Prediction of Transportation Outcomes for LEED-ND Pilot Projects

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At this point, there's no one—at least no one in urban planning—who doesn't know that the initials LEED stand for Leadership in Energy and Environmental Design. The green building certification system developed by the U.S. Green Building Council has become a global phenomenon. Since LEED was launched in 2000 as a single rating system for new construction, it has expanded to encompass more than 65,000 projects in all 50 states and in 106 countries. There are now eight rating systems covering various types of development, from commercial interiors to homes to schools—with more systems to come. In the U.S., LEED initiatives in government, including legislation, ordinances, policies, and more, are found in 142 cities, 36 counties, 28 towns, 34 state governments, 14 federal agencies, 17 public school districts, and 41 institutions of higher education (as of 5/1/10).

USGBC's mission is a sweeping one: "to transform the way buildings and communities are designed, built, and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life." There is no question that LEED has been a success in the marketplace (see Table 1). But is it leading to higher quality development? This is the question addressed in this paper, in the specific context of the LEED for Neighborhood Development (LEED-ND) Pilot Program. To answer the question, we to analyze the potential VMT reduction and energy and CO2 savings of those certified projects relative to a regional average baseline. The pilot projects compare favorably.

Table 1. Numbers of Registered LEED Projects for Each of the Rating Systems (as of May 2010)

Rating System	Approximate Number
New Construction (NC)	16051
Core and Shell (CS)	2871
Commercial Interiors (CI)	2797
Retail (NC and CI)	152
Existing Buildings:	4356

Operations & Maintenance	
Schools	1173
Homes	25588
Neighborhood Development	238

Source: U.S. Green Building Council

Brief History of LEED

The U.S. Green Building Council was founded as a non-profit in 1993 by a small group of professionals with experience in multiple sectors of the building industry. They saw promise in the fledgling green building movement, but recognized the need for a focused effort at the national level to bring about the level of change they sought. The mission of the first USGBC volunteer committee was to go beyond policy statements and case studies to actually define a green building and create a tool based on that definition. In 2000, the LEED Green Building Rating System Version 2.0 was released after a pilot program involving a small number of commercial buildings.

The first LEED rating system and all subsequent versions are based upon a similar premise – each rating system includes a set of prerequisites, which are mandatory, and a set of credits, which projects can pick and choose from in order to amass enough points to qualify for certification. LEED rating systems touch on a variety of issues related to sustainability, including energy savings, water efficiency, land use and transportation choices, and stewardship of natural resources and features. Projects certify to a LEED rating system via submission of documentation to a third-party reviewer, the Green Building Certification Institute.

It is only in recent years that LEED has become more a market force than an experiment. As of May 2010, 5,642 commercial/institutional and 6,318 residential projects have achieved certification. The number of credentialed LEED Professionals – individuals who demonstrate LEED mastery via an exam and ongoing education requirements – is 155,000, showing exponential growth similar to that of LEED projects.

Expansion to Neighborhoods

In 2003, USGBC, the Congress for the New Urbanism, and the Natural Resources Defense Council began to discuss the potential for expanding LEED beyond the scale of single buildings to the scale of neighborhoods. The LEED-ND pilot rating system was developed over the next several years, and was launched in 2007. The pilot program was open to all interested parties, and 238 projects ultimately registered to participate. Because a main purpose of the pilot program was to assess the applicability of the rating system to a variety of real world scenarios, no restrictions were placed on project size, mix of uses, or country. Pilot projects in all phases of development were accepted and grouped into three stages. Stage 1 was available to projects at the conceptual plan phase, Stage 2 was for approved plans that had received most of their land-use entitlements, and Stage 3 was for completed neighborhood developments. As of May 2010, 75 pilot projects have achieved at least one stage of certification.

The pilot projects have provided regular feedback on how the rating system functions on the ground, which has informed revisions adopted as LEED 2009 for Neighborhood Development. Registration under the new rating system opened in April 2010, with full certification anticipated to be available in late 2010.

The LEED-ND rating system defines criteria in key issue areas of sustainability, and awards certification to green neighborhood development projects that can document achievement in these areas. Elements of smart growth, New Urbanism, and green building form the foundation of LEED-ND, producing a rating system that values compact, connected neighborhoods located near existing developed areas, and containing green buildings and infrastructure. For the first time under a LEED program, the location, context, and pattern of land development matters as much as the design of individual buildings. USGBC's stated goal is to encourage development practices that are supportive of public health, protect fragile natural resources, reduce greenhouse gas emissions, and provide a range of other benefits to residents and workers in and near each LEED-ND project.

Sure, the system is a bit complicated, with nine prerequisites and 49 credits under which points can be accumulated (in the pilot rating system). Sure, the credits are a bit arbitrary. Why does a developer get only seven points for a drive-alone mode share of 30 percent or less (which is almost impossible to achieve), but can earn up to eight points for having walkable streets? Sure, you have to trust the applicant to audit his project accurately. But if all of this leads to better development outcomes, who cares? That is the issue to which we now turn.

More Emphasis on Outcomes

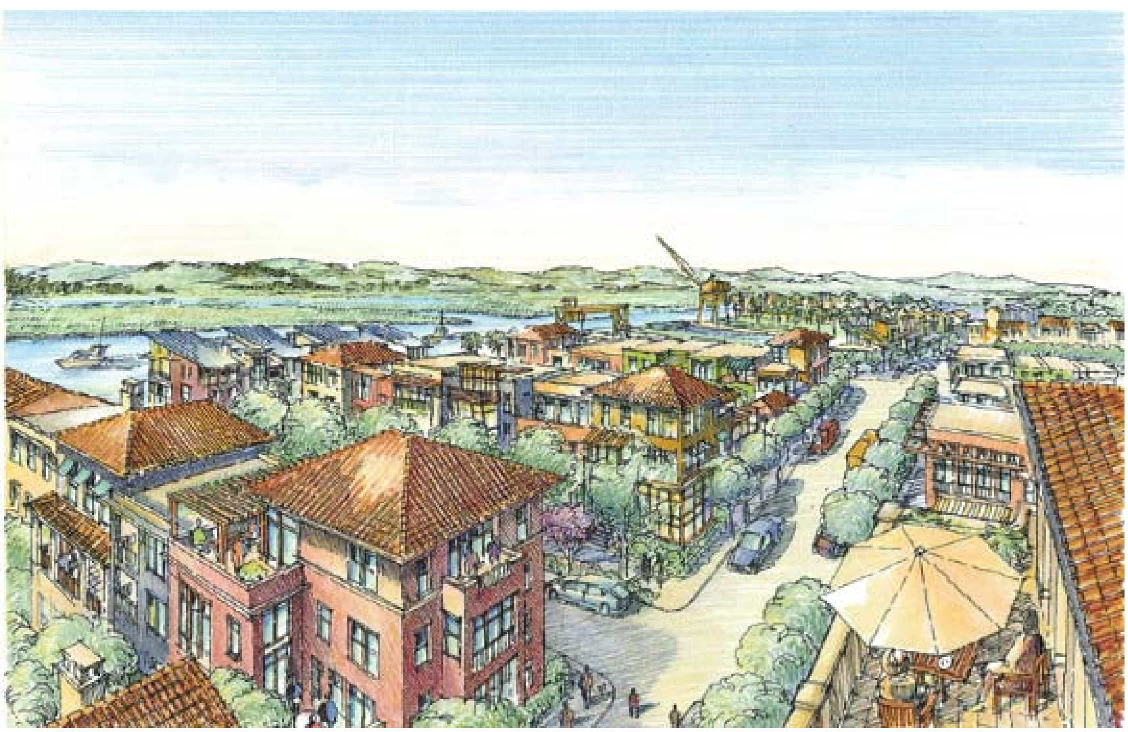
In the 1970s, planning curricula included courses in evaluation research, which unfortunately have been dropped in recent years. We learned that input evaluation (a bus stop is on the property) is less useful than output evaluation (buses come with reasonable frequency), and that in turn is less useful than outcome evaluation (bus ridership is up, and auto use down).

The lead author of this paper was hired to conduct an independent traffic study of the Napa Pipe project, a brownfield redevelopment project in Napa, California. It is one of the first certified projects under the LEED-ND pilot program. The developer wanted the study to credit Napa Pipe for trips that stay within development, or leave the development but are environmentally benign because they use alternative modes of transportation. Our traffic impact assessment suggested that about 7 percent of all trips generated by the Napa Pipe development will not congest the external street network or add vehicle miles traveled in region, either because they will remain within the mixed-use development or will involve transit or walking to external destinations.

This is the kind of outcome evaluation that should become central to the LEED certification process. How much stronger the program will be when built on good outcomes. This study is a step in that direction.

Figure 1. Napa Pipe Site Plan

Figure 2. Artist Rendering of the Napa Pipe Project



Conceptual Framework

The theory of rational consumer choice underlies this study. It is well articulated elsewhere (for example, by Crane 1996; Boarnet and Crane 2001; Cervero 2002; Zhang 2004; and Cao et al.

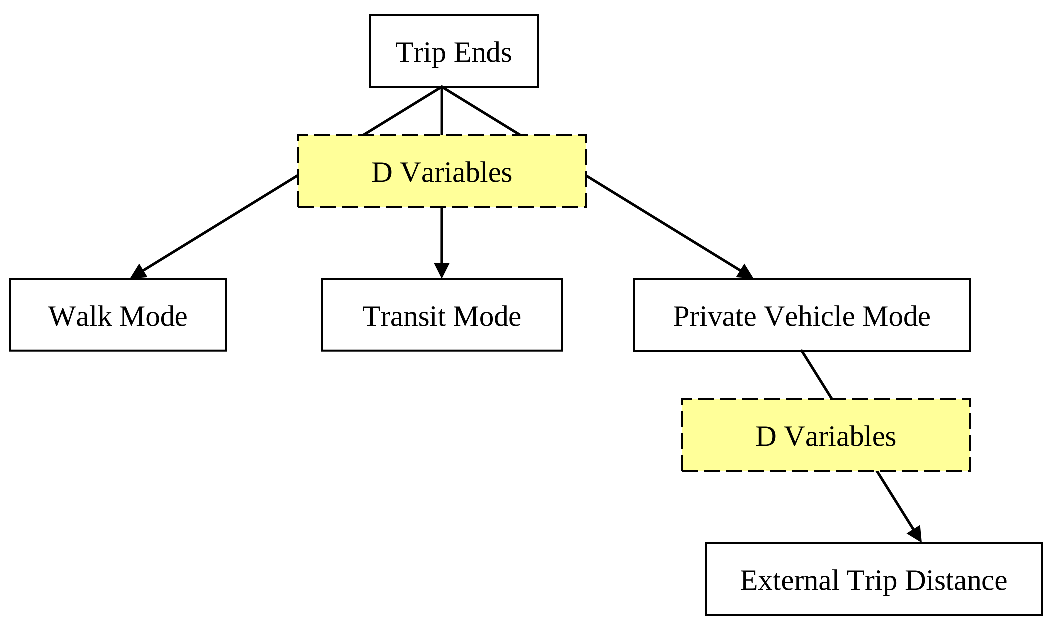
2009). Travel to/from developments is conceived as a series of choices, which depend on D variables (see conceptual framework in Figure 3).

The original three Ds, coined by Cervero and Kockelman (1997), are density, diversity, and design, followed later by destination accessibility and distance to transit (Ewing and Cervero, 2001). Development scale is a sixth D, relevant to analyses where the unit of analysis is a development project. While not part of the environment, demographics are the seventh D, controlled as confounding influences in travel studies.

Mode choices are conceived as dichotomous. A traveler may choose to walk or not. Likewise, the traveler may choose to use transit or not. For private vehicle trips, the traveler chooses a destination. This destination may be near or far. This outcome variable is continuous rather than dichotomous.

The D variables in Figure 3 are characteristics of travelers, MXDs, and regions, as defined below. The D variables determine, moderate, mediate, and confound travel decisions.

Figure 3. Conceptual Framework



Modeling Outcomes

A recent study for the U.S. Environmental Protection Agency developed new methodology for more accurately predicting the traffic-related impacts of mixed-use developments or MXDs (Ewing et al. 2010). Standard protocols were used to identify and generate datasets for 239 MXDs in six large and diverse metropolitan regions—Atlanta, Boston, Houston, Portland, Sacramento, and Seattle.

Data from household travel surveys and GIS databases were pooled for these MXDs, and travel and built environmental variables were consistently defined across regions. Hierarchical modeling was used to estimate models for internal capture of trips within MXDs, walking and transit use on external trips, and trip length for external automobile trips.

MXDs with diverse activities on-site were shown to capture a large share of trips internally, reducing their traffic impacts relative to conventional suburban developments. Smaller MXDs in walkable areas with good transit access were found to generate significant shares of walk and transit trips, thus also mitigating traffic impacts. Centrally located MXDs, small and large, were shown to generate shorter private vehicle trips, which reduces their impacts relative to outlying developments.

Final Samples

The 239 MXDs form our dataset. They range from compact infill sites near the regional core to low-rise freeway oriented developments. The 239 survey sites range in size from less than five acres to over 2,000 acres, and over 15,000 residents and employees. They vary in population and employment densities, mix of jobs, housing and retail, presence or absence of transit, and centrality within the region.

Sample statistics are shown in Table 2. The regions that contribute modest numbers of trip ends to the sample still add statistical power. The importance of Boston, Houston, and Sacramento lies in the number of MXDs each contributes, not in the number of trip ends. Also, the inclusion of the three regions doubles the number of regions in the sample. In a hierarchical analysis, statistical power is limited by the number of degrees of freedom at each level of analysis. There are ample cases at Level 1, the trip end level, but a shortage of cases at Level 2, the MXD level, and a severe shortage at Level 3, the regional level.

Table 2. Sample Statistics

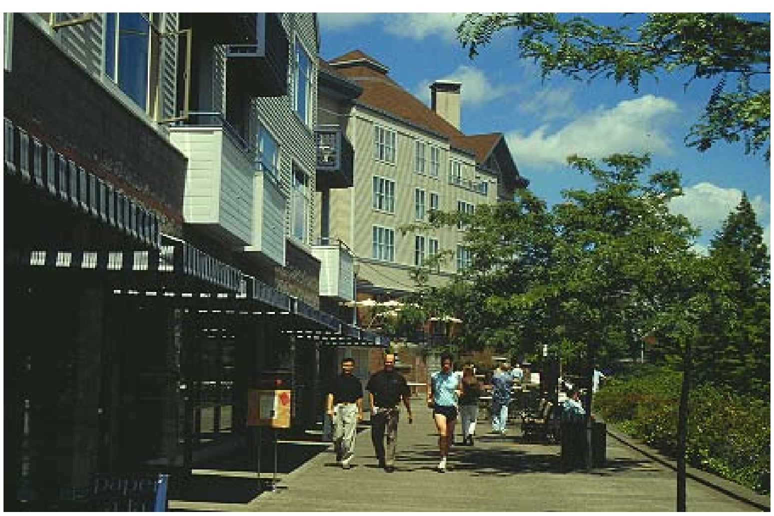
	Survey Year	MXDs	Mean Acreage per MXD	Total Trip Ends	Mean Trip Ends per MXD
Atlanta	2001	24	287	6,167	257
Boston	1991	59	175	3,578	61
Houston	1995	34	401	1,584	47

Portland	1994	53	116	6,146	116
Sacramento	2000	25	179	2,487	99
Seattle	1999	44	207	15,915	362
Total		239	211	35,877	150

RiverPlace, a classic MXD just south of Downtown Portland, illustrates the pattern (see Figures 4 and 5). Of sampled trips, 40 percent are made by walking and 5 percent by transit, well above the regional averages. Its auto trips average 7.2 miles, well below the regional average. On balance, the traffic impact of RiverPlace is a fraction of that generated by single-use suburban developments of comparable composition and size.[i]

Figure 4. RiverPlace in Context

Figure 5. RiverPlace at Eye Level



Outcome Variables

Because the purpose of the present study is different from the earlier study (it is not about internal capture of trips within MXDs), we have gone back to the original data base of 35,877 trip ends to/from/within 239 MXDs in six regions. Using these data, three outcomes have been modeled: odds of trips being by walking, odds of trips being by transit, and length of trips by automobile (see Table 3). These three variables together allow us to predict the average VMT per trip for LEED-ND pilot projects, and compare it to the baseline VMT with conventional development.

Models have been estimated separately by trip purpose—home-based work, home-based other, and non-home-based. We presume that different factors might be at play, or that the same factors might be more or less important, when people travel for different purposes.

Explanatory Variables

Density is always measured as the variable of interest per unit of area. The area can be gross or net, and the variable of interest can be population, dwelling units, employment, building floor area, or something else. Population and employment are sometimes summed to compute an overall activity density per areal unit.

Diversity measures pertain to the number of different land uses in a given area and the degree to which they are represented in land area, floor area, or employment. Entropy measures of diversity, wherein low values indicate single-use environments and higher values more varied land uses, are widely used in travel studies. Jobs-to-housing or jobs-to-population ratios are less frequently used.

Design includes street network characteristics within an area. Street networks vary from dense urban grids of highly interconnected, straight streets to sparse suburban networks of curving streets forming loops and lollipops. Measures include average block size, proportion of four-way intersections, and number of intersections per square mile. Design is also occasionally measured as sidewalk coverage (share of block faces with sidewalks); average building setbacks; average street widths; or numbers of pedestrian crossings, street trees, or other physical variables that differentiate pedestrian-oriented environments from auto-oriented ones.

Destination accessibility measures ease of access to trip attractions. It may be regional or local (Handy 1993). In some studies, regional accessibility is simply distance to the central business district. In others, it is the number of jobs or other attractions reachable within a given travel time, which tends to be highest at central locations and lowest at peripheral ones. The gravity model of trip attraction measures destination accessibility. Local accessibility is a different animal. Handy (1993) defines local accessibility as distance from home to the closest store.

Distance to transit is usually measured as an average of the shortest street routes from the residences or workplaces in an area to the nearest rail station or bus stop. Alternatively, it may be measured as transit route density, distance between transit stops, or the number of stations per unit area.

Development scale may be measured in terms of land area, number of residents, number of jobs, or the sum of residents and jobs, referred to as the activity level. Development scale was the most significant influence on internal capture rates in a study of South Florida MXDs, and more than half of all trips were found to be internalized by community-scale MXDs (Ewing et al., 2001).

The independent variables available in this study are shown in Table 3. These variables are at three different levels of aggregation: the traveler/household level, the MXD level, and the regional level. They are consistently defined across regions.

Table 3. Variable Definitions

Outcome Variables	**Definition**
WALK	Dummy variable indicating that the travel mode on trip is walking (1=walk mode, 0=other)
TRANSIT	Dummy variable indicating that the travel mode on trip is public bus or rail (1=transit, 0=other)
TDIST	Network trip distance between origin and destination locations for an external private vehicle trip, in miles
Explanatory Variables	
	Level-1 Traveler/Household Level Variables
HHSIZE	Number of members of the household
VEHCAP	Number of motorized vehicles per person in the household
BUSSTOP	Dummy variable indicating that the household lives within ¼ mile of a bus stop (1=yes, 0=no)
	Level-2 MXD-Level Variables
AREA	Gross land area of the MXD in square miles
POP, EMP, ACT	Resident population, employment, and activity (population + employment) within the MXD
ACTDEN	Activity density per square mile within the MXD. Sum of population and employment within the MXD, divided by gross land area
JOBPOP	Index that measures balance between employment and resident population within MXD. Index ranges from 0, where only jobs or residents are present in an MXD, not both, to 1 where the ratio of jobs to residents is optimal from the standpoint of trip generation. Values are intermediate when MXDs have both jobs and residents, but one predominates.[1]

[1] JOBPOP = 1 – [ABS (employment – 0.2*population)/(employment + 0.2*population)]

ABS is the absolute value of the expression in parentheses. The value 0.2, representing a balance of employment and population, was found through trial and error to maximize the explanatory power of the variable.

LANDMIX	Another diversity index that captures the variety of land uses within the MXD. Entropy calculation based on net acreage in land use categories likely to exchange trips. For Portland, the land uses were: residential, commercial, industrial, and public or semi-public.2 For other regions, the categories were slightly different.3 The entropy index varies in value from 0, where all developed land is in one of these categories, to 1, where developed land is evenly divided among these categories.
INTDEN	Number of intersections per square mile of gross land area within the MXD
POP1MI, EMP1MI, ACT1MI	Population, employment, and activity (population + employment) within one mile of the MXD centroid. Weighted average for all TAZs intersecting the MXD. Weighting was done by proportion of each TAZ within the MXD boundary relative to an entire TAZ area (i.e., "clipping" the block group with the MXD polygon).
POP5MI, EMP5MI, ACT5MI	Proportion of regional population, employment, and activity (population + employment) within five miles of the MXD centroid
POP10MI, EMP10MI, ACT10MI	Proportion of regional population, employment, and activity (population + employment) within 10 miles of the MXD centroid
EMP10A, EMP20A, EMP30A	Proportion of regional employment accessible within 10-minute, 20-minute, and 30-minute travel time of the MXD using an automobile at midday
EMP30T	Proportion of regional employment accessible within 30-minute travel time of the MXD using transit
STOPDEN	Number of transit stops within the MXD per square mile of land area. Uses 25 ft. buffer to catch bus stops on periphery.
RAILSTOP	Rail station located within the MXD (1=yes, 0=no). Commuter, metro, and light rail systems are all considered
	Level 3 Region-Level Variables
REGPOP, REGEMP, REGACT	Population, employment, and activity (population + employment) within the region
SPRAWL	Measure of regional sprawl developed by Ewing et al. (2002, 2003). Index derived by extracting the common variance from multiple measures through principal components analysis.

[2] The entropy calculation is: LANDMIX = -[single-family share*LN (single-family share) + multifamily share*LN (multifamily share) + commercial share*LN (commercial share) + industrial share*LN (industrial share) + public share*LN (public share)]/ LN (5) --- where LN is the natural logarithm of the value in parentheses.

[3] For Houston, the land uses were: residential, commercial, industrial, and institutional; a "mixed residential and commercial" class of land uses was included with commercial. For Boston, the land uses were: residential, commercial, industrial, and recreational. For Seattle, detailed land uses were aggregated into four categories: residential, commercial, industrial, and institutional. For Atlanta, detailed land uses were aggregated into four categories: residential, commercial, industrial, and institutional. For Sacramento, detailed land uses were aggregated into four categories: residential, commercial, industrial, and institutional; a mixed class of land uses was included with commercial.

Analysis

For walk and transit trips, our dependent variable is the natural log of the odds of an individual making a trip by these modes. For these outcomes, models have been estimated with both linear and logarithmic (natural log) values of the independent variables. The logarithmic models, which express the odds as a power function of the independent variables, outperform the linear models in terms of their pseudo-R2s, sensitivity to changes in values of independent variables, and validation results (see Ewing et al. 2010). Thus only the logarithmic models are presented in this chapter. Coefficient values are arc elasticities of odds with respect to the independent variables.

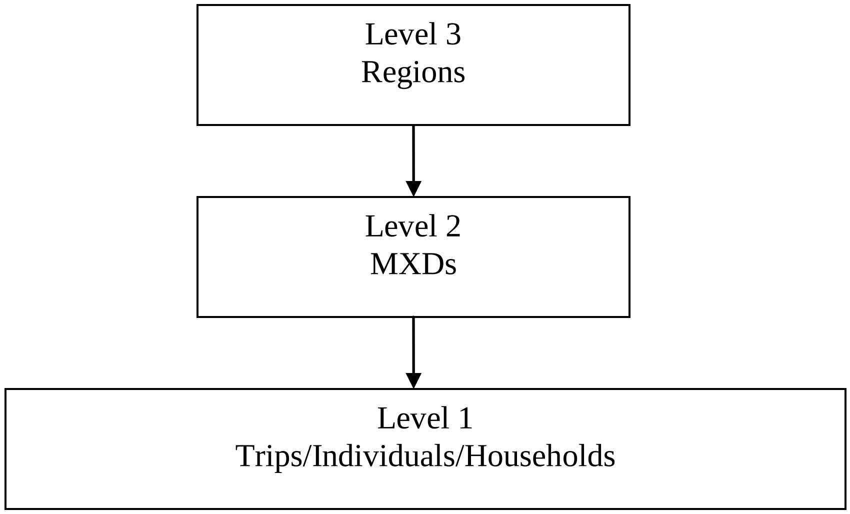
For estimating the trip distance by automobile, models took three forms: linear, semi-logarithmic (linear-log), and log-log forms. The semi-logarithmic models, which express trip distance as a linear sum of logged variables, outperform the other models in terms of their pseudo-R2s and sensitivity to changes in values of independent variables. Only the semi-logarithmic models are presented in this chapter.

Our data and model structure are hierarchical. Hierarchical modeling is required to account for dependence among observations, in this case the dependence of trips to and from a given MXD and dependence of MXDs within a given region. All the trips to/from a given MXD share the characteristics of the MXD, that is, are dependent on these characteristics. This dependence violates the independence assumption of ordinary least squares ("OLS") regression. Standard errors of regression coefficients based on OLS will consequently be underestimated. Moreover, OLS coefficient estimates will be inefficient. Hierarchical (multi-level) modeling overcomes these limitations, accounting for the dependence among observations and producing more accurate coefficient and standard error estimates (Raudenbush and Bryk 2002).

We initially conceived the data structure as a five-level hierarchy, with trips nested within individuals, individuals nested within households, households nested within MXDs, and MXDs nested within metropolitan regions. Upon review of the dataset, we found that the data are not so neatly hierarchical. Many of the individuals in the sample make trips to or from more than one MXD.

This has implications for modeling methodology. Rather than a five-level hierarchy, the choices facing travelers have been modeled in a three-level framework. Individual trip ends are uniquely identified with MXDs. So trips (their characteristics and the associated characteristics of travelers and their households) form Level 1 in the hierarchy, MXDs form Level 2, and regions form Level 3 (see Figure 6).

Figure 6. Data and Model Structure



Models were estimated with HLM 6 (Hierarchical Linear and Nonlinear Modeling) software. Hierarchical linear models were estimated for the continuous outcome (trip distance), while hierarchical nonlinear models were estimated for the dichotomous outcomes (walk vs. other, and transit vs. other). Within a hierarchical model, each level in the data structure is formally represented by its own sub-model. The sub-models are statistically linked.

In our initial model estimations, only the intercepts were allowed to randomly vary across higher level units. All of the regression coefficients at higher levels were treated as fixed. These are referred to as "random intercept" models (Raudenbush and Bryk 2002). As the sample of MXDs expanded, we also tested for cross-level variable interactions with "random coefficient" models. It is certainly possible that the relationship between, say, walking and vehicle availability varies with MXD diversity. As the cross-level interaction terms seldom proved significant, only the random intercept models are presented in the following section.

Results

Results of three model estimations are presented in Tables 4 through 6. Each table presents model coefficient estimates, asymptotic t-ratios, and probability values for the t-ratios.

Odds of Walking

For home-based work trips, the odds of walking decline with household size and vehicle ownership per capita, and increase with job-population balance within the MXD and number of residents + jobs within one mile of the MXD. Walking is thus related to three types of D variables—*diversity*, *destination accessibility*, and *demographics*. Large households achieve economies through car pooling and trip chaining, and thus are less likely to walk. Households with more cars have a lower generalized cost of auto use, making them less likely to walk. On-site balance of jobs and housing creates opportunities for matching origins and destinations, producing short trips that are amenable to walking. The presence of off-site jobs and housing within one mile likewise creates opportunities for matching origins and destinations, still within walking distance. The pseudo-R2 of this model is a relatively low 0.12.

For home-based other trips, the odds of walking decline with household size and vehicle ownership, and increase with job-population balance within the MXD and number of residents + jobs within one mile of the MXD. In addition, the odds of walking increase with intersection density within the MXD.[ii] Walking is thus related to four types of D variables—*diversity*, *design*, *destination accessibility*, and *demographics*. High intersection density increases routing options, makes routes more direct, creates frequent street crossing opportunities, and makes trips seem more eventful. The pseudo-R2 of this model is a respectable 0.39.

For non-home based trips (neither trip end is at home), the odds of walking decline with household size and vehicle ownership, and increase with intersection density within the MXD and number of jobs within a mile of the MXD. The relationship to employment variables results from the greater probability of matching origins to destinations where jobs are concentrated near one another. Walking is related to three types of D variables—*design*, *destination accessibility*, and *demographics*. Possible explanations for these relationships are provided above. The pseudo-R2 of this model is 0.45, the highest of any model estimated.

Activity density has the expected positive sign in all three regressions. It approaches but never reaches significance at the 0.10 level. This is consistent with a finding from a recent meta-analysis of the built environment-travel literature that *density* is the least important of the D variables (Ewing and Cervero 2010).

While there is significant variance of walking from region to region, it is not explained by the variables in our data set. None of the Level 3 variables proved significant, which is not surprising with only six regions. Regional variance is, however, captured in the random effects term of the Level 3 equation.

Table 4. Odds of Walking (log-log form)

	Home-Based Work			Home-Based Other			Non-Home Based		
	coeff	t-ratio	p-value	coeff	t-ratio	p-value	coeff	t-ratio	p-value
Constant	-10.26			-11.84			-12.45		
JOBPOP	0.283	2.84	0.005	0.153	2.60	0.01			
INTDEN				0.440	2.77	0.006	0.815	5.28	<0.001
EMP1MI							0.570	6.84	<0.001
ACT1MI	0.719	4.01	<0.001	0.674	6.23	<0.001			
HHSIZE	-1.50	-7.22	<0.001	-0.805	-11.4	<0.001	-0.221	-3.47	0.001
VEHCAP	-1.93	-8.61	<0.001	-0.862	-11.1	<0.001	-0.220	-3.27	0.001
pseudo-R2	0.12			0.39			0.45		

Odds of Transit Use

In our earlier study (Ewing et al. 2009), we modeled transit use in terms of number of jobs that can be reached within 30 minutes by transit. This indicator was derived from regional travel models for the six regions, and was available for the 239 MXDs in our sample.

In this study, we requested the same indicator from the LEED-ND pilot projects being evaluated. None was able to provide transit accessibility data. Therefore, we have selected the proxy for transit accessibility which, for the 239 MXDs, is highly correlated with the number of jobs reachable within 30 minutes by transit. It is the number of jobs within 10 miles of a site. It implies an average transit travel speed of 20 mph, with stops for passengers. This became our measure of destination accessibility.

For home-based work trips, the odds of transit use decline with household size and vehicle ownership per capita, increase with intersection density within the MXD and number of jobs within 10 miles of the site, and are higher for MXDs with rail stations within them. The odds of transit use are significantly higher for households living within ¼ mile of a bus stop than those farther away. Transit use is thus related to measures of *design*, *destination accessibility*, *distance to transit*, and *demographics*. A higher intersection density translates into a more direct walk to and from transit stops, and also possibly more efficient routing of transit vehicles. A higher proportion of jobs within 10 miles increases the likelihood a particular job being within easy commuting distance for residents. And residence within the standard quarter mile walking distance of a bus stop or proximate to a rail station shortens access trips. The pseudo-R2 of this model is 0.37.

For home-based other trips, the odds of transit use decline with household size and vehicle ownership per capita and increase with the activity density within the MXD. The odds of transit use are significantly higher for households living within ¼ mile of a bus stop than those farther away. This is a weak model. The pseudo-R2 of this model is a negative number since the combined variance at Levels 1 through 3 is greater for the estimated model than the null model with only an intercept and no explanatory variables.

For non-home-based trips, the odds of transit use decline with vehicle ownership per capita, and increase with the proportion of jobs within 10 miles of the MXD. This is the weakest model estimated. The pseudo-R2 of this model also is a negative number.

Activity density has the expected positive sign in all three regressions. It reaches significance in only one regression. This is consistent with a finding from a recent meta-analysis of the built environment-travel literature that *density* is the least important of the D variables (Ewing and Cervero 2010). Having a rail stop within a development also has a positive sign in all three regressions but reaches significance in only one regression.

While there is significant variance of transit use from region to region, it is not explained by the variables in our data set. Again, none of the Level 3 variables proved significant. Regional variance is, however, captured in the *random effects term* of the Level 3 equation.

Table 5. Odds of Transit Use (log-log form)

	Home-Based Work			Home-Based Other			Non-Home Based		
	coeff	t-ratio	p-value	coeff	t-ratio	p-value	coeff	t-ratio	p-value
Constant	-8.04			-6.46			-3.67		
ACTDEN				0.249	2.09	0.037			
INTDEN	0.989	3.63	0.001						
EMP10MI	1.02	2.22	0.027				0.532	2.86	0.005
RAILSTOP	0.759	1.95	0.052						
HHSIZE	-1.09	-6.04	<0.001	-0.837	-7.53	<0.001			
VEHCAP	-1.62	-8.25	<0.001	-1.07	-8.83	<0.001	-0.299	-3.33	0.001
BUSSTOP	0.356	1.99	0.046	0.396	3.44	0.001			
pseudo-R2	0.37			NA			NA		

Length of Automobile Trips

For home-based work trips by private vehicle, trip distance increases with household size and vehicle ownership per capita, and declines with a project's intersection density and proportion of jobs reachable within 30 minutes by automobile. Trip distance is thus related to three types of D variables, *design*, *destination accessibility*, and *demographics*. Larger households have more complex activity patterns, which lengthens trips. More vehicles per household frees up family cars for trips to more distant destinations. On the other hand, MXDs with high intersection density provide more direct routing to destinations. MXDs with good auto accessibility to regional jobs generate shorter trips because more trip attractions are within easy commuting distance. These relationships match expectations. We note, however, that the model fit is relatively weak, with a pseudo-R^2 of just 0.08.

For home-based other trips by private vehicle, trip distance increases with household size and vehicle ownership per capita, and declines with a project's job-population balance and proportion of jobs reachable within 20 minutes by automobile. Trip distance is thus related to three types of D variables, *diversity*, *destination accessibility*, and *demographics*. MXDs with good job-population balance capture some nonwork trips internally, and those with good auto accessibility generate shorter trips. All relationships are highly significant. Yet, the pseudo-R^2 is only 0.04.

For non-home-based trips by private vehicle, trip distance increases with household size and vehicle ownership per capita, and declines with a project's land use entropy, intersection density, and proportion of jobs reachable within 20 minutes by automobile. Trip distance is thus related to four types of D variables, *diversity*, *design*, *destination accessibility*, and *demographics*. The new variable, land use entropy, measures the mix of land uses within the site. Greater mix is associated with shorter non-home-based trips. Other relationships are as described above. The pseudo-R^2 is 0.09.

While there is significant variance of private vehicle trip length from region to region, it is not explained by the variables in our data set. Again, none of the Level 3 variables proved significant. Regional variance is, however, captured in the *random effects term* of the Level 3 equation.

Table 6. Length of Private Vehicle Trips (semi-log form)

	Home-Based Work			Home-Based Other			Non-Home Based		
	coeff	t-ratio	p-value	coeff	t-ratio	p-value	coeff	t-ratio	p-value
Constant	11.40			3.69			8.19		
JOBPOP				-0.475	-3.26	0.002			
LANDMIX							-1.09	-3.84	<0.001
INTDEN	-1.09	-2.29	0.023				-0.912	-2.36	0.019
EMP20A				-0.702	-4.99	<0.001	-0.804	-5.72	<0.001
EMP30A	-0.811	-4.39	<0.001						
HHSIZE	2.95	8.79	<0.001	0.937	6.44	<0.001	0.628	3.53	0.001
VEHCAP	2.78	7.38	<0.001	1.50	9.71	<0.001	0.968	5.33	<0.001
pseudo-R2	0.08			0.04			0.09		

Evaluating LEED-ND Pilot Projects

This section applies the models derived in the preceding section to a set of LEED-ND pilot projects. We begin by describing how these particular projects were recruited to participate in the evaluation, and how data were collected from and for them. Then, we profile each project in qualitative terms. Finally, we use the project data to predict travel outcomes.

Project Recruitment and Data Collection

USGBC staff first contacted project teams of certified LEED-ND projects in early December, 2009. On that date, 56 projects had completed the full review process at one of the three certification stages (Stage 1 Pre-Approval, Stage 2 Certified Plan, or Stage 3 Certified Completed Neighborhood Development). In that correspondence, staff explained that the authors of this chapter intended to analyze the potential VMT reduction and energy and CO2 savings of those certified projects relative to a regional average baseline. The project teams were told that the authors would need input data on population density, land use mix, intersection density, and other planning parameters in order to evaluate these projects with a traffic impact analysis method previously developed for the U.S. EPA.

Ultimately, teams from 19 projects agreed to supply the authors with this information. In February 2010, we contacted these project teams with a standard email request for a project narrative, LEED scorecard, and project data to implement the models of the previous section. We initially received responses from six projects. After a second email reminder two weeks later we received an additional seven responses, resulting in a 68 percent response rate among those agreeing to participate.

After sorting the data, we identified missing or inaccurate information. In some cases, the project did not have data for the requested element. In other cases, the request was misinterpreted, and the data provided were unusable. In these cases, follow-up efforts were made to clarify the request and obtain the relevant data. For projects currently under development, follow-up requests frequently sought to clarify the number of employees expected for different uses (office, retail, etc.) on the site. These data proved difficult to obtain, as forecasts were not always available in a consistent format.

While project representatives provided most of the data themselves, either after the initial or follow-up request, few could provide data for a number of elements, such as vehicles per capita in the project area, total employment within one mile of the project, and total employment within certain automobile and transit travel times. For these variables, we used other sources to obtain the relevant values. To estimate the number of vehicles per person in each project area, we consulted Census 2000 Form 3 "Imputation of Vehicles Available," utilizing data for the census tracts most closely corresponding to the project site boundaries. For each tract, we divided the number of vehicles by population to obtain vehicles per capita for the area.

For employment and population within time and distance bands, we went to an outside contractor, ESRI. Through the ESRI Business Analyst Online service, we obtained employment and population numbers for the desired buffers. This service proved highly functional for our purposes, as Business Analyst Online offers the option to create buffers around a given location based on either mileage or drive-time. First, we identified the number of employees and residents within 1 mile of each project. To do so, we utilized boundaries with 1-mile radii, centered around the sites, ordering Business Summary reports for the areas within the boundaries. For a defined area, this report provided population, employment, and number of businesses within various business categories.

We next created buffers based on 10-, 20- and 30-minute drive times, centered on the projects. Business Analyst Online offers drive-time buffers as an option when defining the geographic area of analysis. We then ordered Business Summary reports for the areas within these drive times, using the report to identify the number of people employed within 10-minute, 20-minute and 30-minute drives of the projects, as well as the population within these drive-times.

Finally, we created boundaries with 5-mile radii, centered around the sites, again ordering Business Summary reports for the areas thus defined. We used this figure to estimate the number of employees within 30 minutes transit travel time. We had previously determined that the two are correlated.

Project Profiles

What follows are brief descriptions of the 12 U.S. projects that volunteered to participate in this evaluation. Project scorecards with respect to LEED-ND prerequisites and credits are relegated to the appendix. Each of the projects evaluated in this study have successfully completed at least one stage of certification using the LEED-ND pilot rating system.

Constitution Square is located in NoMa (north of Massachusetts Avenue), a rapidly developing neighborhood of Washington, D.C. The first phase of Constitution Square, completing construction in 2010, will total 1.6 million square feet over 4.4-acres. The mixed-use project will have offices, a grocery store and additional retail space, 440 apartment units, and a Hilton Garden Inn Hotel. Located next to the New York Avenue metro station, the new development will create an accessible, mixed-use community, while meeting the growing need for office space in the area

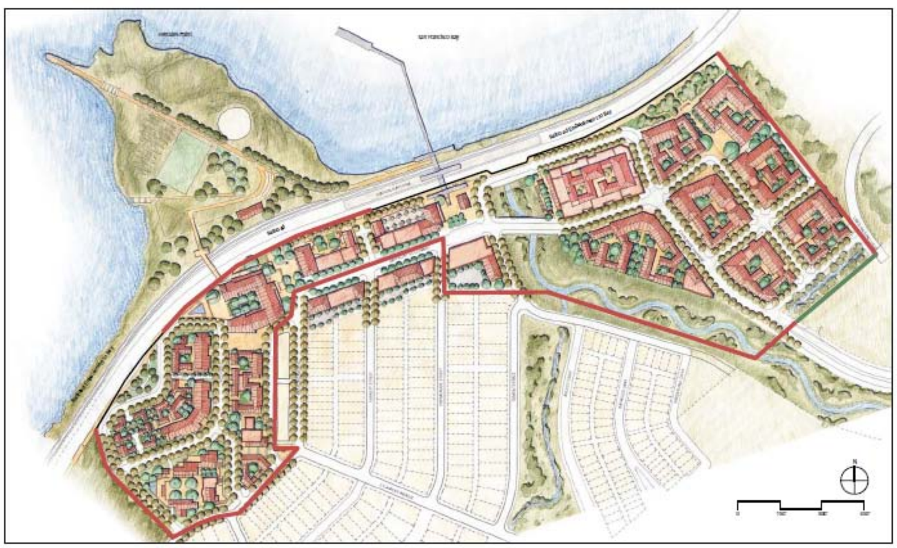
Figure 7. Rendering of Constitution Square

Easy access from Downtown Washington, DC made **Crystal City** a prime location for residential and commercial development. Today it is one of Arlington's largest concentrations of jobs. The area is now undergoing revitalization after the relocation of thousands of Department of Defense jobs. The Crystal City Vision Plan outlines a 260-acre mixed use development that increases density, sustainability, and creates connections with the local transportation system. The plan proposes redeveloped buildings, a new surface transitway, parks, plazas, street improvements, and street front retail to enhance Crystal City's neighborhoods.

Decker Walk is a 0.4-acre development in an urban neighborhood of Baltimore, consisting of 19 contiguous 2 and 3-story rowhouses. The central location allows the rowhouses to take advantage of the existing infrastructure, services and amenities of its surroundings. Most notably, the site is just a few blocks from Patterson Park, a well-used 155 acre park east of Downtown. Innovative designs lower utility costs to the homeowner through efficiency in heating, cooling, insulation, water usage and electrical consumption. Unlike standard new construction homes, these utilize the existing masonry building shell (built in 1920), thereby reducing material usage and waste and increasing the home's thermal performance. The architects made the decision to remove the original walls which divided the backyards, thereby creating an expansive communal space.

Hercules Bayfront is a 40-acre infill urban development in the San Francisco Bay Area, located adjacent to the San Francisco Bay on the site of an old dynamite factory and incorporating multiple historical buildings. When complete, the project will be a pedestrian- and transit-oriented neighborhood where water ferry, commuter and regional rail, and bus will be available to residents and the surrounding community at a single Multi-Modal Transit Station. The new development will include approximately 1,392 new residential units, 115,000 square feet of office space, 90,000 square feet of retail, and 134,000 square feet of Flex Space. The site will include a traditional town center street at Bayfront Boulevard, with shops, galleries, cafes and arcades, as well a mixed residential and commercial area known as The Village. The project also involves major rehabilitation of a creek and riparian area running through the site and the creation of multiple new parks, plazas, and access points to the adjacent Bay Trail.

Figure 8. Hercules Bayfront Site Plan



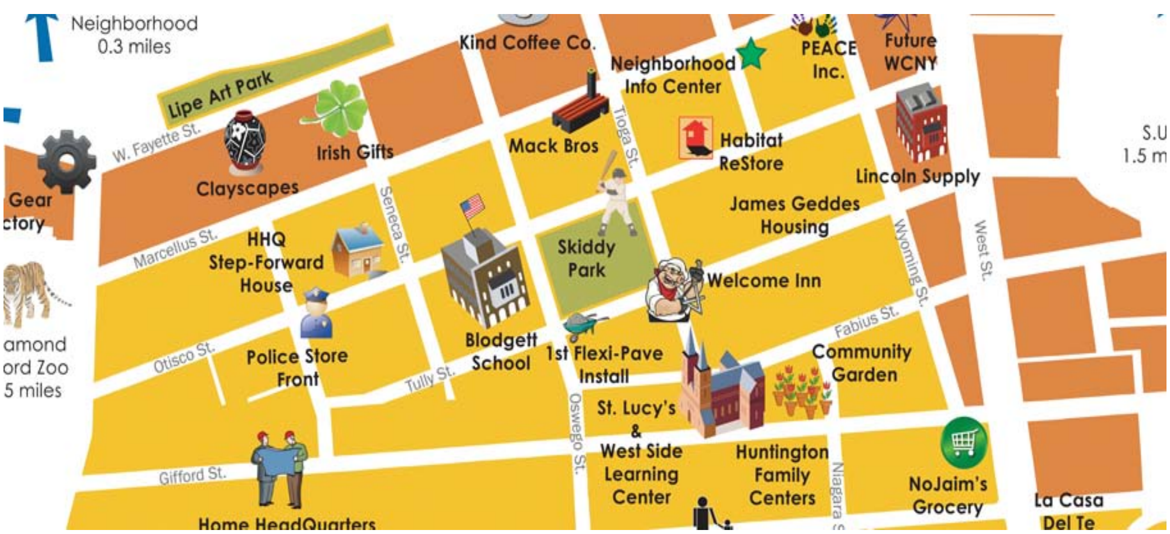
The **MacArthur BART Transit Village** is an 8.2-acre redevelopment of the property adjacent to the MacArthur BART Station. The MacArthur BART Station is located at the geographic center of the Bay Area and serves as a major transportation hub within Alameda County. Once complete, MacArthur Transit Village will provide 624 new housing units, including market rate homeownership, first time homebuyer opportunities, 90 affordable apartments for families, a childcare center, 40,000 square feet of ground floor commercial space and a new BART parking garage. The project also includes a redevelopment of the existing BART Plaza, and improved streets with new sidewalks, streetscapes, and traffic signals.

Mueller is located on 711-acres previously occupied by the Austin, Texas airport. Upon completion, the mixed use urban village will be home to approximately 10,000 people, 10,000 permanent employees, more than 1,100 affordable homes and approximately 140 acres of public open space and greenways. The town center is planned to have cafes, shops, plazas and live/work space with at least 30 percent locally-owned businesses. The first phase of construction began in 2006 and the second phase of residential construction began in the summer of 2008. Located three miles from downtown Austin and the Texas State Capitol and two miles from The University of Texas at Austin, Mueller is becoming a popular location for diverse and affordable residential development. A number of large research facilities and businesses have already relocated to Mueller. Twenty percent of the total site is preserved for parks and open space with a trail system, leaving each residence located within 600 feet of the open space.

The **Napa Pipe** redevelopment is a mixed-use neighborhood on a former World War II industrial site located three miles from downtown Napa. The 150-acre site includes 50 acres of residential land, 50 acres of open space and additional non-residential space for light-industrial and commercial use. Non-residential space will also provide for office, research and development, light industrial, retail, and restaurant use. Focusing on local businesses, the light industrial portion of the development is designed for local artisan and light industry workers. Community facilities will include a boathouse, a transit center, schools, hospitals, a café and a theater. Napa Pipe's special features include senior housing and a reserve area for parks and wetlands.

The **SALT District** project is a 156-acre neighborhood retrofit effort situated in the Near Westside neighborhood of Syracuse, New York. It is the first neighborhood retrofit effort in the United States to achieve any stage of LEED-ND certification. The LEED-ND process was used to inform an evaluation and plan for an existing area. The study area began with many qualities and attributes that are rewarded in the LEED-ND Rating System, such as an infill location and a diversity of uses, but was also missing many important characteristics such as green infrastructure and full street network connectivity. The assessment of the existing SALT District LEED-ND Study Area showed that it would achieve a total of 35 credit points in its existing form, fewer than the 40 required for basic certification. Plans therefore included improving connectivity with new pedestrian paths, bike lanes, and streets, along with green building strategies, added transit facilities and open space. With these changes, the SALT District moved from non-certifiable to Gold certified in the LEED system.

Figure 9. The Salt District



Solea is a 0.36-acre mixed-use, mixed-income project in Washington, DC with for-sale live/work units above 5,000 square feet of for-sale retail/commercial. Solea will serve as a gateway between Shaw, a historically significant neighborhood, and Columbia Heights, the most ethnically diverse neighborhood in Washington, D.C. Affordable residential units are dispersed throughout building in a range of unit sizes to accommodate low and moderate income individuals, families, and seniors in the rapidly gentrifying area.

Figure 10. Solea Condominiums

Station Park Green is a transit-oriented, mixed-use development in San Mateo, California. The 12-acre site accommodates nearly 600 households, 60,000 square feet of retail and 10,000 square feet of office space. Consultants, city planning staff and the community of San Mateo utilized extensive public workshops and meetings to create the community's development plans. As a result, Station Park Green provides parks, greenways and community facilities, with a walkable street grid connecting public spaces. Furthermore, the community's building massing and articulation emphasize public safety while furthering to solar access and climate goals.

Figures 11a&b. Before and After View of Station Park Green

Symphony Park, a new 61-acre development destined to become the cultural and artistic center of Southern Nevada, is located just a few miles north of the famed Strip in the center of downtown Las Vegas. The redevelopment site is planned as a pedestrian-oriented, mixed-use urban center with 1.8 million square feet of office/medical, 4.5 million square feet of residential, two new non-gaming hotels, one casino/hotel/retail center, 475,000 square feet of street-level retail, and a new 379,000 square foot performing arts center. All of its individual buildings are required to achieve LEED certification, including The Smith Center for the Performing Arts. This David Schwarz-designed building is now under construction and aims to be the first performing arts center of its size to achieve silver LEED certification. Upon completion, Symphony Park is estimated to provide 14,110 jobs and $1.8 billion in annual spending – transforming a brownfield site into a vibrant, sustainable urban neighborhood.

Figure 11. Rendering of Symphony Park

Tassafaronga is situated on 7.5 acres on the south side of Oakland, CA. With 179 affordable housing units near transit, green pathways, pocket parks, and open spaces, the redevelopment of this industrial area creates a new pedestrian- and transit-oriented neighborhood. All buildings are designed to the highest level of green standard, LEED for Homes Platinum, incorporating solar power for onsite generation of electricity and hot water. A defunct pasta factory and parcel of unused industrial land are reclaimed as small affordable apartments with a medical clinic that offers AIDs treatment. Many existing structures were reused and much of the demolished building material was recycled into the new structures.

Figure 11. Rendering of Tassafaronga

Transportation Benefits

A singular and somewhat controversial feature of LEED-ND projects is that they must be in a "smart location." The stated intent of this prerequisite is to:

- Encourage development within and near existing communities or public transportation infrastructure.
- Reduce vehicle trips and miles traveled and support walking as a transportation choice.

Smart location options defined in the pilot version of the LEED-ND rating system are:

- Locate the project on an infill site;
- Locate the project near existing or planned adequate transit service so that at least 50% of dwelling units and business entrances within the project are within ¼ mile walk distance of bus or streetcar stops or within ½ mile walk distance of bus rapid transit stops, light or heavy passenger rail stations and ferry terminals.
- Locate the project near existing neighborhood shops, services, and facilities so that the project boundary is within ¼ mile walk distance of at least four, or within ½ mile walk distance of at least six diverse uses.
- Locate the project within a region served by a Metropolitan Planning Organization (MPO) and within a transportation analysis zone for which MPO research demonstrates that the average annual home-based and/or non-home-based rate of Vehicle Miles Traveled (VMT) per capita is lower than the average annual rate of the metropolitan region as a whole.
- Locate the project within a region served by a Metropolitan Planning Organization (MPO) and demonstrate through peer-reviewed analysis that the average annual home-based and/or non-home-based rate of Vehicle Miles Traveled (VMT) per capita of the project will be lower than the average annual rate shown by MPO research for the metropolitan region as a whole.

LEED-ND also provides credits for smart location, good neighborhood design, and green building. The neighborhood Pattern and Design requires walkable streets, compact development, and a connected and open community. Thus, LEED-ND would be expected to produce lower VMT per trip than the regional average, plus higher walk and transit shares of trips.

Forecasts of Travel Outcomes for Pilot Projects

To forecast travel outcomes, we simply substitute values of the relevant independent variables into the model equations in Tables 4 through 6. Appendix B provides input values for each of the LEED-ND pilot projects.

Results of our calculations are shown in Tables 7 through 9. The last column in each table provides weighted average values, with weights based on the proportion of metropolitan VMT for different trip purposes. The weights are 21 percent for home-based work travel, 47 percent for home-based other travel, and 32 percent for non-home based travel.

As shown in Table 7, Constitution Square, Decker Walk, and Solea have predicted walk mode shares of more than 15 percent. Their high walk mode shares are a result of relatively low household size and auto ownership in the vicinity, and relatively high activity density (residents + jobs) within a mile of the site. Station Park Green also has a high predicted walk mode share, mostly due to high job-population balance and intersection density. At the low end of the scale, Hercules Bayfront, Mueller, and Napa Pipe have predicted walk mode shares of approximately 3 percent. These low values (compared to other projects) stem mostly from low employment and activity densities within a mile of the site.

Table 7. Predicted Walk Share of Trips for LEED-ND Pilot Projects

	home-based work	home-based other	non-home based	weighted avg
Constitution Square	34.7%	18.5%	11.6%	19.7%
Crystal City	3.9%	4.6%	4.9%	4.6%
Decker Walk	14.9%	15.6%	14.5%	15.1%
Hercules Bayfront	2.5%	3.3%	2.8%	3.0%
MacArthur BART	6.8%	10.7%	11.3%	10.1%
Mueller	3.1%	3.4%	2.5%	3.1%
NAPA Pipe	3.1%	2.9%	4.5%	3.5%
Symphony Park	8.5%	9.7%	12.6%	10.4%
Solea	13.3%	16.8%	18.6%	16.6%
Station Park Green	12.0%	16.3%	18.7%	16.2%
SALT District	10.7%	12.6%	18.0%	13.9%
Tassafaronga	12.7%	14.1%	10.0%	12.5%

Regarding predicted transit mode shares, displayed in Table 8, Constitution Square and Decker Walk are both around 10 percent, the highest among LEED-ND projects. This is a product of relatively low auto ownership in the vicinity, relatively high accessibility to employment, and all residents living within a quarter mile of a bus stop. At the other extreme, Crystal City, Hercules Bayfront, MacArthur BART, Mueller, and Napa Pipe are under 4 percent. These low transit mode shares result from a combination of relatively high auto ownership, low activity density, low intersection density, and/or low accessibility to employment.

The relatively low predicted transit mode shares for Crystal City, Hercules Bayfront, and MacArthur BART are a function of model parameters and input values. However, as these developments have rail stations within them, the actual transit mode shares are likely to be much higher. Recall that while the models estimated for EPA used an exact measure of transit accessibility (jobs reachable within 30 minutes by transit), the models estimated in this study use a proxy measure correlated with transit accessibility (jobs within 10 miles of a site). Had we had data on transit accessibility for these three sites, predicted transit mode shares would doubtless have been much higher.

Table 8. Predicted Transit Share of Trips for LEED-ND Pilot Projects

	home-based	home-based	non-home	weighted avg

	work	other	based	
Constitution Square	14.1%	18.1%	2.5%	12.3%
Crystal City	4.4%	4.5%	1.8%	3.6%
Decker Walk	25.4%	8.2%	2.4%	10.0%
Hercules Bayfront	1.8%	5.3%	0.8%	3.1%
MacArthur BART	9.2%	3.7%	1.9%	4.3%
Mueller	4.3%	2.3%	2.5%	2.8%
NAPA Pipe	1.2%	5.5%	0.6%	3.1%
Symphony Park	13.7%	6.1%	2.0%	6.4%
Solea	12.0%	7.9%	2.2%	7.0%
Station Park Green	12.6%	5.2%	1.2%	5.5%
SALT District	16.0%	6.9%	2.8%	7.5%
Tassafaronga	13.0%	6.3%	1.6%	6.2%

For all projects, we predict relatively low values of average private vehicle trip length, at least compared to regional averages (see Table 9). In general, home-based work trips represent the longest trips, while home-based other trips appear somewhat shorter. Non-home-based trips are the shortest of the three. It appears that the more urban, centrally located projects exhibit lower average trip lengths. Among the projects, Constitution Square has the shortest weighted average trip length at 3.54 miles, a result of a relatively small average household size, low average auto ownership, and high employment accessibility by automobile. Napa Pipe has the longest weighted average trip length at 5.67 miles, a result of the lowest employment accessibility by automobile.

Table 9. Predicted Average Private Vehicle Trip Length for LEED-ND Pilot Projects

	home-based work	home-based other	non-home based	weighted avg
Constitution Square	3.59	3.71	3.28	3.55
Crystal City	6.92	4.85	4.57	5.19
Decker Walk	2.93	4.83	7.42	5.26
Hercules Bayfront	5.95	5.55	4.65	5.35
MacArthur BART	6.56	4.37	4.04	4.72
Mueller	6.43	4.08	3.87	4.51
NAPA Pipe	6.39	5.35	5.66	5.67
Symphony Park	5.84	4.45	3.54	4.45
Solea	4.51	5.38	3.97	4.74
Station Park Green	4.85	3.69	3.43	3.85
SALT District	4.65	4.71	2.87	4.11
Tassafaronga	3.57	4.34	7.69	5.25

Results of these three tables are combined in Table 10. An approximation to the average VMT per trip was calculated with the following formula:

avg VMT per trip = (1 - avg walk share - avg transit share)*(avg private vehicle trip length)

This is not a precise formula since it doesn't account for bike trips or private vehicle occupancies. Still, it allows a precise comparison of LEED-ND projects to regional averages computed the same way for those regions with National Household Travel Survey (NHTS) data.

Constitution Square once again stands out, with an exceedingly low approximate VMT/trip of 2.42 miles. Napa Pipe has the highest VMT/trip at 5.27 miles, but even this value is low by the standards of conventional sprawl development. Taken together, these LEED-ND pilot projects appear to generate relatively little VMT per trip.

Table 10. Predicted VMT per Trip for LEED-ND Pilot Projects

	Walk Share	Transit Share	Avg Private Vehicle Trip Length	VMT/trip
Constitution Square	19.7%	12.3%	3.55	2.41
Crystal City	4.6%	3.6%	5.19	4.77
Decker Walk	15.1%	10.0%	5.26	3.94
Hercules Bayfront	3.0%	3.1%	5.35	5.02
MacArthur BART	10.1%	4.3%	4.72	4.04
Mueller	3.1%	2.8%	4.51	4.24
NAPA Pipe	3.5%	3.1%	5.67	5.29
Symphony Park	10.4%	6.4%	4.45	3.70
Solea	16.6%	7.0%	4.74	3.62
Station Park Green	16.2%	5.5%	3.85	3.02
SALT District	13.9%	7.5%	4.11	3.23
Tassafaronga	12.5%	6.2%	5.25	4.27

Comparison to Regional Average Values

To draw conclusions about the environmental and climate friendliness of LEED-ND pilot projects, we need a baseline against which to compare them. An obvious baseline is the regional average VMT per trip. If alternative mode shares are higher than the regional average, and private vehicle trip lengths are shorter than the regional average, the average VMT per trip will be lower than the regional average. We can infer that the environmental footprint of LEED projects will be smaller than the regional average, at least with regard to transportation energy use.

To obtain average walk share and average transit share for each region, we utilized the Online Analysis Tools feature of the National Household Travel Survey (NHTS). Using the Table

Designer tool, we accessed the 2009 data, and looked at the “Annual person trips (Travel Day PT)” variable. Using this variable, we categorized results for “Transportation mode on travel day trip (TRPTRANS)” based on the variable of “MSA/CMSA code for HH (HHC_MSA).”

To obtain average private vehicle trip length we again used the Table Designer tool for 2009 data, based on the variable of “Average vehicle trip length – Travel Day.” Results for this variable were categorized by the variable of “MSA/CMSA code for HH (HHC_MSA).”

Finally, an approximation to the average VMT per trip was calculated with the formula above. The VMT per trip, for LEED-ND pilot projects, ranges from 28 percent of the regional average for Constitution Square to 70 percent of the regional average for Napa Pipe. The best explanation that we can propose for these impressive results is that the LEED-ND pilot projects are so urban and so central to their respective regions (with the exception of Napa Pipe) that it greatly depresses VMT relative to regional averages.

Table 6. 2009 NHTS Average Transportation Outcomes by Region

Development	MSA	walk share	transit share	avg private vehicle trip length	Regional VMT per trip	Project/Regional VMT per trip (%)
Constitution Square	Washington--Baltimore, DC--MD—VA—WV	14.4	5.8	10.98	8.76	27.5%
Crystal City	Washington--Baltimore, DC--MD—VA—WV	14.4	5.8	10.98	8.76	54.5%
Decker Walk	Washington--Baltimore, DC--MD—VA—WV	14.4	5.8	10.98	8.76	45.0%
Hercules Bayfront	San Francisco--Oakland--San Jose, CA	14.2	4.1	9.30	7.59	66.1%
MacArthur BART	San Francisco--Oakland--San Jose, CA	14.2	4.1	9.30	7.59	53.2%
Mueller*	Austin-San Marcos, TX	3.8	3.9	6.47	5.97	NA
NAPA Pipe	San Francisco--Oakland--San Jose, CA	14.2	4.1	9.30	7.59	69.7%
Symphony Park	Las Vegas, NV-AZ	NA	NA	NA	NA	NA

Solea	Washington--Baltimore, DC--MD—VA—WV	14.4	5.8	10.98	8.76	41.3%
Station Park Green	San Francisco--Oakland--San Jose, CA	14.2	4.1	9.3	7.59	39.8%
SALT District	Syracuse, NY	NA	NA	NA	NA	NA
Tassafaronga	San Francisco--Oakland--San Jose, CA	14.2	4.1	9.3	7.59	56.3%

* Regional averages from the 2005 Austin Activity Travel Survey.

Conclusion

In summary, this study forecasted walking and transit mode shares as well as private vehicle trip lengths for 12 LEED-ND pilot projects. It applied models derived from 239 mixed use developments to this set of LEED-ND projects. Values for walk mode shares ranged from 3.0 to 19.7 percent of trips. The more moderate mode shares for transit ranged between 2.8 and 12.3 percent of trips. Weighted average private vehicle trip lengths ranged from 3.55 to 5.67 miles. As with the mode share metrics, the most urban and centrally located projects tended to achieve the lowest private vehicle trip lengths.

Finally, this study calculated average VMT per trip. This metric provides a useful measure for comparison to regional values, as projects with alternative mode shares higher than the regional average, and private vehicle trip lengths shorter than the regional average, can expect lower VMT per trip than the regional average. As such, this metric allows us to infer whether the footprint of LEED projects will be smaller than the regional average with regard to transportation energy and emissions. In this study, the VMT per trip for LEED-ND pilot projects represents a fraction of the regional average for all projects.

A number of caveats may apply to these surprisingly favorable results. First, this study only covers a small number of self-selected projects. These projects may represent the best of the best, atypical of mixed-use developments generally or even other LEED-ND projects. Second, the study includes several very small projects and two that are essentially single use, whereas the models applied to these projects were developed from a database of larger mixed-use projects. Third, this study lacked precise data for key variables such as auto ownership and employment accessibility by transit. We used general measures of auto ownership from the 2000 Census for households in the vicinity of projects. The census figures used in this study may differ considerably when compared to actual future auto ownership for these higher income projects. Similarly, lack of exact data forced the use of very general measures for employment accessibility. Finally, the low pseudo-R2 values in this study created an additional potential source of error, reducing accuracy in modeling.

Acknowledging these caveats, this study paves the way for future evaluation of LEED-ND candidate projects. This kind of outcome evaluation should become central to the LEED certification process. When built on a quantifiable expectation of good outcomes, the program will become even stronger.

Appendix A. LEED-ND Scorecards

Constitution Square
Washington, DC
LEED Stage 2 Certification: Gold
Stonebridge Carras

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Brownfield Redevelopment	2
High Priority Brownfields Redevelopment	1
Preferred Location	9
Reduced Automobile Dependence	7
Bicycle Network	1
Housing and Jobs Proximity	3
School Proximity	1
Steep Slope Protection	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	7
Diversity of Uses	4
Diversity of Housing Types	1
Reduced Parking Footprint	2
Walkable Streets	6
Street Network	1
Transit Facilities	1
Access to Surrounding Vicinity	1
Access to Active Public Spaces	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
LEED Certified Green Buildings	2
Reduced Water Use	1
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Contaminant Reduction in Brownfield Remediation	1
Stormwater Management	5
Heat Island Reduction	1

Construction Waste Management	1
Innovation and Design Process	
Exemplary Performance in Housing and Jobs Proximity	1
Exemplary Performance in Reduced Parking Footprint	1
Exemplary Performance in Construction Waste Management	1
LEED Accredited Professional	1
Project Total (pre-certification estimates)	**66**

Solea Condominiums
Washington DC
LEED Stage 3 Certification: Gold
JAIR LYNCH Development Partners

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Preferred Location	10
Reduced Automobile Dependence	8
Housing and Jobs Proximity	3
School Proximity	1
Site Design for Habitat or Wetlands Conservation	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	7
Diversity of Uses	4
Diversity of Housing Types	2
Affordable For-Sale Housing	1
Walkable Streets	6
Street Network	2
Access to Public Services	1
Access to Active Public Spaces	1
Universal Accessibility	1
Community Outreach and Involvement	1
Local Food Production	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
Reduced Water Use	1
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1

Innovation and Design Process	
Innovative Stormwater Management	1
Exemplary Performance in Reduced Auto Dependence	1
Exemplary Performance in Compact Development	1
Exemplary Performance in Housing and Job Proximity	1
Exemplary Performance in Reduced Parking Footprint	1
Project Totals (pre-certification estimates)	**60**

Currie Barracks
Calgary, Alberta
LEED Stage 2 Certification: Gold
Canada Lands

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Brownfield Redevelopment	2
High Priority Brownfields Redevelopment	1
Preferred Location	9
Reduced Automobile Dependence	4
Bicycle Network	1
Housing and Jobs Proximity	3
School Proximity	1
Steep Slope Protection	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	3
Diversity of Uses	4
Diversity of Housing Types	3
Affordable Rental Housing	1
Reduced Parking Footprint	2
Street Network	2
Transit Facilities	1
Access to Surrounding Vicinity	1
Access to Active Public Spaces	1
Access to Active Spaces	1
Community Outreach and Involvement	1
Green Construction and Technology	

Construction Activity Pollution Prevention	Required
Reduced Water Use	2
Building Reuse and Adaptive Reuse	2
Reuse of Historic Buildings	1
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Stormwater Management	5
Infrastructure Energy Efficiency	1
Construction Waste Management	1
Comprehensive Waste Management	1
Light Pollution Reduction	1
Innovation and Design Process	
Innovation in Design: Public Education	1
Innovation in Design: Additional Third Party Certification	1
Exemplary Performance in Diverse Neighborhood Assets	1
Exemplary Performance in Infrastructure Energy Efficiency	1
Exemplary Performance in Historic Reuse	1
Project Total (pre-certification estimates)	**65**

Decker Walk
Baltimore, MD
LEED Stage 2 Certification: Silver
Trace Architects/Patterson Park Community Development Corporation (PPCDC)

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Preferred Location	10
Reduced Automobile Dependence	7
Housing and Jobs Proximity	3
School Proximity	1
Steep Slope Protection	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	5
Diversity of Uses	4
Walkable Streets	4
Street Network	2

Access to Surrounding Vicinity	1
Access to Public Spaces	1
Access to Active Public Spaces	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
Energy Efficiency in Buildings	3
Building Reuse and Adaptive Reuse	2
Reuse of Historic Buildings	1
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Stormwater Management	2
Heat Island Reduction	1
Project Total (pre-certification estimates)	**51**

Mueller
Austin, TX
LEED Stage 2 Certification: Silver
Catellus Development Group

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Brownfield Redevelopment	2
Preferred Location	8
Reduced Automobile Dependence	3
Steep Slope Protection	1
Restoration of Habitat or Wetlands	1
Conservation Management of Habitat or Wetlands	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	1
Diversity of Uses	4
Diversity of Housing Types	3
Affordable For-Sale Housing	2
Street Network	2
Access to Public Services	1
Access to Active Public Spaces	1
Community Outreach and Involvement	1

Green Construction and Technology	
Construction Activity Pollution Prevention	Required
Building Reuse or Adaptive Reuse	2
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Contaminant Reduction in Brownfields Remediation	1
Stormwater Management	5
Heat Island Reduction	1
On-Site Energy Generation	1
Construction Waste Management	1
Comprehensive Waste Management	1
Innovation and Design Process	
Innovation in Design: Integrated Pest Management	1
Exemplary Performance in Suspended Solids and Pollutant Reduction	1
Innovation in Design: Community Education	1
Exemplary Performance: Affordable For Sale Housing	1
LEED Accredited Professional	1
Exemplary Performance: Community Outreach and Involvement	1
Project Total (pre-certification estimates)	**51**

Crystal City
Arlington Co., VA
LEED Stage 1 Certification: Certified
Arlington County

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Preferred Location	9
Reduced Automobile Dependence	6
Housing and Jobs Proximity	3
School Proximity	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	7
Diversity of Uses	4
Reduced Parking Footprint	2

Walkable Streets	6
Street Network	1
Community Outreach and Involvement	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Heat Island Reduction	1
Comprehensive Waste Management	1
Innovation and Design Process	
Exemplary Performance: Housing and Jobs Proximity	1
LEED Accredited Professional	1
Project Total (pre-certification estimates)	**40**

Hercules Bayfront
Hercules, CA
LEED Stage 1 Certification: Gold
AndersonPacific and Opticos Design

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Preferred Location	8
Reduced Automobile Dependence	3
Bicycle Network	1
Housing and Jobs Proximity	3
School Proximity	1
Restoration of Habitats or Wetlands	1
Conservation Management of Habitats or Wetlands	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	4
Diversity of Uses	4
Diversity of Housing Types	3
Reduced Parking Footprint	2
Walkable Streets	7
Street Network	2
Transit Facilities	1

Access to Surrounding Vicinity	1
Access to Public Spaces	1
Access to Active Public Spaces	1
Universal Accessibility	1
Community Outreach and Involvement	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
Building Reuse and Adaptive Reuse	2
Reuse of Historic Buildings	1
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Stormwater Management	5
Heat Island Reduction	1
On-Site Energy Generation	1
On-Site Renewable Energy Sources	1
Infrastructure Energy Efficiency	1
Recycled Content in Infrastructure	1
Construction Waste Management	1
Comprehensive Waste Management	1
Light Pollution Reduction	1
Innovation and Design Process	
Exemplary Performance in Housing and Jobs Proximity	1
Exemplary Performance in Universal Accessibility	1
Exemplary Performance in Reduced Parking Footprint	1
LEED Accredited Professional	1
Project Total (pre-certification estimates)	**64**

MacArthur BART Transit Village
Oakland, CA
LEED Stage 1 Certification: Gold
MacArthur Transit Community Partners (MTCP)

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Brownfield Redevelopment	2
High Priority Brownfields Redevelopment	1
Preferred Location	9
Reduced Automobile Dependence	8

Bicycle Network	1
Housing and Jobs Proximity	3
School Proximity	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	6
Diversity of Uses	4
Diversity of Housing Types	3
Affordable Rental Housing	2
Reduced Parking Footprint	2
Street Network	2
Transit Facilities	1
Transportation Demand Management	1
Access to Surrounding Vicinity	1
Access to Active Public Spaces	1
Community Outreach and Involvement	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
Reduced Water Use	1
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Contaminant Reduction in Brownfield Remediation	1
Stormwater Management	2
Heat Island Reduction	1
Construction Waste Management	1
Comprehensive Waste Management	1
Innovation and Design Process	
Exemplary Performance in Reduced Automobile Dependence	1
Exemplary Performance in Housing and Jobs Proximity	1
Exemplary Performance in Affordable Rental Housing	1
Exemplary Performance in Reducing the Parking Footprint	1
LEED Accredited Professional	1
Project Total (pre-certification estimates)	**63**

Symphony Park
Las Vegas, NV
LEED Stage 2 Certification: Gold
City of Las Vegas and Newland Communities

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required

Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Brownfield Redevelopment	2
High Priority Brownfields Redevelopment	1
Preferred Location	8
Reduced Automobile Dependence	7
Housing and Jobs Proximity	3
School Proximity	1
Steep Slope Protection	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	7
Diversity of Uses	4
Diversity of Housing Types	3
Walkable Streets	7
Street Network	1
Transit Facilities	1
Transportation Demand Management	1
Access to Surrounding Vicinity	1
Access to Public Spaces	1
Access to Active Public Spaces	1
Universal Accessibility	1
Community Outreach and Involvement	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
LEED Certified Green Buildings	3
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Contaminant Reduction in Brownfield Remediation	1
Heat Island Reduction	1
Solar Orientation	1
Construction Waste Management	1
Comprehensive Waste Management	1
Innovation and Design Process	
Innovation in Design: LEED Certified Buildings	1
LEED Accredited Professional	1
Project Total (pre-certification estimates)	**64**

Syracuse SALT District
Syracuse, NY
LEED Stage 1 Certification: Gold
Raimi & Associates

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Preferred Location	8
Reduced Automobile Dependence	4
Housing and Jobs Proximity	3
School Proximity	1
Steep Slope Protection	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	1
Diversity of Uses	4
Diversity of Housing Types	3
Affordable Rental Housing	2
Affordable For-Sale Housing	2
Street Network	2
Transit Facilities	1
Access to Surrounding Vicinity	1
Access to Public Spaces	1
Access to Active Spaces	1
Community Outreach and Involvement	1
Local Food Production	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
LEED Certified Green Buildings	1
Energy Efficiency in Buildings	3
Reduced Water Use	2
Building Reuse and Adaptive Reuse	2
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Stormwater Management	5
Heat Island Reduction	1
Infrastructure Energy Efficiency	1

Recycled Content in Infrastructure	1
Construction Waste Management	1
Comprehensive Waste Management	1
Innovation and Design Process	
Exemplary Performance in Building Reuse and Adaptive Reuse	1
Exemplary Performance in Housing and Job Proximity	1
Exemplary Performance in Rental Affordability	1
Innovation in Design: From the Ground Up	1
LEED Accredited Professional	1
Project Total (pre-certification estimates)	**62**

Tassafaronga Housing
Oakland, CA
LEED Stage 2 Certification: Gold
David Baker + Partners Architects

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Brownfield Redevelopment	2
High Priority Brownfields Development	1
Preferred Location	8
Reduced Automobile Dependence	5
Housing and Jobs Proximity	3
School Proximity	1
Steep Slope Protection	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	3
Diversity of Uses	4
Diversity of Housing Types	3
Affordable Rental Housing	2
Affordable For-Sale Housing	2
Reduced Parking Footprint	2
Street Network	2
Access to Surrounding Vicinity	1
Access to Public Spaces	1
Access to Active Spaces	1

Community Outreach and Involvement	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
LEED Certified Green Buildings	3
Energy Efficiency in Buildings	3
Reduced Water Use	2
Building Reuse and Adaptive Reuse	1
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Stormwater Management	2
Heat Island Reduction	1
Recycled Content for Infrastructure	1
Construction Waste Management	1
Comprehensive Waste Management	1
Innovation and Design Process	
Increased Affordability for Rental Housing	1
Increased Affordability of For Sale Housing	1
Further Reduced Parking Footprint	1
Increased Housing and Jobs Proximity	1
LEED Accredited Professional	1
Project Total (pre-certification estimates)	**66**

Napa Pipe
Napa, CA
LEED Stage 1 Certification: Gold
Eisen|Letunic Transportation, Environmental and Urban Planning

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required
Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Brownfield Redevelopment	2
Preferred Location	6
Reduced Automobile Dependence	2
Bicycle Network	1
Housing and Jobs Proximity	3
Steep Slope Protection	1
Conservation Management of Habitats and Wetlands	1
Neighborhood Pattern and Design	
Open Community	Required

Compact Development	Required
Compact Development	4
Diversity of Uses	4
Diversity of Housing Types	3
Affordable Rental Housing	1
Reduced Parking Footprint	2
Walkable Streets	7
Street Network	2
Transit Facilities	1
Access to Surrounding Vicinity	1
Access to Public Spaces	1
Access to Active Spaces	1
Community Outreach and Involvement	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
Reduced Water Use	3
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Contaminant Reduction in Brownfields Remediation	1
Stormwater Management	1
Heat Island Reduction	1
Solar Orientation	1
Infrastructure Energy Efficiency	1
Construction Waste Management	1
Comprehensive Waste Management	1
Light Pollution Reduction	1
Innovation and Design Process	
Sustainable Development Education Program	1
Bicycle Sharing	1
Exemplary Performance- Recycling Construction Debris	1
Exemplary Performance- Affordable Rental Housing	1
LEED Accredited Professional	1
Project Total (pre-certification estimates)	**62**

Station Park Green
San Mateo, CA
LEED Stage 1 Certification: Gold
EBL+S Development Corporation

Completed Credits	Points Achieved
Smart Location and Linkage	
Smart Location	Required
Proximity to Water and Wastewater Infrastructure	Required
Imperiled Species and Ecological Communities	Required

Wetland and Water Body Conservation	Required
Farmland Conservation	Required
Floodplain Avoidance	Required
Brownfield Redevelopment	2
Preferred Location	8
Reduced Automobile Dependence	5
Bicycle Network	1
Housing and Jobs Proximity	3
School Proximity	1
Steep Slope Protection	1
Neighborhood Pattern and Design	
Open Community	Required
Compact Development	Required
Compact Development	7
Diversity of Uses	4
Diversity of Housing Types	3
Reduced Parking Footprint	2
Walkable Streets	7
Street Network	2
Transit Facilities	1
Access to Surrounding Vicinity	1
Access to Public Spaces	1
Access to Active Spaces	1
University Accessibility	1
Community Outreach and Involvement	1
Green Construction and Technology	
Construction Activity Pollution Prevention	Required
LEED Certified Green Buildings	3
Reduced Water Use	2
Minimize Site Disturbance through Site Design	1
Minimize Site Disturbance during Construction	1
Heat Island Reduction	1
Infrastructure Energy Efficiency	1
Recycled Content for Infrastructure	1
Construction Waste Management	1
Comprehensive Waste Management	1
Innovation and Design Process	
LEED Accredited Professional	1
Project Total (pre-certification estimates)	**65**

Appendix B. Variable Values for LEED-ND Pilot Projects

	HHSIZE	VEHCAP	BUSSTOP	ACTDEN	JOBPOP	LANDMIX	INTDEN	EMP1MI	ACT1MI	EMP10MI	EMP20A	EMP30A	RAILSTOP
Constitution Square	1.59	0.23	1	745205	0.06	0.90	128	57024	99510	0.46	0.51	0.79	0
Crystal City	1.80	0.63	0.85	213034	0.17	0.81	111	21104	36869	0.43	0.52	0.78	1
Decker Walk	1.45	0.30	1	45600	0.01	0.00	344	23483	73357	0.49	0.56	0.83	0
Hercules Bayfront	2.5	0.38	0.58	225628	0.10	0.84	223	2632	12125	0.06	0.14	0.58	1
MacArthur BART	2.88	0.50	1	145047	0.56	0.61	299	27591	73435	0.38	0.53	0.80	1
Mueller	2.17	0.49	0.4	18003	0.33	0.85	143	4280	15005	0.66	0.74	0.84	0
NAPA Pipe	2.28	0.30	1	38242	0.53	0.60	295	3732	3732	0.04	0.03	0.08	0
Symphony Park	2.00	0.44	1	196792	0.18	0.96	229	40995	53027	0.43	0.46	0.48	1
Solea	1.86	0.36	1	197333	0.01	0.42	267	66520	166965	0.45	0.53	0.77	0
Station Park Green	2.50	0.36	1	91429	0.80	0.44	645	21347	46989	0.13	0.44	0.46	1
SALT District	1.78	0.39	1	134460	0.03	0.99	242	72747	90134	0.74	0.76	0.84	0
Tassafaronga	2.46	0.25	1	38059	0.11	0.00	512	7160	41049	0.20	0.31	0.82	0
239 MXD avg	2.59	0.83	0.48	21259	0.43	0.53	270	32458	61268	0.18	0.20	0.35	0

[i] According to the National Household Travel Survey of 2009, 14 percent of Portland's trips are by walking, and 2 percent are by transit. The average vehicle trip length in the Portland Consolidated Metropolitan Statistical Area is 8.9 miles.

[ii] For projects falling within a single block, the intersection density of the quarter mile buffer was used instead.