Technical Memorandum

TO: File

FROM: Ray Shank, PE

DATE: August 18th, 2014

SUBJECT: **I-5 Mellen Street to Blakeslee Junction**
VISSIM Model Confidence and Calibration Report
Existing Conditions – PM Peak

The purpose of this memorandum is to document the methods used in the development of the Existing PM Peak Conditions VISSIM microsimulation model for the I-5 / Mellen Street to Blakeslee Junction (MTB) project. The calibration of the model to real world conditions is also documented in this memorandum.

Model Development

The Federal Highway Administration's (FHWA's) *Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software* and *WSDOT's Protocol for VISSIM Simulation* were used as guidelines for the development of the VISSIM model. As outlined in the FHWA guidelines, four steps must be completed before calibrating a VISSIM model:

1. Project Scope
2. Data Collection
3. Base Model Development
4. Error Checking

The following sections outline the details of how these four steps were applied to the Existing Conditions PM Peak VISSIM model developed for this project.

Project Scope

The project scope was developed through coordination between Lewis County, the City of Centralia, and the Washington State Department of Transportation (WSDOT). This scope outlined a study area along I-5 between Mellen Street and Harrison Avenue that included several intersections adjacent to the interchanges. The following intersections were evaluated in the study for modeling purposes:

- Mellen Street/Airport Road
- Mellen Street/SB I-5 Ramps
- Mellen Street/NB I-5 Ramps
- Mellen Street/Ellsbury Street
- Harrison Avenue/Johnson Road
- Harrison Avenue/Belmont Avenue North
- Harrison Avenue/Belmont Avenue South
- Harrison Avenue/SB I-5 Ramps
- Harrison Avenue/NB I-5 Ramps
- Harrison Avenue/High Street

As outlined in the scope, the I-5 mainline operation from just north and south of the project area were modeled in VISSIM.

Data Collection

The second step in the development of a VISSIM model is the data collection process. The data required between different simulation tools and projects varies. For the development of this VISSIM model, vehicle turn movement counts, posted speeds, roadway geometry, and signal timing data were collected. Travel time data was also collected along I-5, Mellen Street and Harrison Avenue for calibration purposes.

Base Model Development

The next step in the development of a VISSIM model is building the base model that will be used for calibration and development of subsequent scenarios and future alternatives. The base model development for this project began with coding in geometry (number of lanes, link behavior type, and link lengths) over an aerial of the study area. The freeway was coded with VISSIM's default "freeway" link behavior type and the local street network was coded with VISSIM's default "urban" link behavior type.

Once the geometric network was created, desired speeds were coded into the network. The desired speeds were based on the travel time study performed in the field and the desired speed distributions were coded as plus and minus four miles per hour from the posted speed along the freeway. For the arterials, speed distributions were coded as plus and minus 2.5 miles per hour. An additional speed parameter that was coded into the network was the reduced speed turning zones for turns. The reduced speed zones were coded with a desired speed distribution of plus or minus 1.5 miles per hour from 9 miles per hour for right turns and 15 miles per hour for left turns (consistent with Synchro). Trucks were assumed to have a slightly slower speed than that of cars.

The next step was coding intersection control. The PM peak hour signal timing data was used in development of the base model. Signal timing, as provided by WSDOT, was coded into the VISSIM model at study intersections using the VISSIM-provided RBC controllers. Detectors at the intersections were coded to just prior to the stop bars. Right turns on red were coded in where allowed in the field using VISSIM's right turn on red feature. Stop signs were coded in at intersections that are stop controlled using the default stop parameters of VISSIM.

Next, conflict points and priority rules were coded into VISSIM. Conflict points were coded in locations where links/connectors cross and have the potential for vehicles to cross paths. The default parameters were maintained in the base model development for conflict points, with the exception of the "avoid blocking" parameter. For locations where a vehicle would be anticipated to enter the conflict point zone and possibly block it, the "avoid blocking" parameter was coded to 0 (allows vehicles to enter zone). Additionally, priority rules were incorporated into the model in some locations where it was determined that a conflict point would not sufficiently replicate the behavior of conflicting vehicles. The priority rule parameters were set to values that are anticipated to properly reflect actual field conditions.

Traffic entering the system (vehicle inputs) was the next item coded into the base model. The vehicle inputs include two parameters: traffic volumes (hourly flow rate) and vehicle compositions. The traffic volumes were based on existing PM peak hour turn movement counts. The vehicle compositions were based the types of vehicles on the road, such as heavy vehicles and passenger vehicles. Truck percentages for the local streets were obtained from historical short traffic counts. Truck percentages along I-5 were based on WSDOT's Transportation Data Office's vehicle classification data.

For routing traffic through the VISSIM network, VISSIM's static routing feature was used and the volumes coded into the vehicle input portion of the network were based on the PM peak hour turn movement counts. To avoid unrealistic weaving conditions, static routes were combined along the three major corridors in the model: I-5, Harrison Avenue, and Mellen Street. This routing structure improves the vehicular movements in the model to be more characteristic of real world conditions. The routing for cars and trucks were assumed to be similar for modelling purposes.

The final step in developing the base model was to determine the seeding period (initialization period) for the VISSIM models. A VISSIM model starts with zero vehicles on the network, which is not how the peak hour actually begins in the field. Therefore, some time period must be added onto the beginning of the simulation period to allow vehicles to be on the network by the time data collection begins. For this model, a 15 minute seeding time was selected.

Additional details for the base model development can be found in Attachment A.

Error Checking

The error checking portion of the model development focused on fixing coding errors before the calibration process began. Error checking is a process that includes a review of the coded data and a review of the animation. All coded data (geometry, speeds, signal timing data, and traffic volumes) was reviewed by the model developer and by a quality control reviewer.

The review of the animation was conducted to determine locations where conflict points or priority rules might be missing, where signal timing may not be operating correctly, or any other locations where general coded parameters may have been overlooked. Some parameters in the model were adjusted based on the modeler's judgment to accurately reflect the interactions of vehicles on the network as part of this review. A list of these adjustments is provided in Attachment A.

While a majority of the sample simulation runs did not produce an error file, two runs (random seed 5 and 10) contained errors.

Run 5 *Simulation time 3432: Vehicle 8382 (on route 5 from routing decision 11) reached the end of link 81 while searching for the next link (10085) of the route.*

Run 10 *Vehicle input 99 (link 133) could not be finished completely (remain: 4 vehicles).*

These errors are considered minor and rare. They are not anticipated to influence the average results of the model. Electronic copies of these error files are available per request.

Confidence

Given the varying results that inherently exist between microsimulation runs (due to the random seed number), every model is required to evaluate its reported results to ensure that they are representative of the model and not skewed towards a statistical outlier. This is critical since the true average of the model results is unknown.

Initial Sample Size

To determine the level of confidence in the reported results, an initial sampling of the model outputs is required. The model results are based on a sample of 11 simulation runs, which is recommended by WSDOT as a minimum to reduce the impact that an atypical run will have on

the sample average. The random seed numbers used in the initial sampling are as follows: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11.

Confidence Level
The confidence level is the probability that the true mean lies within the target confidence interval. A confidence level of 95 percent was selected for this project, which is the typical approach as defined in the Traffic Analysis Toolbox.

Confidence Interval
The confidence interval is the range of values within which the true mean value may lie. To have confidence that the true mean will lie within the calibration targets (see the calibration section later in the memo), the allowable variation between the model and real world observations were used as the basis for the initial confidence interval.

Traffic throughput volumes and travel times were selected as two measures of effectiveness (MOE) to justify the confidence in the model results. The Confidence Report Template spreadsheets developed by WSDOT were used in the development of the Confidence Interval.

Required Number of Simulation Runs
In order to ensure that the results reported are representative of the unknown model average, the following formula, outlined in *FHWA's Toolbox*, shall be applied:

$$N = \left(2 * t_{0.025, N-1} \frac{s}{R} \right)^2$$

R = Confidence Interval for the true mean

$t_{0.025,N-1}$ = Student's t-statistic for two-sided error of 2.5 percent (totals 5 percent) with N-1 degrees of freedom (this is related to a 95% Confidence Level)

s = Standard Deviation about the mean for selected MOE

N = Number of required simulation runs

The standard deviations for the two MOEs were determined from the preliminary 11 simulation runs.

Based on the number of runs calculation using the sample model results, the preliminary 11 simulation runs are sufficient to obtain the desired confidence level of 95 percent. Detailed calculations are provided in Attachment B.

Calibration
The calibration process involved a review of model parameters and possible adjustments to these parameters to get the model to replicate field conditions. The calibration process collects data outputs from VISSIM (such as traffic volumes and travel time) and compares them to field collected data.

Using engineering judgment, default parameters and geometry were adjusted in the model where necessary to reflect field operating conditions. A list of these adjustments is provided in Attachment A.

Base Model Calibration Results

An iterative process of making adjustments in the model and comparing the VISSIM data outputs to the field collected data was conducted until calibration targets were met. This section outlines the calibration targets, the results of the calibration process, and provides documentation of the calibrated VISSIM outputs.

To ensure that results representative of the true average of the model were used, confidence tests (outlined earlier in this memo) were performed throughout the iterative calibration process.

One of the calibration targets set was for traffic throughput volumes. As outlined in the *Analysis Methods and Assumptions* document, the model was calibrated to within a GEH of 3 for throughput volumes throughout the study corridor. This included all state facility segments, all entry and exit locations, and all entrance and exit ramp locations within the calibration area. Provided in Table 1 is a comparison of the field volumes to the calibrated VISSIM outputs from the 11 simulation runs. A more detailed throughput volume calibration report is provided in Attachment C.

Table 1 – Throughput Volume Calibration Results for the Existing PM Peak Hour Model

VISSIM Model Data Measurement	Route	Direction of Travel	Additional Description	"Field" Throughput Volume (vph)	Average Model Throughput Volume (vph)	GEH	Calibration Test
1	I-5	SB	Before Harrison Offramp	2435	2481	0.7	PASS
2	I-5	SB	Between Harrison Ramps	1870	1915	0.7	PASS
3	I-5	SB	At Skookumchuck River Bridge	2590	2647	0.8	PASS
4	I-5	SB	Between Mellen Ramps	2240	2285	0.7	PASS
5	I-5	SB	After Mellen Onramp	2705	2742	0.5	PASS
6	I-5	NB	Before Mellen Offramp	2505	2531	0.4	PASS
7	I-5	NB	Between Mellen Ramps	2145	2177	0.5	PASS
8	I-5	NB	At Skookumchuck River Bridge	2540	2561	0.3	PASS
9	I-5	NB	Between Harrison Ramps	1785	1790	0.1	PASS
10	I-5	NB	After Harrison Onramp	2170	2161	0.1	PASS
11	I-5	SB	Harrison Offramp	565	567	0.1	PASS
12	I-5	SB	Harrison Onramp	720	733	0.5	PASS
13	I-5	NB	Harrison Offramp	755	771	0.6	PASS
14	I-5	NB	Harrison Onramp	385	372	0.7	PASS
15	I-5	SB	Mellen Offramp	350	360	0.5	PASS
16	I-5	SB	Mellen Onramp	465	456	0.4	PASS
17	I-5	NB	Mellen Offramp	360	356	0.2	PASS
18	I-5	NB	Mellen Onramp	395	385	0.5	PASS
19	Harrison	EB	Before Johnson	560	560	0.0	PASS
20	Harrison	EB	Between Johnson and Belmont North	790	796	0.1	PASS
21	Harrison	EB	Between Belmont North and Belmont South	1155	1178	0.5	PASS
22	Harrison	EB	Between Belmont South and SB Ramps	1315	1342	0.5	PASS
23	Harrison	EB	Between SB Ramps and NB Ramps	1015	1016	0.0	PASS
24	Harrison	EB	Between NB Ramps and High	1045	1057	0.3	PASS
25	Harrison	EB	After High	965	981	0.4	PASS
26	Harrison	WB	Before High	1100	1093	0.2	PASS
27	Harrison	WB	Between High and NB Ramps	1140	1127	0.3	PASS
28	Harrison	WB	Between NB Ramps and SB Ramps	1480	1478	0.0	PASS
29	Harrison	WB	Between SB Ramps and Belmont South	1625	1633	0.1	PASS
30	Harrison	WB	Between Belmont South and Belmont North	1385	1387	0.0	PASS
31	Harrison	WB	Between Belmont North and Johnson	970	961	0.2	PASS
32	Harrison	WB	After Johnson	705	711	0.2	PASS
33	Mellen	EB	Before Airport	510	492	0.8	PASS
34	Mellen	EB	Between Airport and SB Ramps	545	527	0.8	PASS
35	Mellen	EB	Between SB Ramps and NB Ramps	645	645	0.0	PASS
36	Mellen	EB	Between NB Ramps and Ellisbury	710	712	0.1	PASS
37	Mellen	EB	After Ellisbury	670	669	0.1	PASS
38	Mellen	WB	Before Ellisbury	675	674	0.0	PASS
39	Mellen	WB	Between Elisburry and NB Ramps	705	695	0.3	PASS
40	Mellen	WB	Between NB Ramps and SB Ramps	605	601	0.2	PASS
41	Mellen	WB	Between SB Ramps and Airport	390	385	0.3	PASS
42	Mellen	WB	After Airport	365	361	0.2	PASS
43	Johnson	NB	South of Harrison Intersection	350	364	0.7	PASS
44	Johnson	NB	North of Harrison Intersection	190	191	0.1	PASS
45	Johnson	SB	North of Harrison Intersection	200	195	0.3	PASS
46	Johnson	SB	South of Harrison Intersection	395	385	0.5	PASS
47	Belmont North	NB	South of Harrison Intersection	215	220	0.3	PASS
48	Belmont North	NB	North of Harrison Intersection	430	439	0.4	PASS
49	Belmont North	SB	North of Harrison Intersection	380	383	0.2	PASS
50	Belmont North	SB	South of Harrison Intersection	215	208	0.5	PASS
51	Belmont South	NB	South of Harrison Intersection	180	182	0.2	PASS
52	Belmont South	SB	South of Harrison Intersection	260	263	0.2	PASS
53	High	NB	South of Harrison Intersection	130	126	0.4	PASS
54	High	NB	North of Harrison Intersection	135	132	0.3	PASS
55	High	SB	North of Harrison Intersection	80	76	0.5	PASS
56	High	SB	South of Harrison Intersection	115	114	0.1	PASS
57	Airport	NB	South of Mellen Intersection	40	41	0.2	PASS
58	Water Treatment Plant	NB	North of Mellen Intersection	10	9	0.4	PASS
59	Water Treatment Plant	SB	North of Mellen Intersection	20	19	0.2	PASS
60	Airport	SB	South of Mellen Intersection	40	41	0.2	PASS
61	Ellisbury	NB	South of Mellen Intersection	45	38	1.1	PASS
62	Ellisbury	NB	North of Mellen Intersection	15	16	0.1	PASS
63	Ellisbury	SB	North of Mellen Intersection	15	11	1.2	PASS
64	Ellisbury	SB	South of Mellen Intersection	55	56	0.1	PASS
Sum of All Segment Flows Calibration Test				51,565	51,879	0.6%	PASS

Note: Average Model Data based on 11 simulation runs.

As can be seen in Table 1, all locations fall within the calibration target of being within a GEH of 3. Additionally the total network traffic volumes fall within the calibration target of being within 5% of the total traffic throughput volumes.

Another calibration target used was for travel times along I-5, Mellen Street, and Harrison Avenue. As outlined in the *Analysis Methods and Assumptions* document, corridor travel times in VISSIM were calibrated using the following criteria.

Facility Type	Equation
Free-Flowing	$\Delta = \frac{1}{\frac{1}{t} - \frac{4.4}{L}} - t$
Interupted Flow	$\Delta = \frac{1}{\frac{1}{t} - \frac{0.1 * 5280\,S}{3600\,L}} - t$

Δ = Allowable Travel Time Variation (+/- seconds)
t = Average Model Travel Time (seconds)
L = Length (feet)
S = Free Flow Speed (mph); Posted Speed may be used for Free Flow Speed if unknown

Table 2 provides a comparison of the VISSIM collected travel times to the field collected (GPS floating car) travel times.

Table 2 – Travel Time Calibration Results for Existing PM Peak Hour Model

VISSIM Model Data Measurement	Route	Start Location	End Location	"Field" Travel Time (s)	Average Model Travel Time (s)	Difference (s)	Calibration Goal based on Facility Type (+/- seconds)	Calibration Test
1	Harrison (WB)	W Bridge St	Caveness Dr	183	159	-23	+/- 31	PASS
2	Harrison (EB)	Caveness Dr	W Bridge St	184	166	-18	+/- 34	PASS
3	Mellen (EB)	Military Rd	Yew St	107	97	-10	+/- 20	PASS
4	Mellen (WB)	Yew St	Military Rd	139	121	-18	+/- 33	PASS
5	I-5 (NB)	Bridge over minor road (South of Mellen Couplet)	Padrick Rd (North of Blakeslee Junction)	221	221	1	+/- 11	PASS
6	I-5 (SB)	Padrick Rd (North of Blakeslee Junction)	Bridge over minor road (South of Mellen Couplet)	225	221	-4	+/- 11	PASS

Note: Average Model Data based on 11 simulation runs.

As shown in Table 2, VISSIM model travel time data was compared to the PM peak floating car travel time runs. The VISSIM data differed from the field data by less than the allowable variation defined in the calibration goals. Therefore, this model can be considered calibrated for travel time.

A more detailed travel time calibration report is provided in Attachment C.

Conclusion

Based on the calibration targets and visual inspections of the field in comparison with the base VISSIM model, it was determined that the base model is adequately calibrated. This base model will be used as the foundation for other VISSIM models developed for this project.

Attachment A

VISSIM Model Assumptions and Adjustments from Default Parameters

I-5/Mellen Street To Blakeslee Junction
General VISSIM Assumptions
Date Created: 10/13/2009
Created by: SW Region Planning Office

Parameters not addressed in this document remained its default value/setting.

Type	Category	Setting	Assumption	Reason
Base Data	Distribution	Desired Speed	Linear Distribution	Default Distributions are Linear; No sufficient Speed Data to develop curves
	Driving Behavior	Urban	5 max observed vehicles	Enhances interaction between vehicles
			Observe vehicles on next lane(s) checked	Helps prevent vehicles from visually colliding with each other
		Urban Heavy LT	New Behavior Added to reflect weaving section on Harrison between Belmont and the SB ramp terminal	This new behavior is similar to the Urban driving behavior in all ways except waiting time before diffusion and observing vehicles in the next lane(s). The wait time before diffusion was lowered to 30 seconds as vehicles were inappropriately blocking the mainline throughs as opposed to traveling to the next available left turn. The observing vehicles in the next lane(s) was unchecked due to the vehicles that change lanes and inappropriatly block the lane they just left.
		Freeway	Observe vehicles on next lane(s) checked	Helps prevent vehicles from visually colliding with each other
Traffic	Vehicle Compositions	Arterial	98% Cars (27.5 mph - 32.5 mph), 2% Trucks (25 mph - 30 mph)	Truck percentage on Harrison and Mellen came from counts taken in 2007 and 2004, respectively; Speeds are based on a travel time study completed on 9/16/2009
		Side Street	98% Cars (20.0 mph - 25.0 mph), 2% Trucks (15.0 mph - 20.0 mph)	Truck percentage on Harrison and Mellen came from counts taken in 2007 and 2004, respectively; Speeds are based on the posted speed limit
		Freeway	85% Cars (59.0 mph - 67.0 mph), 15% Trucks (56.0 mph - 64.0 mph)	Truck percentage on Interstate based on TDO's vehicle classification data from 2008; Speeds are based on a travel time study completed on 9/16/2009
Signal Control	Controllers	Both Ramp Terminals	Actuated Signal Control Type	Existing Signal Timing was used for these signals
Links & Connectors	Lane Change	Lookback Distance	Varys on location	Lane Change and Emergency Stop lookback distances vary by individual locations. Typically, if there is a turn bay the Emergency Stop distance extends to just before the end of the storage bay. This allows for more accurate vehicle queuing.
Vehicle Inputs	All Inputs	Start Up Time	0-900: Lowered Peak Hour Volume by amount added in Peak 15 mins	Seeding time for the network; Reduced traffic volume was used as this accounts for non-peak traffic already in the network as the peak hour begins
		Peak Hour Factor	PHF = 0.96 for I-5; PHF = 0.92 for Harrison and Mellen	900-1800: Average Flow Rate, 1800-2700: PHF applied, 2700-3600: Average Flow Rate, 3600-4500: Lowered Average Flow Rate by amount added in peak 15 mins
Routing Decisions	Static	Mellen	Cars and Trucks have same routes	Due to lack of information and low truck percentage on Mellen in the peak hour, cars and trucks travel along the same routes.
		I-5 and Harrison	Cars and Trucks have different routes	Due to more information for these roadways separate routes for cars and trucks could be created.
Priority Rules & Conflict Areas	Location	All Intersections	Combinations of Priority Rules and Conflict Areas were used	Allows more flexibility to realistically capture existing conditions
Detectors	Location	All Signalized Intersections	Detectors were placed just before the stop bar	Existing locations of the detectors was unavailable. For consistancy, all detectors are located just before the stop bar for signalized intersections.

Attachment B

Confidence Report
Vehicle Throughput and Travel Time

WSDOT VISSIM Throughput Volume Confidence Report
Model Results Confidence Test

Project: I-5/Mellen Street to Blakeslee Junction

Scenario: Existing Conditions - PM Peak

Prepared By: Ray Shank - WSDOT

Date: August 19, 2014

Select Confidence Level for this analysis *(typically 95% Confidence Level is used)*	**95.0%**
Select Confidence Interval Target Acceptable Variation in Results Based on the Selected GEH Statistic	**3**
Number of Sample Runs	11
Number of Sites Failing to meet the Confidence Interval Target	**0**

Location Description						Model Results				Confidence Interval Target		Model Results Confidence Test	
VISSIM Model Data Measurement	Route	Mile Post	Direction of Travel	Number of Lanes	Additional Description	Average Model Volume (vph)	Standard Deviation (Model)	Confidence Interval based on a 95.0% Confidence Level (Volume Range)	Confidence Interval based on a 95.0% Confidence Level (Percentage)	Confidence Interval based on GEH of 3 (Volume Range)	Confidence Interval based on GEH of 3 (Percentage)	TEST - Model Results meet the following criteria. Selected Confidence Level = 95.0% Uniquely Defined Desired Confidence Interval	Number of Runs Required to meet Desired Confidence Criteria
1	I-5		SB	2	Before Harrison Offramp	2481	36.80	+/- 25	+/- 1.0%	+/- 147	+/- 5.9%	PASS	11
2	I-5		SB	2	Between Harrison Ramps	1915	39.34	+/- 26	+/- 1.4%	+/- 128	+/- 6.7%	PASS	11
3	I-5		SB	2	At Skookumchuck River Bridge	2647	48.49	+/- 33	+/- 1.2%	+/- 152	+/- 5.7%	PASS	11
4	I-5		SB	2	Between Mellen Ramps	2285	55.64	+/- 37	+/- 1.6%	+/- 141	+/- 6.2%	PASS	11
5	I-5		SB	2	After Mellen Onramp	2742	74.06	+/- 50	+/- 1.8%	+/- 154	+/- 5.6%	PASS	11
6	I-5		NB	2	Before Mellen Offramp	2531	36.56	+/- 25	+/- 1.0%	+/- 148	+/- 5.8%	PASS	11
7	I-5		NB	2	Between Mellen Ramps	2177	33.82	+/- 23	+/- 1.0%	+/- 138	+/- 6.3%	PASS	11
8	I-5		NB	2	At Skookumchuck River Bridge	2561	44.26	+/- 30	+/- 1.2%	+/- 149	+/- 5.8%	PASS	11
9	I-5		NB	2	Between Harrison Ramps	1790	30.56	+/- 21	+/- 1.1%	+/- 125	+/- 7.0%	PASS	11
10	I-5		NB	2	After Harrison Onramp	2161	40.36	+/- 27	+/- 1.3%	+/- 137	+/- 6.3%	PASS	11
11	I-5		SB	1	Harrison Offramp	567	14.48	+/- 10	+/- 1.7%	+/- 69	+/- 12.2%	PASS	11
12	I-5		SB	1	Harrison Onramp	733	14.45	+/- 10	+/- 1.3%	+/- 79	+/- 10.8%	PASS	11
13	I-5		NB	1	Harrison Offramp	771	25.66	+/- 17	+/- 2.2%	+/- 81	+/- 10.4%	PASS	11
14	I-5		NB	1	Harrison Onramp	372	18.60	+/- 12	+/- 3.4%	+/- 55	+/- 14.8%	PASS	11
15	I-5		SB	1	Mellen Offramp	360	14.91	+/- 10	+/- 2.8%	+/- 54	+/- 15.1%	PASS	11
16	I-5		SB	1	Mellen Onramp	456	25.86	+/- 17	+/- 3.8%	+/- 61	+/- 13.5%	PASS	11
17	I-5		NB	1	Mellen Offramp	356	19.94	+/- 13	+/- 3.8%	+/- 54	+/- 15.2%	PASS	11
18	I-5		NB	1	Mellen Onramp	385	21.55	+/- 14	+/- 3.8%	+/- 56	+/- 14.4%	PASS	11
19	Harrison		EB	1	Before Johnson	560	26.87	+/- 18	+/- 3.2%	+/- 68	+/- 12.1%	PASS	11
20	Harrison		EB	2	Between Johnson and Belmont North	796	23.75	+/- 16	+/- 2.0%	+/- 82	+/- 10.4%	PASS	11
21	Harrison		EB	2	Between Belmont North and Belmont South	1178	25.13	+/- 17	+/- 1.4%	+/- 101	+/- 8.5%	PASS	11
22	Harrison		EB	2	Between Belmont South and SB Ramps	1342	27.36	+/- 18	+/- 1.4%	+/- 107	+/- 8.0%	PASS	11
23	Harrison		EB	2	Between SB Ramps and NB Ramps	1016	26.45	+/- 18	+/- 1.7%	+/- 93	+/- 9.2%	PASS	11
24	Harrison		EB	2	Between NB Ramps and High	1057	34.28	+/- 23	+/- 2.2%	+/- 94	+/- 8.9%	PASS	11
25	Harrison		EB	2	After High	981	28.16	+/- 19	+/- 1.9%	+/- 91	+/- 9.3%	PASS	11
26	Harrison		WB	2	Before High	1093	21.13	+/- 14	+/- 1.3%	+/- 97	+/- 8.9%	PASS	11
27	Harrison		WB	2	Between High and NB Ramps	1127	20.74	+/- 14	+/- 1.2%	+/- 98	+/- 8.7%	PASS	11
28	Harrison		WB	2	Between NB Ramps and SB Ramps	1478	31.74	+/- 21	+/- 1.4%	+/- 113	+/- 7.6%	PASS	11
29	Harrison		WB	3	Between SB Ramps and Belmont South	1633	27.73	+/- 19	+/- 1.1%	+/- 119	+/- 7.3%	PASS	11
30	Harrison		WB	3	Between Belmont South and Belmont North	1387	21.04	+/- 14	+/- 1.0%	+/- 109	+/- 7.9%	PASS	11
31	Harrison		WB	2	Between Belmont North and Johnson	961	25.44	+/- 17	+/- 1.8%	+/- 90	+/- 9.4%	PASS	11
32	Harrison		WB	1	After Johnson	711	18.15	+/- 12	+/- 1.7%	+/- 78	+/- 10.9%	PASS	11
33	Mellen		EB	1	Before Airport	492	31.03	+/- 21	+/- 4.2%	+/- 64	+/- 12.9%	PASS	11

Location Description						Model Results				Confidence Interval Target		Model Results Confidence Test	
VISSIM Model Data Measurement	Route	Mile Post	Direction of Travel	Number of Lanes	Additional Description	Average Model Volume (vph)	Standard Deviation (Model)	Confidence Interval based on a 95.0% Confidence Level (Volume Range)	Confidence Interval based on a 95.0% Confidence Level (Percentage)	Confidence Interval based on GEH of 3 (Volume Range)	Confidence Interval based on GEH of 3 (Percentage)	TEST - Model Results meet the following criteria. Selected Confidence Level = 95.0% Uniquely Defined Desired Confidence Interval	Number of Runs Required to meet Desired Confidence Criteria
34	Mellen		EB	1	Between Airport and SB Ramps	527	28.29	+/- 19	+/- 3.6%	+/- 66	+/- 12.5%	PASS	11
35	Mellen		EB	1	Between SB Ramps and NB Ramps	645	29.54	+/- 20	+/- 3.1%	+/- 74	+/- 11.5%	PASS	11
36	Mellen		EB	1	Between NB Ramps and Ellisbury	712	22.36	+/- 15	+/- 2.1%	+/- 78	+/- 11.0%	PASS	11
37	Mellen		EB	1	After Ellisbury	669	20.30	+/- 14	+/- 2.0%	+/- 75	+/- 11.3%	PASS	11
38	Mellen		WB	1	Before Ellisbury	674	21.14	+/- 14	+/- 2.1%	+/- 75	+/- 11.1%	PASS	11
39	Mellen		WB	2	Between Elisburry and NB Ramps	695	22.50	+/- 15	+/- 2.2%	+/- 76	+/- 11.0%	PASS	11
40	Mellen		WB	1	Between NB Ramps and SB Ramps	601	25.23	+/- 17	+/- 2.8%	+/- 71	+/- 11.8%	PASS	11
41	Mellen		WB	1	Between SB Ramps and Airport	385	8.72	+/- 6	+/- 1.5%	+/- 56	+/- 14.4%	PASS	11
42	Mellen		WB	1	After Airport	361	12.54	+/- 8	+/- 2.3%	+/- 54	+/- 15.1%	PASS	11
43	Johnson		NB	1	South of Harrison Intersection	364	19.28	+/- 13	+/- 3.6%	+/- 55	+/- 15.0%	PASS	11
44	Johnson		NB	1	North of Harrison Intersection	191	6.41	+/- 4	+/- 2.2%	+/- 38	+/- 20.1%	PASS	11
45	Johnson		SB	1	North of Harrison Intersection	195	10.93	+/- 7	+/- 3.8%	+/- 39	+/- 20.0%	PASS	11
46	Johnson		SB	1	South of Harrison Intersection	385	10.67	+/- 7	+/- 1.9%	+/- 56	+/- 14.5%	PASS	11
47	Belmont North		NB	1	South of Harrison Intersection	220	9.90	+/- 7	+/- 3.0%	+/- 42	+/- 19.1%	PASS	11
48	Belmont North		NB	1	North of Harrison Intersection	439	18.44	+/- 12	+/- 2.8%	+/- 60	+/- 13.7%	PASS	11
49	Belmont North		SB	1	North of Harrison Intersection	383	10.39	+/- 7	+/- 1.8%	+/- 56	+/- 14.7%	PASS	11
50	Belmont North		SB	1	South of Harrison Intersection	208	8.32	+/- 6	+/- 2.7%	+/- 41	+/- 19.5%	PASS	11
51	Belmont South		NB	1	South of Harrison Intersection	182	6.17	+/- 4	+/- 2.3%	+/- 38	+/- 20.9%	PASS	11
52	Belmont South		SB	1	South of Harrison Intersection	263	13.47	+/- 9	+/- 3.4%	+/- 46	+/- 17.5%	PASS	11
53	High		NB	1	South of Harrison Intersection	126	11.40	+/- 8	+/- 6.1%	+/- 31	+/- 24.6%	PASS	11
54	High		NB	1	North of Harrison Intersection	132	11.99	+/- 8	+/- 6.1%	+/- 32	+/- 24.2%	PASS	11
55	High		SB	1	North of Harrison Intersection	76	7.42	+/- 5	+/- 6.6%	+/- 24	+/- 31.6%	PASS	11
56	High		SB	1	South of Harrison Intersection	114	10.10	+/- 7	+/- 6.0%	+/- 30	+/- 26.0%	PASS	11
57	Airport		NB	1	South of Mellen Intersection	41	3.26	+/- 2	+/- 5.3%	+/- 16	+/- 40.0%	PASS	11
58	Water Treatment Plant		NB	1	North of Mellen Intersection	9	2.33	+/- 2	+/- 17.9%	+/- 7	+/- 74.5%	PASS	11
59	Water Treatment Plant		SB	1	North of Mellen Intersection	19	2.89	+/- 2	+/- 10.1%	+/- 10	+/- 52.1%	PASS	11
60	Airport		SB	1	South of Mellen Intersection	41	4.79	+/- 3	+/- 7.8%	+/- 16	+/- 38.9%	PASS	11
61	Ellisbury		NB	1	South of Mellen Intersection	38	5.82	+/- 4	+/- 10.4%	+/- 16	+/- 41.2%	PASS	11
62	Ellisbury		NB	1	North of Mellen Intersection	16	4.32	+/- 3	+/- 18.7%	+/- 10	+/- 61.1%	PASS	11
63	Ellisbury		SB	1	North of Mellen Intersection	11	2.61	+/- 2	+/- 16.4%	+/- 8	+/- 69.9%	PASS	11
64	Ellisbury		SB	1	South of Mellen Intersection	56	8.23	+/- 6	+/- 9.9%	+/- 20	+/- 35.1%	PASS	11

Model Volume Variation - Confidence Interval (CI) Comparison
VISSIM Model CI (based on a Confidence Level of 95.0%) vs. Acceptable CI (based on a GEH of 3)

Model Confidence Interval is in **RED**
Acceptable Confidence Interval is in **BLACK**

Volume Variation (Vehicles per Hour)

3000
2500
2000
1500
1000
500
0

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64

VISSIM Model Data Measurement

WSDOT VISSIM Travel Time Confidence Report
Model Results Confidence Test

Project: I-5/Mellen Street to Blakeslee Junction

Scenario: Existing Conditions - PM Peak

Prepared By: Ray Shank - WSDOT

Date: August 19, 2014

Number of Sample Runs	11
Select Confidence Level for this analysis *(typically 95% Confidence Level is used)*	95.0%
Number of Sites Failing to meet the Confidence Interval Target	0

Confidence Test: Passed

Confidence Interval Target Acceptable Variation in Results Based on Facility Type	Uninterrupted Flow	$\Delta = \frac{1}{\frac{1}{t} - \frac{4.4}{L}} - t$
	Interrupted Flow	$\Delta = \frac{1}{\frac{1}{t} - \frac{0.1 * 5280\ S}{3600\ L}} - t$

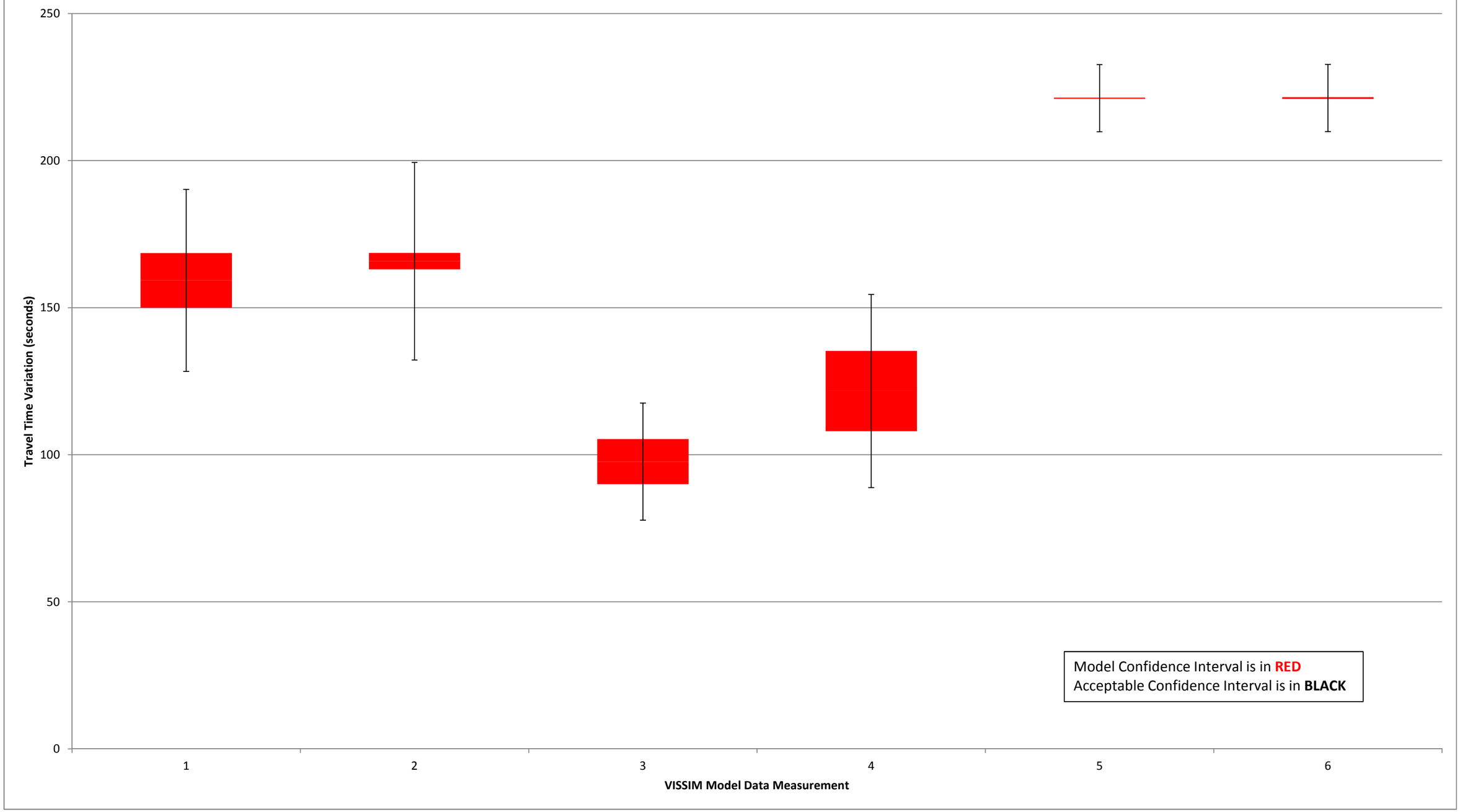
Notes:

Δ = Allowable Travel Time Variation (+/- seconds)
t = Travel Time (seconds)
L = Length (feet)
S = Free Flow Speed (mph); Under certain circumstances the Posted Speed Limit may be used

Analysis Interval	
Model Start Time	900
Model End Time	4500

Location Description								Model Results				Confidence Interval Target		Model Results Confidence Test	
VISSIM Model Data Measurement	Route	Start Location	End Location	Distance (ft)	Additional Description	Facility Type	Free-Flow Speed (MPH)	Average Model Travel Time (s)	Standard Deviation	Confidence Interval based on a 95.0% Confidence Level (+/- seconds)	Confidence Interval based on a 95.0% Confidence Level (+/-Percentage)	Confidence Interval based on Facility Type (+/- seconds)	Confidence Interval based on Facility Type (+/- Percentage)	TEST - Model Results meet the following criteria. Selected Confidence Level = 95.0% Uniquely Defined Desired Confidence Interval	Number of Runs Required to meet Desired Confidence Criteria
1	Harrison (WB)	W Bridge St	Caveness Dr	4313	-	Interrupted Flow	30	159	13.79	+/- 9	+/- 5.8%	+/- 31	+/- 19.4%	PASS	11
2	Harrison (EB)	Caveness Dr	W Bridge St	4316	-	Interrupted Flow	30	166	4.16	+/- 3	+/- 1.7%	+/- 34	+/- 20.3%	PASS	11
3	Mellen (EB)	Military Rd	Yew St	2515	-	Interrupted Flow	30	97	11.39	+/- 8	+/- 7.9%	+/- 20	+/- 20.5%	PASS	11
4	Mellen (WB)	Yew St	Military Rd	2506	-	Interrupted Flow	30	121	20.32	+/- 14	+/- 11.3%	+/- 33	+/- 27.1%	PASS	11
5	I-5 (NB)	Bridge over minor road (South of Mellen Couplet)	Padrick Rd (North of Blakeslee Junction)	19865	-	Unintterrupted Flow	60	221	0.30	+/- 0	+/- 0.1%	+/- 11	+/- 5.2%	PASS	11
6	I-5 (SB)	Padrick Rd (North of Blakeslee Junction)	Bridge over minor road (South of Mellen Couplet)	19841	-	Unintterrupted Flow	60	221	0.43	+/- 0	+/- 0.1%	+/- 11	+/- 5.2%	PASS	11

Model Travel Time Variation - Confidence Interval (CI) Comparison
VISSIM Model CI (based on a Confidence Level of 95.0%) vs. CI Target



Attachment C

Calibration Report
Vehicle Throughput and Travel Time

WSDOT VISSIM Throughput Volume Calibration Test

Project: I-5/Mellen Street to Blakeslee Junction

Scenario: Existing Conditions - PM Peak

Prepared By: Ray Shank - WSDOT

Date: August 18, 2014

Calibration Targets

Criteria	Target Details
GEH < 3.0	All state facility segments within the calibration area
GEH < 3.0	All entry and exit locations within the calibration area
GEH < 3.0	All entrance and exit ramps within the calibration area
GEH < 5.0	At least 85% of applicable local roadway segments
Sum of all segment flows within the calibration area	Within 5%

Number of Sample Runs	11
Number of Sites Failing to meet the Calibration Target	0

Location Description						"Field" Volumes		Model Volume		Calibration Test		
VISSIM Model Data Measurement	Route	Direction of Travel	Number of Lanes	Additional Description	Facility Type	Total Volume (vph)	Vehicles Per Lane (vphpl)	Average Total Volume (vph)	Average Vehicles Per Lane (vphpl)	GEH Target	GEH	Calibration Test
1	I-5	SB	2	Before Harrison Offramp	Interstate	2435	1218	2481	1240	3.0	0.7	PASS
2	I-5	SB	2	Between Harrison Ramps	Interstate	1870	935	1915	958	3.0	0.7	PASS
3	I-5	SB	2	At Skookumchuck River Bridge	Interstate	2590	1295	2647	1323	3.0	0.8	PASS
4	I-5	SB	2	Between Mellen Ramps	Interstate	2240	1120	2285	1143	3.0	0.7	PASS
5	I-5	SB	2	After Mellen Onramp	Interstate	2705	1353	2742	1371	3.0	0.5	PASS
6	I-5	NB	2	Before Mellen Offramp	Interstate	2505	1253	2531	1266	3.0	0.4	PASS
7	I-5	NB	2	Between Mellen Ramps	Interstate	2145	1073	2177	1089	3.0	0.5	PASS
8	I-5	NB	2	At Skookumchuck River Bridge	Interstate	2540	1270	2561	1281	3.0	0.3	PASS
9	I-5	NB	2	Between Harrison Ramps	Interstate	1785	893	1790	895	3.0	0.1	PASS
10	I-5	NB	2	After Harrison Onramp	Interstate	2170	1085	2161	1081	3.0	0.1	PASS
11	I-5	SB	1	Harrison Offramp	Interstate	565	565	567	567	3.0	0.1	PASS
12	I-5	SB	1	Harrison Onramp	Interstate	720	720	733	733	3.0	0.5	PASS
13	I-5	NB	1	Harrison Offramp	Interstate	755	755	771	771	3.0	0.6	PASS
14	I-5	NB	1	Harrison Onramp	Interstate	385	385	372	372	3.0	0.7	PASS
15	I-5	SB	1	Mellen Offramp	Interstate	350	350	360	360	3.0	0.5	PASS
16	I-5	SB	1	Mellen Onramp	Interstate	465	465	456	456	3.0	0.4	PASS
17	I-5	NB	1	Mellen Offramp	Interstate	360	360	356	356	3.0	0.2	PASS
18	I-5	NB	1	Mellen Onramp	Interstate	395	395	385	385	3.0	0.5	PASS
19	Harrison	EB	1	Before Johnson	Local	560	560	560	560	5.0	0.0	PASS

Location Description						"Field" Volumes		Model Volume		Calibration Test		
VISSIM Model Data Measurement	Route	Direction of Travel	Number of Lanes	Additional Description	Facility Type	Total Volume (vph)	Vehicles Per Lane (vphpl)	Average Total Volume (vph)	Average Vehicles Per Lane (vphpl)	GEH Target	GEH	Calibration Test
20	Harrison	EB	2	Between Johnson and Belmont North	Local	790	395	796	398	5.0	0.1	PASS
21	Harrison	EB	2	Between Belmont North and Belmont South	Local	1155	578	1178	589	5.0	0.5	PASS
22	Harrison	EB	2	Between Belmont South and SB Ramps	Local	1315	658	1342	671	5.0	0.5	PASS
23	Harrison	EB	2	Between SB Ramps and NB Ramps	Local	1015	508	1016	508	5.0	0.0	PASS
24	Harrison	EB	2	Between NB Ramps and High	Local	1045	523	1057	528	5.0	0.3	PASS
25	Harrison	EB	2	After High	Local	965	483	981	490	5.0	0.4	PASS
26	Harrison	WB	2	Before High	Local	1100	550	1093	546	5.0	0.2	PASS
27	Harrison	WB	2	Between High and NB Ramps	Local	1140	570	1127	564	5.0	0.3	PASS
28	Harrison	WB	2	Between NB Ramps and SB Ramps	Local	1480	740	1478	739	5.0	0.0	PASS
29	Harrison	WB	3	Between SB Ramps and Belmont South	Local	1625	542	1633	544	5.0	0.1	PASS
30	Harrison	WB	3	Between Belmont South and Belmont North	Local	1385	462	1387	462	5.0	0.0	PASS
31	Harrison	WB	2	Between Belmont North and Johnson	Local	970	485	961	481	5.0	0.2	PASS
32	Harrison	WB	1	After Johnson	Local	705	705	711	711	5.0	0.2	PASS
33	Mellen	EB	1	Before Airport	Local	510	510	492	492	5.0	0.8	PASS
34	Mellen	EB	1	Between Airport and SB Ramps	Local	545	545	527	527	5.0	0.8	PASS
35	Mellen	EB	1	Between SB Ramps and NB Ramps	Local	645	645	645	645	5.0	0.0	PASS
36	Mellen	EB	1	Between NB Ramps and Ellisbury	Local	710	710	712	712	5.0	0.1	PASS
37	Mellen	EB	1	After Ellisbury	Local	670	670	669	669	5.0	0.1	PASS
38	Mellen	WB	1	Before Ellisbury	Local	675	675	674	674	5.0	0.0	PASS
39	Mellen	WB	2	Between Elisburry and NB Ramps	Local	705	353	695	348	5.0	0.3	PASS
40	Mellen	WB	1	Between NB Ramps and SB Ramps	Local	605	605	601	601	5.0	0.2	PASS
41	Mellen	WB	1	Between SB Ramps and Airport	Local	390	390	385	385	5.0	0.3	PASS
42	Mellen	WB	1	After Airport	Local	365	365	361	361	5.0	0.2	PASS
43	Johnson	NB	1	South of Harrison Intersection	Local	350	350	364	364	5.0	0.7	PASS
44	Johnson	NB	1	North of Harrison Intersection	Local	190	190	191	191	5.0	0.1	PASS
45	Johnson	SB	1	North of Harrison Intersection	Local	200	200	195	195	5.0	0.3	PASS
46	Johnson	SB	1	South of Harrison Intersection	Local	395	395	385	385	5.0	0.5	PASS
47	Belmont North	NB	1	South of Harrison Intersection	Local	215	215	220	220	5.0	0.3	PASS
48	Belmont North	NB	1	North of Harrison Intersection	Local	430	430	439	439	5.0	0.4	PASS
49	Belmont North	SB	1	North of Harrison Intersection	Local	380	380	383	383	5.0	0.2	PASS
50	Belmont North	SB	1	South of Harrison Intersection	Local	215	215	208	208	5.0	0.5	PASS
51	Belmont South	NB	1	South of Harrison Intersection	Local	180	180	182	182	5.0	0.2	PASS
52	Belmont South	SB	1	South of Harrison Intersection	Local	260	260	263	263	5.0	0.2	PASS
53	High	NB	1	South of Harrison Intersection	Local	130	130	126	126	5.0	0.4	PASS
54	High	NB	1	North of Harrison Intersection	Local	135	135	132	132	5.0	0.3	PASS
55	High	SB	1	North of Harrison Intersection	Local	80	80	76	76	5.0	0.5	PASS
56	High	SB	1	South of Harrison Intersection	Local	115	115	114	114	5.0	0.1	PASS
57	Airport	NB	1	South of Mellen Intersection	Local	40	40	41	41	5.0	0.2	PASS
58	Water Treatment Plant	NB	1	North of Mellen Intersection	Local	10	10	9	9	5.0	0.4	PASS
59	Water Treatment Plant	SB	1	North of Mellen Intersection	Local	20	20	19	19	5.0	0.2	PASS
60	Airport	SB	1	South of Mellen Intersection	Local	40	40	41	41	5.0	0.2	PASS
61	Ellisbury	NB	1	South of Mellen Intersection	Local	45	45	38	38	5.0	1.1	PASS
62	Ellisbury	NB	1	North of Mellen Intersection	Local	15	15	16	16	5.0	0.1	PASS
63	Ellisbury	SB	1	North of Mellen Intersection	Local	15	15	11	11	5.0	1.2	PASS

Location Description						"Field" Volumes		Model Volume		Calibration Test		
VISSIM Model Data Measurement	Route	Direction of Travel	Number of Lanes	Additional Description	Facility Type	Total Volume (vph)	Vehicles Per Lane (vphpl)	Average Total Volume (vph)	Average Vehicles Per Lane (vphpl)	GEH Target	GEH	Calibration Test
64	Ellisbury	SB	1	South of Mellen Intersection	Local	55	55	56	56	5.0	0.1	PASS

Sum of All Segment Flows Calibration Test	
Total "Field" Volumes	51,565
Total Model Volumes	51,879
Percent Difference	0.6%

WSDOT VISSIM Travel Time Calibration Report

Project: I-5/Mellen Street to Blakeslee Junction

Scenario: Existing Conditions - PM Peak
Prepared By: Ray Shank - WSDOT
Date: August 19, 2014

Number of Sample Runs	**11**
Number of Sites Failing to meet the Calibration Goal	**0**

Calibration Goal Acceptable Variation in Results Based on Facility Type	**Uninterrupted Flow**	$\Delta = \frac{1}{\frac{1}{t} - \frac{4.4}{L}} - t$
	Interrupted Flow	$\Delta = \frac{1}{\frac{1}{t} - \frac{0.1 * 5280\ S}{3600\ L}} - t$

Notes:
Δ = Allowable Travel Time Variation (+/- seconds)
t = Travel Time (seconds)
L = Length (feet)
S = Free Flow Speed (mph); Under certain circumstances the Posted Speed Limit may be used

Analysis Interval	
Model Start Time	900
Model End Time	4500

Location Description							"Field" Travel Times (s)	Average Model Travel Time (s)	Difference	Calibration Goal based on Facility Type (+/- seconds)	Calibration Test
VISSIM Model Data Measurement	Route	Start Location	End Location	Distance (ft)	Additional Description	Facility Type	Free-Flow Speed (MPH)				
1	Harrison (WB)	W Bridge St	Caveness Dr	4,313	-	Interrupted Flow	30	183	159	-23	+/- 31	PASS
2	Harrison (EB)	Caveness Dr	W Bridge St	4,316	-	Interrupted Flow	30	184	166	-18	+/- 34	PASS
3	Mellen (EB)	Military Rd	Yew St	2,515	-	Interrupted Flow	30	107	97	-10	+/- 20	PASS
4	Mellen (WB)	Yew St	Military Rd	2,506	-	Interrupted Flow	30	139	121	-18	+/- 33	PASS
5	I-5 (NB)	Bridge over minor road (South of Mellen Couplet)	Padrick Rd (North of Blakeslee Junction)	19,865	-	Unintterrupted Flow	60	221	221	1	+/- 11	PASS
6	I-5 (SB)	Padrick Rd (North of Blakeslee Junction)	Bridge over minor road (South of Mellen Couplet)	19,841	-	Unintterrupted Flow	60	225	221	-4	+/- 11	PASS