

A. Additional Calibration Analysis

In response to comments received from the stakeholders, Cambridge Systematics undertook additional analysis related to the AM calibrated model. Three specific requests were made that are detailed in this appendix. The first is a more detailed description of the calibration procedure; the second is a comparison of the volume calibration and travel time calibration for each freeway segment; and, the third is to try to improve the travel time calibration between William Street and Walden Avenue. Simultaneously, further efforts were made to improve the stability of the model results.

1.2 CALIBRATION PROCEDURE

In simulation there are three methods to determining the route a vehicle takes from its origin to destination: Deterministic, Stochastic and User Equilibrium. In deterministic routing the modeler assigns each route between OD pairs and the number of vehicles traveling each route. In stochastic routing the modeler assigns an attractiveness to each link in the network, typically in the form of speed or travel time, and the software is free to determine the attractive routes between OD pairs as well as the number of drivers taking each route. In user equilibrium routing the model is run iteratively to determine the route attractiveness, the modeler has little to no control - the travel time from each iteration feeds the route choice of the next iteration, until a level of equilibrium is achieved.

Dynamic User Equilibrium (DUE) was employed for this modeling effort. It was chosen because it is the best suited to model future scenarios that affect drivers route choice, which is an important MOE for the future scenarios tested in this project. It is referred to as dynamic because route attractiveness changes throughout the simulation. By employing DUE the calibration process becomes much more time consuming because the modeler has very little control over the vehicle routing.

During the calibration the following issues were discovered and dealt with accordingly:

- Arterial routes were too attractive compared to freeway routes during congested hours therefore, the speed limits, which dictate the travel time, on the arterials was reduced to 20-25 mph and 15-20 mph on local and collector streets.

- The occupancy in the right two lanes approaching the 90-290 interchange was too low, therefore, the driver characteristics were adjusted for those approaching the 90-290 interchange. Drivers were made to be more comfortable sitting in a lane travelling below their desired speed if that lane led to their off-ramp.
- The variability, introduced through the perception error of route attractiveness, can lead to gridlock starting at lower capacity movements, therefore, throughout the calibration process adjustments were made where needed to attributes such as: the distance to which a left-turn vehicle can proceed into the intersection on a permitted phase; the ability for vehicles to queue jump at congested left and right turns; and, the distance a vehicle needs to travel through an intersection to be considered out of a conflict area.
- The demand model does not accurately reflect the operational capacities, therefore, the capacity is updated in the demand model and the ODME procedure is re-run and new subarea demands for the simulation model are produced.

1.3 COMPARING TRAVEL TIMES AGAINST VOLUMES

It was requested that Cambridge Systematics not only show the volume calibration statistics for the entire network for each hour but also show the calibration statistics for the freeway compared to the travel times in each segment. The results are shown below in Table A.1 and the explanation of the results follows.

Table A.1 Travel Time and Volume Calibration Comparison

Direction	Freeway Segments	Travel Times															Volume																		
		6:30-7:00			7:00-7:30			7:30-8:00			8:00-8:30			8:30-9:00			9:00-9:30			Modelled				Counts				Volume Difference				GEH			
		Mod	Obs	Diff	Mod	Obs	Diff	Mod	Obs	Diff	Mod	Obs	Diff	Mod	Obs	Diff	Mod	Obs	Diff	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00
SB	Grand Island Blvd to Niagara Falls Blvd	5.4			5.5 5.0 0.5			5.6 5.1 0.5			5.6 5.0 0.5 5.5 5.0 0.6			5.4			Station ID	530602-	517	1258	1718	979	545	1336	1227	959	-25	-48	-9	13	1	1	0	0	
		533434-	439	1128	1077	858	445	988	1007	777	-6	140	70	83	0	4	2	3																	
		530038-1	1268	2618	2661	2098	1246	2639	2594	2050	22	9	68	46	1	0	1	1																	
		530037-1	1787	4053	4145	2960	1719	4051	3741	2832	68	2	404	128	2	0	6	2																	
		530036-1	2211	4543	4705	3319	2230	4948	4365	2968	-8	-405	141	351	0	6	5	6																	
	Niagara Falls Blvd to Sheridan Dr	3.0 2.0 0.4			3.1 2.8 0.4			3.3 2.8 0.4			3.2 2.7 0.5 3.1 2.8 0.3			3.0			530577-1	2984	5097	4970	3304	2628	3334	4836	3258	-46	-317	114	246	1	4	2	4		
		530922-2	2916	5077	5031	3513	2711	5135	4720	3738	205	-118	111	-223	4	2	4	4																	
		530676-2	3841	5007	4974	3467	3647	5117	4758	3883	204	150	116	285	6	2	2	6																	
		530572-2	2902	4795	4915	3782	2800	5173	4938	3664	102	-378	23	118	2	5	0	2																	
		530571-2	3107	4472	4664	3746	2454	4553	4468	3290	653	-81	96	456	12	1	1	8																	
Sheridan Dr to Rt 33 (changed from Cleveland Dr)	3.9 3.5 0.5			5.3 4.9 0.4			7.1 8.7 2.6			6.4 8.5 2.1 5.4 4.5 0.9			4.1 3.4 0.7			M4205 W	3415	4343	4139	3733	3219	4939	4704	3687	196	-596	-165	46	3	9	5	1			
	Rt 33 (changed from Cleveland Dr) to William St	3.1			3.2			3.2 3.2 0.0			3.2 3.2 0.0 3.2 3.1 0.1			3.2 3.0 0.2			M4224 W	2853	3958	4101	3284	2762	4354	3881	3157	91	-406	120	127	2	6	3	2		
		M4233 W	2465	3632	3770	3024	2332	3949	3618	2897	163	-317	152	127	3	5	2	2																	
NE	Niagara Falls Blvd to Kummers Ave	4.3			3.0			5.0 5.5 0.5			5.0 5.3 0.3 5.0 5.2 0.2			4.3			530038-2	1709	2980	2482	1900	1766	3077	2584	2886	-57	-97	-102	14	1	2	2	0		
		530037-2	2069	3503	3150	2549	2152	3754	3299	2475	-89	-361	-49	74	2	4	1	1																	
		530036-2	2120	3449	3137	2500	1910	3443	3195	2657	220	6	68	-74	5	0	1	1																	
	Main St to Niagara Falls Blvd	4.4			4.5 4.0 0.5			4.6 4.3 0.3			4.5 4.1 0.5 4.5 3.9 0.6			4.5			530577-2	2217	3561	3479	2930	1852	3538	3558	2963	365	-27	-79	-33	8	0	1	1		
		530922-1	1998	3146	3084	2494	1797	3657	4006	3886	201	-366	-117	198	5	5	5	7																	
		530576-1	2240	3664	4186	3328	2253	3954	4131	3339	-13	-300	55	-11	0	5	1	0																	
		530572-1	2486	3809	4109	3398	2724	4122	3966	3103	-238	-313	143	295	5	5	4	5																	
		530571-1	2924	4370	4617	3763	2851	4270	4078	3164	79	100	439	601	1	2	7	10																	
	Route 33 to Main St	2.2			2.8 2.7 0.1			3.2 3.2 0.0			3.2 2.9 0.3 3.1 2.9 0.2			2.6			536407-	2506	3517	3740	3144	1867	3514	3443	2488	639	3	197	656	14	0	5	12		
		M4205 E	3016	4436	4799	3935	2458	4630	4575	3356	558	-164	124	579	11	2	3	10																	
Walden Ave to Route 33	1.6			3.0 2.5 0.6			2.9 3.4 0.5			3.5 4.4 0.9 2.5 2.0 0.3			1.7			M4224 E	3469	5303	5013	4069	3354	5321	4840	3642	146	58	667	410	2	1	0	7			
William St to Walden Ave	1.7			1.8 2.4 0.6			1.9 3.5 1.7			1.9 3.5 1.6 1.8 3.2 3.5			1.7			M4233 E	3862	5674	5036	3893	3691	5597	4867	3740	201	77	169	153	3	1	2	2			

There are two segments that have travel times that do not fall within the one minute calibration target. Sheridan Drive to Route 33 and William Street to Walden Avenue. In each case the modeled travel times are below the observed travel times, but in the case of Sheridan Drive to Route 33 the corresponding volumes are low and in the case of the segment from William Street to Walden Avenue the volumes are high.

Between Sheridan Drive and Route 33 the model does simulate the queue of vehicles approaching the freeway connector from I-290 to I-90 SB/WB which means that there is a choke point, a bottleneck. Increasing the number of vehicles through the bottleneck to better match the count would result in a smaller queue and decreased travel times. But, the travel times are already low in this section, so decreasing them further is contradictory to the goal. The same is true if the travel times were increased by restricting the bottleneck further, the volumes would decrease which is contradictory to the goal.

Since the travel times are low and the volumes are high between William Street and Walden Avenue introducing a bottleneck to the area should result in increased travel times, decreased volumes and overall a better match for both performance measures. In actuality, the creation of a bottleneck did result in higher travel times throughout the peak period but the desired effect on volumes was not achieved. The bottleneck created a significant queue, which meant the volume downstream was negatively affected, especially in the final hour when the restrained volume at the bottleneck dissipated. The extra volume released from the bottleneck in the final hour had a major effect on the calibration statistics.

1.4 AM MODEL REVISION EFFORT

To address the concerns of the stakeholders regarding the travel times between William Street and Walden Avenue and to test the hypothesis suggested in the preceding section related to better matching the travel times and volumes in this segment the following tests were completed in the weeks following the September meeting.

In the first test a local parameter was added at mainline NB I-290 near ramps at Walden Avenue to change the car following behavior and increase the travel time. However, it was noticed in the middle of the simulation that vehicles tried to exit from I-290 to off-ramp at William Street and get back on to the on-ramp at William Street or detour to parallel arterials with no congestion on NB mainline I-290.

Another run, test 6, was conducted testing the effect of changing the Freeway Transfer Parameters in Route Choice of Driver Behavior parameters. Freeway to non-freeway penalty was changed from 20 seconds to 40 seconds and its bias was changed from 15% to 30% in the effort of reducing the number of vehicles getting off at William Street off-ramp to detour. The northbound travel time improved

but because it was a global parameter that was changed the travel time for some southbound sections became worse. The results from this test are shown below in Table A.2 and Table A.3

Table A.2 Northbound Travel Time Calibration (test 6)

Travel Time Segment	Travel Time (Minutes)	Travel Time			
		7:00-7:30	7:30-8:00	8:00-8:30	8:30-9:00
William to Walden	Observed	2.4	3.6	3.5	5.2
	Simulated	2.0	3.3	4.5	3.0
	Difference	-0.4	-0.3	1.0	-2.2
Walden to Rt 33	Observed	2.5	3.4	4.4	2.8
	Simulated	2.2	3.5	3.8	3.4
	Difference	-0.2	0.1	-0.6	0.6
Rt 33 to Main	Observed	2.7	3.2	2.9	2.9
	Simulated	2.3	2.4	2.6	2.3
	Difference	-0.4	-0.8	-0.3	-0.6
Main to Niagara Falls	Observed	4.0	4.3	4.1	3.9
	Simulated	4.5	4.6	4.6	4.5
	Difference	0.5	0.3	0.5	0.6
Niagara Falls to Kenmore	Observed	N/A	5.5	5.3	5.2
	Simulated	5.0	5.0	5.0	5.0
	Difference		-0.5	-0.3	-0.3

Table A.3 Southbound Travel Time Calibration (test 6)

Travel Time Segment	Travel Time (Minutes)	Travel Time					
		6:30-7:00	7:00-7:30	7:30-8:00	8:00-8:30	8:30-9:00	9:00-9:30
Grand Island to Niagara Falls	Observed	N/A	5.0	5.1	5.0	5.0	N/A
	Simulated	5.3	5.5	5.6	5.5	5.5	5.4
	Difference		0.5	0.5	0.5	0.5	
Niagara Falls to Sheridan	Observed	2.6	2.8	2.8	2.7	2.8	N/A
	Simulated	3.0	3.1	3.2	3.1	3.1	3.0
	Difference	0.4	0.3	0.4	0.4	0.3	
Sheridan to Rt 33	Observed	3.5	4.9	9.7	8.5	4.5	3.4
	Simulated	3.8	4.6	6.2	7.0	5.8	4.0
	Difference	0.3	-0.3	-3.5	-1.5	1.3	0.6
Rt 33 to William	Observed	N/A	N/A	3.2	3.2	3.1	3.0
	Simulated	3.2	3.2	3.2	3.2	3.2	3.2
	Difference			0.0	0.0	0.1	0.2

Table A.4 Volume Calibration (test 6)

GEH < 7	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00
Freeway	81%	89%	94%	84%
All Links	74%	87%	85%	84%

The two global parameters were changed back to their original values in the next test and a local parameter for car following was added on the southbound I-290 in the vicinity of the ramps at Main Street. Multiple model runs were conducted to test the impacts of different values of this local parameter. Each model run consisted of a 30 run DUE assignment followed by a simulation run.

Given the time constraints, test 8 was conducted as final effort to improve the travel time after several attempts with varying local parameters. The values of the two local parameters used in test 8 are listed in Table A.5.

Table A.5 Local Parameters Settings (test 8)

Direction	Location	Accelerating Parameters	Decelerating Parameters
NB	Mainline I-290, north of NB on-ramp from WB Walden Ave	Alpha=1.81, Beta=-1.67, Gamma=-0.89	Alpha=3.65, Beta=1.08, Gamma=1.45
SB	Mainline I-290, south of SB off-ramp to EB Main St.	Alpha=2.71, Beta=-1.67, Gamma=-1.05	Alpha=4.45, Beta=1.08, Gamma=1.6

The northbound travel time results for test 8 are shown in Table A.6 below.

Table A.6 Northbound Travel Time Calibration (test 8)

Travel Time Segment	Travel Time (Minutes)	7:00-9:00			
		7:00-7:30	7:30-8:00	8:00-8:30	8:30-9:00
William to Walden	Observed	2.4	3.6	3.5	5.2
	Simulated	2.2	4.0	5.8	4.1
	Difference	-0.3	0.4	2.3	-1.1
Walden to Rt 33	Observed	2.5	3.4	4.4	2.8
	Simulated	2.7	3.6	3.8	3.6
	Difference	0.2	0.2	-0.6	0.8
Rt 33 to Main	Observed	2.7	3.2	2.9	2.9
	Simulated	2.4	2.4	2.5	2.4
	Difference	-0.3	-0.8	-0.4	-0.5
Main to Niagara Falls	Observed	4.0	4.3	4.1	3.9
	Simulated	4.5	4.6	4.6	4.6
	Difference	0.5	0.3	0.5	0.7
Niagara Falls to Kenmore	Observed	N/A	5.5	5.3	5.2
	Simulated	5.0	5.0	5.0	5.0
	Difference		-0.5	-0.3	-0.2

Modeled travel times compared better with the observed travel times for the northbound direction. The travel time between William Street and Walden Avenue suggest that a queue formed but in the wrong time period, it formed in the first half of the 8:00 a.m. to 9:00 a.m. instead of the second half, as observed.

The southbound travel time results for test 8 are shown in Table A.7 below.

Table A.7 Southbound Travel Time Calibration (test 8)

Travel Time Segment	Travel Time (Minutes)	6:30-7:00	7:00-7:30	7:30-8:00	8:00-8:30	8:30-9:00	9:00-9:30
Grand Island to Niagara Falls	Observed	N/A	5.0	5.1	5.0	5.0	N/A
	Simulated	5.3	5.5	5.6	5.6	5.5	5.4
	Difference		0.5	0.5	0.5	0.5	
Niagara Falls to Sheridan	Observed	2.6	2.8	2.8	2.7	2.8	N/A
	Simulated	3.0	3.1	3.3	3.2	3.1	3.0
	Difference	0.4	0.3	0.5	0.5	0.3	
Sheridan to Rt 33	Observed	3.5	4.9	9.7	8.5	4.5	3.4
	Simulated	3.8	4.8	7.5	9.8	8.7	5.1
	Difference	0.3	-0.1	-2.2	1.3	4.2	1.7
Rt 33 to William	Observed	N/A	N/A	3.2	3.2	3.1	3.0
	Simulated	3.2	3.2	3.2	3.2	3.2	3.2
	Difference			0.0	0.0	0.1	0.2

Table A.8 Volume Calibration (test 8)

GEH < 7	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00
Freeway	84%	86%	94%	75%
All Links	74%	81%	85%	83%

Modeled travel times compared well with the observed travel times for southbound direction, except for the segment between Sheridan and Route 33 where the queue took longer to develop and longer to dissipate, but the maximum extent was reached.

Improvements in the travel time calibration resulted in poorer volume calibration leading to the conclusion that the variability in the data, both travel times and volumes, is the leading cause of the remaining discrepancies in the model calibration. It is recommended that the previous model as defined in the calibration document be approved as the calibrated model.