FEHR PEERS

Memorandum

Date: June 30, 2021

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From: Eric Howard and Ron Milam, Fehr & Peers

Subject: El Dorado County Travel Demand Model Validation Memorandum

RS19-3865

This memorandum summarizes the process used to validate the El Dorado County Travel Demand Model (EDCTDM) after updating it to include improved sensitivity to built-environment characteristics. The validation process includes both the static and dynamic validation tests outlined in the California Transportation Commission's *2017 Regional Transportation Plan Guidelines*[1]. Static validation tests compare model's volume estimates to observed traffic counts for the base year to verify the model's accuracy. Since future year forecasts cannot be compared to observed conditions yet, dynamic validation tests are used to verify that the model's outputs respond in the appropriate direct and magnitude when input changes are made. We performed the static validation tests on two different EDCTDM versions. The first version represents the original 2018 model while the second version includes the enhanced built environment sensitivity.

Static Validation

Table 1 presents the results of static validation tests conducted to evaluate the accuracy of EDCTDM compared to traffic counts. The counts were collected during 2018, except the counts on US 50, which were collected in 2016. The following measures of effectiveness are used to evaluate the performance of the EDCTDM.

- ***Volume-to-Count Ratio –*** describes the general relationship between the EDCTDM's volume estimates and the observed counts. Values greater than one indicate that the volume estimates are high compared to the counts. Values below one indicate the estimates are low.

[1] California Transportation Commission. 2017 Regional Transportation Plan Guidelines. 2017. https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/f0009312-2017rtpguidelinesformpos-a11y.pdf

- ***Percent of links within the Caltrans volume-to-count deviation allowance –*** measures if the EDCTDM's volume estimates match the observed counts compared to the deviation thresholds specified by Caltrans. The deviation thresholds shrink as the observed counts increase indicating that lower tolerance for errors exists on higher volume facilities.
- ***Model-Wide Correlation Coefficient*** – represents the correlation between the EDCTDM volume estimate and observed count data. This value can range between -1 and 1, with a value of 1 indicating a positive linear relationship and 0 indicating no relationship.
- ***Model-Wide Percent Root Mean Square Error (% RMSE)*** – a measure of accuracy based on the difference between the EDCTDM's predicted volumes and the observed count data.

Table 1: Static Validation Test Results

Metric	Validation Criteria	2018 Original		2018 Original with Built Environment Enhancement	
		Value	Passes Criteria?	Value	Passes Criteria?
Model/Count Ratio	-	0.96	-	0.94	-
% Links Within Caltrans Maximum Deviation	> 75%	79%	Yes	78%	Yes
Correlation Coefficient	> 0.88	0.98	Yes	0.98	Yes
% RMSE	< 50%	27%	Yes	28%	Yes

Figure 1 below is a scatterplot that shows the relationship between the EDCTDM's estimate of roadway volumes and the observed traffic counts for the same roadway link. The points on the plot have been color-coded based on the functional classification of the roadway link. The line in the scatterplot represents the linear regression model that describes the relationship between the roadway counts and the EDCTDM volumes ($y = 0.93x + 318.33$). This equation has an R^2 value of 0.96, which indicates that 96% of the variation of EDCTDM's volume estimates are explained by the observed traffic counts. The R^2 value is close to 1, which indicates that the EDCTDM's volume estimates and the observed traffic counts are good predictors of each other.

Figure 2 shows a scatterplot of the relationship between the EDCTDM's volume estimates using the built environment adjustments and the observed traffic counts. This figure looks almost identical to Figure 1 because the data, and corresponding regression equation ($y = 0.93x + 195.13$), are similar. The R^2 value for the the built environment adjusted equation (0.9571) is almost identical to the unadjusted equation (0.9570). The major difference between these two equations is the y-intercept value (318.33 compared to 195.13). The differences in these values indicate that the built environment vehicle trip reductions result in a uniform decrease in the volume estimates of around 120 vehicles. This adjustment indicates that adding built-environment sensitivity to the model caused some TAZs to generate fewer vehicle trips, which is expected.

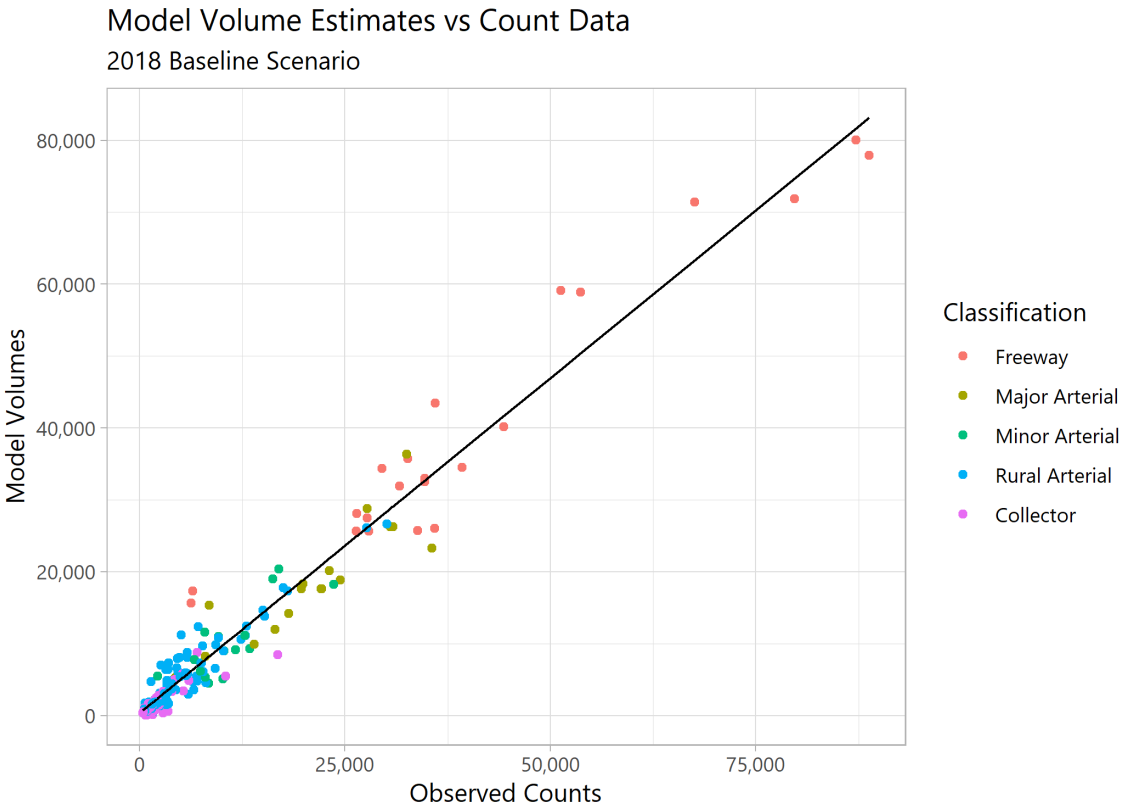

Figure 1 Scatterplot Comparing the Model Volumes to the Observed Count Data for the Unadjusted Scenario

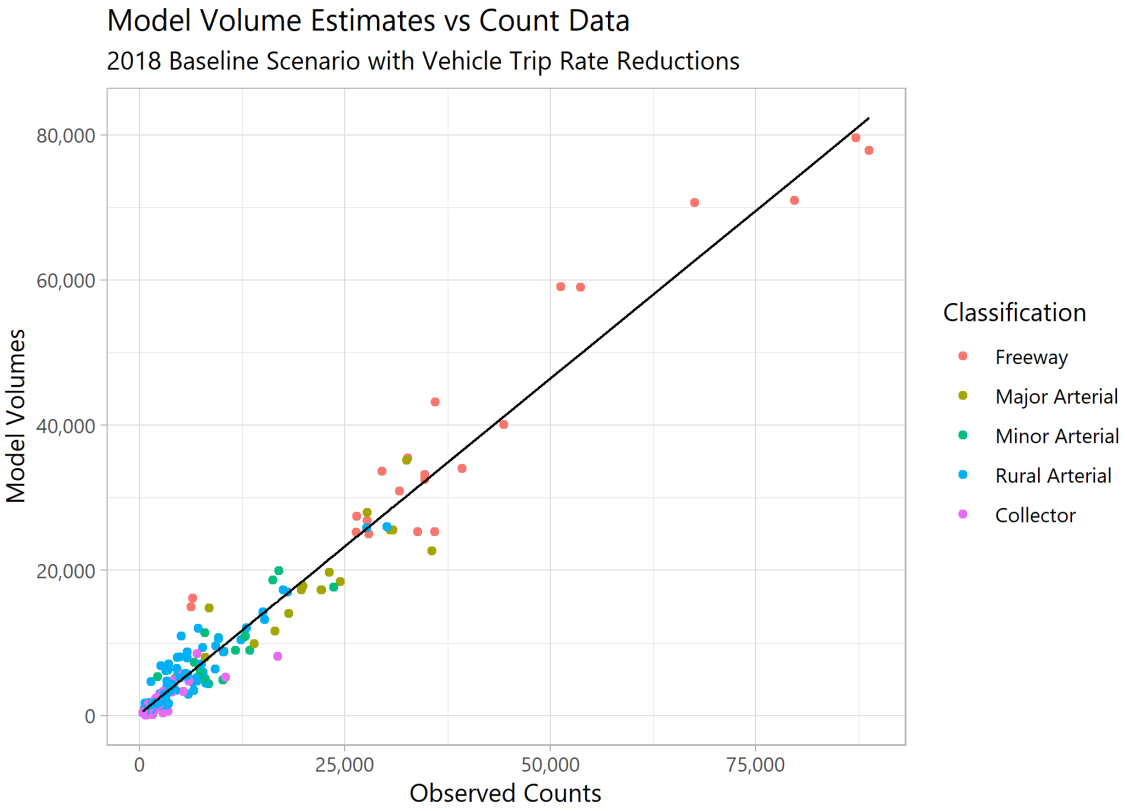

Figure 2 Scatterplot Comparing the Model Volumes to the Observed Count Data for the Scenario with the Built Environment Adjustment

In addition to the model-wide validation tests, it is also important to evaluate how the EDCTDM volume estimates match the observed counts by facility type. The following tables show the percent errors between the volume estimates and observed counts and compares them to their desired target percentage by facility type. Table 2 evaluates the percent error by classification for the baseline version, and Table 3 compares the percent errors for the version with the built-environment adjustments.

Table 2 Percent Error by Roadway Classification for the 2018 Baseline Scenario

Roadway Classification	# Count Locations	Model	Counts	Difference	% Error	Target	Within Target?
Freeway	22	896,248	902,120	-5,872	-0.7%	7%	Yes
Major Arterial	18	342,078	388,950	-46,872	-12.1%	15%	Yes
Minor Arterial	15	152,985	165,706	-12,721	-7.7%	15%	Yes
Rural Arterial	76	452,756	443,128	9,628	2.2%	15%	Yes
Collector	35	77,950	104,266	-26,316	-25.2%	25%	No

[1] Targets are based on the acceptable precent errors identified in Figure 2.2 of FHWA's Travel Model Validation and Reasonableness Checking Manual, Second Edition.
https://www.fhwa.dot.gov/planning/tmip/publications/other_reports/validation_and_reasonableness_2010/fhwahep10042.pdf

Table 3 Percent Error by Roadway Classification for the 2018 Scenario with Built Environment Adjustments

Roadway Classification	# Count Locations	Model	Counts	Difference	% Error	Target[1]	Within Target?
Freeway	22	886,539	902,120	-15,581	-1.7%	7%	Yes
Major Arterial	18	334,051	388,950	-54,899	-14.1%	15%	Yes
Minor Arterial	15	149,073	165,706	-16,633	-10.0%	15%	Yes
Rural Arterial	76	441,543	443,128	-1,585	-0.4%	15%	Yes
Collector	35	75,592	104,266	-28,674	-27.5%	25%	No

[1] Targets are based on the acceptable precent errors identified in Figure 2.2 of FHWA's Travel Model Validation and Reasonableness Checking Manual, Second Edition.
https://www.fhwa.dot.gov/planning/tmip/publications/other_reports/validation_and_reasonableness_2010/fhwahep10042.pdf

The percent error tables indicate that model underestimates volumes for major arterials and collector roadways. In the 2018 baseline scenario the count location on Missouri Flat Road just north of Forni Road accounted for 26% of the total percent error associated with major arterials. This location introduced enough error to the total percent error value for major arterials, that the value is above the preferable target of +/- 10%, but still under the acceptable target of +/- 15%. Similarly, the count location at White Rock Road just south of Silva Valley Parkway accounted for 32% of the total percent error associated with the collector roadways.

Dynamic Validation

The dynamic validation tests were focused on the new enhanced built-environment version of the model. Tests were specifically designed to evaluate how the VMT and roadway volume forecasts generated by the EDCTDM change due to land use and network changes. Generally, we would expect the VMT to increase or decrease consistently with the land use changes. Additionally, we expect the roadway volumes of parallel facilities to change if roadway segments are removed or expanded.

Table 4 summarizes how the TAZ and El Dorado County VMT estimates change as the number of single-family housing units is modified in TAZs 221 and 413. In general, the changes in the single-family housing units match the corresponding changes in VMT. For TAZ 221, an 11% decrease in housing units resulted in a 12% reduction in VMT, and an 11% increase in housing units resulted in a 9% increase in VMT. The changes to single-family households in TAZ 413 also resulted in a corresponding shift in VMT. A 79% reduction in housing units resulted in an 81% reduction in VMT, an 8% reduction in housing units resulted in a 7 to 8% reduction in VMT, and a 79% increase in units resulted in a 79 to 80% increase in VMT.

Table 5 shows how the VMT estimates change as the amount of office square footage increases. While the VMT changes are not as consistent as the single-family dwelling unit changes, the direction and magnitude of the change in VMT matches the shift in office employees. TAZ 388 saw a 29 to 36% reduction in VMT for a 74% decrease in office employees, along with a 3 to 4% reduction in VMT for a 7% decrease in office employees. Additionally, TAZ 388 saw a 3% increase in VMT for a 7% increase in office employees, a 28 to 36% increase in VMT for a 74% increase in office employees, and a 273 to 367% increase in VMT for a 735% increase in office employees. Similar trends were seen in the change in office employees for TAZ 612.

Table 4: Results of the sensitivity tests evaluating changes in the number of single-family dwelling units using the 2018 baseline scenario.

TAZ	# Single-Family Dwelling Units	Change in Dwelling Units	TAZ VMT Metrics					El Dorado County VMT Metrics			
			% Change in Dwelling Units	Total VMT	Total VMT % Difference	Home-Based VMT	Home-Based VMT % Difference	Total VMT	Total VMT % Difference	Home-Based VMT	Home-Based VMT % Difference
221	876	0	0.00%	43,710	0.00%	59,154	0.00%	3,606,897	0.00%	3,046,839	0.00%
	776	-100	-11.42%	38,402	-12.14%	52,206	-11.75%	3,601,567	-0.15%	3,040,621	-0.20%
	866	-10	-1.14%	43,316	-0.90%	58,666	-0.82%	3,607,753	0.02%	3,048,262	0.05%
	886	10	1.14%	43,380	-0.76%	59,098	-0.09%	3,608,713	0.05%	3,047,949	0.04%
	976	100	11.42%	47,508	8.69%	65,016	9.91%	3,611,464	0.13%	3,052,960	0.20%
	1,876	1,000	114.15%	86,932	98.88%	121,255	104.98%	3,631,201	0.67%	3,100,197	1.75%
413	126	0	0.00%	3,596	0.00%	3,768	0.00%	3,606,897	0.00%	3,046,839	0.00%
	26	-100	-79.37%	682	-81.03%	724	-80.78%	3,602,020	-0.14%	3,038,512	-0.27%
	116	-10	-7.94%	3,330	-7.40%	3,483	-7.58%	3,606,736	0.00%	3,045,359	-0.05%
	136	10	7.95%	3,892	8.23%	4,083	8.35%	3,606,866	0.00%	3,046,824	0.00%
	226	100	79.37%	6,439	79.04%	6,786	80.07%	3,609,609	0.08%	3,051,786	0.16%
	1,126	1,000	793.65%	30,365	744.35%	33,756	795.77%	3,635,820	0.80%	3,098,889	1.71%

Table 5: Results of the sensitivity tests evaluating changes in the number of office employees using the 2018 baseline scenario.

TAZ	# of Office Employees	Change in Employees	% Change in Employees	TAZ VMT Metrics				El Dorado County VMT Metrics			
				Total VMT	Total VMT % Difference	Home-Based Work VMT	Home-Based Work VMT % Difference	Total VMT	Total VMT % Difference	Home-Based Work VMT	Home-Based Work VMT % Difference
388	136	0	0.00%	6,344	0.00%	3,038	0.00%	3,606,897	0.00%	409,693	0.00%
	36	-100	-73.53%	4,526	-28.67%	1,941	-36.12%	3,606,963	0.00%	408,797	-0.22%
	126	-10	-7.35%	6,169	-2.76%	2,929	-3.58%	3,603,423	-0.10%	409,225	-0.11%
	146	10	7.35%	6,509	2.59%	3,143	3.46%	3,597,395	-0.26%	408,776	-0.22%
	236	100	73.53%	8,149	28.44%	4,139	36.26%	3,607,074	0.00%	410,388	0.17%
	1,136	1,000	735.29%	23,672	273.11%	14,177	366.71%	3,611,414	0.13%	418,949	2.26%
612	1,926	0	0.00%	77,819	0.00%	43,160	0.00%	3,606,897	0.00%	409,693	0.00%
	926	-1,000	-51.92%	56,525	-27.36%	28,096	-34.90%	3,591,262	-0.43%	395,463	-3.47%
	1,826	-100	-5.19%	76,178	-2.11%	42,490	-1.55%	3,605,449	-0.04%	409,687	0.00%
	1,916	-10	-0.52%	77,444	-0.48%	42,692	-1.08%	3,605,329	-0.04%	408,848	-0.21%
	1,936	10	0.52%	77,906	0.11%	42,997	-0.38%	3,604,972	-0.05%	408,552	-0.28%
	2,026	100	5.19%	79,968	2.76%	44,671	3.50%	3,609,331	0.07%	410,823	0.28%
	2,926	1,000	51.92%	99,407	27.74%	58,278	35.03%	3,615,982	0.25%	423,604	3.40%

Table 6 shows the results of a network modification test. The test involved removing Carson Road just north of Schnell School Road, to see if the roadway volumes would be shifted to parallel facilities. The test results show that most of the trips traveling over the removed segment were redistributed to adjacent facilities. This redistribution indicates that the EDCTDM responds appropriately to network changes.

Table 6: Change in volumes from removing Carson Road just north of Schnell School Road from the model network using the 2018 baseline scenario

Description	Volumes from the Unadjusted Network	Volumes from the scenario with Carson Rd, North of Schnell School Rd removed	Difference
Carson Rd, North of Schnell School Rd	1,563	0	-1,563
Mosquito Rd	6,205	6,627	422
Carson Rd, Southeast of North Canyon Rd	400	834	434
North Canyon Rd, North of Carson Rd	84	490	406

SUMMARY

The enhanced built environment version of the EDCTDM passed the static validation tests with one exception for collector facilities and produced reasonable dynamic validation results. While the model is ready for project applications, similar static and dynamic tests should be performed in project study areas to ensure appropriate local confidence and sensitivity given the diverse land use contexts throughout the County.