Quantifying the Benefits of Compass Blueprint for Los Angeles: A Methodology for Valuing the Impacts of Compact, Transit Oriented Land Use

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As if holding dubious national records for sprawl, traffic congestion and air pollution were not challenge enough, the Los Angeles region is facing the prospect of accommodating an additional 6.3 million residents by 2030. Obviously, reflecting on its history and its existing land use patterns and transportation system, regional leaders have recognized that they are going to have to try something very different if the region is to avoid grinding to a halt in the near future. Strong hopes have been placed in the region's growth vision, Compass Blueprint, and its implementation plan, the Compass 2% Strategy. Blueprint envisions a future Los Angeles that features higher-density mixed-use centers oriented around an expanded regional rail transit network, as well as intensified, mixed-use multimodal corridors. The 2% Strategy was so-named to convey the net effect of the Compass vision to try to accommodate the expected increment of growth within 2% of the region's land area.

Compass Blueprint is the motif that has been used to develop the region's most recent Regional Transportation Plan, which will also form the basis for assessing air quality conformity. The major question, of course, is whether these radical planning concepts will be sufficient to fend off paralyzing congestion or unacceptable levels of air pollution as the anticipated growth arrives. A related question is whether communities will be willing to dramatically change their future development plans to incorporate the necessary changes in zoning, density and transportation services to enable this vision.

This paper describes efforts undertaken on behalf of the Southern California Association of Governments (SCAG) to both articulate and sell the vision to the community, and to quantify the impacts of the future designs on travel demand (trips, mode use, vehicle miles of travel), traffic congestion, and air quality. Portland-based Fregonese-Calthorpe Associates (FCA) was retained to lead the first element, and in a major regional planning and outreach effort, helped communities across the region revise their comprehensive and general plans to embody the Blueprint concepts. Subsequently, J. Richard Kuzmyak, Transportation Consultant, and Caliper Corporation were retained to develop the methodology for quantifying the effects of the new transportation and land use designs.

Properly evaluating the impacts of a sweeping land use and transportation vision like Compass Blueprint requires special methods to account for the effects on travel behavior attributable to higher density, mixed-use, transit-focused and pedestrian friendly development. These characteristics, commonly termed the "4Ds" (Density, Diversity, Design and Transit Accessibility), have their effect at a fairly localized scale. This scale, roughly equivalent to reasonable walking distance, is well below the traffic analysis zone (TAZ) resolution of conventional regional four-step travel models. If a way were not found to account for this local land use effect, much of the anticipated travel benefit hoped for with Blueprint might not be demonstrated.

The Kuzmyak/Caliper research team was selected to attempt this quantification, for two important reasons. First, Mr. Kuzmyak had recently conducted research for the Baltimore Metropolitan Council that resulted in a set of statistical models that had proved very effective in

incorporating measures of the 4Ds. This research, published in *Transportation Research Record 1977*[1], provided a substantial framework for basing the Blueprint analysis. Meanwhile, SCAG had just completed conversion of its regional model into TransCAD, created by Caliper Corporation. This both provided SCAG with an advanced GIS-based platform for analyzing spatially-oriented concepts like the 4Ds, as well as making available the software developers to help create the best interface between the 4Ds and the SCAG four-step model.

Initial efforts were made to see if there was a way to incorporate the 4Ds relationships directly within the SCAG regional model, and in effect convert the VMT-based approach developed by Kuzmyak in Baltimore to a more comprehensive trip-based approach. Data from SCAG's 2001 regional household travel survey were analyzed using the GIS visual and mapping capabilities in TransCAD to ascertain whether such behaviors as additional walking, shorter trip lengths, and trip grouping could be associated with such features as mixed use, density, or transit accessibility. If strong correspondence among these elements could be found, it was reasoned that factors might be developed to adjust the trip generation or trip distribution procedures to show sensitivity to the 4Ds characteristics. Unfortunately, there was not sufficient time in the tight production schedule to engage in detailed experimentation, nor were the data felt to be sufficiently comprehensive to support a prolonged investment in this approach. Moreover, even if reasonable adjustment procedures were found, the prospect of having to recalibrate the SCAG model posed unacceptable risks.

As a result, the approach that was viewed most practical was to adapt the VMT-based Baltimore 4Ds modeling procedure to Los Angeles, and then using it to post-process outputs from the SCAG regional model. The Baltimore procedure consisted of a set of regression models that predicted, first, household vehicle ownership, and then daily household VMT. Both models included in their specification the key determinants of household demographics (household size, number of workers, income), regional accessibility (gravity-model type calculation of total jobs reachable by auto plus transit), and the 4Ds measures (entropy and walk opportunities). Additionally, the VMT model incorporated vehicle ownership as an important explanatory variable, which was input from the vehicle ownership model, and thereby also sensitized to the accessibility and land use variables. Separate models of home-based work VMT and non-work VMT were also estimated with favorable statistics.

A key innovation in the Baltimore models was the development of a Walk Opportunities measure as one of the 4Ds variables. A concept was looked for that would reflect the "Design" aspect of the 4Ds without the nagging subjectivity concern of the PEF factor approach commonly used. Moreover, there was a desire to reflect not just statistical notions of density and mix of uses, and the "ability" to walk based on design, but to capture the essence of there being "something worth walking to". To capture this, GIS tools were used to picture a ¼ mile buffer around sample households in the travel survey, and then Dunn & Bradstreet data were used to identify the type and location of commercial, retail and recreational activities within the buffer. Also using GIS, the street network was superimposed on the buffer, making it possible to determine the ease with which each of these opportunities could be reached by the household. The activities were given "weights" to reflect their value/relevance to households, and the weighted activities – discounted by their respective walk impedance – summed into a total Walk Opportunities score. The measure worked so well in the Baltimore models that it was recomputed for the re-estimation of the models in Los Angeles, with slight changes in the weights used based on available data from an earlier LA-based research project.

[1] Kuzmyak, J.R., C. Baber and D. Savory. "Use of a Walk Opportunities Index to Quantify Local Accessibility." *Transportation Research Record 1977*, Transportation Research Board (2006).

An interesting dilemma occurred in the process of trying to replicate the models for Los Angeles. Even though the project had access to the same basic data and tools – and even a much larger household survey sample – initial estimation results were discouraging. Put simply, the Los Angeles population appeared to be much less sensitive to the land use measures that worked so well in Baltimore, raising the specter that Los Angeles might not "fit the paradigm" of which Baltimore, a traditional eastern city, was perhaps a classic example. Subsequent explorations of the survey sample suggested an alternative explanation, that there simply weren't enough samples of households living in areas with "smart growth" characteristics to represent this difference in the sample. The result was that the total household VMT models were producing R^2 values in the 0.1 range, with poor statistics on many of the critical variables.

Two events eventually turned the tide. First, the Baltimore research had shown that the local land use variables – entropy and walk opportunities – proved to be much more important in the non-work VMT model than they did in the HBW VMT model. This fed an initial hypothesis that the Compass Blueprint land use changes would have their greatest impact on non-work travel, while perhaps having less effect on work travel since job and housing locations were generally sufficiently distant from each other as to remove walking or biking as a travel alternative. This hypothesis was given strong support from data compiled by Solimar Research[2] in the South Bay Cities subregion of Los Angeles. The South Bay Cities study collected travel data from residents in several older mixed-use communities, and demonstrated that households living near walkable, mixed-use centers made a high percentage of their non-work trips to those centers (60 to 80%), and also made a high percentage (43 to 72%) by walking or bicycle. This behavior was observed *despite the fact that most of these residents had jobs that were located in places sufficiently far from home that more than 90% drove alone to work.* This preference was further reinforced by the absence of transit to the site and the availability of free parking at more than 90% of the work locations.

This finding caused a major methodological shift toward having the 4Ds approach focus in on primarily non-work travel while assuming that the SCAG regional model would be more effective for longer-distance, primarily commute travel in which factors like regional jobs-housing balance and transit accessibility would be extremely important. Using this paradigm, the 4Ds research focused on developing a model of non-work travel, still accompanied by a separate pre-model of vehicle ownership. The modeling convention was still to predict total household VMT, but to directly account for the amount of that VMT that was work-related by inclusion of HBW VMT as an independent variable in the equation. This resulted in the equations pictured in Figure 1, with greatly improved parameter estimates and R^2 values. T-statistics for the estimated coefficients are shown in brackets.

The model results include estimates of the point elasticity for each variable, calculated at the shown sample mean. The Los Angeles models have a close structural similarity to the Baltimore models, where the demographic variables – household size, income, and vehicle ownership have the most influential elasticities. However, these are also the variables least likely to see great changes in forecasting, whereas the 4Ds variables *would* be expected to vary considerably. In fact, SCAG's demographers elected to freeze the values of household size and (real) income when applying the regional model to analysis of the 2035 RTP scenarios. In these models Reg Acc TR is regional transit accessibility, representing the number of job reachable by transit, discounted by the respective travel impedance. LU Mix is the variable name given to land use

[2] Solimar Research Group. "Mixed-Use Centers in the South Bay: How Do They Function and Do They Change Travel Demand?" A report to the South Bay Cities Council of Governments (June 2005).

"entropy". And Walk Opportunities is as earlier described, but it is included in the model in the log format because of the nonlinear distribution seen in the occurrence of "good" environments.

Figure 1. Estimated 4Ds Models for Analyzing Compass Blueprint

	Vehicles per Household			Daily Household Driver VMT		
	Coeff	**Mean**	**Elasticity**	**Coeff**	**Mean**	**Elasticity**
Constant	0.812			1.596		
HH Size	0.235	2.459	0.286	0.0415	2.642	0.109
	[38.65]			[5.28]		
Workers				0.0315	1.60	0.05
				[1.86]		
Income	0.166	4.56	0.375	0.0605	4.834	0.293
	[35.80]			[10.13]		
Vehicles		2.01		0.1032	2.04	0.211
				[8.37]		
Reg Acc TR	**-0.000001**	46457	-0.023	**-0.000001**	47428	-0.0474
	[-5.267]			[-3.93]		
LU Mix	**-0.154**	0.259	-0.020			
	[-3.06]					
***Ln* Walk Opp**	**-0.0334**	4.848	-0.017	**-0.0278**	4.848	-0.1336
	[-5.27]			[-3.83]		
Ln HBW VMT				0.5322	3.446	0.833
				[66.02]		
R-squared	0.261			0.507		
# Obs	9,407			5,926		

Once the 4Ds models were vetted and accepted by SCAG's committees, the next challenge was fashioning a way to apply them to the more aggregate information that would be used to define the Blueprint and Base scenarios. When developing the portrayals of Blueprint land use, the Fregonese team opted for a grid cell approach and 17 composite land use type definitions[3]. Since the 4Ds models were developed from disaggregate household data and resolution of land use in ¼ mile buffers, it was necessary to develop a method for bridging these relationships over to the grid cell information. To do this, the mix of uses and implied connectivity for each of these 17 categories was reviewed and used to calculate an average Land Use Mix and Walk Opportunities value for each. This value was accorded to the respective 5-acre grid cell, at which level future household allocations had also been made. Since the post-processor models had to be applied at a zone level, an average LU Mix and Walk Opps was calculated for each TAZ by computing a household-weighted average across all grid cells in the TAZ. Transit Accessibility, which had been calculated for the individual household in model estimation, was also now calculated at the TAZ level for the application step.

In the transition from 2035 Baseline (no change in land use) and Blueprint scenarios, households were reallocated from areas with inferior land use and transit characteristics to those designed to

[3] Downtown Center, Downtown Residential, City Center, City Residential, Town Center, Town Residential, City Neighborhood, Residential Subdivision, Large Lot, Rural Cluster, Activity Center, Transit Station, Transit Corridor, Main Street, Office Park, Industrial, and Highway Commercial

have improved characteristics. Allocation occurred at the grid cell level, with households added to 1,344 zones and removed from 2,654 zones between Baseline and Blueprint. County growth control totals were respected in Blueprint, although an experimental scenario, "Envision", was more aggressive and overrode these constraints, shifting population across the region to improve jobs-housing balance and take advantage of higher compact growth potentials.

When the SCAG model was applied in a first stage analysis of the difference between Baseline and Blueprint, it predicted a reduction in total daily VMT for the region of 19.8 million, or 3.5%. Application of the 4Ds methodology to this initial result yielded an additional 8.6 million daily VMT, bringing the total reduction to 5%. The question, however, is that while a reduction of 28.4 million daily VMT seems impressive, is this significant considering the scale of the Blueprint planning effort?

The question earns several responses. First, the results were significant enough for SCAG to adopt the Blueprint scenario as their latest RTP plan, meaning that it will be the basis for future transportation investment priorities and air quality conformity tests. The more aggressive "Envision" scenario, that would have also shifted growth forecasts among and not just within counties, demonstrated much greater impact, but had not yet been subjected to political testing and hence could not be adopted. Indeed, the largest percentage reductions in VMT due to improved land use occurred in the outer counties (Riverside, Imperial, San Bernardino), hence targeting more growth to the inner counties (Los Angeles, Ventura and Orange) with more compact growth and transit opportunities would yield higher proportionate gains. Third, only a relatively small percentage of regional households were actually moved about in the Blueprint scenario. While almost all TAZs experienced household reallocations, in fact only about 896,000 households were in play, which amounts to 11.6% of a projected 2035 regional base of over 7.7 million.

The fourth and perhaps most revealing finding was that the household reallocations that occurred between the Baseline and Blueprint were done without the benefit of the analytic input acquired through the 4Ds modeling process. A post-analysis review of the Blueprint allocations revealed that judgement alone did not result in the uniform assignment of households to TAZs where the 4Ds had been improved. This was determined by looking at the TDM "Adjustment Factor" that had been calculated for each TAZ by applying the 4Ds models to each TAZ under Baseline and Blueprint land use patterns. This review determined that while there were 2,174 TAZs where household reallocations either removed them from TAZs with "poor" land use or put them into TAZs with "good" land use, there were also 1,787 TAZs where the opposite was true, and households were either taken out of TAZs with "good" land use or put into TAZs with "poor" land use. While there were a variety of factors that influenced household placement during the planning process, had this model-based information been available during the process, a very different and possibly more favorable distribution might have occurred. In light of these results, SCAG intends to use this additional planning tool proactively in its future programs, both at the regional planning and at the local (community) planning levels.