characteristics Results – Year 2010 – Urban Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	223971	44259	13196	34024
Number Of Vehicle in Class5	4105753	778651	271282	668274
Number Of Vehicle in Class6	1583906	335057	127184	162511
Number Of Vehicle in Class7	317020	95854	27850	7142
Number Of Vehicle in Class8	1240294	213475	78335	167284
Number Of Vehicle in Class9	9557649	1345286	578696	1265240
Number Of Vehicle in Class10	75011	13660	5804	10982
Number Of Vehicle in Class11	392789	48683	5165	23871
Number Of Vehicle in Class12	163699	22110	3226	8727
Number Of Vehicle in Class13	26030	3480	1559	3387
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	17686122	2900515	1112297	2351442
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	26.462	25.902	26.179	26.969
Avg Weight of Class5	14.417	14.958	14.437	13.525
Avg Weight of Class6	29.718	31.621	30.654	26.113
Avg Weight of Class7	66.709	67.611	66.578	60.897
Avg Weight of Class8	37.563	39.653	36.157	34.303
Avg Weight of Class9	51.690	51.787	49.474	52.120
Avg Weight of Class10	61.792	61.585	63.249	61.012
Avg Weight of Class11	53.944	51.702	52.588	53.505
Avg Weight of Class12	55.467	54.917	57.712	56.225
Avg Weight of Class13	91.461	93.575	90.448	91.405
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	40.214	38.924	38.158	37.877
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0127	0.0153	0.0119	0.0145
Percent Vehicles in Class5	0.2321	0.2685	0.2439	0.2842
Percent Vehicles in Class6	0.0896	0.1155	0.1143	0.0691

Percent Vehicles in Class7	0.0179	0.0330	0.0250	0.0030
Percent Vehicles in Class8	0.0701	0.0736	0.0704	0.0711
Percent Vehicles in Class9	0.5404	0.4638	0.5203	0.5381
Percent Vehicles in Class10	0.0042	0.0047	0.0052	0.0047
Percent Vehicles in Class11	0.0222	0.0168	0.0046	0.0102
Percent Vehicles in Class12	0.0093	0.0076	0.0029	0.0037
Percent Vehicles in Class13	0.0015	0.0012	0.0014	0.0014
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	64.765	64.047	65.588	64.168
Avg Speed in Class5	65.067	64.961	64.808	65.087
Avg Speed in Class6	60.664	59.861	60.691	61.357
Avg Speed in Class7	54.623	53.418	54.880	58.200
Avg Speed in Class8	63.179	62.909	63.128	62.501
Avg Speed in Class9	64.385	63.706	64.437	63.949
Avg Speed in Class10	64.826	64.460	65.095	64.083
Avg Speed in Class11	64.154	64.220	64.301	63.270
Avg Speed in Class12	66.247	65.571	67.185	66.108
Avg Speed in Class13	63.134	62.817	62.970	61.193
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	63.967	63.231	63.790	63.973
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.117	40.046	39.665	40.526
Avg Length by Class5	28.693	28.740	28.829	28.190
Avg Length by Class6	29.479	29.529	29.621	29.453
Avg Length by Class7	27.542	27.717	27.285	28.630
Avg Length by Class8	58.375	56.367	57.790	59.621
Avg Length by Class9	68.521	67.708	68.405	69.146
Avg Length by Class10	72.610	72.313	72.524	72.942
Avg Length by Class11	74.844	74.613	74.743	75.000
Avg Length by Class12	78.425	78.023	79.609	79.713
Avg Length by Class13	98.578	94.849	93.767	98.328
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 71. Truck Characteristics Results – Year 2010 – Rural Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	151523	24142	7731	23988
Number Of Vehicle in Class5	1755709	283153	116806	297874
Number Of Vehicle in Class6	477129	85322	33577	61174
Number Of Vehicle in Class7	48502	13442	4422	1957
Number Of Vehicle in Class8	525457	85760	31640	70019
Number Of Vehicle in Class9	10055113	1160184	546452	1531810
Number Of Vehicle in Class10	57755	8859	4158	9666
Number Of Vehicle in Class11	367304	46825	10056	27192
Number Of Vehicle in Class12	223937	25535	6969	18031
Number Of Vehicle in Class13	12293	1716	1058	2113
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	13674722	1734938	762869	2043824
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	29.594	27.988	29.538	28.988
Avg Weight of Class5	14.283	14.943	14.278	13.526
Avg Weight of Class6	29.283	31.394	30.318	26.736
Avg Weight of Class7	66.748	67.252	67.915	60.963
Avg Weight of Class8	36.689	38.331	35.743	34.274
Avg Weight of Class9	54.967	54.756	52.712	55.371
Avg Weight of Class10	64.212	65.417	65.836	63.074
Avg Weight of Class11	55.380	54.254	55.923	55.450
Avg Weight of Class12	56.823	57.823	57.131	58.986
Avg Weight of Class13	96.755	105.529	95.899	91.056
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	48.024	46.158	45.205	47.494
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0111	0.0139	0.0101	0.0117
Percent Vehicles in Class5	0.1284	0.1632	0.1531	0.1457
Percent Vehicles in Class6	0.0349	0.0492	0.0440	0.0299

Percent Vehicles in Class7	0.0035	0.0077	0.0058	0.0010
Percent Vehicles in Class8	0.0384	0.0494	0.0415	0.0343
Percent Vehicles in Class9	0.7353	0.6687	0.7163	0.7495
Percent Vehicles in Class10	0.0042	0.0051	0.0055	0.0047
Percent Vehicles in Class11	0.0269	0.0270	0.0132	0.0133
Percent Vehicles in Class12	0.0164	0.0147	0.0091	0.0088
Percent Vehicles in Class13	0.0009	0.0010	0.0014	0.0010
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	66.930	64.545	67.596	67.394
Avg Speed in Class5	67.036	66.761	66.906	67.419
Avg Speed in Class6	65.075	64.685	65.009	65.796
Avg Speed in Class7	61.711	61.728	61.422	62.646
Avg Speed in Class8	65.658	65.395	65.538	65.944
Avg Speed in Class9	66.490	66.404	66.574	66.481
Avg Speed in Class10	67.635	67.319	67.643	67.897
Avg Speed in Class11	65.122	65.245	65.890	65.704
Avg Speed in Class12	66.636	66.906	68.255	67.561
Avg Speed in Class13	64.255	65.495	63.695	63.131
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.435	66.245	66.502	66.588
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	41.189	40.722	40.858	41.112
Avg Length by Class5	28.267	28.282	28.410	27.817
Avg Length by Class6	29.934	30.034	30.123	29.739
Avg Length by Class7	27.464	27.415	27.292	28.345
Avg Length by Class8	58.181	56.089	57.638	59.847
Avg Length by Class9	69.165	68.352	68.870	69.600
Avg Length by Class10	73.186	72.780	73.017	73.514
Avg Length by Class11	74.230	73.991	74.067	74.654
Avg Length by Class12	78.316	78.517	80.292	80.185
Avg Length by Class13	86.059	84.769	86.201	85.912
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 72. Truck Characteristics Results – Year 2010 – Multilane Highways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	75435	16571	3494	10450
Number Of Vehicle in Class5	1260726	225696	88475	199705
Number Of Vehicle in Class6	611103	134092	47916	60645
Number Of Vehicle in Class7	141486	45887	12163	2917
Number Of Vehicle in Class8	343139	59920	23903	42897
Number Of Vehicle in Class9	3418890	469407	204276	475457
Number Of Vehicle in Class10	23263	4071	1769	3579
Number Of Vehicle in Class11	62750	8492	2248	4183
Number Of Vehicle in Class12	35048	3192	560	2369
Number Of Vehicle in Class13	6543	820	553	1144
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	5978383	968148	385357	803346
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	26.758	24.882	27.400	27.249
Avg Weight of Class5	14.145	14.822	14.140	13.047
Avg Weight of Class6	29.483	31.806	30.377	24.838
Avg Weight of Class7	66.845	66.638	67.359	63.144
Avg Weight of Class8	37.567	39.309	36.045	32.654
Avg Weight of Class9	53.045	52.063	51.169	53.649
Avg Weight of Class10	62.873	61.055	65.161	62.965
Avg Weight of Class11	55.188	54.295	57.171	55.233
Avg Weight of Class12	55.517	55.872	62.313	56.128
Avg Weight of Class13	81.296	87.480	82.649	76.666
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	41.646	40.112	39.600	40.040
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.013	0.017	0.009	0.013
Percent Vehicles in Class5	0.211	0.233	0.230	0.249
Percent Vehicles in Class6	0.102	0.139	0.124	0.075

Percent Vehicles in Class7	0.024	0.047	0.032	0.004
Percent Vehicles in Class8	0.057	0.062	0.062	0.053
Percent Vehicles in Class9	0.572	0.485	0.530	0.592
Percent Vehicles in Class10	0.004	0.004	0.005	0.004
Percent Vehicles in Class11	0.010	0.009	0.006	0.005
Percent Vehicles in Class12	0.006	0.003	0.001	0.003
Percent Vehicles in Class13	0.001	0.001	0.001	0.001
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	58.381	56.649	59.090	58.563
Avg Speed in Class5	57.517	56.538	57.395	58.631
Avg Speed in Class6	53.710	52.319	53.634	55.254
Avg Speed in Class7	47.438	45.861	47.973	52.543
Avg Speed in Class8	56.972	56.427	56.655	56.874
Avg Speed in Class9	60.674	59.161	60.359	61.313
Avg Speed in Class10	59.374	57.778	59.106	60.477
Avg Speed in Class11	61.176	62.164	64.866	62.854
Avg Speed in Class12	63.269	60.252	66.971	64.633
Avg Speed in Class13	56.992	57.268	56.941	56.699
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	58.753	56.782	58.235	59.892
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.175	39.886	39.575	40.396
Avg Length by Class5	27.827	28.137	27.857	27.059
Avg Length by Class6	28.454	28.386	28.629	28.424
Avg Length by Class7	26.664	26.534	26.681	27.358
Avg Length by Class8	55.833	54.801	55.474	58.086
Avg Length by Class9	67.173	66.365	66.902	67.676
Avg Length by Class10	71.869	71.452	71.705	72.502
Avg Length by Class11	73.508	73.263	73.028	73.191
Avg Length by Class12	77.459	76.619	78.772	78.902
Avg Length by Class13	86.528	86.434	87.087	86.306
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 73. Truck Characteristics Results – Year 2010 – Freeways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	300059	51830	17433	47562
Number Of Vehicle in Class5	4600736	836108	299613	766443
Number Of Vehicle in Class6	1449932	286287	112845	163040
Number Of Vehicle in Class7	224036	63409	20109	6182
Number Of Vehicle in Class8	1422612	239315	86072	194406
Number Of Vehicle in Class9	16193872	2036063	920872	2321593
Number Of Vehicle in Class10	109503	18448	8193	17069
Number Of Vehicle in Class11	697343	87016	12973	46880
Number Of Vehicle in Class12	352588	44453	9635	24389
Number Of Vehicle in Class13	31780	4376	2064	4356
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	25382461	3667305	1489809	3591920
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	27.969	27.200	27.424	27.926
Avg Weight of Class5	14.440	14.989	14.463	13.650
Avg Weight of Class6	29.674	31.466	30.671	26.821
Avg Weight of Class7	66.631	68.239	66.400	59.857
Avg Weight of Class8	37.239	39.266	36.036	34.656
Avg Weight of Class9	53.439	53.415	51.019	53.952
Avg Weight of Class10	62.839	63.542	64.149	61.770
Avg Weight of Class11	54.588	52.822	54.379	54.479
Avg Weight of Class12	56.323	56.517	57.024	58.276
Avg Weight of Class13	95.602	99.405	95.332	95.106
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	44.085	42.033	41.394	42.865
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.012	0.014	0.012	0.013
Percent Vehicles in Class5	0.181	0.228	0.201	0.213
Percent Vehicles in Class6	0.057	0.078	0.076	0.045

Percent Vehicles in Class7	0.009	0.017	0.013	0.002
Percent Vehicles in Class8	0.056	0.065	0.058	0.054
Percent Vehicles in Class9	0.638	0.555	0.618	0.646
Percent Vehicles in Class10	0.004	0.005	0.005	0.005
Percent Vehicles in Class11	0.027	0.024	0.009	0.013
Percent Vehicles in Class12	0.014	0.012	0.006	0.007
Percent Vehicles in Class13	0.001	0.001	0.001	0.001
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	67.463	66.644	67.781	67.027
Avg Speed in Class5	67.888	67.844	67.815	67.675
Avg Speed in Class6	65.046	64.831	64.973	65.293
Avg Speed in Class7	60.695	60.648	60.496	62.276
Avg Speed in Class8	65.591	65.423	65.812	64.983
Avg Speed in Class9	66.476	66.292	66.610	66.159
Avg Speed in Class10	67.466	67.307	67.681	66.999
Avg Speed in Class11	64.932	64.972	65.435	64.719
Avg Speed in Class12	66.790	66.720	67.972	67.326
Avg Speed in Class13	64.832	64.907	64.957	63.314
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.525	66.359	66.615	66.374
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.644	40.412	40.212	40.850
Avg Length by Class5	28.768	28.748	28.952	28.340
Avg Length by Class6	30.060	30.215	30.191	29.944
Avg Length by Class7	28.079	28.510	27.652	29.140
Avg Length by Class8	58.917	56.659	58.377	60.041
Avg Length by Class9	69.205	68.385	69.014	69.747
Avg Length by Class10	73.071	72.728	72.951	73.358
Avg Length by Class11	74.641	74.410	74.516	74.961
Avg Length by Class12	78.452	78.408	80.152	80.140
Avg Length by Class13	96.217	92.473	91.679	95.462
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 74. Truck Characteristics Results – Year 2011 – Urban Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	159200	30807	9427	25198
Number Of Vehicle in Class5	2925333	550441	193832	471950
Number Of Vehicle in Class6	1141965	240566	90439	120375
Number Of Vehicle in Class7	267993	84969	22671	6269
Number Of Vehicle in Class8	862792	155488	53390	119662
Number Of Vehicle in Class9	7318486	1026778	446191	982437
Number Of Vehicle in Class10	53662	9310	4271	8192
Number Of Vehicle in Class11	306557	39557	3983	19055
Number Of Vehicle in Class12	122155	16045	2461	7609
Number Of Vehicle in Class13	18685	2204	1137	2732
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	13176828	2156165	827802	1763479
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	27.209	26.806	27.067	27.636
Avg Weight of Class5	14.927	15.414	14.967	14.057
Avg Weight of Class6	29.500	31.557	30.248	26.214
Avg Weight of Class7	66.674	67.068	67.340	60.903
Avg Weight of Class8	36.950	39.430	35.646	33.278
Avg Weight of Class9	53.228	53.134	50.822	53.696
Avg Weight of Class10	63.373	64.136	64.816	62.123
Avg Weight of Class11	55.326	53.133	53.343	55.002
Avg Weight of Class12	56.776	55.869	58.203	57.555
Avg Weight of Class13	93.136	93.897	89.413	90.524
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	41.741	40.391	39.541	39.606
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0121	0.0143	0.0114	0.0143
Percent Vehicles in Class5	0.2220	0.2553	0.2342	0.2676
Percent Vehicles in Class6	0.0867	0.1116	0.1093	0.0683

Percent Vehicles in Class7	0.0203	0.0394	0.0274	0.0036
Percent Vehicles in Class8	0.0655	0.0721	0.0645	0.0679
Percent Vehicles in Class9	0.5554	0.4762	0.5390	0.5571
Percent Vehicles in Class10	0.0041	0.0043	0.0052	0.0046
Percent Vehicles in Class11	0.0233	0.0183	0.0048	0.0108
Percent Vehicles in Class12	0.0093	0.0074	0.0030	0.0043
Percent Vehicles in Class13	0.0014	0.0010	0.0014	0.0015
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	64.599	63.686	65.314	63.844
Avg Speed in Class5	65.356	65.236	65.165	65.250
Avg Speed in Class6	60.996	60.087	61.223	61.510
Avg Speed in Class7	54.100	52.451	54.891	57.437
Avg Speed in Class8	62.594	62.231	62.757	61.905
Avg Speed in Class9	64.685	64.106	64.745	64.160
Avg Speed in Class10	65.266	64.611	65.605	64.510
Avg Speed in Class11	64.359	64.509	64.197	63.516
Avg Speed in Class12	66.674	66.211	67.379	66.526
Avg Speed in Class13	63.423	62.768	63.104	61.323
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	64.172	63.370	64.074	64.090
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.181	39.895	39.987	40.646
Avg Length by Class5	28.964	28.884	29.215	28.475
Avg Length by Class6	29.496	29.530	29.636	29.601
Avg Length by Class7	27.034	26.948	27.024	28.160
Avg Length by Class8	57.154	55.439	56.415	58.856
Avg Length by Class9	68.806	67.934	68.612	69.507
Avg Length by Class10	72.627	72.293	72.480	72.991
Avg Length by Class11	74.993	74.836	74.984	75.287
Avg Length by Class12	78.680	78.455	80.007	80.084
Avg Length by Class13	99.611	94.868	96.175	99.355
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 75. Truck Characteristics Results – Year 2011 – Rural Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	104631	16588	5799	15924
Number Of Vehicle in Class5	1183884	190265	81229	197659
Number Of Vehicle in Class6	324529	59482	22244	39481
Number Of Vehicle in Class7	30370	8384	2981	1291
Number Of Vehicle in Class8	347929	58405	20674	47453
Number Of Vehicle in Class9	6383396	753217	348491	967522
Number Of Vehicle in Class10	36171	5528	2646	6019
Number Of Vehicle in Class11	249396	29130	5667	16926
Number Of Vehicle in Class12	147535	17607	4589	11915
Number Of Vehicle in Class13	7398	986	646	1241
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	8815239	1139592	494966	1305431
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	30.423	28.362	29.947	30.315
Avg Weight of Class5	14.668	15.200	14.745	13.869
Avg Weight of Class6	29.906	31.986	30.509	26.641
Avg Weight of Class7	66.190	67.125	67.812	57.933
Avg Weight of Class8	36.981	38.934	35.661	34.420
Avg Weight of Class9	55.403	55.256	52.748	55.781
Avg Weight of Class10	64.332	65.138	65.417	63.787
Avg Weight of Class11	56.013	54.695	54.507	55.114
Avg Weight of Class12	57.311	57.960	55.251	59.637
Avg Weight of Class13	97.730	105.979	99.681	92.359
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	48.128	46.332	44.794	47.567
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0119	0.0146	0.0117	0.0122
Percent Vehicles in Class5	0.1343	0.1670	0.1641	0.1514
Percent Vehicles in Class6	0.0368	0.0522	0.0449	0.0302

Percent Vehicles in Class7	0.0034	0.0074	0.0060	0.0010
Percent Vehicles in Class8	0.0395	0.0513	0.0418	0.0364
Percent Vehicles in Class9	0.7241	0.6610	0.7041	0.7412
Percent Vehicles in Class10	0.0041	0.0049	0.0053	0.0046
Percent Vehicles in Class11	0.0283	0.0256	0.0114	0.0130
Percent Vehicles in Class12	0.0167	0.0155	0.0093	0.0091
Percent Vehicles in Class13	0.0008	0.0009	0.0013	0.0010
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	66.558	64.520	67.276	66.778
Avg Speed in Class5	66.898	66.926	66.611	67.237
Avg Speed in Class6	64.745	64.642	64.930	65.440
Avg Speed in Class7	61.738	62.000	61.480	61.454
Avg Speed in Class8	65.730	65.573	65.616	65.968
Avg Speed in Class9	66.451	66.335	66.551	66.460
Avg Speed in Class10	67.421	67.301	67.534	67.504
Avg Speed in Class11	65.316	65.395	66.115	65.998
Avg Speed in Class12	66.966	67.193	68.198	67.769
Avg Speed in Class13	65.926	65.877	65.262	65.714
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.385	66.242	66.440	66.538
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	41.398	40.683	41.209	41.413
Avg Length by Class5	28.522	28.353	28.809	28.049
Avg Length by Class6	29.980	30.126	30.214	29.893
Avg Length by Class7	27.725	27.549	27.368	29.338
Avg Length by Class8	58.267	55.977	57.686	59.889
Avg Length by Class9	69.247	68.461	68.985	69.725
Avg Length by Class10	73.034	72.576	72.996	73.447
Avg Length by Class11	74.316	74.160	74.285	74.660
Avg Length by Class12	78.367	78.758	80.255	79.913
Avg Length by Class13	86.094	84.374	85.863	86.699
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 76. Truck Characteristics Results – Year 2011 – Multilane Highways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	36234	8790	1610	5371
Number Of Vehicle in Class5	628866	113048	44576	98564
Number Of Vehicle in Class6	344089	77888	26282	35097
Number Of Vehicle in Class7	90012	30789	7712	1870
Number Of Vehicle in Class8	188740	34279	12573	25306
Number Of Vehicle in Class9	1335499	206456	86381	167273
Number Of Vehicle in Class10	8258	1650	690	1068
Number Of Vehicle in Class11	11815	1444	131	390
Number Of Vehicle in Class12	9504	834	21	347
Number Of Vehicle in Class13	2017	229	202	292
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	2655034	475407	180178	335578
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	25.168	23.817	25.529	26.007
Avg Weight of Class5	14.488	15.058	14.638	13.389
Avg Weight of Class6	27.810	29.895	28.409	23.664
Avg Weight of Class7	68.287	68.176	69.091	62.737
Avg Weight of Class8	38.446	40.515	36.942	33.058
Avg Weight of Class9	51.268	50.754	48.862	51.290
Avg Weight of Class10	63.666	62.740	65.836	63.253
Avg Weight of Class11	55.324	52.893	53.001	48.482
Avg Weight of Class12	52.447	54.480	59.209	47.455
Avg Weight of Class13	87.317	96.438	87.441	83.622
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	38.914	38.817	37.349	35.611
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.014	0.018	0.009	0.016
Percent Vehicles in Class5	0.237	0.238	0.247	0.294
Percent Vehicles in Class6	0.130	0.164	0.146	0.105

Percent Vehicles in Class7	0.034	0.065	0.043	0.006
Percent Vehicles in Class8	0.071	0.072	0.070	0.075
Percent Vehicles in Class9	0.503	0.434	0.479	0.498
Percent Vehicles in Class10	0.003	0.003	0.004	0.003
Percent Vehicles in Class11	0.004	0.003	0.001	0.001
Percent Vehicles in Class12	0.004	0.002	0.000	0.001
Percent Vehicles in Class13	0.001	0.000	0.001	0.001
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	56.242	55.295	55.909	57.461
Avg Speed in Class5	56.628	56.119	56.340	57.752
Avg Speed in Class6	53.586	52.498	53.823	54.566
Avg Speed in Class7	46.596	45.200	47.511	50.273
Avg Speed in Class8	54.625	54.314	54.488	54.624
Avg Speed in Class9	57.752	57.031	57.770	57.758
Avg Speed in Class10	56.785	55.637	56.715	57.577
Avg Speed in Class11	60.469	59.083	59.104	59.438
Avg Speed in Class12	62.908	60.588	61.386	63.659
Avg Speed in Class13	58.226	56.330	57.512	55.829
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	56.353	55.085	56.153	57.145
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	39.473	39.304	38.742	39.761
Avg Length by Class5	28.079	28.192	28.301	27.311
Avg Length by Class6	28.060	27.961	28.274	28.124
Avg Length by Class7	26.428	26.338	26.400	27.428
Avg Length by Class8	55.744	54.557	55.239	57.854
Avg Length by Class9	66.466	65.783	66.298	66.794
Avg Length by Class10	71.421	71.140	71.091	72.216
Avg Length by Class11	74.504	73.794	73.827	74.723
Avg Length by Class12	78.544	76.447	78.690	80.442
Avg Length by Class13	87.463	85.666	87.093	88.995
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 77. Truck Characteristics Results – Year 2011 – Freeways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	227597	38605	13616	35751
Number Of Vehicle in Class5	3480351	627658	230485	571045
Number Of Vehicle in Class6	1122405	222160	86401	124759
Number Of Vehicle in Class7	208351	62564	17940	5690
Number Of Vehicle in Class8	1021981	179614	61491	141809
Number Of Vehicle in Class9	12366383	1573539	708301	1782686
Number Of Vehicle in Class10	81575	13188	6227	13143
Number Of Vehicle in Class11	544138	67243	9519	35591
Number Of Vehicle in Class12	260186	32818	7029	19177
Number Of Vehicle in Class13	24066	2961	1581	3681
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	19337033	2820350	1142590	2733332
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	29.011	28.155	28.475	29.074
Avg Weight of Class5	14.918	15.413	14.953	14.107
Avg Weight of Class6	30.136	32.254	30.875	27.067
Avg Weight of Class7	65.906	66.531	66.665	59.626
Avg Weight of Class8	36.684	39.062	35.386	33.700
Avg Weight of Class9	54.562	54.462	52.009	55.053
Avg Weight of Class10	63.769	64.731	64.958	62.793
Avg Weight of Class11	55.641	53.815	54.041	55.127
Avg Weight of Class12	57.237	57.026	56.273	59.032
Avg Weight of Class13	95.036	97.724	93.861	91.690
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	45.041	43.057	42.162	43.899
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.012	0.014	0.012	0.013
Percent Vehicles in Class5	0.180	0.223	0.202	0.209
Percent Vehicles in Class6	0.058	0.079	0.076	0.046

Percent Vehicles in Class7	0.011	0.022	0.016	0.002
Percent Vehicles in Class8	0.053	0.064	0.054	0.052
Percent Vehicles in Class9	0.640	0.558	0.620	0.652
Percent Vehicles in Class10	0.004	0.005	0.005	0.005
Percent Vehicles in Class11	0.028	0.024	0.008	0.013
Percent Vehicles in Class12	0.013	0.012	0.006	0.007
Percent Vehicles in Class13	0.001	0.001	0.001	0.001
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	66.830	65.955	67.261	66.110
Avg Speed in Class5	67.458	67.390	67.381	67.232
Avg Speed in Class6	64.352	63.967	64.429	64.707
Avg Speed in Class7	58.455	57.300	59.159	60.703
Avg Speed in Class8	65.133	64.828	65.409	64.564
Avg Speed in Class9	66.345	66.102	66.484	66.009
Avg Speed in Class10	67.080	66.861	67.410	66.445
Avg Speed in Class11	64.882	65.009	65.409	64.741
Avg Speed in Class12	66.977	66.881	67.932	67.350
Avg Speed in Class13	64.628	64.301	64.700	63.239
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.255	65.927	66.348	66.112
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.853	40.368	40.654	41.121
Avg Length by Class5	28.973	28.848	29.248	28.529
Avg Length by Class6	30.076	30.240	30.199	30.110
Avg Length by Class7	27.396	27.329	27.349	28.668
Avg Length by Class8	57.793	55.782	57.083	59.380
Avg Length by Class9	69.286	68.468	69.078	69.880
Avg Length by Class10	72.929	72.556	72.854	73.263
Avg Length by Class11	74.693	74.566	74.584	74.995
Avg Length by Class12	78.507	78.668	80.173	79.971
Avg Length by Class13	96.474	92.085	93.122	95.910
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 78. Truck Characteristics Results –Years 2008, 2009, 2010 and 2011 – Urban Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	754161	146565	44399	113521
Number Of Vehicle in Class5	13884572	2654076	921163	2244547
Number Of Vehicle in Class6	5631830	1184972	458071	558052
Number Of Vehicle in Class7	1192171	349426	106125	31146
Number Of Vehicle in Class8	4301928	766023	271652	569250
Number Of Vehicle in Class9	32859462	4622385	1990521	4290625
Number Of Vehicle in Class10	262056	46759	20841	38118
Number Of Vehicle in Class11	1418008	170549	16427	89227
Number Of Vehicle in Class12	522690	66854	10131	29779
Number Of Vehicle in Class13	99717	11087	5777	15902
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	60926595	10018696	3845107	7980167
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	26.919	26.511	26.788	27.297
Avg Weight of Class5	14.562	15.089	14.614	13.620
Avg Weight of Class6	30.330	32.219	31.451	26.658
Avg Weight of Class7	66.022	66.698	66.008	62.181
Avg Weight of Class8	37.708	39.781	36.627	34.484
Avg Weight of Class9	51.843	51.966	49.570	52.183
Avg Weight of Class10	61.956	62.140	63.066	61.039
Avg Weight of Class11	54.435	52.177	52.460	54.249
Avg Weight of Class12	55.553	55.056	57.528	55.569
Avg Weight of Class13	85.151	89.711	87.277	79.026
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	40.520	39.184	38.476	38.106
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0124	0.0146	0.0115	0.0142
Percent Vehicles in Class5	0.2279	0.2649	0.2396	0.2813
Percent Vehicles in Class6	0.0924	0.1183	0.1191	0.0699

Percent Vehicles in Class7	0.0196	0.0349	0.0276	0.0039
Percent Vehicles in Class8	0.0706	0.0765	0.0706	0.0713
Percent Vehicles in Class9	0.5393	0.4614	0.5177	0.5377
Percent Vehicles in Class10	0.0043	0.0047	0.0054	0.0048
Percent Vehicles in Class11	0.0233	0.0170	0.0043	0.0112
Percent Vehicles in Class12	0.0086	0.0067	0.0026	0.0037
Percent Vehicles in Class13	0.0016	0.0011	0.0015	0.0020
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	65.141	64.358	65.912	64.287
Avg Speed in Class5	65.249	65.070	65.075	65.148
Avg Speed in Class6	61.437	60.830	61.568	61.660
Avg Speed in Class7	56.390	55.316	56.944	58.170
Avg Speed in Class8	63.416	63.010	63.382	62.750
Avg Speed in Class9	64.592	63.912	64.637	64.079
Avg Speed in Class10	65.245	64.746	65.500	64.523
Avg Speed in Class11	64.080	64.148	64.072	63.389
Avg Speed in Class12	66.252	65.678	67.267	66.164
Avg Speed in Class13	64.125	63.193	62.780	63.198
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	64.218	63.511	64.096	64.096
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.143	40.052	39.731	40.623
Avg Length by Class5	28.629	28.611	28.801	28.127
Avg Length by Class6	29.395	29.467	29.574	29.349
Avg Length by Class7	27.369	27.481	27.237	28.057
Avg Length by Class8	58.148	56.079	57.463	59.668
Avg Length by Class9	68.298	67.418	68.208	69.022
Avg Length by Class10	72.640	72.275	72.531	73.008
Avg Length by Class11	74.771	74.566	74.850	75.041
Avg Length by Class12	78.298	77.961	79.815	79.771
Avg Length by Class13	97.597	94.711	95.990	96.597
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 79. Truck Characteristics Results –Years 2008, 2009, 2010 and 2011 – Rural Areas

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	487650	75343	25627	76885
Number Of Vehicle in Class5	6069582	1038992	410626	1025989
Number Of Vehicle in Class6	1677197	324448	117633	209538
Number Of Vehicle in Class7	194365	58643	17561	8513
Number Of Vehicle in Class8	1877879	318795	114640	238313
Number Of Vehicle in Class9	34854744	4085751	1928144	5287588
Number Of Vehicle in Class10	206427	31817	15386	34284
Number Of Vehicle in Class11	1266870	152740	33025	91835
Number Of Vehicle in Class12	705180	79487	21310	55109
Number Of Vehicle in Class13	49627	7001	4152	8589
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	47389521	6173017	2688104	7036643
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	29.970	28.280	29.617	29.575
Avg Weight of Class5	14.358	15.040	14.379	13.572
Avg Weight of Class6	29.221	31.471	29.989	26.701
Avg Weight of Class7	64.866	65.455	65.640	59.262
Avg Weight of Class8	37.093	38.361	36.155	34.803
Avg Weight of Class9	54.785	54.731	52.322	55.253
Avg Weight of Class10	63.565	64.282	65.179	62.986
Avg Weight of Class11	54.886	54.475	54.762	54.313
Avg Weight of Class12	56.616	57.538	57.543	58.324
Avg Weight of Class13	91.833	99.513	92.169	88.556
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	47.895	45.892	44.936	47.447
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0103	0.0122	0.0095	0.0109
Percent Vehicles in Class5	0.1281	0.1683	0.1528	0.1458
Percent Vehicles in Class6	0.0354	0.0526	0.0438	0.0298

Percent Vehicles in Class7	0.0041	0.0095	0.0065	0.0012
Percent Vehicles in Class8	0.0396	0.0516	0.0426	0.0339
Percent Vehicles in Class9	0.7355	0.6619	0.7173	0.7514
Percent Vehicles in Class10	0.0044	0.0052	0.0057	0.0049
Percent Vehicles in Class11	0.0267	0.0247	0.0123	0.0131
Percent Vehicles in Class12	0.0149	0.0129	0.0079	0.0078
Percent Vehicles in Class13	0.0010	0.0011	0.0015	0.0012
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	67.080	64.647	67.769	67.529
Avg Speed in Class5	67.022	66.619	66.779	67.467
Avg Speed in Class6	64.987	64.241	64.931	65.849
Avg Speed in Class7	61.813	61.865	61.648	62.402
Avg Speed in Class8	65.656	65.240	65.464	65.947
Avg Speed in Class9	66.584	66.444	66.695	66.585
Avg Speed in Class10	67.639	67.219	67.662	67.889
Avg Speed in Class11	64.848	65.077	65.647	65.249
Avg Speed in Class12	66.451	66.692	68.125	67.230
Avg Speed in Class13	65.786	65.728	65.349	65.697
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.487	66.203	66.558	66.668
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.536	40.466	40.271	40.632
Avg Length by Class5	28.222	28.171	28.357	27.792
Avg Length by Class6	30.011	30.042	30.205	29.850
Avg Length by Class7	27.715	27.503	27.596	28.588
Avg Length by Class8	57.942	55.829	57.341	59.537
Avg Length by Class9	68.911	68.110	68.688	69.362
Avg Length by Class10	73.146	72.746	73.092	73.504
Avg Length by Class11	74.166	73.897	73.850	74.596
Avg Length by Class12	78.224	78.473	80.279	80.089
Avg Length by Class13	86.976	85.593	86.813	87.312
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 80. Truck Characteristics Results –Years 2008, 2009, 2010 and 2011 – Multilane Highways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	246329	51811	11631	35051
Number Of Vehicle in Class5	4004235	780379	284341	635464
Number Of Vehicle in Class6	1830706	418336	144222	179602
Number Of Vehicle in Class7	394984	127892	35015	9654
Number Of Vehicle in Class8	1150929	217862	79074	140436
Number Of Vehicle in Class9	11364993	1591884	687981	1582036
Number Of Vehicle in Class10	78262	14087	6281	11639
Number Of Vehicle in Class11	221365	30357	7667	15037
Number Of Vehicle in Class12	115813	9934	2171	8733
Number Of Vehicle in Class13	18833	2683	1541	3051
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	19426449	3245225	1259924	2620703
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	28.085	25.544	28.344	28.524
Avg Weight of Class5	14.494	15.261	14.534	13.308
Avg Weight of Class6	30.128	32.221	31.339	25.530
Avg Weight of Class7	66.594	66.434	66.936	63.021
Avg Weight of Class8	38.470	39.501	37.151	34.671
Avg Weight of Class9	52.853	52.308	50.785	53.182
Avg Weight of Class10	62.817	61.274	65.058	62.519
Avg Weight of Class11	54.384	53.896	55.514	53.239
Avg Weight of Class12	54.486	55.114	61.442	53.151
Avg Weight of Class13	83.596	85.845	86.045	81.532
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	42.015	40.170	39.925	40.408
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0127	0.0160	0.0092	0.0134
Percent Vehicles in Class5	0.2061	0.2405	0.2257	0.2425

Percent Vehicles in Class6	0.0942	0.1289	0.1145	0.0685
Percent Vehicles in Class7	0.0203	0.0394	0.0278	0.0037
Percent Vehicles in Class8	0.0592	0.0671	0.0628	0.0536
Percent Vehicles in Class9	0.5850	0.4905	0.5460	0.6037
Percent Vehicles in Class10	0.0040	0.0043	0.0050	0.0044
Percent Vehicles in Class11	0.0114	0.0094	0.0061	0.0057
Percent Vehicles in Class12	0.0060	0.0031	0.0017	0.0033
Percent Vehicles in Class13	0.0010	0.0008	0.0012	0.0012
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	60.018	57.579	60.640	60.211
Avg Speed in Class5	58.145	57.737	58.007	59.230
Avg Speed in Class6	54.927	54.254	54.961	56.113
Avg Speed in Class7	50.342	49.110	51.080	54.476
Avg Speed in Class8	58.516	58.191	58.127	58.323
Avg Speed in Class9	61.631	60.247	61.363	62.363
Avg Speed in Class10	61.194	59.643	61.125	62.407
Avg Speed in Class11	61.718	62.847	65.460	63.394
Avg Speed in Class12	63.899	61.866	67.247	65.326
Avg Speed in Class13	60.500	60.365	60.053	60.416
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	59.858	58.278	59.409	60.914
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	39.155	39.560	38.492	39.382
Avg Length by Class5	27.601	27.917	27.629	26.849
Avg Length by Class6	28.418	28.498	28.627	28.242
Avg Length by Class7	26.727	26.522	26.772	27.511
Avg Length by Class8	55.473	54.350	54.984	57.511
Avg Length by Class9	66.264	65.701	66.101	66.626
Avg Length by Class10	71.681	71.377	71.622	72.207
Avg Length by Class11	72.875	72.597	71.834	72.610
Avg Length by Class12	77.105	76.161	77.918	78.618
Avg Length by Class13	87.283	86.867	87.273	87.653
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

Table 81. Truck Characteristics Results –Years 2008, 2009, 2010 and 2011 – Freeways

	Full Day	Morning Peak	Mid-Day	Evening Peak
Number Of Vehicle in Class1	0	0	0	0
Number Of Vehicle in Class2	0	0	0	0
Number Of Vehicle in Class3	0	0	0	0
Number Of Vehicle in Class4	995482	170097	58395	155355
Number Of Vehicle in Class5	15949919	2912689	1047448	2635072
Number Of Vehicle in Class6	5478321	1091084	431482	587988
Number Of Vehicle in Class7	991552	280177	88671	30005
Number Of Vehicle in Class8	5028878	866956	307218	667127
Number Of Vehicle in Class9	56349213	7116252	3230684	7996177
Number Of Vehicle in Class10	390221	64489	29946	60763
Number Of Vehicle in Class11	2463513	292932	41785	166025
Number Of Vehicle in Class12	1112057	136407	29270	76155
Number Of Vehicle in Class13	130511	15405	8388	21440
Number Of Vehicle in Class14	0	0	0	0
Number Of Vehicle in Class15	0	0	0	0
Total Number of Vehicles	88889667	12946488	5273287	12396107
Avg Weight of Class1	-	-	-	-
Avg Weight of Class2	-	-	-	-
Avg Weight of Class3	-	-	-	-
Avg Weight of Class4	28.125	27.589	27.720	28.148
Avg Weight of Class5	14.501	15.026	14.543	13.676
Avg Weight of Class6	30.058	31.995	31.089	27.018
Avg Weight of Class7	65.568	66.559	65.568	61.083
Avg Weight of Class8	37.304	39.329	36.316	34.559
Avg Weight of Class9	53.459	53.477	50.954	54.015
Avg Weight of Class10	62.635	63.386	63.734	61.854
Avg Weight of Class11	54.671	53.197	53.719	54.376
Avg Weight of Class12	56.338	56.498	57.249	57.840
Avg Weight of Class13	87.916	94.839	89.925	82.487
Avg Weight of Class14	-	-	-	-
Avg Weight of Class15	-	-	-	-
Average Weight Overall	44.124	42.136	41.423	42.922
Percent Vehicles in Class1	0	0	0	0
Percent Vehicles in Class2	0	0	0	0
Percent Vehicles in Class3	0	0	0	0
Percent Vehicles in Class4	0.0112	0.0131	0.0111	0.0125
Percent Vehicles in Class5	0.1794	0.2250	0.1986	0.2126
Percent Vehicles in Class6	0.0616	0.0843	0.0818	0.0474

Percent Vehicles in Class7	0.0112	0.0216	0.0168	0.0024
Percent Vehicles in Class8	0.0566	0.0670	0.0583	0.0538
Percent Vehicles in Class9	0.6339	0.5497	0.6127	0.6451
Percent Vehicles in Class10	0.0044	0.0050	0.0057	0.0049
Percent Vehicles in Class11	0.0277	0.0226	0.0079	0.0134
Percent Vehicles in Class12	0.0125	0.0105	0.0056	0.0061
Percent Vehicles in Class13	0.0015	0.0012	0.0016	0.0017
Percent Vehicles in Class14	0	0	0	0
Percent Vehicles in Class15	0	0	0	0
Avg Speed in Class1	-	-	-	-
Avg Speed in Class2	-	-	-	-
Avg Speed in Class3	-	-	-	-
Avg Speed in Class4	67.359	66.552	67.777	66.811
Avg Speed in Class5	67.707	67.587	67.662	67.478
Avg Speed in Class6	64.700	64.366	64.694	64.847
Avg Speed in Class7	59.862	59.519	60.191	60.560
Avg Speed in Class8	65.373	65.040	65.511	64.824
Avg Speed in Class9	66.421	66.185	66.563	66.075
Avg Speed in Class10	67.323	67.080	67.529	66.828
Avg Speed in Class11	64.687	64.767	65.062	64.418
Avg Speed in Class12	66.623	66.546	67.894	67.031
Avg Speed in Class13	65.280	64.838	64.553	64.595
Avg Speed in Class14	-	-	-	-
Avg Speed in Class15	-	-	-	-
Average Speed Overall	66.380	66.106	66.471	66.229
Avg Length by Class1	-	-	-	-
Avg Length by Class2	-	-	-	-
Avg Length by Class3	-	-	-	-
Avg Length by Class4	40.580	40.385	40.215	40.907
Avg Length by Class5	28.732	28.640	28.945	28.305
Avg Length by Class6	29.910	30.010	30.062	29.865
Avg Length by Class7	27.693	27.924	27.491	28.383
Avg Length by Class8	58.683	56.422	58.055	60.076
Avg Length by Class9	69.087	68.199	68.943	69.721
Avg Length by Class10	73.100	72.703	73.010	73.441
Avg Length by Class11	74.630	74.421	74.613	75.015
Avg Length by Class12	78.375	78.390	80.293	80.133
Avg Length by Class13	95.046	91.934	93.049	94.150
Avg Length by Class14	-	-	-	-
Avg Length by Class15	-	-	-	-

APPENDIX D - Truck Acceleration vs. Speed Curves

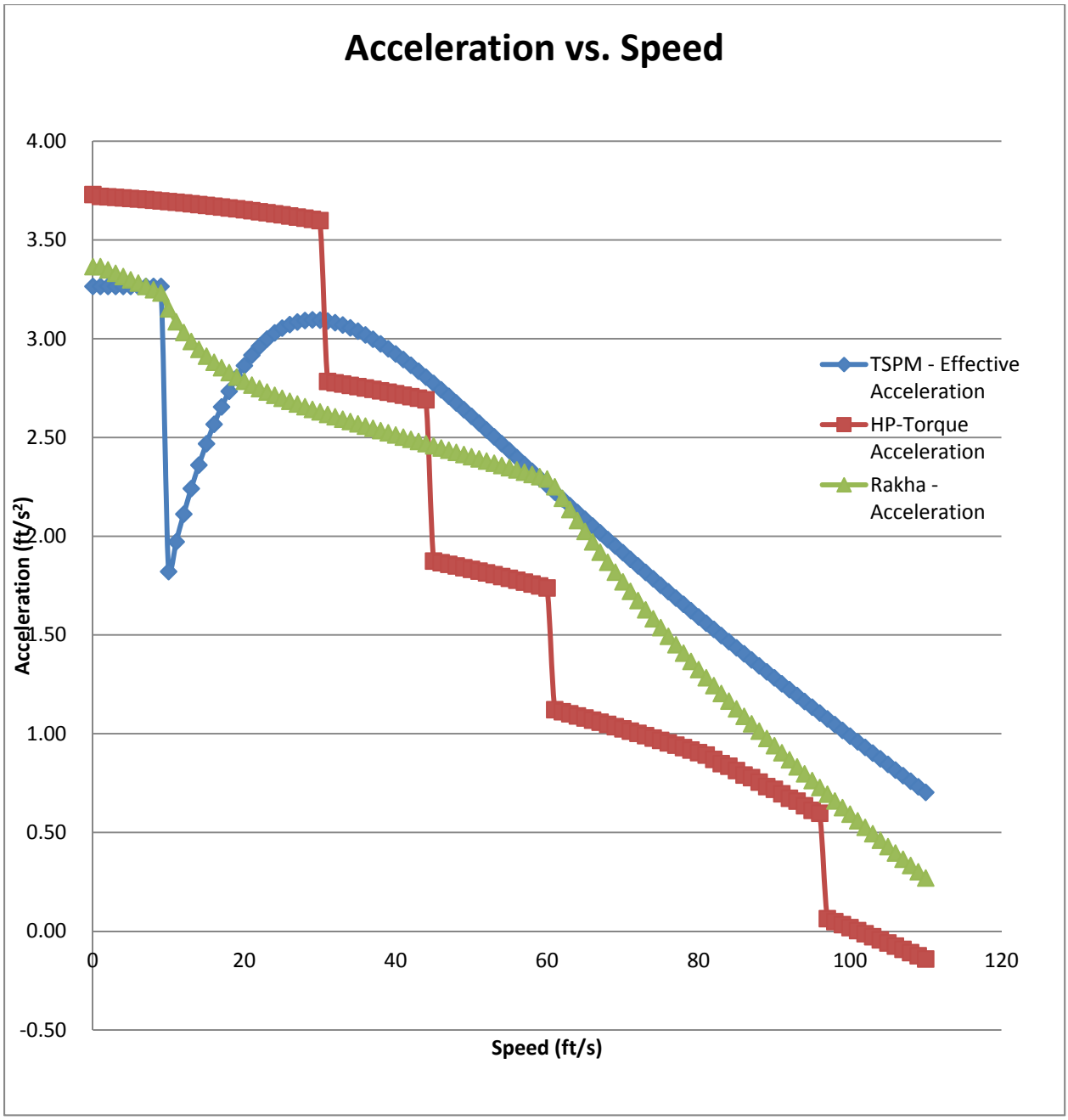

Figure 13. Acceleration vs. Speed Curve - Single Unit Truck on a Level Grade

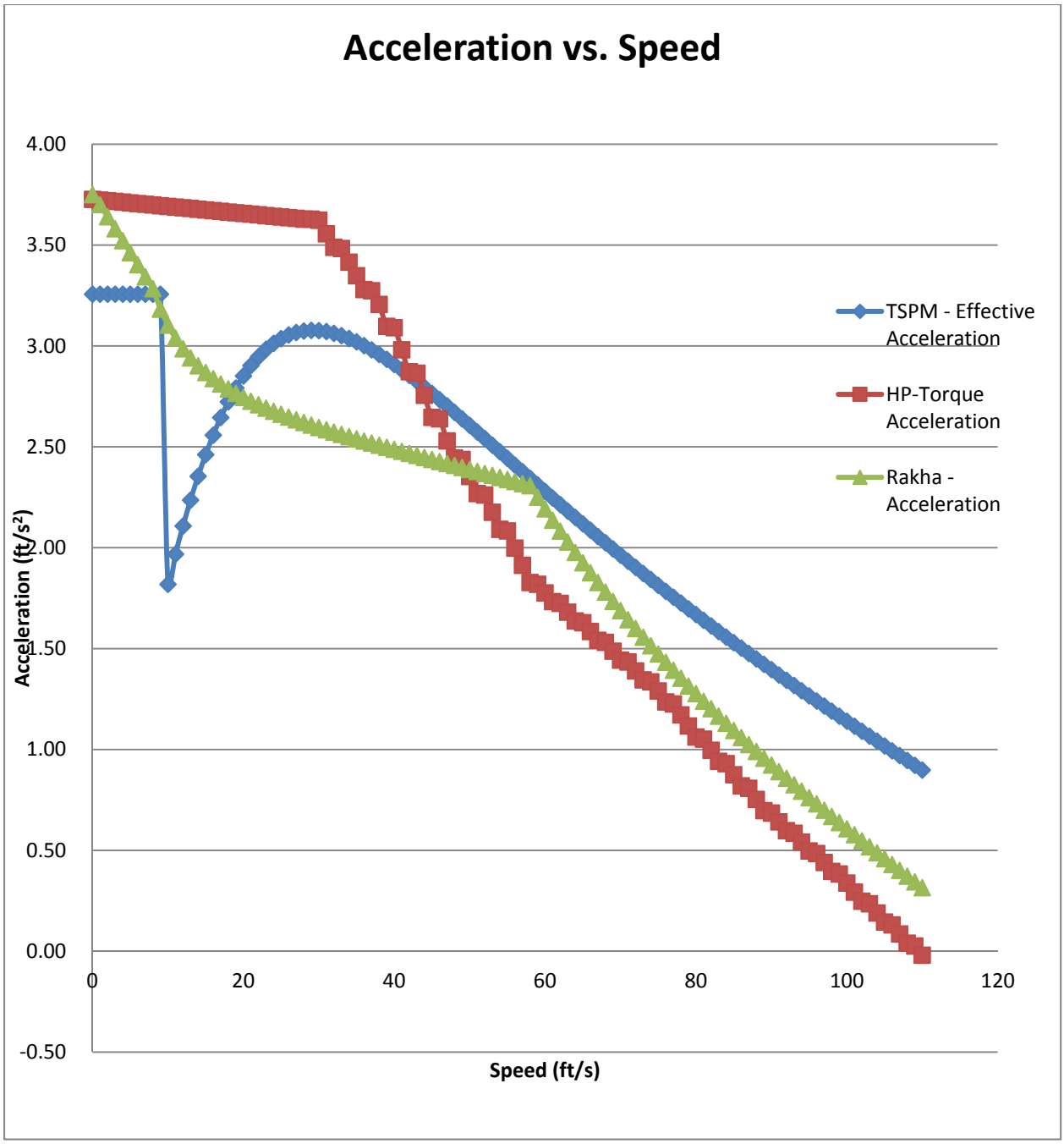

Figure 14. Acceleration vs. Speed Curve – Class 8 Truck on a Level Grade

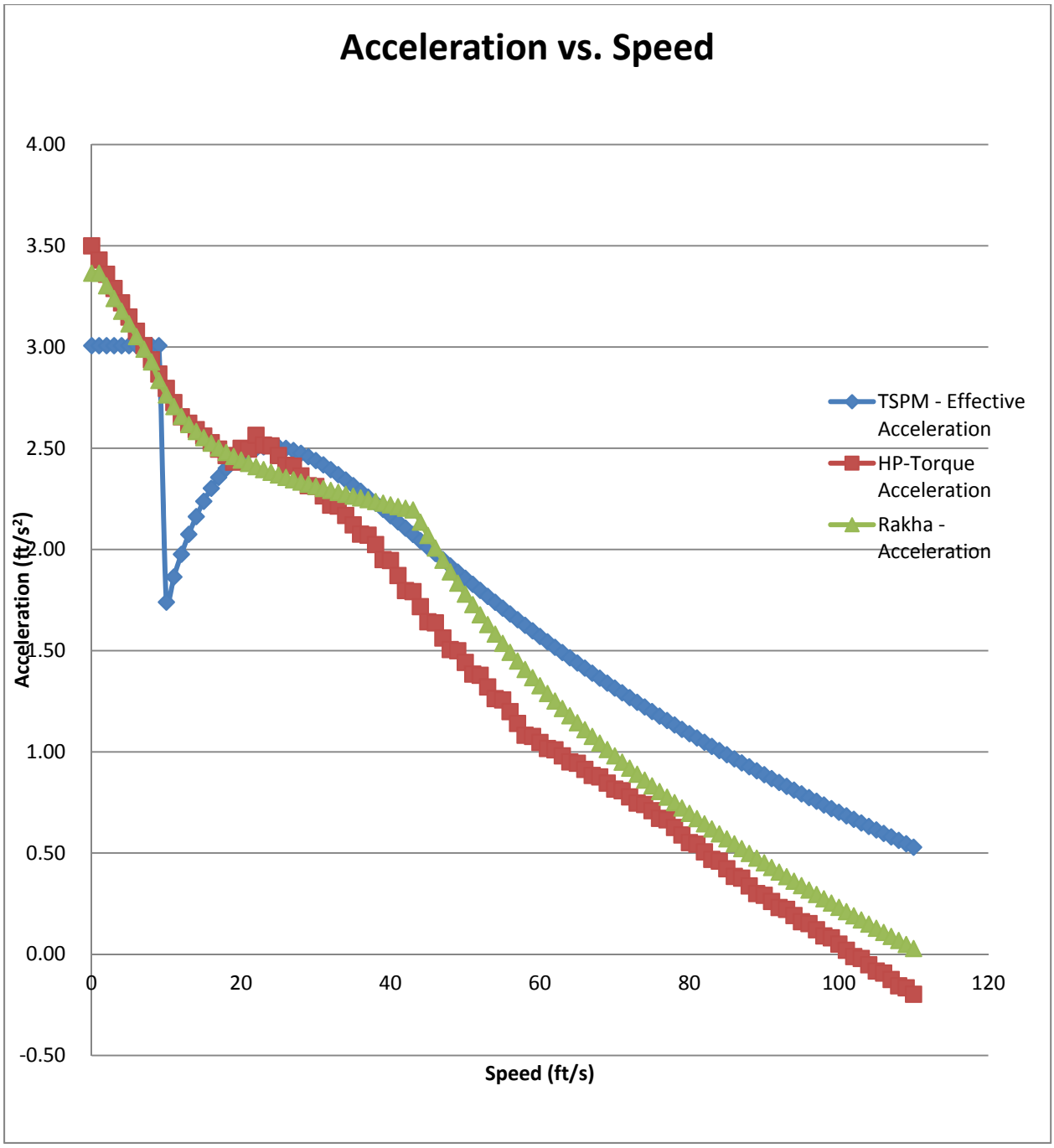

Figure 15. Acceleration vs. Speed Curve – Class 9 Truck on a Level Grade

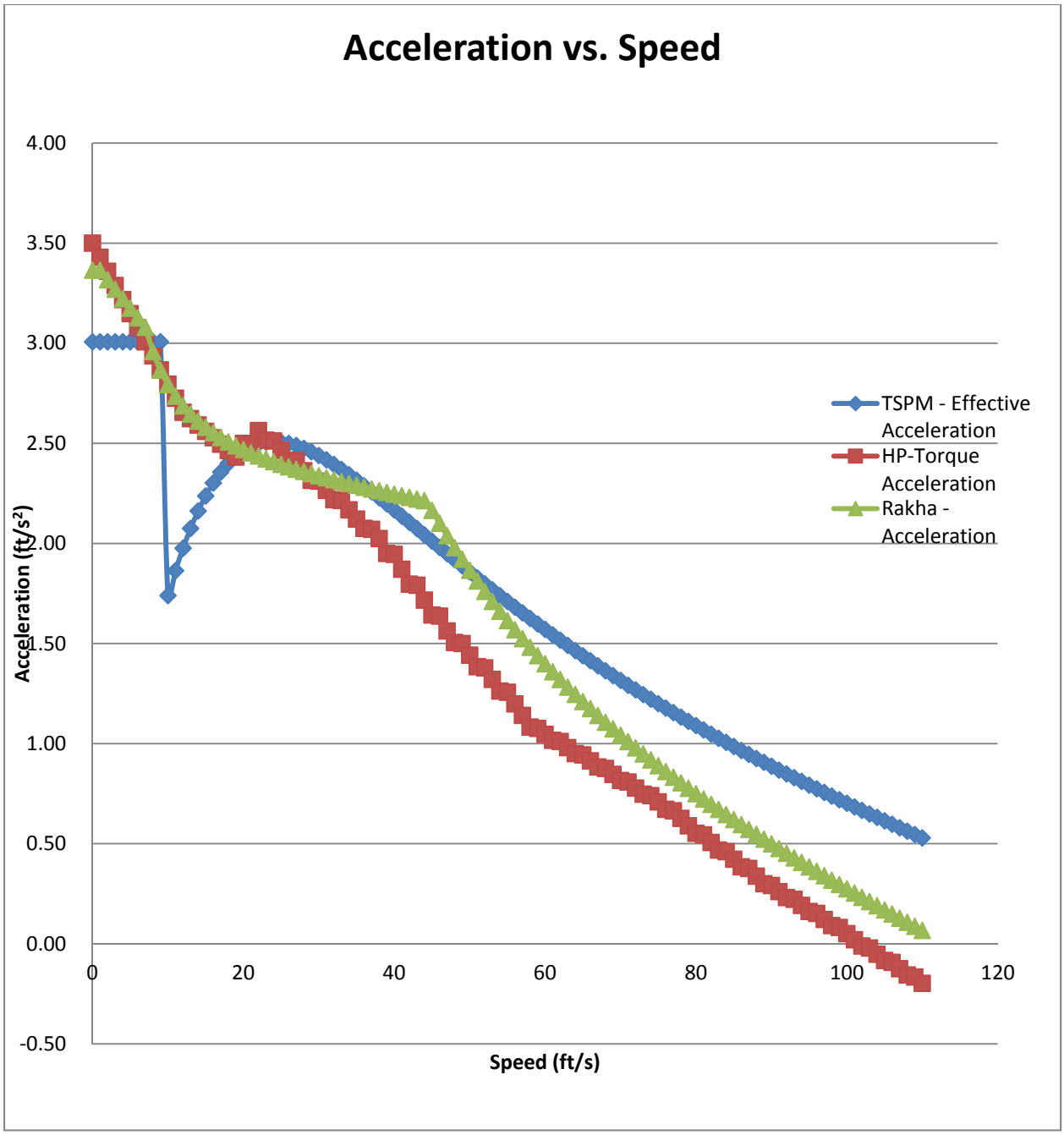

Figure 16. Acceleration vs. Speed Curve – Class 11&12 Truck on a Level Grade

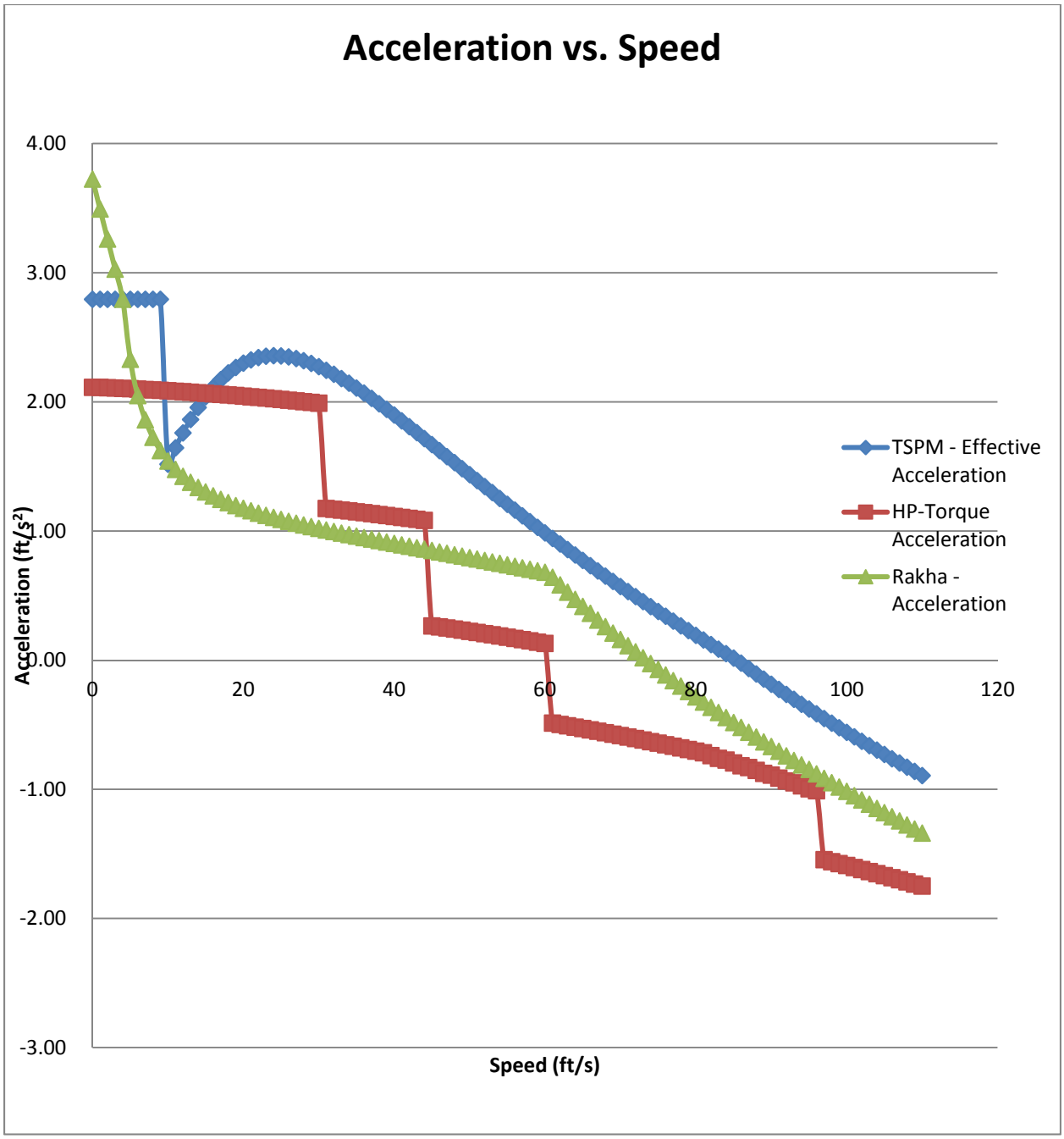

Figure 17. Acceleration vs. Speed Curve – Singe Unit Truck on a 5% Grade

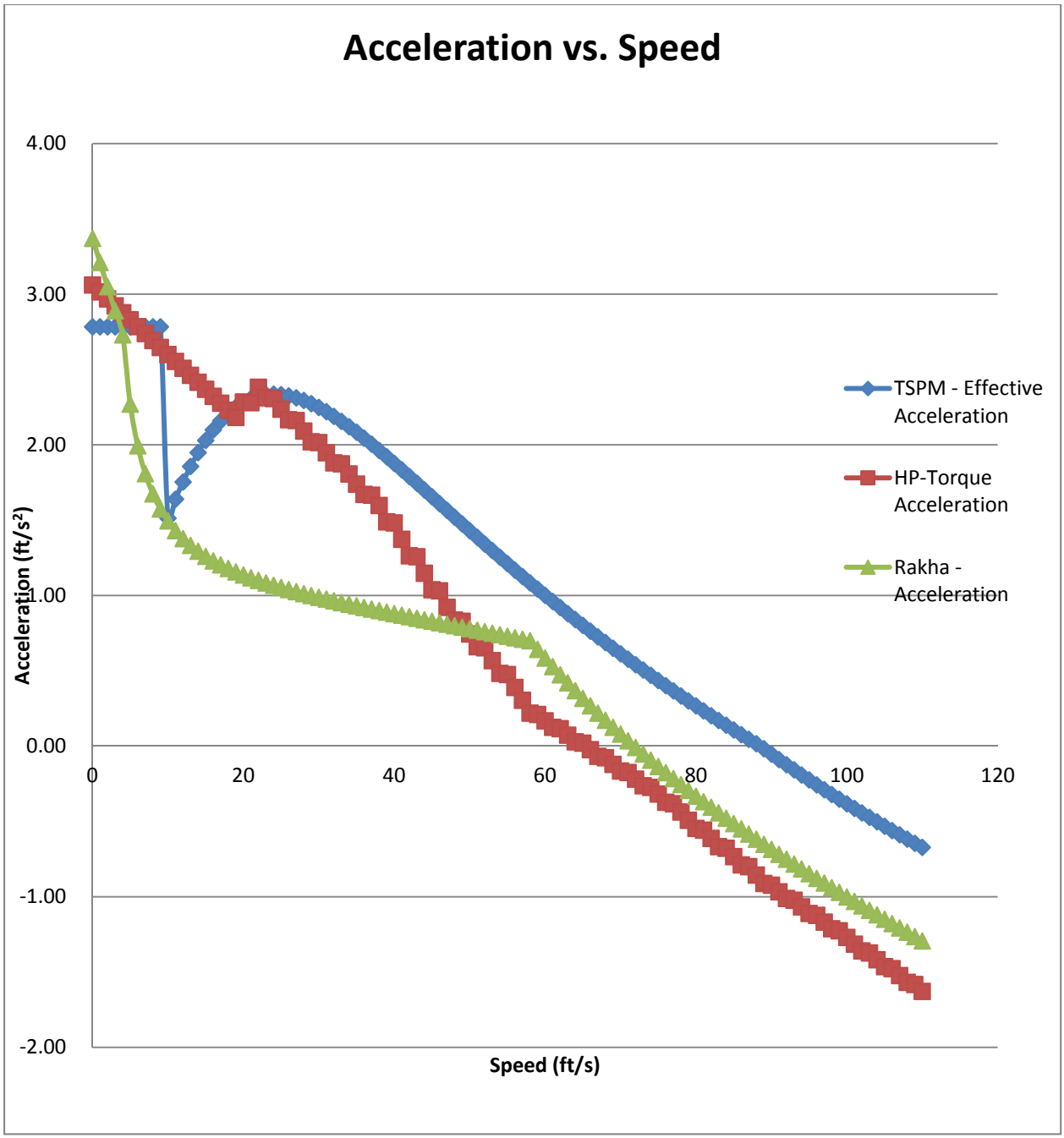

Figure 18. Acceleration vs. Speed Curve – Class 8 Truck on a 5% Grade

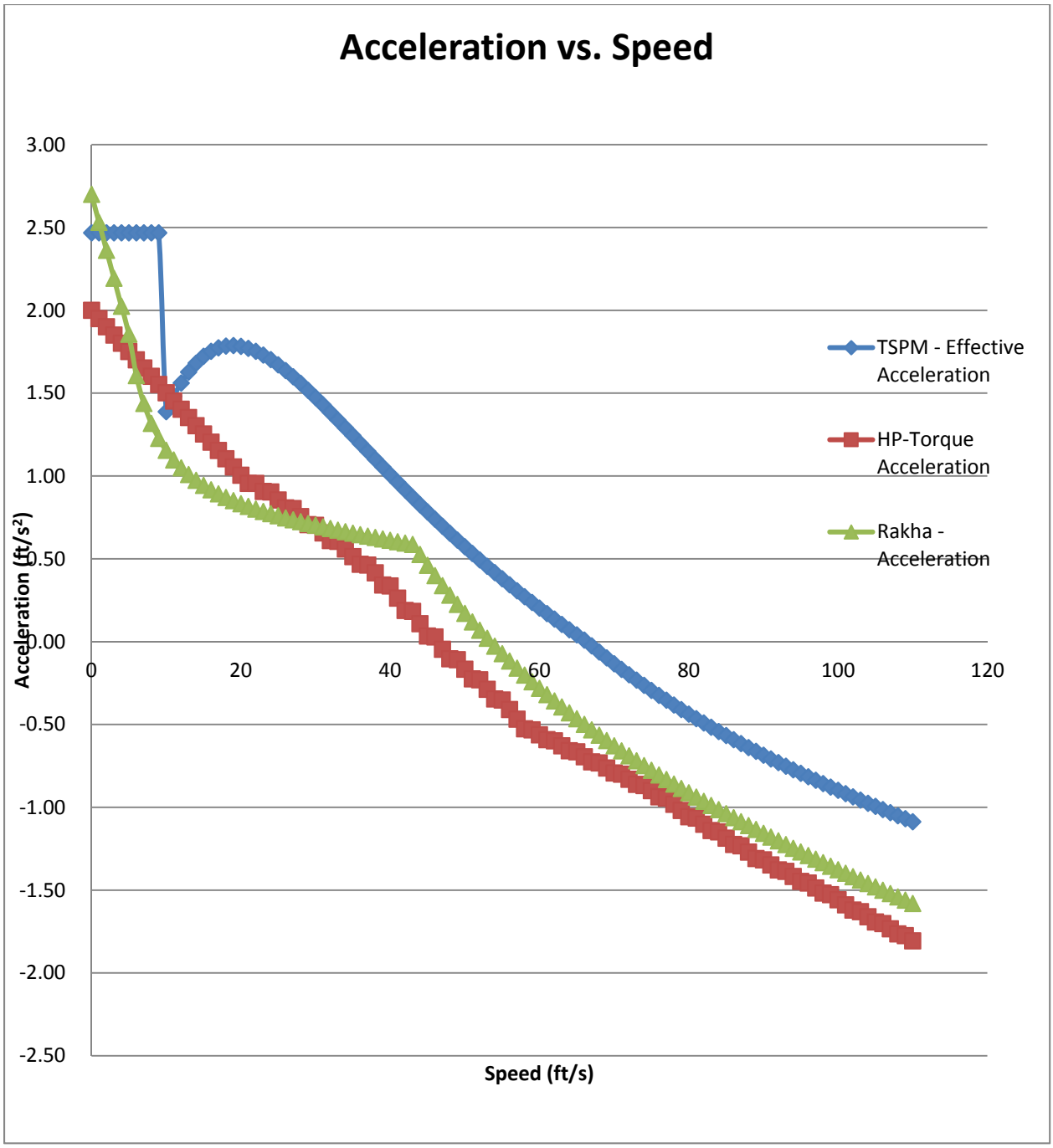

Figure 19. Acceleration vs. Speed Curve – Class 9 Truck on a 5% Grade

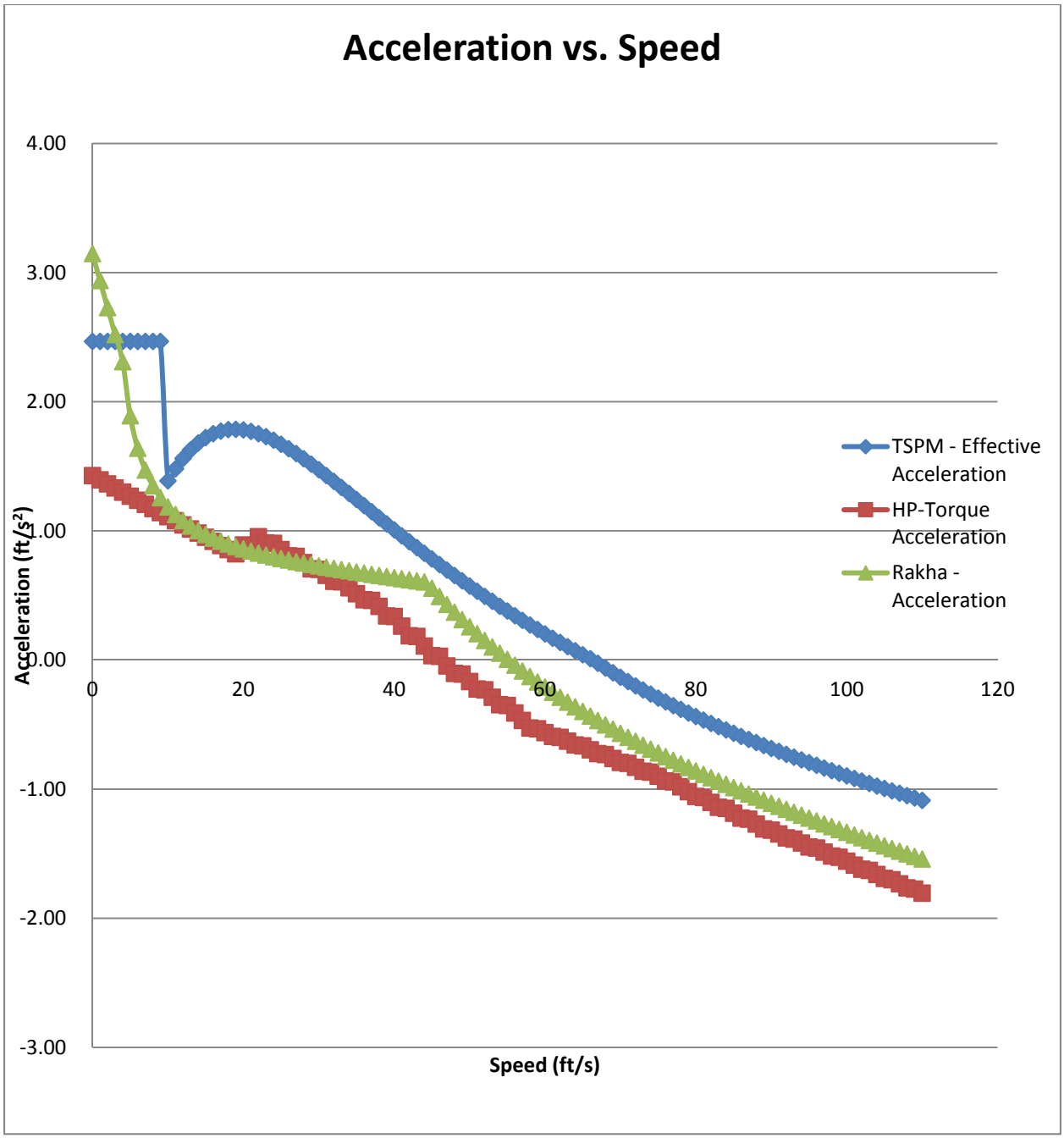

Figure 20. Acceleration vs. Speed Curve – Class 11&12 Truck on a 5% Grade

APPENDIX E - Truck Performance Comparison Curves CORSIM-NG vs. TruckSim

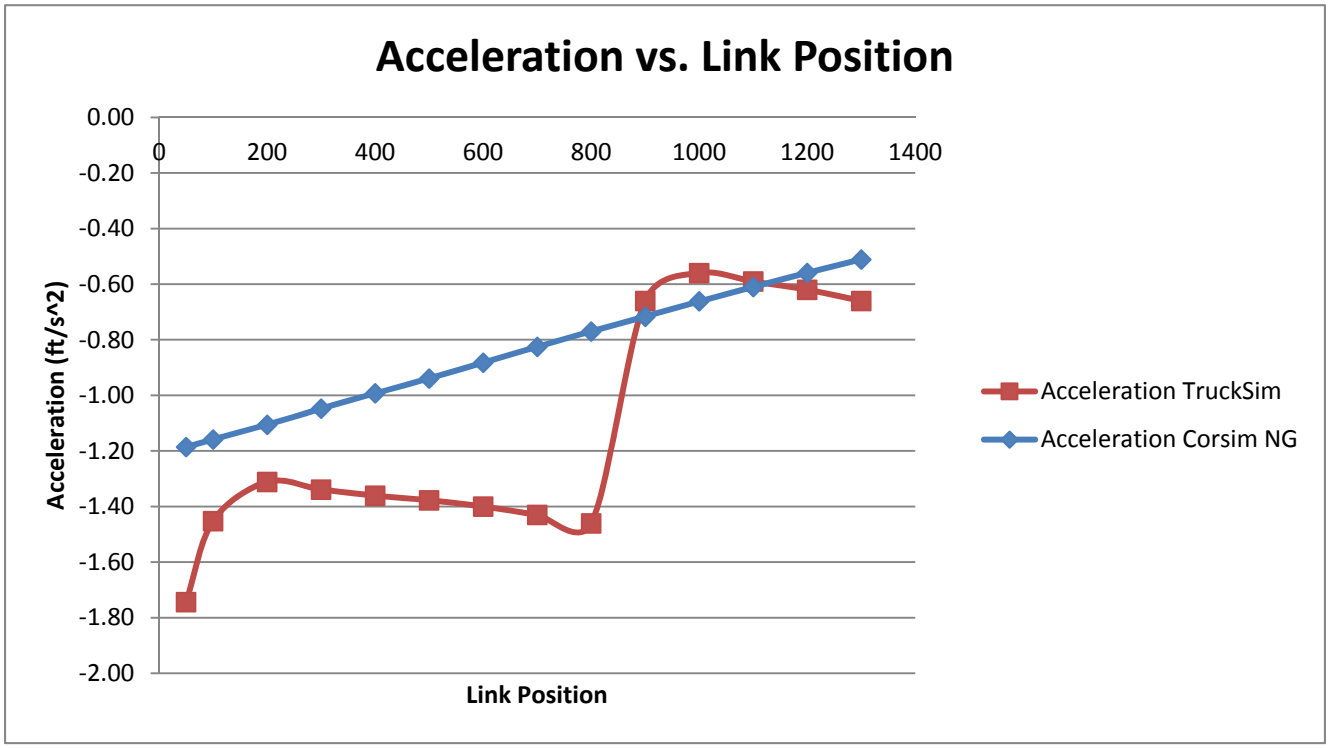

Figure 21. Acceleration of a Single Unit Truck on a 1320-footLink with 9% Grade

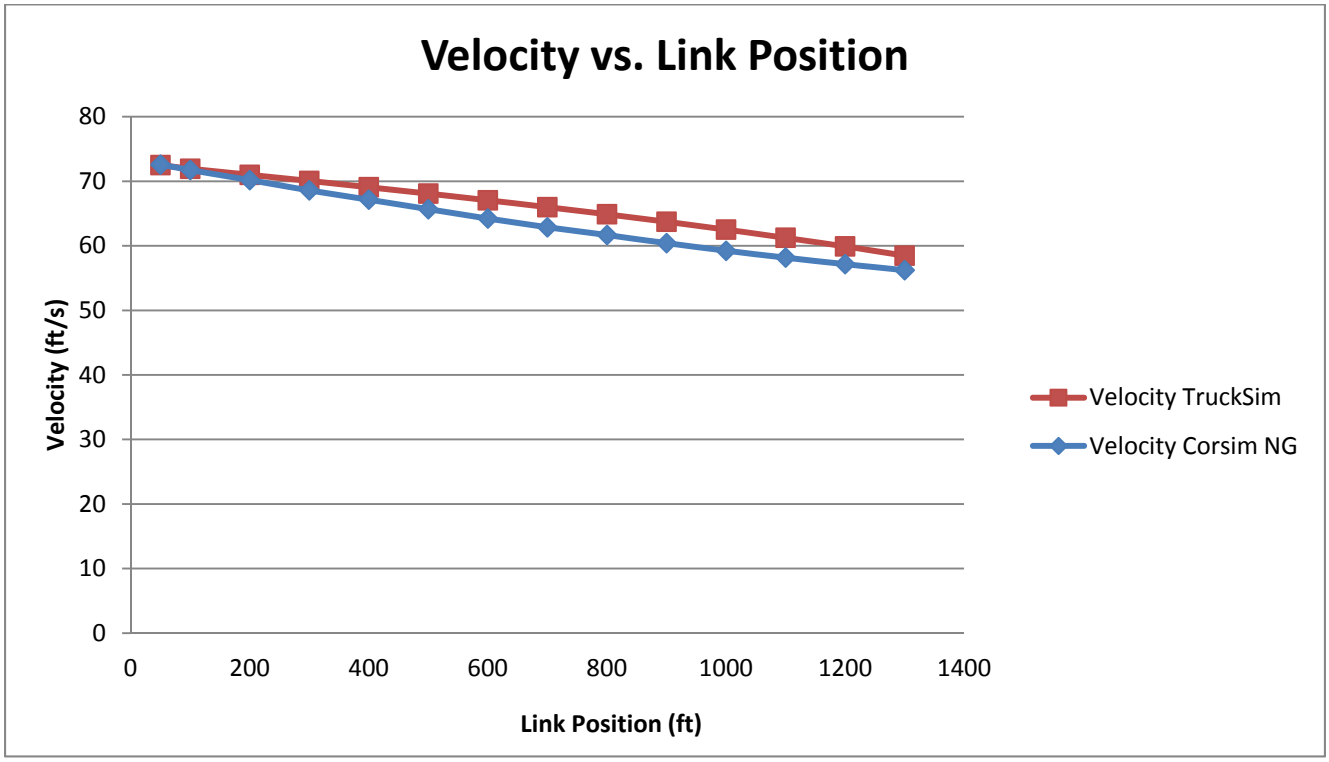

Figure 22. Velocity of a Single Unit Truck on a 1320-foot Link with 9% Grade

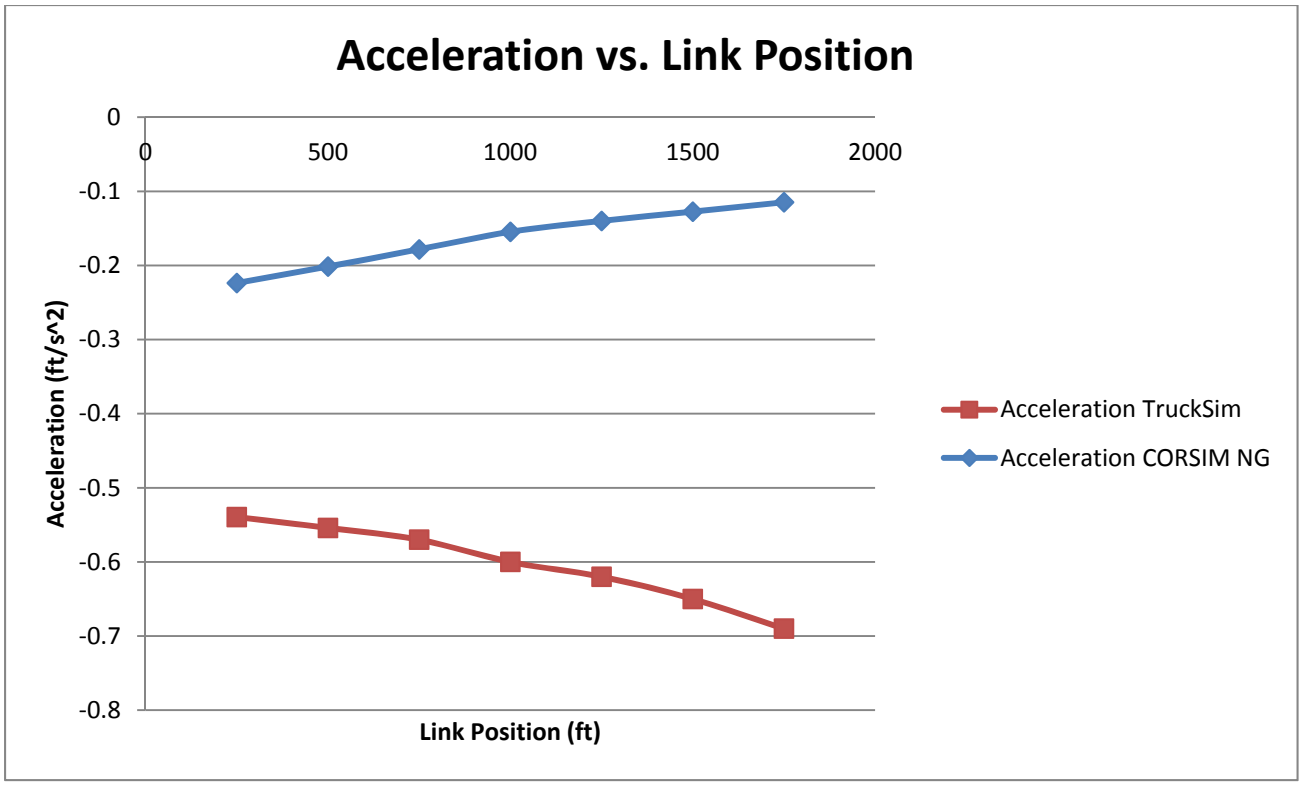

Figure 23. Acceleration of an Intermediate Semi-trailer on a 1760-foot Link with 6% Grade

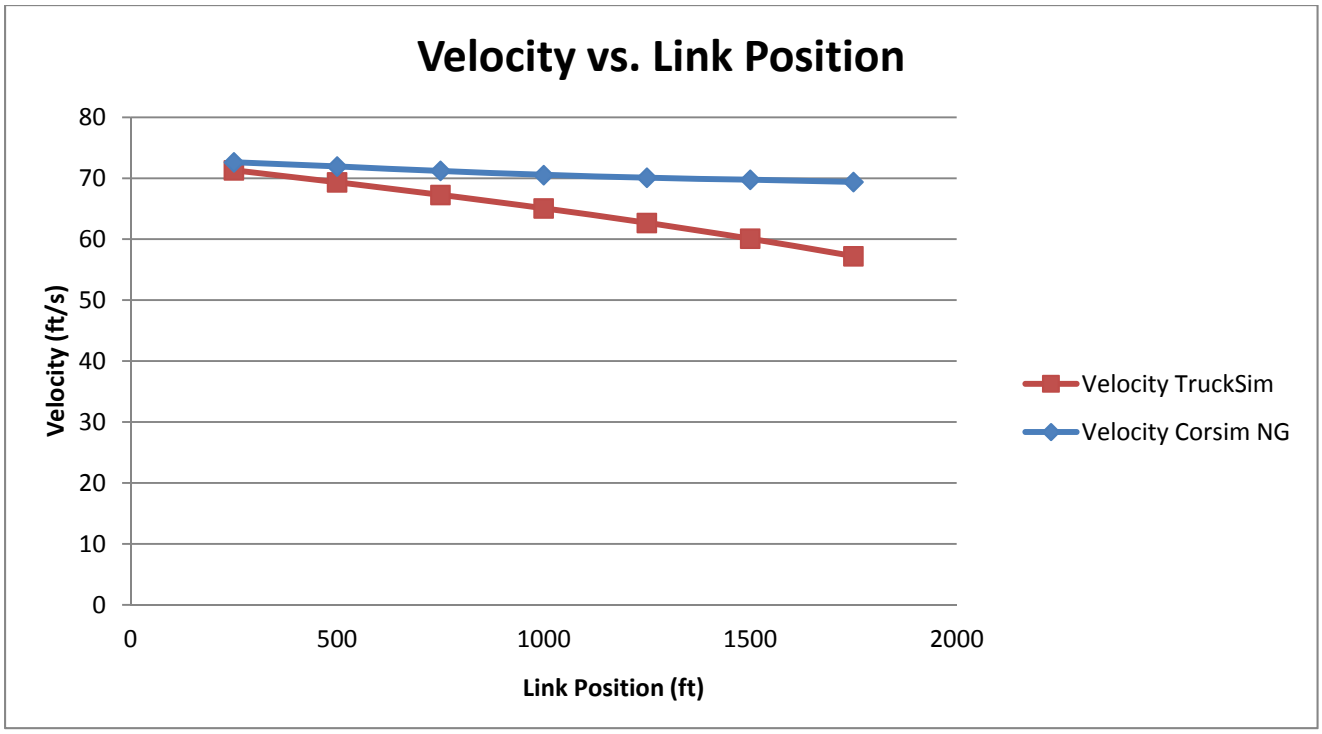

Figure 24. Velocity of an Intermediate Semi-trailer on a 1760-foot Link with 6% Grade

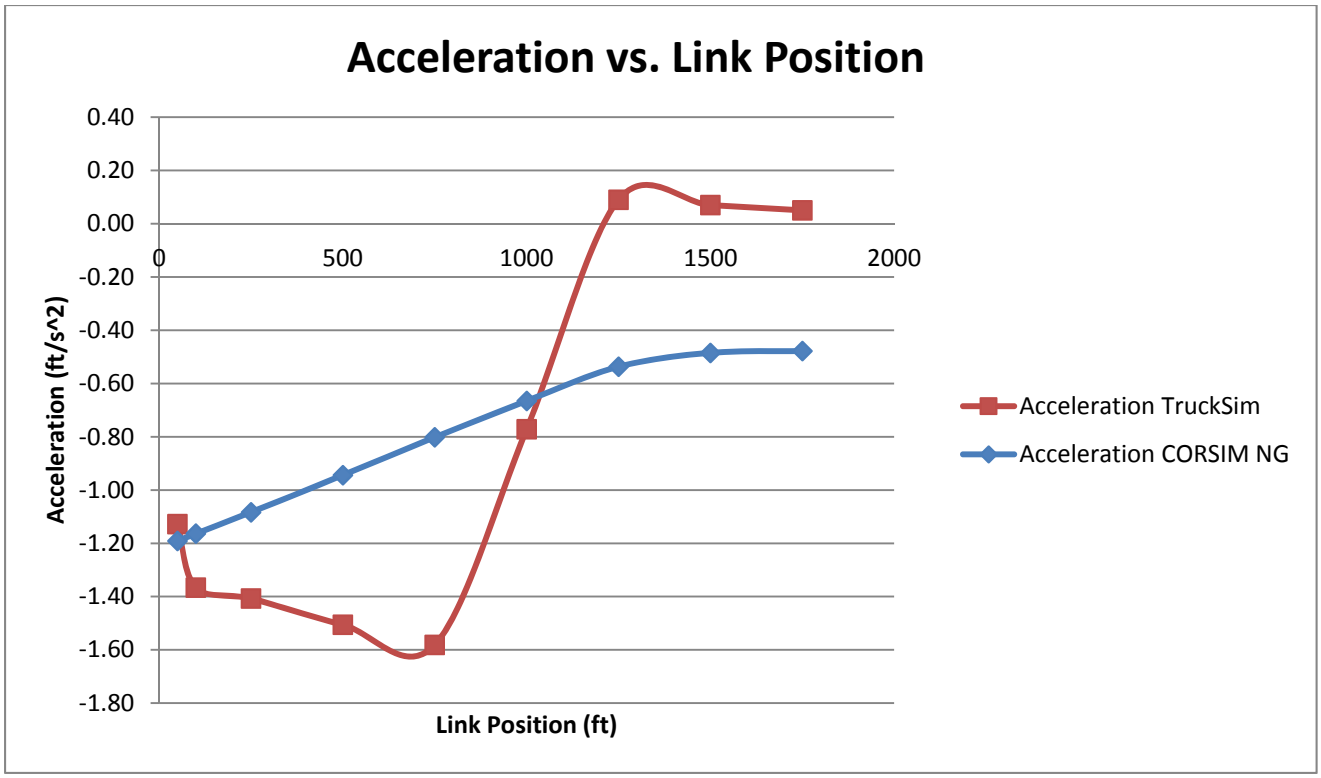

Figure 25. Acceleration of an Intermediate Semi-trailer on a 1760-foot Link with 9% Grade

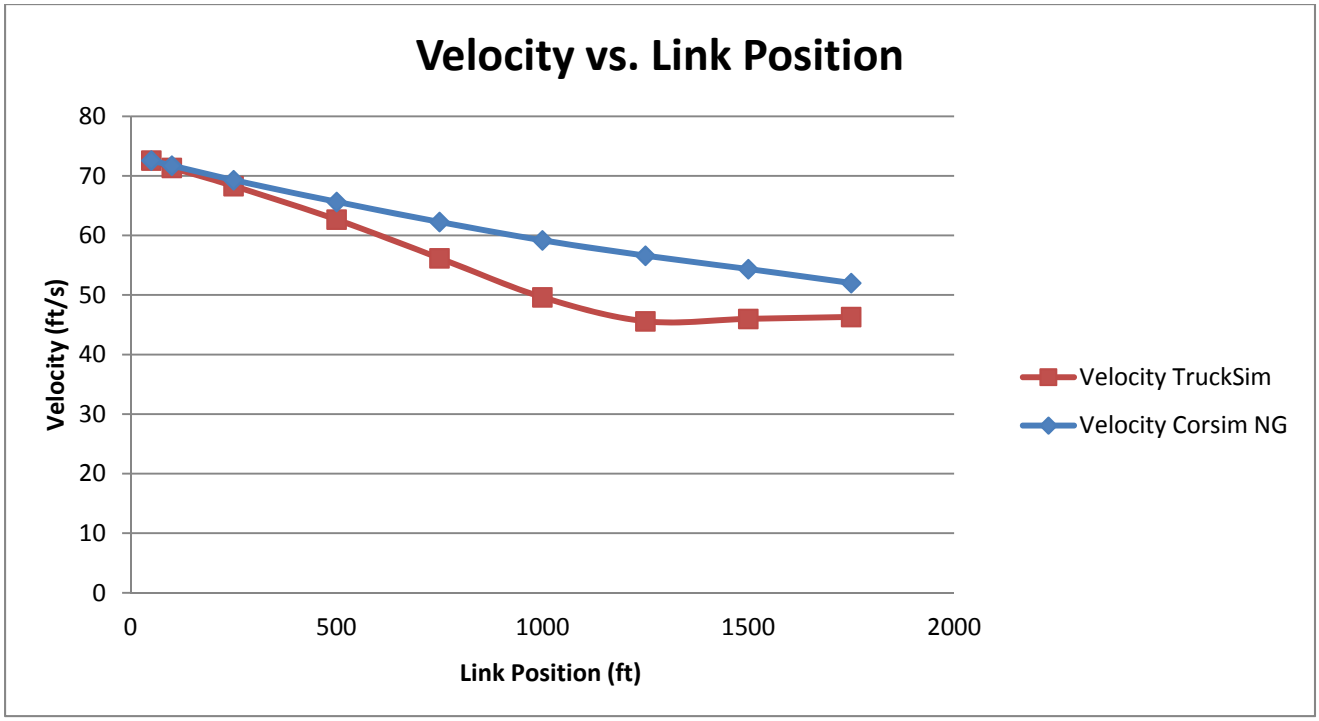

Figure 26. Velocity of an Intermediate Semi-trailer on a 1760-foot Link with 9% Grade

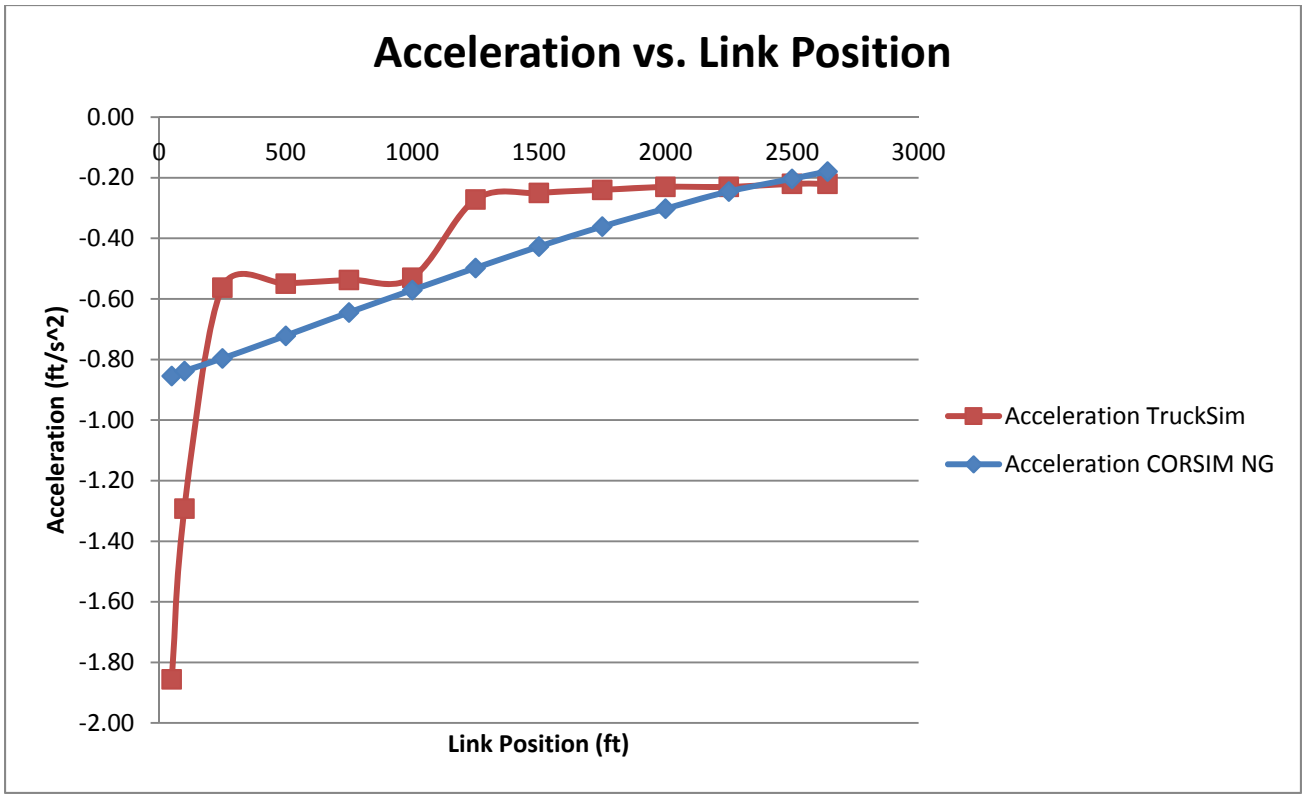

Figure 27. Acceleration of an Interstate Semi-trailer on a 2640-foot Link with 6% Grade

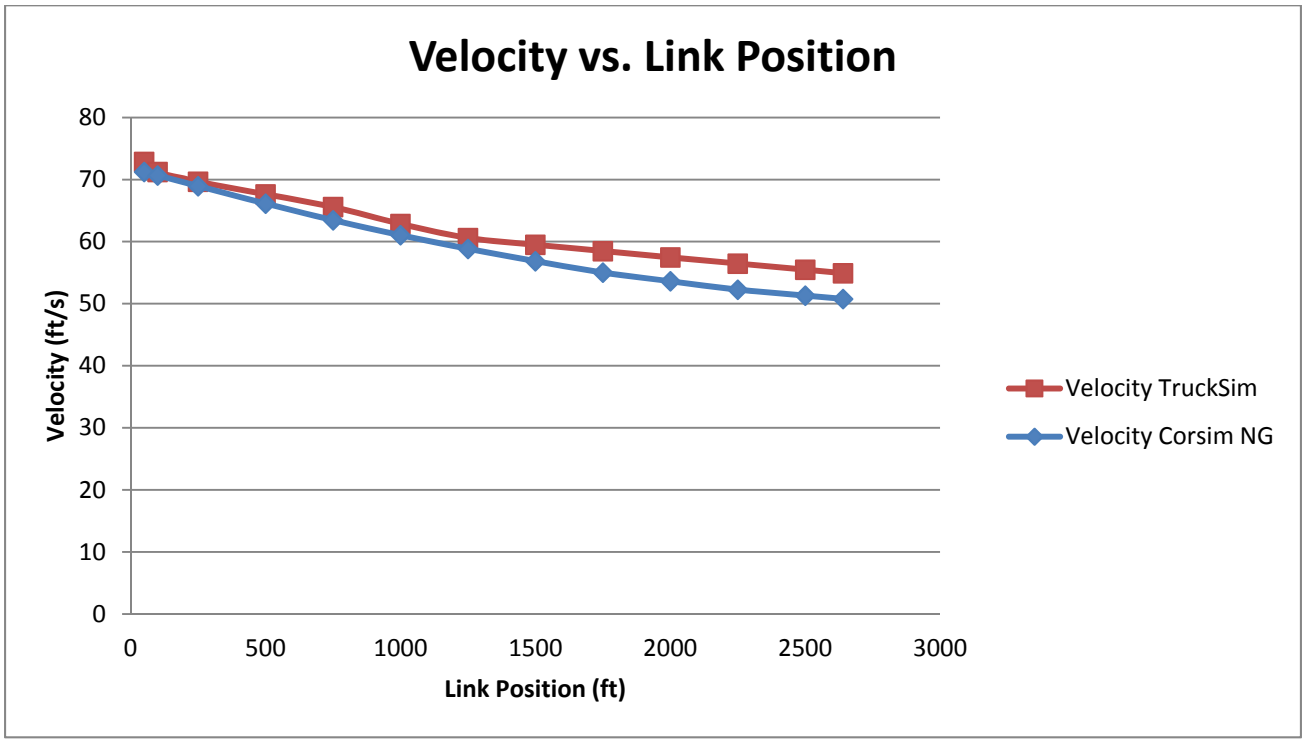

Figure 28. Velocity of an Interstate Semi-trailer on a 2640-foot Link with 6% Grade

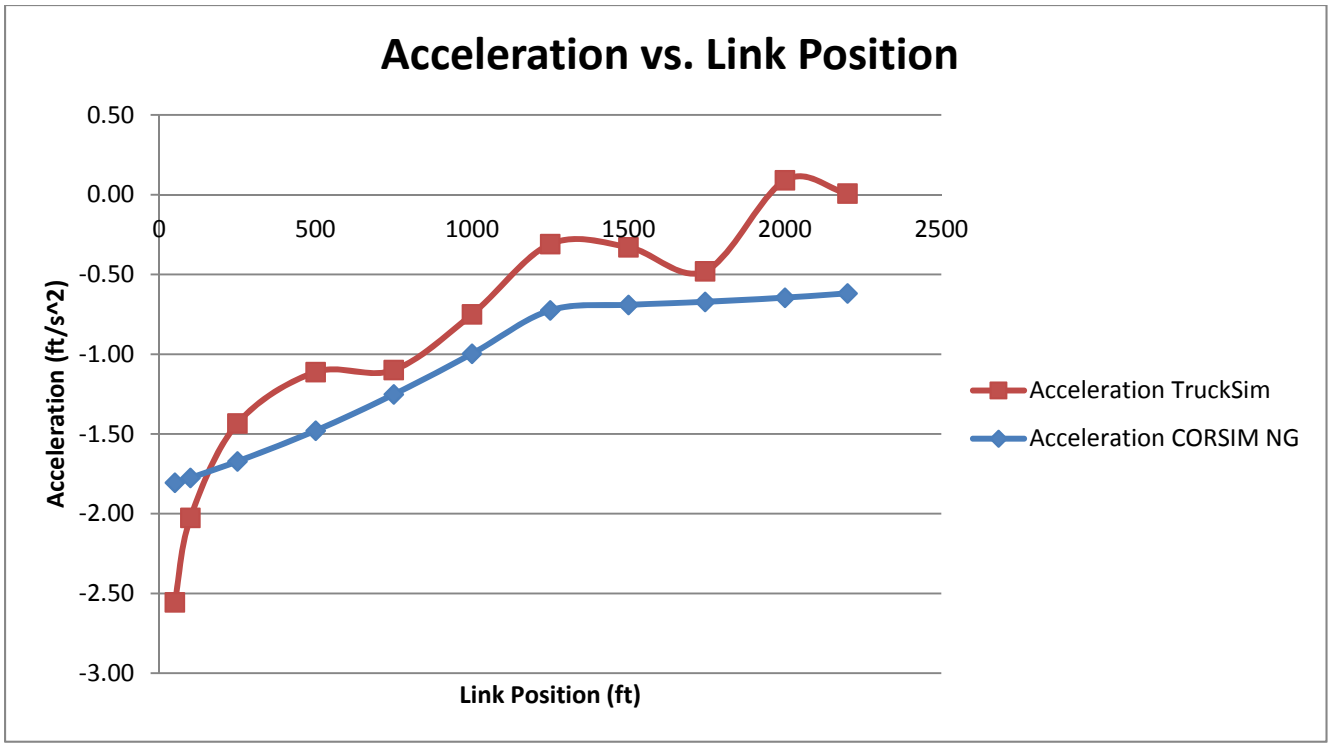

Figure 29. Acceleration of an Interstate Semi-trailer on a 2640-foot Link with 9% Grade

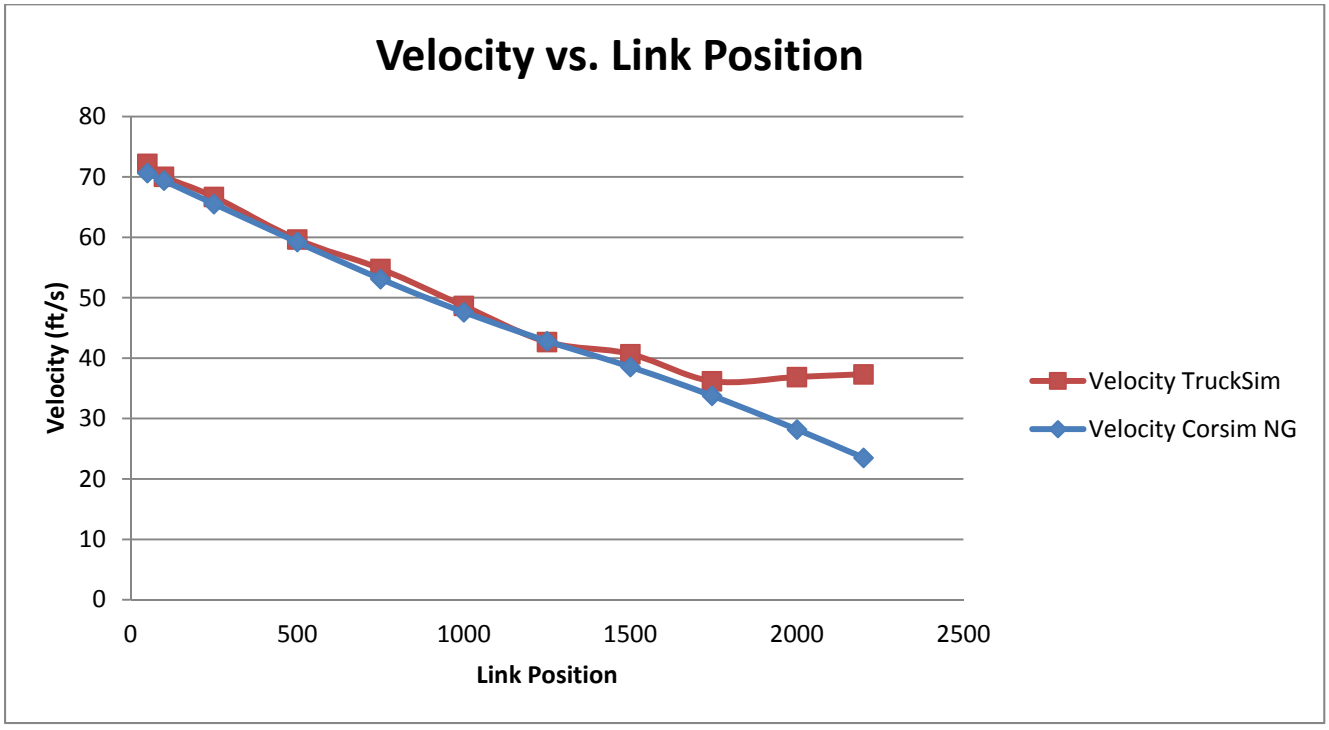

Figure 30. Velocity of an Interstate Semi-trailer on a 2640-foot Link with 9% Grade

APPENDIX F - Full Vehicle Dynamics Approach to Truck Acceleration Modeling in CORSIM-NG Example Calculation

Inputs

$W := 53000$ height := 10 width := 8

$A_f := height \cdot width = 80$

$C_D := 0.66$ $r := 1.66$

$i := 0.05$ $\eta_d := 0.80$ DiffGearRatio := 3.50

$\rho := 0.002378$ sea level value

$G := .05$ $g := 32.2$

$V := 50 \cdot \frac{5280}{3600}$ $V = 73.333$ ft/s Current velocity

Calculate Resistance Forces

Aerodynamic resistance

$R_a := \frac{\rho}{2} \cdot C_D \cdot A_f \cdot V^2$ $R_a = 337.613$

Rolling resistance

$f_{rl} := 0.01 \cdot \left(1 + \frac{V}{147}\right)$ $f_{rl} = 0.015$

$R_{rl} := f_{rl} \cdot W$ $R_{rl} = 794.399$

Grade Resistance

$R_g := W \cdot G$ $R_g = 2650.0$

Sum of resistance forces

$R_{tot} := R_a + R_{rl} + R_g$ $R_{tot} = 3782.0$

Calculate Engine-Generated Tractive Effort

Overall Gear Reduction Ratio

$Gear := 8$ for speeds between 43 mi/h and 55 mi/h Current transmission gear

$TransGearRatio := 1.35$ Current transmission gear ratio

$\varepsilon_0 := DiffGearRatio \cdot TransGearRatio = 4.725$

Engine Speed

$$n_e := \frac{V \cdot \varepsilon_0}{2 \cdot \pi \cdot r \cdot (1 - i)} \qquad n_e = 34.97 \ \frac{rev}{s} \qquad RPM := n_e \cdot 60 = 2098.2 \ \frac{rev}{min}$$

Note: If vehicle is stopped, engine speed at startup is a function of throttle input

Determine torque from torque-engine speed relationship

For the section of the torque-engine speed curve that covers this RPM value, torque is given by the following equation

$M_e := -1.0741 \cdot RPM + 3455.6 \qquad M_e = 1201.9$ ft-lb

$$F_e := \frac{M_e \cdot \varepsilon_0 \cdot \eta_d}{r} \qquad F_e = 2737.0 \ lb$$

Calculate Maximum Acceleration

$\gamma_m := 1.04 + 0.0025 \cdot \varepsilon_0^{\,2} \qquad \gamma_m = 1.096$ acceleration mass factor

$$a := \frac{F_e - R_{tot}}{\gamma_m \cdot \left(\frac{W}{g}\right)} \qquad a = -0.579 \ \frac{ft}{sec^2}$$

For the given conditions, the truck will decelerate. For these same conditions, but with a level grade, the truck would have a maximum acceleration of 0.890 ft/s^2.

APPENDIX G - Gear Change Capable Truck Performance Comparison Curves: Revised CORSIM-NG vs. TruckSim

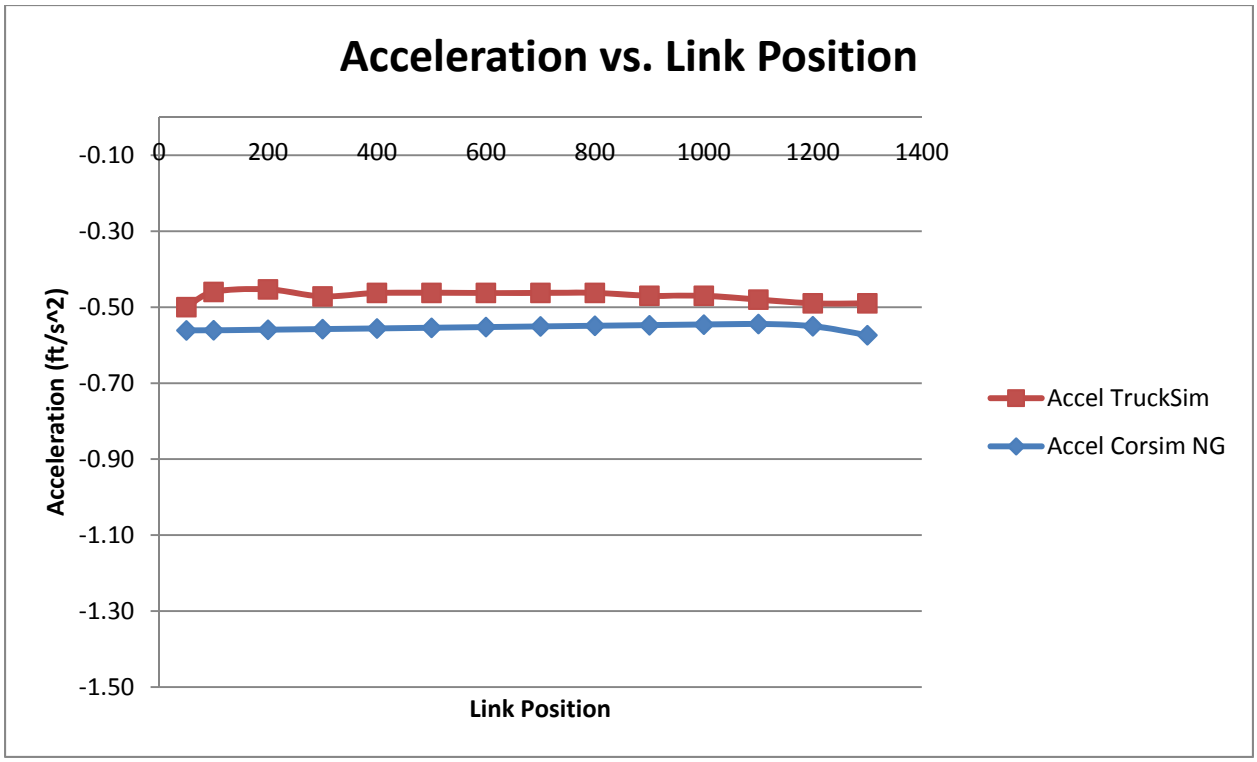

Figure 31. Gear Change Capable Acceleration of a Single Unit Truck on a 1320-foot Link with 6% Grade

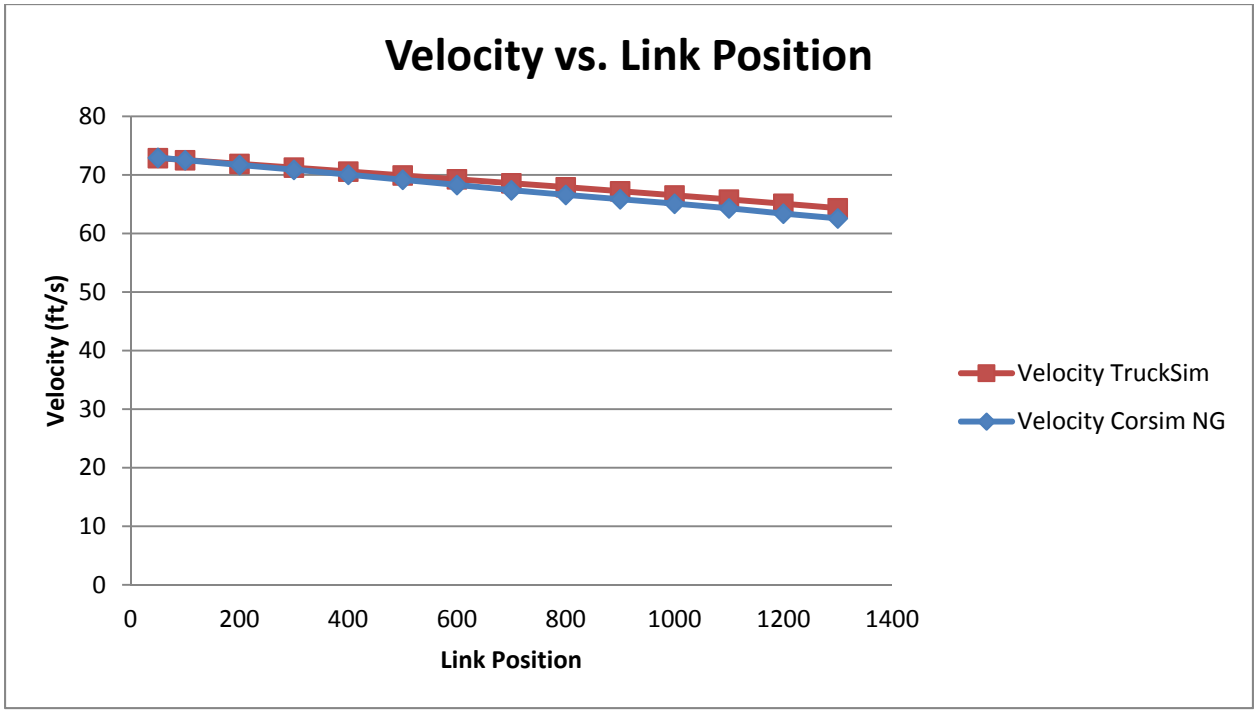

Figure 32. Gear Change Capable Velocity of a Single Unit Truck on a 1320-foot Link with 6% Grade

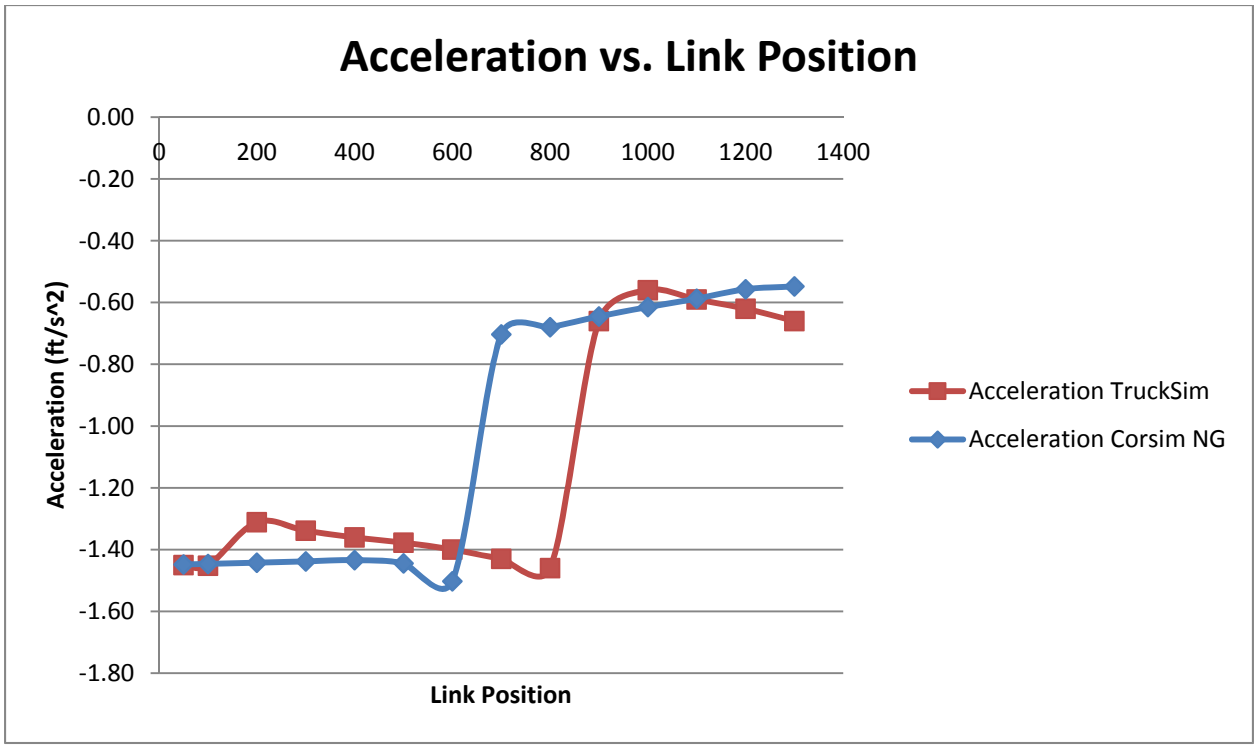

Figure 33. Gear Change Capable Acceleration of a Single Unit Truck on a 1320-foot Link with 9% Grade

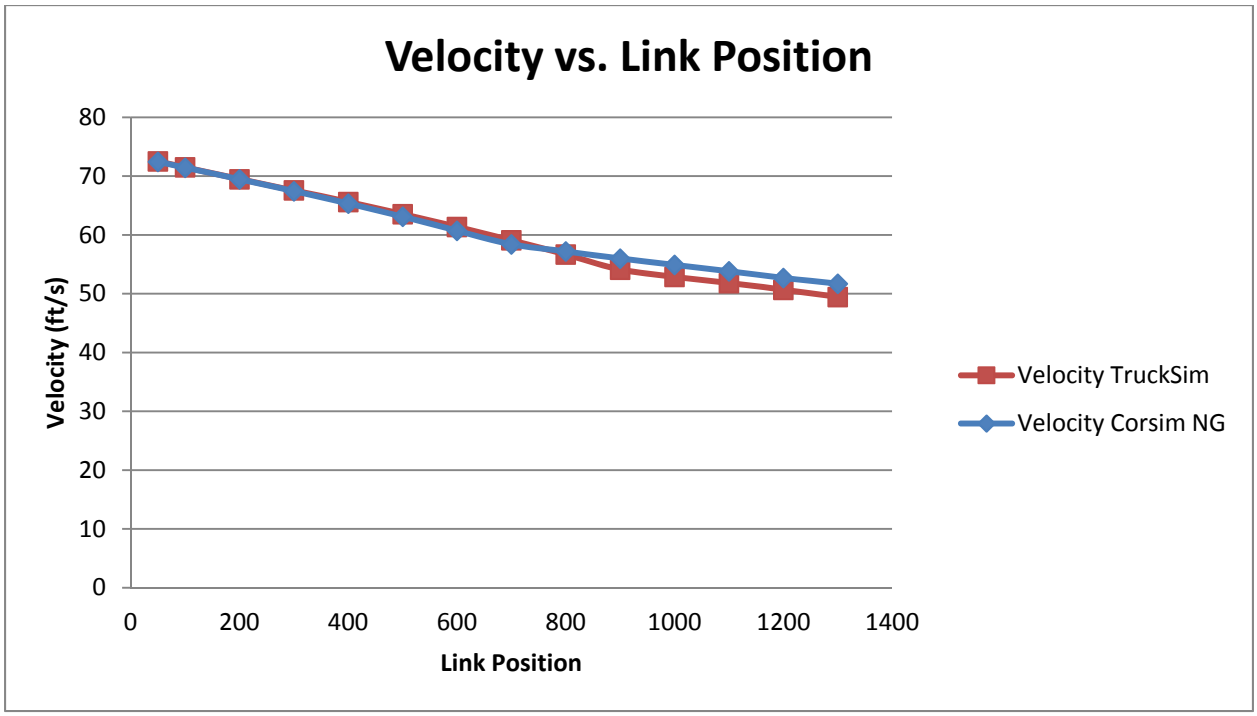

Figure 34. Gear Change Capable Velocity of a Single Unit Truck on a 1320-foot Link with 9% Grade

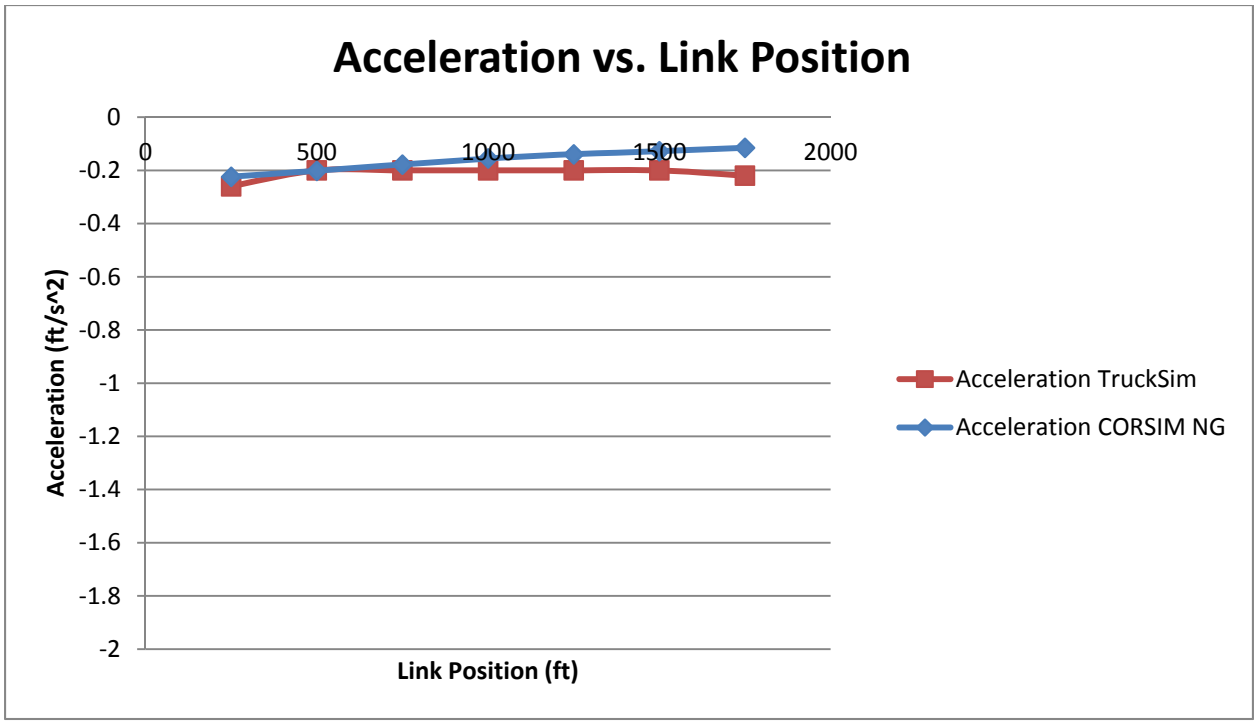

Figure 35. Gear Change Capable Acceleration of an Intermediate Semi-trailer on a 1760-foot Link with 6% Grade

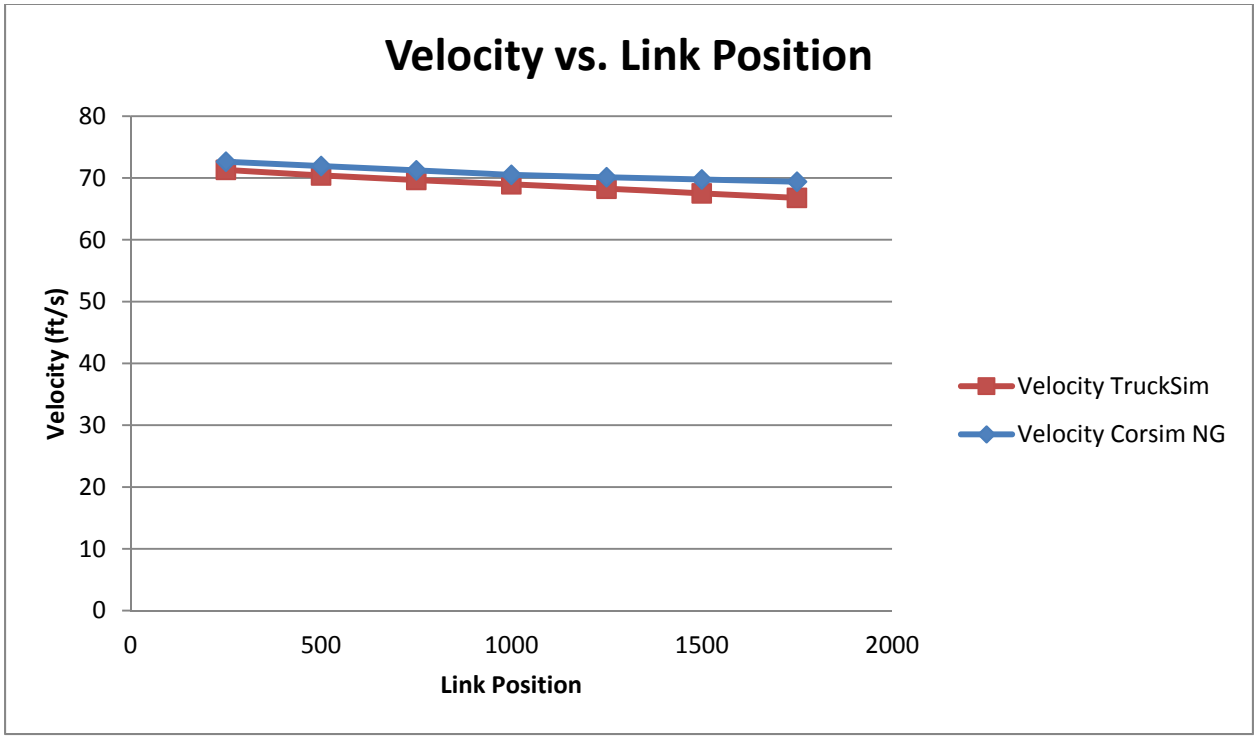

Figure 36. Gear Change Capable Velocity of an Intermediate Semi-trailer on a 1760-foot Link with 6% Grade

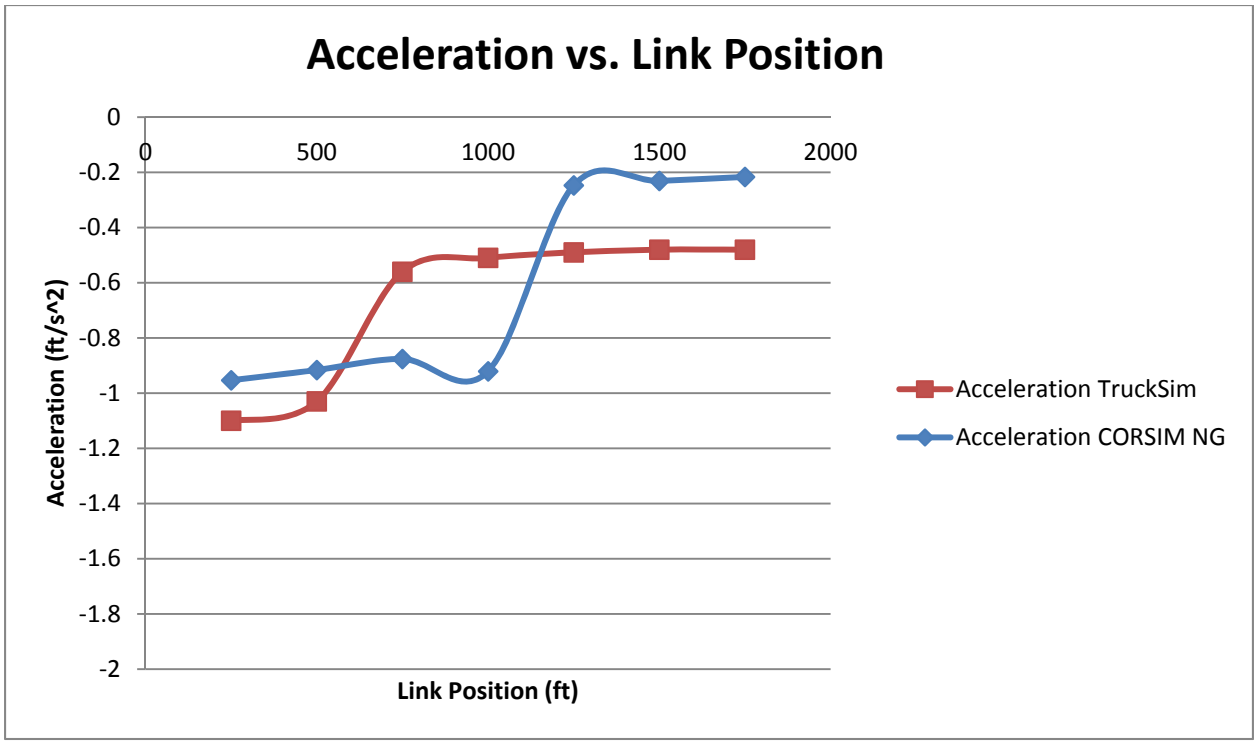

Figure 37. Gear Change Capable Acceleration of an Intermediate Semi-trailer on a 1760-foot Link with 9% Grade

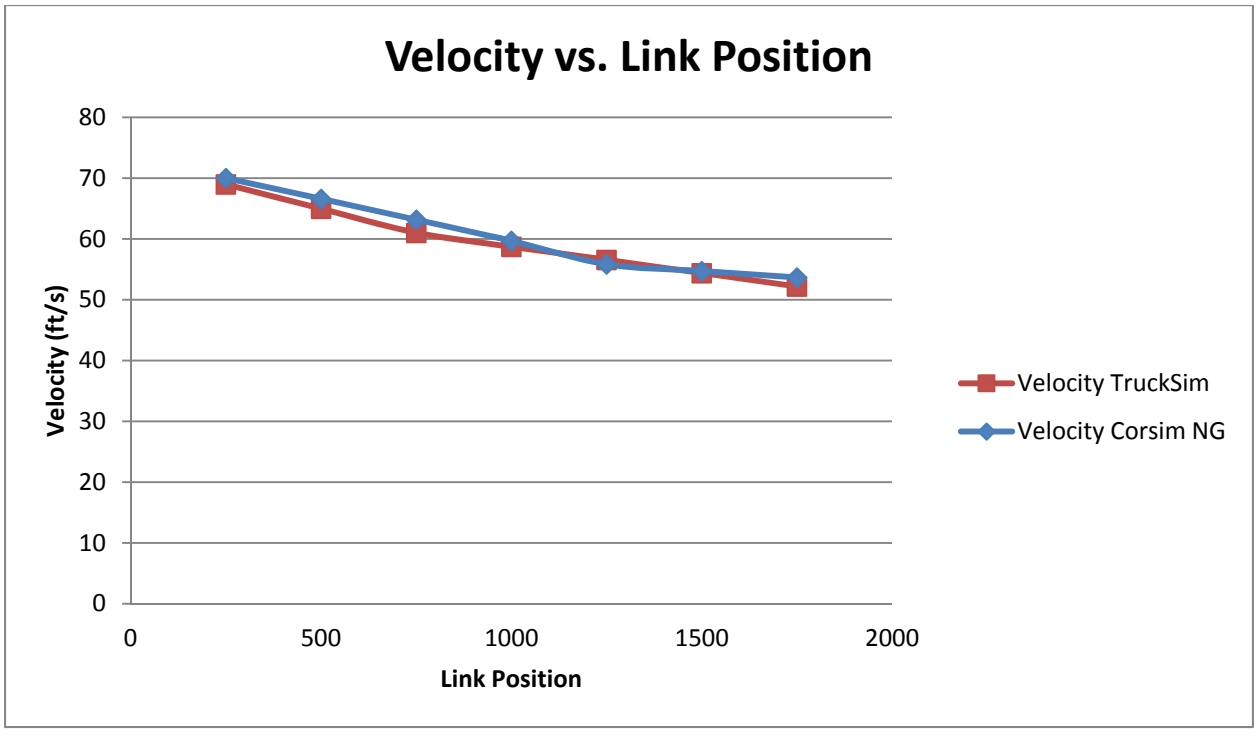

Figure 38. Gear Change Capable Velocity of an Intermediate Semi-trailer on a 1760-foot Link with 9% Grade

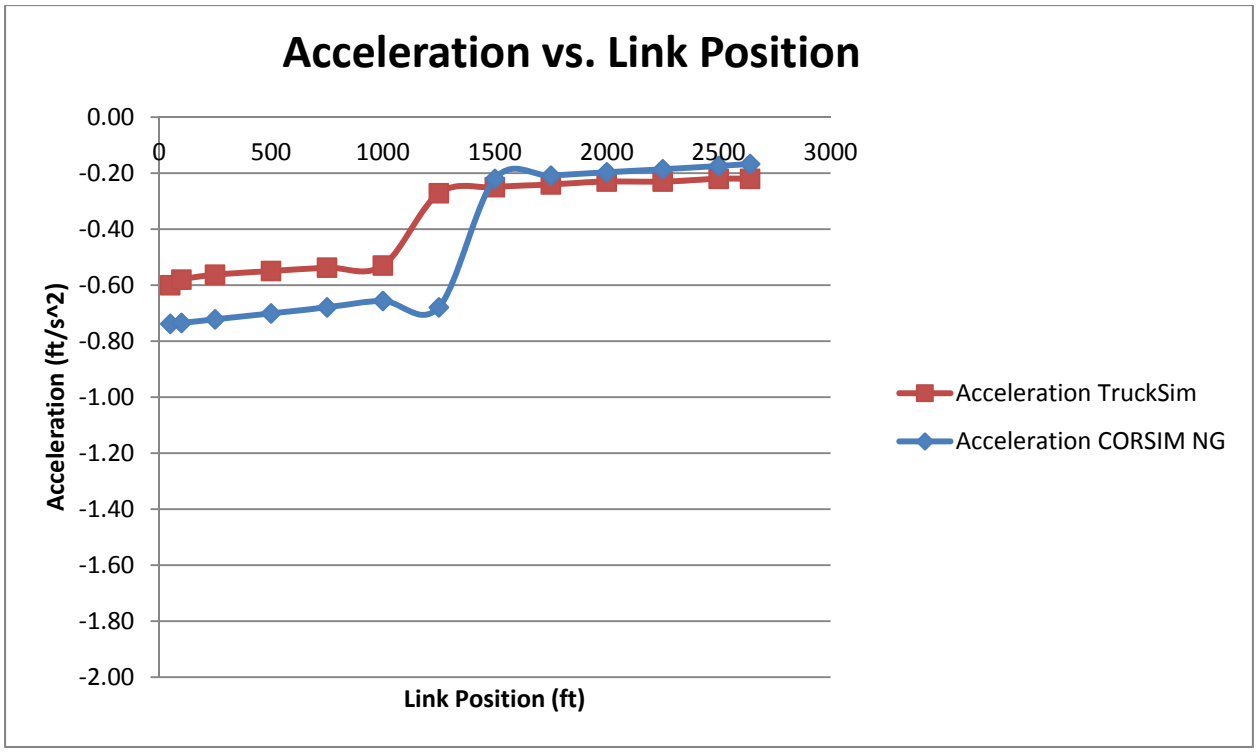

Figure 39. Gear Change Capable Acceleration of an Interstate Semi-trailer on a 2640-foot Link with 6% Grade

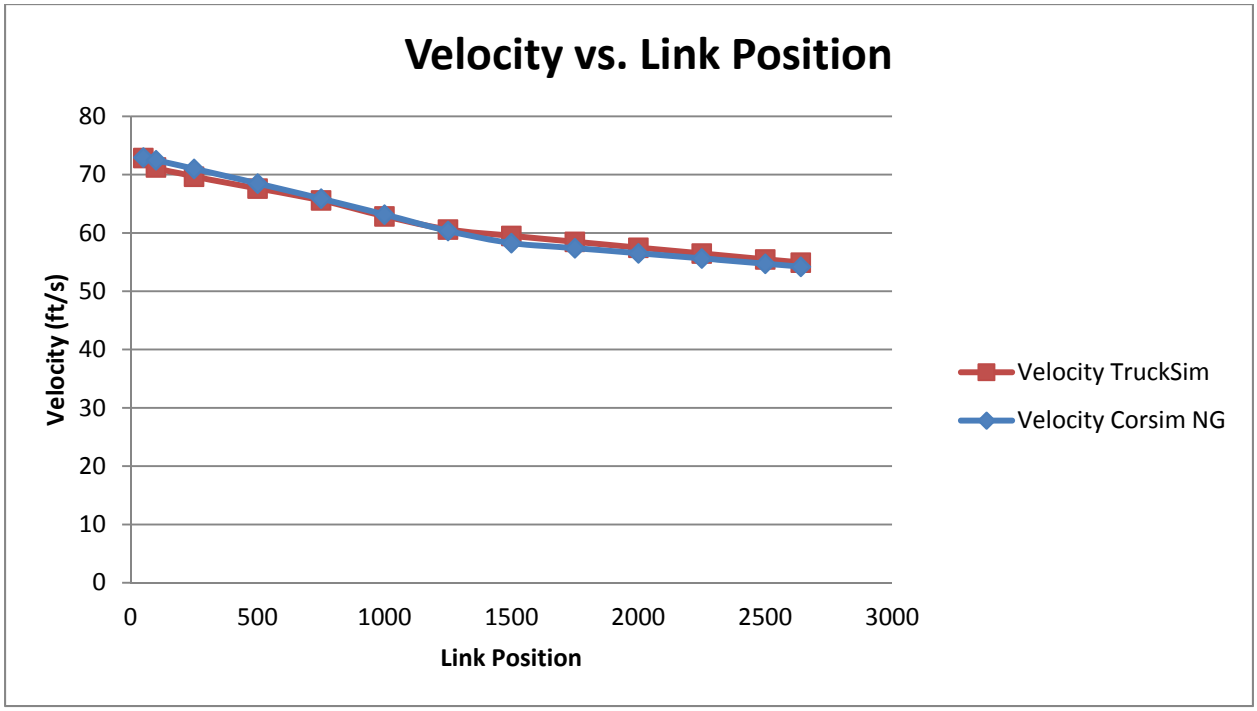

Figure 40. Gear Change Capable Velocity of an Interstate Semi-trailer on a 2640-foot Link with 6% Grade

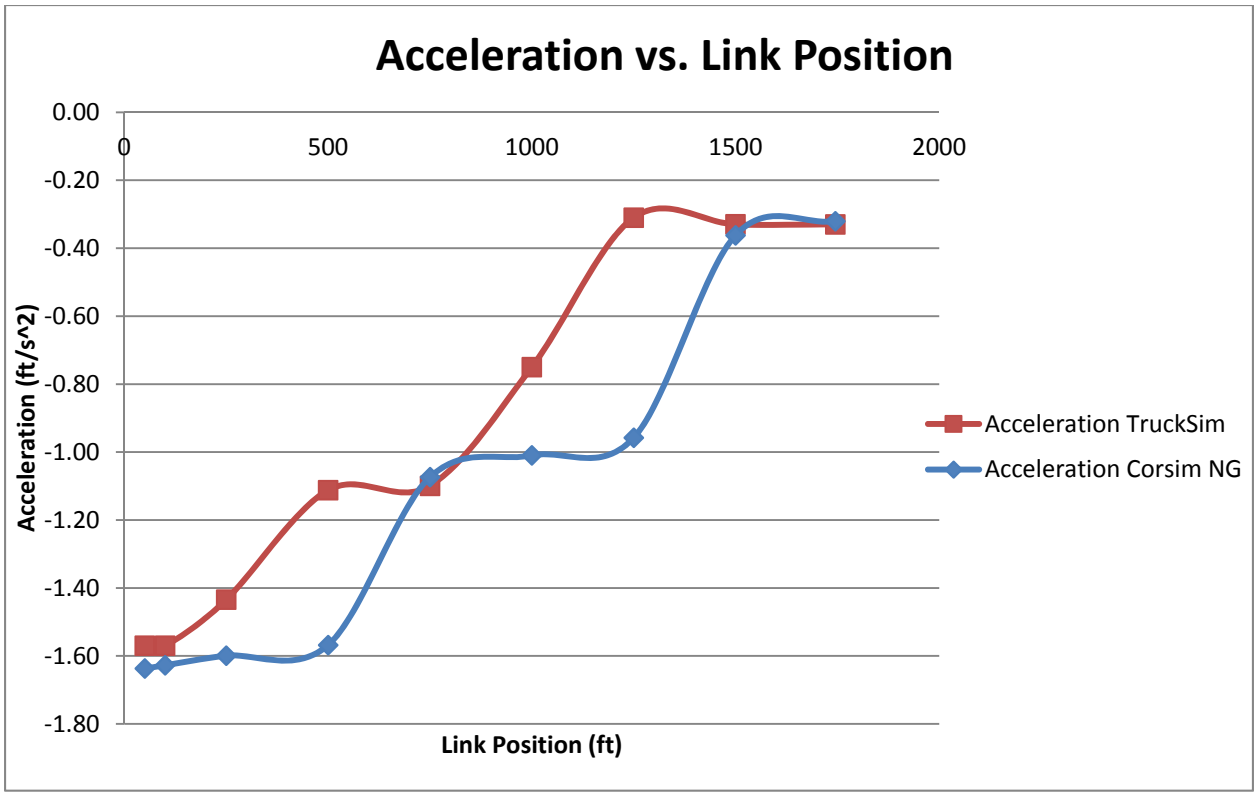

Figure 41. Gear Change Capable Acceleration of an Interstate Semi-trailer on a 2640-foot Link with 9% Grade

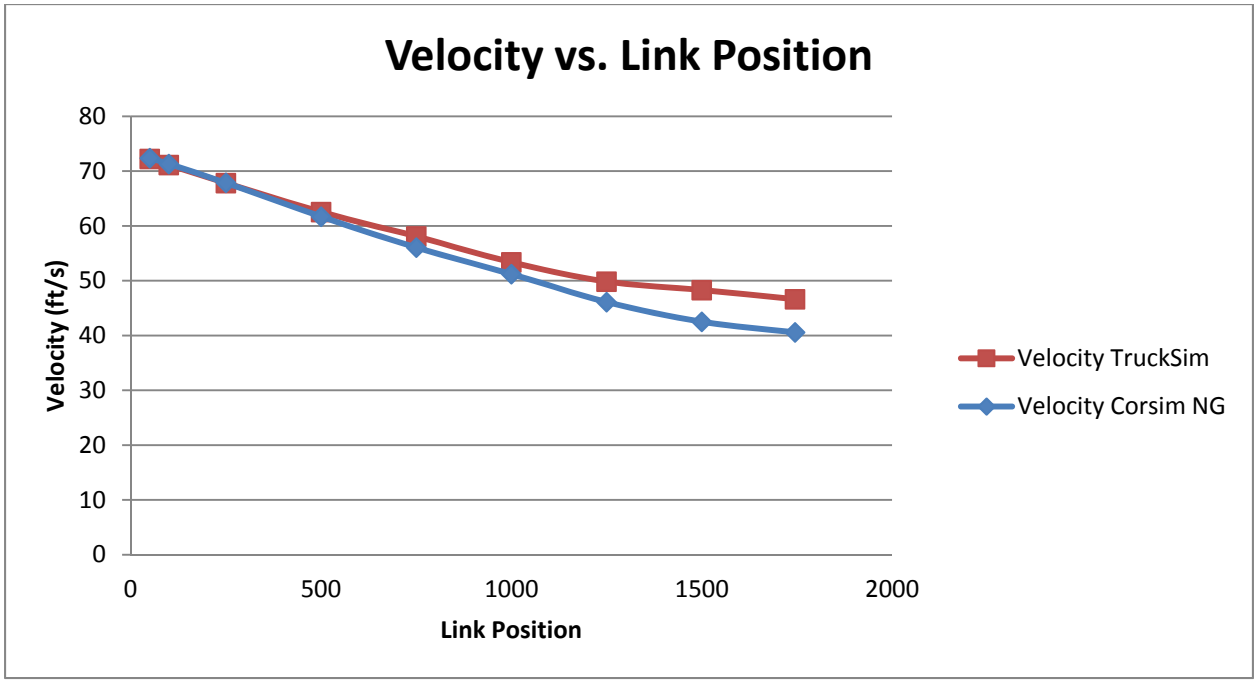

Figure 42. Gear Change Capable Velocity of an Interstate Semi-trailer on a 2640-foot Link with 9% Grade