Transportation Costs of New Development: Procedural Guide, User Guide and Model

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Transportation Costs of New Development

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INTRODUCTION

Development Impacts on Transportation Costs

The charge of this research is to produce an assemblage of procedures to calculate the transportation costs of new development. This procedural guide provides direction on calculating transportation cost impacts through the multiple layers of costs. The individual sections of *direct, indirect,* and *induced* transportation impacts have been carefully and critically addressed to employ procedures that can be used to estimate both costs and revenues[1] that are associated with growth. In addition, the authors have been careful to state which of these cost/revenue calculations are likely to be required as part of the development process and, even more importantly, which of these calculation procedures actually lead to a capital fee (direct capital costs) or operating charge (none) being levied against a particular development. As indicated above, of the six layers of potential operating/capital costs, only two are regularly calculated as part of the development review process (direct capital and direct operating costs); and only one is ultimately charged as a fee (direct capital costs)─the latter in only a handful of states. Regardless, it is important to fully understand the presence and magnitude of these costs.

The sections that follow are divided into capital and operating cost (and revenue) calculation procedures through the three layers of identified transportation costs: *direct, indirect,* and *induced*. In each case, the procedural guide reflects the abundance or paucity of available information and a strong/weak case to be made for various types of calculations.

The *direct transportation capital* costs of new development have a strong and consistent literature of how these costs should be calculated and apportioned. These costs involve new roads, parking areas, bus stations at schools, municipal parking structures and lots, and so on. The professional field agrees that these costs exist and that there are detailed procedures in place to calculate these costs/revenues─and again, the research team has adopted these procedures to calculate direct transportation capital costs. In some cases, field practice is that the developer is actually charged after calculations are made. Because of this charging, the literature on capital costs is very detailed and thorough on how costs should be calculated and what types of costs should be included, as well as revenue credits tendered. The section dealing with these types of costs is longer than other sections due to the considerations that must be understood and undertaken in development-related capital costs. In the above case, members of the research team are authors of many of capital cost studies and nearly all of the existing procedural guides.

The *direct transportation operating* cost impacts of new development also have a strong and identified literature that basically agrees that costs exist and can be calculated, and that procedures are present to effect this calculation. The types of costs involved here are transportation expenditures for road cleaning and snow removal, upkeep and repair, signalization/signage, transporting students, and the like. These costs, though frequently calculated, are usually not assigned to a developer. They are often paid in the form of property taxes and other revenues of new residents/businesses.

[1] The question of whether revenues would be shown or not was debated between the research team and the panel. The research team desired to show revenues because these revenues exist at the field level for operating purposes (analyzed by fiscal impacts) and, in some cases, for capital purposes (analyzed by impact fee calculations). Revenues are shown because they exist in all cases in the operating sphere and are the basis of costs when they exist in the capital sphere.

Nonetheless, the research team has adopted these procedures to calculate direct transportation operating costs.

The next layer of cost/revenue calculations is *indirect* costs. These costs come about because (1) those who occupy new direct nonresidential space choose to reside in the community in *new housing*, and (2) those who live in the development's new residential units create expenditures that support additional *new jobs* locally. A second round of costs exists, definitely related to the first, and should be acknowledged. These costs are secondary costs that are usually not assigned as additional costs. Tracing the linkage of these costs, whether or not indirect costs are charged in the same fashion as direct or primary costs, is totally unrelated to whether these costs exist and are, in fact, related to direct costs. The field has acknowledged that these are costs associated with development, and they can be calculated. Few calculation procedures have emerged to quantify these costs. This is because neither indirect capital costs nor indirect operating costs are actually charged to a developer. Capital costs of indirect development seldom are charged to the original developer but rather may appear as another round of primary costs to another developer. Accordingly, the sections of this guide that explain indirect transportation costs and revenues are much shorter and much less involved than those used for either direct transportation capital or direct operating costs. They essentially reflect procedures to calculate these costs/revenues that are practiced by a limited number of impact fee or fiscal impact analysts who occasionally calculate these costs.

For *indirect transportation capital costs,* the research team relies heavily on direct capital cost procedures and uses the demand created by *indirect transportation operating costs* as the scale of development to apply direct capital cost procedures. Again, research team members—the primary authors of the limited studies that exist for these types of calculations—employ the same methodology used in calculating direct transportation capital and direct transportation operating expenditures.

Field procedures do exist for indirect transportation operating costs/revenues. Every fiscal impact practitioner knows these types of analyses, but they are required in less than 10 percent of the analyses undertaken. With regard to indirect operating costs, usually these costs are a fraction of direct costs. This is true because only a share of direct employees live in the community, and the consumer expenditures of both residents and employees may not take place in the development community.

The third category of costs is *induced costs*. The literature on induced transportation costs is both established and growing. It remains controversial, however. Increasingly, there is less argument about its presence than its magnitude. There is also less argument today that it is related to other rounds of growth in the community. Thus, the field is growing to accept the presence of induced transportation costs but continues to disagree about both its magnitude and ways to calculate its locational effects. Because of multiple contributors to these costs (other modes of transportation, other roads, other non-local development), the research team has adopted conservative field measures for induced costs on a single community. These measures draw upon existing studies to determine elasticities of demand. These are used to determine induced costs. Authors of the procedures used here are aware of the work in this area of inquiry and have taken it into account. Thus, procedures for calculating development-initiated induced transportation costs, while in place, are not as accepted as those for direct and indirect costs. Significant contributors to the literature on induced transportation costs are on the research team and have authored procedures for these calculations.

One final effort has been made to view the full range of transportation costs related to new development. A procedure for introducing a control on the magnitude of combined costs (direct, indirect, and induced) has been established. This procedure for both capital and operating costs again reflects the professional work of the research team. Research team modelers are pioneers who have provided ways of looking at the multilevel aspects of at least

one category of transportation costs (capital and maintenance costs of roads). Their procedures are used to project the outer bounds of all costs. The outer bounds of all costs serves as a governing term beyond which the magnitude of calculated costs should be looked at. This is a useful procedure to provide a gross estimate of total costs assignable to a specific development.

The advisory panel's comments concerning the initial research design, as well as its fulfillment, have been instrumental in conceptualizing the resulting product. This input was invaluable. What follows are the best ideas of the research team, guided by the panel, for calculating the transportation costs of new development.

It should be realized that, at the project level for fieldwide acceptance, there is no magic bullet to absolutely calculate the multilevel transportation costs of prospective development. What this procedural guide does is consider methods to approximate these costs to obtain a handhold on their existence and magnitude. The structure and format of this approximation procedure is the essence of this volume.

Courtesy of Jon Erickson (both pictures)

SUMMARY

A Model to Calculate the Transportation Costs of New Development

OVERVIEW TO THE GUIDE

The summary that follows provides a brief overview of cost-revenue calculations and shows them in the context of one another as well as in the overall flow of all costs and revenues. More detailed explanation and a running example are contained in the four steps (chapters) that follow.

This procedural guide is a tool to enable transportation, planning, and other professionals to view the multilayered costs of new development on transportation. It is both a measured (entering data) and a quick (using default information) guide to development impacts that range from a small subdivision to a large expansion into a new development area. The latter might include the next phase of an urban growth boundary or development approved via an adequate public facilities ordinance.

The procedural guide will inform the user about the cumulative (direct, indirect, and induced) impacts of a single development proposal. This has nothing to do with charging the developer for the development's impacts. The costs and revenues shown here reflect likely impacts; charging for impacts is a local decision. In fact, in the field, capital costs are charged only for *direct* impacts (and only when an impact fee ordinance is in place); *indirect* and *induced* capital impacts are never charged with direct impacts but only as the direct effects of additional development. Operating costs are never directly charged in the field, even though subsequent residents pay property and other taxes.

The assumptions of these methods are that the best indicator of future capital costs is available through the impact fee methodology; the best indicator of future operating costs is available through the fiscal impact methodology.

Each of these methods is the standard for the field. For capital costs, the future level of service is typically specified at the current level of service or, in a few cases, at a level of service above or below current levels. For operating costs, the future level of service is almost always the existing level of service. In the typical calculation (direct capital and operating costs), the level of service specified for capital facilities is the same as the level of service specified for operating facilities. The capital cost procedure is completed first. This is followed by the operating cost procedure.

The data that implements the above procedures must be obtained from a development pro forma about a specific development; the local, county, and/or school district budget; and information from the U.S. Census on the jurisdiction where development is taking place. Most of these data can be collected almost immediately from the Internet, but it would still take multiple days to develop a site-specific solution; conversely, also within this model, defaults can be employed to go almost immediately to a more generalized solution. This latter procedure is through the Preview Model.

The purpose of this procedural guide is to frame the integrated procedure that will be used to model the direct, indirect, and induced transportation costs of new development. Transportation costs are the direct mobility-inducing capital and operating services provided by government to residents, workers, visitors, or pupils within the impacted jurisdiction. Five separate models are integrated into one continuous model for the transportation cost procedures enacted here.

The procedural guide is divided into four steps, each one dealing with a component of transportation impact. (A final section provides a control element.) Each presents a calculation procedure that represents a generic type of model in a particular aspect of cost specification; an appendix uses a transportation and land-use model to test for the magnitude of induced costs. Other models are discussed in relationship to the basic model to present contrasts but also to

incorporate features of these models if they are necessary and not proprietary. The model included on the CD is the best and most durable model that currently exists in the field of capital and operating cost calculations.

STEP I-A.1

DIRECT TRANSPORTATION CAPITAL COSTS OF DEVELOPMENT

Auto-Related

Direct capital costs involve the automobile and transit infrastructure expenditures to service new persons, employees, and students. This includes the expenditures for road building and widening, intersection/overpass construction or improvement, and signalization installation, all related to automobile travel. It also includes funds for pedestrian and bicycle ways. Further, direct capital costs involve any capital expenditures necessary for transit initiation, extensive repair, or improvement.

The standard field model for these types of costs is the Nicholas-Nelson Road or Highway Impact Fee Model. The road or highway impact fee model is much more sophisticated in 2010 than it was when introduced 25 years ago. The reality, however, is that the same formula is used, and the "devil is in the details." The basic formula is that the impact fee equals vehicle-miles traveled (VMT) multiplied by the net cost per vehicle-mile traveled. Costs are proportionately or "rationally" assigned. As will be shown in the detailed section, each of the above are loaded words, the key being the concept of "rational nexus [or assignment]," which means that only those costs actually attributable to the new increment of development are assigned to the new increment. These break down into three components: (1) levels of service and service areas, (2) improvement costs, and (3) revenue credits (Exhibit A-1).

First, for levels of service, standards must exist to determine the level of service that the new improvements are attempting to replicate. These levels of service apply to service areas that must also be determined. Deficiencies in service levels must be identified to ensure that these are not assigned to the new development increment.

Second, with regard to improvement costs, the cost of the new facilities must be determined. This is obviously related to levels of service discussed above and to accepted procedures for calculating these costs.

Third, for revenue credits, sources of payment other than local expenditures should be netted from these costs. Any current form of payment for these facilities that would be paid for by a component of taxes or through development exactions must be subtracted from the assigned cost to the developer. Similarly, the time-value of money must be credited for capital facilities not built immediately. Further, any sources of revenue (motor fuels tax) that the development would contribute after it is built should also be taken from the cost calculation. Finally, the site, when it was vacant, paid for capital facilities in the form of debt service; this should be further subtracted from the imposed cost calculation.

The above are accounted for in the base data that enters the equations below:

A. Capital Costs = VMT x Net Cost ÷ Vehicle- Miles Traveled

1. VMT = Trips x % Net x Length ÷ 2
2. Cost per VMT = Cost ÷ VMC x VMC ÷ VMT
3. Net Cost per VMT = Cost ÷ VMT *minus* Credit ÷ VMT*

1. Vehicle-miles traveled is determined using adjusted national figures for trip rates and lengths for different types of land uses (single-family, multifamily, retail, office, industrial) and adjusting totals for vehicle-miles traveled by using local average daily travel counts. The percentage of "new" represents the share of all trips that are primary as opposed to pass-by or diverted trips. For most residential uses, new trips are said to equal 100 percent; for most office uses, 75 percent; retail, 50 percent; and school, 25 percent. A local trip length

* For any scaled capital charge (i.e., variation by size of unit or number of occupants, the credit must also be scaled. The net procedure must be careful to calculate the impact fee at the average point and then apply the credit to the same average point to develop the appropriate net cost. Then, the net cost may be adjusted up or down depending on the desire to apply scaled costs. Any cost that is scaled must have a revenue credit that is also appropriately scaled.

adjustment factor is then created to adjust national trip lengths to local trip lengths.

2. Cost per vehicle-mile traveled is determined using historical costs for costs per vehicle-mile (system capacity), multiplied by the ratio of the capacity of a newly supplied roadway (hourly vehicle-miles of capacity for the peak hour) to the actual vehicle-miles traveled on that roadway (vehicle-miles of travel). This yields the cost per peak-hour vehicle-mile traveled.

3. Net cost per vehicle-mile traveled involves applying the various "revenue credits" to the cost determined above. These involve credits for bonds that are already obligated as part of the capital improvement program (CIP) and are paid for by a portion of property taxes that the development incurs annually. Also included here are other bond issues for transportation improvements that will be paid for in the future out of recurring tax payments provided by the developer. The net cost per peak-hour VMT is then multiplied by the peak-hour VMT for various types of units, and then by the number of units proposed within various types. This procedure develops aggregate costs by development component and for the development as a whole, to provide direct transportation capital improvements related to that development (Exhibit A-1). If impact fees vary by size so too must the revenue credit.

Direct Transportation Capital Costs Calculated in Step I-A.1
EXAMPLE: $6,933,062

* These and the following calculations are found elsewhere in this report and are summarized in Exhibits A-1 through A-6.

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STEP I-A.2
DIRECT TRANSPORTATION CAPITAL REVENUES OF DEVELOPMENT

Auto- and Transit-Related

Direct capital revenues are calculated to fully cover direct capital costs. The actual cost calculation is to produce revenue capable of covering costs. Unlike operating revenues, there is neither a surplus nor a deficit. Revenues are calculated carefully to directly cover forthcoming capital costs (Exhibit A-1).

Direct Transportation Capital Revenues Calculated in Step I-A.2
EXAMPLE: $6,933,062

Courtesy of Center for Urban Policy Research

EXHIBIT A-1

The Direct Transportation Capital Costs of Future Development: Model Outline

STEP 1-A.1 and STEP 1-A.2—DIRECT TRANSPORTATION CAPITAL COSTS AND REVENUES OF DEVELOPMENT

TYPE OF COSTS/ REVENUES	*DEPARTMENT*	*TRANSPORTATION COSTS/ REVENUES GENERATED*	*DOES DEVELOPER ACTUALLY PAY FOR COSTS? (where applicable ordinances exist)*
MUNICIPAL/COUNTY			
TOTAL COSTS	**OFFICE OF IMPACT FEES**	**New or Expanded Off-Site Roads**	
		Bike/Walking Lane Designations	
	VMT x Net Cost/VMT	**Deceleration Lanes**	**YES**
		Added or Improved Intersections	
		Traffic Signalization	
		Transit Capital	
TOTAL REVENUES	**OFFICE OF IMPACT FEES**		
	Total Property Tax/Other Taxes	**Amount Equal to Costs Incurred**	**YES**
SCHOOL DISTRICT	**OFFICE OF IMPACT FEES**		
TOTAL COSTS		**Parking Lots, Service Roads**	**YES**
		School Bus Pick-up Lanes	
	SPECIFIC ITEMS	**Handicapped Auto/Bus Access**	
TOTAL REVENUES	**OFFICE OF IMPACT FEES**		
		Amount Equal to Costs Incurred	**YES**

— DIRECT TRANSPORTATION CAPITAL COSTS VERSUS REVENUES —

COSTS: $6,933,062 [Step I-A.1]	**REVENUES: $6,933,062 [Step I-A.2]**

Source: Summary of materials and information of Step I-A.

STEP I-B.1

DIRECT TRANSPORTATION OPERATING COSTS OF DEVELOPMENT

Auto- and Transit-Related

The models involved in this aspect of transportation costs are those that calculate the direct operating costs and revenues of development. Costs are calculated first using the standard field fiscal impact model—the Rutgers Per Capita Multiplier Method—to calculate future direct operating transportation costs. What emerges from this model are the future operating expenditures for transportation caused by local development. This is done by isolating the transportation component of future public works, debt service, economic development, and other expenditures as part of municipal or county expenditures and, as well, the transportation component of future school district expenditures. In the first case, isolating transportation within public works expenditures at local or county levels provides information on how much is spent on regular road repair (potholes, crumbling curbs, and the like); cleaning (including litter pickup) and snow removal; repairs to road equipment (vehicles, traffic lights, signage); and road-care supplies (sand, salt, grit, tar). This also includes subsidies to local or regional transit. In addition, there is the debt service component of local and county budgets. This contains the active portion of nonimpact-fee–provided capital improvement plan (CIP) expenditures, including capital expenditures for major road resurfacings, overpass restructuring, and intersection realignment. It also includes the purchase of road equipment vehicles and local transit vehicles. The latter may be used for the disadvantaged, disabled, or elderly.

In order to calculate the direct operating costs of future development, the current municipal/-county general fund budget is divided into those operating expenditures serving persons versus those serving employees. This is done usually by calculating, first, the *number*, and second the *value* of residential properties as a share of all developed revenue-producing properties (office, retail [commercial], and industrial). These are averaged and applied to the current municipal/county budget to divide the budget into resident-supporting and employee-supporting services. Number of properties overassigns costs to residential; value of properties underassigns costs to residential. An average is most accurate. In cities of less than 100,000 population, the resident-supporting service share usually varies between 75 percent and 95 percent of the total municipal/county budget. In larger cities, it could be less. This component of services is divided by the current number of residents locally to develop a per person amount, which generally varies from $700 to $1,400 per person (2011$). The remaining 5 to 25 percent of the municipal or county budget is divided by the number of employees locally to develop a per-employee amount. This number varies from $150 to $350 per employee (2011$). These amounts, multiplied by the projected number of new persons and employees associated with development, yield total direct operating costs of development to the municipality or county. From total costs, general administration, public safety, public works, recreation and culture, and health and welfare costs are broken out first. Within each of these, the operating transportation costs to persons and employees are further isolated (Exhibit A-2). The U.S. Census of Governments has a component of municipal and county budgets that it labels as transportation. In the absence of local data this figure expressed as a percent of all costs could be used.

The most current annual school district budget is also used to derive total school district costs. This is divided by the number of students served to determine a per student amount for school services. This per student amount is then multiplied by the number of expected new students to develop total new school costs. To this number is applied the percentage of the current school budget that is devoted to regular transportation services (student and special education transportation) and the portion of the debt service number that involves school road

and parking lot repair and bus platform repair. These per student numbers, multiplied by the expected number of students related to development, are the direct school district transportation operating costs related to development (Exhibit A-2).

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Thus, the basic fiscal impact model takes the development pro forma (a detailed specification of components of development including number of units and size/value of units) and converts it to a demand generator of persons, students, and employees. From here, the direct model for operating (fiscal impacts) obligations takes over and calculates required per person and per student costs. These are then percent-aged to determine solely operational and debt service transportation costs.

To summarize, for direct transportation oper-ating costs, it is the transportation share of municipal or county departmental expenditures; it is also the transportation share of future municipal or county departmental debt service; and finally, it is the transportation share of future school district operating and debt service maintenance expenditures.

Direct Transportation Operating Costs Calculated in Step I-B.1
EXAMPLE: $2,953,381

STEP I-B.2 DIRECT TRANSPORTATION OPERATING REVENUES

Auto- and Transit-Related

Direct operating revenues are the share of direct operating costs by service provider (municipal or county and school district) that new transportation-related costs represent of total new operating costs. This percentage, applied to all revenues generated, is the share of revenues generated for these purposes (Exhibit A-2). There could be a surplus or a deficit associated with revenues related to costs. Often, residential development produces an overall deficit; nonresidential development produces an overall surplus. If the overall impact is a deficit, so too are transportation impacts. If the overall impact is a surplus, so too are transportation impacts.

Direct Transportation Operating Revenues Calculated in Step I-B.2
EXAMPLE: $1,880,255

EXHIBIT A-2
The Direct Transportation Operating Costs of Future Development: Model Outline

STEP 1-B.1 AND STEP 1-B.2—DIRECT TRANSPORTATION OPERATING COSTS AND REVENUES OF DEVELOPMENT

GENERAL FUND EXPENDITURES AND REVENUES
SCHOOL DISTRICT EXPENDITURES AND REVENUES

TYPE OF COSTS/ REVENUES	*DEPARTMENT*	*TRANSPORTATION COSTS/ REVENUES GENERATED*	*DOES DEVELOPER ACTUALLY PAY FOR COSTS?*
MUNICIPAL/COUNTY ADMINISTRATOR'S OFFICE			
TOTAL COSTS	**Public Safety**	**Road Repair/Management**	
	Public Works →	**Vehicle Operations/Management**	**NO**
	Economic Development	**Transit Subsidies**	
	Recreation and Culture	**Special Transportation**	
	Debt Service →	**Road Construction/Expansion**	
		Transportation Debt Currently Paid	**NO**
TOTAL REVENUES	**ADMINISTRATOR'S OFFICE**		
	Total	**% of Total**	
	Property Tax/Other Taxes	**Per Capita Amount**	
	Miscellaneous/Charges		
	Intergovernmental Transfers	**Per Worker Amount**	
SCHOOL DISTRICT ADMINISTRATOR'S OFFICE			
TOTAL COSTS	**Non-Personnel**		
	Student Transportation →	**Student/Special Transportation**	**NO**
	Debt Service →	**Transportation Debt Currently Paid**	**NO**
	TOTAL		
TOTAL REVENUES	**ADMINISTRATOR'S OFFICE**		
	Property Tax		
	Tuitions	**% of Total**	**NO**
	Miscellaneous Revenues	**Per Student Amount**	
	Intergovernmental Transfers		

— DIRECT TRANSPORTATION OPERATING COSTS VERSUS REVENUES —

COSTS: $2,953,381 [Step I-B.1]

REVENUES: $1,880,255 [Step I-B.2]

Source: Summary of materials and information of Step I-B.

STEP II—A.1

INDIRECT TRANSPORTATION CAPITAL AND OPERATING COSTS AND REVENUES

Auto- and Transit-Related

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Indirect capital costs amount to the impacts of the additional increment of residential or nonresidential development on required additional capital infrastructure. As was the case for direct impacts, these are primarily automobile related (e.g., roads, intersections, signalization, deceleration lanes, and so on) but may also include capital costs for transit.

The same initial procedures to calculate direct costs are used to calculate indirect capital costs. In other words, the new increment of indirect development is calculated from either new local consumer income expenditures of residential development occupants (generating additional commercial space and employees) or local residency decisions of new nonresidential development occupants (generating additional residential households and students occupying new housing) (Exhibit A-3).

This additional increment of development is then subjected to the basic capital cost calculations discussed under direct capital costs. For indirect automobile-related capital costs, one estimates vehicle-miles traveled (VMT) of the new increment of population, multiplied by the additional cost per vehicle-mile traveled. The net cost per VMT relates to the same basic considerations as in direct capital costs. These are (1) level of service (including service area); (2) improvement costs; and (3) revenue credits. Specifics for the above as they relate to level of service include defining whether it is an actual or desired level of service and finding a procedure to eliminate potentially chargeable current deficiencies. As it relates to improvement costs, the actual costs of improvements that would be delivered over the provision or use period must be calculated in current dollars. As it relates to revenue credits, only those costs paid for by capital revenues should be calculated; current property tax payments for similar items must be subtracted; and future sources of revenues from development occupants must be credited (motor fuels tax and so on).

The net cost per VMT is then multiplied by the peak-hour VMT for various types of units and by the number of units of each type to calculate indirect capital costs related to development (Exhibit A-3). As a practical matter, most of the cost parameters used for direct capital costs are reused in this section against the new increment of development.

Indirect Transportation Capital Costs Calculated in Step II-A.1
EXAMPLE: $1,289,409

STEP II—A.2

INDIRECT TRANSPORTATION CAPITAL REVENUES

Auto- and Transit-Related

Indirect capital revenues to support indirect capital costs equal the derived capital costs for indirect development (Exhibit A-3). As contrasted with the case for direct capital revenues, these capital costs are not directly chargeable to the initial development. The capital costs can be calculated and become the potential revenues associated with these indirect costs, but they may also be the direct costs of another development and, accordingly, are usually charged that way.

Indirect capital revenues amount to the capital cost per unit or per 1000 square feet times the

additional number of units and/or square feet of development that have been created by direct employees living in new housing outside the direct development. This is also contributed to by new employees occupying new nonresidential space outside the direct development due to the local expenditures of direct resident households (Exhibit A-3).

Indirect Transportation Capital Revenues Calculated in Step II-A.2
EXAMPLE: $1,289,409

STEP II—B.1

INDIRECT TRANSPORTATION OPERATING COSTS OF DEVELOPMENT

Auto- and Transit-Related

Indirect transportation operating costs are the costs engendered by those employees and persons who come to live in a jurisdiction related to direct growth. These costs involve a range of costs similar to direct operating costs; however, their magnitude is usually somewhat smaller.

Indirect transportation operating costs are engendered by new nonresidential development in the form of new local employees who choose to live in the community in which they work. A share of new office parks' employees live locally. They engender direct costs as employees, and they and their families contribute indirect costs if they choose to reside locally.

There are also the local or county and school district transportation operating costs of those employees who are a part of new or added nonresidential space supported by the local expenditures of direct new residents. These employees are located in new or added nonresidential space because consumer income is being spent by residents of new single-family or multifamily development within the community.

The indirect costs discussed above are felt by the municipality or county in terms of new public works components (transportation), operating costs (road repair/maintenance, road supplies and equipment). They are also felt by the municipality/county in the form of vehicles to transport the disadvantaged, disabled, and elderly. These are also new debt service obligations (road/intersection improvements and construction) paid out of the operating budget. These indirect costs are also felt by school districts that have to provide transportation services to the new students of indirect residences (Exhibit A-3). They are also felt by EMS vehicles supporting emergency cases.

For new nonresidential development to a community, indirect operating costs amount to the share of new employment to the jurisdiction that will live in new housing (outside the proposed development) in the jurisdiction. Nationwide, 41 to 44 percent of those who work in a jurisdiction (census-defined place) live in that jurisdiction. "Places" are cities, towns, townships, boroughs, and large developments that the census isolates. In almost all areas, they are smaller than counties. These percentages are most true for communities where income is closer to the median of the state. Where it is higher, percentage of residence is lower; where income is lower, percentage of residence is higher for those localities closer to the median, but the percentage drops off significantly as household income decreases (Exhibit A-3).

If the local provider of non-educational services is a county, the percentage of those who work and live in the same county varies from about 66 percent to 83 percent.

For nonresidential development, a share of those who come to work in a jurisdiction is then assumed to live in that jurisdiction in new housing. The number of existing property reoccupancies exceeds the number of new property occupancies nationwide by a factor of six to one. Thus, at the jurisdictional level, for the average-size jurisdiction, it is assumed that only a small percentage of new local employees occupy new owner or rental housing in the jurisdiction outside the original development. This number is obviously higher for counties.

For the other category of indirect impacts, those spawned by the expenditures of direct residents, the Rutgers Per Capita Multiplier Model has within it a subroutine that converts value of residential construction to household incomes of occupants. This is used to calculate the indirect employees that will be generated by primarily residential development. Household income of occupants is then converted first to disposable income (household income minus taxes and benefit charges). It is then converted to consumer income (disposable income minus housing expenditures) per household and allocated to either convenience goods or shopping goods. Each of these is adjusted by the percentage likely to be spent in the specific local jurisdiction. This percentage is usually larger for convenience goods than it is for shopping goods and more for a larger jurisdiction than for a small jurisdiction. The amount of money spent per household divided by the amount spent annually to support a square foot of shopping or convenience goods produces the new square footage required for additional nonresidential space.

Additional square footage of nonresidential space produces additional local employees/-families who cause transportation operating costs. These new people, multiplied by the per person costs to provide municipal or county non-educational local public services, multiplied by the public works, economic development, and debt-service shares—and within each, the transportation component—yield the indirect transportation operating costs of new residential development.

Those who live locally are given housing-type distributions and values/rents at the ratio of dollar per square foot of nonresidential rents or building costs, to the average for the jurisdiction or county. The above numbers are fed into a new mini-development pro forma that creates new household members and students who generate municipal/county and school district costs, a share of which are transportation related.

Indirect Transportation Operating Costs Calculated in Step II-B.1
EXAMPLE: $418,510

STEP II—B.2

INDIRECT TRANSPORTATION OPERATING REVENUES

Auto- and Transit-Related

Indirect transportation operating revenues are the percentage share of indirect transportation operating costs to total indirect operating costs, applied to *all* indirect operating revenues. They are calculated by considering all local revenues likely to flow to the jurisdiction (property tax, other tax, charges, miscellaneous revenues, intergovernmental transfers) and multiplying this revenue increment by the percentage of all indirect operating costs in a particular jurisdiction that are transportation related. This revenue increment could be larger or smaller in absolute amount than calculated costs. At the time of fiscal impact (revenues and costs), these transportation operating fiscal impacts often carry the same fiscal impact sign as is calculated for the development's fiscal impact on all services. If the overall impact (revenues – costs) is positive, the direct and indirect transportation impacts (revenues – costs) are positive; if overall impact is negative, usually the direct and indirect transportation impacts are negative (Exhibit A-3). This need not always be the case.

Indirect Transportation Operating Revenues Calculated in Step II-B.2
EXAMPLE: $267,215

EXHIBIT A-3
The Indirect Transportation Capital and Operating Costs of Future Development: Model Outline

STEPS II A and B — INDIRECT
TRANSPORTATION CAPITAL AND OPERATING COSTS/REVENUES OF DEVELOPMENT

GENERAL FUND EXPENDITURES AND REVENUES
SCHOOL DISTRICT EXPENDITURES AND REVENUES

	TYPE OF COSTS/ REVENUES	DEPARTMENT		TRANSPORTATION COSTS/ REVENUES GENERATED	DOES DEVELOPER ACTUALLY PAY FOR COSTS?
	A. CAPITAL				
	MUNICIPAL/	OFFICE OF IMPACT FEES			
COUNTY/		Municipal/County	→	New or Expanded Off-site Roads	
	SCHOOL DISTRICT			Bicycle/Walking Lane Designations	
TOTAL	COSTS			Deceleration Lanes	
				Added/Improved Intersections	NO
				Traffic Signalization	
				Transit Capital	
		School District	→	Student/Special Transportation	
				Parking Lots/Service Roads	
				School Bus Pick-up Lanes	
				Handicapped Auto/Bus Access	NO
	TOTAL REVENUES	OFFICE OF IMPACT FEES		Amount Equal to Costs Incurred	NO

—INDIRECT TRANSPORTATION CAPITAL COSTS VERSUS REVENUES —

COSTS: $1,289,409 [Step II—A.1]	REVENUES: $1,289,409 [Step II—A.2]

	TYPE OF COSTS/ REVENUES	DEPARTMENT		TRANSPORTATION COSTS/ REVENUES GENERATED	DOES DEVELOPER ACTUALLY PAY FOR COSTS?
	B. OPERATING				
	MUNICIPAL/COUNTY ADMINI	STRATOR'S OFFICE			
SCHOOL	DISTRICT				
	TOTAL COSTS	Public Safety		Road Repair/Management	
		Public Works	→	Vehicle Operations/Management	NO
		Economic Development		Transit Subsidies	
		Recreation and Culture		Special Transportation	
				Student/Special Transportation	
		SCHOOL DISTRICT			
		Debt Service		Road Construction/Expansion	
			→	Transportation Debt Currently Paid	NO
				School District Debt Currently Paid	
	TOTAL REVENUES	ADMINISTRATOR'S OFFICE			
	→	Total		% of Total	
		Property Tax/Other Taxes		Per Capita/Worker Amount	NO
		Miscellaneous/Charges			
		Intergovernmental Transfers		Per Student Amount	

— INDIRECT TRANSPORTATION OPERATING COSTS VERSUS REVENUES —

COSTS: $418,510 [Step II—B.1]	REVENUES: $267,215 [Step II—B.2]

Source: Summary of materials and information of Step II.

Courtesy of Jon Erickson

STEP III

INDUCED TRANSPORTATION CAPITAL AND OPERATING COSTS/REVENUES

Access brings development. A new road, an improved road, or a new or improved transitway—all of which enable improved travel times—draw residences and businesses to the location of the improved transportation site. In the long run this causes increased vehicle-miles traveled (VMT) to jurisdictions adjacent to the improved road or transitway. Whether this development is "induced" or "redistributed," in most instances it is development in a community/county that would not have occurred absent the improvement of the roadway or transit system. Several facts are more obvious than others as they relate to induced demand. Interstate and state highway road improvements or added pieces have more effect locally than county or local thoroughfare additions. Locations near exits on a limited-access highway prosper with these highway additions. At the metropolitan scale, impact is redistributive; at the local scale, it may be a determinant for one location or another. Since most interstate and state highways are already built, new or improved local or county through-roads are the typical target of induced demand analyses.

STEPS III — A and B
Induced Transportation Capital and Operating Costs

The elasticities of direct VMT can be used to calculate the impacts of induced demand. VMT related to development is not linear and varies with: (1) density (development), (2) diversity (development), (3) design (streets), (4) destination (accessibility), (5) (distance to transit), (6) development (scale), and (7) demographics.

A descriptor of the development using the first five of the above seven "D's" is used to characterize the development. This descriptor would also contain residential units and non-residential space. This would yield a direct VMT figure (a nonlinear function of VMT) as well as lane-miles of additional roadway capacity (holding constant the chosen level of service). This calculation employs elasticity ratios (that might vary from 0.1 [at initiation] to 0.9 [steady-state]) to calculate induced VMT. This produces extra lane-miles of roadway capacity to serve the induced VMT. Because new population and employment are necessary for this calculation, a slightly different procedure will be used.

Induced transportation involves both redistributed traffic and final steady-state traffic on a road with new capacity. At the beginning, it is mostly redistributed traffic that has taken advantage of the new capacity. At steady-state conditions (a considerable time after that improvement is made), it involves a share of new residents brought to the area, also taking advantage of the new capacity.

The initial activity at a location is the combination of population and employment. Induced transportation as a result of a road improvement causes additional activity. In this example, the initial activity is the original population and employment of the

Courtesy of Jon Erickson

jurisdiction before direct development; the induced activity is a function of the direct and indirect activity. The direct and indirect development adds about 26 percent extra population and employment to the jurisdiction. The percentage increase in highway capacity as a result of the direct and indirect development is assumed equal to the percentage increment of activity added during these stages (26 percent).

The elasticity applied to the road capacity increase (26 percent) is the average elasticity of VMT with respect to capacity, which again could be as low as 0.1 percent at initiation and 0.9 percent at steady-state. An average elasticity of 0.5 is assumed. This elasticity is multiplied by the percentage of persons who will live inside the jurisdiction in new housing (as opposed to outside the jurisdiction or in existing housing). This is 50 percent, or 0.5.

The calculation to estimate induced population increase is thus 26 percent (direct and indirect activity) multiplied by the elasticity (0.5) and then multiplied by the percentage who live inside the jurisdiction in new housing (0.5). The induced combined activity increase is thus about 6.5 percent (26 percent x 0.5 x 0.5). This number of new residents and employees is used with the capital cost procedure to calculate induced capital costs and with the fiscal impact procedure to calculate new operating costs. The results for both are shown below.

Induced Transportation Capital/Operating Costs Calculated in Steps III and III	
EXAMPLE: $1,948,599 (Capital)	EXAMPLE: $2,241,657 (Operating)

STEPS III — A and B
Induced Transportation Capital and Operating Revenues

At the time of fiscal impact (revenues minus costs), the resultant fiscal calculation should usually carry the same sign of revenues in their relationship to costs that was determined under direct operating costs. Thus, if revenues minus costs under direct operating costs resulted in a deficit, operating costs in the final step will most probably, although not always, exceed operating revenues and also produce a deficit.

Induced capital revenues are equal to the costs derived in the calculation for induced capital costs (Exhibit A-4).

Induced Transportation Capital/Operating Revenues Calculated in Step III	
EXAMPLE: $1,948,599 (Capital)	EXAMPLE: $1,293,346 (Operating)

Exhibit A-4

The Induced Transportation Capital and Operating Costs of Future Development: Model Outline

STEPS III A and B —
INDUCED TRANSPORTATION CAPITAL AND OPERATING COSTS/REVENUES OF DEVELOPMENT

GENERAL FUND EXPENDITURES AND REVENUES
SCHOOL DISTRICT EXPENDITURES AND REVENUES

TYPE OF COSTS/ REVENUES	*DEPARTMENT*	*TRANSPORTATION COSTS/ REVENUES GENERATED*	*DOES DEVELOPER ACTUALLY PAY FOR COSTS?*
A. CAPITAL			
MUNICIPAL/ COUNTY/ SCHOOL DISTRICT TOTAL COSTS	COUNTY TRANSPORTATION OFFICE		
	Municipal/County → Elasticities used to calculate induced VMT; from here, follow calculations of Direct Road Capital Costs	General Amount— Not Subdivided by Category	NO
	School District → Use ratio of Induced Road Capital Costs to Direct Road Capital Costs; apply to Direct Capital School District Costs	General Amount— Not Subdivided by Category	NO
	TOTAL		NO
TOTAL REVENUES	COUNTY TRANSPORTATION OFFICE	Amount Equal to Costs Incurred	

— INDUCED TRANSPORTATION CAPITAL COSTS VERSUS REVENUES —

Example: COSTS: $1,948,599 [Step III—A.1]	REVENUES: $1,948,599 [Step III—B.1]

TYPE OF COSTS/ REVENUES	*DEPARTMENT*	*TRANSPORTATION COSTS/ REVENUES GENERATED*	*DOES DEVELOPER ACTUALLY PAY FOR COSTS?*
B. OPERATING			
MUNICIPAL/COUNTY SCHOOL DISTRICT TOTAL COSTS	COUNTY TRANSPORTATION OFFICE		
	Ratio of Induced Capital Costs (see below) to → Direct Capital Costs; apply to Direct Municipal/County Operating Costs	General Amount — Not Subdivided by Category	NO
	SCHOOL DISTRICT		
	Ratio of Induced → Municipal/County Operating Costs to Direct Municipal/County/ Operating Costs; apply to Direct Operating School District Costs	General Amount — Not Subdivided by Category	NO
TOTAL REVENUES	COUNTY TRANSPORTATION OFFICE		
	→ Ratio of Direct Operating Surplus/Deficit applied to Induced Operating Costs	Amount Proportional to Revenues that Caused Fiscal Costs	NO

— INDUCED TRANSPORTATION OPERATING COSTS VERSUS REVENUES —

Example: COSTS: $2,241,657 Step III—B.1]	REVENUES: $ 1,293,346 [Step III—B2]

Source: Summary of materials and information of Step III.

CONCLUSIONS

The Scope of the Model

The transportation costs of new development are an intricate web of impact fee procedures for capital costs and fiscal impact analysis for operating costs. Even these are not that straightforward in that: (1) these capital costs are used only for direct impacts in the typical impact fee calculation; and (2) these operating costs in isolation are rarely sought as part of the usual fiscal impact analysis.

Calculating the direct transportation cost impacts of new development requires the above two steps to be activated by a development pro forma. The development pro forma produces the persons, employees, and students that will generate requirements for the necessary roads, road improvements, intersection improvements, and signalization for automobile capital expenditures. This pro forma also produces the demand for road repairs, cleaning, plowing, litter removal, and line-striping for automobile operational expenditures. A portion of these capital and operating expenditures involves public transit, especially for schools and the disadvantaged and disabled, and increasingly for the aged.

Indirect transportation costs of new development involve those who are attracted to the community as a result of the first development increment. These are employees who, along with their families, choose to live nearby or employees who occupy retailing generated by the consumer income of new persons, development residents, or persons who are part of a nonresidential development and choose to live nearby. Both of these types of additional growth related to the initial growth have cost impacts that are calculated identically to the original growth increment. Usually, this development increment's costs are a fraction of the original development because most nonresidential developments' employees often do not live in the community where development takes place; if they do, they live primarily in existing housing, for which equal-replacement impact on capital requirements and operating services and is assumed.

The final component of development impacts involves costs brought about by transportation system improvements and those who are attracted locally due to these improvements. This causes another component of development that also has additional capital cost and operations implications for the jurisdiction. These also could be relatively minor impacts to the jurisdiction itself. This is because: (1) induced traffic may come from rerouted sources as opposed to induced development; (2) residents from induced development may live in the region and not in the specific community; and (3) people from induced development who choose to live in the community may buy existing rather than new housing.

Insofar as accounting is concerned, in most jurisdictions there is no accounting. These jurisdictions require neither impact fees for capital costs nor fiscal impact analysis for operating costs. In these cases, no money is exchanged, and transportation impacts of particular developments are funded as part of local property tax and other revenues. Additional costs may be planned for and funded at the metropolitan planning organization or state level, or even generally funded by the local capital improvements program, but no organized impact assessment procedure exists to relate these transportation costs to specific segments of development or to charge the developer for these transportation costs.

In less than half of the nation's states do jurisdictions regularly calculate and charge impact fees for capital facilities. When this is done, it is almost always for roads, very seldom for transit, and is almost never done separately for school district transportation capital costs. This, then, is one instance where transportation costs (usually related to roads) are diligently tracked for one component of these costs, and charges are actually levied. It happens, though, on a regular basis in only a small portion of the nation's local jurisdictions.

Additionally, in some locations, direct fiscal impact analysis is required to gauge the

magnitude of operational impacts. In these locations, even though the magnitude of operational impacts is calculated, it is almost never calculated for transportation impacts, and their results *never* lead to any type of direct charging other than what subsequent residents or businesses pay in local property and other taxes.

Indirect capital costs are usually not calculated simply because they are viewed as the direct capital costs of another development. Indirect fiscal impact analyses are also almost never done (1 in 10 analyses), and never is this related to transportation operating costs. Impact fee procedures do not recognize operational costs (because they would be an unauthorized tax at the local level), and they do not recognize indirect or induced costs because of the issue of double-counting what are believed to be subsequent primary costs. Finally, induced development costs are virtually never calculated and have not been seriously considered to actually charge a development because of the uncertainty of the presence and magnitude of these costs (Exhibit A-5).

In sum, there are procedures in the field that are available to calculate and assign various types of transportation capital and operating costs. They exist as part of models that are almost never brought together to calculate development impacts much less development impacts on transportation. It is now time to put forward an integrated model that calculates these costs (and revenues) so that the field can adequately assess both the magnitude and causation factors of these costs (Exhibit A-5).

Because no organized effort exists, these models traditionally have been used for other purposes whose outputs are both limited for transportation evaluation and may call for something that they should not, i.e., no indirect capital cost impact fees.

Techniques are available, however, to calculate these costs and to relate them to the initial development source. This is the benefit of the model and guides. Careful documentation is included as to whether these costs could or should be charged against an individual development increment.

Total Transportation Capital Costs/Revenues Calculated in Steps I–III (A and B)	
EXAMPLE: $10,171,070 (Costs)	EXAMPLE: $10,171,070 (Revenues)

Total Transportation Operating Costs/Revenues Calculated in Steps I–III (A and B)	
EXAMPLE: $5,613,548 (Costs)	EXAMPLE: $3,440,817 (Revenues)

Limitations of Models Generally

The statement of methods and model that are being introduced to the transportation field via this document involves one of the most comprehensive yet targeted transportation cost methods/models ever produced. The purpose of this research was to produce/assemble methods and a model that calculated the transportation costs of new development. These methods/model are the very best that can be assembled at this point in time. They are put together by the most experienced academics/professionals that practice in these areas. A great deal of effort has gone into preparing each of the research products associated with the overall effort.

EXHIBIT A-5
THE TRANSPORTATION COSTS (AND REVENUES) OF NEW DEVELOPMENT: SUMMARY DISPLAY

		STEP I-A: DIRECT TRANSPORTATION CAPITAL COSTS (IMPACT FEES)			***STEP II-A: INDIRECT TRANSPORTATION CAPITAL COSTS (A FRACTION OF DIRECT)***			***STEP III-A: INDUCED TRANSPORTATION CAPITAL COSTS (A FRACTION OF DIRECT)***			***STEP IV-A: TOTAL TRANSPORTATION CAPITAL COSTS CHANGE (∑ I-III)***	
		COSTS	**REVENUES**		**COSTS**	**REVENUES**		**COSTS**	**REVENUES**		**COSTS**	**REVENUES**
CAPITAL COSTS/ OPERATING COSTS:	**A. CAPITAL COSTS**	$6,933,062	$6,933,062	+	$1,289,409	$1,289,409	+	$1,948,599	$1,948,599	≈	$10,171,070	$10,171,070
NEW DEVELOPMENT (2,000 UNITS RESIDENTIAL; 750,000 ft.[2] NONRESIDENTIAL)		***STEP I-B: DIRECT TRANSPORTATION OPERATING COSTS (FISCAL IMPACTS)***			***STEP II-B: INDIRECT TRANSPORTATION OPERATING COSTS (A FRACTION OF DIRECT)***			***STEP III-B: INDUCED TRANSPORTATION OPERATING COSTS (A LARGE FRACTION OF DIRECT)***			***STEP IV-B: TOTAL TRANSPORTATION OPERATING COSTS CHANGE (∑ I-III)***	
		COSTS	**REVENUES**		**COSTS**	**REVENUES**		**COSTS**	**REVENUES**		**COSTS**	**REVENUES**
	B. OPERATING COSTS	$2,953,381	$1,880,255	+	$418,510	$267,215	+	$2,241,657	$1,293,346	≈	$5,613,548	$3,440,817
									TOTAL TRANSPORTATION COSTS OF DEVELOPMENT		$10,171,070 $5,613,548	$10,171,070**(C)** $3,440,817**(O)**
ACCOUNTED FOR	**CAPITAL/ OPERATING**	$6,933,062 $2,953,381	$6,933,062 $1,880,255		NONE $418,510	NONE $267,215		NONE NONE	NONE NONE		$6,933,062 $3,371,060	$6,933,062 $2,147,471
ACCOUNTED FOR AND ACTUALLY CHARGED	**CAPITAL/ OPERATING**	$6,933,062 NONE	$6,933,062 NONE		NONE NONE	NONE NONE		NONE NONE	NONE NONE		$6,933,062 NONE	$6,933,062 NONE
IGNORED FROM ACCOUNTING	**CAPITAL/ OPERATING**	NONE NONE	NONE NONE		$1,289,409 NONE	$1,289,409 NONE		$1,948,599 $2,241,657	$1,948,599 $1,293,346		$3,238,008 $2,241,657	$3,238,008 $1,293,346
IGNORED FROM CHARGING	**CAPITAL/ OPERATING**	NONE $2,953,381	NONE $1,880,255		$1,289,409 $418,510	$1,289,409 $267,215		$1,948,599 $2,241,657	$1,948,599 $1,293,346		$3,238,008 $5,633,573	$3,238,008 $3,464,167
NET CHARGED	**CAPITAL/ OPERATING**	$6,933,062 NONE	$6,933,062 NONE		NONE NONE	NONE NONE		NONE NONE	NONE NONE		$6,933,062 NONE	$6,933,062 NONE

O = Operating; C = Total Capital

Source: Summary of materials and information of Steps I-IV A and B.

It should be realized, however, that there is never a totally appropriate vehicle to model and interpret real world actions. This is the Achilles heel of model building and one not avoided in this effort. At best, included here are approximations of the steps involved in providing services to new development. Associated with these steps are costs. Since the steps are approximated so too are the costs. While these costs are carefully put together, they have their limitations. Other processes may produce other costs.

The data that are included here encompass: (1) a description of the development; (2) various items from the local municipal/county or school district budget; (3) local financial information that may not be found in the budget such as property tax rate and equalization ratio; (4) nonproperty tax revenues expressed per capita or per $1000 property valuation; (5) information from the Abstract of Ratables on the total valuation and number of residential and nonresidential parcels; (6) residential demographic multipliers by housing type—nonresidential employment multipliers by employment category; (7) input-output multipliers used in the approximation of overall costs.

Like methods, there may be better data or alternative data. The research team believes that these are the best and most appropriate data but the user may choose to develop other data sources.

What the Model Can Do

The Transportation Costs of New Development Model will produce the three stages or levels of costs believed to be associated with new development. These are direct, indirect, and induced costs. It will produce values for both capital and operating costs. The Model will do this almost instantaneously with minimal data entry; it will do this over a longer period time with detailed, site-specific data.

The Model can show the user the differences in scale between direct, indirect, and induced costs. It can show differences between regular recurring operating costs and one-time, capital costs. The Model can show deficits/surpluses on the operating side and the exact amount of revenues necessary to cover costs on the capital side.

The Model can do the above with the accuracy and precision of the data that have been entered. The best scenario involves all collected data specific to the site of the development application. These data reflect local conditions and are probably very current and accurate. Other data, because they may not be specific to site of analysis provide potentially less accuracy. This is the choice of the user.

What the Model Cannot Do

The Model was never meant to be used to charge developers a fee for either their overall impacts or their transportation impacts. The impact fee procedure discussed in this Guide is meant to provide an estimate of the net capital costs associated with development and the transportation capital costs associated with this same development. So too, with operating costs. Using the fiscal impact procedure was never meant to show that a fiscal deficit was created and had to be made up with an annual stipend provided by the developer. Similarly, if an operating surplus was created the municipality would not be obligated to reimburse the developer this amount.

Both the full impact fee procedure and the impact fee procedure's nuances have not been included here. Neither have those procedures and nuances of fiscal impact analysis. As such, the Model is insufficient to calculate either full impact fees or true fiscal surpluses or deficits. The model is well capable, however, of providing an accurate estimate of the transportation costs associated with new development. This is what is should be used for and what it does well.

STEP I—A

Direct Transportation Capital Costs

INTRODUCTION—THE CALCULATION OF CAPITAL COSTS

Direct impacts of development on transportation capital costs have been reacted to through the specific assignment of capital costs to a developer or to the general public to pay for these costs (Snyder and Stegman 1986). Whether these are for transportation, land, or public buildings, in the form of impact fees (to a developer) or debt/debt service costs (to the general public), these costs are calculated similarly (Purdum and Frank 1987). The practitioner literature on capital cost calculation comes primarily from the consultant literature on impact fees (Blaesser and Kentopp 1990). From this point on, impact fee calculations will be termed "capital cost calculations." Three examples of capital cost calculations are shown here. They are typical of the field products at the project level.[2]

Courtesy of G. Lowenstein

Capital costs are one-time payments to help finance growth-related infrastructure that is needed to accommodate development (Nelson 1988). An important step in the capital cost methodology is establishing the criteria that distinguish "system improvements" from "project-level improvements" (Nelson 2006; see also Bauman and Ethier 1987). The former are funded through capital cost charges while the latter are addressed through development agreements or exactions for individual projects (Freilich and Bushek 1995). System improvements benefit multiple development projects, or even the entire jurisdiction (Singell and Lillydahl 1990). For example, a traffic signal that facilitates access to a shopping center is a project-level improvement, whereas a traffic signal a mile away from the shopping center, at the intersection of two arterial streets, would be regarded as a system improvement that expands the capacity of the entire transportation network (Brueckner 1997).

The typical capital cost methodology uses a generic three-step capital cost formula as a framework for analysis (Nicholas 1987b). The generic capital cost formula, illustrated in Exhibit I–A.1 below, is a simple multiplication of three ratios (Nelson 2006). The first ratio, shown in the left box, specifies the relationship between demand units and development units. Determining the "best" demand indicator for each type of infrastructure is an important step that may highlight or mask relative variation in service demands by type of housing (Blewett and Nelson 1988). The second ratio, shown in the middle box, is the typical level-of-service (LOS) standard that most people associate with capital cost charges. Quantitative measures, such as acres of parks per thousand persons, establish the relationship between infrastructure units and demand units. The third ratio in the generic capital cost formula is also an important quantitative standard because cost factors vary significantly across the country. This is essentially how the Per Capita Multiplier Method in fiscal impact analysis is used to create "demand units per development unit," and in the case of residential development, the number of persons and number of units. These will be discussed in depth later.

[2] *Note:* The reason that the impact fee procedure is chosen here is that it is one of the few local capital cost procedures that specifically isolates and assigns capital costs to new development.

Exhibit I–A.1
Basic Capital Cost Calculation Steps

Source: Exhibit courtesy of Dwayne Guthrie (in Nelson 2006)

CAPITAL COST CALCULATION MODELS

This portion of the section reviews transportation capital cost models used commonly among some of the nation's leading practitioners in the field. These models are:

- Nelson/Nicholas (2000) for Martin County, Florida
- Duncan Associates (2004) for Tucson, Arizona
- Henderson-Young (2003) for Osceola County, Florida
- Tischler-Bise (2005) for Effingham County, Georgia
- Tindale-Oliver (2004) for Albuquerque, New Mexico

All models presented are in active use and none have been overturned in court. All generate substantial amounts of revenue for their respective communities (Frank and Downing 1988). Additional models using the proportionate-share transportation impact fee calculation methodology developed by these and other practitioners as applied to operations and maintenance are also discussed. The purpose of this exercise is to choose a set of procedures reflective of field practice that embodies all or most of the aforementioned steps. This will draw upon a variety of field models.

Courtesy of C. Galley

Capital Cost Steps

Transportation capital costs—or more simply "road" capital costs since the vast majority of these kinds of capital costs are used to help finance road capital costs—were developed in the 1970s, principally in Florida (York 1995). California and other areas had exacted road improvement concessions from development for several decades (Abbott 2001), but Florida pioneered the capital cost approach reviewed in detail earlier (Florida Advisory Council on Intergovernmental Relations 1991; see also Clarke and Evans 1999; Lawler and Powers 2004).

Impact Fee Service Areas

There is no precise ordering of the capital costs design steps outlined previously because capital costs procedures need to design service areas to ensure reasonable benefit to development paying capital costs—in particular that the charges paid will be used to benefit the development that is charged—many capital charge planning processes begin with service-area design (Bringardner 2000). There are also no hard-and-fast rules on how this is done, however, so the design depends in large part on local assessment of travel demand through a combination of engineering and planning assessments. Albuquerque, New Mexico, for example, has seven service areas (Tindale-Oliver 2004), yet for about the same land area Atlanta, Georgia (Duncan Associates and Nelson 1993) has one. San Diego, California, with about the same land area but a multiple of population, has twenty-three (Nelson 1988). All models include service area considerations even though the number of declensions may vary considerably (Gilliland, Krebs, and Vanderberg 1992).

Exhibit I–A.2
Atlanta Existing Transportation Level of Service

Level of Service Factor	Citywide Demand
1992 Estimated VMT (All Links)	337,265
1992 VMC (All Links)	478,217
1992 VMT/VMC Ratio	0.7053

Source: Duncan Associates and Nelson 1993

Calculating Aggregate Demand

The next step in the design process is assessing aggregate demand in relation to supply or the capacity of the system to handle traffic. With minor variation, all models begin with an assessment of current conditions. Exhibit I–A.2 shows the result of an assessment of road demand for Atlanta based on analysis of engineering consulting firms used by Duncan Associates and Nelson (1993). This is a common but not universally applied approach to assessing current demands, but the variants are mathematically comparable.

Determining Level of Service

From here, decisions are made as to the level of service (LOS) that will drive transportation planning as well as capital costs calculation. Selection of the LOS is nuanced greatly by state departments of transportation. For example, the Florida DOT has a highly developed matrix of LOS by road type and function, yet Georgia, as most states, does not (Nicholas 1992). Many jurisdictions revert to the classic A-B-C-D-E-F LOS approach devised initially by the Institute of Traffic (now Institute of Transportation) Engineers and then by the Transportation Research Board. There is no convention on the appropriate LOS policy for any given service area – it is largely a question of how heavily used local officials want roads to be, keeping in mind that higher VMT/VMC ratios result in lower capital costs per trip-mile. All models include identification of the LOS that will then drive projections of future demands and costs (Montana Department of Transportation 2002).

Calculating the Demand Unit

The demand unit is often the next consideration. Normally, the impact unit is the trip-miles (“vehicular miles of travel”) of peak or average daily demand assigned to each land use (Hodge and Cameron 1989). The choice of peak or average daily demand is subject to local decision. While there may be preference to design facilities to meet the peak demand, it is often the case that cost implications and simple impracticability to meet peak demand at an LOS less than congestion results in choosing the average daily approach. The choice of trip-miles versus trips is also important. Early transportation capital costs studies were based only on trip generation by land use. Best current practices would use trip-miles as the impact fee unit (Landis 2001).

Type of Costs

Type of costs becomes logically the next consideration that is apparent in all models. The approach to calculating costs to accommodate new development comes in two versions: increment-expansion based or capital-improvement based. Not knowing exactly which facilities to build or when, the increment-expansion based approach is used most commonly. In this approach, the average cost per lane-mile of capacity based on recently completed projects or those set out in the capital improvement program or plan becomes the multiplier (Nelson and Nicholas 2001).

Cost Unit

The cost unit is the cost per unit of demand to meet transportation needs (McFarlane 1999).

This is often calculated in one of two ways: cost per trip or cost per trip mile. Initially, transportation capital costs were calculated based on the cost per trip to serve new development. Trip data came from the Institute of Transportation Engineers' *Trip Generation* book (2003, Seventh Edition). The cost-unit calculation has evolved among most (but not all) consulting firms to include cost per trip-mile of a development that includes trip generation either from the ITE or local studies, multiplied by the distance per trip either from federal sources (such as the *Nationwide Household Transportation Survey* (Federal Highway Administration 2001) or its successor(s), local transportation planning agencies (such as Metropolitan Planning Organizations), or specialized studies by engineers. This calculation itself has evolved over the years to adjust for pass-by and diverted trips, the trip distance assignable to a local government jurisdiction, origin- or destination-only trips (to avoid double-counting the same trip), and other purposes (Nelson 2004).

Unit Size

The size of a development is important in determining the impact on a transportation system. Office buildings, shopping centers and the like impact on road systems based mostly on their size. So do residential land uses. In early years, capital cost calculations for residential land uses did not account for differences in the size of those units even though such data as the *American Housing Survey, Nationwide Household Transportation Survey*, and *American Community Survey* showed that up to a point, the larger the residential unit, the more the trips and the greater the trip-miles. Some practitioners still do not make these refinements, but whether it is done by size or number of bedrooms, most practitioners calculating capital costs consider size. If the charge is considered by size, so too should be any calculated credits (Nelson 2005).

Courtesy of C. Galley

Credits

Credits are adjustments made to reflect the net capital cost of new development on transportation systems. Capital cost principles require that new development pay only for its net capital facility impacts on transportation systems. Technically, the total or "gross" cost of meeting new development needs are estimated and then reduced by the availability of federal, state, local and other funds that may be used to help finance the same facilities. A critical element of this process is to calculate new revenues that new development may generate to help pay for the very facilities that capital cost charges finance. This addresses the double-payment issue raised earlier. Common sources of new revenue generated by new development include state and local gasoline taxes, and property and sales taxes that are dedicated to transportation capital costs or routed through local general funds for the same purpose. Although they may vary by procedure, most capital cost analysts attempt to account for "revenue credits." These calculations, however, do not address operations, maintenance, repair, or replacement costs. As indicated above, if the cost is scaled by size, so too should be the credit (Nelson, Nicholas and Juergensmeyer 2008).

LEVELS OF SERVICE AND SERVICE AREAS

As indicated above, transportation planning is often based on determining needs for small areas, called service areas, in relation to some overall target of consumption, called level of service or (LOS). Both will be discussed here.

The Transportation Costs of New Development Model can be used to address virtually any size area from a city to a county to a region to a state and even to a nation; the only limiting factor is suitable data for any given area. The model is, however, designed to be based on a single jurisdiction, usually a municipality or a county. But the model is adaptable to larger or smaller areas. Sub-municipal or sub-county areas, are called service areas.

Levels of Service

Conceptually, "Level of service" (LOS) is a measure of the relationship between service capacity and service demand for public facilities in terms of demand-to-capacity ratios or the comfort or convenience of use or both. If, for example, roadways are congested, one would conclude that the level of service provided by these facilities is low. However, in some cases a community might be willing to tolerate a relatively low level of service. This could be because a low level of service is less expensive to provide, or because it promotes some other policy objective (such as congestion that might encourage use of mass transit alternatives).

Adopted versus Existing Levels of Service

A distinction should be made between the actual level of service, which can be measured at a given point in time, and the desired level of service. Ideally, the desired level of service is formally adopted in the local government's comprehensive plan. The relationship between the adopted level of service that is used to calculate the transportation costs of new development and the actual level of service existing at the time of capital cost assignment has important implications in financing future transportation facilities to serve the needs of development. These implications are summarized in Exhibit I-A.2a.

Exhibit I-A.2a
Adopted Level of Service Compared with Existing Level of Service

Characteristic	Below	Same	Higher
Costs of New Development	Low	Moderate	High
Future Level of Service	Decline	Maintain	Improve
Existing Deficiencies	None	None	Remedy
Excess Capacity	Recoup	None	None

Source: *Development Impact Fees, Final Report*. Duncan & Associates, Arthur C. Nelson, et al., Atlanta, Georgia (1993).

If a community establishes a desired level of service that is higher than the existing level, existing facilities will be found to be deficient when compared to the adopted standard. It would be inequitable, and in the case of capital cost charging perhaps illegal, to have new developments be charged to elevate the current level of service to the desired level of service – especially if existing development is not also charged to accomplish the same thing. The community should "remedy" the "deficiency" from sources other than new development.

Conversely, the community could adopt a level of service that is *below* the level currently provided. This would mean that existing facilities have excess capacity that would be available to serve new development. Some communities may consider "recouping" the value of the investment which was essentially for the benefit of new development. While recoupment can be used for revenue enhancement setting an artificially low level of service for this purpose alone would be shortsighted. Once the excess capacity has been absorbed, the community may find such

degraded conditions untenable and may incur higher future costs to regain some degraded level of service.

The third option, of course, is to adopt a level of service that is identical to the existing level of service. This is often the simplest and most direct approach. It does not create any existing deficiencies or excess capacity, and simply charges new development the cost to maintain the level of service that existed prior to the development.

The level of service can vary by service area. For instance, a municipality may be willing to tolerate higher levels of traffic congestion in the downtown area, where alternative transportation options such as mass transit are more readily available, than in outlying areas, where the automobile is the primary transportation mode. If there is a logical reason for providing more intensive services in a particular part of a community or constraints that prevent extending capital facilities to certain areas, it may be best to assign different levels of service to different service areas, and provide the reasons for this in the comprehensive plan.

Service Areas

It is now necessary to turn to service areas which are geographic areas defined by a community ideally based on sound engineering and planning principles. Natural or environmental boundaries such as aquifer recharge areas, watersheds or flood plains might be used in defining service areas. Planning considerations might include political divisions or utility service boundaries. Other planning considerations include traffic analysis zones, census tracts, facility maintenance districts, neighborhood planning units, and so forth.

Albuquerque, New Mexico, will be used as an example in its design of seven service areas for capital cost calculation purposes. As mentioned previously, Albuquerque decided to create seven service areas for the purpose of determining the transportation costs of new development. In contrast, Atlanta, which is a city of about the same population size and geographic area, determined it needed only one service area. The reason for seven in Albuquerque is that not all the areas of the city were expected to have the same amount of growth in development (and, therefore, in roadway facilities demand and capacity needs) over the next 20 or so years. Therefore, based on expected growth rates for the 2002-2025 period and existing city traffic sheds, the City of Albuquerque was subdivided into seven service areas:

Courtesy of Jon Erickson

- *Downtown*
- *NE Heights*
- *Near North Valley*
- *Far NE Heights*
- *I-25 Corridor*
- *NW Mesa*
- *SW Mesa*

Figure 1 illustrates these seven service areas on a map of the City of Albuquerque.

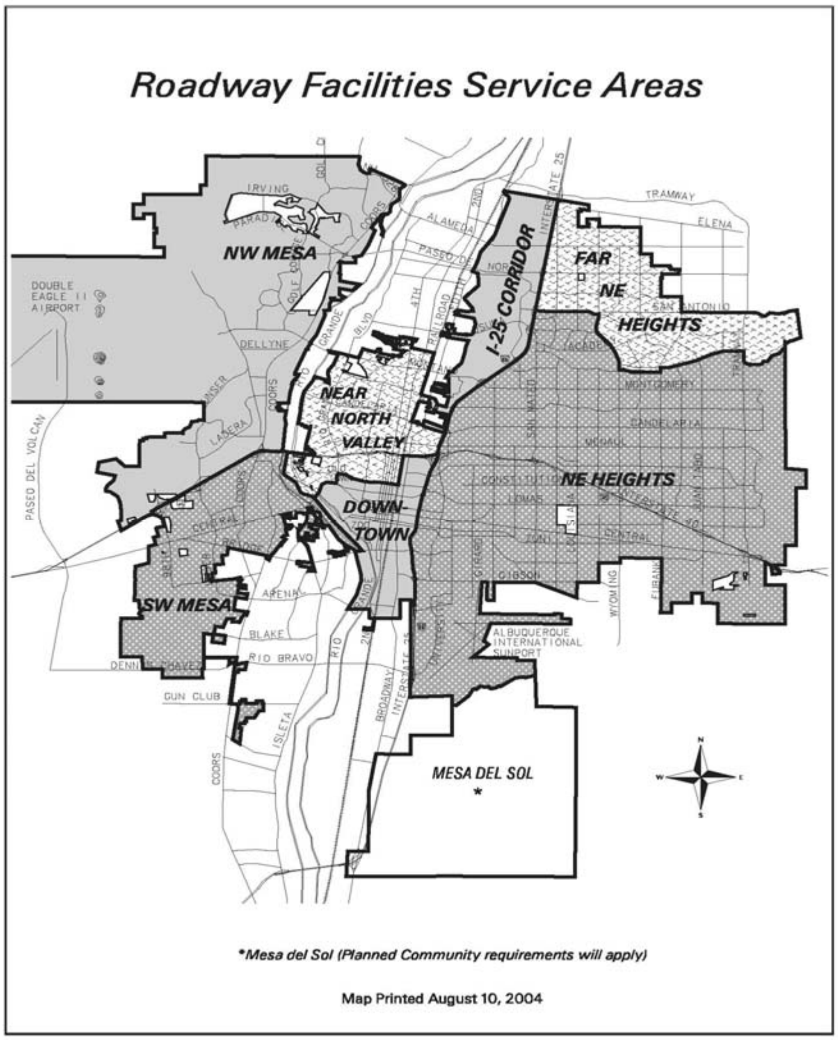


Figure 1. Albuquerque transportation facility service areas.

Source: *Roadway Impact Fee Final Report*, Tindale-Oliver & Associates and Arthur C. Nelson et al., Albuquerque, New Mexico (2004).

Although the city has one level of service standard citywide, each service area has its own costs to meet the needs of new development, as seen in Exhibit I-A.2b.

Exhibit I-A.2b
Estimated Cost per Lane Mile by Service Area
Within the City of Albuquerque, 2002-2025

#	Service Area	# of Projects	Total Cost	Lane Miles Added	Avg. Lane Mile Cost
1	DOWNTOWN	N/A	N/A	N/A	N/A
2	NE HEIGHTS	4	$32,449,228	19.88	$1,632,255
3	NEAR NORTH VALLEY	1	$7,690,710	4.54	$1,693,989
4	FAR NE HEIGHTS	3	$12,393,267	6.18	$2,005,383
5	I-25 CORRIDOR	2	$8,571,585	5.06	$1,693,989
6	NW MESA	36	$173,059,625	85.20	$2,031,216
7	SW MESA	23	$90,139,480	45.50	$1,981,087
Total		**69**	**$324,303,894**	**166.36**	**$1,949,410**

Source: *Roadway Impact Fee Final Report*, Tindale-Oliver and Associates and Arthur C. Nelson et al., Albuquerque, New Mexico (2004).

However, since other revenues are also available to cover many of these costs – such as state and federal highway funding and local bond issues paid off by all development citywide, the "net" transportation cost of new development goes down. Exhibit I-A.2c shows the transportation cost to serve new development in terms of capital cost charges for each of Albuquerque's seven service areas, based on a broad range of new development types.

Courtesy of Center for Urban Policy Research

Exhibit I-A.2c
City of Albuquerque: Net Transportation cost of New Development Schedule

ITE LUC	Land Use	Unit	Service Area: Downtown	NE Heights	Near North Valley	Far NE Heights	I-25 Corridor	NW Mesa	SW Mesa
	RESIDENTIAL:								
210	Single Family Detached / Mobile Home Indv Lot								
	Less than 1,500 sf	du	$0	$0	$0	$1,069	$2,113	$2,626	$2,702
	1,500 sf to 2,499 sf	du	$0	$0	$0	$1,585	$3,160	$3,933	$4,046
	2,500 sf or Larger	du	$0	$0	$0	$1,754	$3,521	$4,388	$4,516
220	Multi-Family	du	$0	$0	$0	$512	$1,276	$1,651	$1,706
230	Condominium/ Townhouse	du	$0	$0	$0	$218	$885	$1,212	$1,260
240	Mobile Home Park	du	$0	$0	$0	$765	$1,344	$1,629	$1,671
251	Retirement Home	du	$0	$0	$0	$74	$335	$462	$481
253	Congregate Care Facility (Attached)	du	$0	$0	$0	$67	$193	$255	$264
	LODGING:								
310	Hotel	room	$0	$0	$0	$0	$869	$1,306	$1,371
320	Motel	room	$0	$0	$0	$336	$837	$1,082	$1,119
416	RV Park	RV Space	$0	$0	$0	$441	$1,025	$1,312	$1,354
	RECREATION:								
430	Golf Course	Hole	$0	$0	$0	$3,513	$8,206	$10,510	$10,848
411	General Recreation (City Park)	Acres	$0	$0	$0	$162	$374	$478	$493
444	Movie Theaters w/Matinee	screen	$0	$0	$0	$4,644	$9,422	$11,768	$12,112
492	Racquet Club/Health Club/Spa/Dance Studio	1,000 sf	$0	$0	$0	$6,231	$10,440	$12,507	$12,810
495	Community Center	1,000 sf	$0	$0	$0	$2,769	$5,818	$7,316	$7,535
	INSTITUTIONAL:								
610	Hospital	1,000 sf	$0	$0	$0	$954	$2,902	$3,858	$3,998
620	Nursing Home	bed	$0	$0	$0	$200	$358	$436	$447
520	Elementary School	student	$0	$0	$265	$502	$618	$675	$683
522	Middle School	student	$0	$0	$252	$630	$814	$905	$919
530	High School	student	$0	$0	$141	$551	$752	$850	$865
540	Junior/Community College	student	$0	$0	$0	$146	$329	$419	$432
550	University	student	$0	$0	$0	$299	$661	$839	$865
560	Church	1,000 sf	$0	$0	$318	$2,208	$3,134	$3,589	$3,656
566	Cemetery	Acres	$0	$0	$521	$2,324	$3,208	$3,642	$3,706
	OFFICE:								
710	Under 50,000 sf	1,000 sf	$0	$0	$0	$2,076	$4,412	$5,559	$5,727
710	50,000-100,000 sf	1,000 sf	$0	$0	$0	$1,612	$3,427	$4,318	$4,449
710	100,001-200,000 sf	1,000 sf	$0	$0	$0	$1,375	$2,922	$3,681	$3,793
710	200,001-400,000 sf	1,000 sf	$0	$0	$0	$1,172	$2,491	$3,139	$3,234
710	Greater than 400,000 sf	1,000 sf	$0	$0	$0	$999	$2,124	$2,676	$2,757
770	Business Park	1,000 sf	$0	$0	$0	$1,277	$2,895	$3,689	$3,806
	RETAIL:								
820	Under 100,000 GSF	1,000 sf	$0	$0	$0	$200	$2,760	$4,016	$4,201
820	100,000 to 400,000 GSF	1,000 sf	$0	$0	$0	$662	$2,894	$3,990	$4,151
820	400,001 to 800,000 GSF	1,000 sf	$0	$0	$0	$792	$2,920	$3,965	$4,118
820	Greater than 800,000 GSF	1,000 sf	$0	$0	$0	$875	$2,932	$3,942	$4,090
931	Quality Restaurant	1,000 sf	$1	$0	$0	$3,448	$9,458	$12,409	$12,843
934	Fast Food Rest w/ Drive-Thru	1,000 sf	$2	$0	$0	$5,594	$25,755	$35,654	$37,107
942	Auto Repair or Body Shop	1,000 sf	$0	$0	$0	$2,224	$4,920	$6,244	$6,438
841	New/Used Auto Sales	1,000 sf	$0	$0	$0	$444	$3,758	$5,385	$5,624
850	Supermarket	1,000 sf	$0	$0	$0	$2,135	$4,580	$5,781	$5,957
853	Convenience Store with Gas Pumps	1,000 sf	$1	$0	$0	$0	$6,461	$12,476	$13,359
862	Home Improvement Superstore	1,000 sf	$0	$0	$0	$2,170	$5,031	$6,436	$6,642
881	Pharmacy/Drug Store w/ Drive-Thru	1,000 sf	$0	$0	$0	$1,082	$2,885	$3,771	$3,901
890	Furniture Store	1,000 sf	$0	$0	$0	$411	$849	$1,064	$1,096
	INDUSTRY:								
110	General Light Industrial/Utilities	1,000 sf	$0	$0	$395	$2,187	$3,065	$3,496	$3,559
120	General Heavy Industrial	1,000 sf	$0	$1,045	$1,879	$2,264	$2,453	$2,546	$2,560
130	Industrial Park	1,000 sf	$0	$0	$0	$1,308	$2,185	$2,616	$2,679
140	Manufacturing	1,000 sf	$0	$0	$850	$1,832	$2,313	$2,550	$2,584
150	Warehouse	1,000 sf	$0	$0	$0	$921	$1,546	$1,852	$1,897
151	Mini-Warehouse	1,000 sf	$0	$0	$0	$394	$709	$864	$886

Source: *Roadway Impact Fee Final Report*, Tindale-Oliver and Associates and Arthur C. Nelson et al., Albuquerque, New Mexico (2004).

HOW MODELS ADDRESS TRANSPORTATION COSTS

Model inputs and outputs are relatively straightforward. A typical set of inputs is as follows. The 2004 study for Tucson provides a useful review of the inputs and outputs. The Tucson example shows how the overriding principles of capital cost calculations are incorporated into the cost calculation. There are many other ways of doing the same thing. For example, capital cost models vary on whether they use peak or average daily demand; highly localized travel studies versus national data or combinations of the two; the level of detail of land uses considered; and costs and revenues; because local conditions vary considerably among jurisdictions. The models all follow the same general steps. This model follows the Tucson study and starts with the following formula:

CHARGE = VMT x NET COST/VMT

Where:

MT = TRIPS x % NEW x LENGTH ÷ 2

TRIPS = Trip ends generated by the development during the PM peak hour

% NEW = Percentage of trips that are primary trips, as opposed to pass-by or diverted-link trips

LENGTH = Average length of a trip on major road system

÷ 2 = Avoids double-counting trips for origin and destination

NET COST/VMT = COST/VMT - CREDIT/VMT

COST/VMT = COST/VMC x VMC/VMT

COST/VMC = Average cost to create a new VMC based on historical or planned improvements

VMC/VMT = The systemwide ratio of capacity to demand in the major road system

CREDIT/VMT = Credit per VMT, based on revenues to be generated by new development

(See User Guide and Model, Step 6 – Enter Finc.-Mult. Info; More Intricate Capital Cost Calculation, Row 87 to Row150.)

The travel demand generated by specific land-use types is a product of three factors: 1) trip generation, 2) percentage of new trips, and 3) trip length. The first two factors are well documented in the professional literature, and the average trip generation characteristics identified in studies of communities across the nation should be reasonably representative of trip generation characteristics in the example used here: Tucson, Arizona. In contrast, trip lengths are much more likely to vary among communities, depending on the geographic size and shape of the community and its major road system.

Trip generation rates are usually based on information published in the most recent edition of the Institute of Transportation Engineers' (ITE) *Trip Generation* manual or other comparable sources. Trip generation rates represent trip-ends, or driveway crossings at the site of a land use. Thus, a single one-way trip from home to work counts as one trip-end for the residence and one trip-end for the workplace, for a total of two trips. To avoid overcounting, all trip rates are divided by two. This places the burden of travel equally between the origin and destination of the trip and eliminates double-charging for any particular trip.

Few road capital charges have been adopted that vary by the size of the dwelling unit. This is largely because road capital charges are generally based on national trip generation rate data, and the Institute of Transportation Engineers (ITE) *Trip Generation* manual does not provide rates by dwelling unit size. However, the fact that trip generation rates for residential uses vary by the size (and even the income) of the household is actually well documented in the transportation planning literature. Duncan (2004) uses local data combined with national data to calculate trip generation rates by house size. To reiterate: if size is used to calculate the charge, size should also be used to calculate the credit (Nelson, Nicholas, and Juergensmeyer 2008).

Trip rates are adjusted by a new trip factor to exclude pass-by and diverted-link trips. This adjustment is intended to reduce the possibility of overcounting by including only primary trips generated by the development. Pass-by trips are those trips that are already on a particular route for a different purpose and simply stop at a particular development on that route. For example, a stop at a convenience store on the way home from the office is a pass-by trip for the convenience store. A pass-by trip does not create an additional burden on the street system and therefore should not be counted in the assessment of impact fees. A diverted-link trip is similar to a pass-by trip, but a diversion is made from the regular route to make an interim stop. The reduction for pass-by and diverted-link trips will be drawn from the ITE manual and other published information.

The average trip length is the most difficult travel demand factor to determine. In the context of a road capital charge using a consumption-based methodology, the relevant input is the average length of a trip on the major road system within the service area. The average trip length can be approximated by dividing the total VMT on the major road system by the total number of trips generated by existing development in the service area. Total VMT on the major road system was estimated by multiplying the length of each road segment by the current traffic volume on that segment and summing for the entire system. Total trips can be estimated by multiplying existing land uses by the appropriate trip generation rates (adjusted for new trip factors and dividing by two) and summing for all existing development in the service area.

The Tucson model used by Duncan Associates but representative of the current state of practice determined the average length of a trip generated by a new development on the major roadway system within Tucson's city limits. This was done by using national data for average trip lengths, and then calibrating total VMT to local conditions using local adjustment factors. This is not the only way to adjust trip length to local conditions.

In the Tucson study, the first step in developing the adjustment factor for local trip lengths was to estimate the total peak hour vehicle-miles of travel (VMT) that would be expected on Tucson's major roadway system based on national travel demand characteristics. Other capital cost practitioners use an average daily approach but the calculation steps are similar. Existing land use data for the City of Tucson were compiled using information from the Pima County Tax Assessor. Existing land uses are multiplied by trip generation rates, percentage of primary trips and average trip lengths and summed to estimate total county-wide VMT. As shown in Exhibit I–A.3 for illustration, existing land uses, using national trip length data, were expected to generate approximately 1.5 million VMT in the afternoon peak hour.

Courtesy of Jon Erickson

Exhibit I–A.3
Projected Citywide VMT based on the Tucson Study

Land Use Type	Unit	Existing Units	Trip Rate	Primary Trips	Pk Hr Trips	Length (miles)	Pk Hr VMT
Single-Family Detached	Dwelling	112,141	0.44	100%	49,342	12.19	601,479
Multi-Family	Dwelling	93,457	0.31	100%	28,972	12.19	353,165
Mobile Home/RV Park	Pad	18,415	0.28	100%	5,156	12.19	62,854
Hotel/Motel*	Rooms	10,440	0.27	80%	2,255	7.43	16,755
Gen. Retail/Commercial	1,000 sq.ft.	38,342	1.87	43%	30,831	6.61	203,792
Office/Institutional	1,000 sq.ft.	30,632	0.69	75%	15,852	12.19	193,237
Hospital	1,000 sq.ft.	689	0.59	75%	305	9.89	3,015
Nursing Home	1,000 sq.ft.	2,238	0.21	75%	352	9.89	3,486
Church	1,000 sq.ft.	1,102	0.33	75%	273	7.43	2,026
Elementary/Sec. School	1,000 sq.ft.	8,521	0.49	24%	1,002	7.50	7,516
Industrial/Warehouse	1,000 sq.ft.	23,358	0.32	70%	5,232	12.19	63,780
Total		104,882			139,572		1,511,105

Notes: *Assumes 500 sq. ft. per room. Peak-hour trips is the product of trip rate and primary trips. Peak hour VMT is product of trips and trip length.

Source: Duncan Associates 2004, *see* Tables 14, 41, and 42

Exhibit I–A.4
VMT based on the Tucson Study

Peak Hour VMT on Segments with Counts	654,815
Lane-Miles of Segments with Counts	1,075
Average Peak Hour Volume per Lane-Mile	609
Total Lane-Miles	1,256
Estimated Total Peak Hour VMT	764,660

Source: Duncan Associates 2004

Exhibit I–A.5
Local Trip Length Adjustment Factor
based on the Tucson Study

Actual Peak Hour Vehicle-miles of Travel (VMT)	764,660
Projected Peak Hour Vehicle-miles of Travel (VMT)	1,511,105
Local Adjustment Factor	0.51

Source: Duncan Associates 2004

Exhibit I–A.6
Local Average Trip Lengths by Purpose based on the Tucson Study

Trip Purpose	National	Local Factor	Local
To or from work	12.19	0.51	6.22
Doctor/Dentist	9.89	0.51	5.04
Average	9.82	0.51	5.01
School/Church	7.50	0.51	3.83
Family/Personal	7.43	0.51	3.79
Shopping	6.61	0.51	3.37

Source: Duncan Associates 2004

Exhibit I–A.7
Summary Travel Demand Schedule based on the Tucson Study

Land Use Type	ITE Code	Unit	Peak-hour Trips	New Trips	Trip Length	Peak-hour VMT
Residential Unit Size:						
Less than 500 sq. ft.		Dwelling	0.24	100%	6.22	1.49
500 - 749 sq. ft.		Dwelling	0.30	100%	6.22	1.87
750 - 999 sq. ft.		Dwelling	0.35	100%	6.22	2.18
1,000 - 1,249 sq. ft.		Dwelling	0.38	100%	6.22	2.36
1,250 - 1,499 sq. ft.		Dwelling	0.42	100%	6.22	2.61
1,500 - 1,999 sq. ft.		Dwelling	0.46	100%	6.22	2.86
2,000 - 2,999 sq. ft.		Dwelling	0.48	100%	6.22	2.99
3,000 - 3,999 sq. ft.		Dwelling	0.50	100%	6.22	3.11
4,000 sq. ft. or more		Dwelling	0.52	100%	6.22	3.23
Single-Family Detached		Dwelling	0.44	100%	6.22	2.74
Multi-Family		Dwelling	0.31	100%	6.22	1.93
Mobile Home/RV Park	240	Pad	0.28	100%	6.22	1.74
Hotel/Motel	310/320	Room	0.27	80%	3.79	0.82
General Retail/Commercial	820	1000 sq. ft.	1.87	43%	3.37	2.71
Office/Institutional		1000 sq. ft.	0.69	75%	6.22	3.22
Hospital	610	1000 sq. ft.	0.59	75%	5.04	2.23
Nursing Home	620	1000 sq. ft.	0.21	75%	5.04	0.79
Church	560	1000 sq. ft.	0.33	75%	3.79	0.94
Elementary/Sec. School	520/530	1000 sq. ft.	0.49	24%	3.83	0.45
Industrial/Warehouse		1000 sq. ft.	0.32	70%	6.22	1.39

Note: "Pk Hr Trips" = ½ of trip ends during PM peak hour of adjacent street traffic from Institute of Transportation Engineers (ITE), *Trip Generation*, 7th ed., 2003 (where ITE code provided, others from Tucson Public Works Department, June 3, 2004 memorandum); single-family detached and multi-family trip rates from Table 7; residential trip rates by square feet size category from Table 8; new trip percentage for shopping center from ITE, *Trip Generation Handbook,* March 2001; percentage for schools from paper by Hitchens, 1990 *ITE Compendium*; remaining percentages are local estimates from Tucson Public Works Department, June 3, 2004 memorandum; average trip lengths from Table 13.

Source: Duncan Associates 2004

The next step in developing the local travel trip length adjustment factor was to determine actual peak hour VMT on the city's major roadway system. This is based on roadway segment lengths, and recent travel volumes are used to estimate actual peak hour VMT. Average daily traffic counts taken over a recent three-year period were made available by the Pima Association of Governments and multiplied by ten percent to approximate peak hour volumes. This is shown in Exhibit I–A.4.

A final step was calculating the ratio of actual to projected VMT on the major roadway system to factor-out federal and state highways that are not funded by Tucson's impact fees. This is shown in Exhibit I–A.5.

Applying the local adjustment factor to the national average trip lengths provides a reasonable estimate of local average trip lengths on Tucson's major road system, as shown in Exhibit I–A.6. The work trip is the dominant type of peak hour trip for residential, office and industrial land uses.

The result of combining trip generation rates, new trip factors and average trip lengths produces a travel demand schedule that establishes the VMT during the average weekday generated by various land use types per unit of development. These inputs are summarized in Exhibit I–A.7.

Cost inputs are considered next. In the case of the Tucson study (2004), the cost per VMC was calculated based on a representative list of historical improvements. The first step was to divide the total cost of the improvements by the number of additional lane-miles created to get a cost per lane-mile. The second step was to divide the average cost per lane-mile by the average capacity added by a new lane to determine the average cost per new VMC. The third and final step was to multiply the cost per VMC by the system-wide VMC/VMT ratio to get the cost per VMT to maintain the current systemwide level of service.

The average cost per lane-mile was based on City of Tucson road improvements completed over a four-year period (2000-2003). These projects were either new roads, or they involved the complete reconstruction and/or widening of interim roads. The City had very limited information on right-of-way (ROW) costs, since most of the ROW was dedicated and it was difficult to assign a cost for the land. Consequently, ROW costs were excluded. As shown in Exhibit I–A.8, the average cost per lane-mile added by these improvements, in current dollars (2004), is $1.3 million.

Exhibit I–A.8
Average Construction Cost Per Lane Mile based on the Tucson Study

Arterial	Segment	Miles	Lanes	New Lane-Miles	Cost	Cost per Lane-Mile 2004
Golf Links	Pantano-Harrison	1.00	0 6	6.00		
Golf Links	Harrison-Bonanza	0.50	0 4	2.00		
Golf Links	Pantano-Bonanza	1.50		8.00	$8,860,278	$1,107,535
Harrison	Golf Links-OST	1.25	0 4	5.00	$5,841,510	$1,168,302
12th Avenue*	Drexel Rd to Valencia Rd	1.00	0 4	4.00	$4,810,679	$1,202,670
Pima St*	Swan Rd to Craycroft Rd	1.00	0 4	4.00	$7,903,501	$1,975,875
Ft Lowell	Laurel-Swan	0.25	0 4	1.00	$1,918,478	$1,918,478
Pantano	Golf Links-Escalante	1.00	0 4	4.00	$5,290,657	$1,322,664
Total		6.00		26.00	$34,625,103	$1,331,735

* Reconstruction of existing interim four-lane roadway
Source: Project descriptions and costs from Tucson Department of Transportation, December 22, 2003.

As in most cases, nationally accepted transportation level of service (LOS) categories were used, chiefly ITE's A–F system, and this was also used in the Tucson study. Consultants working in other states, such as in Florida, use that state department of transportation's level of service system. In the Tucson case, ITE's six categories, ranging from LOS A to LOS F, generally describe driving conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. LOS A represents free flow, while LOS F represents the breakdown of traffic flow, characterized by stop-and-go conditions.

In contrast to LOS, service volume capacity is a quantitative measure, expressed in terms of the rate of flow (vehicles passing a point during a period of time). Service volume capacity represents the maximum rate of flow that can be accommodated by a particular type of roadway while still maintaining a specified LOS. The service volume capacity at LOS E represents that maximum volume that can be accommodated before the flow breaks down into stop-and-go conditions that characterize LOS F, and thus represents the ultimate capacity of the roadway. For the study used in this example, Tucson's adopted level of service was LOS E, which has the same maximum service volume as the capacity of the roadway. Consequently, the discussion can dispense with levels of service and focus on roadway capacity.

The capacity of an individual roadway depends on a number of factors, including number of lanes, lane width, topography, percentage of truck traffic, and so on. In impact fee analysis, generalized capacity estimates are typically used based strictly on number of lanes. In the Tucson study, data from the Florida Department of Transportation (FDOT) was used. FDOT has done extensive work developing generalized capacity estimates to be used for planning purposes based on *Highway Capacity Manual* procedures, to develop planning-level capacity estimates for use in this analysis. Exhibit I–A.9 shows these adjustments to road capacity by type of road facility.

Exhibit I–A.9
Average Peak Hour Capacity Per Lane Mile
by Type of Road based on the Tucson Study

	Total Capacity	Capacity per Lane
Two-Lane Undivided	1,480	740
Two-Lane w/Continuous Turn Lane	1,554	777
Four-Lane Divided	3,120	780
Six-Lane Divided	4,690	782

Source: Data for major city/county roadways from Florida Department of Transportation, *2002 Quality/Level of Service Handbook*, 2002, Table 4-4: Generalized Peak Hour Two-Way Volumes for Florida's Urbanized Areas (http://www11.myflorida.com/planning/systems/sm/los/ default.htm).

Exhibit I–A.10
Average Capacity Added Per Lane Mile based on the Tucson Study

Arterial	Segment	Miles	Lanes Ex	Lanes Fut	New Ln-Mi	Peak Hour Capacity Ex	Peak Hour Capacity Fut	Peak Hour Capacity New	New VMC	Added Cap/Ln
Golf Links	Pantano-Harrison	1.00	0	6	6.00	0	4,690	4,690	4,690	782
Golf Links	Harrison-Bonanza	0.50	0	4	2.00	0	3,120	3,120	1,560	780
Golf Links	Pantano-Bonanza	1.50			8.00				6,250	781
Harrison	Golf Links-OST	1.25	0	4	5.00	0	3,120	3,120	3,900	780
12th Avenue*	Drexel Rd to Valencia	1.00	0	4	4.00	0	3,120	3,120	3,120	780
Pima St*	Swan Rd to Craycroft	1.00	0	4	4.00	0	3,120	3,120	3,120	780
Ft Lowell	Laurel-Swan	0.25	0	4	1.00	0	3,120	3,120	780	780
Pantano	Golf Links-Escalante	1.00	0	4	4.00	0	3,120	3,120	3,120	780
Total		6.00			26.00				20,290	780

Note: Added capacity per lane is new VMC divided by new lane-miles.
Source: Duncan Associates 2004; see tables 15 and 16.

In the Tucson study (2004) analysts calculated the appropriate capacity per lane to use in the capital costs calculations. Using the same projects employed to determine the average cost per lane-mile, the average hourly capacity added, according to FDOT generalized planning guidelines, was calculated to be 780 vehicles per lane, as shown in Exhibit I–A.10.

The capacities shown in Exhibit I–A.10 above were used to estimate systemwide capacity. For each road segment on the existing major roadway system for which traffic counts were available, the generalized capacity of the segment was multiplied by the length of the segment in miles to determine vehicle-miles of capacity (VMC). These were summed for all segments to determine systemwide capacity. Dividing the systemwide capacity (VMC) by system-wide demand (VMT) calculated earlier yields the VMC/VMT ratio. As shown in Exhibit I–A.11, the major roadway system currently has 1.16 units of capacity for every unit of demand. This represents the current systemwide level of service.

The first step in determining the cost per service unit to add capacity to the major roadway system was to divide the average cost per lane-mile by the average hourly capacity added per new lane. The resulting average cost per VMC was multiplied by the systemwide VMC/VMT ratio to determine the cost per VMT. As shown in Exhibit I–A.12, the average cost per service unit was $1,980 per peak hour VMT (2004).

Exhibit I–A.11
Existing Systemwide Capacity/Demand Ratio
based on the Tucson Study

Hourly Vehicle-Miles of Capacity (VMC) Peak Hour	759,051
Vehicle-Miles of Travel (VMT)	654,815
Existing VMC/VMT Ratio	1.16

Source: Duncan Associates 2004

Exhibit I–A.12
Average Cost Per Service Unit based on the Tucson Study

	2004
Average Cost per New Lane-Mile	$1,331,735
Average Hourly Capacity Added per New Lane	780
Average Cost per Peak Hour VMC	$1,707
Systemwide VMC/VMT Ratio	1.16
Cost per Peak Hour VMT	$1,980

Source: Duncan Associates 2004

The final set of inputs relates to "revenue credits." That is, credit against the cost per service unit is given for outstanding debt for past road improvements, and for motor fuel tax and vehicle license fee revenue that is generated by new development and used to make capital improvements. The City of Tucson had $125 million in outstanding debt from the 1994 and 2000 bond authorizations as well as several refunding issues for past street improvements. Tucson relies exclusively on state-shared fuel taxes, also known as Highway User Revenue Funds (HURF), to retire the street bonds. Consequently, it is necessary to give credit for motor fuel tax and vehicle license fee revenue that is generated by new development and used to make capital improvements and retire street bonds. The credit for outstanding debt for past road improvements was calculated by dividing total outstanding debt by existing VMT on the major road system to determine the credit per VMT. The credit is $164 per vehicle mile traveled. Essentially, this means that new development will be allowed to pay the same portion of its road costs through HURF-funded debt that existing development does.

Tucson's transportation portion of its Capital Improvements Program (CIP) is funded almost exclusively with motor fuel taxes and highway user fees in one form or another, including HURF, revenue bonds (repaid with HURF money), and funding from Pima Association of Governments (PAG) and the Arizona Department of Transportation (ADOT). Of the total transportation funding for the five-year period of some $238 million, only $66,556,400 is for capacity-expanding improvements, such as widening existing roads, constructing new roads, installing traffic signals or making intersection improvements. The remaining non-capacity projects include bikeway/pedestrian improvements, transit improvements, drainage projects, lighting and safety improvements and resurfacing, rehabilitation and reconstruction projects. The transportation capital costs charge was based on funding only this portion of the CIP.

Potential future sources of revenue need to be considered as well. The Tucson study noted that voters approved a County bond issue in 1997 that included funding for a number of future city streets. These bonds are repaid with the County's allocation of HURF funds, which is based on the population of the unincorporated area of Pima County. Credit for the portion of this funding going to future city street improvements was not required, since development inside the Tucson city limits does not result in increased funding. Nevertheless, to be conservative, a credit was calculated in the study. This came to an additional $349 per vehicle mile traveled based on 2004 data.

Two outputs were thus generated. The first was the net road cost per vehicle mile traveled, shown in Exhibit I–A.13. The next was the schedule of capital costs charges shown in Exhibit I–A.14.

Exhibit I–A.13
Net Road Cost Per Vehicle Mile Traveled
Based on the Tucson Study

	2004 Road Cost
Cost per Peak Hour VMT	$1,980
Debt Credit per Peak Hour VMT	$164
CIP/County Funding Credit per Peak Hour VMT	$349
Net Cost per Peak Hour VMT	$1,467

Source: Duncan Associates 2004

Exhibit I–A.14
Schedule of Road Capital Cost Charges
(at 100% assessment) Based on the Tucson Study

Land Use Type	Unit	Peak Hour VMT	Net Cost/VMT (2004 Cost)	Net Cost/ Unit (2004 Cost)
Progressive Residential Fees by Unit Size:				
Less than 500 sq. ft.	Dwelling	1.49	$1,467	$2,186
500 - 749 sq. ft.	Dwelling	1.87	$1,467	$2,743
750 - 999 sq. ft.	Dwelling	2.18	$1,467	$3,198
1,000 - 1,249 sq. ft.	Dwelling	2.36	$1,467	$3,462
1,250 - 1,499 sq. ft.	Dwelling	2.61	$1,467	$3,829
1,500 - 1,999 sq. ft.	Dwelling	2.86	$1,467	$4,196
2,000 - 2,999 sq. ft.	Dwelling	2.99	$1,467	$4,386
3,000 - 3,999 sq. ft.	Dwelling	3.11	$1,467	$4,562
4,000 sq. ft. or more	Dwelling	3.23	$1,467	$4,738
Single-Family Detached	Dwelling	2.74	$1,467	$4,020
Multi-Family	Dwelling	1.93	$1,467	$2,831
Mobile Home Park	Pad	1.74	$1,467	$2,553
Hotel/Motel	1,000 sq. ft	0.82	$1,467	$1,203
NONRESIDENTIAL				
General Retail	1,000 sq. ft.	2.71	$1,467	$3,976
Commercial Office	1,000 sq. ft.	3.22	$1,467	$4,724
Institutional	1,000 sq. ft.	2.23	$1,467	$3,271
Hospital	1,000 sq. ft.	0.79	$1,467	$1,159
Nursing Home	1,000 sq. ft.	0.94	$1,467	$1,379
Church Elementary/Sec. School	1,000 sq. ft.	0.45	$1,467	$660
Industrial/Warehousing	1,000 sq. ft.	1.39	$1,467	$2,039

Source: Duncan Associates 2004

MODELING VMT REDUCTIONS FOR MIXED-USE DEVELOPMENTS

A recent study for the U.S. Environmental Protection Agency developed a 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. ***(See User Guide and Model Step -4 Nonres. Demo. Multipliers, VMT Adjustment for Mixed Use and Other Factors, Row 33 to Row 50 and Step 6-Enter Finc.-Mult. Info.; Row 29.)***

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, that reduce their impacts relative to outlying developments.

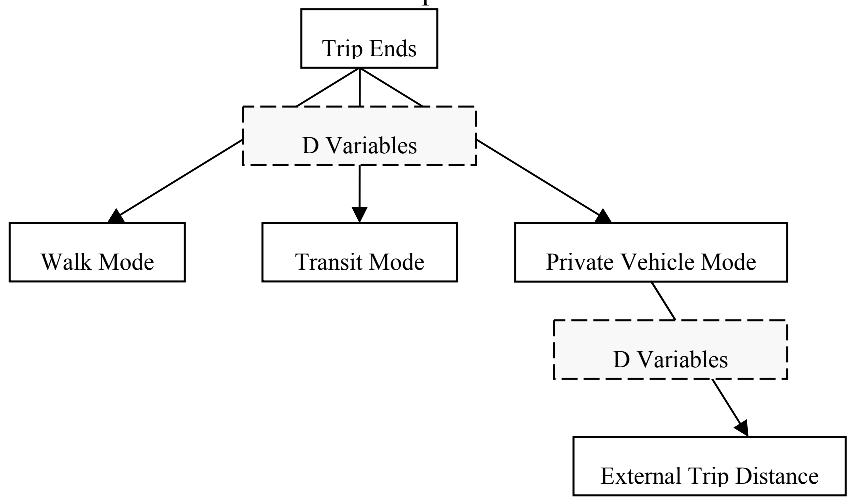
To model VMT (vehicle miles traveled) reductions for MXDs, the same database as below was used, but one that employs a simplified model structure.

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 and from developments is conceived as a series of choices, which depend on D variables (see conceptual framework in Exhibit I-A.14a).

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.

Exhibit I-A.14a. Conceptual Framework



The D variables in Figure I-A.14a are characteristics of travelers, MXDs, and regions, as defined below. The D variables determine, moderate, mediate, and confound travel decisions

Final Samples

The 239 MXDs form the 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 Exhibit I-A.14b. 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.

Exhibit I-A.14b. 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

Outcome Variable

Because the purpose of this Model study is different from the earlier study (it is not about internal capture of trips within MXDs), the original data base of 35,877 trip ends to/from/within 239 MXDs in six regions is employed. Using these data, the outcome modeled is VMT per trip, a continuous variable equal to actual miles traveled for auto trips and set equal to 0 for walk trips, bike trips, and transit trips.

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 set-backs; 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 is 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 Exhibit I-A.14c on the following page. 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.

Exhibit I-A.14c . Variable Definitions

Outcome Variables	Definition
VMTTRIP	Network trip distance between origin and destination locations for an external private vehicle trip, in miles; 0 for walk, bike, and transit trips
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.[3]
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.[4] For other regions, the categories were slightly different.[5] 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.

[3] 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.

[4] 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.

[5] 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 of MXD Trip Reductions

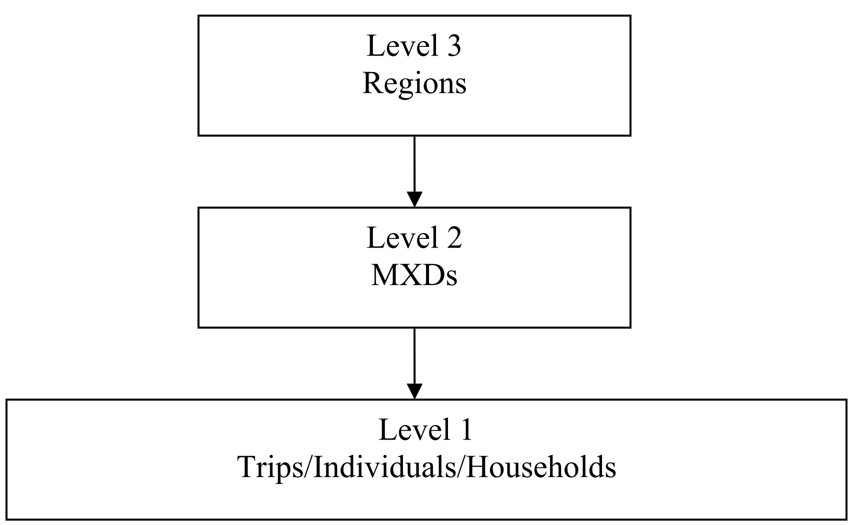
For estimating the VMT per trip, models take three forms: linear, semi-logarithmic (linear-log), and log-log forms. The log-log models, which express log VMT per trip as a linear sum of logged variables, outperform the other models in terms of their pseudo-R2s and sensitivity to changes in values of independent variables. Log-log form models also have the advantage of giving as coefficients arc elasticities of VMT per trip with respect to the D variables. Only the log models are presented in this discussion. Note that the constant 1 was added to each VMT per trip value so that the dependent variable for nonauto trips would assume a value of 0 when the l natural logarithm was taken. For the same reason, the constant 1 was added to each value of VEHCAP and BUSSTOP.

The 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).

The data structure was initially conceived 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, it was 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 the 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 Exhibit I-A.14d).

Exhibit I-A.14d. Data and Model Structure



Models are estimated with HLM 6 (Hierarchical Linear and Nonlinear Modeling) software. Hierarchical linear models are estimated for the continuous outcome VMT per trip. Within a hierarchical model, each level in the data structure is formally represented by its own submodel. The submodels are statistically linked.

In the 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, cross-level variable interactions with "random coefficient" models were also tested for. 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 of MXD Trip Reductions

Results of model estimation are presented in Exhibit I-A.14e. The table presents model coefficient estimates, asymptotic t-ratios, and probability values for the t-ratios. All variables included in the final model are significant at the 0.001 level or beyond.

VMT per trip increases with household size and vehicle ownership per capita, and declines with a project's job-population balance, intersection density, and proportion of regional jobs reachable within 20 minutes by automobile. VMT per trip is also less for those living within a quarter mile of a bus stop. Trip distance is thus related to five types of D variables, *diversity*, *design*, *destination accessibility*, *distance to transit*, 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 good job-population balance capture some trips internally. 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 driving distance. These relationships match expectations. It should be noted that the model fit is adequate, with a pseudo-R^2 of just 0.16.

Exhibit I-A.14e. VMT per Trip (log-log form)

	coeff	t-ratio	p-value
Constant	1.49		
JOBPOP	-0.044	-3.81	<0.001
INTDEN	-0.189	-5.79	<0.001
EMP20A	-0.072	-6.29	<0.001
HHSIZE	0.242	23.2	<0.001
VEHCAP	0.847	37.8	<0.001
BUSSTOP	-0.225	-11.9	<0.001
pseudo-R2	0.16		

DIRECT TRANSPORTATION CAPITAL COSTS OF DEVELOPMENT

All of the steps illustrated in the Tucson study as well as the Mixed-Use Development Study are built in as inputs to the capital costs model. This results in a road cost per vehicle mile traveled on the capital costs schedule. These costs are applied to the same hypothetical development used for calculating operating costs, as is shown in the next section. ***(See User Guide and Model, Step 6-Enter Finc.-Mult. Info; Row 36 to Row 153 and Step 7-View Model Output; Output 1, Row 8 to Row 17.)***

This is not to say Tucson is the best model for calculating road capital costs as each jurisdiction is probably different enough to require individualized analysis. In addition, capital cost calculation practice is an evolving field so what was generally reasonable practice in the past may not be reasonable in the future. Finally, capital cost calculation enabling statutes may require particular steps or assumptions not used in standard practice. The study employs the Tucson model because it is illustrative of the principal considerations needed for estimating and ultimately calculating road capital cost charges. The model allows the user to change assumptions and astute professionals can actually change the model itself.

The capital calculation relating to the direct capital costs of development on transportation is the sum of transportation capital costs that the development will incur based upon the various types of units included in the development. This is shown in Exhibit I-A.15. The direct capital costs of development related to transportation for the hypothetical example amounts to a total of $6,933,062 due to:

1. A total of 2,000 dwelling units consisting of 1,200 2 bedroom town houses of 1,400 square feet incurring a capital cost per unit of $2,070 and 800 3 bedroom town houses of 2,000 square feet incurring a capital cost per unit of $2,562 for a total of $4,534,575 for residential units and
2. 750,000 ft.^{2} of office space incurring a capital cost per 1,000 square feet of $3,198, for a nonresidential cost of $2,398,487 and a total project cost of $6,933,062.

This is the result of the rational nexus calculation of proportional impacts. It includes

1. Adopting a level of service (existing standards) and a service area (the entire community) for future transportation needs;
2. Using current cost practices to estimate future costs; and
3. Establishing revenue credits for:
   a. Capital infrastructure that the development is paying for and should not have to pay for;
   b. Other than local government contributors to capital infrastructure; and
   c. The value of money given the delivery schedule of future capital facilities.

Exhibit I–A.15

Applying the Tucson Study Methodology for Direct Capital Costs to the Development Being Analyzed

Number of Residential Units/ 000s of Square Feet of Nonresidential Space	***Cost per Residential/Nonresidential Unit***	***Total Direct Capital Costs) (Transportation)***
Dwelling units	$2,070	$2,484,586
1,200 2 bedroom Town Houses @ 1,400 sq.ft.		
800 2 bedroom Town Houses @ 2,000 sq.ft.	$2,562	$2,049,989
Office space 750,000 square feet	$3,198	$2,398,487
To tal		**$6,933,062**

The above calculations are based on the model's basic method of calculating capital costs. This method starts with a matrix of capital costs per residential unit. For single family detached, single family attached, and garden apartment units the costs are based on the square footage of the unit. This is because *American Housing Survey* data show that occupancy increases as unit size increases, up to a point. Costs for other housing types, where available, are based on bedrooms. This is because Census data show that occupancy increases as the number of bedrooms increases. Credits are also scaled by size. For nonresidential space the costs (per 1,000 square feet) are based on the type of space. This matrix also has differing costs depending upon the population size of the jurisdiction/county of the development. Typically, larger jursidictions are more costly than smaller ones, especially in land cost. The model looks up the appropriate costs for each residential unit type and for each nonresidential type. The cost is then adjusted by the multiple use adjustment. A provision is made in the model for each of these values to be replaced by local values if desired.

A More Intricate Me thod for Calculating Capital Costs

An alternate, more intricate, method of calculating capital costs, written by Arthur C. Nelson and Reid Ewing, is also provided. This method requires additional local information on the road system and its financing and cannot effectively be used without researching information on the local road network. ***(See User Guide and Model, Step 6-Enter Finc.-Mult Info.; Row 87 to Row 153.)***

The procedure starts off by asking the cost per lane mile of new road construction (one lane, one direction) in the impacted area of the jurisdiction ("service area"). The model includes some road cost data for selected states, but local figures are preferred (typically by local public works officials and consulting civil engineers). The procedure then asks for a measure of the local vehicle miles traveled, either the average (auto) trip length (miles) for the study region (U.S. average is 10.13 miles); the localized trip length ratio for an MSA or an MSA group (which are listed in the model); or detailed localized trip lengths (miles) by trip purpose, including to/from work, shopping, social and recreational, and others. These values are used later to develop the capital cost per residential unit or thousand square feet of nonresidential space. Defaults are included in the model but local data are preferred and usually available without much if any research. For instance, MPO travel models typically have locally derived trip lengths and purposes.

Other information needed includes the percentage of all travel on local roads, and average daily capacity per lane mile for planned construction (Florida DOT level of service suggests 7,300 for 2-lane roads and 7,775 for 4-lane roads, up to 8,250 for expansion of existing 4-lane roads).

The cost per lane-mile of new road construction (one lane, one direction) is then adjusted by the percentage of road costs financed from nonlocal sources and percentage of road costs financed from local sources not part of capital cost. This is then divided by the average daily miles traveled capacity to calculate the local road cost per lane mile trip. These calculations are done automatically in the model. The result is a project-specific estimate of road impact cost.

The current annual road debt payment (from the budget information) is adjusted by the share of the current road debt for capacity expansion to give the amount of annual road debt payments for capacity expansion. It is then divided by the estimated daily VMT to derive the annual road debt payment per daily VMT. This is then converted to the present value debt service payments for capacity expansion using the years of debt service payments and the discount rate for present value calculation.

The present value debt service payments calculation is subtracted from the previously computed local road construction cost per lane-mile to calculate the net capital cost per VMT. The model thus assumes that new capacity will be financed by new debt proportional to existing debt and capacity.

The estimated current daily VMT is then subtracted from road network capacity (based on

local level of service applied to local road network) to generate excess or deficient capacity. The volume-to-capacity ratio is then entered and applied to the previously computed net capital cost per VMT. This result is used in the calculation of cost per average daily VMT of new development net of adjustments, and this figure is used in turn to calculate the capital costs per residential unit or thousand square feet of nonresidential space.

DIRECT TRANSPORTATION CAPITAL REVENUES OF DEVELOPMENT

The direct capital revenues of new development need to equal the direct capital costs of that development. This is because once these direct capital costs are calculated, an impact fee or other exaction amounting to these costs could be assigned to development in jurisdictions where this type of charging is allowed. In jurisdictions where impact fees are not used, there may be project-specific studies leading to case-by-case or ad hoc exactions on the new development to mitigate at least part of its cost impact on communities. Many communities assess neither capital charges nor exactions. This model may aid those communities especially in understanding the order of magnitude of cost impacts associated with new development.

In any case, the cost procedure shown here is both reasonable and appropriate, leading to the direct transportation capital costs of new development. Revenues are equal to this number in impact fee or exaction (or proffer) jurisdictions. In those jurisdictions where there are no impact fees, these costs are paid for by general fund debt service outlays, but this model now shows officials and the public what those costs are.

MODEL FOR DIRECT TRANSPORTATION CAPITAL COSTS

The model for direct transportation capital costs has a series of inputs and outputs that often are not directly linked but have been discussed earlier.

Inputs

Population Generation

The model takes new direct numbers of units for new residential demand. It uses the amount of new nonresidential space in thousands of square feet that will be generated for nonresidential demand. These numbers, multiplied by the cost factors listed below, amount to the direct capital costs of new development.

Cost Factors

Costs employ calculations to derive per-residential unit and per-1,000-square-feet capital expenditures. Model users can use default assumptions or locally derived figures. These capital expenditures go through a series of calculations to ensure proportionality, current standards, and cost calculation procedures, and various types of revenue credits. These net per-unit costs (including credits), multiplied by the number of new direct units and thousands of square feet of nonresidential development, equal the direct capital costs of new development. They are mitigated in mixed-use developments.

Revenue Factors

Revenue factors are exactly the same numbers as costs due to the reality of rational nexus—revenues required must directly reflect costs incurred.

Courtesy of Center for Urban Policy Research

Outputs

Residential/Nonresidential Unit Generation

- The number of residential units in the development.
- The number of thousands of square feet of nonresidential space in the development.

(See User Guide and Model Step 7-View Model Output; Row 8 to Row 17.)

Cost Factors

- Net transportation capital costs per unit related to direct development.
- Whether or not the development involves mixed uses.

Revenue Factors

- Transportation capital revenues related to direct development (units x capital costs per unit).

ADVANTAGES OF THE DIRECT TRANSPORTATION CAPITAL COST MODEL

This is the first model to link direct transportation capital costs with outputs from direct transportation operating costs. It also is the first model to address all of the pre-considerations before net costs are calculated.

CONCLUSIONS

Procedures for the calculation of direct transportation capital costs have some inherent shortcomings, including the following:

- They are usually "Average-costing" rather than "tipping point" constructs to improve political acceptance and judicial scrutiny.
- They are based on historical costs or at least current estimates of costs and normally do not consider the escalation of costs into the future. Period-to-period capital costs do consider inflation, but this usually has not been built into multi-year projections or calculations. Those studies that calculate inflation use *Marshall & Swift*, the *Engineering News and Record's 20-Cities Construction Cost Index*, or other sources.
- Capital cost procedures typically do not consider differences in costs to expand capacity in different parts of the jurisdiction. For example, the Tucson study, as most others, calculates a jurisdiction-wide net impact cost and applies it to all development throughout the city. In many cases the jurisdiction is divided into "benefit" districts so revenue generated in one area is spent there but the fee paid is based on an overall average.
- By implication albeit not by design, capital charges paid by new development in stable or slow-growing areas with sufficient infrastructure could end up subsidizing new development in fast-growing areas and/or those with infrastructure capacity limits. Only one firm accounts for this: Tindale-Oliver for several Florida jurisdictions as well for Albuquerque.

Courtesy of Jon Erickson

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STEP I—B

Direct Transportation Operating Costs

INTRODUCTION

The direct transportation operating costs caused by development can be analyzed by adapting fiscal impact analysis procedures used at the local level to estimate the total costs versus revenues of local development (Wheaton and Schussheim 1955; Isard and Coughlin 1957; Kain 1967). Fiscal impact analysis calculates costs to the municipality or county that involve transportation operating costs such as the repair, maintenance, cleaning, and plowing of local streets, as well as the purchase and maintenance of small equipment to carry out these purposes (CHZM Hill 1993). Fiscal impact analysis also calculates costs to the municipality or county that involve debt service that is used to pay down ongoing transportation capital improvements. Fiscal impact analysis further involves the calculation of transportation operaing costs in the form of bus transportation for school children of a school district as well as the school district's debt service to provide capital facilities such as access roads to schools and school parking lots and bus platforms. With certain modifications, this technique can estimate these costs for most size developments (Mace and Wicker 1968). The technique and its rationale are discussed immediately below. Specific procedures follow: first, calculating transportation operating costs, then calculating transportation operating revenues.

DIRECT TRANSPORTATION OPERATING COSTS AND REVENUES

Fiscal impact analysis is a studied, technical assessment of the costs versus revenues of land development (Duncan and Associates 1989). Step-by-step procedures to carry out the Per Capita Multiplier Method are detailed in a number of other procedural guides. The most comprehensive guide is the Rutgers University publication entitled *The Fiscal Impact Handbook* (Burchell and Listokin 1978). The *Handbook* has been synthesized and updated in a periodic series called *The Practitioner's Guide to Fiscal Impact Analysis* (Burchell and Listokin 1980; Burchell, Listokin, and Dolphin 1985). Another useful overview of the different fiscal techniques is provided in a 1989 report published by the International City Management Association, entitled *Analyzing the Fiscal Impact of Development* (Tischler 1989). Finally, one of the most recent automated (modeling) approaches to fiscal impact analysis was captured in the ULI publication by Burchell, Listokin, and Dolphin—*The Development Impact Assessment Handbook* (with model) (Burchell, Listokin, and Dolphin 1994). A final guide, *Fiscal Impact Analysis: Methodologies for Planners* (prepared by the TischlerBise firm), was recently published by the American Planning Association (Bise 2010).

While it is not appropriate to duplicate the detail of the former publications for this procedural guide, it is necessary to summarize their methods of cost-revenue assessment. Several basic procedures guide all fiscal impact analyses, particularly those that employ the Per Capita Multiplier Method (Canter 1986):

- disaggregate municipal/county costs into cost categories
- determine the population generated by growth—people, students, and employees;
- translate this population into consequent total public service costs;
- isolate specific cost sectors (transportation) from total costs;
- project the revenues created by growth, and the subset for transportation; and
- compare development-created costs to revenues: If costs exceed revenues, a deficit is incurred; if revenues exceed expenditures, a surplus is realized. These are the resultant fiscal impacts.

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Derivatives of the Per Capita Multiplier Method are found in most models. These include: FISCALS produced by TischlerBise; FIT (Fiscal Impact Tool) produced by the Federal Reserve Board; FIAM (Fiscal Impact Analysis Model) produced by Fishkind and Associates; FIELD (Fiscal Impact Evaluation of Land Development) produced by Hillsborough County, Florida; the local impact of homebuilding produced by the National Association of Home Builders; and the Cost of Community Services produced by the American Farmland Trust. The latter two studies have been criticized for advocacy positions, respectively, for supporting or denying the benefits of development. Basically, similar Per Capita methods are undertaken nationwide by TischlerBise, Duncan Associates, Fishkind Associates, Economic Research Associates, Gruen and Gruen, Glatting-Jackson, ECONorthwest, and Calthorpe Associates. The steps of fiscal impact analysis follow (Fishkind Associates 2006; Hillsborough County 2007; FHWA 2002; Duncan and Associates 1989).

Step 1 — Disaggregate the Municipal/County Budget into Departmental Categories

The municipal/county budget should be broken down by its basic service categories. These are, typically: general administration, public safety, public works, economic development, recreation/culture, health/human services and debt service (Exhibit I-B.1). Within both public works and debt service there should be a large component of transportation services or capital repair/expansion that is transportation-related. This also could be true in the economic development portion of the budget wherein public transit expenditures are found. The breaking down of the budget into service delivery sectors will also be done for the school budget as explained later. These budget categories are similar to those used by the *U.S. Census of Governments* from which per capita expenditures and staffing levels per 1,000 population can be obtained (Burchell and Listokin 1978). ***(See User Guide and Model, Step 5-Enter Budget Info; Row 1 to Row 18 [municipality/county] and Row 86 to Row 100 [School District].)***

Exhibit I–B.1
Municipal Operating Budget, by Function

Expenditure	*Total Amount (2007 $)*	*Transportation Expenditures*
General Administration	$2,750,000	—
Public Safety	7,000,000	—
Public Works (Transportation)	3,540,000	$1,416,000
Economic Development (Transportation)	1,350,000	337,500
Recreation/ Culture	1,850,000	—
Health/Human Services	450,000	—
Debt Service (Transportation)	2,000,000	1,000,000
Total	**$18,940,000**	**2,735,500**

Source: Averages of municipal budget entries, several New Jersey municipalities, 2007.

Step 2 — Allocate Costs between Residential and Nonresidential Uses

With non-educational services, it is incorrect simply to divide incurred outlays by the local population because such services benefit both residential and nonresidential land uses. Service costs must therefore be apportioned between these two types of development. The portion of local costs associated with residential development can be estimated using property value and parcel data to assign costs. For example, if one

knows that all expenditures for health and human services have some relationship to both persons and employees in the community, the value/parcel procedure can be used to allocate costs. In using this procedure, the residential share of all service costs is estimated by dividing the residential single-family and multifamily property value and number of parcels by the value and number of parcels of all residential and nonresidential (commercial and industrial) properties. These two results are averaged and this value is applied to local costs to determine the residential share of residential/nonresidential costs (Exhibit I-B.2). The reason for the averaging is that using the number of parcels alone overassigns to the residential sector; using the value of parcels alone underassigns to the residential sector (Burchell, Dolphin & Erickson 2009**). *(See User Guide and Model, Step 5-Enter Budget Info.; Row 20 to Row 37.)***

The Number of New Persons and/or Employees

It is important to identify the aspects of growth that affect public service provision. For residential development, the population and student generation associated with different housing configurations is a major influence on municipal and school district operating and capital obligations. Housing types that are most population-intensive place the greatest cost burden on the public sector to provide services to accommodate growth (Burchell, Listokin, and Dolphin 2007). ***(See User Guide and Model Step 2-Development Description, Row 1 to Row 62; Step 3-Resid. Demo. Multipliers, row 1 to Row 33; and Step 4-Nonres. Demo. Multipliers; Row to Row 30.)***

The fiscal impact analyst uses demographic multipliers to predict the populations that will result from new housing development. Multipliers calculate the number of the three principal users of local services: persons (new residents) and employees for municipal services; and students, for school services. The multipliers for household size represent the average number of persons living in a housing unit. The multipliers for students represent the average number of students that attend local schools and are generally specified according to grouped grade categories (i.e., K–6, 7–8, 9–12). The multipliers for employees represent the average number of employees per 1,000 square feet of various types of nonresidential space.

The discussion thus far has focused on the attribute of residential growth—population (persons and students)—that prompts a public service response. While agreement is widespread that bedrooms are the appropriate "unit" to be considered with respect to residential development, the debate over the corresponding nonresidential "unit" continues. Several studies, however, have concluded that it is the employment intensity of nonresidential development that prompts public service costs (Beaton 1983). Employment intensity is typically expressed in terms of the number of employees per 1,000 square feet of nonresidential space. It is higher for certain categories of use, such as office development, than it is for warehousing, for example. Data sources for the number of employees per 1,000 square feet are discussed shortly.

The first step in the analysis is to estimate the new population and employees associated with the proposed development. The DataPlace™ Web site contains tabulated demographic information by housing type for each state, provided by Rutgers University for the Fannie Mae Foundation (scroll to bottom of page for "Residential Demographic Multipliers):
(http://www.dataplace.org/resources/datasets?bt).
These multipliers are also on the Model CD.

These are current as of the year 2000 and should be used to project persons and students associated with new development of X number of units. Data also exist for the number of employees per 1,000 square feet of nonresidential space. These data are obtained from nonresidential management services, from energy studies for various types of buildings, and from large employers on a case-by-case basis. These numbers show the occupancy density of space by type of user of that space. Numbers are largest for office space and smallest for

warehouse space. Retail and industrial space fall in-between these two other categories.

Exhibit I-B.2 **Calculating the Residential Share of the Municipal Budget**	
2007 Assessed Valuation and Number of Parcels	
Assessed Valuation	
Total assessed value of developed parcels	$2,100,000,000
Residential single-family and multifamily assessed value	$1,575,000,000
Residential value percentage	75%
Parcels	
Total developed parcels (#)	7,000
Residential and multifamily developed parcels (#)	6,650
Residential parcel percentage	95%
Estimated share of residentially associated costs = 85% (75% + 95% ÷2)	

Exhibit I-B.3 shows the number of people, students, and employees that will, on average, result from a mixed-use development of 2,000 two- and three-bedroom townhouses and 750,000 square feet of office space. This amounts to 4,956 new persons, of which 700 will be students. There will also be 2,625 new on-site employees.

Exhibit I-B.3 also shows the market, or true, value of the development, as well as the assessed value, using an 80 percent equalization ratio. Overall, the development has a market value of $630 million ($480 million residential; $150 million nonresidential) and an assessed value of $504 million ($384 million residential; $120 million nonresidential).

Exhibit I–B.3
Calculating the Number of New Persons, Students, and Employees: The Development Pro Forma

Townhouse/Office Development	*Townhouse*		*Office*	*Total Residential and Nonresidential*		*TOTAL*
	2BR **$200,000**	**3BR** **$300,000**	**FT² (000) ($200/ft.²)**	**Total Residential**	**Total Nonresidential (000's sq.ft.)**	
a) Number of housing units	1,200	800	750	2,000	750	
b) Persons per unit	2.11	3.03	-	-	-	
c) Students per unit	0.25	0.5	-	-	-	
d) Employees per 1,000 ft.²	-	-	3.5	-	-	
Total Persons	2,532	2,424	-	4,956		
Students	300	400	-	700		
Employees	-	-	2,625	-		
Total Value	$240,000,000	$240,000,000	$150,000,000	$480,000,000	$150,000,000	**$630,000,000**
Assessed Value	$192,000,000	$192,000,000	$120,000,000	$384,000,000	$120,000,000	**$504,000,000**

Step 3 — Residential Versus Nonresidential Municipal/County Costs

Having calculated the portion of costs associated with residential and nonresidential uses, one can apply the proportion to the appropriate service categories to derive residentially associated costs for each service category. In the example on the next page, total costs are multiplied by 0.85 to estimate residentially associated costs, and the remainder (0.15) represents those costs associated with nonresidential uses (Burchell, Listokin, and Dolphin 1994). ***(See User Guide and Model, Step 5-Enter Budget Info.; Row 20 to Row 37.)***

The figures that are used to assign residential and nonresidential municipal/county costs are derived from the share of parcels and valuation that is residential as opposed to nonresidential. Transportation expenditures related to residential and nonresidential development are also isolated at this time. Exhibit I-B.4 shows the total annual municipal/county and school district expenditures divided between residential and nonresidential uses as well as those specifically assigned to transportation. ***(See User Guide and Model, Step 5-Enter Budget Info.; Row 1 to Row 18.)***

Exhibit I–B.4

Estimating Municipal/County Residential and Nonresidential Costs

2009 Residential vs. Nonresidential Municipal/County Costs

Expenditure	***Total (1.00)***	***Residential (0.85)***	***Nonresidential (0.15)***
General Government	$2,750,000	$2,337,500	$412,500
Public Safety	$7,000,000	$5,950,000	$1,050,000
Public Works	$3,540,000	$3,009,000	$531,000
Transportation	($1,416,000)	($1,203,000)	($212,400)
Economic Development	$1,350,000	$1,147,500	$202,000
Transportation	($337,000)	($286,875)	($50,625)
Health/Human Services	$450,000	$382,500	$67,500
Recreation/Culture	$1,850,000	$1,572,500	$270,000
Debt Service	$2,000,000	$1,700,000	$300,000
Transportation	($1,000,000)	($850,000)	($150,000)
TOTAL Overall	**$18,940,000**	**$16,099,000**	**$2,841,000**
Transportation	**($2,753,500)**	**($2,340,475)**	**($413,025)**

2009 School District Education Costs

Expenditure	***Total***	***Transportation***	
Teaching	$87,420,000		
Administration	$14,100,000		
Transportation	$28,200,000	**Transportation**	**$28,200,000**
Debt Service	$11,280,000	**Transportation**	**$3,384,000**
TOTAL Overall	**$141,000,000**	**Transportation**	**$31,584,000**

Step 4 — Per Person Estimates and Per Employee Estimates of Municipal/County Costs

To estimate per person, per employee, and per student figures, divide the residentially associated expenditures and nonresidentially associated expenditures of the municipal/county budget by total population and total "at place employment" in the municipality/county, respectively. A similar procedure is used to divide the school district operating budget by the number of students attending public schools locally. In the following example, assume that: (1) the population of a community is 23,530; (2) the number of employees working in the community is 10,000; and (3) the number of students is 9,400. This produces per person costs of $684 ($99.47 per person to transportation); per employee costs of $284 per employee ($41.30 to transportation); and per student costs of $15,000 ($3,360 to transportation) (Exhibit I-B.5) (Levin 1975a, b).

Exhibit I–B.5

Estimating Municipality/County/School District Per Person, Per Employee, and Per Student Costs

Expenditure(Municipal/County)	*Per Capita (Transportation)*	*Per Worker (Transportation)*
General Administration	$99.34	$41.25
Public Safety	$252.87	$105.00
Public Works	$127.88	$53.10
Transportation	($51.15)	($21.24)
Economic Development	$48.77	$20.25
Transportation	($12.19)	($5.06)
Health/Human Services	$16.26	$6.75
Recreation/Culture	$66.83	$27.75
Debt Service	$72.25	$30.00
Transportation	($36.12)	($15.00)
TOTAL Overall	**$684.19**	**$284.00**
Transportation	**($99.47)**	**($41.30)**
Expenditure(School)	*Per Student Total*	*Per Student (Transportation)*
Teaching	$9,300	$0.00
Administration	$1,500	$0.00
Transportation	$3,000	$3,000
Debt Service	$1,200	$360
TOTAL	**$15,000**	**$3,360**

Step 5 — Calculate the Total and Transportation-Related Operating Costs Associated with New Development

Apply the municipal/county per person and per employee costs to the estimated population and workforce associated with the development to derive the municipal/county operating costs associated with development (Burchell and Listokin 1980). Apply the school district per student operating costs to the estimated students associated with the development. In the municipal costs example (see Exhibit I-B.6), this amounts to about $4.14 million in additional costs annually, of which transportation amounts to $601,381 annually. For school district costs, it amounts to $10.5 million, of which $2.35 million is for annual transportation costs (Exhibit I-B.6). ***(See User Guide and Model, Step 7-View Model Ouput; Output 2 Row 19 to Row 59.)***

The Per Capita Multiplier Method is the classic average-costing approach. Service costs are projected at the average per unit outlay per person, per employee, and per student. The technique is straightforward, relatively easily effected, and, in most cases, yields a quick handhold on the impacts of development. For these and other reasons, it is the most common technique employed in the field. As such, step-by-step procedures for implementing the Per Capita Multiplier Method are incorporated into this model.

Exhibit I–B.6

Calculating Total Municipal/County and School District Operating Costs

Municipal/County Residential Operating Costs	***Amount (Total Costs)***	***Transportation Costs***
a. Per person costs	$684	$99.47
b. Population of development	4,956	4,956
Total (a X b)	**$3,390,848**	**$492,962**
Municipal/County Nonresidential Operating Costs		
c. Per employee costs	$284	$41.30
d. Employees in development	2,625	2,625
Total (c X d)	**$745,763**	**$108,419**
TOTAL MUNICIPAL/COUNTY	**$4,136,610**	**$601,381**
School District Operating Costs	***Amount (Total Costs)***	***Transportation Costs***
e. Per student cost	$15,000	$3,360
f. Students in development	700	700
Total (e X f)	**$10,500,000**	**$2,352,000**
TOTAL SCHOOL DISTRICT	**$10,500,000**	**$2,352,000**
TOTAL: MUNICIPAL/COUNTY AND SCHOOL DISTRICT OPERATING COSTS	**$14,636,610**	**$2,953,381**

Total and Transportation-Related Operating Revenues Associated with New Development

Public service jurisdictions rely on revenues that include both local and extralocal sources. Local sources comprise a variety of types of levies, while extralocal sources pertain usually to intergovernmental transfers from the state and federal governments (Pigg et al. 2003; Vermont League of Cities and Towns and Vermont Natural Resources Council 1990). ***(See User Guide and Model, Step 5-Enter Budget Info.; Row 20 to Row 85.)***

The combined local levies are often the more significant sources of income and encompass taxes and charges as well as miscellaneous revenues. The most significant tax is commonly the levy on property. Other taxes include levies on gross receipts (consumer sales), personal property, real estate transfer, and income taxes. In addition to taxes, government jurisdictions receive income from fees and assorted revenues from interest earnings, permits, charges for services, fines and penalties, and the like (Burchell, Listokin, and Dolphin 1985).

In considering growth-induced revenues, the full matrix of local (municipal/county) revenues should be examined as follows:

I. Own-Source Revenues

A. ***Taxes***

1. Property taxes
2. Sales taxes
3. Income taxes
4. Personal property taxes

B. ***Charges and Miscellaneous Revenues***

1. Interest, rents, royalties
2. Licenses and permits
3. Public charges
4. Fines and forfeits
5. Sales of fixed assets
6. Other miscellaneous

II. Intergovernmental Revenues

A. State intergovernmental revenues

B. Federal intergovernmental revenues

In projecting specifically how growth affects both local and extralocal revenues, the fiscal impact analyst first considers the basis for each revenue source and then examines how development will affect each. To illustrate, the property tax is a percentage levy on the value of land and improvements (real property). In some jurisdictions, a property tax is also imposed on personal property, including the value of automobiles. To project property tax revenues related to growth, the analyst first determines the assessed value of the development in terms of its property tax constituent components—real and personal (including automobiles). The assessed valuation is then multiplied by the prevailing property tax rate.

Similar step-by-step calculations project revenue collections associated with the other revenue sources. To illustrate, many governments receive income from the gross receipts (sales) tax. To calculate growth effects, the analyst estimates how development will add to aggregate gross receipts and then projects the concomitant gain in gross receipts tax revenues based on the applicable tax rate. Another source of local income is interest earnings typically derived from investing major revenues before they are disbursed to pay for local expenses. The local interest earnings from growth can be determined by calculating how development adds proportionately to local revenue resources (i.e., property tax base) that can be invested before they are used. Local income from interest earnings can be projected to vary with population.

In certain instances, revenue collections are related to population size. For example, many local governments raise funds from fines, licenses, and permits. As growth adds to the population base, the community will receive more revenue from traffic violations and overdue library charges, and collect more bicycle registration fees, etc. Therefore, local income from fines and licenses can also be expected to increase as a proportionate share of population (TischlerBise 2007).

Intergovernmental income is projected similarly. Thus, if a state granted $100 per student for textbooks, the development-associated income for such aid would be equal to the number of new students multiplied by $100. Where school aid formulas are more complex, and, for example, incorporate ratios between the local versus state average equalized valuation per student, the analyst would then ascertain how these relationships would change with the onset of development and thus how state support formulas would be altered.

Courtesy of Voorhees Transportation Center

Property Tax Revenue

The usual first step in the analysis of revenues is to calculate property tax revenues. This is done using the assessed value of the proposed development multiplied by the local municipal/county and school district tax rates. The development will have mixed residential and nonresidential components or solely residential and nonresidential components. For a mixed residential and nonresidential development there should be multiple (residential and nonresidential) results for both the municipality/county and school district. These are shown in Exhibit I-B.7 by the type of government to which they accrue. These are municipality, county, and school district. Only the municipality or county and school district are used in the calculation shown in Exhibit I-B.7. ***(See User Guide and Model, Step 7-View Model Ouput; Output 2 Row 34 to Row 35.)***

Other Revenues: Miscellaneous Revenues, Charges, Intergovernmental Transfers

Calculate the residentially generated revenues associated with the development by multiplying the per person or development value estimate of revenue by the population increase or the increment of development value. Either/both, or specific formulas, could be used for various types of revenues. The example shown in Exhibit I-B.8 uses the per capita approach. Calculate the nonresidential revenues associated with the development by multiplying the per employee estimate of revenue by the employment increase associated with the development. A series of steps is involved before this can be done, as explained in Exhibit I-B.8.

Exhibit I–B.7

Calculating Municipal/County and School District Property Tax Revenue

Property Tax Revenue	***Total***	***Municipal/ County***	***School District***
a. Assessed value of development	$504,000,000	$504,000,000	$504,000,000
b. Local tax rate	0.0200	0.0050	0.0100
Total Property Taxes (a x b)	**$10,080,000**	**$2,520,000**	**$5,040,000**

Exhibit I–B.8

Calculating Property Tax Revenue Per Person and Per Employee

Property Tax Revenue	*Total*	*Persons / Employees / Students (#)*	*Per Person / Employee/ Student*
Municipal/County			
Residential	$1,920,000	4,956	$387.41
Nonresidential	600,000	2,265	$228.57
Total $	**2,520,000**	—	—
School District			
Residential	$3,840,000		
Nonresidential	1,200,000		
Total $	**5,040,000**	700	$7,200
Municipal or County and School	**$7,560,000**	—	—

Allocate Miscellaneous Revenues, Charges, and Intergovernmental Transfers

The same procedure that was used to estimate costs is used to estimate revenues (with the exception of property tax revenue). The property tax revenue is calculated directly, as discussed below. Revenues are initially apportioned to residential and non-residential using property value and parcel information or the same ratio of 0.85 to represent the residential share. The remainder represents the nonresidential share.

To derive the per person and per worker estimates of revenues one proceeds as follows: divide municipal/county residentially induced revenues by total persons to derive a per person estimate of revenues; divide municipal/county nonresidentially induced revenues by local employees for a per employee estimate of nonresidential revenues. In each case, isolate a transportation share from its appropriate source (see Exhibits I-B.9 and I-B.10).

Exhibit I–B.9

Municipal/County and School District Revenue Budgets and Transportation Shares

Municipal/County Sources of Revenue	***TOTAL***	***Residential***	***Nonresidential***
Property taxes	$12,140,000	$10,319,000	$1,821,000
Other taxes	1,000,000	850,000	150,000
Interest earnings	500,000	425,000	75,000
State intergovernmental revenues	1,500,000	1,275,000	225,000
Licenses and permits	700,000	595,000	105,000
Fines and forfeits	430,000	365,500	64,500
Public charges	1,000,000	850,000	150,000
Federal intergovernmental revenues	600,000	510,000	90,000
Other miscellaneous revenues	1,070,000	909,500	160,500
Total	**$18,940,000**	**$16,099,000**	**$2,841,000**
School District Sources of Revenue	***TOTAL***	***Transportation Share***	
Property taxes	$106,000,000	$21,000,000	
Tuition	750,000	—	
Miscellaneous revenues	1,250,000	150,000	
State aid	20,000,000	2,000,000	
Federal aid	13,000,000	1,300,000	
Total	**$141,000,000**	**$24,450,000**	

Exhibit I–B.10
Per Person / Per Employee / Per Student Municipal/County and School District Revenues

Municipal/County Per Person and Per Employee Revenue Sources	***Per Person***	***Transportation Share***	***Per Employee***	***Transportation Share***
Property taxes	$387.41	$19.37	$228.57	$11.43
Other taxes	36.12	10.11	$15 .00	$3.30
Interest earnings	18.06	—	$7.50	—
State intergovernmental revenues	54.19	34.22	$22.50	$11.25
Licenses and permits	25.29	—	$10.50	—
Fines and forfeits	15.53	6.99	$6.45	$2.26
Public charges	36.12	19.87	$15.00	$6.75
Federal intergovernmental revenues	21.67	11.92	$9.00	$4.05
Other miscellaneous revenues	38.65	—	16.05	—
Total (without property tax)	**$245.64**	**$84.11**	**$102.00**	**$27.61**
Total (with property tax)	**$633.05**	**$103.48**	**$330.57**	**$39.04**
School District Per Student Revenue Sources	***Per Student***	***Transportation Share***		
Property taxes	$7,200	$1,440		
Tuition	$80	—		
Miscellaneous revenues	$133	$16		
State aid	$2,128	$213		
Federal aid	$1,383	$138		
Total (without property tax)	**$3,724**	**$367**		
Total (with property tax)	**$10,923**	**$1,807**		

Total Local Revenues: Transportation Share

Total revenues equals the residential revenues expressed per person as well as the residential portion of the property tax calculation separately expressed per person. It further includes the nonresidential revenues expressed per employee, including the nonresidential portion of the property tax calculation expressed per employee.

School district per student revenues are also included in total revenues. Transportation shares are broken out from each (Exhibit I-B-12). ***(See User Guide and Model, Step 7-View Model Ouput; Output 2 Row 19 to Row 59.)***

Exhibit I–B.11

Calculating Municipal/County and School District Future Operating Revenue

	A.	**B.**	**C.**	**D.**
Municipal/County Revenues	***Per Person***	***Transportation Share***	***Per Employee***	***Transportation Share***
All other revenues	$245.65	$84.11	$102.00	$27.461
Property tax revenues	$387.41	$19.37	$228.57	$11.43
Total $	**633.05**	**$103.48**	$330.57	$39.04
X people/employees in development	4,956	4,956	2,625	2,625
Municipal/county revenues	$3,137,411	$512,871	$867,750	$102,469
Total				
Municipal/County (A + C)	**$4,005,161**			
Transportation (B + D)		**$615,340**		
School District Revenues	***Per Student***	***Transportation Share***		
All other revenues	$3,723	$367		
Property tax revenues	$7,200	$1,440		
Total $	**10,923**	**$1,807**		
X students in development	700	700		
School district revenues	$7,646,383	$1,264,915		
Total				
School District $	**7,646,383**			
Transportation		**$1,264,915**		

Comparing Costs to Revenues: Transportation Operating Costs/Revenues of Development

Once the growth-induced population is projected, the next step is to determine the basic values for a fiscal impact assessment by translating the forecasted population into costs and estimating the development-generated revenues (Gray and Dann 1989). Revenues are matched against costs: if they exceed costs, a surplus is incurred; if they fall short of costs, a deficit is realized. When the per capita approach is used, the cost-revenue comparison is typically expressed as an end-state value, as if all development were taking place immediately at current indices of costs and revenues.

In the example chosen, application of the per capita approach yielded total annual revenues approaching $11.7 million, of which $1.9 million is allocated for transportation. This is

Exhibit I–B.12
Transportation Operating Costs/Revenues of Development

Net Fiscal Impact	Project-Specific (Total)	Transportation Share
I. Revenues		
Municipal/County	$4,005,161	$615,340
School District	7,646,383	1,264,915
Total	**$11,651,544**	**$1,880,255**
II. Costs		
Municipal/County	$4,136,610	$601,381
School District	10,500,000	2,352,000
Total	**$14,636,610**	**$2,953,381**
III. Net Fiscal Impact		
Municipal/County	-$131,449	$13,959
School District	-$2,853,617	-$1,087,085
To tal	**-$2,985,066**	**-$1,073,126**

compared with annual costs of $14.6 million, of which $3.0 million is allocated to transportation. The result is a net fiscal deficit of approximately $2.99 million, of which transportation costs constitute a $1.07 million deficit. This yields a composite of the different fiscal impacts of the respective project components. Thus, the single-family attached homes with relatively high household and student profiles produce a fiscal deficit in both the municipality/county and the school district. This loss cannot be offset by the surplus associated with the project's office space uses.

PER CAPITA MODEL FOR DIRECT TRANSPORTATION OPERATING COSTS AND REVENUES

The model of direct transportation operating costs follows the Per Capita Multiplier Method—the most widely applied fiscal impact technique—and encompass the basic steps of cost-revenue analysis. First, the model projects the number of people/employees/students generated by development. Second, it translates the population increment into attendant public service costs by multiplying the development-generated population by the per person/employee/student expenditure factors. Third, the model considers the revenues added by growth and, finally, compares revenues to costs to yield the net fiscal impact.

The analysis for this step in the direct operating cost model is effected through a series of inputs and outputs. The inputs include base data either built into the model (i.e., demographic multipliers) or added by the user (i.e., the project pro forma and local fiscal data). The outputs include the total and transportation costs of development, preceded by the development-created population, service costs, revenues, and ultimately, net fiscal impacts.

The inputs and outputs are as indicated below.

Population Factors. To project the development-created population and employment, the most recent demographic multipliers (residential and nonresidential) are applied to the development pro forma.

Cost Factors encompass the public service costs for the different public jurisdictions affected by growth, including the municipality/county and school district. To apportion municipal/county expenditures associated with residential and nonresidential uses, respectively, the analyst enters the valuation and number of parcels that exist locally of the two respective land-use categories. The data are readily available from the local business administrator, treasurer, and assessor. Costs are broken out by sector; in each case, transportation costs are separately specified.

Revenue Factors include parameters for calculating the development-created property tax, local nonproperty tax, and state and federal intergovernmental transfers. As with local costs, these factors are unique to each jurisdiction; therefore, the specific local values must be entered into the model.

The values are readily available. For the property tax, the analyst obtains the applicable assessment-to-sales (equalization) ratio and the property tax rates from the assessor's office for entry into the model. For local nonproperty-tax income and intergovernmental sources, revenues are expressed on either a per capita basis or on a valuation-added basis (i.e., per $1,000 of assessed value). These values are obtained from the existing municipal/county budget.

The direct operating cost model contains a number of *outputs* that are related to the input fields as follows:

Population Generation. For the development under examination, the model generates the number of persons as well as number of students added; the latter may be differentiated by school grade level (K–6, 7–8, 9–12). In parallel, where nonresidential or mixed-use development is considered, the model yields the number of employees.

Cost Generation. The model multiplies the project-created population by the existing cost parameters to generate the project-created outlays required of the municipality/county, school district, and other public jurisdictions.

Revenue Generation. The property tax determination involves two calculations. First, the assessed value is computed by applying the assessment (equalization) ratio to the market value of the project (both previously entered). The model then applies the property tax rate for the applicable public jurisdictions to the assessed valuation to yield the development-created property tax revenue by jurisdiction.

The model projects local nonproperty tax income by multiplying the project-created population and valuation by the previously determined nonproperty tax revenue per person and per $1,000 valuation, respectively. The intergovernmental revenue generated by growth is calculated through a similar procedure.
The sum of the development-generated property tax, nonproperty tax, and federal and state aid yields the total income generated by growth.

Net Fiscal Impact/Effects. The net fiscal impact is determined by comparing the development-generated revenues to development-generated costs. The resulting surplus or deficit figures (total and for transportation) are indicated individually for all the affected public service jurisdictions as well as in aggregate. These cost-revenue outcomes are then placed in perspective

by comparing the figures to the underlying budgets for each affected public jurisdiction.

Courtesy of Voorhees Transportation Center

ADVANTAGES AND LIMITATIONS OF THE DIRECT OPERATING COST/REVENUE MODEL

The direct operating cost model offers numerous benefits. First, it is patterned after the Per Capita Multiplier Method, which is the most applicable and widely used cost-revenue method. Its data demands are not burdensome; the input factors are either built into the model or else are readily obtainable. For instance, the equalization ratio and property tax rates as well as the number and value of parcels by residential/nonresidential type are either posted in official public documents such as the annual tax roll or are available from a telephone call to or interview with the tax assessor. Similarly, the other cost and revenue parameters, including municipal/county and school district expenditures, are also readily collected from published budgetary documents and/or from contacting the local business administrator and school district budget officer.

Despite its modest input data demands, the model produces a full array of fiscal impact outputs, including a detailed breakout of development-generated population; costs (including transportation) by public service jurisdiction; costs caused by the residential versus nonresidential components of a project; revenues (including transportation) by jurisdiction; revenues differentiated into property, other local source, and intergovernmental categories; and, finally, the net fiscal impacts by individual jurisdiction (including transportation). Thus, the model does not give a "black box" final result but arrays and shows all the calculations and intermediate products that lead to the calculation of the final transportation revenues versus costs impacts.

Nonetheless, the model does have some shortcomings. As a per capita methodology, the model is widely applicable though not always best suited to all situations. To illustrate, in cases of severe excess or slack capacity, the case study approach may provide a more accurate picture of the impacts of growth.

Another shortcoming concerns the manner in which the model calculates revenues. Revenue inputs are factored on a per person or valuation-increment basis. While such an approach is generally acceptable, it oversimplifies the complexities of projecting certain revenues—especially intergovernmental transfers. Intergovernmental aid is often distributed according to complicated formulas that relate local to state relationships (local valuation per student compared to a state foundation level) whose values themselves change annually. This model is not structured to reflect such a high level of specificity and, as such, yields an approximation rather than the most accurate projection of development-created revenues.

Such order-of-magnitude information is useful in several situations. When a project is first considered, the analyst often explores alternative development possibilities in terms of type, scale, and location to minimize transportation and other costs. An analysis of the fiscal effects of the various scenarios can help the analyst select the most promising options. The analysis would typically be undertaken in conjunction with parallel studies of economic feasibility and environmental and traffic impacts.

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Courtesy of Matt Crosby

STEP II—A and B

Indirect Transportation Capital and Operating Costs

INTRODUCTION

This section of the analysis deals with the indirect transportation capital and operating costs of development.[6] It concerns the impact of additional persons who come to a community as a result of employment directly developed in the community—in other words, the families of employees who choose to live in the community (in new development) in which they work. It also concerns additional new employees and the facilities that are spawned due to retail and service expenditures of the direct persons of residential development.

In the first case, employees in a mixed-use development decide to live locally. These new indirect persons impose costs and create revenues, some of which relate to transportation capital needs and operating impacts (residential demand). In the second case, new persons create new employees and nonresidential space related to their additional local retail and service expenditures. These employees will cause additional local police, fire, public works, and other service costs (nonresidential demand). Generally speaking, the indirect capital and operating costs are a fraction of the direct capital and operating costs because, in the first case, new employees may continue their residence at their prior location, they may buy or rent used housing, or they may buy or rent new housing outside the jurisdiction of their employment (Burchell & Listokin LLC 2005). In the second case, expenditures of new persons for convenience goods will not be wholly contained within the jurisdiction, and expenditures for shopping goods will, in large share, fall outside the jurisdiction. Nonetheless, there are indirect impacts associated with development that must be accounted for, and a share of these indirect costs relate to transportation (Ewing and Cervero 2001; Henderson, Young and Company 2003).

Courtesy of Voorhees Transportation Center

INDIRECT TRANSPORTATION CAPITAL AND OPERATING COSTS

Both the indirect transportation capital and operating costs of a mixed-use development flow directly from the direct capital and operating costs (Nelson, Nicholson, and Jurgensmeyer 2009). They involve two types of impacts that are viewed simultaneously. The first is the number of development employees who choose to live locally, causing residential support services. The second is the number of employees created by the new local expenditures of direct residents (Burchell-Listokin and Associates 1997).

[6]Almost all of the indirect fiscal impact analysis examples came from two practitioner firms: Burchell-Listokin and TischlerBise. There are multiple examples in the New York and Washington, DC, metropolitan areas of fiscal impact analysis undertaken including indirect costs.

The mixed-use development example of direct capital and operating costs is used to generate indirect operating costs of development, including those related to transportation.

Indirect Servicing Obligation

For a mixed-use development or for a single-use *nonresidential* development, the first step in determining indirect capital and operating impacts is to calculate the share of employees that will reside locally. The next step for a mixed-use development or a single-use *residential* development is to calculate the new employees supported by the expenditures of new persons.

Employees That Will Live Locally Because They Are Part of the Nonresidential Portion of the Development

To determine the likelihood of employees that live locally, one uses the latest *U.S. Census, American Community Survey 2005-2009* data (see Exhibit II-1 for sample 2000 data) (Burchell, Dolphin, et. al. 2007).

The average of the cities is approximately 30 percent. Thirty (30) percent of those who work locally live locally. Of those who live locally, about two-thirds (20 percent) live in used housing, and about one-third (10 percent) live in new housing. Thus, one-third of 30 percent, or 10 percent of the employees, are assumed to live locally in new housing (263). These employees are assumed to have a median household income of $50,000 and can support housing selling for about $150,000 (see next page).

For residents of new housing units, a median household income of $80,000 (2006) is used (see Exhibit II-2). The above assumptions, obviously, are required as inputs to the model. For example purposes, the data on the following pages are used here.

Exhibit II-1

Five Cities of 25,000 Population with Employee Residency: Percentages and Median Income

City	Population	Employee Residency Percentage (%)	Median Income ($)
Emporia City (Kansas)	26,702	85.5%	$30,809
New Castle City (Pennsylvania)	26,311	48.6	25,598
Winter Park (Florida)	**24,227**	**28.6**	**48,884**
Leewood City (Kansas)	27,870	16.3	102,496
Jefferson City (Kentucky)	26,610	24.3	51,999

Source: U.S. Census of Population and Housing, 2000

Exhibit II-2

Employees and Households Generated by Indirect Development

Employees/ Households in Development		Average Household Income	House Price That Can Be Afforded	Consumption Income	Additional Employee Households Who Will Live Locally	Additional Square Feet of Local Convenience	Additional Square Feet of Local Retail
Employees	2,625	$50,000	$150,000	$25,000	263	11,229	3,938
Households	2,000	$80,000	$240,000	$40,000		136,889	48,000

Employees/ Households in Development		Additional Employees of Local Connivance	Additional Employees of Local Retail	Total Added Employees	Additional People	Additional Students	Additional Housing Units	Additional Square Feet of Nonresidential Space
Employees	2,625	28	10	38				
Households	2,000	342	120	462				
Total				500	675	98	263	200,056

Source: CUPR calculations—see text.

Employees That Will Be Created Locally Due to Expenditures of Those Who Live/Work in the New Development

Forty million dollars ($40 million) in expenditures by 2,000 households spending $22,000 annually for local convenience and shopping goods will support 185,000 square feet of retailing/personal services space assuming $225 of sales supports one square foot of convenience or shopping space. At $200 construction cost per square foot, this amounts to nonresidential development of $37 million, occupied by 462 employees at 2.5 employees per 1,000 ft.^{2} (see Exhibit II-2).

Thus, in the first-case, indirect development (employees who would live locally) would generate 263 employee households that would live in new housing locally, valued at approximately $150,000 per unit. In the second case, indirect development (persons who would create a demand for new employment) would generate an aggregate amount of structure value of $37 million (185,000 ft.^{2} at $200 per ft.^{2}) that would be occupied by 462 additional employees (at 2.5 employees per 1,000 ft.^{2}). This is the indirect development related to the direct development for which new operating costs were calculated (TischlerBise 2007).

The expenditures of these employee households will generate a demand for an additional 15 thousand square feet of local convenience and retail space supporting an additional 38 employees. The total demand for additional employees, from both the new residential units and the new employees who live locally, is 500 employees in 200,000 square feet of space.

If the base development contains retail or convenience space, the indirect employment will be adjusted appropriately.

INDIRECT TRANSPORTATION CAPITAL COSTS /REVENUES

In the calculation of indirect transportation capital costs, there must be the same sensitivity to the factors affecting costs that was evident in the calculation of direct transportation capital costs. In other words,

1. The principle of rational nexus must oversee all calculations of cost, i.e., the cost must be proportionate to the impact. It could be scaled according to size.
2. A level-of-service standard must be established: To what level will the transportation service be dispensed?
3. The cost of the improvement must be based on reasonable estimates to provide the capital facility.
4. Revenue credits: to what degree is the development already paying for existing capital infrastructure through debt service and the like? These must be credited and potentially scaled to size.
5. The degree to which other levels of government contribute to the capital good (and therefore should not be part of the developer's cost).
6. The time-value of money if the new capital facility for which the development is to pay is far into the future, or the old capital facility for which the proposed development is already paying is far in the past.

Thus, rational nexus, levels of service, improvement costs, and revenue credits must be a part of every calculation (Duncan Associates et al. 2004).

Calculating Indirect Transportation Capital Costs

The indirect transportation capital costs of development are calculated in much the same way direct capital costs were calculated in Exhibit I-A.15. This procedure is shown in Exhibit II-3 (Tindale Oliver & Associates 2004).

Thus, the indirect transportation capital costs for direct development of 2,000 dwelling units and 750,000 square feet of office space amount to $1.29 million. This is due to the fact that the expenditures of the 2,000 direct households of the development along with 263 employee households living locally in new housing will support 500 new employees in 200,000 square feet of retail space. At $3,997 per 1,000 square feet of retailing space for capital costs, this amounts to a one-time cost of $799,718 for indirect capital costs.

In addition, from 2,625 employees in the 750,000 square feet of office space, approximately 10 percent live in new housing in the community of the development. At $1,865 per dwelling unit, multiplied by the 263 employee households, this amounts to a one-time cost of $489,691. The total, as indicated above, is $1,289,409.

Indirect Transportation Capital Revenues

The indirect capital revenues amount to the same number as the indirect capital costs. It is a $3,997 charge per 1,000 square feet of nonresidential space (retailing), or $3,997 x 200 (or $799,718), for revenues to support costs for new employees in 200,000 square feet of retailing. It is $1,865 per dwelling unit, or $489,691 for employees who are part of the nonresidential space of the development and choose to reside locally. The total of indirect nonresidential transportation revenues is $1,289,409 (TischlerBise 2005). Revenues equal cost because there is a very deliberate revenue calculation procedure that equates revenues with costs calculated in a particular way.

Exhibit II-3

Applying the Duncan Methodology for Direct Capital Costs/Revenues to Indirect Development Being Analyzed

	Number of Residential Units/ 000s of Square Feet of Nonresidential Space	*Cost per Residential/ Nonresidential Unit*	*Total Indirect Capital Costs/Revenues (Transportation)*
Retail Space	200 (200,000 ft.^{2} to accommodate 500 new employees @ 2.5 employees/1,000 ft.^{2})	$3,997	$799,718
Dwelling units	263	$1,865	$489,691
			$1,289,409

Source: CUPR Calculations—see text.

MODEL FOR INDIRECT TRANSPORTATION CAPITAL COSTS

The model for indirect transportation capital costs follows the direct transportation capital cost calculation procedure and uses the demand numbers from the indirect transportation operating cost model.

In this case, inputs and outputs build on the inputs and outputs of the above-noted models.

Inputs

Population Generation

The model also generates new indirect resident households for costing purposes. It includes numbers of units of additional residential demand. The model also uses the amount of additional nonresidential space that will be generated. This produces the number of new employees for costing purposes.

Cost Factors

Costs amount to the calculated per-unit and per-1,000-square-feet capital costs that have been tabulated in the direct transportation capital cost component of the model, multiplied by the number of new indirect units and thousands of square feet of nonresidential space.

Revenue Factors

Revenue factors are exactly the same numbers as costs due to the reality of rational nexus—revenues required must directly reflect costs incurred.

(See User Guide and Model Step 6-Enter Finc.-Mult. Info.; Row 6 to Row 22.)

Courtesy of New Jersey Department of Transportation

Outputs

Population Generation

- The number of employee-resident households that will live locally in new housing.
- The number of new employees that will work in nonresidential facilities supported by new households of the development.

Cost Factors

- Transportation capital costs related to indirect development.

Revenue Factors

- Transportation capital revenues related to indirect development.

(See Users Guide and Model, Step 7-View Model Output, Row 66 to Row 81.)

Courtesy of Voorhees Transportation Center

ADVANTAGES OF THE INDIRECT TRANSPORTATION CAPITAL COST MODEL

This is one of the first models to detail indirect transportation capital costs related to a specific development proposal.

INDIRECT TRANSPORTATION OPERATING COSTS

Indirect transportation operating costs are those costs related to providing for 263 additional residences and 500 additional employees. The above number of new residences locally (263) would have the average household size and student ratios of the direct development examples. These are 2.57 people per unit and 0.375 students per unit. This would produce 675 additional persons and 98 new students.

The number of projected indirect new persons, employees, and students shown in Exhibit II-4, multiplied by the municipal/county, and school district costs per person, employee, or school child with transportation broken out separately, amount to $2.08 million of combined additional municipal/county and school district costs, of which additional indirect transportation operating costs amount to $418,510 annually.

INDIRECT TRANSPORTATION OPERATING REVENUES

Indirect transportation operating revenues are those revenues related to receiving property tax and other revenues from 263 new residences and structure(s) housing an additional 500 employees. The 263 indirect residences generate 675 additional persons and 98 additional students. The $40 million in nonresidential facilities generates 500 additional employees. The number of persons, employees, and students multiplied by the per person, per employee, and per student revenues generates the revenues shown in Exhibit II-5 (National Association of Home Builders 2007).

What these figures indicate is that indirect operating revenues amount to $1.67 million for combined municipality and school district, of which $267,000 is for transportation purposes.

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Exhibit II-4
Transportation Operating Costs of Indirect Development

Number of New Persons, Employees, and Students		Per Capita, Per Employee, Per Student Costs		TOTAL COSTS	
		Municipal, County and School District Costs	***Transportation Costs***	***Municipal, County, and School District Costs***	***Transportation Costs***
Persons	675	(person)$684	$99.47	$461,572	$67,103
Employees	500	(employee) $284	$41.30	$142,089	$20,657
Students	98	$15,000	$3,360	$1,476,563	$330,750
			TOTAL COSTS:	**$2,080,224**	**$418,510**

Source: CUPR calculations—see text.

Exhibit II-5
Transportation Operating Revenues of Indirect Development

Number of New Persons, Workers, and Students		Per Capita, Per Worker, Per Student Revenues		TOTAL REVENUES	
		Municipal, County, and School District Revenues	***Transportation Revenues***	***Municipal, County, and School District Revenues***	***Transportation Revenues***
Persons	675	(person)$633	$103	$427,073	$69,814
Employees	500	(employee) $331	$39	$165,332	$19,523
Students	98	$10,923	$1,807	$1,075,273	$177,879
			TOTAL REVENUES:	**$1,667,678**	**$267,215**

Source: CUPR calculations—see text.

COMPARING REVENUES TO COSTS: NET FISCAL IMPACTS AND TRANSPORTATION SHARE

The net fiscal impact involves subtracting revenues from costs. Because costs exceed revenues, the fiscal impact for indirect development proves to be negative, as it was for direct development. Overall, revenues amount to $1.66 million, of which transportation revenues amount to $267,215. Overall costs amount to $2.08 million, of which transportation costs amount to $418,510. The net fiscal impact is an overall deficit of (–) $11,256 at the municipal level and (–) $401,290 at the school district level. The transportation surplus is about $1,576, at the municipal level and a deficit of (–) $152,871 at the school district level. The combined indirect fiscal deficit is (–) $412,546, of which transportation costs exhibit a deficit of (–) $151,295. As indicated in the case of direct impacts, the overall fiscal impacts are negative (Exhibit II-6) (American Farmland Trust 2004).

Exhibit II-6
Net Fiscal Operating Impacts:
Revenues versus Costs of Indirect Development

Net Fiscal Impact	Project-Specific	Transportation Share
I. Revenues		
Municipal/County	$592,405	$89,337
School District	$1,075,273	$177,879
Total	$1,667,678	$267,215
II. Costs		
Municipal/County	$603,661	$87,760
School District	$1,476,563	$330,750
Total	$2,080,224	$418,510
III. Net Fiscal Impact		
Municipal/County	-$11,256	$1,576
School District	-$401,290	-$152,871
Total	-$412,546	-$151,295

Source: CUPR calculations—see text.

PER CAPITA MODEL FOR INDIRECT TRANSPORTATION OPERATING COSTS

The model for indirect transportation operating costs follows the per capita methodology. It builds on information provided by the direct transportation operating-costs model and calculates fiscal impacts for the indirect increment of development. First, the model projects the number of people, employees, and students generated by growth. Second, it translates the population increment into attendant public service costs by multiplying the development-generated population by the per person, per employee, and per student expenditure factors. Third, the model considers the revenues added by growth and, finally, compares revenues to costs to yield the net fiscal impact. In each case, transportation expenditures, revenues, and net fiscal impact are broken out separately.

The inputs and outputs build on the inputs and outputs of the direct transportation operating cost component of the overall model. In many cases, the outputs of the direct transportation operating component serve as the inputs to the indirect operating cost component.

Courtesy of Voorhees Transportation Center

Inputs

Population Generation

The model uses U.S. Census information on the share of employees that reside locally as well as ratios of new-to-used sales transactions to determine the percentage of employees that will live locally in new housing. This generates new indirect person households for costing purposes. It includes numbers for persons and students.

The model uses consumer income of development households as well as: (1) percentages of income spent on convenience goods/services and shopping goods/services; (2) percentages of convenience goods and shopping goods that are captured locally; and (3) square-foot expenditures necessary to support various types of retail growth, to determine the amount of new nonresidential space that will be generated. This produces the number of new employees for costing purposes.

Cost Factors

Costs use the calculated per person, per employee, and per student costs that have been tabulated in the direct transportation operating cost component of the model multiplied by the number of new indirect persons, employees, and students generated from the Population Generation segment.

Revenue Factors

Revenues (except for property tax) use the calculated per person, per employee, and per student revenues that have been tabulated in the direct transportation operating revenue component of the model multiplied by the number of new indirect persons, employees, and students generated from the Population Generation segment. The property tax component is different for this calculation of revenues because new employee housing units are less expensive than housing units for other new residents. ***(See User Guide and Model Step 6-Enter Finc.-Mult. Info.; Row 6 to Row 22.)***

Outputs

Population Generation

- The number of employee households that will live locally in new housing.
- The number of new employees that will work in nonresidential facilities supported

by new resident households of the development.

Cost Factors

- Total and transportation operating costs related to indirect development. This involves municipal or county and school district future indirect costs.

Revenue Factors

- Total and transportation operating revenues related to indirect development. This involves municipal or county and school district future indirect revenues.

Net Fiscal Impacts/Effects

- The net fiscal impact is determined by comparing indirect development revenues with indirect development costs. The resulting surplus or deficit is produced for each jurisdiction involved, together with the transportation cost fiscal impact.

(See Users Guide and Model, Step 7-View Model Output, Row 83 to Row 110.)

ADVANTAGES OF THE INDIRECT OPERATING COST MODEL

This is the first model to detail indirect transportation costs versus revenues related to a specific development proposal. It also provides some sense of the magnitude of such costs (relative to direct costs) for an individual community of this size.

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Courtesy of Jon Erickson

STEP III—A and B

Induced Transportation Capital and Operating Costs*

OVERVIEW

The third section of this report deals with transportation costs from induced development. Debate exists concerning whether and to what extent the addition of highway capacity induces new traffic and promotes urban development in proximity to the added highway capacity (Cervero and Landis 1995). The notion of induced traffic challenges the view that the expansion of existing roads or the building of new roads will necessarily relieve highway congestion (Addison 1990; Boarnet 1997). The idea of induced development also challenges the view that highway investments are a response to growth and development, as opposed to a cause of them. In the highway "wars" that ensue between environment and development interests, opposing sides have very different positions on the nature and magnitude of induced traffic and induced development (Giuliano 1995). This procedural guide will attempt to separate facts from debating points.

The theory of induced traffic rests on the economic theory of supply and demand (Cervero 2003). When the capacity of a specific highway or road network is expanded in order to relieve congestion, road supply grows (from S1 to S2; see Exhibit III–1). Initially, the increase in road supply leads to a reduction in travel times, that is, the cost of travel declines (from P1 to P2). Lower travel times cause an increase in the quantity of travel demanded (from Q1 to Q2). In the short term, demand and supply are reconciled at a point where the amount of traffic on the expanded highway is greater than that which existed without the expansion, and the price is lower (P2 and Q2 in Exhibit III–1 below). This increase in the demand for travel represents the short-term induced traffic effect (Cervero and Hansen 2000, 2002).

In the short term, a variety of sources can contribute to increased traffic without any induced development. These include route switches, mode switches, and changes in destination. In addition, there is the possibility of new trips that would not have occurred without the addition of infrastructure capacity.

Courtesy of R. Ewing

In the long term, increases in highway capacity may improve accessibility and lower travel times to the point that residences and businesses are drawn to locate near the expanded highway capacity (Mohring 1961; Czamandski 1966; Corsi 1974). The demand curve shifts upward from D1 to D3 (Exhibit III–2). Eventually a new equilibrium will be reached. Demand and supply are reconciled at a point where the amount of travel on the expanded highway is considerably greater than would have existed without the expansion, and the price of travel is similar to what it was originally as congestion returns to an equilibrium level (P3 and Q3 in Exhibit III–2 below).

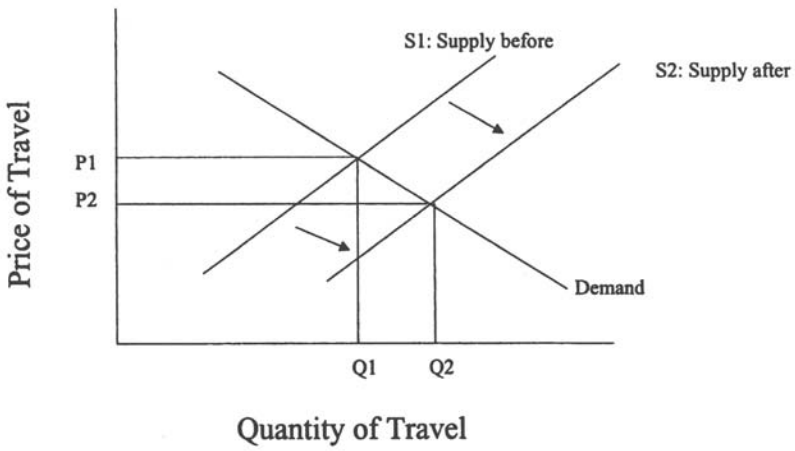
*This section discusses induced transportation capital and operating costs relative to new development. The literature description is more fully annotated in this section due to the nature of the presence, contributors to, and scale of induced transportation. It draws on the review in Ewing (2008).

Courtesy of R. Ewing

This increase in the demand for travel represents the induced development effect, and the full increase in quantity of travel represents the long-term induced traffic effect (Fulton, Noland, Meszler, and Thomas 2000).

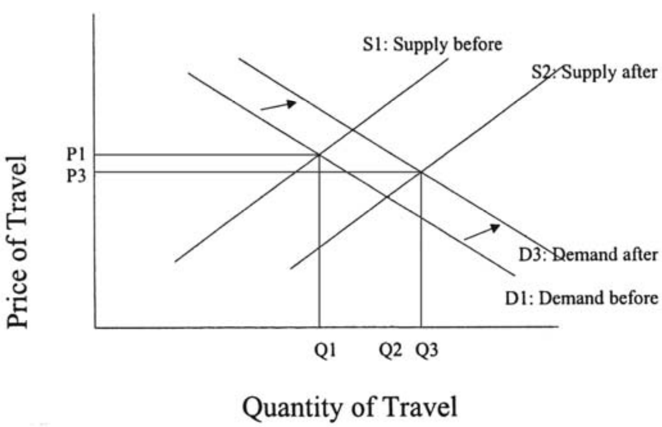
With induced development, the question is always whether the new development that occurs in proximity to the highway was attracted there as a consequence of the expansion or whether it would have occurred anyway, regardless of the change in local accessibility. If the development itself would not have occurred otherwise, both the traffic it generates and the development itself can unambiguously be considered induced (Bhatta and Drennan 2003).

Exhibit III–1
Short-Term Effect of Highway Expansion



Source: See text.

Exhibit III–2
Long-Term Effect of Highway Expansion



Source: See text.

DEFINITIONS

Conceptually, the notion of induced traffic is easier to explain than to measure or quantify. The first obstacle to measurement is reaching agreement on a definition. Given a common definition, the phenomenon can be subjected to empirical testing, and comparisons can be made across the various studies that have attempted to estimate induced traffic (Hills 1996). It will be useful to borrow from the work of DeCorla-Souza (2000). This work poses a number of questions that need to be resolved when defining induced traffic. These are:

- *Type of travel*—whether the travel being referred to is "person" travel or "vehicle" travel;
- *Unit of measure*—whether the induced travel consists only of absolutely new trips (trips) or whether it also includes the lengthening of trips (miles);
- *Time frame of reference*—whether induced travel refers to any increase in total daily personal travel or whether it refers to increases in peak-period travel resulting from shifts in the time of day when personal travel is undertaken;
- *Geographic frame of reference*—whether it is limited to a specific facility, corridor, or subarea, or whether it is regionwide travel that is of interest, or whether a national perspective is necessary; and
- *Period of impact*—whether travel impacts occur in the short term (up to 1 year) or the long term (up to 20 years).

The definition of induced traffic proposed by DeCorla-Souza (2000) serves as a useful baseline to compare with other definitions of induced traffic. He defines induced traffic as "any increase in daily vehicle miles of travel (daily VMT) in the long term at the region-wide level resulting from expansion of highway capacity." This definition implies:

- vehicle, not person, trips;
- daily travel, without regard to peak and off-peak periods;
- regionwide, not limited to a specific corridor or facility; and
- long term.

Most authors agree that induced traffic is measured in terms of overall VMT, and most agree that it is the added increment of VMT that is induced. Typical are Noland and Lem (2000), who define induced traffic as "the increase in VMT attributable to any transportation infrastructure project that increases capacity." Mokhtarian et al. (2002) define induced demand as "the increment of new vehicle traffic (measured either as average daily traffic—ADT, or vehicle-miles traveled—VMT) that would not have occurred at all without the capacity of improvement." Litman (2001) distinguishes between diverted traffic (trips shifted in time, route and destination), and induced vehicle travel (shifts from other modes, longer trips, and new vehicle trips). The latter clearly increases VMT, and the former may or may not.

By emphasizing the contribution of road improvements to growth of vehicular traffic, these definitions create a methodological challenge: to separate the capacity-induced effect from exogenous factors that also drive the growth in vehicular traffic (Carlino and Mills 1987). Population growth, increases in income, increased participation of women in the labor force, and various other sociodemographic factors all contribute to growth of VMT. It is only the increased VMT associated with a reduction in the cost of travel (due to road improvements) that qualifies as induced travel. Much of the empirical research has been aimed at distinguishing the induced traffic that occurs when highway capacity is expanded from the increase in travel that would have occurred in any event due to exogenous factors.

For example, if there is a notable increase in trips to a theme park following a major improvement to the highway linking an urban area with the theme park, this would clearly be considered induced traffic in the short run. And, if the theme park expands to take advantage of the increased capacity of the highway link, this too would be considered induced but would fall

into the category of induced development, a long-run phenomenon.

ELASTICITIES OF TRAVEL DEMAND WITH RESPECT TO TRANSPORTATION SUPPLY

Cervero (2002) compares elasticity values across studies in a so-called meta-analysis. An elasticity is the ratio of the percentage change in one variable to the percentage change in another variable, typically for small changes in the latter. It is a dimensionless quantity that is often assumed to be transferable from one situation to another. An elasticity of VMT with respect to lane-miles of 0.5 implies that every one percent increase in lane-miles is accompanied by a 0.5 percent increase in VMT. Or, approximately, a doubling of lane-miles (100 percent increase) is accompanied by a 50 percent increase in VMT. At the facility level, a doubling of lane-miles would result if a facility were widened from two to four lanes.

Exhibit III-3
Average Elasticities

	Facility-Specific Studies	Areawide Studies
Short-Term	0	0.4
Medium-Term	1.27	NA
Long-Term	0.63	0.73

Source: Cervero, (2002)

Based on the meta-analysis, Cervero (2002) concludes that "…the preponderance of research suggests that induced-demand effects are significant, with an appreciable share of added capacity being absorbed by increases in traffic, with a few notable exceptions." The exceptions are among the more sophisticated studies, so elasticity estimates may be on the high side.

In his meta-analysis, Cervero (2002) extracts average elasticities. The short-term elasticity of VMT with respect to highway capacity varies from 0 to 0.4. These values represent the growth of VMT that occurs immediately after facilities are opened. The long-term elasticity of VMT with respect to highway capacity varies from 0.63 to 0.73. These values represent the growth of VMT that occurs over a period of more than five years.

Cervero observes: "All that can be said with certainty is that induced demand effects exist . . . and they accumulate over time."

Further, Cervero notes that "over the past several decades in California road supply has had both a cause and an effect in relation to VMT. Elasticity of VMT with respect to lane miles is 0.56. Elasticity of lane miles with respect to VMT =0.33. (See also Exhibit III-3). ***(See User Guide and Model Step 6-Enter Finc.-Mult. Info., Row 31 to Row 33.)***

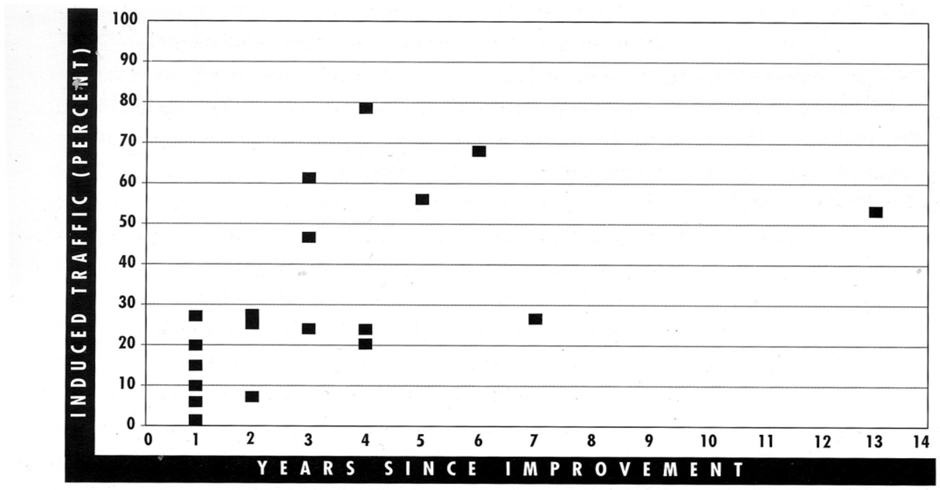
INDUCED TRANSPORTATION CAPITAL AND OPERATING COSTS

The transportation cost impacts of induced demand will follow the example used in all other sections. The development planned is one involving 2,000 dwelling units and 750,000 square feet of nonresidential development. The community has 23,530 residents and an employment base of 10,000 before development and indirect effects.

The direct effects of the development are an additional 4,956 residents and 2,625 jobs. Indirect effects are an additional 675 residents (2.57 residents per household) and 500 jobs (2.5 workers per 1,000 ft.^{2}). Ultimately, the community contains 29,161 residents and 13,125 jobs (see Exhibit III-3).

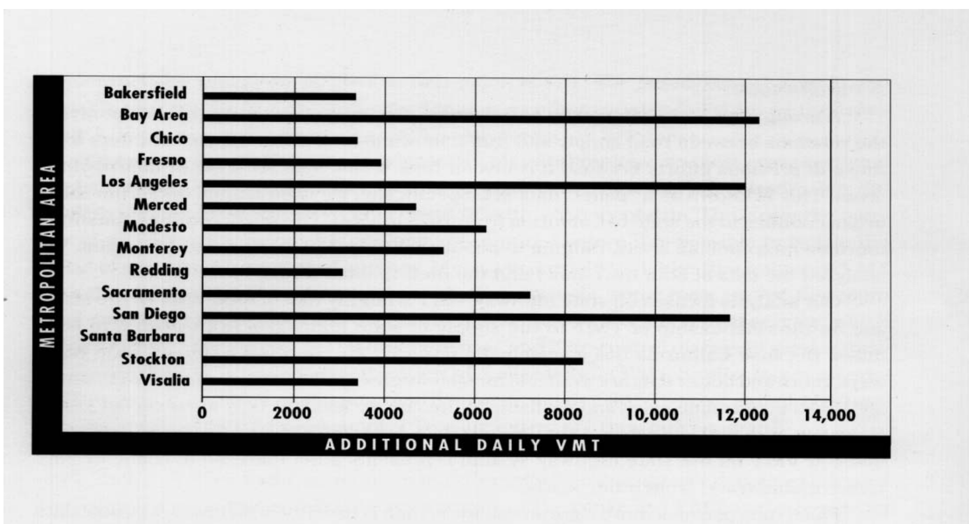
If road capacity is not expanded, there will be no induced traffic or induced development. In fact, there may be some suppression of travel demand as congestion grows worse. Likewise, if roads are at capacity to begin with and the new capacity fills up quickly with new residents and new workers, there will be no induced traffic or induced development. But these conditions are highly unlikely.

Exhibit III-4
Growth of Traffic Over Time



Source: Hansen, Mark. "Do New Highways Generate Traffic", (1995)

Exhibit III-5
Additional VMT per Lane Mile



Source: Hansen, Mark. "Do New Highways Generate Traffic", (1995)

It is possible to assume instead that highway facilities are expanded to serve the new residents and employees and provide long-run congestion relief (Hansen, Gillen, and Puvathingal 1998). The amount of induced traffic and induced development will depend on three factors: how much excess capacity exists at the time of the new development, how much capacity is expanded, and how much congestion is tolerated in the long-run. The more congested highways are to begin with, the more capacity is added, the less congestion is tolerated in the long run, the greater will be the induced effects.

Since population and employment are growing by an average of about 26.1 percent in the hypothetical community, highway capacity will have to expand by about 26.1 percent to begin with, without considering the effects of induced traffic or exogenous factors. To simplify the analysis, let's say that the capacity is supplied all at once, before any new development occurs. How much additional traffic will the expanded capacity induce? On day one, before any new development occurs, the expanded highway capacity will generate additional VMT as existing residents and nonresidents respond to the added capacity (and reduced congestion) by taking more private vehicle trips, and taking longer trips due to route diversion (Hansen 1995; Hansen and Huang 1997). There will also be a shift in trip making from the off-peak to the peak period. Using Cervero's short-term elasticities of VMT with respect to capacity, the community will immediately experience an increase in VMT of somewhere between 0 percent (using Cervero's short-term facility-specific elasticity) and 26.1 percent x 0.4, or about 10.44 percent (using Cervero's short-term areawide elasticity).

The expanded highway facilities will gradually fill up as existing residents travel more, nonresidents travel more on community highways, and new residents and employees use these facilities (Holtz-Eaken 1994, 1995). How much will VMT grow, including all of these effects (Kockelman, ten Siethoff, Walton, and Mahmassani, 2001)? Using Cervero's long-term elasticities of VMT with respect to capacity, the community would be expected to experience an increase in VMT of between 26.1 percent x 0.63, or 16.44 percent (using Cervero's long-term facility-specific elasticity) and 26.1 percent x 0.73, or 19.05 percent (using Cervero's long-term areawide elasticity) due to induced traffic and induced development. These are contributions to VMT due to highway expansion alone, on top of the growth of VMT due to direct and indirect population and employment growth associated with the planned development. This is in the long-run, say, between five and 10 years after highway expansion. So the 26.1 percent highway expansion will provide only temporary congestion relief until the new highway capacity fills up with direct, indirect, and induced development.

Induced development is responsible for the difference between short-term and long-term elasticities of VMT with respect to highway capacity. That is to say, all of the extra travel by existing residents and workers is embodied in the short-term elasticities, so the difference must be due to new persons and employees within the community or its surroundings. Specifically, using Cervero's areawide elasticities, VMT will increase by 19.05 percent minus 10.44 percent, or 8.61 percent, due to induced development. Using Cervero's facility-specific elasticities, VMT will increase by 16.44 percent minus 0 percent, or 16.44 percent. The difference is split between the two estimates, indicating a near 13 percent increase in VMT due to induced development.

It is tricky to translate this rise in VMT into an increase in community population and employment due to induced development. It is not known whether the extra traffic on community highways is generated internally or externally (Noland 2000; Noland and Lem 2002). It could all be due to internal growth, or it could mostly be due to growth outside the community but within the community's service area. The split between internally and externally generated traffic will depend, in part, on the size of the community itself. For a small community, much of the traffic is likely to be passing

through. For a large community, most of the traffic will be generated internally.

Large master-planned communities capture about half of all trips internally (Ewing et al. 2001). It is therefore assumed that half of the induced development occurs within the community, and half outside. That is, of the 13 percent growth of VMT due to induced development, an estimated 6.5 percent will be attributable to population and employment growth within the community. In this example the value of 6.5283 percent will be used. It is a derivative of a slightly shorter and more direct version of the calculation. See Exhibit III-6 for the calculation. Population would grow by 1,536 (23,530 x 6.5283 percent), including 614 students, and employment would grow by 653 (10,000 x 6.5283 percent). Summing direct, indirect, and induced development, the totals for the community in this example would be 30,697 population and 13,778 employment.

Note that with induced development, the community's roads will be more congested in the long run than they were before any additional development occurred and before roads were expanded. To wit, road capacity was expanded by only 26.1 percent, but population grew by 30.5 percent (23,530 to 30,697) and employment grew by 37.8 percent (10,000 to 13,778). Assuming the community's roads were congested to begin with, this increase in congestion will trigger additional road building in the long term, which will again trigger more induced development, which yet again will trigger more road building, and so on in an infinite series of ever smaller increments. If road capacity is expanded by 19 percent to accommodate the growth of VMT, this will lead to another 0.73 x 19 percent, or 13 percent growth of VMT (using the long-run areawide elasticity of VMT with respect to capacity); if road capacity is expanded by 13 percent to accommodate this growth of VMT, this will lead to another 0.73 x 13 percent, or 9 percent growth of VMT.

This infinite series converges with a 64 percent growth of VMT and capacity over many decades. Clearly, there is so much uncertainty associated with the scale and recurring nature of these effects, and such long time lags, this study assumes that there are no additional rounds of highway expansion due to induced development and no added capital or operating costs.

Thus, to summarize for purposes of cost estimation, VMT will increase by 19 percent due to induced traffic, and capital and operating costs will also increase by 19 percent. Approximately two-thirds of that increase, or 13 percent, will be due to induced development, the balance due to increased vehicular travel by existing residents. Depending on the size of the community and rate of internally generated traffic, a very small or very large percentage of the induced development may occur within the community. For a large city, it may nearly all be internally generated (Garcia-Mila, McGuire, and Porter 1996). For a small city or town that is part of a large metropolitan area, most of highway induced development may occur outside the city or town boundaries. Residents can be assessed only for that portion of costs that they occasion.

Given the assumptions made in this example, Exhibit III-8 shows the new operating costs ($2,241,657) and revenues ($1,293,346) attributable to induced development. If one wanted to estimate occasioned capital costs as well, one could assume one round of capital expansion to serve the 19 percent growth of VMT, and apply the same capital cost factors as for indirect costs.

INDUCED TRANSPORTATION CAPITAL COSTS/REVENUES

The capital effects of induced development can be relatively small due to the variety of residential choices available to those who would use an improved road exhibiting excess capacity. These new users could be diversions from other roads or modes of travel (transit) that would not change residence; they could be those that would not live in the community where the original development took place; or they could be new users that would live in non-new housing in the

community of the new development (Voith 1993, 1998).

Calculating Induced Transportation Capital Costs/Revenues

For just those households that would select new housing in the community of development, this would represent a net increase in population of 1,536 and an increase of employment of 653. The increase in population is converted into added housing units and the increase in employment is converted into added nonresidential space. These increases are then multiplied by the capital cost/revenue per unit or the capital cost/revenue per thousand square feet to generate the capital costs and revenues of the induced development. **(See Users Guide and Model, Step 7-View Model Output, Row 118 to Row 127.)**

Exhibit III-6
Calculating Induced Development
Residents, Units, Jobs, Square Feet of Nonresidential Space

Initial Activity (Residents and Jobs in Existence before Development)	23,530 Residents + 10,000 Jobs = 33,530
Added Activities from Development Generated Direct and Indirect Growth	5,631 Added Residents + 3,125 Added Jobs =8,756
Direct and Indirect Activities as Percent of Initial Activities	8,756 / 33,530 =0 .261132236
Multiply Above by Elasticity of VMT with Respect to Capacity	0 .261132236 X 0.5 = 0.130566118
Multiply above by Percent of Induced Development inside Jurisdiction	0.130566118 X 0.5 = 0.0652831
Induced Population (Base Residents Times above Value	23,530 X 0.0652831 = 1,536
Induced Jobs (Base Jobs Times above Value)	10,000 X 0.0652831 = 653
Induced Students (Base Jobs Times above Value)	9,400 X 0.0652831 = 614
Induced Housing Units (Induced Population Divided by Household Size)	1,536 / 2.503 = 613
Induced Square Feet of Nonresidential Space (Induced Jobs / Average Jobs per 1,000 sq. ft). X 1,000	(653 / 2.1373) X 1,000= 305,446

Matt Crosby

Exhibit III-7

Calculating the Transportation Capital Costs and Revenues of Induced Development

	Costs
MUNICIPAL	
Residential	
Per Unit cost/revenue	$1,918
Induced Units	614
Subtotal	$1,177,267
Nonresidential	
Per thousand square foot cost/revenue	$2,525
Induced thousands of square feet	305
Subtotal	$771,333
TOTAL	$1,948,599

CALCULATING INDUCED TRANSPORTATION OPERATING COSTS/REVENUES

The operating effects of induced development are calculated from the number of induced residents calculated above, multiplied by the operating cost per person and operating revenues per person developed in Step I-B. Similarly, the school district costs and revenues of induced development are calculated from the number of induced students multiplied by the transportation cost and revenues per student from Step I-B. Finally, the employment cost/revenue of induced development is calculated from the number of induced employees multiplied by the cost and revenue per employee from Step IB. These costs follow from induced capital costs (Boarnet and Haughwout 2000; Boarnet and Chalermpong 2000). **(See User s Guide and Model, Step 7-View Model Output, Row 129 to Row 150.)**

Courtesy of Arlene Pashman

Exhibit III–8
Calculating the Transportation Operating Costs and Revenues of Induced Development

	Costs	Revenues	Net Fiscal Impact
MUNICIPAL			
Residential			
Per Person Cost/Revenue	$99.47	$103. 48	
Population Induced by Development	1,536	1,536	
Subtotal	**$152,793**	**$158,964**	**$6,171**
Nonresidential			
Per Employee Cost/Revenue	$41.30	$39.04	
Employees Induced by Development	653	653	
Subtotal	**$26,964**	**$25,484**	**(-) $1,480**
SCHOOL DISTRICT			
Per Student Cost/Revenue	$3,360	$1,807	
Students Induced by Development	614	614	
Subtotal	**$2,061,900**	**$1,108,898**	**(–)953,002**
TOTAL	**$2,241,657**	**$1,293,346**	**(–) $948,311**

Source: CUPR calculations—see text.

CONCLUSIONS

In summary, what does research (reviewed here and elsewhere) tell us about the development impacts of major highway projects in the post-interstate era? We can state the following with a reasonable degree of certainty:

- Major highway investments have small net effects on economic growth and development within metropolitan areas, instead mostly moving development around the region to take advantage of improved accessibility. Induced development is very close to a zero-sum game (Payne-Maxie, 1980.
- Highway investment patterns tend to favor suburbs over central cities, and thereby contribute to decentralization and low-density development (Lichter and Fuguitt 1980).
- Major highway investments may actually hurt regional productivity, if they induce "low-density" development patterns (Rephann and Isserman 1994).
- Corridors receiving major highway investments experience land appreciation, and therefore are likely to be developed at higher densities than developable lands outside the corridor (Clark and Murphy 1996).

- Highways may be necessary, but alone they are not sufficient to induce development (Hartgen 2003).
- Counties and municipalities receiving major highway investments attract population and employment growth to a greater degree than they would otherwise (Garcia-Mila 1996; Boarnet 1998).
- Nearby counties and municipalities may experience more or less growth than they would otherwise, depending on the strength of spillover effects and the size of the county/city (Stephanedes and Eagle 1986, 1987).
- Nonresidential development is more strongly attracted to major highways than is residential development, particularly in the immediate vicinity of facilities (Ryan 1999, 2005).
- The induced development impacts are wider and deeper for interstate quality highways than lesser highways and streets. The effects on metro areas are less; on counties and cities considerably more (Hartgen 2003).
- It takes significant time after construction for development to adjust to a new land-use/transportation equilibrium. The development impacts could be felt for ten years or more (Thompson 1993; Cervero 2003).
- The induced development impacts of major highways extend out at least one mile, and probably farther (Cervero 2003).

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STEP IV

A Control for All Costs

INTRODUCTION

This final section deals with the availability of an upper-level control on transportation costs related to development. This serves the purpose of producing an outer bound of transportation costs related to new development. An input-output approach is used to provide a control for both capital costs and operating costs. This section will begin with a discussion of complex "large view" transportation models and move to a discussion of an input-output modeling approach.

APPROACHES TO ESTIMATING HIGHWAY CONSTRUCTION COSTS

Outside of the road impact fee literature there appears to be little published research on estimating the cost of new capital improvements attributable to proposed residential and non-residential development (Burchell 1992; Burchell, Dolphin, and Galley 2000; Burchell, Lowenstein et al., 2002). One common theme in the highway cost literature centers on the connection between predicted and actual costs (Putman 1991) . There are many components that affect the actual cost of a project including the weather, inflation and the amount of construction occurring in the region. Attoh-Okine (2002) summarizes this literature and constructs a conceptual probabilistic model for dealing with uncertainty in construction cost estimation. Others have proposed alternate approaches. El-Choum (1995) explored cost overruns using factor analysis, while Touran and Suphot (1997) used rank correlation on construction variables. The analytic approaches ramp up with the use of artificial neural networks for estimating highway costs (Al-Tabtabai et al. 1999). Wilmot and Cheng (2003) develop a probability model to predict future construction costs by examining components, and continue with an artificial neural network approach (Wilmot and Bing 2005). In these studies the focus is on projecting future highway construction costs, with empirically derived models designed in a variety of mathematical motifs. These studies are only marginally important to the central concern of this research. However, the above studies are originally concerned with an overall cost of a project and the influences on their cost.

MODELS AT VARIOUS GEOGRAPHIC AND COSTING LEVELS

Computer models useful for urban-focused applications walk a fine line between being overly simple and too complex. This tension manifests itself in different applications. Perhaps the most obvious case is the four-step urban transportation planning process (trip generation, trip distribution, mode split, and traffic assignment). This widely used model system has been used both nationally and internationally for over half a century. The models work at a zonal level and produce results that were both used successfully in many planning applications and critiqued as inadequate (Garrett and Wachs 1996). The four-step process cannot answer policy and planning questions important to decision makers working in the current political and societal environment. Dissatisfaction with the four-step process spawned a federally sponsored initiative, the Travel Model Improvement Program (TMIP). The TMIP supports the improvement and even possible replacement of the four-step process (TMIP 2006a).

One exciting initiative was the development of TRANSIMS, an activity-based transportation demand model that works at the household behavioral level rather than the aggregated zonal level found in the four-step process (TMIP

2006b). The TRANSIMS model structure is more complex in design and more data-hungry than its simpler four-step brethren. Since the travel decisions of thousands of individual households are simulated separately, considerable computer resources are required. TRANSIMS is better than most models but it is much more complex.

Another variant of the microsimulation approach, the New York Metropolitan Transportation Council Best Practice Model (BPM), also demonstrates the two-edged sword of these complex model designs. As the agency states:

> Where traditional models use an average rate of travel, the BPM uses a microsimulation method to simulate the travel pattern of each person in the region. This provides a closer level of detail which, combined with the model's use of the journey, increases the accuracy and usefulness of analyses. However, this also increases the complexities of the model causing increased processing times and a requirement of high end computers. . . . The total time to run the model from journey generation to highway and transit assignments is more than one hundred hours. (New York Metropolitan Transportation Council 2003, p. 2)

Obviously, the above criticism leading to large computers and long processing times is no longer valid. Activity-based models can be done on spreadsheets and handled with a laptop. The above may not be the best examples but the point to be made is that complexity may take away from the big picture; the data involvement and processing causes one to lose a handhold on the ultimate nature of the final product.

These above two examples—TRANSIMS and BPM—still remain, however, as more complex transportation demand models than the traditional four-step processes. They offer richer and broader outputs that are more behaviorally realistic; they can also handle a greater range of policy initiatives. For example, depending on the types and numbers of trips, operating and capital costs can be calculated.

These examples also point to the question of the complexity of any proposed transportation cost model. The design of the model and the amount of required data affect the richness of outputs and the potential to capture multistage impact results. One example of a relatively straightforward model that estimates the amounts of additional population, housing units, and employees likely to occur as a result of rounds of development will be explored. It is useful in laying the groundwork for overall model control and has been actively discussed in the literature of development impacts (Nelson 2007).

THE NELSON I-O MODEL AS AN OVERALL CONTROL FOR CAPITAL/OPERATING COSTS

New large-scale development often occurs where the in-place transportation infrastructure cannot accommodate the ensuing growth in traffic and congestion. Consequently, transportation infrastructure improvements must be made to improve access and mitigate congestion. Typically, development occurs in stages as incremental improvements are made to the surrounding infrastructure to improve access to developing areas and accommodate increased traffic generated by those areas. Impacts may also spill over to adjoining areas and neighborhoods. When an area is improved, it often contributes to new incremental development over time. Eventually, the transportation system becomes overburdened because of the continued growth and constrained financial resources for further improvements. The improvements are made, and this leads to another round of development.

While it is common practice to do an impact study before any new development, there is no recognized guide for predicting how rounds of development will expand and change over time, and how that will impact transportation needs. There is a need to help local planners, transportation engineers, decision makers, and the public predict cumulative (several stages) transportation costs in newly developing areas associated with rounds of development and to identify sources of revenue to address these costs. One way in which to address this situation is to develop a control for predicting cumulative transportation costs in newly developing areas associated with incremental (direct, indirect, and induced) development over time. This also

provides a means to regain focus on the overall or cumulative impacts.

As a starting point, it is important to understand the cumulative impacts of large-scale development considering direct, indirect and induced effects (Burchell 1997). The approach developed here may be one way in which these impacts may be estimated easily for virtually any development project, but especially large-scale projects.

The method presented here was pioneered by Nelson (2004) for estimating land-use and facility impacts broadly but not highway impacts or associated costs. It attempts to account for interactions in land uses, which are difficult to ascertain in the best of circumstances, and does so with numerous simplifying assumptions. Notably, it combines economic base theory and input-output (I-O) analysis to apportion impacts among land uses. Because I-O analysis assumes no impact from change in households in a region, economic base theory is used. The problem is that I-O analysis evaluates the effect that a change in one productive sector of the economy, such as a factory, would have on all others. Since households merely support economic activity, a change in households per se would merely reflect a change somewhere else in the economy. In the real world this is not realistic.

There are numerous examples where a development is purely residential. The new residents bring new jobs—especially in retail, FIRE, and services—to the community, but not the other way around. Yet, because there is no I-O multiplier associated with household change per se, there is no impact. Again, this is not intuitively correct. Economic base analysis can be used to estimate impacts associated with a change in residential development. Of course, where there are changes in both employment and housing units associated with a development, they both need to be considered.

What if new, unanticipated development occasions employees, whether basic or non-basic? What will be the impact on other economic sectors and on households attracted to the community? The employment impact can easily be estimated using employment multipliers generated from I-O analysis. I-O multipliers account for interindustry relationships within regions. The analysis is based on an accounting framework called the I-O table. The I-O table shows, for each industry, industrial distributions of inputs purchased and outputs sold between industries. One calculation of the I-O process leads to direct-effect employment multipliers by economic sectors. For example, the national direct-effect employment multiplier for motor vehicles and equipment is 7.4625 (i.e., for each job in this sector, a total of 7.4625 jobs are created), one for itself and 6.4625 for all others. On the other hand, the national direct effect employment multiplier for personal services (e.g., hair salons and barbers) is just 1.7871, one for itself and 0.7871 for others. I-O tables are useful to trace implications of changes in the regional economy; they are not very useful for estimating land use and facility needs. The direct-effect employment multipliers, however, are useful in a general sense, which is developed here.

There is one important limitation to these multipliers, however: One does not know which industries are affected by a change in one of the other industries. For example, how are the other 6.4625 jobs created from motor vehicle employment or the 0.7871 from personal services distributed? Although the BEA produces I-O tables for regions of any configuration, it does not do so with direct-effect employment multipliers. The approach used here is to assume that the distribution of additional jobs attracted is similar to the distribution of new jobs anticipated in the land-use plan. The underlying assumption is that the region will attract only those firms that are a good fit with it, and the spin-off impacts will be distributed roughly proportionately to the region's employment makeup. Remember that the objective of this analysis is to estimate approximate magnitudes of impact, not to calculate precise impacts. The user, perhaps working with others knowledgeable of the local economy, can refine the estimates of impact to make them more realistic given local conditions.

CALCULATING A CONTROL FOR TRANSPORTATION CAPITAL AND OPERATING COSTS

As indicated earlier, Arthur C. Nelson, in *Planner's Estimating Guide: Projecting Land-Use and Facility Needs for Comprehensive Plans*, devises a technique that uses economic base analysis for residential development and Input-Output (I-O) analysis for nonresidential development to estimate cumulative land-use changes occasioned by development unanticipated in comprehensive plans (Nelson 2007). In particular, he develops multipliers for the residential or household sector, as well as for the nonresidential sector, and applies these impacts to a locality using percentages of those who would live and work in the same community. This procedure, though speculative as Nelson notes, produces the only land-use multipliers based on these economic theories for long-range planning purposes of which we are aware. Nelson's approach is adopted for control purposes. The following multipliers are employed to estimate all new households and new jobs created by new development in the community:

1.4000 Households
3.9389 Industrial
2.5382 Office
2.1871 Hotel
1.8057 Retail

These multipliers are derived for the nation as a whole and vary over time as well as by location. The user will have the ability to either accept the nationally based default multipliers or override with multipliers based on localized information.

In the example community, the weighted average multiplier for all land-use developments proposed is calculated as:

(1.4000 x 2,000 housing units) +
(3.9389 x 0 industrial jobs) +
(2.5382 x 2,625 office jobs) +
(2.1871 x 0 hotel jobs) +
(1.8057 x 0 retail jobs)) /
(2,000 housing units + 0 industrial jobs + 2,625 office jobs + 0 hotel jobs + 0 retail jobs) = 2.0461

This multiplier is applied to both capital and operating revenues. However, the multiplier is adjusted to reflect the number of new employees living in the jurisdiction from Step 6. The reasoning is that new employees living elsewhere impact other jurisdictions in terms of both costs and revenues (see Exhibit IV-2 and Exhibit IV-3) (Peccia 2005; Kumar 2006

Control for Transportation Capital Costs and Revenues

Using Nelson's model, it is found that total capital costs as estimated by the Control for All Costs are lower than the actual cost estimate: $7,658,261 compared to $10,171,071, or $2,512,810 less. The control provides a lower bound of impact.

The cost of capital facilities throughout this procedural guide indicates that, through capital cost or other methodological calculations, revenues are equated to costs. So too with this control. The control multiplier produces a control of $7,658,261 in revenues against actual revenues of $10,171,071, or 24.7 percent less (Exhibit IV.2). Again, the control provides a lower bound of impact.

The difference between the Control for All Costs and what was estimated for the sum of the main model is not an explicit error term. Although it functions that way, it really indicates what the net costs would be in a closed system—that is, where all economic transactions and interactions occur in the same space. The larger the study area (a state or multistate region, for instance), the smaller the error. The reality is that at the local level, up to the scale of most metropolitan areas, economies are open and there is considerable "leakage" of transactions from the local area, though there can also be capture. The error can be considered the upper or lower bound of the estimate for the transportation costs of new development in the direction of the error itself. That is, if the control difference is a positive number, the transportation cost of new development will range from the model estimate to an upper bound being the control total. If the control difference is a negative number, the transportation cost of new development will

range from the model estimate to a lower bound, being the control total. Practitioners should use the estimate derived from the model for their routine decision making; the reason is that it is based on the particular impacts of the new development in question. In contrast, the Control for All Costs suggests the overall economic impact assuming all transactions and interactions occur within the community itself in the form of an upper or lower bound.). **(See Users Guide and Model, Step 7-View Model Output, Row 178 to Row 187.)**

Exhibit IV-2 **Calculating Controls for Total Capital Costs/Revenues of Development on Transportation**		
CAPITAL COSTS/REVENUES		
• Direct Capital Costs	$6,933,062	Direct Costs/Revenues
• Multiplier before adjustment	2.0460	
• Share of new workers living in jurisdiction	10.00%	
• Adjusted local multiplier	1.10460	
• Multiply by I-O multiplier	$7,658,261	Control Costs/Revenues
• Total Capital Costs	$10,171,071	Actual Costs/Revenues
Difference from the calculation of all capital costs	−$2,512,810	Cost/Revenue Difference
	Control less	Control Vs. Summed Calculation (Cost)
	Control less	Control Vs. Summed Calculation (Revenues)

Source: See text.

Courtesy of Arlene Pashman

Exhibit IV-3

Calculating Controls for Total Operating Costs/Revenues of Development on Transportation

OPERATING COSTS/REVENUES		
• Direct Operating Costs and Revenues	$2,953,381	Direct Costs
	$1,880,225	Direct Revenues
• Multiply by I-O multiplier	1.10460	
• Resulting Total Operating Costs and Revenues	$3,262,305	Control Costs
	$2,076,930	Control Revenues
• Calculate Total Operating Costs and Revenues	$5,613,548	Actual Costs
	$3,440,817	Actual Revenues
Difference from the calculation of all Operating Costs	$2,351,244	Cost Difference
	$1,363,887	Revenue Difference
	Control less	Control Vs. Summed Calculation (Cost)
	Control less	Control Vs. Summed Calculation (Revenues)

Source: See text.

Control for Transportation Operating Costs and Revenues

Control estimates for operating costs and revenues are calculated similarly, using the same overall multiplier adjusted to reflect the employees choosing to live in the local jurisdiction. In this situation, however, the variation between control (multiplier-based) operating costs and revenues is larger than for capital costs and revenues though the magnitude of dollars is considerably lower. The direction is the same: the control costs/revenues are lower than the actual costs/revenues. The control provides a lower bound of impact. **(See Users Guide and Model, Step 7-View Model Output, Row 189 to Row 200.)**

CONCLUSIONS

In all types of projections, at one time or another, there is a necessity to search for a reasonable look at what might be a control for all individual projections. Is there anything out in the literature that enables a frame to be put around the calculation of all costs? The frame is the work of Arthur C. Nelson (2004), who attempts to provide estimates of total numbers of people, housing units, and employees emerging from direct, indirect, and induced impacts of development. Nelson uses I-O Analysis (including the household sector) to project the highway facility costs of this aggregation of people, housing units, and employees.

Nelson's method for deriving a multiplier for mixed land uses is unique and pioneering. The adaptation of his approach results in a single, internally derived multiplier for a subject development. The outcomes appear to be within reason.

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USER GUIDE - Appendix I

Transportation Costs of New Development

User Guide:

A Guide to Data Entry and Spreadsheet Understanding

Transportation Costs of New Development User Guide

CONTENTS

Transportation Costs of New Development: A Guide to Data Entry and Spreadsheet Understanding

The User Guide is a line-by-line description of the information used by the *Transportation Cost of New Development Model*. The model, which is a Microsoft EXCEL spreadsheet, consists of six data entry sheets and three main output sheets. The data entry sheets are: “1-Start Here-Background”; “2-Development Description”; “3-Resid. Demo. Multipliers” ; “4-Nonres. Demo. Multipliers”; “5-Enter Budget Info.”; and “6-Enter Finc.-Mult Info”. Many of the data entry locations are provided with default values which can be used until final values are researched. Rutgers University, center for Urban Policy Research is committed to supporting this model for at least five years. Questions may be directed to William Dolphin, Computer Specialist at 732-932-3133 extension 527 or wdolphin@rci.rutgers.edu. An e-mail list has been set up to allow discussion of this Model and also to distribute any updates which may be made. See the end of this document for sign-up information.

Sheet “1-Start Here-Background” is the location for the entry of background information on the local jurisdiction (Municipality or County) in which the projected development is located.

Sheet “2-Development Description” is the location for the entry of information on the types of development planned, the valuation of the residential units, the square footage of the residential units and the various types and square footages of nonresidential development. This is also the location where the Preview Method, a shortcut version of the full model, can be accessed. The Preview Method is provided to enable the user to test or use the model with a minimum amount of data entry. The data supplied within the Preview Model are representative default values.

Sheet “3-Resid. Demo. Multipliers” is the location for entry or override of residential demographic multipliers which are used to project the likely number of persons who will live in the residential units.

Sheet “4-Nonres. Demo. Multipliers” is the location for entry of the employees per thousand square feet of nonresidential space multipliers which projects the employees likely to work in the development. Also entered on this sheet is information on the mixed use-characteristics of the development which might reduce VMT.

Sheet “5-Enter Budget Info.” is the location for entry of information on the budget of the local jurisdiction (Municipality/County and School District.

Sheet “6-Enter Finc.-Mult Info” has two parts. The first is the location for entry of additional information used in the various steps of the model. The second part of this sheet is the location of entry of detailed information used in the more intricate version of the capital cost projections.

In the pages that follow material in italics is background material about the data required by the model or the results of the model. The non-italic material comprises the headings copied from the model. Data entry occurs in columns A to E. The model sheets are protected so that data can be entered only in the appropriate cells. Information to the right of column H involves calculations which may be of interest to the advanced user but are initially hidden to reduce potential confusion during data entry. Users who wish to see the programming in these areas can easily unprotect the sheets since a password is not used. Changes made in the originally protected areas should be done with care because they may cause problems in the model’s subsequent operation.

It is important to always start a new model run with a blank copy of the model.

STEP 1 - START HERE - ENTER BACKGROUND INFORMATION ON JURISDICTION

SHEET 1- Start Here-Background

This sheet gathers general information about the local jurisdiction (Municipality or County) where the development is located. If a development is in more than one jurisdiction separate models must be run for each jurisdiction with the appropriate budget information as well as the share of the development which exists in each jurisdiction. Housing unit type and employyment type information are necessary if Induced Capital Costs. are being calculated. All the other data items on this sheet are necessary except for land area of the jurisdiction. Land area could be used to show density changes or to express certain data per acre.

Please scan this entire User Guide (user guide.doc) before starting. *It will give you a sense of what is included here.*
Background Color Code for Data Entry Steps (Steps 1 thru 6).

Yellow cells should not need to be changed and are assumed to be protected.

White cells on Steps 1 to 6 are for actual data entry.

Depending upon the makeup of the project, many white cells could remain blank.

Default values are provided for some data items.

Pay attention to the notation "Actually Used". Cells with this designation indicate what values are being used by the model (either default or user entered).

White cells with small red triangles in the upper right corner contain additional explanatory comments relating to what should be entered in the cell.

Pointing to the cell will cause these comments to appear.

Gray cells indicate that a default value has been overridden.

Scroll down each step until you reach the END OF STEP notation in column A.

WELCOME TO:
TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL

Rutgers University, University of Utah, New Jersey Institute of Technology

National Cooperative Highway Research Program
Project 08-59

STEP 1 - START HERE - ENTER BACKGROUND INFORMATION ON JURISDICTION ALSO VIEW THE ADDITIONAL DATA REQUIREMENTS SHOWN IN ROWS 54 TO 71 BELOW

Please read the entire User Guide (user guide.doc) before starting.
Background Color Code for Data Entry Steps (Steps 1 thru 6)
Yellow cells should not need to be changed and are assumed to be protected
White cells on Steps 1 to 6 are for actual data entry
Depending upon the makeup of the project, many white cells could remain blank
Default values are provided for some data items. Default values are documented as to source.
Pay attention to the notation "Actually Used". Cells with this designation indicate what values are being used by the model (either default or user entered)
White cells with small red triangles in the upper right corner contain additional explanatory comments relating to what should be entered in the cell
Pointing to the cell will cause these comments to appear
Gray cells indicate that a default value has been overridden
Scroll down each step until you reach the END OF STEP notation in column A

Jurisdictions Providing Public Services to the Development			
Name of Primary Jurisdiction (Municipality/County) for this analysis	Newtown City		
Name of School District (if school analysis is desired)	Newtown Schools		
Area of Jurisdiction (Municipality/County) (sq. mi.)	5.00	Optional	
Current Population of Local Jurisdiction (Municipality/County)	23,530	Required	
Current Households in Local Jurisdiction (Municipality/County)	9,400	Required	
Current Number of Persons Working in Jurisdiction (Municipality/County)	10,000	Required	
Current Enrollment in School District	9,400	Required if School Related Transportation Costs are Being Calculated	
Year (4 digit) of Analysis (for inflation adjustment of selected default values)	2010		2010
Information Required if Induced Capital Costs/Revenues are Being Calculated	See Information Starting in Row 78 for Source of Data		
Housing Unit Types (Current Conditions)	Housing Units		
Single Family Detached Units	5,150		
Single Family Attached Units	430		
Multi-family Units	4,230		
Mobile Homes	60		
Total (The total is computed by the spreadsheet for checking purposes)	9,870		
Employment Types (Current Persons Working in Jurisdiction)			
Manufacturing, Transportation, Warehousing and Utilities, Agriculture, and Construction and Wholesale Trade	Employees 2,530		
Retail Trade, Arts, Entertainment, Recreation, Accommodations and Food Services	2,550		
Information, Finance, Insurance, and Real Estate, Professional, Scientific, Management and Administrative, Educational Services, Health Care and Social Assistance	4,530		
Public Administration and Armed Forces	390		
Total (Computed)	10,000		

If employment data for the above cells is unavailable see Step 6, Row 29

LIST OF OTHER DATA REQUIRED

In addition to the information above, the following information needs to be entered in later steps in order to utilize this model:

- Development Description
  - Number of residential units by type; square footage per unit and sale price per unit
  - Nonresidential square footage by type of nonresidential space; value per square foot
- Budget Items (If Budget Information is not readily available and accessible the Preview Method can be used. See end of Step 2)
  - Local jurisdiction (and School District if appropriate); expenditures by category; share of each category related to transportation.
  - Jurisdiction Property Tax Rate; total assessed value for residential and nonresidential properties; equalization ratio (if property valuation is not at full market value); and estimated share of Property Tax related to transportation (this is initially an intuitive approximation but can be subsequently researched).
  - Number of residential and nonresidential parcels
  - Personal property tax information, if relevant.
  - Jurisdiction non-property tax revenue information by category of revenue, broken down by population related and employment related revenues; by share that is transportation related.
- Optional items (Defaults have been provided); default values are documented as to source.
  - Local Demographic Multipliers (Persons and Students per Unit) for the housing types being planned
  - Local Nonresidential Multipliers (Employees per 1,000 sq.ft. of nonresidential space) for types of planned nonresidential space.
  - Input-Output Multipliers used in the control of all costs
  - Local detailed information relating to calculating Capital Costs
  - Miscellaneous values used in various steps (can be overridden if desired)

Model Version 4.0

This area of the sheet can be used to summarize the Census data. The summary results must be copied to the cells above.

B25024. UNITS IN STRUCTURE - Universe: HOUSING UNITS — Enter numbers from Census in Column B
Data Set: American Community Survey Estimates — Then copy summaries from Column D to rows 37 to 40 above
Survey: American Community Survey

Units in Structure	Estimate		Summaries (Not linked)
Total:	9,870		
1, detached	5,150	Single Family Detached Units	5,150
1, attached	430	Single Family Attached Units	430
2	472	Multi-family Units	4,230
3 or 4	671	Mobile Homes	60
5 to 9	932	Total (Boat, RV, van, etc. excluded)	9,870
10 to 19	1,178		
20 to 49	450		
50 or more	528		
Mobile home	60		
Boat, RV, van, etc.	0		

C08526. MEANS OF TRANSPORTATION TO WORK BY INDUSTRY FOR WORKPLACE GEOGRAPHY - Universe: WORKERS 16 YEARS AND OVER
Data Set: American Community Survey Estimates
Survey: American Community Survey — Note that this is WORKPLACE Geography
Enter numbers from Census in Column B
Then copy summaries from Column D to rows 44 to 50 above

	Estimate		Summaries (Not linked)
Total:	10,000	Employ. Types (Current Persons Working in Jurisdiction)	
Agriculture, forestry, fishing and hunting, and mining	27	Manufacturing, Transportation, Warehousing and Utilities,	
Construction	996	Agriculture, and Construction and Wholesale Trad	2,530
Manufacturing	853	Retail Trade, Arts, Entertainment, Recreation,	
Wholesale trade	283	Accommodations and Food Services	2,550
Retail trade	1,141	Information, Finance, Insurance, and Real Estate, Professional,	
Transportation and warehousing, and utilities	371	Scientific, Management and Administrative, Educational	
Information and finance and insurance, and real estate and rental and leas	1,010	Services, Health Care and Social Assistance	4,530
Professional, scientific, and management, and administrative and waste m	1,291	Public Administration and Armed Forces	390
Educational services, and health care and social assistance	2,229	Total (Computed)	10,000
Arts, entertainment, and recreation, and accommodation and food services	920		
Other services (except public administration)	489		
Public administration	386		
Armed forces	4		

Workers include members of the Armed Forces and civilians who were at work last week.
END OF STEP 1

Data Sources:
U.S. Census- See U.S. Department of Commerce, Census Bureau, U.S. Census of Population and Housing, 2000 and
American Community Survey, 2005-2009

Jurisdictions Providing Public Services to the Development

Row 24 Name of Primary Jurisdiction (Municipality/County) for this analysis. *This is used to label output.*

Row 25 Name of School District (if school analysis is desired). *This is used to label output.*

Row 28 Area of Jurisdiction (Municipality/County) (sq. mi.) – *This is an optional entry. As indicated above, it is used for a display of density change, but is not currently used for any other calculation.*

Row 29 Current Population of Local Jurisdiction (Municipality/County) – American Community Survey* table B01003 or Census Population Estimates. – *This is the population that will be used to develop cost per person. Normally it would be the year-round population of the area but there may be cases where some share of seasonal population would be included in this value. This is particularly true for the capital cost calculations where often a "functional" population is used.*

Row 30 Current Households in Local Jurisdiction (Municipality/County) American Community Survey Table B11001[7]. – *This value is used in the Induced Costs and Revenues. section.*

Row 31 Current Number of Persons Working in Jurisdiction (Municipality /County) – *This number is the full-time equivalent at-place employment of the area, public and private. The general source of this information is the American Community Survey[8] Table C08526-(Workplace Geography) Total.*

[7] American Community Survey data for communities of all sizes should be available late in 2010. Data for areas of 20,000 or more is available now.
[8] See prior footnote on American Community Survey.

Row 32 Current Enrollment in School District – *This value includes all students whose education is paid for by School District funds.*
Row 33 Year of Analysis (for inflation adjustment of selected default values). *The default rate of inflation can be overridden on Sheet 6. See Sheet 6 Row 24 for information on which default data items have the inflation adjustment applied.*

Information Required if Induced Capital Costs/Revenues are Being Calculated:
Housing Unit Types (Current Conditions) *The general source of this information is the American Community Survey Table B25024*[9]
Row 37 Single Family Detached Units – *Free-standing homes intended for one family.*
Row 38 Single Family Attached Units – *Townhouses; single family joined at the side.*
Row 39 Multi-family Units – This is the total of 2 units, 3 or 4 units, 5 to 9 units, etc.
Row 40 Mobile Homes – *This includes mobile or manufactured homes capable of being brought to a site.*
If this information is not available for the area being studied estimates of the distribution of current units by type should be provided. The model uses this information on the current housing conditions in various parts of the model. Rows 83 to 94 provide a guide to summing the detailed data
Row 41 Total – The total is computed by the spreadsheet for checking purposes.
Employment Types (Current Persons Working in Jurisdiction) – *The general source of this information is the American Community Survey Table C08526- (Workplace Geography) This table should be summed into the following categories:*
Row 44 Manufacturing, Transportation, Warehousing and Utilities,
Agriculture, and Construction and Wholesale Trade
Row 46 Retail Trade, Arts, Entertainment, Recreation,
Accommodations and Food Services
Row 49 Information, Finance, Insurance, and Real Estate, Professional,
Scientific, Management and Administrative, Educational
Services, Health Care and Social Assistance
Row 50 Public Administration and Armed Forces
Row 51 Total – *The total is computed by the spreadsheet for checking purposes.*
Rows 104 to 116 provide a guide to summing the detail of the Census table.
If employment data for the above cells is unavailable see Step 6, Row 29
Step 6, Row 29 allows the user to enter a local figure (or estimate) for employees per 1,000 square feet of nonresidential space. If no data is entered in rows 44 to 50 and a local figure is not entered a default employees per 1,000 square feet value is used in Step 6, Row 29.

LIST OF OTHER DATA REQUIRED
In addition to the information above, the following information needs to be entered in later steps in order to utilize this model: *The items in this list will be discussed later in this document, Step by Step.*
Development Description
Number of residential units by type; square footage per unit and sales price per unit.
Nonresidential square footage by type of nonresidential space; value per square foot.
Budget Items (If Budget Information is not readily available and accessible the Preview Method can be used. See end of Step 2).
Local jurisdiction (and School District if appropriate); expenditures by category; share of each category related to transportation.
Jurisdiction Property Tax Rate; total assessed value for residential and nonresidential properties; equalization ratio (if property valuation is not at full market value); estimated share of Property Tax related to transportation (this is initially an intuitive approximation but can be subsequently researched).
Number of residential and nonresidential parcels.
Personal property tax information, if relevant.
Jurisdiction non-property tax revenue information by category of revenue, the former broken down by population related and

[9] See prior footnote on American Community Survey

employment related revenues; by share that is transportation-related.

Optional items (Defaults have been provided).

Local Demographic Multipliers (Persons and Students per Unit) for the housing types being planned.

Local Nonresidential Multipliers (Employees per 1,000 sq.ft. of nonresidential space) for types of planned nonresidential space.

Input-Output Multipliers used in the control of all costs.

Local detailed information relating to calculating Capital Costs.

Miscellaneous values used in various steps (can be overridden if desired).

Model Version 4.0

END OF STEP 1

The following rows help organize housing unit data and employment data. The American Community Survey is a good source for this information. If the detail data from the American Community Survey is copied into the rows shown below the data will be added up in column D to match the groups of data necessary for the calculations. Note that the results have to be cut-and-pated from column D to the cells in rows 37 to 52.

Row 78 B25024. UNITS IN STRUCTURE - Universe: HOUSING UNITS

Row 79 Data Set: American Community Survey Estimates

Row 80 Survey: American Community Survey

Row 83 Units in Structure

Row 84 Total:

Row 85 1, detached

Row 86 1, attached

Row 87 2

Row 88 3 or 4

Row 89 5 to 9

Row 90 10 to 19

Row 91 20 to 49

Row 92 50 or more

Row 93 Mobile home

Row 94 Boat, RV, van, etc.

C08526. MEANS OF TRANSPORTATION TO WORK BY INDUSTRY FOR WORKPLACE GEOGRAPHY - Universe: WORKERS 16 YEARS AND OVER

Data Set: American Community Survey Estimates

Survey: American Community Survey

Row 103 Total:

Row 104 Agriculture, forestry, fishing and hunting, and mining

Row 105 Construction

Row 106 Manufacturing

Row 107 Wholesale trade

Row 108 Retail trade

Row 109 Transportation and warehousing, and utilities

Row 110 Information and finance and insurance, and real estate and rental and leasing

Row 111 Professional, scientific, and management, and administrative and waste management services

Row 112 Educational services, and health care and social assistance

Row 113 Arts, entertainment, and recreation, and accommodation and food services

Row 114 Other services (except public administration)

Row 115 Public administration

Row 116 Armed forces

Workers include members of the Armed Forces and civilians who were at work last week.

STEP 2 - DEVEL OPMENT DE SCRIPTION - ENTER INFOR MATION ON DEVE L-OPMENT BEING ANALYZED

SHEET 2-Development Description

This sheet gathers the description of the development. Common residential unit types and bedroom sizes are provided along with "other" rows for types which do not appear. Common nonresidential types also appear along with "other" rows for unique types.

STEP 2 - DEVELOPMENT DESCRIPTION - ENTER INFORMATION ON DEVELOPMENT BEING ANALYZED

DEVELOPMENT DESCRIPTION AND PREVIEW METHOD

Fill in cells only for included housing/nonresidential types

1. Name of Development = In-Town Square
2. Name of Owner =

3. Development Composition

A. Number of Residential Units by type and size

Unit Type and Size			Units	Square Feet Per Unit	Sales Price per Unit
Single-family det.	2 bedroom	=			
	3 bedroom	=			
	4 bedroom	=			
	5 bedroom	=			
Garden Apt.	1 bedroom	=			
	2 bedroom	=			
	3 bedroom	=			
Town House	2 bedroom	=	1,200	1,400	$200,000
	3 bedroom	=	800	2,000	$300,000
	4 bedroom	=			
High-rise	Studio*	=			
	1 bedroom*	=			
	2 bedroom*	=			
Mobile Home	1 bedroom*	=			
	2 bedroom	=			
	3 bedroom	=			
Other	Type 1*	=			
	Type 2*	=			
	Type 3*	=			
Age-Restricted	1 bedroom*	=			
	2 bedroom*	=			
Total Residential Units		=	2,000		

* Default person and student multipliers not available in the program for these unit types. Multipliers must be provided if these types are used.

B. Nonresidential Space by Type		Square Feet	Value per sq.ft.
Office			
General	=	750,000	$200
Office Park	=		
Medical	=		
Retail			
Convenience	=		
Supermarket	=		
Shopping	=		
Restaurant	=		
Industrial			
General Light	=		
Industrial Park	=		
Manufacturing	=		
Warehousing	=		
Hotel	=		
Other Nonresidential Type			
Other Type 1	=		
Other Type 2	=		
Other Type 3	=		
Total Nonresidential Space	=	750,000	

END OF STEP 2 - UNLESS BELOW PREVIEW METHOD IS USED

(Preview Method is suggested especially for initial use of the model)

PREVIEW METHOD ALTERNATIVE - NO ADDITIONAL DATA ENTRY (OTHER THAN CODE BELOW) - QUICK SOLUTION TO TRANSPORTATION IMPACTS OF NEW DEVELOPMENT

The following rows relate to the "Preview Method". This is a shortcut procedure which can be used if the local jurisdicition's budget information is not available

Selecting this option causes values to be entered to enable a default calculation

The values may be overridden as appropriate if local information is available

To use the "Preview Method" type "1" in cell D74

Note that Step 1-Start Here and Step 2-Development Description must be filled out

If it is desired to override the default demographic multipliers, then Steps 3 and 4 must be filled out < enter 1 for Preview Method

After entering "1" in cell D74 and overriding any defaults for which local data are available the user should skip to: STEP 7 - View Model Output to view results

Be sure to start with a clean blank copy of the model each time the model is run

	Override Default Below	Suggested Default Value
Total Operating Cost per Person		$684
Total Operating Cost per Employee		$284
Total Operating Cost per Student		$15,000
Transportation Operating Cost per Person		$99
Transportation Operating Cost per Employee		$41
Transportation Operating Cost per Student		$3,360
Total Non-Tax Operating Revenue per Person		$246
Total Non-Tax Operating Revenue per Employee		$102
Total Non-Tax Operating Revenue per Student		$3,723
Transportation Non-Tax Operating Revenue per Person		$84
Transportation Non-Tax Operating Revenue per Employee		$28
Transportation Non-Tax Operating Revenue per Student		$367
Municipal/County Property Tax Rate for Preview Method		0.005
Municipal/County Equalization Ratio for Preview Method		0.8
School Property Tax Rate for Preview Method		0.01
School Equalization Ratio for Preview Method		0.8

END OF STEP 2

Data Sources:

Project Pro-Forma relating to Development

DEVELOPMENT DESCRIPTION AND PREVIEW METHOD

(Row 7 thru Row 62 relate to Procedural Guide Step I-B Direct Transportation Operating Costs Calculating the Total and Transportation-Related Operating Costs Associated with the Development along with Step I-A, Direct Transportation Capital Costs of Development and Exhibit I-A.15.)

Fill in cells only for included housing/nonresidential types

Row 7 1. Name of Development. *This is used to label the output.*

Row 8 2. Name of Owner. *This is used to label the output.*

Row 9 Total Project Land Area in Acres – *Optional, not extensively used in calculations.*

Row 10 Distance of Project to nearest rail-based transit system (default is 10 miles) *Optional, not extensively used in calculations.*

Row 11 Walkability (short description) – *This is simply a comment.*

Row 12 Bicycle access (short description) – *This is simply a comment.*

3. Development Composition. *The information below will normally come from the pro forma of the development.*

A. Number of Residential Units by type and size. *For each housing type and bedroom size that exists in a development: the number of units, the square footage of the unit (used for traffic generation and transportation capital costs), and the (market) sale price of the unit (including land) should be entered in the appropriate column of the appropriate line.*

Unit Type and Size

Row 17	Single-family det.	2 bedroom
Row 18		3 bedroom
Row 19		4 bedroom
Row 20		5 bedroom
Row 21	Garden Apt.	1 bedroom
Row 22		2 bedroom
Row 23		3 bedroom
Row 24	Town House	2 bedroom
Row 25		3 bedroom
Row 26		4 bedroom
Row 27	High-Rise	Studio*
Row 28		1 bedroom*
Row 29		2 bedroom*
Row 30	Mobile Home	1 bedroom*
Row 31		2 bedroom
Row 32		3 bedroom
Row 33	Other	Type 1*- *These “Other” entries are provided to allow for unit types not on the list. They could also be used if there were units of the same type and bedroom size but with different price points. Appropriate multipliers must be provided if the “Other” entries are used.*
Row 34		Type 2*
Row 35		Type 3*
Row 36	Age-Restricted	1 bedroom*
Row 37		2 bedroom*

Row 38 Total Residential Units. *This is an automatic check of the total.*

* Default person and student multipliers are not available in the program for these unit types. Multipliers must be provided if these types are used. *The program does not have default multipliers for High Rise (any bedroom size), 1 bedroom Mobile Home, Age Restricted (any bedroom size) or Other types. If these types are being used multipliers have to be researched and entered in the appropriate locations on Sheet 3-Resid. Demo. Multipliers.*

B. Nonresidential Space by Type. *For each type of use that exists in a development the square footage of that type to be developed and the (market) value of a square foot of that type of space, including land should be entered on the appropriate line.*

Office

Row 43	General
Row 44	Office Park
Row 45	Medical

Retail

Row 47	Convenience
Row 48	Supermarket
Row 49	Shopping
Row 50	Restaurant

Industrial

Row 52	General Light
Row 53	Industrial Park
Row 54	Manufacturing
Row 55	Warehousing

Row 57 Hotel

Other Nonresidential Type – *These "Other" entries are provided to allow for nonresidential types not in the list. They could also be used if there are multiple price points in a single nonresidential type. Appropriate employee multipliers must be provided if the "Other" entries are used.*

Row 59 Type 1
Row 60 Type 2
Row 61 Type 3
Row 62 Total Nonresidential Space

END OF STEP 2 - UNLESS BELOW PREVIEW METHOD IS USED

(Preview Method is suggested especially for initial use of the model)

PREVIEW METHOD ALTERNATIVE - NO ADDITIONAL DATA ENTRY (OTHER THAN CODE BELOW) - QUICK SOLUTION TO TRANSPORTATION IMPACTS OF NEW DEVELOPMENT

The following rows relate to the "Preview Method". This is a shortcut procedure which can be used if the local jurisdiction's budget information is not available.
Selecting this option causes values to be entered to enable a default calculation.
The values may be overridden as appropriate if local information is available.

Row 74 To use the "Preview Method" type "1" in cell D74.
Note that Step 1-Start Here and Step 2-Development Description must be filled out.
If it is desired to override the default demographic multipliers then Steps 3 and 4 must be filled out.
After entering "1" in cell D74 and overriding any defaults for which local data are available the user should skip to STEP 7 - View Model Output to view results.

The following entries, to END OF STEP 2 USING PREVIEW METHOD, can be overridden if desired if local data is available. *The Preview Model should be considered a screening tool to be used to gain familiarity with the basics of the Model. lf detailed budget information is not available but local per-person, per-employee, and per-student costs and revenues are available, those local values should be used, along with local property tax information, in order to best utilize the Preview Method. Without local costs and revenues the Preview Method must be used cautiously. It enables the user to get a feel for the possible results for a development while detailed local budget information is being gathered. It is important to realize that the generalized default property tax information is not appropriate for all states and the user should at least consider supplying local property tax rates and equalization ratios. In any jurisdiction with the property tax as a major component of local revenues, it is important to keep the property tax separate from all other revenues. If property tax revenues are considered as part of the per person revenues, with the tax rate zeroed out, changes in the valuation of units in a development will have no effect on the operating revenues. Unless the property tax is minimal, this would not be a correct way of addressing this step.*

Row 78 Total Operating Costs per Person – *The total of all operating costs attributable to the population of the jurisdiction divided by the number of persons in the jurisdiction.*

Row 79 Total Operating Costs per Employee – *The total of all operating costs attributable to the employment or the nonresidential land uses of the jurisdiction divided by the number of employees in the jurisdiction.*

Row 80 Total Operating Costs per Student – *The total of all School District operating costs divided by the number of students in the district. It is assumed here that the School District budget is separate from the jurisdiction budget.*

Row 82 Transportation Operating Costs per Person – *The total of all transportation-related operating costs attributable to the persons of the jurisdiction divided by the number of persons in the jurisdiction.*

Row 83 Transportation Operating Costs per Employee – *The total of all transportation-*

related operating costs attributable to the employment or the nonresidential land uses of the jurisdiction divided by the number of employees in the jurisdiction.

Row 84 Transportation Operating Costs per Student – *The total of all transportation-related School District operating costs divided by the number of students in the district.*

Row 86 Total Non-Tax Operating Revenues per Person – *The total of all operating revenues - other than property tax- attributable to the persons of the jurisdiction divided by the number of persons in the jurisdiction.*

Row 87 Total Non-Tax Operating Revenues per Employee – *The total of all operating revenues - other than property tax - attributable to the employment or the nonresidential land uses of the jurisdiction divided by the number of employees in the jurisdiction.*

Row 88 Total Non-Tax Operating Revenues per Student – *The total of all School District operating revenues - other than property tax - divided by the number of students in the district.*

Row 90 Transportation Non-Tax Operating Revenues per Person – *The total of all transportation-related operating revenues - other than property tax - attributable to the persons of the jurisdiction divided by the number of persons in the jurisdiction.*

Row 91 Transportation Non-Tax Operating Revenues per Employee – *The total of all transportation-related operating revenues - other than property tax - attributable to the employment or the nonresidential land uses of the jurisdiction divided by the number of employees in the jurisdiction.*

Row 92 Transportation Non-Tax Operating Revenues per Student – *The total of all School District transportation-related operating revenues - other than property tax - divided by the number of students in the district.*

Row 94 Municipal/County Property Tax Rate for Preview Method – Tax Rate (per dollar of value - related to assessed value). *Be sure to enter the tax rate carefully since the rate is usually expressed in a form other than rate per dollar of value. A default value is provided to show what a rate per dollar value might look like. This rate and ratio information is necessary since, if per capita, per employee, and per student values are computed on a sum of all revenues, including tax revenues, the model will not be sensitive to changes in valuation in different scenarios.*

Row 95 Municipal/County Equalization Ratio for Preview Method – *The equalization ratio of residential and nonresidential property should be entered here. This value is necessary to estimate the assessed value of the new construction. This is the ratio of assessed to full market value of the property. A value of 1 would be used if property were taxed at full market value, i.e. assessed value to market value equals 1.00.*

Row 96 School Property Tax Rate for Preview Method - *Property Tax Rate (per dollar of value - related to assessed value) See the jurisdiction discussion above. The model assumes that the School District Budget is separate from the Local Jurisdiction Budget.*

Row 97 School Equalization Ratio for Preview Method – See Municipal /County Equalization Ratio discussion above.

END OF STEP 2 - USING P REVIEW METHOD

STEP 3 - SELECT RESIDENTIAL DEMOGRAPHIC MULTIPLIERS FROM BELOW

SHEET 3-Resid. Demo. Multipliers

This sheet gathers information on the likely number of occupants of the residential portion of the development. Default multipliers to calculate forthcoming persons and students are provided.

STEP 3 - SELECT RESIDENTIAL DEMOGRAPHIC MULTIPLIERS FROM BELOW

In-Town Square

Unit Type and Size		Override Defaults here if desired: Persons per Unit	Students per Unit: Total Students per Unit (K-12)	Default Multipliers Unless Overridden: Persons per Unit	Total Students per Unit (K-12)	Default Multipliers: Default Persons per Unit	Default Total Students per Unit (K-12)
Single-family det.	2 bedroom			2.370	0.320	2.370	0.320
	3 bedroom			2.840	0.580	2.840	0.580
	4 bedroom			3.530	1.010	3.530	1.010
	5 bedroom			4.150	1.430	4.150	1.430
Garden Apt.	1 bedroom			1.540	0.110	1.540	0.110
	2 bedroom			2.190	0.290	2.190	0.290
	3 bedroom			3.420	0.960	3.420	0.960
Town House	2 bedroom	2.110	0.250	2.110	0.250	1.930	0.170
	3 bedroom	3.030	0.500	3.030	0.500	2.550	0.440
	4 bedroom			3.380	0.830	3.380	0.830
High-rise	Studio*			0.000	0.000	0.000	0.000
	1 bedroom*			0.000	0.000	0.000	0.000
	2 bedroom*			0.000	0.000	0.000	0.000
Mobile Home	1 bedroom*			0.000	0.000	0.000	0.000
	2 bedroom			2.280	0.330	2.280	0.330
	3 bedroom			2.990	0.710	2.990	0.710
Other	Type 1*			0.000	0.000	0.000	0.000
	Type 2*			0.000	0.000	0.000	0.000
	Type 3*			0.000	0.000	0.000	0.000
Age-Restricted	1 bedroom*			0.000	0.000	0.000	0.000
	2 bedroom*			0.000	0.000	0.000	0.000
* No default multipliers provided		Total Persons	Total Students				
		4,956	700				
		Average Persons and Students per Unit					
		2.478	0.35				

END OF STEP 3

Data Sources

National Study of Demographic Multipliers (2006) conducted for Fannie Mae using 2000 U.S. Census Data (on CD)

(Row 8 to Row 32 refer to the Procedural Guide, Step I-B, the Number of New Persons and/or Employees)

Unit Type and Size. *The expected number of persons and students for each development type that exists in the project should be provided or the defaults utilized. The default multipliers provided for some types and bedroom sizes are U.S. nationwide data from Fannie Mae Foundation Residential Demographic Multipliers prepared in June 2006 based on 2000 Census. A folder containing multiplier reports for each state for selected unit types, bedroom sizes, and value/rent ranges based on the 2000 Census is on the CD. See the "multiplier pdfs plus" folder. "Multifamily units" on the CD is used for garden apartments in the example used here.*

Row 8 Single-family det. 2 bedroom. *Default multipliers are provided for many of these identified types but locally or state-based multipliers should be used if available. Local multipliers need to be supplied only for the types of units and nonresidential space actually found in the development.*

Row 9 3 bedroom
Row 10 4 bedroom
Row 11 5 bedroom
Row 12 Garden Apt. 1 bedroom
Row 13 2 bedroom
Row 14 3 bedroom
Row 15 Town House 2 bedroom
Row 16 3 bedroom
Row 17 4 bedroom
Row 18 High-rise Studio*

** indicates that default multipliers are not provided for High-rise, "Other", 1 bedroom Mobile Homes, and Age Restricted Units.*

Row 19 1 bedroom*
Row 20 2 bedroom*
Row 21 Mobile Hom 1 bedroom*
Row 22 2 bedroom
Row 23 3 bedroom
Row 24 Other Type 1*. *Multipliers must be entered if any "Other" types are used since no defaults can be provided.*

Row 25 Type 2*
Row 26 Type 3*
Row 27 Age-Restricted 1 bedroom*
Row 28 2 bedroom*

END OF STEP 3

STEP 4 - SELECT NONRESIDENTIAL DEMOGRAPHIC MULTIPLIERS FROM BELOW

SHEET 4-Nonres. Demo. Multipliers
This sheet organizes information on the likely number of employees of the nonresidential portion of the development. It also organizes information on the mixed-use characteristics of the development and whether or not there may be savings in VMT from these characteristics. In addition, information on I-O Multipliers is entered on this sheet.

STEP 4 - SELECT NONRESIDENTIAL DEMOGRAPHIC MULTIPLIERS FROM BELOW

In-Town Square

NONRESIDENTIAL EMPLOYMENT MULTIPLIERS	Employees per 1,000 sq.ft. Override Defaults Here	Default Multipliers Unless Overridden Employees per 1,000 sq.ft. Actually Used	Default Employees per 1,000 sq.ft.
B. Nonresidential Space by Type			
Office			
General		3.50	3.50
Office Park		4.00	4.00
Medical		4.50	4.50
Retail			
Convenience		2.50	2.50
Supermarket		1.50	1.50
Shopping		2.00	2.00
Restaurant		2.50	2.50
Industrial			
General Light		1.50	1.50
Industrial Park		1.50	1.50
Manufacturing		1.00	1.00
Warehousing		0.50	0.50
Hotel		0.70	0.70
Other Nonresidential Type			
Type 1			
Type 2			
Type 3			
Total Employees	2,625	Average Employees per 1,000 sq.ft.	3.50

VMT Adjustment for Mixed-Use and Other Factors

Job-Population Balance and Household Size Calculated Automatically

D-Factor coefficients			value used	default calc
Factor 1: Job-Population Balance (0-1)			0.548199768	0.548199768
Factor 2: Intersection Density (0-665)			257	257
Factor 3: Employment Accessibility (0-0.65)			0.19	0.19
Factor 4: Household Size (0-5.3)			2.478	2.478
Factor 5: Vehicle Ownership (1-2.73)			1.8	1.8
Factor 6: Bus Stop Accessibility (1-2)			1.43	1.43
Factor 7: (name)			0	
Total VMT Percentage Change		Mixed-Use VMT Adjustment	-0.024994394	-0.024994394

Calculation Enabled, see Cell C28 on 6-Enter Finc.-Mult.Info to disable

job-population balance = 1 - ABS (jobs - 0.2 x population)/(jobs + 0.2 x population) [Automatically Calculated]
intersection density = number of intersections/square miles of gross land area
employment accessibility = share of regional employment within 20 minutes by auto
household size = average persons per occupied dwelling unit [Automatically Calculated]
vehicle ownership = 1+ average vehicles per household member
bus stop accessibility = 1+ proportion of population within 1/4 mile of a bus stop

I-O MULTIPLIERS USED IN THE CONTROL OF ALL COSTS (For Advanced Users)

	Override I-O Default Multiplier Here	I-O Multiplier Actually Used	Default I-O Multiplier
Nonresidential Space by Type			
Office			
General		2.5382	2.5382
Office Park		2.5382	2.5382
Medical		2.5382	2.5382
Retail			
Convenience		1.8057	1.8057
Supermarket		1.8057	1.8057
Shopping		1.8057	1.8057
Restaurant		1.8057	1.8057
Industrial			
General Light		3.9389	3.9389
Industrial Park		3.9389	3.9389
Manufacturing		3.9389	3.9389
Warehousing		3.9389	3.9389
Hotel		2.1871	2.1871
Other Nonresidential Type			
Type 1			
Type 2			
Type 3			
Residential		1.4000	1.4000
Calculated Multiplier before Adjustment		2.0460	2.0460
Adjusted Local Multiplier		1.1046	1.1046

END OF STEP 4

Data Sources

David Listokin et al., New Jersey Demographic Multipliers: The Profile of Occupants of Residential and Nonresidential Development, 2006

Mixed Use Adjustment - See Procedural Guide, Step I-A, Modeling VMT Reductions for Mixed Use Developments

I-O Multipliers - See Procedural Guide, Step IV

(Row 4 to Row 30 refer to the Procedural Guide, Step I-B, The Number of New Persons and/or Employees.)

NONRESIDENTIAL EMPLOYMENT MULTIPLIERS. *The number of employees per one-thousand square feet for each nonresidential type should be entered here for each category of nonresidential space in the project.*

Default multipliers are provided but locally researched multipliers can be entered instead. These multipliers come from a variety of nonresidential sources of information such as ULI, BOMA, the National Council of Shopping Centers. There is also information available from energy use studies by facility type. These have been compiled by staff at the Rutgers University, Center for Urban Policy Research.

B. Nonresidential Space by Type

Office

Row 11 General

Row 12 Office Park

Row 13 Medical

Retail

Row 15 Convenience

Row 16 Supermarket

Row 17 Shopping

Row 18 Restaurant

Industrial

Row 19 General Light

Row 20 Industrial Park

Row 21 Manufacturing

Row 22 Warehousing

Row 25 Hotel

Other Nonresidential Type *Multipliers must be entered if any "Other" types are used since no defaults can be provided.*

Row 27 Other Type 1

Row 28 Other Type 2

Row 29 Other Type 3

Total Employees

Employees/1,000 ft2 of Nonresidential Space Derived from multiple sources of nonresidential information including ITE; CA dept. of Energy; BOMA; Portland, Or; State of Washington; CBECS.

See: Listokin, David Who Lives in New Jersey Housing, 2006, Bloustein School of Planning and Public Policy, New Brunswick, NJ

VMT Adjustment for Mixed-Use and Other Factors.

(Row 33 to Row 50 refer to the Procedural Guide, Step I-A, Modeling VMT Reductions for Mixed-Use Developments.)

Job-Population Balance and Household Size Calculated Automatically.

D-Factor coefficients

Row 36 Factor 1: Job-Population Balance (0-1) *= 1 - ABS (jobs - 0.2 x population)/(jobs + 0.2 x population).*

Row 37 Factor 2: Intersection Density (0-665) *number of intersections /square miles of gross land area.*

Row 38 Factor 3: Employment Accessibility (0-0.65) = *share of regional employment within 20 minutes by auto.*

Row 39 Factor 4: Household Size (0-5.3) = *average persons per occupied dwelling unit.*

Row 40 Factor 5: Vehicle Ownership (1-2.73) *= 1+ average vehicles per household member.*

Row 41 Factor 6: Bus Stop Accessibility (1-2) *= 1+ proportion of population within 1/4 mile of a bus stop.*

Row 42 Factor 7: (name) – *This row can be used for a custom measure.*

Row 43 Total VMT Percentage Change *If the Mixed-Use VMT Adjustment is appropriate or desired for a development enter one (1) in cell C33 on Step 6-Enter Finc.-Mulkt.Info. If the Total VMT Percentage Change is a positive number the VMT estimated for the development will be increased. If the value is less than one the estimated VMT will be decreased because the Mixed Use characteristics of the development should reduce the amount of traffic generated.*

The Job-Population Balance and the Household Size components of the Mixed-Use VMT Adjustment are automatically calculated for projects with residential units. A Mixed-Use VMT Adjustment based on those calculated components and the default values of the other components is generated. This adjustment will only be applied to the model if a one (1) is entered in Cell C33 on Step 6-Enter Finc.-Mult.Info .

I-O MULTIPLIERS USED IN THE CONTROL OF ALL COSTS (For Advanced Users)

(Row 53 to Row 83 refer to the Procedural Guide, Step IV, A Control for all Costs.)

These are multipliers that are applied to direct operating/capital costs/revenues to provide an order of magnitude of the scale of all transportation costs related to development. This is a number that can be compared to the sum of direct, indirect, and induced costs/revenues..

Nonresidential Space by Type

Office

Row 58 General
Row 59 Office Park
Row 60 Medical

Retail

Row 62 Convenience
Row 63 Supermarket
Row 64 Shopping
Row 65 Restaurant

Industrial

Row 67 General Light
Row 68 Industrial Park
Row 69 Manufacturing
Row 70 Warehousing
Row 72 Hotel

Other Nonresidential Type – *If "Other" types are used, multipliers must be researched since no defaults can be supplied.*

Row 74 Other Type 1
Row 75 Other Type 2
Row 76 Other Type 3
Row 77 Residential

Row 80 Calculated Multiplier before Adjustment – *Calculated from the total of residential units multiplied by the Residential I-O multiplier plus the various nonresidential I-O multipliers for nonresidential types multiplied by the appropriate number of square feet.*

Row 82 Adjusted Local Multiplier

I-O Multipliers adapted from Arthur C. Nelson, Planner's Estimating Guide: Projecting Land Use and Facility Needs, Chicago, American Planning Association, 2004.

END OF STEP 4

STEP 5 - ENTE R M UNICIPAL/COUNTY AND SC HOOL EXPENDITURE, REVENUE, AND TAX BASE INFORMATION

SHEET 5-Enter Budget Info.
This sheet organizes the jurisdiction (Municipality/County) and School District Budget information. This is a tabulation of costs by category, revenues by category, and the transportation component of these costs and revenues. In addition tax rate and equalization information are gathered.

STEP 5 - ENTER MUNICIPAL/COUNTY AND SCHOOL EXPENDITURE, REVENUE, AND TAX BASE INFORMATION

In-Town Square
Newtown City

If detailed budget information is not available see the "Preview" method discussed at the end of Step 6-Enter Model Info.

Municipal/County Information

Main categories	Total Annual Expenditures	Override Default Percentage of Expenditures Related to Transportation	Actually Used Percentage of Expenditures Related to Transportation	Default Percentage of Expenditures Related to Transportation
General Government	$2,750,000		0.0%	0.0%
Public Safety	$7,000,000		0.0%	0.0%
Public Works	$3,540,000		40.0%	40.0%
Economic Development	$1,350,000		25.0%	25.0%
Health/Human Services	$450,000		0.0%	0.0%
Recreation & Culture	$1,850,000		0.0%	0.0%
Debt Service	$2,000,000		50.0%	50.0%
Other #1			0.0%	
Other #2			0.0%	
Other #3			0.0%	
Total (automatic)	$18,940,000	2,753,500		

Service Population	This information is entered in Step "1-Start Here"		
Population in Jurisdiction (Current)	23,530	Average Household Size	
Households in Jurisdiction	9,400	2.50	
Employment in Jurisdiction (Current)	10,000		
All persons working in jurisdiction, not just employees of the jurisdiction			
Jurisdiction Real Property Tax Rate (per dollar of value - related to assessed value)		Tax Rate Used	
Residential	0.005	0.005	
Nonresidential	0.005	0.005	
Real Property Tax Base (Assessed Value)			
Residential	$1,575,000,000		
Nonresidential	$525,000,000		
Parcels			
Residential	6,650		
Nonresidential	350		
		Value to be used	
Residential Share of Costs-Default is based on Value & Parcels		85%	85% is the suggested default
Real Property Equalization Ratio		Ratio Used	
Residential	0.80	0.8	
Nonresidential	0.80	0.8	

Personal Property Tax (Boats, Automobiles, Structure, Furniture)		
Residential Personal Property Tax Rate (Per Dollar of Value)		
Residential Personal Property as % of total residential market value		16.5% would be a suggested default
Equalization Ratio for Residential Personal Property		
Business Personal Property Tax Rate		
Business Personal Property as % of total nonresidential market value		25% would be a suggested default
Equalization Ratio for Business Personal Property		

Transportation Revenues	Override	Actually used	Suggested Default
Percentage of Property Tax Related to Transportation		5.00%	5.00%
Percentage of Personal Property Tax Related to Transportation		5.00%	5.00%

Nonproperty Tax Revenues

Category (Include incoming Intergovernmental Aid)	Current yearly Revenue (Total)(Calculated)	Current yearly Revenue Related to Population	Current Yearly Revenue Related to Employees	Percentage of This Revenue Which Will Increase with New Development	
Interest Earnings	$500,000	$425,000	$75,000	100.00%	See Transportatio
State Intergovernmental Revenues	$1,500,000	$1,275,000	$225,000	100.00%	Shares Below
Licenses and Permits	$700,000	$595,000	$105,000	100.00%	
Fines and Forfeits	$430,000	$365,500	$64,500	100.00%	
Public Charges	$1,000,000	$850,000	$150,000	100.00%	
Federal Intergovernmental Revenues	$600,000	$510,000	$90,000	100.00%	
Other Miscellaneous Revenues	$1,070,000	$909,500	$160,500	100.00%	
Sales Tax	$1,000,000	$850,000	$150,000	100.00%	
Additional Entry #1	$0				
Additional Entry #2	$0				
Additional Entry #3	$0				
Additional Entry #4	$0				
Additional Entry #5	$0				

	Override Default Percentage of Population Revenues Related to Transportation	Actually Used Percentage of Population Revenues Related to Transportation	Default Percentage of Population Revenues Related to Transportation	Override Default Percentage of Employment Revenues Related to Transportation	Actually Used Percentage of Employment Revenues Related to Transportation
Interest Earnings		0.00%	0.00%		0.00%
State Intergovernmental Revenues		65.00%	65.00%		50.00%
Licenses and Permits		0.00%	0.00%		0.00%
Fines and Forfeits		45.00%	45.00%		35.00%
Public Charges		55.00%	55.00%		45.00%
Federal Intergovernmental Revenues		55.00%	55.00%		45.00%
Other Miscellaneous Revenues		0.00%	0.00%		0.00%
Sales Tax		28.00%	28.00%		22.00%
Additional Entry #1					
Additional Entry #2					
Additional Entry #3					
Additional Entry #4					
Additional Entry #5					

School District Information

In-Town Square

Newtown Schools

	Total Annual Expenditures	Override Default Percentage of Expenditures Related to Transportation	Actually Used Percentage of Expenditures Related to Transportation	Default Percentage of Expenditures Related to Transportation
Main Categories				
Teaching	$87,420,000		0.0%	0.0%
Administration	$14,100,000		0.0%	0.0%
Transportation	$28,200,000		100.0%	100.0%
Debt Service	$11,280,000		30.0%	30.0%
Other #1			0.0%	
Other #2			0.0%	
Other #3			0.0%	
Other #4			0.0%	
Other #5			0.0%	
Total (automatic)	$141,000,000	31,584,000		

Service Population	Enter enrollment in Step "1-Start Here"	
Students Served by district (Current)	9,400	
School District 1 Property Tax Rate (per dollar of value - related to assessed value)		Tax Rate Used
Residential	0.01	0.01
Nonresidential	0.01	0.01
Equalization Ratio		
Residential	0.8	0.8
Nonresidential	0.8	0.8

Personal Property Tax	
Personal Property (Related to Persons) Tax Rate (per Dollar of Value)	
Personal Property as % of total residential value	
Equalization Ratio for Personal Property	
Nonresidential Tax Rate	
"Personal" Property as % of total nonresidential value	
Equalization Ratio for Nonresidential Property	

Transportation Revenues	Override	Actually used	Suggested Default
Percentage of Property Tax Related to Transportation		20.00%	20.00%
Percentage of Personal Property Tax Related to Transportation		0.00%	0.00%

Nonproperty Tax Revenues

Category (Include Incoming Intergovernmental Aid)	Current Yearly Revenue Related to Students	Percentage of This Revenue Which Will Increase with New Development	Override Default Percentage of Revenues Related to Transportation	Actually Used Percentage of Revenues Related to Transportation	Default Percentage of Revenues Related to Transportation
Tuition	$750,000	100.00%		0.00%	0.00%
Miscellaneous Revenues	$1,250,000	100.00%		12.00%	12.00%
State Aid	$20,000,000	100.00%		10.00%	10.00%
Federal Aid	$13,000,000	100.00%		10.00%	10.00%
Additional Entry #1				0.00%	0.00%
Additional Entry #2				0.00%	0.00%
Additional Entry #3				0.00%	0.00%
Additional Entry #4				0.00%	0.00%
Additional Entry #5				0.00%	0.00%
Additional Entry #6				0.00%	0.00%
Additional Entry #7				0.00%	0.00%
Additional Entry #8				0.00%	0.00%
Additional Entry #9				0.00%	0.00%
Total (Automatic Calculation)	$35,000,000				

END OF STEP 5

Data Sources:

County Abstract of Ratables by Community for Current Year. Input value reflects multiple years of fiscal impact practice.

Averaged budgets for local communities in New Jersey and New Mexico where property and sales taxes are alternatively dominant.

Also available from the U.S. Census of Governments is the transportation share of local expenditures,

(U.S. Census of Governments, Local Government Finances by Level of Government)

(Row 8 to Row 32 refer to the Procedural Guide, Step I-B, Per Person Estimates and Per Employee Estimates of Municipal /County Costs.)

Municipal/County Information. – *For each row enter the total annual expenditure (in dollars) for that category as found in the current jurisdiction budget. Also to be entered is the percentage of that expenditure which is related to transportation. Default transportation percentages are provided but local information should be obtained /calculated and entered if it is available. Expenses and revenues are those generated only by the single jurisdiction being considered. If multiple jurisdictions are involved, either overlaying or adjacent, separate model runs must be done for each jurisdiction. In the case of adjacent jurisdictions the pro forma must be allocated appropriately within the boundaries of each jurisdiction. Default information comes from a series of municipal budgets in New Jersey and Florida and county budgets in New Mexico and South Carolina. This information was discussed with local officials and averaged to obtain the defaults contained in the model.*

Main categories
Row 8 General Government
Row 9 Public Safety
Row 10 Public Works
Row 11 Economic Development
Row 12 Health/Human Services
Row 13 Recreation & Culture
Row 14 Debt Service
Row 15 Other #1 – *These "Other" entries are provided for budget categories not shown above. A percentage of expenditure related to transportation must be provided unless that percentage is zero.*
Row 16 Other #2
Row 17 Other #3
Row 18 Total (automatic)

Service Population
Row 21 Population in Jurisdiction (Current) – *This figure is copied from Sheet 1.*
Row 22 Households in Jurisdiction – *This figure is copied from Sheet 1.*
Row 23 Employment in Jurisdiction (Current) – *This figure is copied from Sheet 1.*

(Row 25 to Row 84 refer to the Procedural Guide, Step I-B, Total and Transportation - Related Operating Revenues Associated with New Development)

Jurisdiction Real Property Tax Rate (per dollar of value - related to assessed value). *Be sure to enter the tax rate carefully since the rate is usually expressed in a form other than rate per dollar of value. At this particular step a default value is provided but only to show the user what a rate per dollar value might look like.*
Row 26 Residential
Row 27 Nonresidential

(Row 29 to Row 34 refer to the Procedural Guide, Step I-B, Allocate Costs between Residential and Nonresidential Uses)

Real Property Tax Base (Assessed Value) – *These numbers are the total assessed value of current residential and nonresidential property. They are used, along with the parcel information below, to develop a residential share of costs, and its reciprocal, a nonresidential share of costs. If these values are not available a default will be used but a local value will better distribute costs.*
Row 30 Residential
Row 31 Nonresidential

Parcels – *These numbers are the total number of current residential and nonresidential parcels. See note above.*
Row 34 Residential
Row 35 Nonresidential

Row 37 Residential Share of Costs – *Default is based on Value & Parcels. It is the averaged percentage of the percentage of residential real property tax base over the total residential and nonresidential real property tax base and of the percentage residential parcels over nonres-idential and nonresidential parcels. Using value alone often attributes too large a share of expenses to nonresidential properties; using parcels alone often attributes too large a share of expenses to residential properties. A default is*

provided when local detail is not available. Nonresidential Share of Costs – 100 minus the Residential Share of Costs.

Real Property Equalization Ratio – *The equalization ratio of residential and nonresidential property should be entered here. This value is necessary to estimate the assessed value of the new construction. A value of 1 would be used if property is taxed at full market value.*

Row 40 Residential

Row 41 Nonresidential

Personal Property Tax (Boats, Automobiles, Structure, Furniture) – *These entries are necessary only in areas where personal property is taxed on an annual basis. This would include the contents of houses, cars, boats, etc. if they are taxed based on value. The tax rate and equalization information to be entered here should be entered in a similar way as the information requested above. Personal property as a percentage of residential market value is used to determine how to estimate the value of personal property associated with the new construction.*

Row 44 Residential Personal Property Tax Rate

Row 45 Residential Personal Property as % of total residential market value

Row 46 Equalization Ratio for Residential Personal Property

Row 47 Business Personal Property Tax Rate – *These business entries are necessary only in areas where the machinery, vehicles, etc. of businesses are taxed as business personal property. The personal property notes above also apply to business entries.*

Row 48 Business Personal Property as % of total nonresidential market value

Row 49 Equalization Ratio for Business Personal Property

Transportation Revenues

Row 52 Percentage of Property Tax Related to Transportation. *This will have to be determined by a careful analysis of budget revenue items. It often, however, is the same percentage as the percentage of costs related to transportation.*

Row 53 Percentage of Personal Property Tax Related to Transportation

Nonproperty Tax Revenues

(In this category include incoming Intergovernmental Aid) Entries here are total annual revenues from all nonproperty tax revenues. Nonproperty tax covers all recurring revenues which are not directly related to property valuation. The model needs these values to be broken down into revenues related to population, that is related to the number of persons or households in the jurisdiction and their payments, expenditures, etc. Revenues related to employees considers revenues from the persons working in the jurisdiction, such as traffic fines of employees, sales tax from employee purchases, etc. The percentage of revenue that will increase with new development refers to whether or not these revenues will change or will not be affected by development. For example, intergovernmental revenue may not increase, and may even decrease, due to new development, depending on the funding formula. The transportation-related shares of each budget item must be determined from careful research of the jurisdiction budget to determine the sources of transportation funds. See earlier discussion on the sources of transportation-related costs. Often the transportation-related revenue share is equated to the transportation-related cost share.

Row 57 Interest Earnings

Row 58 State Intergovernmental Revenues

Row 59 Licenses and Permits

Row 60 Fines and Forfeits

Row 61 Public Charges

Row 62 Federal Intergovernmental Revenues

Row 63 Other Miscellaneous Revenues

Row 64 Sales Tax

Row 65 Additional Entry #1 – *These additional entries can be used for revenues which do not fit the categories provided.*

Row 66 Additional Entry #2

Row 67 Additional Entry #3

Row 68 Additional Entry #4

Row 69 Additional Entry #5

Row 71 Interest Earnings

Row 72 State Intergovernmental Revenues

Row 73 Licenses and Permits
Row 74 Fines and Forfeits
Row 75 Public Charges
Row 76 Federal Intergovernmental Revenues
Row 77 Other Miscellaneous Revenues
Row 78 Sales Tax
Row 79 Additional Entry #1 – *These additional entries can be used for values which do not fit the categories provided.*
Row 80 Additional Entry #2
Row 81 Additional Entry #3
Row 82 Additional Entry #4
Row 83 Additional Entry #5

School District Information
(Row 87 to Row 100 refer to the Procedural Guide, Step I-B, Per Person Estimates and Per Employee Estimates of Municipal/County Costs {School District}.)

Main Categories – *The School District budget data is entered as annual values similar to the local jurisdiction data above.*
Row 91 Teaching
Row 92 Administration
Row 93 Transportation
Row 94 Debt Service
Row 95 Other #1
Row 96 Other #2
Row 97 Other #3
Row 98 Other #4
Row 99 Other #5
Row 100 Total (automatically provided)

Service Population
Row 103 Students Served by School District (Current) – *This figure is copied from Sheet 1.*

(Row 106 to Row 141 refer to the Procedural Guide, Step I-B, Total and Transportation-Related Operating Revenues Associated with New Development)

School District Property Tax Rate (per dollar of value - related to assessed value) *See the jurisdiction discussion above. This model assumes that the School District budget is separate from the local jurisdiction budget. This is equivalent to an Independent School District. Even in a Dependent School District (where budgets are not individual but are contained in the local jurisdiction's budget) the School Budget is a separate account.*
Row 107 Residential
Row 108 Nonresidential

Equalization Ratio – *See jurisdiction discussion above.*
Row 111 Residential
Row 112 Nonresidential

Personal Property Tax – *See discussion under local jurisdiction Personal Property Tax.*
Row 115 Personal Property (Related to Persons) Tax Rate
Row 116 Personal Property as % of Total Residential Value
Row 117 Equalization Ratio for Personal Property
Row 118 Nonresidential Tax Rate
Row 119 "Personal" Property as % of Total Nonresidential Value
Row 120 Equalization Ratio for Nonresidential Property

Transportation Revenues
Row 123 Percentage of Property Tax Related to Transportation
Row 124 Percentage of Personal Property Tax Related to Transportation

Nonproperty Tax Revenues
Category (Include Incoming Intergovernmental Aid)
Row 128 Tuition
Row 129 Miscellaneous Revenues
Row 130 State Aid
Row 131 Federal Aid
Row 132 Additional Entry #1
Row 133 Additional Entry #2
Row 134 Additional Entry #3
Row 135 Additional Entry #4
Row 136 Additional Entry #5
Row 137 Additional Entry #6
Row 138 Additional Entry #7
Row 139 Additional Entry #8
Row 140 Additional Entry #9
Row 141 Total (automatic calculation)

STEP 6 - ENTER INFORMATION ON DEVELOPMENT FINANCIALS AND MULTIPLIERS

SHEET 6-Enter Finc. – Mult Info
This sheet gathers additional information necessary for the calculation of indirect and induced. costs and revenues. The main part of this sheet involves information related to calculating the Direct Capital Costs and Revenues. of the project, including an Advanced Calculation Method which requires additional data in order to provide more accurate estimates.

STEP 6 - ENTER INFORMATION ON DEVELOPMENT FINANCIALS AND MULTIPLIERS

0	Gray shading indicated default overridden		
Factors Used in Indirect Development Operating Costs/Revenues	Entries below will override defaults	Value Used in Calculations	Suggested Default
Percentage of Employees Who Will Live Locally in New Housing (U.S. Census)		10%	10%
Average Income of New Residential Households (Municipality/County)		$80,000	$80,000
(Suggested Default is 1/3 of average housing unit price)	Development Description must be completed for income default to be available		
Average Income of New Employee Households (Municipality/County) [Automatically Inflated]		$51,500	$51,500
Household Size for Employee Resident Households		2.570	2.570
Students in Employee Resident Households		0.375	0.375
Share of Total Income that Is considered Consumption Income		50%	50%
Percentage of Consumption Income to Convenience Goods		55%	55%
Percentage of Convenience Goods Purchased Locally		70%	70%
Dollars of Expenditure to Support 1 square foot of Convenience Retail Space (Automaticlaly Inflated)		$232	$232
Employees per 1,000 Sq. Ft. Convenience Space		2.500	2.500
Percentage of Consumption Income to Shopping Goods - Reciprocal of Convenience Goods- Automatically Calculated		45%	45%
Percentage of Shopping Goods Purchased Locally		30%	30%
Dollars of Expenditure to Support 1 Square Foot of Shopping Goods Retail Space		$232	$232
Employees per 1,000 Sq. Ft. Retail Space		2.500	2.500
Factors Relating to All Stages of the Model			
Automatic Inflation Factor (3% a year from 2010) Override			
(Program automatically applies this inflation factor which is 0 in 2010 and is cumulative to the future)		3.00%	3.00%
Inflation is applied to the Capital Cost Defaults, Income of New Employee Households			
and Expenditure to Support 1 square foot of Retail or Convenience Space			
VMT Adjustment for Mixed-Use and Other Factors for Direct Development			
- Enter 1 in Cell C28 to utilize this adjustment. If this option is used see			
Step 4-Nonres. Demo. Multipliers Cell D43 to view the assumptions used.			
If Step 1- Current Employment Data, rows 43-51 is unavailable enter current average			
Employees per 1,000 square feet of nonresidential space or leave blank to accept		2.25	2.25
Factors Used in Induced Development Operating Costs/Revenues			
Elasticity of VMT with Respect to Capacity. (See Users Guide)		0.500	0.500
Percentage of Induced Development Inside Jurisdiction		50.0%	50.0%
Enter 1 to Suppress the Display of Indirect and Induced Calculations		Normal Display	

		Enter zeros if there is no Direct Capital Cost			
These values will override the Default Direct Capital Cost Calculations They also will override the More Intricate Direct Capital Cost Calculations Changes would not be made here if the More Intricate Calculations Are Used		Capital Cost per Unit per Unit Override (Optional)	Capital Cost Used	Default Capital Cost per Unit (with VMT Adj Step 4)	Default Capital Cost for Single Family Detached, Garden Apartme Town House will show up after the square unit is entered on Step 2-Development De
3. Development Composition					
Single-family det.	2 bedroom		$0	$0	Also see Directions
	3 bedroom		$0	$0	
	4 bedroom		$0	$0	
	5 bedroom		$0	$0	
Garden Apt.	1 bedroom		$0	$0	
	2 bedroom		$0	$0	
	3 bedroom		$0	$0	
Town House	2 bedroom		$2,070	$2,070	
	3 bedroom		$2,562	$2,562	
	4 bedroom		$0	$0	
High-rise	Studio*		$0	$1,107	
	1 bedroom*		$0	$1,107	
	2 bedroom*		$0	$1,107	
Mobile Home	1 bedroom*		$0	$820	
	2 bedroom		$0	$820	
	3 bedroom		$0	$820	
Other	Type 1*		$0		
	Type 2*		$0		
	Type 3*		$0		
Age-Restricted	1 bedroom*		$0	$1,107	
	2 bedroom*		$0	$1,107	
Single Family Detached (average) [Used in special calculation]			$2,562	$2,562	
Single Family Attached (average) [Used in special calculation]			$2,081	$2,081	

B. Nonresidential Space by Type	Capital Cost per 1,000 sq.ft. Override (Optional)	Capital Cost Used	Default Capital Cost per 1,000 sq.ft.
Office			
General		$3,198	$3,198
Office Park		$3,198	$3,198
Medical		$3,198	$3,198
Retail			
Convenience		$3,997	$3,997
Supermarket		$3,997	$3,997
Shopping		$3,997	$3,997
Restaurant		$3,997	$3,997
Industrial			
General Light		$1,045	$1,045
Industrial Park		$1,045	$1,045
Manufacturing		$1,045	$1,045
Warehousing		$1,045	$1,045
Hotel		$769	$769

END OF STEP - UNLESS MORE INTRICATE CAPITAL COST CALCULATION IS TO BE USED

More Intricate Capital Cost Calculation - Used to Calculate a Locally Based Capital Cost

Type Y Here if You Are Using this Optional Procedure>>>>>>>>

ROAD COST Inflation Adjustments				
Base year (year of Road Cost Estimate)			2010	2010
Analysis year (user must input year of analysis for Road Cost estimate)		2010		
Average annual composite inflation assumption			2.50%	2.50%
Inflation adjustment factor (calculated- based on cell C94)		100.00%	Used only for road costs - see also row 25 above	
Cost per Lane Mile of New Road Construction (one lane, one direction) in the Impacted Area of the Jurisdiction ("service areas")			$1,000,000	$1,000,000
(See table in rows 244+ for values for selected states) -- Be sure to adjust for inflation as appropriate.				

	Override Defaults	Value to Be Used	Suggested Default
Enter Average Trip Length (Miles) for Study Region (U.S. average is 10.14 mi)		10.14	10.14
OR (enter information in either B102 or B104, not both)			
Enter Localized Trip Length Ratio (See Row 154+) for MSA or MSA Group		1.00	1.00
OR			
Enter Localized Trip Lengths (miles) by Trip Purpose			
Trip Purpose			
To/From Work		12.66	12.66
Work Related Business		17.95	17.95
Shopping		6.73	6.73
Personal Business		7.07	7.07
School/Church		8.80	8.80
Social & Recreational		8.85	8.85
All Trips		10.14	10.14
Travel on Local Roads - Percentage of All Travel		15.0%	15.0%
Enter Average Daily Capacity Per Lane Mile for Planned Construction		7,775	7,775

Florida DOT Level of Service Suggests 7,300 for 2-Lane Roads and 7,775 for 4-Lane Roads up to 8,250 for Expansion of Existing 4-Lane Roads

Percentage of Road Costs Financed from Nonlocal Sources			25.00%	25.00%
Percentage of Road Costs Financed from Local Sources not part of Capital Cost			25.00%	25.00%
Local Road Construction Cost per Lane Mile (calculated)		$500,000		
Average Daily Miles Traveled Capacity (copied from above)		7,775		
Local Road Construction Cost per Lane Mile Trip (calculated)		$64.31		
	Locally Derived Numbers should Be Used			
Estimated Daily VMT for Analysis Year	Override	Figure Used	Default	
Residential		347,045	347,045	
Nonresidential		263,248	263,248	
Total (calculated)		610,294	610,294	
Current Annual Road Debt Payments (from 5-Enter Budget Info.)	$1,000,000			
Share of Current Road Debt for Capacity Expansion		100.00%	100.00%	
Amount of Annual Road Debt Payments for Capacity Expansion (calculated)	$1,000,000			
Annual Road Debt Payment per Daily VMT (calculated)	$1.64			
Years of Debt Service Payments		20	20	
Discount Rate for Present Value Calculation		4.00%	4.00%	
Present Value Debt Service Payments for Capacity Expansion (calculated)	$22.27			
Net Capital Cost Per VMT (calculated)	$42.04			
Transportation Capacity Conditions	Locally Derived Numbers Should Be Used		90% volume to capacity Ratio	
Road Network Capacity (based on local level of service applied to the local road network)-(VMC)	700,000	700,000	678,104	
Estimated Daily VMT for analysis year (copied from above)	610,294			
Excess (deficient) capacity (calculated)	89,706			
	Override below if Desired	Figure Used	Calculated Figure	
Volume-to-Capacity Ratio Policy		0.872	0.872	
Net Capital Cost Per VMT for Implementation (calculated)	$36.65			

(Row 4 through Row 22 relate to the Procedural Guide, Step II, Indirect Transportation Capital and Operating Costs.)

Factors Used in Indirect Development Operating Costs/Revenues

Row 7 Percentage of Employees Who Will Live Locally in New Housing (U.S. Census) – *This value is derived from Public Use Microdata Files (PUMS). It is those who have come to work in the county over the last decade by where they live and whether it is in newly constructed housing.*

Row 8 Average Income of New Residential Households (Municipality /County)

(Suggested Default is 1/3 of average housing unit price) – *This method of determining a default has been suggested by real estate practitioners. In runs with no residential units a default of $80,000 is used for the indirect cost calculations.*

Source: Credit Guidelines for Housing Purchases.

Row 11 Average Income of New Employee Households (Municipality /County)

Row 12 Household Size for Employee Resident Households from Household Size Multipliers – *from 3-Resid. Demo. Multipliers, 2 bedroom Garden Apartment.*

Row 13 Students in Employee Resident Households – *from 3-Resid. Demo. Multipliers, 2 bedroom Garden Apartment.*

Row 14 Share of Total Income that is considered Consumption Income. *This value was derived from "Economic Inequality through the Prisms of Income and Consumption, Monthly Labor Review, April 2005 (11-24)*

Row 15 Percentage of Consumption Income to Convenience Goods *(Default derived from Bureau of Economic analysis, Table 2.4.6 Real Personal Consumption Expenditures by Type of Produce, Chained Dollary (2008,2009).*

Row 16 Percentage of Convenience Goods Purchased Locally *(See BEA reference above).*

Row 17 Dollars of Expenditure to Support 1 square foot of Convenience Retail Space – (*Urban Land Institute Dollars and Cents of Shopping Centers).*

Row 18 Employees per 1,000 Sq. Ft. Convenience Space – (*Employees per 1,000 square feet on 4-Nonres. Demo. Multipliers).*

Row 19 Percentage of Consumption Income to Shopping Goods - Reciprocal of Convenience Goods- Automatically Calculated

Row 20 Percentage of Shopping Goods Purchased Locally. *(Default derived from Bureau of Economic analysis, Table 2.4.6 Real Personal Consumption Expenditures by Type of Produce, Chained Dollary (2008,2009).*

Row 21 Dollars of Expenditure to Support 1 Square Foot of Shopping Goods Retail Space – (*Urban Land Institute Dollars and Cents of Shopping Centers)*.

Row 22 Employees per 1,000 Sq. Ft. Retail Space – (*Employees per 1,000 square feet on 4-Nonres. Demo. Multipliers).*

Factors Relating to All Stages of the Model

Automatic Inflation Factor (3% a year from 2010) Override

Row 26 (Program automatically applies this inflation factor which is 0 in 2010 and is cumulative to the future) – *The 3% inflation factor is based on long term cost of living trends (1985-2007-Federal Reserve Bank of Minneapolis, Inflation Calculator).*

Inflation is applied to the Capital Cost Defaults, Income of New Employee Households,

And Expenditure to Support 1 square foot of Retail or Convenience Space

Inflation is also applied to the Preview Method Defaults when they are used. *It is assumed that the detailed jurisdiction cost and revenue figures entered on Sheet 5-enter Budget Info. are the most up-to-date figures available and therefore will not need inflation adjustment.*

Row 28 VMT Adjustment for Mixed-Use and Other Factors for Direct Development

- Enter 1 in Cell C28 to utilize this adjustment. If this option is used see

Step 4-Nonres. Demo. Multipliers Cell D43 to view the assumptions used*. This cell allows the user to*

decide whether or not to utilize the Mixed Use Adjustment in their Model run. The program automatically calculates the Job /housing balance and household size components used in this adjustment. Since the other components require additional data the use of this adjustment has been made optional

(Row 28 refers to the Procedural Guide, Step I-A, Modeling VMT Reductions for Mixed-Use Developments.)

Row 29 If Step 1- Current Employment Data, rows 43-51, is unavailable enter current average

Employees per 1,000 square feet of nonresidential space or leave blank to accept default.

(Row 31 through Row 33 relate to the Procedural Guide, Step III, Induced Transportation Capital. and Operating Costs.)

Factors Used in Induced Development Operating Costs/Revenues – *This measure is automatically calculated by dividing the added persons and employees from both direct and indirect development total by the base population of the local jurisdiction (Municipality/County) plus the total employment of the local jurisdiction (Municipality/County) and then adjusting the result by the Elasticity of VMT with Respect to Capacity and by the Percentage of Induced Development Inside Jurisdiction to give a multiplier which is applied to the base population and employment to generate Induced Persons and Induced Employees* .

Row 31 Elasticity of VMT with Respect to Capacity

Row 32 Percentage of Induced Development Inside Jurisdiction

Row 35 Enter 1 (one) to Suppress the Display of Indirect and Induced Calculations – *This option hides the Indirect and Induced results. 1 would be selected if the user did not wish to generate these results.*

These values will override the Default Direct Capital Cost Calculations.

They also will override the Advanced Direct Capital Cost Calculations.

Normally changes would not be made here if the Advanced Calculations Are Used.

3. Development Composition

Row 41 Single-family det. 2 bedroom – *These cells allow the user to override the default Direct Capital Cost calculations. The defaults are based on practitioner experience and vary depending upon unit type and size of jurisdiction. These cells should only be used when the "Special Direct Capital Cost*

Calculations" (below) are not used unless the results of the special calculations seem inappropriate for a unit type.

Row 42		3 bedroom
Row 43		4 bedroom
Row 44		5 bedroom
Row 45	Garden Apt.	1 bedroom
Row 46		2 bedroom
Row 47		3 bedroom
Row 48	Town House	2 bedroom
Row 49		3 bedroom
Row 50		4 bedroom
Row 51	High-rise	Studio
Row 52		1 bedroom
Row 53		2 bedroom
Row 54	Mobile Home	1 bedroom
Row 55		2 bedroom
Row 56		3 bedroom
Row 57	Other	Type 1
Row 58		Type 2
Row 59		Type 3
Row 60	Age-Restricted	1 bedroom
Row 61		2 bedroom

Row 62 Single Family Detached (average) [Used in special calculation].

Row 63 Single Family Attached (average) [Used in special calculation]

B. Nonresidential Space by Type

Office

Row 69 General
Row 70 Office Park
Row 71 Medical

Retail

Row 73 Convenience
Row 74 Supermarket
Row 75 Shopping
Row 76 Restaurant

Industrial

Row 78 General Light
Row 79 Industrial Park
Row 80 Manufacturing
Row 81 Warehousing

Row 83 Hotel

END OF S TEP - UNL ESS MORE INTRICATE CAPITAL COST CALCULATION IS TO BE USED

(Row 83 to Row 150 refer to the Procedural Guide, Step I-A, A More Intricate Method for Calculating Capital Costs.)

More Intricate Capital Cost Calculation – Used to Calculate a Locally Based Capital Cost

Row 89 Type Y Here if You Are Using this Optional Procedure>>>>>>>> *The presence of a "Y" in this cell is checked in several formulas to determine how calculations are to be carried out.*

ROAD COST Inflation Adjustments – *This inflation adjustment is independent of the adjustment above because road costs are affected by factors other than general inflation. Labor, materials as well as demand/supply factors affect total costs. The below procedure takes these into account.*

Row 92 Base year (Year of Road Cost Estimate) – *This is the year of the latest available "Cost per Lane Mile of New Road Construction" (as entered below).*

Row 93 Analysis year (user must input year of analysis) – *This is the expected year of actual construction. This cell must be filled in with a four digit year or other parts of the analysis will not work.*

Row 94 Average annual composite inflation assumption – *This is the inflation assumption to apply.*

Row 95 Inflation adjustment factor – *Computed inflation percentage (output) – annual inflation raised to the power of analysis year minus base year. This value cannot be overridden directly but will reflect changes made in the average annual composite inflation assumption above.*

Row 97 Cost per Lane Mile of New Road Construction (one lane, one direction) in the Impacted Area of the Jurisdiction ("service areas").

(See table in rows 244+ for values for selected states) – Be sure to adjust for inflation as appropriate. *Enter the year of the estimate under Base year above. Also enter the analysis year and inflation assumption for the most accurate future estimate of road cost.*

Row 102 Enter Average Trip Length (Miles) for Study Region (U.S. average is 10.11 mi.)
OR
Row 104 Enter Localized Trip Length Ratio (See Row 154+) for MSA or MSA Group
OR
Enter Localized Trip Lengths (miles) by Trip Purpose
Trip Purpose
Row 108 To/From Work
Row 109 Work Related Business
Row 110 Shopping
Row 111 Personal Business
Row 112 School/Church
Row 113 Social & Recreational
Row 114 All Trips

Row 116 Travel on Local Roads – Percentage of All Travel
Row 117 Enter Average Daily Capacity Per Lane Mile for Planned Construction
Florida DOT Level of Service Suggests 7,300 for 2-Lane Roads and 7,775 for 4-Lane Roads up to 8,250 for Expansion of Existing 4-Lane Roads

Row 125 Percentage of Road Costs Financed from Nonlocal Sources.
Row 126 Percentage of Road Costs Financed from Local Sources not part of Capital Cost.
% of Road Costs Financed from Nonlocal Sources
% of Road Costs Financed from Local Sources (not part of Capital Cost)
See: James Nicholas, PhD and Arthur C. Nelson, PhD, 30 years experience in calculating impact fees

Row 127 Local Road Construction Cost per Lane Mile – *This is calculated by the program. It is Cost per Lane Mile of New Construction times the calculation of 1 minus Percentage of Road Costs Financed from Nonlocal Sources minus Percentage of Road Costs Financed from Local Sources not Part of Capital Cost. This gives the cost per new lane mile adjusted for nonlocal source funds and for non-capital funds.*
Local Road Construction Cost
See: Per Lane Mile (Suburban) in Burchell, Robert W., Sustainability As Partner to Economic Regeneration: The Impact Assessment of the New Jersey State Plan, March 2010
Row 128 Average Daily Miles Traveled Capacity – *Copied from Average Daily Capacity Per Lane Mile above.*
Row 129 Local Road Construction Cost per Lane Mile Trip – *This is calculated by the program and is Local Road Construction Cost per Lane Mile divided by Average Daily Miles Traveled Capacity.*

Estimated Daily VMT for Analysis Year
Row 132 Residential
Row 133 Nonresidential
Row 134 Total (Calculated)

Row 136 Current Annual Road Debt Payments (from 5-Enter Budget Info.).
Row 137 Share of Current Road Debt for Capacity Expansion.
Row 138 Amount of Annual Road Debt Payments for Capacity Expansion – *This is calculated from Current Annual Road Debt Payments times Share of Current Road Debt for Capacity Expansion.*
Row 139 Annual Road Debt Payment per Daily VMT.
Row 140 Years of Debt Service Payments.
Row 141 Discount Rate for Present Value Calculation.
Row 142 Present Value Debt Service Payments for Capacity Expansion.

Row 143 Net Capital Cost Per VMT – *This is automatically calculated from Local Road Construction Cost per Lane Mile Trip minus Present Value Debt Service Payments for Capacity Expansion. This is the transportation cost per VMT to serve the needs of new development.*
Transportation Capacity Conditions – Locally Derived Numbers Should Be Used.
Row 145 Road Network Capacity (based on local level of service applied to local road network) – *The analyst inputs the estimate of the roadway system capacity. This information is usually readily at hand or can be estimated from local knowledge based on type of roads and the level of service standard assigned to them.*

Row 146 Estimated Daily VMT for analysis year (from above) – *Copied from cell C134 above.*
Row 147 Excess (deficient) capacity – *Calculated from Road Network Capacity minus Estimated Daily VMT for analysis year. This is the difference* between *capacity and demand. A negative number means there is more demand than capacity; a positive one means excess capacity remains in the system.*

Row 149 Volume-to-Capacity Ratio Policy – *This ratio adjusts the Net Capital Cost Per VMT to account for policy or other factors used to apportion such costs, or default to the current V/C ratio. The default value here is the internally calculated ratio of volume to capacity; a number less than 1.0 means there is excess capacity in the system while a number more than 1.0 means the system is operating at more volume than capacity based on the local level of service. The analyst can decide to override the V/C ratio based on local policy or other factors. V/C ratio is the ratio used to adjust transportation cost of new development per VMT in Step 6.*

Row 150 Net Capital Cost Per VMT for Implementation – *Calculated from Net Cost per VMT times Volume-to-Capacity Ratio Policy. This is the net capital cost per VMT to be assigned to new development for planning, financing, and other policy purposes.*

STEP 7 - V IEW OUTPUT F OR DIRECT., INDIRECT., AND I NDUCED. COSTS /REVENUES

SHEET 7-View Model Output
This sheet presents a detailed series of tabulations of the outputs of the various stages of the Model.

STEP 7 - VIEW OUTPUT FOR DIRECT, INDIRECT, AND INDUCED COSTS/REVENUES				
TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL			Page 1	
In-Town Square				
April 8, 2011				
12:20 PM				
OUTPUT 1 - DIRECT CAPITAL COSTS/REVENUES				
Residential/Nonresidential Unit Generation				
Residential Units	2,000			
Nonresidential Space (000 sq. ft.)	750			
Average Cost/Revenue per Residential Unit	2,267.288			
Average Cost/Rev. per 1,000 sq.ft. Nonresidential Space	3,197.983			
Transportation Capital Costs related to	Residential	Nonresidential	Total	
Direct Development	$4,534,575	$2,398,487	$6,933,062	
Transportation Capital Revenues related to				
Direct Development	$4,534,575	$2,398,487	$6,933,062	
OUTPUT 2 - DIRECT OPERATING COSTS/REVENUES				
Population Added	4,956			
Students Added Grades K-12	700			
Employees Added	2,625			
Residential Market Valuation	$480,000,000			
Nonresidential Market Valuation	$150,000,000			
Total Market Valuation	$630,000,000			
	Total	Transportation Share		
Per Person Costs	$684.19	$99.47		
Per Employee Costs	$284.10	$41.30		
Per Student Costs	$15,000.00	$3,360.00		
Municipal/County Costs (person & Employee)	$4,136,610	$601,381		
School Costs	$10,500,000	$2,352,000		
Total	$14,636,610	$2,953,381		
Municipal/County Property Tax Revenues (res & nonres)	$2,520,000	$125,997		
School Property Tax Revenues	$5,040,000	$1,008,000		
	Municipal/ County	School	Municipal/County Transportation	School Transp.
Nonproperty Tax Revenue (Total)(no intergov)	$1,026,508	$148,936	$215,545	$11,170
Intergovernmental Revenue (Total)	$458,653	$2,457,447	$273,798	$245,745
	Municipal/ County Total	School Total	Municipal/County Transportation	School Transportation
Personal Property Tax (Residential Property)	$0	$0	$0	$0
Personal Property Tax (Business)	$0	$0	$0	$0
Personal Property Tax (Total)	$0	$0	$0	$0
	Municipal/ County/ School	Transportation Share		
Total Income Generated by Growth (Municipal/County)	$4,005,161	$615,340		
Total Income Generated by Growth (School)	$7,646,383	$1,264,915		
Per Person Revenues (All Sources)	$633.05	$103.48		
Per Employee Revenues (All Sources)	$330.57	$39.04		
Per Student Revenues (All Sources)	$10,923.40	$1,807.02		
Municipal/County Surplus/Deficit	-$131,449	$13,959		

TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL			Page 2	
In-Town Square				
April 8, 2011				
12:20 PM				
OUTPUT 3 - INDIRECT CAPITAL COSTS/REVENUES				
Population Generation				
Employee Resident Households in New Housing	263			
New Employees that will be Supported by	Convenience	Retail	Total	
Development Residential Households	370	130	500	
Additional square feet (,000) of Conv. and Retail Space	148	52	200	
Capital Cost per Residential Unit	$1,865	(2 bedroom garden apartment, 1,000 sq. ft.)		
Capital Cost per 1,000 square feet Retail Space	$3,997			
Cost Factors				
Transportation Capital Costs Related to	Residential	Nonresidential	Total	
Indirect Development	$489,691	$799,718	$1,289,409	
Revenue Factors				
Transportation Capital Revenues Related to				
Indirect Development	$489,691	$799,718	$1,289,409	
OUTPUT 4 - INDIRECT OPERATING COSTS/REVENUES				
Population Generation				
Employee Resident Households in New Housing	263			
New Employees Supported by Development	Convenience	Retail	Total	
Residential Units	370	130	500	
Persons in Employee Resident Households	675			
Students in Employee Resident Households	98			
	All Costs/ Revenues	Transportation Costs/Revenues		
Cost per Resident	$684	$99		
Cost per Employee	$284	$41		
Cost per Student	$15,000	$3,360		
Revenue per Resident	$633	$103		
Revenue per Employee	$331	$39		
Revenue per Student	$10,923	$1,807		
Cost Factors	Municipal/ County	School	Total	
Total Operating Costs Related				
to Indirect Development	$603,661	$1,476,563	$2,080,224	
Total Transportation Operating Costs Related				
to Indirect Development	$87,760	$330,750	$418,510	
Revenue Factors				
Total Operating Revenue Related				
to Indirect Development	$592,405	$1,075,273	$1,667,678	
Total Transportation Revenue Related				
to Indirect Development	$89,337	$177,879	$267,215	
Net Fiscal Impacts/Effects				
Total	-$11,256	-$401,290	-$412,546	
Transportation	$1,576	-$152,871	-$151,295	

TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL			Page 3	
In-Town Square				
April 8, 2011				
12:20 PM				
OUTPUT 5 - INDUCED CAPITAL COSTS/REVENUES				
Induced Residential Units	614			
Induced Employment	653			
Additional square feet of Nonresidential Space	305,452			
Capital Cost per Residential Unit	$1,918			
Capital Cost per 1,000 square feet Nonresidential Space	$2,525			
	Residential	Nonresidential	Total	
Induced Capital Costs	$1,177,266	$771,333	$1,948,599	
Induced Capital Revenues	$1,177,266	$771,333	$1,948,599	
OUTPUT 6 - INDUCED OPERATING COSTS/REVENUES				
Population/Employment Generation				
Persons Induced by Development	1,536			
Employees Induced by Development	653			
Students Induced by Development	614		Transportation-Related	
Per Person, Student, or Employee Cost/Revenue	Costs	Revenues	Costs	Revenues
Per Person Cost/Revenue	$684	$633	$99	$103
Per Employee Cost/Revenue	$284	$331	$41	$39
Per Student Cost/Revenue	$15,000	$10,923	$3,360	$1,807
Cost Factors	Total		Transportation-Related	
Person-Related Costs	$1,050,992		$152,793	
Employee-Related Costs	$185,469		$26,964	
Student-Related Costs	$9,204,911		$2,061,900	
Revenue Factors				
Person-Related Revenues	$972,439		$158,964	
Employee-Related Revenues	$215,807		$25,484	
Student-Related Revenues	$6,703,265		$1,108,898	
Fiscal Impact				
Municipal/County Residential	-$78,553		$6,171	
Municipal/County Nonresidential	$30,338		-$1,480	
School District	-$2,501,647		-$953,002	
Total	-$2,549,861		-$948,311	

TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL			Page 4	
In-Town Square				
April 9, 2011				
4:02 PM				
OUTPUT 7 - TOTAL IMPACTS				
		Municipality/County		
	Total Operating Impacts	Transportation Operating Impacts	Transportation Capital Impacts	
Costs	$0	$868,898	$10,171,070	
Revenues	$0	$889,125	$10,171,070	
Total	$0	$20,227	$0	
		School District		
	Total Operating Impacts	Transportation Operating Impacts	Transportation Capital Impacts	
Costs	$0	$4,744,650	$0	
Revenues	$0	$2,551,692	$0	
Total	$0	-$2,192,959	$0	
OUTPUT 8 - OVERALL CONTROL CHECKS				
Calculating Controls for Total Capital Costs				
and				
Total Operating Costs/Revenues of Development on Transportation				
CAPITAL COSTS/REVENUES				
· Direct Capital Costs	$6,933,062	Direct Costs		
· I-O Multiplier before adjustment	2.0460	(See Note A below)		
· Share of new Employees living in jurisdiction	10.00%			
· Adjusted local I-O multiplier	1.10460	(See Note A below)		
· Multiply by I-O Multiplier (Control Costs)	$7,658,264	Control		
· Total Capital Costs	$10,171,070	Actual Costs		
Difference from the Calculation of all Capital Costs	$2,512,806	Cost Difference		
	Control less	Control Vs. Summed Calculation (Cost)		
	Control less	Control Vs. Summed Calculation (Revenues)		
OPERATING COSTS/REVENUES				
· Direct Operating Costs and Revenues	$2,953,381	Direct Costs		
	$1,880,255	Direct Revenues		
· Adjusted local I-O multiplier	1.10460	(See Note A below)		
· Resulting Total Operating Costs and Revenues	$3,262,306	Control Costs		
	$2,076,931	Control Revenues		
· Calculate Total Operating Costs and Revenues	$5,613,548	Actual Costs		
	$3,440,817	Actual Revenues		
Difference from the calculation of all operating costs	$2,351,242	Cost Difference		
	$1,363,886	Revenue Difference		
	Control less	Control Vs. Summed Calculation (Cost)		
	Control less	Control Vs. Summed Calculation (Revenues)		
Note A - If desired, these values can be overridden at the end of Step 4 - Nonresidential Multipliers.				
END OF STEP				

TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL

OUTPUT 1 - DIREC T CAPIT AL COSTS /REVENUES.

(Row 8 to Row 17 refer to the Procedural Guide, Step 1-A, Direct Transportation Capital Costs, Exhibit I-A.15.)

Residential/Nonresidential Unit Generation

Row 10 Residential Units – *Units added by development as described in pro forma.*

Row 11 Nonresidential Space – *Thousands of square feet added by development as described in pro forma.*

Row 12 Average Cost/Revenue per Residential Unit – *The transportation-related capital cost to the jurisdiction (Municipality /County) for each unit based on current residentially related travel patterns in the jurisdiction (Municipality /County).*

Row 13 Average Cost/Rev. per 1,000 sq.ft. Nonresidential Space – *The transportation-related capital cost to the jurisdiction (Municipality/County) for each 1,000 sq.ft. of nonresidential space based on current employee-related travel patterns in the jurisdiction (Municipality/County).*

Transportation Capital Costs related to Direct Development:

Row 15 Residential – *The above per-unit costs multiplied by the number of units added by the development.*

Row 15 Nonresidential – *The above per 1,000 ft^2 costs multiplied by the number of thousands of square feet added by the development.*

Transportation Capital Revenues related to Direct Development:

Row 17 Residential – *The above per unit revenues multiplied by the number of units added by the development.*

Row 17 Nonresidential – *The above per 1,000 ft^2 revenues multiplied by the number of thousands of square feet added by the development.*

OUTPUT 2 - DIR ECT OPERATING COSTS/REVENUES

(Row 19 to Row 60 refer to the Procedural Guide, Step 1-B, Direct Transportation Operating Costs, Exhibit I-B.12.)

Row 20 Population Added – *The number of persons added to the jurisdiction (Municipality/County) by the development.*

Row 21 Student Added Grades K-12 – *The number of students added to the jurisdiction (Municipality/County) by the development.*

Row 22 Employees Added – *The number of employees added to the jurisdiction (Municipality/County) by the development.*

Row 23 Residential Market Valuation – *The market value of the residential units added by the development.*

Row 24 Nonresidential Market Valuation – *The amount of the market value of the nonresidential space added by the development.*

Row 25 Total Market Valuation – *The market value of the residential units and nonresidential space added by the development.*

Row 28 Per Person Costs – *The operating cost to the jurisdiction (Municipality /County) for each person based on current residentially related expenditures in the jurisdiction (Municipality/County).*

Row 28 Transportation Share of Per Person Costs – *The operating cost to the jurisdiction (Municipality/County) for each person based on current residentially related transportation expenditures in the jurisdiction (Municipality /County).*

Row 29 Per Employee Costs – *The operating cost to the jurisdiction (Municipality/County) for each employee based on current nonresidentially related expenditures in the jurisdiction (Municipality/County).*

Row 29 Transportation Share of Per Employee Costs – *The operating cost to the jurisdiction (Municipality/County) for each employee based on current nonresidentially related transportation expenditures in the jurisdiction (Municipality/County).*

Row 30 Per Student Costs – *The operating cost to the School District for each student based on*

current school-related expenditures in the jurisdiction (School District).
Row 30 Transportation Share of Per Student Costs – *The operating cost to the School District for each student based on current school-related transportation expenditures in the jurisdiction (School District).*

Row 31 Municipal/County Costs (person & employee) – *The total operating cost to the jurisdiction (Municipality/County) for the persons and employees added by the development based on the above costs.*
Row 31 Transportation Share of Municipal/County Costs – *The transportation-related operating cost to the jurisdiction (Municipality/County) for the persons and employees added by the development based on the above costs.*
Row 32 School Costs – *The total operating cost to the School District for the students added by the development based on the above costs.*
Row 32 Transportation Share of School Costs – *The transportation-related operating cost to the School District for the students added by the development based on the above costs.*

Row 33 Total – *The total operating cost to the local jurisdiction (Municipality /County) and School District for the persons, employees, and students added by the development based on the above costs.*
Row 33 Transportation Share of Total Costs – *The transportation-related operating cost to the local jurisdiction (Municipality /County) and School District for the persons, employees, and students added by the development based on the above costs*.

Row 34 Municipal/County Property Tax Revenues (res & nonres) – *The amount of revenue from property tax (land and structures) generated by the new development for the local jurisdiction.*
Row 34 Municipal/County Property Tax Revenues (res & nonres) – Transportation Share – *The amount of revenue from property tax (land and structures) generated by the new development for the local jurisdiction to fund transportation expenses. Share is analogous to transportation cost share.*

Row 35 School Property Tax Revenues – *The amount of revenue from property tax (land and structures) generated by the new development for the School District.*
Row 35 School Property Tax Revenues (res & nonres) – Transportation Share – *The amount of revenue from property tax (land and structures) generated by the new development for the School District to fund transportation expenses. Share is analogous to transportation cost share.*

Row 38 Nonproperty Tax Revenue (Total) (no intergov) – Municipality /County – *The amount of revenue from sources other than intergovernmental revenues and property tax (land and structures) generated by the new development for the jurisdiction.*
Row 38 Nonproperty Tax Revenue (Total)(no intergov) – School District – *The amount of revenue from sources other than intergovernmental revenues and property tax (land and structures) generated by the new development for the School District.*
Row 38 Nonproperty Tax Revenue (Total)(no intergov) – Municipality /County Transportation – *The amount of revenue from sources other than intergovernmental revenues and property tax (land and structures) generated by the new development for the jurisdiction to fund transportation expenses.*
Row 38 Nonproperty Tax Revenue (Total)(no intergov) – School District Transportation – *The amount of revenue from sources other than intergovernmental revenues and property tax (land and structures) generated by the new development for the School District to fund transportation expenses.*

Row 39 Intergovernmental Revenue (Total) – Municipality/County – *The amount of intergovernmental revenues generated by the new development for the jurisdiction.*
Row 39 Intergovernmental Revenue (Total) – School District – *The amount of intergovernmental revenues generated by the new development for the School District.*

Row 39 Intergovernmental Revenue (Total) – Municipality/County Transportation – *The amount of intergovernmental revenues*

generated by the new development for the jurisdiction to fund transportation expenses.
Row 39 Intergovernmental Revenue (Total) – School District Transportation – *The amount of intergovernmental revenues generated by the new development for the School District to fund transportation expenses.*

Row 43 Personal Property Tax (Residential Property) Municipal/County Total – *The amount of revenue from taxes levied on personal property generated by the new development for the jurisdiction.*
Row 43 Personal Property Tax (Residential Property) School District Total – *The amount of revenue from taxes levied on personal property generated by the new development for the School District.*
Row 43 Personal Property Tax (Residential Property) Municipal/County Transportation – *The amount of revenue from taxes levied on personal property generated by the new development for the local jurisdiction to fund transportation expenses.*
Row 43 Personal Property Tax (Residential Property) School District Transportation – *The amount of revenue from taxes levied on personal property generated by the new development for the School District to fund transportation expenses.*

Row 44 Personal Property Tax (Business) Municipal/County Total – *The amount of revenue from taxes levied on business personal property (equipment, etc.) generated by the new development for the jurisdiction.*
Row 44 Personal Property Tax (Business) School District Total – *The amount of revenue from taxes levied on business personal property (equipment, etc.) generated by the new development for the School District.*
Row 44 Personal Property Tax (Business) Municipal/County Transportation – *The amount of revenue from taxes levied on business personal property (equipment, etc.) generated by the new development for the local jurisdiction to fund transportation expenses.*
Row 44 Personal Property Tax (Business) School District Transportation – *The amount of revenue from taxes levied on business personal property (equipment, etc.) generated by the new development for the School District to fund transportation expenses.*

Row 45 Personal Property Tax (Total) Municipal/County – *The amount of revenue from all taxes levied on personal property generated by the new development for the jurisdiction.*
Row 45 Personal Property Tax (Total) School District – *The amount of revenue from all taxes levied on personal property generated by the new development for the School District.*
Row 45 Personal Property Tax (Total) Municipal/County Transportation – *The amount of revenue from all taxes levied on personal property generated by the new development for the local jurisdiction to fund transportation expenses.*
Row 45 Personal Property Tax (Total) School District Transportation – *The amount of revenue from all taxes levied on personal property generated by the new development for the School District to fund transportation expenses.*
Row 48 Total Income Generated by Growth (Municipal/County) – *Total of revenues from all sources generated by the new development for the local jurisdiction.*
Row 48 Total Income Generated by Growth (Municipal/County) Transportation Share – *Total of revenues from all sources generated by the new development for the local jurisdiction to fund transportation expenses.*

Row 49 Total Income Generated by Growth (School District) – *Total of revenues from all sources generated by the new development for the School District.*
Row 49 Total Income Generated by Growth (School) Transportation Share – *Total of revenues from all sources generated by the new development for the School District to fund transportation expenses.*

The following Per Person, Revenues are calculated from "before the development" data and are applied to the persons, employees, and students of the new development.
Row 51 Per Person Revenues (All Sources) Municipal/County – *All local jurisdiction revenues related to persons expressed on a per-person basis.*

Row 51 Per Person Revenues (All Sources) Municipal/County Transportation Share – *All local jurisdiction transportation revenues related to persons expressed on a per-person basis.*
Row 52 Per Employee Revenues (All Sources) Municipal/County – *All local jurisdiction revenues related to employees expressed on a per-employee basis.*
Row 52 Per Employee Revenues (All Sources) Municipal/County Transportation Share – *All local jurisdiction transportation revenues related to employees expressed on a per-employee basis.*
Row 53 Per Student Revenues (All Sources) School District – *All School District revenues expressed on a per-student basis.*
Row 53 Per Student Revenues (All Sources) School District Transportation Share – *All School District transportation revenues expressed on a per-student basis.*

Row 55 Municipal/County Surplus /Deficit – *The local jurisdiction revenues related to new development subtracted from the local jurisdiction costs related to new development. If this figure is positive, the development is fiscally sound in relation to the local jurisdiction; if it is negative, the development is not generating enough revenues to cover its costs.*
Row 55 Municipal/County Surplus /Deficit – Transportation Share – *The local jurisdiction transportation revenues related to new development subtracted from the local jurisdiction transportation costs related to new development. If this figure is positive, the development is fiscally sound in relation to transportation expenses of the local jurisdiction; if it is negative, the development is not generating enough revenues to cover its transportation costs.*

Row 56 School Surplus/Deficit – *The School District revenues related to new development subtracted from the School District costs related to new development. If this figure is positive, the development is fiscally sound in relation to the School District; if it is negative, the development is not generating enough revenues to cover its school costs.*

Row 56 School Surplus/Deficit –Transportation Share – *The School District transportation revenues related to new development subtracted from the School District transportation costs related to new development. If this figure is positive, the development is fiscally sound in relation to transportation expenses of the School District; if it is negative, the development is not generating enough revenues to cover its school transportation costs.*

Row 57 Total Surplus/Deficit – *The local jurisdiction and School District revenues related to new development subtracted from the local jurisdiction and School District costs related to new development. If this figure is positive, the development is fiscally sound; if it is negative, the development is not generating enough revenues to cover its overall costs.*
Row 57 Total Surplus/Deficit –Transportation Share – *The local jurisdiction and School District transportation revenues related to new development subtracted from the local jurisd-iction and School District transportation costs related to new development. If this figure is positive, the development is fiscally sound in relation to transportation expenses; if it is negative, the development is not generating enough revenues to cover its overall trans-portation costs.*

Row 58 Municipal/County Surplus /Deficit as Share of Budget – *This is the local jurisdiction surplus or deficit as a percentage of the total local jurisdiction budget.*
Row 59 School Surplus/Deficit as Share of Budget – *This is the School District surplus or deficit as a percentage of the total School District budget.*

OUTPUT 3 - INDIRECT CAPITAL COSTS /REVENUES.

(Row 66 to Row 81 refer to the Procedural Guide, Step II, Indirect Transportation Capital and Operating Costs, Exhibit II-3.)

Population Generation

Row 68 Employee Resident Households in New Housing – *The number of new housing units (in addition to the development housing units).*

Row 70 New Employees that will be Supported by Development Residential Households - Convenience – *The number of convenience goods employees supported by the local expenditures of the persons living in the new residential units and by resident employees in new units. This will be reduced up to the number of convenience employees added by the base development, if any.*

Row 70 New Employees that will be Supported by Development Residential Households - Retail – *The number of retail goods employees supported by the local expenditures of the persons living in the new residential units and by resident employees in new units. This will be reduced up to the number of retail employees added by the base development, if any.*

Row 70 New Employees that will be Supported by Development Residential Households - Total – *The number of retail and convenience goods employees supported by the local expenditures of the persons living in the new residential units and by resident employees in new units. This will be reduced up to the number of retail and convenience employees added by the base development, if any. If a reduction is done a notation "Reduced by ## Direct Employees" will show the total reduction.*

Row 71 Additional square feet (000) of Convenience Space – *The additional convenience goods space generated by the local expenditures of the persons living in the new residential units (including resident employees)*

Row 71 Additional square feet (000) of Retail Space – *The additional retail goods space generated by the local expenditures of the persons living in the new residential units (including resident employees).*

Row 71 Additional square feet (000) of Convenience and Retail Space – *The additional convenience goods and retail goods space generated by the local expenditures of the persons living in the new residential units (including resident employees).*

Row 73 Capital Cost per Residential Unit – *The transportation-related capital cost of a type of unit that might be occupied by an employee moving into the area. Currently this is a 2-bedroom garden apartment.*

Row 74 Capital Cost per 1,000 square feet Retail Space – *The transportation-related capital cost of 1,000 sq. ft. of retail space.*

Cost Factors

Row 78 Transportation Capital Costs Related to Indirect Development – *This is the capital cost of the residential units of the new employees moving into the area to work in the new nonresidential development.*

Row 78 Transportation Capital Costs Related to Indirect Development Nonresidential – *This is the capital cost of the nonresidential space generated to support the local spending of the occupants of the new development units.*

Row 78 Transportation Capital Costs Related to Indirect Development Total – *This is the capital cost of the residential units of the new employees moving into the area to work in the new nonresidential development and the capital cost of the nonresidential space generated to support the local spending of the occupants of the new development units.*

Revenue Factors

Row 78 Transportation Capital Revenues Related to Indirect Development – *This is the capital revenues of the residential units of the new employees moving into the area to work in the new nonresidential development.*

Row 78 Transportation Capital Revenues Related to Indirect Development Nonresidential – *This is the capital revenues of the nonresidential space generated to support the local spending of the occupants of the new development units.*

Row 78 Transportation Capital Revenues Related to Indirect Development Total – *This is the capital revenues of the residential units of the new employees moving into the area to work in the new nonresidential development and the capital revenues of the nonresidential space generated to support the local spending of the occupants of the new development units.*

OUTPUT 4 - INDIRECT OPERATING COSTS/REVENUES

(Row 83 to Row 110 refer to the Procedural Guide, Step II, Indirect Transportation Capital and Operating Costs, Exhibit II-4, Exhibit II-5 and Exhibit II-6.)

Population Generation

Row 85 Employee Resident Households in New Housing – *The number of new housing units (in addition to the development housing units) occupied by employees of the new development nonresidential space.*

Row 87 New Convenience Employees Supported by Development Residential Units – *The number of convenience goods employees supported by the local expenditures of the persons living in the new residential units.*

Row 87 New Retail Employees Supported by Development Residential Units – *The number of retail goods employees supported by the local expenditures of the persons living in the new residential units.*

Row 87 New Convenience and Retail Employees Supported by Development Residential Units – *The total number of convenience goods and retail goods employees supported by the local expenditures of the persons living in the new residential units.*

Row 89 Persons in Employee Resident Households – *The total number of persons living in the new housing units occupied by employees of the new development nonresidential space.*

Row 90 Students in Employee Resident Households – *The total number of students living in the new housing units occupied by employees of the new development nonresidential space.*

Row 92 Cost per Person (Total) – *The operating cost to the local jurisdiction (Municipality /County) for each person based on current residentially related expenditures in the local jurisdiction (Municipality/County).*

Row 92 Cost per Person - Transportation Share of Per Person Costs – *The operating cost to the local jurisdiction (Municipality /County) for each person based on current residentially related transportation expenditures in the local jurisdiction (Municipality /County).*

Row 93 Cost per Employee (Total) – *The operating cost to the local jurisdiction (Municipality/County) for each employee based on current nonresidentially related expenditures in the local jurisdiction (Municipality /County).*

Row 93 Cost per Employee - Transportation Share – *The operating cost to the local jurisdiction (Municipality/County) for each employee based on current nonresidentially related transportation expenditures in the local jurisdiction (Municipality /County).*

Row 94 Cost per Student (Total) – *The operating cost to the School District for each student based on current school-related expenditures in the local School District.*

Row 94 Cost per Student –Transportation Share – *The operating cost to the School District for each student based on current School District-related transportation expenditures in the local School District.*

Row 95 Revenue per Person (All Revenues) – *All local jurisdiction revenues related to persons expressed on a per-person basis.*

Row 95 Revenue per Person (Transportation Revenues) – *All local jurisdiction transportation revenues related to persons expressed on a per-person basis.*

Row 96 Revenue per Employee (All Revenues) – *All local jurisdiction revenues related to employees expressed on a per-employee basis.*

Row 96 Revenue per Employee (Transportation Revenues) – *All local jurisdiction transportation revenues related to employees expressed on a per-employee basis.*

Row 97 Revenue per Student (All Revenues) – *All School District revenues expressed on a per-student basis.*

Row 97 Revenue per Student (Transportation Revenues) – *All School District transportation revenues expressed on a per-student basis.*

Cost Factors

Row 100 Total Municipal/County Operating Costs Related to Indirect Development – *The municipality/county operating costs related to the residential units of new employees moving*

into an area to work in the new nonresidential development as well as the operating costs related to the nonresidential space generated to support the local spending of occupants of new development units.

Row 100 Total School District Operating Costs Related to Indirect Development – *The School District operating costs related to the residential units of new employees moving into an area to work in the new nonresidential development as well as the operating costs related to the nonresidential space generated to support the local spending of occupants of new development units.*

Row 100 Total Operating Costs Related to Indirect Development – *The total operating costs related to the residential units of new employees moving into an area to work in the new nonresidential development as well as the operating costs related to the nonresidential space generated to support the local spending of occupants of new development units.*

Row 102 Total Municipal/County Transportation Operating Costs Related to Indirect Development – *The municipal /county transportation operating costs related to the residential units of new employees moving into an area to work in the new nonresidential development and the transportation operating costs related to nonresidential space generated to support the local spending of occupants of new development units.*

Row 102 Total School District Transportation Operating Costs Related to Indirect Development – *The School District transportation operating costs related to the residential units of new employees moving into an area to work in the new nonresidential development and the transportation operating costs related to nonresidential space generated to support the local spending of occupants of new development units.*

Row 102 Total Transportation Operating Costs Related to Indirect Development – *The total transportation operating costs related to the residential units of new employees moving into an area to work in the new nonresidential development and the transportation operating costs related to nonresidential space generated to support the local spending of occupants of new development units.*

Revenue Factors

Row 105 Municipal/County Operating Revenue Related to Indirect Development – *The municipal/county operating revenues related to the residential units of new employees moving into the area to work in new nonresidential development and the operating revenues related to nonresidential space generated to support the local spending of occupants of new development units.*

Row 105 School District Operating Revenue Related to Indirect Development – *The School District operating revenues related to the residential units of new employees moving into the area to work in new nonresidential development and the operating revenues related to nonresidential space generated to support the local spending of occupants of new development units.*

Row 105 Total Operating Revenue Related to Indirect Development – *The operating revenues related to the residential units of new employees moving into the area to work in new nonresidential development and the operating revenues related to nonresidential space generated to support the local spending of occupants of new development units.*

Row 107 Municipal/County Transportation Revenue Related to Indirect Development – *The municipal /county transportation operating revenues related to the residential units of new employees moving into an area to work in new nonresidential development and the transportation operating revenues related to nonresidential space generated to support the local spending of occupants of new development units.*

Row 107 School District Transportation Revenue Related to Indirect Development – *The School District transportation operating revenues related to the residential units of new employees moving into an area to work in new nonresidential development and the transportation operating revenues related to nonresidential space generated to support the local spending of occupants of new development units.*

Row 107 Total Transportation Revenue Related to Indirect Development – *The transportation operating revenues related to the*

residential units of new employees moving into an area to work in new nonresidential development and the transportation operating revenues related to nonresidential space generated to support the local spending of occupants of new development units.

Net Fiscal Impacts/Effects

Row 109 Total – *The municipal /county indirect development operating revenues minus the municipal/county indirect development operating costs providing the municipal/county net fiscal impact.*

Row 109 Total – *The School District indirect development operating revenues minus the School District indirect development operating costs providing the School District net fiscal impact.*

Row 109 Total – *The indirect development operating revenues minus the indirect development operating costs providing the net fiscal impact.*

Row 110 Transportation – *The municipal/county indirect development transportation-related operating revenues minus the municipal/county indirect development transportation-related operating costs providing the municipal /county transportation-related net fiscal impact.*

Row 110 Transportation – *The School District indirect development transportation-related operating revenues minus the School District indirect development transportation-related operating costs providing the School District transportation-related net fiscal impact.*

Row 110 Transportation – *The indirect development transportation-related operating revenues minus the indirect development transportation-related operating costs providing the transportation-related net fiscal impact.*

OUTPUT 5 - INDUCED C APITAL COSTS/REVENUES.

(Row 118 to Row 127 refer to the Procedural Guide, Step III, Induced Transportation Capital and Operating Costs, Exhibit III-4.)

Row 119 Induced Residential Units – *The number of units generated by induced development*.

Row 120 Induced Employment – *The employment generated by induced development.*

Row 121 Additional square feet (000) of Nonresidential Space – *The amount of space needed for the employment generated by induced development.*

Row 122 Capital Cost per Residential Unit – *This is the same cost as developed earlier under Direct Capital Costs /Revenues..*

Row 123 Capital Cost per 1,000 square feet Nonresidential Space – *This is the same cost developed earlier under Direct Capital Costs/Revenues.*

Row 125 Transportation Capital Costs Related to Induced Development – Residential – *This is the capital cost of the residential units of the added persons induced by the development.*

Row 125 Transportation Capital Costs Related to Induced Development Nonresidential – *This is the capital costs of the nonresidential space generated to support the added employment induced by the development.*

Row 125 Transportation Capital Costs Related to Induced Development Total – *This is the total of the capital costs of the residential units of the added persons induced by the development added to the capital costs of the nonresidential space generated to support the added employment induced by the development.*

Row 127 Transportation Capital Revenues Related to Induced Development – Residential – *This is the capital revenues of the residential units of the added persons induced by the development.*

Row 127 Transportation Capital Revenues Related to Induced Development Nonresidential – *This is the capital revenues of the nonresidential space generated to support the added employment induced by the development.*

Row 127 Transportation Capital Revenues Related to Induced Development Total – *This is the total of the capital revenues of the residential units of the added persons induced by the development added to the capital revenues of the nonresidential space generated to support*

the added employment induced by the development.

OUTPUT 6 - INDUCED OPERATING COSTS/REVENUES

(Row 129 to Row 150 refer to the Procedural Guide, Step III, Induced Transportation Capital and Operating Costs, Exhibit III-5.)

Population/Employment Generation

Row 131 Persons Induced by Development – *The number of persons generated by induced development.*

Row 132 Employees Induced by Development – *The number of employees generated by induced development.*

Row 133 Students Induced by Development – *The number of students generated by induced development.*

Per Person, Student, or Employee Costs

Row 135 Per Person Cost – *This is the same per-person cost as that developed earlier under direct operating costs.*

Row 136 Per Employee Cost – *This is the same per-employee cost as that developed earlier under direct operating costs.*

Row 137 Per Student Cost – *This is the same per-student cost as that developed earlier under direct operating costs.*

Per Person, Student, or Employee Revenues

Row 135 Per Person Revenue – *This is the same per-person revenue as that developed earlier under direct operating revenues.*

Row 136 Per Employee Revenue – *This is the same per-employee revenue as that developed earlier under direct operating revenues.*

Row 137 Per Student Revenue – *This is the same per-student revenue as that developed earlier under direct operating revenues.*

Cost Factors

Row 139 Person-Related Costs – *This is the operating cost of the added people induced by the development.*

Row 139 Person-Related Transportation Costs – *This is the transportation-related operating cost of the added people induced by the development.*

Row 140 Employee-Related Costs – *This is the operating cost of the added employees induced by the development.*

Row 140 Employee-Related Transportation Costs – *This is the transportation-related operating cost of the added employees induced by the development.*

Row 141 Student-Related Costs – *This is the operating cost of the added students induced by the development.*

Row 141 Student-Related Transportation Costs – *This is the transportation-related operating cost of the added students induced by the development.*

Revenue Factors

Row 143 Person-Related Revenues – *This is the operating revenues of the added people induced by the development.*

Row 143 Person-Related Transportation Revenues – *This is the transportation-related operating revenues of the added people induced by the development.*

Row 144 Employee-Related Revenues – *This is the operating revenues of the added employees induced by the development.*

Row 144 Employee-Related Transportation Revenues – *This is the transportation-related operating revenues of the added employees induced by the development.*

Row 145 Student-Related Revenues – *This is the operating revenues of the added students induced by the development.*

Row 145 Student-Related Transportation Revenues – *This is the transportation-related operating revenues of the added students induced by the development.*

Fiscal Impact

Row 147 Municipal/County Residential – *This is the fiscal impact (revenues minus costs) of the added people induced by the development.*

Row 147 Transportation-Related Municipal /County Residential – *This is the transportation-related fiscal impact (revenues minus costs) of the added people induced by the development.*

Row 148 Municipal/County Nonresidential – *This is the fiscal impact (revenues minus costs)*

of the added employees induced by the development.

Row 148 Transportation-Related Municipal /County Nonresidential – *This is the transportation-related fiscal impact (revenues minus costs) of the added employees induced by the development.*

Row 149 School District – *This is the fiscal impact (revenues minus costs) of the added students induced by the development.*

Row 149 Transportation-Related School District – *This is the transportation-related fiscal impact (revenues minus costs) of the added students induced by the development.*

Row 150 Total – *This is the fiscal impact (revenues minus costs) of the total added persons, employees, and students induced by the development.*

Row 150 Transportation-Related Total – *This is the transportation-related fiscal impact (revenues minus costs) of the total added persons, employees, and students induced by the development.*

TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL

OUTPUT 7 - TOTAL IMPACTS

Row 160 to Row 170 This is a simple summarization of jurisdiction (Municipality /County) and School District Total and Transportation-related Costs, Revenues, and Fiscal Impacts (Total)

OUTPUT 8 - OVERALL CONTROL CHECKS

Calculating Controls for Total Capital Costs/Revenues

(Row 173 to Row 201 refer to the Procedural Guide, Step IV, A Control for All Costs.)

Capital Costs/Revenues

Row 179 Direct Capital Costs – *Total of Direct Transportation-related Residential and Nonresidential Capital Costs.*

Row 180 I-O Multiplier before adjustment – *Base I-O Multiplier developed in Step 4-Nonres. Demo. Multipliers.*

Row 181 Share of New Employees Living in Jurisdiction – *This value is used to adjust the Base Local Multiplier.*

Row 182 Adjusted Local I-O Multiplier – *This is the Base I-O Multiplier (above) minus 1 and then multiplied by the Share of New Employees Living in Jurisdiction; with 1 added to that result.*

Row 183 Multiply by I-O Multiplier (Control Costs) – *The Direct Transportation-related Capital Cost figure is multiplied by the Adjusted Local Multiplier.*

Row 184 Total Capital Costs (Actual Costs) – *This is the sum of the Direct, Indirect, and Induced Transportation-related Capital Costs.*

Row 185 Difference from the Calculation of all Capital Costs – *This is the Total Capital Costs (Actual Costs) minus the Control Costs.*

Row 186 Control Vs. Summed Calculation (Cost) *This indicates whether the calculated Cost Control Value is less than or greater than the Model Value.*

Row 187 Control Vs. Summed Calculation (Revenues) *This indicates whether the calculated Revenue Control Value is less than or greater than the Model Value.*

Calculating Controls for Total Operating Costs/Revenues of Development on Transportation

Operating Costs/Revenues

Row 190 Direct Operating Costs – *Total of direct transportation-related residential and nonresidential operating costs from both the jurisdiction (Municipality /County) and the School District.*

Row 191 Direct Operating Revenues – *Total of direct transportation-related residential and nonresidential operating revenues from both the jurisdiction (Municipality/County) and the School District.*

Row 192 Adjusted Local I-O Multiplier – *This is the adjusted I-O Multiplier from the capital costs above.*

Row 193 Resulting Total Operating Costs (Control) – *the direct transportation-related*

operating cost figure is multiplied by the adjusted local multiplier

Row 194 Resulting Total Operating Revenues (Control) – *The direct transportation-related operating revenues figure is multiplied by the adjusted local multiplier.*

Row 195 Calculate Total Operating Costs (Actual) – *This is the sum of the direct, indirect, and induced transportation-related capital costs from both the jurisdiction (Municipality/County) and the School District.*

Row 196 Calculate Total Operating Revenues (Actual) – *This is the sum of the direct, indirect, and induced transportation-related capital revenues from both the jurisdiction (Municipality/County) and the School District.*

Row 197 Cost Difference – *This is the total capital costs (actual costs) minus the control costs.*

Row 198 Revenue Difference – *This is the total capital revenues (actual revenues) minus the control revenues.*

Row 199 Control Vs. Summed Calculation (Cost) *This indicates whether the calculated Cost Control Value is less than or greater than the Model Value.*

Row 200 Control Vs. Summed Calculation (Revenues) *This indicates whether the calculated Revenue Control Value is less than or greater than the Model Value.*

END OF STEP

STEP 8 - VIEW COMBINED COSTS /REVENUES SUMMARY BY TYPE OF IMPACT

Sheet 8 View Model C-R Summary is a summary of the costs and revenues, total and transportation-related, at the direct, indirect, and induced. steps of the model for the jurisdiction (Municipality /County) and the School District.

STEP 8 - VIEW COMBINED COSTS/REVENUES SUMMARY BY TYPE OF IMPACT		
TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL		
	Using Basic Capital Cost Calculation	
In-Town Square		
	MUNICIPAL/COUNTY	
	Transportation	Transportation
	Direct Capital Impacts	Direct Operating Impacts
Costs	$6,933,062	$601,381
Revenues	$6,933,062	$615,340
Difference	$0	$13,959
	Transportation	Transportation
	Indirect Capital Impacts	Indirect Operating Impacts
Costs	$1,289,409	$87,760
Revenues	$1,289,409	$89,337
Difference	$0	$1,576
	Transportation	Transportation
	Induced Capital Impacts	Induced Operating Impacts
Costs	$1,948,599	$179,757
Revenues	$1,948,599	$184,448
Difference	$0	$4,691
	Transportation	Transportation
	Total Capital Impacts	Total Operating Impacts
Costs	$10,171,070	$868,898
Revenues	$10,171,070	$889,125
Difference	$0	$20,227
	SCHOOL DISTRICT	
	Transportation	Transportation
	Direct Capital Impacts	Direct Operating Impacts
Costs	No School Level	$2,352,000
Revenues	Capital Impacts	$1,264,915
Difference		-$1,087,085
	Transportation	Transportation
	Indirect Capital Impacts	Indirect Operating Impacts
Costs		$330,750
Revenues		$177,879
Difference		-$152,871
	Transportation	Transportation
	Induced Capital Impacts	Induced Operating Impacts
Costs		$2,061,900
Revenues		$1,108,898
Difference		-$953,002
	Transportation	Transportation
	Total Capital Impacts	Total Operating Impacts
Costs		$4,744,650
Revenues		$2,551,692
Difference		-$2,192,959
END OF STEP		

STEP 9 - VIEW POP ULATION /EMPLOY-MENT/STUDENT/VMT/ TRIPS SUM-MARY BY TYPE OF IMPACT

Sheet 9 View Other Data Summary is a display of the persons, employees, students, residential units, and nonresidential space, first without the planned development and then showing the number of persons, employees, students, residential units, and amount of nonresidential space added by direct, indirect, and induced development.

STEP 9 - VIEW POPULATION / EMPLOYMENT / STUDENT / VMT AND TRIPS SUMMARY BY TYPE OF IMPACT						
TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL						
In-Town Square						
	Population	Population Density	Employees	Students	Residential Units	Nonresidential Space
Area without Development	23,530	4,706	10,000	9,400	9,870	4,678,889
Direct Operating Additions	4,956		2,625	700	2,000	750,000
% Increase	*21%*		*26%*	*7%*	*20%*	*16%*
Area with Direct Development	28,486	5,697	12,625	10,100	11,870	5,428,889
Indirect Operating Additions	675		500	98	263	200,056
% Increase	*2%*		*4%*	*1%*	*2%*	*4%*
Area with Indirect Development	29,161	5,832	13,125	10,198	12,133	5,628,944
Induced Operating Additions	1,536		653	614	614	305,452
% Increase	*5%*		*5%*	*6%*	*5%*	*5%*
Area with Induced Development	30,697	6,139	13,778	10,812	12,746	5,934,397
Total of Increases Due to Development	7,167		3,778	1,412	2,876	1,255,508
Total as % of Area without Development	*30%*		*38%*	*15%*	*29%*	*27%*
		VMT			One-Way Trips	
	Residential VMT	Nonresidential VMT	Total VMT	Residential Trips	Nonresidential Trips	Total Trips
Area without Development	347,045	263,248	610,294	40,265	34,355	74,620
Direct Operating Additions	84,776	49,022	133,798	6,696	8,263	14,960
% Increase	*24%*	*19%*	*22%*	*17%*	*24%*	*20%*
Area with Direct Development	431,821	312,270	744,091	46,961	42,618	89,580
Indirect Operating Additions	10,172	20,173	30,345	804	2,998	3,802
% Increase	*2%*	*6%*	*4%*	*2%*	*7%*	*4%*
Area with Indirect Development	441,993	332,443	774,436	47,765	45,616	93,381
Induced Operating Additions	22,356	18,040	40,396	2,416	2,475	4,891
% Increase	*5%*	*5%*	*5%*	*5%*	*5%*	*5%*
Area with Induced Development	464,349	350,483	814,832	50,181	48,091	98,272
Total of Increases Due to Development	117,304	87,235	204,539	9,916	13,737	23,652
Total as % of Area without Development	*34%*	*33%*	*34%*	*25%*	*40%*	*32%*

(The VMT and trips calculations refer to the Procedural Guide, Step I-A, Direct Transportation Capital and Operating Costs, A More Intricate Method for Calculating Capital Costs.)

STEP 10 - OVE RALL CONCLUSIONS ON TRANSPORTATION C OSTS OF DEVEL-OPMENT

Sheet 10 View Overall Conclusions is a summary of the overall results of the Model calculations.

STEP 10 - OVERALL CONCLUSIONS ON TRANSPORTATION COSTS OF DEVELOPMENT	
TRANSPORTATION COSTS OF NEW DEVELOPMENT MODEL	
In-Town Square	
1. The	In-Town Square Development produces $10,171,070 in transportation-related capital costs
	and $10,171,070 in transportation-related capital revenues for a break-even
	impact to Newtown City.
2. The	In-Town Square Development produces $868,898 in transportation related operating costs
	and $889,125 in transportation-related operating reveunes to Newtown City
	for an overall operating surplus of $20,227.
3. The	In-Town Square Development Causes a deficit of -$2,192,959 in transportation-related
	costs versus revenues to the Newtown Schools school district.
END OF STEP	

Step 10 View Overall Conclusions is a summary of the overall results of the Model calculations.

ABOUT THE **trans_costs@email.rutgers.edu** E-MAIL LIST.

This list is intended for correspondence between the users of this Model. Only list members can send messages. To subscribe to this list go to https://email.rutgers.edu/mailman/listinfo/NCHRP_trans_costs and fill out the form according to the subscription directions under Subscribing to NCHRP_trans_costs. You will be sent email requesting confirmation, to prevent others from gratuitously subscribing you. Under current settings you will also have to wait until your subscription is OKed by the list administrator. At that time you will receive a "Welcome" e-mail. This list will be used to send out any updates that may become available and for information sharing among Model users.

Be sure you do not use a valuable password for this system because the system sends password reminders as plain text e-mails.

This is currently a hidden list, which means that the list of members is available only to the list administrator.

To see the collection of prior postings to the list, visit the NCHRP_trans_costs Archives. (The current archive is only available to the list members.)

Anyone who does not wish to receive e-mails from other users but wishes to receive any relevant update information should send a message to wdolphin@rutgers.edu and ask that information be sent to you directly.

MODEL TESTING BY USERS / PANEL MEMBERS - Appendix II –

Testing the Model's Functions Using a Limited Number of Users

Testing the Model through Panel Responses

TRANSPORTATION COSTS OF NEW DEVELOPMENT: MODEL TESTING BY USERS

I. INTRODUCTION -- USERS

The Transportation Costs of New Development Model is a Microsoft EXCEL spreadsheet consisting of six data entry sheets and three main output sheets. The Model Software is on a CD. Information about a development project and the local jurisdiction is entered into the Model. Documented default values are provided for certain data inputs where data are not self-entered. The Model outputs produce specific values for the direct, indirect, and induced. costs/revenues associated with new development. While the Model generally performed well during testing, some improvements were and should have been made in certain areas.

II. GENERAL CRITIQUES

The Procedural Guide is a description of the methods utilized in the Model and their origins. It is essential background material before using the Model Software. The User Guide provides assistance to users of the Model Software. It gives step-by-step instructions for data entry about where to obtain data and about using default values. It should be used at the time of activation of the Model. Default values allow for a short-cut ("Preview Method") which gives output information with minimal data entry. This is a very valuable time saver when employing the Model. The User Guide is helpful in providing specific U.S. Census tables to obtain background information, but provides only limited suggestions on where to obtain municipal/county and school district budget information. The answer to this question is that budget information is obtained at the physical site or Internet site of the municipality for which costs are trying to be estimated. An additional technical problem experienced during testing is the appearance of error messages when trying to "save as" the read-only copy of the EXCEL spreadsheet provided on the CD. (This will be discussed on page 174).

III. STEP-BY-STEP CRITIQUES

Step 1: "Start Here – Enter Background Information on Jurisdiction"

Step 1 requires input of general background information on the jurisdiction. This information is readily available from the U.S. Census American Community Survey (ACS). Basic information about housing units, school district enrollment, and employment in the jurisdiction is required. The User Guide offers helpful step-by-step instructions for where to find particular data identifying specific Census tables. In testing the Model, the City of Clifton, New Jersey (Passaic County) was used as the local jurisdiction because its population was large enough to be included in the ACS 2005-2009 5-year estimates (population = 78,049), and it had a self-contained but independent school district (i.e., not part of a regional or multi-jurisdictional system). Clifton's municipal and school district budgets were also available on its website and contained better-than-average summary information. This information was weighted with other New Jersey communities (property tax state) and with some communities from New Mexico (sales or gross receipts tax state.)

Overall, Step 1 was very straightforward; however, better aligning the categories for housing and employment data with the ACS would make the Model more user-friendly. For example, data in the ACS Table B08526 (Workplace Geography) contains 13 categories of employment. The Model requires the user to sum this information into 4 categories and provides no place to input data from the ACS category "Other Services." A similar inconvenience was found in the input of housing information where the Model requires the user to add up numbers from 6 categories on the ACS Table B25024 (Housing Units) into one "multifamily" category on the Model. The Model also provides no place to input data from the "boat, RV, van, etc." which is on the ACS Table. The lack of alignment of the Model's categories with Census categories is certainly a minor inconvenience, but one that should be remedied.

Step 1 Response—Model Alterations Undertaken

The Model has been adjusted to crosswalk the 13 ACS categories of employment into the four categories of employment that the Model requires. Since the latter are computations of the NAICS categories ultimately to be collapsed into the form of nonresidential space occupants, i.e., office, industrial, retail, and other (hotel, motel, etc.), the crosswalk is an easy solution. The Model has been further adjusted to automatically combine the six multifamily categories of housing into one combined multifamily number. A calculator is provided. Since the output of this section of the Model is standard residential types, the extremely small ACS category of people living in "boats, RVs, or vans" is not included.

Step 2: "Development Description – Enter Information on Development Being Analyzed"

Step 2 gathers information on the development being analyzed. Development size, type (residential /nonresidential), and market price are entered. Categories are provided for several types of residential (single-family det., garden apt., town house, high-rise, mobile home, age-restricted) and non-residential (office, retail, industrial). Additional spaces are provided for "other" types of the developments, making the Model more flexible. Default multipliers are not provided for "other" categories and must be entered by the user. In testing the Model, a mixed-use development was proposed containing 500 two-bedroom town houses with a sale price of $300,000 and 15,000 square feet of retail space at $200 per square foot. No problems were encountered during Step 2 of the Model.

At the end of Step 2, the "Preview Method" can be utilized to receive immediate output information on the costs of the development using default values for the local government budget, tax revenues and school district data. The user can type "1" in cell D74 and engage the Preview Method. As much local data as is available is entered here, and documented default values are used for unknown inputs.

Step 2 Response—Model Alterations Undertaken

Even though few if any problems were encountered in the Model related to the step that gathers information on the specific development being analyzed, several "other" types of development have been suggested as development types not included within the original Model. Suggested default values and their sources are also provided for these selected "other" types of development.

Step 3: "Select Resid ential Demographic Multipliers From Below"

This sheet gathers information on the likely number of occupants for the residential portion of the development. In testing the Model, the provided default values were used for this step. Using these values requires no input from the user as the Model has this information already entered into it. Default values for persons and school children per unit were not provided for "other" types of residential development.

Step 3 Response—Model Alterations Undertaken

Occupants of residential types of dwellings have been expanded to include condominiums, units with a den that might be used as a bedroom, and time share units.

Step 4: "Select Nonresidentia l Demo-graphic Multipliers From Below"

Sheet 4 gathers information on the likely number of employees in the nonresidential portion of the development. In testing the Model, the provided default multipliers were used. Again, nothing was required of the user (if using defaults) on this step.

Step 4 Response—Model Alterations Undertaken

The number of employees for additional nonresidential types has been included. This was added to the default option but can also be used as an instructive guide if developing your own nonresidential employment multipliers.

This includes: movie theatres, restaurants, libraries, nursing homes, assisted living, etc.

Step 5: " Enter Municipal/County and School Expenditure, Revenue, and Tax Base Information"

Step 5 gathers information on the jurisdiction (municipality/county) and school district budget information. In testing the Model, municipal and school district budgets were obtained for Clifton, New Jersey on the Internet. The bulk of the difficulties encountered during testing were experienced during this step. The biggest issue is the lack of alignment between categories on the Model and categories on municipal and school district budgets. Budgets are readily available for most jurisdictions on the Internet but often lack good summary information. Most New Jersey municipalities seem to be using a similar budget format which is in excess of 70 pages. In researching budgets from jurisdictions in other states, budgets were hundreds of pages for even small cities such as Santa Fe, New Mexico and South Bend, Indiana.

Clifton, New Jersey was chosen for testing the Model as it was one of the few jurisdictions that had user-friendly summary information breaking down expenditures into a manageable number of categories. It was still difficult to translate these categories into the Model's categories. The Model contains only 7 categories with 3 spaces for "Other" categories. Clifton's budget appropriations were divided into two major categories: "Departmental Operations" and "Non-Departmental Operations." They were broken down further into 21 smaller categories. Some of these (e.g., Fire, Police, Municipal Debt Service, Sanitation & Sewer) fit nicely into the Model's categories (Public Safety, Public Works, Debt Service). Many others (especially in the "Non-Departmental Operations" category) were difficult to place into one of the Model's categories (e.g., Insurance, Purchase of Vehicles, Energy Costs, Pensions and Social Security, Capital Improvements). The "Other" categories could be used for these nonconforming expenditures, but then no default expenditures related to transportation are provided. Municipal and county budgets should be researched further, and the Model's input categories should be adjusted to align to the most commonly used budget categories. If this is not feasible, then additional information should be provided in the User Guide to aid the user in converting available budget information into the Model's categories.

Next, municipal/county revenue information is entered into the Spreadsheet. For New Jersey municipalities, most of this information is available on the Internet on the state's website (http://www.state.nj.us/dca/lgs/taxes/taxmenu.shtml. There is an equivalent website on budget information that exists at the state level in most states.). Then, school district information is entered into the Model. Clifton's school district budget is also located on the Internet. The Model contains expenditure categories for teaching, administration, transportation, debt service, and "other". Clifton's school district budget contains 4 large categories for appropriations including "General Current Expense," "Capital Expenditures," "Special Grants and Entitlements," and "Repayment of Debt." Only "Repayment of Debt" fits easily into the Model. Over 40 subcategories are also listed on the school district budget and were translated into the Model's categories, albeit with some difficultly and a lack of clarity. School district budgets tended to be much simpler and easy to convert into the Model's input categories; however, it would be helpful to have more information in the User Guide about what types of expenditures fall into which categories.

Step 5 Response—Model Alterations Undertaken

A crosswalk of budget categories from the municipal and school district budget to Model budget categories has been added to the Model. In most cases of transfer from a local or a school district budget to the Model's budget categories, these decisions are intuitive, but some actually require research. The crosswalk supplants much of this decision making. Again, this was introduced in the default option but is instructive if the user is making judgments on specific budget categories for expenditures or

revenues in the other data-entry version of the Model.

Step 6: "Enter Information on Development Financials and Multipliers"

Sheet 6 gathers additional data for the calculation of indirect and induced costs and revenues if the user is employing the "Advanced Calculation Method." In testing the Model with a hypothetical development, the supplied default values were used. Step 6 is the last step requiring data input. All subsequent sheets provide output values.

Step 7: "View Output for Direct, Indirect, and Induced Costs /Revenues"

Within each of the above categories, information is included on population, students, and employees added; residential and nonresidential value added (Direct Costs only); and ultimately, the transportation costs and revenues associated with this stage of development. This is in the form of capital costs/revenues and operating costs/revenues as well as the differences in each of these categories. This information is clearly organized and presented for maximum user benefit.

Step 8: "View Combined Costs /Revenues Summary by Type of Impact"

This is a summary of Direct, Indirect, Induced, and Total Capital and Operating Costs/Revenues for the municipality/county and for the school district. Information is summarized for the three levels of costs as well as their total; all categories are clearly presented.

Step 9: "View Population /Employment/Student Summary by Type of Impact"

This is a summary of the population, employees, students, residential units, and nonresidential space added during the three stages of development. It also shows the percentage increase in going from one stage to another. Again, all information is clearly presented.

Step 7-9 Response – Basic Output Tables

In Steps 7-9, a detailed series of tabulations of the outputs of various stages of the Model is calculated and displayed automatically (given proper input data in previous steps). These data relate to the direct, indirect, and induced costs/revenues of the development. This information is easily followed as presented.

IV. SUMMARY AND CONCLUSIONS -- USERS

In testing the Model Software for the Transportation Costs of New Development, some potential problems were discovered. Data input categories should be adjusted to align better with Census tables. Extracting values for general categories from long and detailed municipal and county budgets was the most difficult aspect of using the Model Software. The Model's input categories should be adjusted, and/or additional explanation should be provided in the User Guide. The "Preview Method" uses default values to offer a short-cut when certain data are not available, but its applications are limited. When all of the detailed input data can be found, the Model displays and summarizes information about the direct, indirect, and induced costs/revenues associated with new development. The Model produced error messages when saving material.

General Response—Model Alterations Undertaken

When attempting to save entered data using "save as," sometimes an error message appears. This occurs only when the user's computer is equipped with EXCEL 2003 as opposed to EXCEL 2007. The Model has been adjusted to allow for both versions without getting an error message. This is the type of question that will be answered for additional categories of Model performance on a regular basis as part of Rutgers' commitment of five years user support.

TRANSPORTATION COSTS OF NEW DEVELOPMENT: MODEL TES TING BY PANEL MEMBERS

QUESTIONS AND RESPONSES

Reviewer: The Model is difficult to follow due to the volume of material.

Response— The overall Model must be able to account for and process many residential and nonresidential development types that take up space in the Model and make it appear to be unwieldy and overly complex. Users of the Model know how to bypass material that does not pertain to their development type and get on to other stages of the Model. This is true of the format of many models.

The material for the Model involves fiscal impact and impact fee spreadsheets that planners have been using for years. There are a number of these spreadsheets out there, and we get questions on a regular basis at Rutgers requesting assistance in interpreting them. These are from people who usually have executed the Model, derived a solution, and are asking us if their results appear reasonable.

Reviewer: The Model contains unexplained default material.

Response— As to the Preview Method or other material in the longer Model that contains default values, the references to this information have been built into the Model, and the sources appear at the end of the Model much like a bibliography.

Reviewer: Basic Factors in the direct capital cost. section require better labeling.

Response – Labeling has been added to entries in the calculation areas of the various sheets. VMT is in cell B146, VMC in cell B145 (labeled Road Network Capacity), and Cost/VMT is in cell B150, all in Sheet 6. These entries are only valid if the more intricate (data entry) version of the Model is used. Otherwise an accepted default value for capital cost per unit is used.

A table presenting residential and nonresidential VMT and trips for the three stages of development is now included in Step 9- View Other Data Summary.

Reviewer: Why under capital costs do revenues always equal costs?

Response— Throughout the Procedural Guide, the research team explains that the basis for the cost calculation is what could possibly be charged to the developer if impact fees existed and were in place. This produces the result that revenues equal costs.

In the field, differences are often obtained because the calculation has ignored many of the component procedures included here. An example would be showing capital costs to be more because the capital cost calculation did not include a "credit" for revenues received elsewhere. This is the correct calculation of costs, and the resultant cost is what is charged to a developer to pay for these costs in jurisdictions wheer impact fees prevail. Revenues do equal costs because they are based on net costs that can survive litigation. They are being calculated both correctly and very precisely. They do not ignore cost imbalances. Cost imbalances do not exist because the calculation is so thorough.

Reviewer: The results of operational calculations were close in total. Only the school district seems to make a difference. Why is this happening?

Response – For the development specified in the text, which is a mixed-use development (750,000 square feet of office space and 2,000 residential units), which has both positive-producing sectors (nonresidential) and negative-producing sectors (residential), there is a 33 percent difference between transportation operating costs and revenues (costs more; revenues less). See Summary Exhibit A-5 (Costs $2.95 million; Revenues $1.88 million). This includes the school district

calculations. This is exactly as it should be. The municipality's/county's results are relatively close because of the mixed-use development, and, when combined with the school district results, produces an overall negative number, largely because of the school children in the school district. Even this is not terribly negative due to reasonably expensive 2- and 3-bedroom townhouses ($200,000 2BR; $300,000 3BR) with low numbers of school children per unit (0.25/2BR; 0.50/3BR).

The calculations found in the Procedural Guide are absolutely correct. This would be more apparent in a straight fiscal impact analysis using a development pro forma as the base calculation device, but this is not shown in the Guide due to the extra complexity that it would introduce.

Reviewer: The spreadsheet may have errors! I got an inflation rate of 30%.

Response – Testing has not uncovered an error in the inflation rate displayed in cell D25. If a project is planned for 2020, the rate will be 30%. If a project is planned for 2011, it will be 3%. Those are the values we obtained in our testing. If the analyst chooses a 10-year projection for the development coming on-stream, the inflation rate is 30 percent. The analyst must use a realistic development projection future (Step 1). Most would choose one to three years depending on development size. This feature was tested several times with the year of Model development (2010), and 0 percent inflation was produced. If 2011 was selected as the year of development, 3 percent was produced. You cannot get 30 percent inflation if you put in 2010 (0 percent) or 2011 (3 percent) in the Year row of Step 1. If you put 2020 in the Year row, you will get 30 percent inflation.

Reviewer: The Procedural Guide and User Guide need more cross-referencing.

Response – The research team has paid attention to the reviewer's request and has put cross-references into the document. The research team has made a decision that the cross-referencing is most efficient if it goes from the Procedural Guide to the other two as a group, and from the other two as a group to the Procedural Guide. The team has selected the direction as mainly from the User Guide/Model to the Procedural Guide. If necessary, it will also go from the Procedural Guide to the User Guide/Software. The base of cross-referencing is the User Guide /Model, and most takes place between the implementing base (User Guide /Model) and explanatory base (Procedural Guide).

Reviewer: What function does the "Control for All Costs" provide?

Response -- As the reviewer indicates, this is a check on the summed scale of the component procedures. It is meant to provide an estimate of all costs from a completely different source of information. This is another way of looking at all summed costs. It is essentially a way of saying that if we used the household sector to estimate the impacts of growth and that household sector was allowed to expand much the way employment has been allowed to expand via traditional I-O Analysis, do we not have a similar situation as when we trace individual household growth through multiple levels of impact? This should not be used as a reality check but rather as another way of getting to the total effects and scale of growth.

Reviewer: How difficult do you believe field support will be?

Response -- The field is sufficiently desirous to get a tool like this, and the younger generation has the skills to use it. They will poke around and produce analyses to the point where they have a result and ask for comments, or they may not ask for comments. They will get through the Model, however, because for models of this type, it is relatively straightforward.

Reviewer: Do you have a folder with demographic multipliers for each state nationwide?

Response – This folder is available on the enclosed CD.

MODEL TESTING WITH LAND USE MODEL - Appendix III

Using Integrated Travel Demand and Land Use Modeling for Analyzing Induced Travel Demand and Its Comparison with Predicted Values

- **Des Moines, Iowa**
- **Colorado Springs, Colorado**
- **Old Bridge (Browntown), Middlesex County, New Jersey**

INTRODUCTION

Additional traffic is an inevitable transportation consequence of new real estate developments, either residential or nonresidential. In order to provide required level of service on nearby roadways, it is often necessary to improve or expand the transportation infrastructure in the vicinity of new developments, especially roads that provide access to the new development. However, in addition to serving the traffic generated by the new development, the improved highway infrastructure would likely serve the area traffic that may be attracted to the new transportation infrastructure incidental to the real estate development in question. The latter is referred to in the literature as induced traffic. In order to properly assess future traffic demand (or traffic volumes) on improved facilities it is necessary to fully understand the impact of induced traffic and include it in the analysis of traffic cost implications of new land developments.

OBJECTIVE

The objective of this testing appendix is threefold:

- Develop a methodology for calculating the induced travel demand from a residential and commercial development.
- Use the methodology to evaluate the impacts of the induced travel demand on a highway network around a new development.
- Demonstrate the application using case studies.

The evaluation methodology is an interactive application of the travel demand forecasting model (traditional four step or TRANSIMS) and the Transportation, Economic and Land Use Model (TELUM).

METHODOLOGY

Background

There are two general sources or components of induced traffic:

- *Traffic resulting from re-routing of area traffic from other facilities* to the new, expanded or improved, transportation facility that is primarily introduced to accommodate growth of local traffic. For example, certain trips that utilized other roads may re-route and use the new or expanded roadways, taking the advantage of additional capacity and improved level of service resulting in less congestion, faster travel, or shorter route between the trip origin and destination. The re-routed trips can include local trips (that have an origin or destination in the area in which the facility is located) or through-trips that have neither origin nor destination in the area where the improved facility is located.
- *Traffic as a result of the induced demand caused by the development.* The new transportation facility may induce residential and business development. The induced development is defined as additional residential and nonresidential development in the area relative to the initial development.

The first component of the induced traffic occurs upon implementation of the infrastructure improvement (e.g. road widening, new road, new highway ramp, etc.). Re-routed trips considered here seek only to improve their travel time or cost, while their origins and destinations do not change. This portion of induced traffic can be estimated by re-running a regional travel demand model on the highway network that includes the new real estate development-related transportation infrastructure improvements (and related improved travel impedances). Resulting volumes or vehicle-miles traveled and their comparison with the baseline numbers (based on the network without the improvement) would reveal the amount of re-routed traffic. This

traffic may impose a congestion penalty as additional user (average) travel time experienced by the initial users of the facility, which may result in an increase in the average user travel cost following the highway improvement. This is explained by the Braess Paradox.[10]

The second component of induced traffic is a result of the interactions between changes in land use and changes in the transportation infrastructure after the new development and infrastructure improvements are put in place. The new improved transportation facility may attract jobs and residences. The interactions between new geographic allocation of jobs and residences, as well as changes in transportation network (in terms of improved level of service or expanded roadway capacity), will cause changes in travel desire and thus regional travel patterns.

Modeling Approach

In order to estimate the level of induced traffic as a result of these interactions, it is necessary to go through the following four-step iterative process:

1. Given the nature of the proposed development, estimate the changes in trip tables to and from the development and the related regional zones.
2. Collect data on highway network capacity and link travel times. Record the design of new infrastructure improvements in the regional highway network.
3. Maintain a travel demand forecasting model that yields trip rates, trip interchanges, travel paths and resulting travel times and VMT. The model is capable of finding the least time travel assignment and estimating the re-distributed travel patterns.
4. Maintain a calibrated land use model that allocates and re-allocates residences and employment to zones based on zonal attractiveness and accessibility (as described in the inter-zonal trip tables). Given the regional growth in population, employment, current and proposed land use and available land, run the land use models to estimate zonal allocations.

In the first step of this process, the new trip attractions and productions are estimated based on the new residential and/or nonresidential development in the analyzed area. The new development includes both direct and indirect development. Direct is the initial residential and/or nonresidential development in the area of study. For example, this could be a condominium complex, or an office building, or a combination of residential and commercial developments. Indirect is a result of the direct development, as it provides additional residencies for people who will be working in the new office building or commercial establishment, as well as new businesses to serve subsequent residential and nonresidential-engendered expenditures (e.g., convenience stores, restaurants, various professional services, etc.).

In the second step, the regional highway network in the travel demand model is updated with highway improvements related to the new development. These changes would likely impact both local and regional travel patterns as the improvements usually provide more capacity, reducing the congestion and improving mobility. Therefore, more users will be attracted to the improved highways after the improvements are implemented.

In the third step the travel demand model is used to estimate the new travel patterns, i.e., vehicle volumes and vehicle-miles traveled (VMT) on the highway network adjacent to the new development. The results can be compared to traffic volume and VMT before the highway improvement, and the induced travel due to

[10] **Braess's paradox**, credited to the mathematician Dietrich Braess, states that adding extra capacity to a transporation network, when the drivers selfishly choose their route to minimize their individual travel time (cost), can in some cases reduce overall performance. The final effect of this paradox is that an extension (or widening) of the road network may cause a redistribution of the existing traffic that results in longer individual travel times (cost).

rerouting can be calculated as the difference between the two.

In the fourth step a land use model is employed and implemented, based on the travel impedances obtained from the travel demand model executed in the third step. The underlying land use is equivalent to that immediately after completion of the analyzed residential and/or nonresidential development. The land use model will determine the changes in location of residences and jobs in the region as a result of changed travel times (impedances) between regions' zones due to the implemented highway improvements. The new pattern of household and job locations (land use) is then fed back into the travel demand model, which can now be used to estimate the traffic flows on the regional highway network with the new land use. Comparison of these results with the outputs obtained from the travel demand model in the third step will reveal the induced travel due to changes in land use resulting from the initial (direct and indirect) development and related highway improvements.

Changes in the transportation system and land use (i.e. location of residences and jobs) are mutually dependent; therefore, procedures explained in steps three and four can be repeated in an iterative fashion to obtain incremental projections of land use and travel patterns (e.g. in 5-year increments) following the real estate development and related highway improvement.

Modeling Methodology

To ascertain the impact of induced traffic, as a result of increased highway capacity on the two principal arterials, it is necessary to determine travel demand and vehicle-miles traveled associated with the initial (direct) development and indirect development in the study area. The methodology applied in this study utilizes a travel demand model to estimate the impact of direct and indirect development, and a combination of travel demand and land use models to estimate induced effects. A series of model runs of both travel-demand and the land use model are executed to capture all three elements of change in traffic as they relate to highway improvements. The following is a description of phases in which the modeling methodology is executed.

PHASE 1: Baseline

- Run the baseline travel demand model (before any development).
- Capture the vehicle-miles traveled (VMT) by origin-destination (O-D) pair on principal arterials in the vicinity of zones representing the area of the intended development.

PHASE 2: Direct Development Impacts

- Add the direct residential and commercial development in the studied zones. The new development is expressed in terms of additional population and dwelling units (households), as well as additional jobs.
- Update the trip generation data in the travel demand model (trip attractions and productions will change as a result of the direct development).
- Rerun the travel demand model and capture the VMT by O-D on selected highway links serving the studied area (zones).

PHASE 3: Indirect Development Impacts

- Add the indirect residential and commercial development in the studied zones. The indirect development is expressed in terms of additional population and dwelling units (households), as well as additional jobs.
- Update the trip generation data in the travel demand model (trip attractions and productions will change as a result of the indirect development).
- Rerun the travel demand model and capture the VMT by O-D on selected highway links serving the studied area (zones).

PHASE 4: Highway Improvement

- Improve the highway facilities that serve the studied area (i.e. new developments). The improvements are ex-

pressed in terms of increase in highway capacity.

- Rerun the travel demand model and capture the VMT by O-D on selected highway links serving the studied area (zones).

PHASE 5: Reallocation of Jobs and Households

- Based on the regional and zonal demographic, socio-economic and land use data, and travel patterns obtained from the travel demand model executed in PHASE 4, develop a land use model for the region. The purpose of the land use model in this phase is to provide the forecasts of household and employment locations immediately following the direct and indirect developments and highway improvements.
- The land use model should consider (as inputs) zone-to-zone travel impedances produced by the travel demand model in PHASE 4. It should also produce (as outputs) the number of jobs and households in each zone.
- In the land use model the employment and household minima are set for the analyzed zones at the current level (PHASE 4), and regional population and employment growth is disregarded (i.e. it is assumed there is no population and employment growth on the regional level). This scenario would reveal a shift in location of existing households and jobs as a result of new developments and highway improvements. It is relevant only in the short time period following the improvements (0-5 years).
- Capture the data on future locations of jobs and households by zone in the region.

PHASE 6: Induced Development and Travel Impacts

- Update the demographic and employment data in the trip generation module of the regional travel demand model, based on outputs from the land sue model in PHASE 5 (trip attractions and productions will change as a result of the induced development).
- Rerun the travel demand model and capture the VMT by O-D on selected highway links.

PHASE 7: Regional Change in Land Use (5-year projection)

- Update the impedances (zone-to-zone travel times) in the land use model based on the outputs from the travel demand model obtained in PHASE 6. These impedances are assumed to impact location decisions (for both jobs and residences) in the region five years after the analyzed developments and highway improvements.
- In the land use model the regional population and employment growth is set according to regional projections, while keeping the employment and household minima for the zones located within the analyzed community. This scenario provides conditions for analysis of the regional changes in location of jobs and households considering projected population and economic growth for a period of 5 years following the land development and corresponding infrastructure improvements.

As mentioned in the methodology description, the applicable land use modeling tool must be able to consider (i.e., accept as an input) estimated zone-to-zone impedances or travel times. This is one of the basic outputs of the regional travel demand models. As an output, it should be able to produce the forecasted location of jobs and households (or residences) on a zonal level.

The above described methodology is demonstrated using three case studies of hypothetical residential and commercial developments in three different regions. The case studies are presented next.

CASE STUDY: DES MOINES, IOWA

The study area selected for this case study is located in the region of the Des Moines Area

Metropolitan Planning Organization (DMAMPO). To facilitate the implementation of the proposed methodology, the Des Moines Area travel-demand forecasting model was obtained. Based on the socioeconomic and land use data provided by the DMAMPO, as well as the trip impedances produced by the travel demand model, a land use model was developed using the TELUM land use modeling software. The background on the TELUM land use modeling software is provided in Appendix III-B of this Procedural Guide.

About the Case Study Area

The case study takes place in the Des Moines Area Metropolitan Planning Organization (DMAMPO) in Des Moines, Iowa. The DMAMPO is located in south-central Iowa. On the U.S. scale, it is considered to be a small-to-medium sized MPO, with a population of about 394,000 people, and an employment base of approximately 248,000 jobs.[11] The MPO covers an area of about 320,000 acres. The regional highway network is dominated by three interstate highways (I-35, I-80, and I-235) and three U.S. highways (US 6, US-65, and US-69). Des Moines area regional highway network is shown in Figure I-1.

The entire region is divided into 641 traffic analysis zones (TAZs). The TAZ structure is based on the US Census Blocks. For each TAZ the research team assembled a dataset required by the DMAMPO travel demand forecasting model and the TELUM land use model, including detailed demographic, employment, and land use data.

The Case Study is located in a community encompassing five (5) TAZs, namely TAZ 113 and TAZ 122 to 125. The community ("community") has 15,758 residents living in 6,402 dwelling units or households. There are 4,797 jobs. The total land area is 2,573.44 acres. Of the total area, 1,005.53 acres are for residential and 493.20 acres are for commercial land use. The street and highway network occupies 448.65 acres, and 295.15 acres are available for development.

The community is served by several collector streets and minor arterials, and two principal arterials. The two principal arterials run north-south and east-west and intersect in the middle of the community. The length of each arterial through the community is approximately 3 miles. These are 4-lane arterials with signalized intersections, and capacity varying between 28,000 and 32,000 vehicles per day in both directions. The locations of the community and two principal arterials are shown in Figure I-2.

Case Study Land Development and Highway Improvements

Before proceeding with the case study description, it is important to note that the proposed residential and nonresidential developments, as well as the highway improvements described in this case study, do not represent actual (existing or planned) projects. Rather, they should be regarded as realistic exercises whose purpose is to showcase a modeling approach for estimating the cost implications of new land development.

[11] Based on the 2000 U.S. Census and data provided by the Des Moines Area MPO.

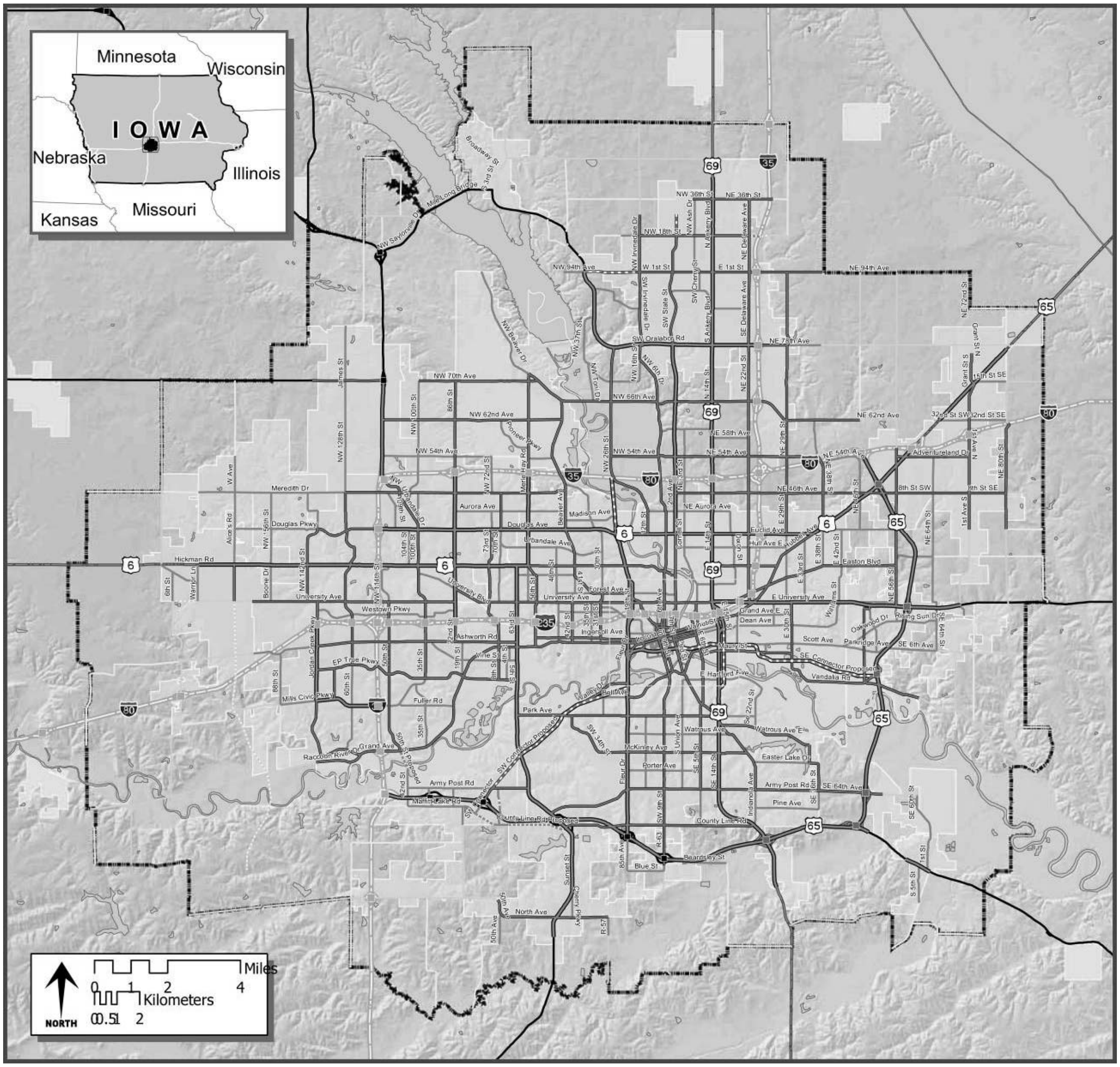

Figure I-1. Des Moines Area MPO regional boundaries and highway network

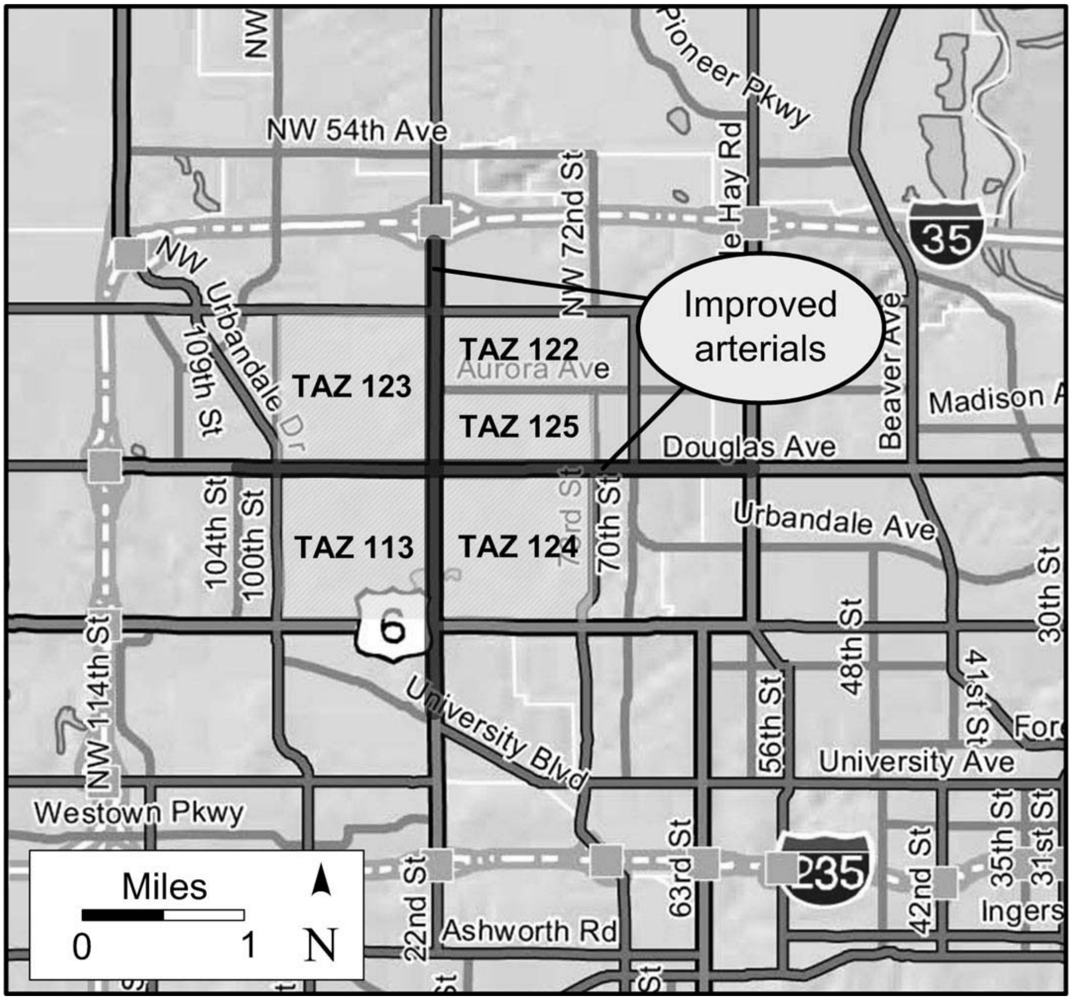

Figure I-2. The case study is located within the community of five TAZs – 113, 122-125

Direct New Development

Land development analyzed in the case study is located in the vicinity of the intersection and along the two principal arterials in the community. The new development includes:

- Residential – two- and three-bedroom townhouses with 1,000 dwelling units (households) and 2,500 new residents (1,500 employed residents, 250 school-children); and
- Commercial – three office buildings with 1,100 on-site jobs (all in Services sector).

The community's population after this direct development will grow to 18,258, and number of households to 7,402. The employment will grow to 5,897 jobs. The community will also have 1,880 school children.

Indirect New Development

As a result of the new development, additional jobs in the retail sector will be created in the same community. In addition, new employee households (supported by jobs in direct development) will locate in the new housing in the community. The additional development will add:

- 120 dwelling units (households),
- 360 new residents (180 employed residents, 37 schoolchildren), and

- 250 jobs (all in Retail sector).

These additional residential and commercial developments are referred to as indirect new development, as they come as a result of initial direct development.

Total New Development

Ultimately, after both direct and indirect development, the community will have 18,618 residents occupying 7,522 households. There will also be 6,148 jobs in the community, and 1,917 children of school age.

Highway Improvements

To support the new development's transportation needs, the two principal arterials adjacent to the developments are upgraded. These 4-lane arterials with signalized intersections are upgraded to include intersection signalization improvements, construction of left-turn lanes, and lane widening at several locations. The improvements are implemented on sections of the two arterials within the community. These improvements increase road capacity to 40,000 vehicles per day in both directions.[12]

Induced Development

The highway capacity improvement increases the attractiveness of the community as a location for new jobs and households. The capacity increase will attract more through-traffic to the arterials. Some of those traveling through the community on their way between home and work may decide to relocate their households and jobs near or even within the analyzed community. These are considered to be induced effects of the new land development and related transportation system improvements.

Direct and indirect developments, as well as induced relocation of jobs and residencies and rerouting of trips, will put a burden on the local highway network. In order to estimate the transportation infrastructure costs associated with each component of the demand (direct, indirect, induced), it is necessary to identify the corresponding amount of travel, usually expressed in vehicle-miles traveled.

Case Study Results

The results are summarized in Table I-1, Table I-2, and Table I-3. Table I-1 reports the annual local traffic VMT as well as the total annual VMT (including both local and through traffic) on two arterials for each phase of the modeling process (referred to as scenarios in the table and the analysis that follows). The local traffic consists of trips with either trip end (origin and/or destination) in one of the five zones comprising the analyzed community. Conversely, through-traffic consists of trips that have neither trip-end within the analyzed community. The table also provides the average V/C (volume over capacity) ratio on the arterial sections within the community as the measure of traffic congestion. The V/C ratios indicate that the local arterials were already operating at capacity and were congested before the new development was introduced. The Baseline case had a V/C ratio of 1.02. The local traffic accounted for 29.8 percent of all VMT on the two principal arterials serving the 5-TAZ community in which the new development was located.

The incremental changes in population, households and employment in the community are shown in Table I-2, while Table I-3 provides an overview of incremental increases in total and local VMT between different scenarios.

The addition of new development with 2,500 people, 1,000 households and 1,100 jobs added 1.95 million VMT per year, a 3 percent increase in the total VMT over the baseline. At the same time, however, VMT of local traffic increased by 3.8 million. This means that the number of through-trips was displaced and thus decreased as the local trips occupied more of the available capacity. Indeed, the local traffic, including the traffic generated by the direct development, accounted for 34.57 percent of the total VMT.

[12] The initial capacity was 28,000 and 32,000 vehicles per day in both directions.

Because the highway improvements have not been made, the travel conditions deteriorated as more VMT were added, increasing the average V/C ratio to 1.06.

Adding the indirect development in the community of 360 people, 120 households and 250 jobs, and without any highway improvements, would generate another 1.16 million VMT annually, a 1.72 percent increase over the VMT inclusive of direct impacts. Most of this increase came as a result of the indirect development (86 percent, as shown in Table I-3), increasing the share of local traffic VMT to 35.45 percent. The V/C ratio increased to 1.07 as the arterials become more heavily congested.

Table I-1. Annual VMT for different scenarios in Des Moines case study

Phase	Scenario	Total VMT	Local VMT	Local VMT as % of Total	Average V/C
1	Baseline[13]	65,254,389	19,435,905	29.78%	1.02
2	Direct Development[14]	67,207,135	23,233,901	34.57%	1.06
3	Direct and Indirect Development[15]	68,365,321	24,236,655	35.45%	1.07
4	Direct and Indirect Development with Highway Improvement[16]	78,288,091	25,688,405	32.81%	0.91
5, 6	Induced-1: land use shift[17]	79,620,490	26,982,527	33.89%	0.93
7, 8	Induced-2: regional growth (5 yr.)[18]	86,041,228	29,901,400	34.75%	1.01
7, 8	Induced-3: regional growth (10 yr.)[19]	95,393,512	31,687,968	33.22%	1.12

[13] ***Baseline*** = This is the highway network and zonal trip tables before any new development

[14] ***Direct*** = Direct development in the community produced new trips. Highway network remained unchanged.

[15] ***Direct + Indirect*** = Indirect development was added in the community. Together with the direct development, it generated additional local trips. Highway network remained unchanged.

[16] ***Direct + Indirect + Hwy upgrade*** = Travel demand remained the same as in the previous scenario. The highway capacity on two principal arterials serving the community increased by approximately 30 percent.

[17] ***Induced-1: land use shift*** = There is a relocation of population and employment and thus existing travel demand (relocation of zonal trip productions and attractions) as a result of providing additional capacity on two arterials. No growth in the regional population and employment was assumed. The changes in locations of jobs and households are calculated using the TELUM land use model.

[18] ***Induced-2: regional growth (5 yr.)*** = 9 percent growth in regional population and 5.7 percent growth in employment after the highway improvement. TELUM is used to forecast allocation of portion of the households and jobs in the community. This allocation creates new future travel demand (new zonal trip productions and attractions). This is calculated by implementing TELUM land use model for the first 5-year increment.

[19] ***Induced-3: regional growth (10 yr.)*** = 18.8 percent growth in regional population and 11.7 percent growth in employment after the highway improvement. TELUM is used to forecast allocation of portion of the households and jobs in the community. This allocation creates new future travel demand (new zonal trip productions and attractions). This is calculated by implementing TELUM land use model for the second 5-year increment.

Table I-2. Change in population, households, and employment in the community

Development[20]	Added Population	Added Households	Added Jobs
Direct	2,500	1,000	1,100
Indirect	360	120	250
Induced-1: immediate	-33	-12	995
Induced-2: 5 years	1,682	678	290
Induced-3: 10 years	72	27	1,457
Total	**4,581**	**1,813**	**4,092**

[20] Direct and Indirect change in population/households and jobs is known and is an external input, while induced changes (immediate, 5 years and 10 years following the development) are calculated using TELUM.

Table I-3. Change in VMT between modeling phases

Phase	THROUGH (REGIONAL) TRAFFIC			LOCAL TRAFFIC				
	Total VMT	Incremental Increase	Cumulative Increase	Total VMT	Incremental Increase	Cumulative Increase	Incremental Increase as a % of Total Increase	% Increase Compared to Induced-2 Cumulative[21]
Baseline	45,818,484	--	--	19,435,905	--	--		--
Direct Development	43,973,234	-1,845,250	-1,845,250	23,233,901	3,797,996	3,797,996	195%	36%
Direct and Indirect Development	44,128,666	155,432	-1,689,818	24,236,655	1,002,754	4,800,750	68%	10%
Direct and Indirect Development with Highway Improvement	52,599,686	8,471,020	6,781,202	25,688,405	1,451,750	6,252,500	14%	14%
Induced-1: Land Use Re-allocation	52,637,963	38,277	6,819,479	26,982,527	1,294,122	7,546,622	97%	12%
Induced-2: Regional Growth (5 yr.)	56,139,828	3,501,865	10,321,344	29,901,400	2,918,873	10,465,495	45%	28%

[21] These percentages are calculated as ratios between incremental increase in local traffic in each phase and cumulative VMT increase in local traffic after Induced-2 phase (10,465,495 VMT).

After introducing both direct and indirect development in the analyzed community, the DMAMPO transportation model network was updated by increasing the capacity of the arterials to 40,000 vpd, a 30 percent increase. The model was then re-run. As the capacity of the arterials increased, travel conditions improved (i.e. travel times decreased) and more traffic was attracted to the newly upgraded roads. The lower travel time on the arterials caused a portion of local traffic that used alternative routes in and out of the community to be switched to the arterials. In addition, many through-trips (that did not have either origin or destination within the community) switched to the improved arterials as well, as they provided faster travel with less congestion.

The model recorded an increase of nearly 10 million VMT in total, a 14.5 percent increase compared to the level before the highway improvements took place. At the same time local traffic increased by 1.45 million VMT and made up 32.81 percent of the total traffic. The average V/C ratio dropped to 0.91, indicating more moderate traffic conditions. The fact that the local traffic increased after the highway improvements without any additional developments indicates that a portion of the trips that would have used the adjacent arterials before the improvements, avoided these roads due to congestion. After the improvement was implemented these trips switched onto the arterials.

Ascertaining direct, indirect, and induced transportation implications

At this point in the analysis it is possible to calculate the direct, indirect, and the first two components of the induced traffic. Using the data provided in Table I-3 one can conclude that the direct traffic impact is equal to the additional local traffic generated as a result of introducing the direct development: in this case this would be 3,797,996 VMT per year. It can also be noted that the pressure of the local traffic “chased out” some of the through-traffic, reducing it by 1,845,250 VMT per year. The indirect traffic impact can be estimated as the additional (incremental) traffic recorded after the indirect development is added to the network. This is 1,002,754 VMT per year. Unlike the traffic generated by the direct development, this additional traffic had no impact on rerouting the through traffic (it actually grew marginally by 155,432 VMT per year).

The component of the induced traffic, capturing the new trips attracted by the direct or indirect development, is estimated as a difference in local VMT before and after the introduction of highway improvements. This induced traffic captures the trips that were attracted to the community after the capacity on local arterials has been added. They account for 1,451,750 VMT annually. The second component of the induced traffic includes the through-trips that were re-routed to the arterials traversing the community after the roadway improvements were implemented. This impact, in terms of VMT increase, can be estimated as the difference between the total increase in traffic after the introduction of highway improvements and the combined increase in traffic due to direct and indirect development and the first component of the induced traffic: This is calculated as 6,781,202 VMT. The calculation is shown below:

(1) Total increase in traffic:	78,288,091 - 65,254,389	=	13,033,702 VMT
(2) Direct impact:		=	3,797,996 VMT
(3) Indirect impact:		=	1,002,754 VMT
(4) Induced local trips:		=	1,451,750 VMT
Induced through-trips:	(1) – [(2) + (3) +(4)]	=	6,781,202 VMT

It is revealing that the component of the induced traffic via through-trips immediately following the roadway improvement contributed to the overall traffic increase as much as the sum of all additional trips associated with the direct and indirect development, and local induced trips.

Impact of land use changes on induced development

The analysis so far did not consider the relocation of jobs and households (i.e. change of land use) as the result of the community development as well as the growth in regional population and employment. The TELUM land use model was used to estimate regional land use changes and to calculate the changes in the analyzed community.

The baseline TELUM model captures the moment after the direct and indirect development has taken place and the highway improvements have been completed. It uses the inter-zonal travel time impedances from the travel demand forecasting model. Two scenarios were developed. In scenario Induced-1 there were no changes in the regional population, number of households, and employment. However, their location was allowed to change from one zone to another.

The TELUM model estimated the 5-zone community would attract additional 995 jobs, but would lose population and households (Table I-2). This seems to indicate that the improved mobility increased the attractiveness of the community for commercial rather than residential development. Consequently, the trip attractions and productions in the community changed. This is illustrated by the results of the travel demand model run after updating the trip generation attributes for all zones in the DMAMPO region based on the TELUM outputs. The total increase in traffic on two analyzed roadways was 1,332,399 VMT annually, while the local VMT increased by 1,294,122 (Table I-3). This means that most of the additional VMT (approximately 97 percent) was generated by the new development in the community, while a small portion of the increase came as a result of increase in through traffic. The increase of external traffic may suggest that certain households and jobs may have located near the community to take advantage of capacity improvements on the arterials. Of course, the share of local traffic measured as a percentage of total VMT increased from 32.81 percent to 33.89 percent, and because more traffic used the same facility, the V/C ratio increased from 0.91 to 0.93 (Table I-1).

Graphical interpretation of TELUM outputs, showing the relative zonal changes in employment and number of households in zones adjacent to the highway improvement, is provided in Figure I-3 and Figure I-4. In Figure I-4 one can observe that all five TAZs attracted more jobs. Employment in zone 123 increased by more than 25 percent. Figure I-4 shows that three TAZs (123, 113, and 124) lost population, while TAZs 122 and 125 increased in population.

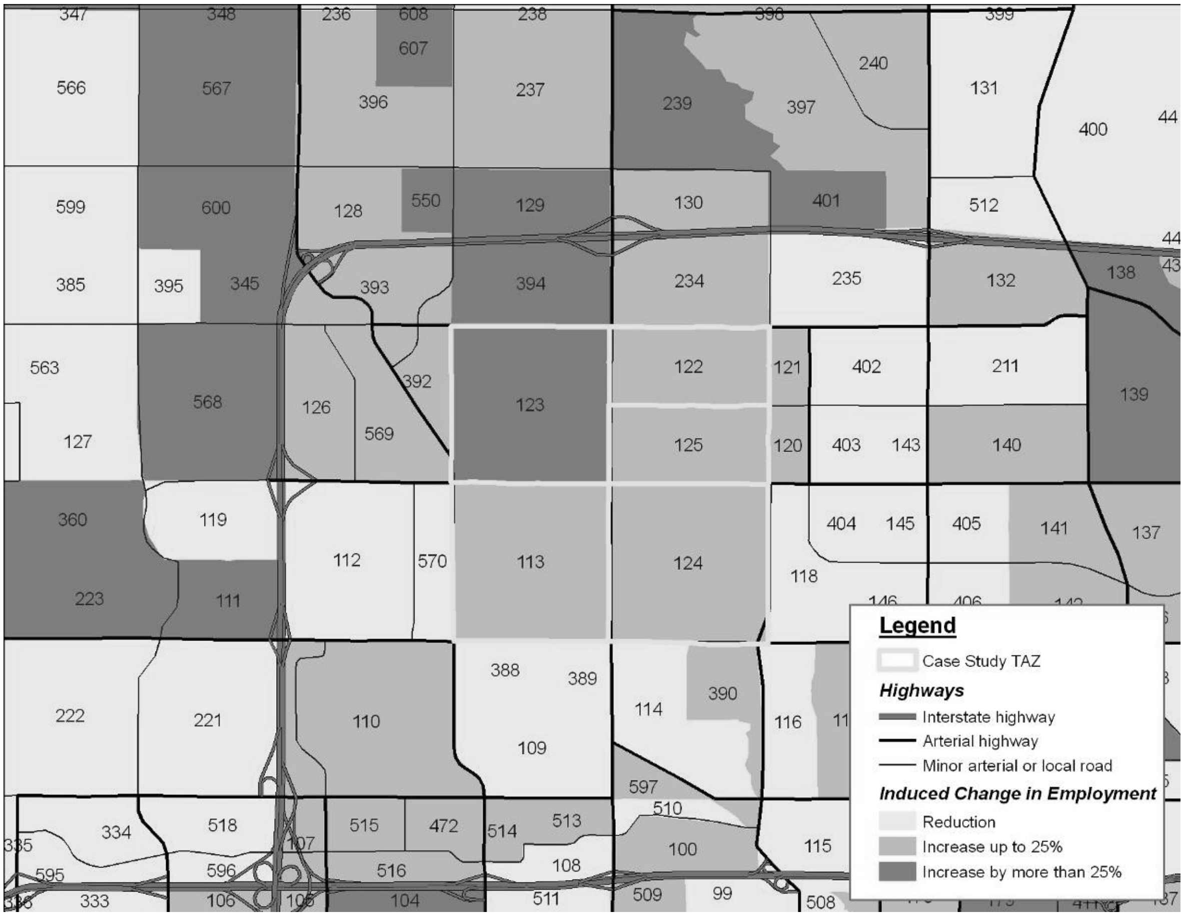

Figure I-3. Induced zonal change in employment following the land use shift (No growth in regional employment or population is assumed.)

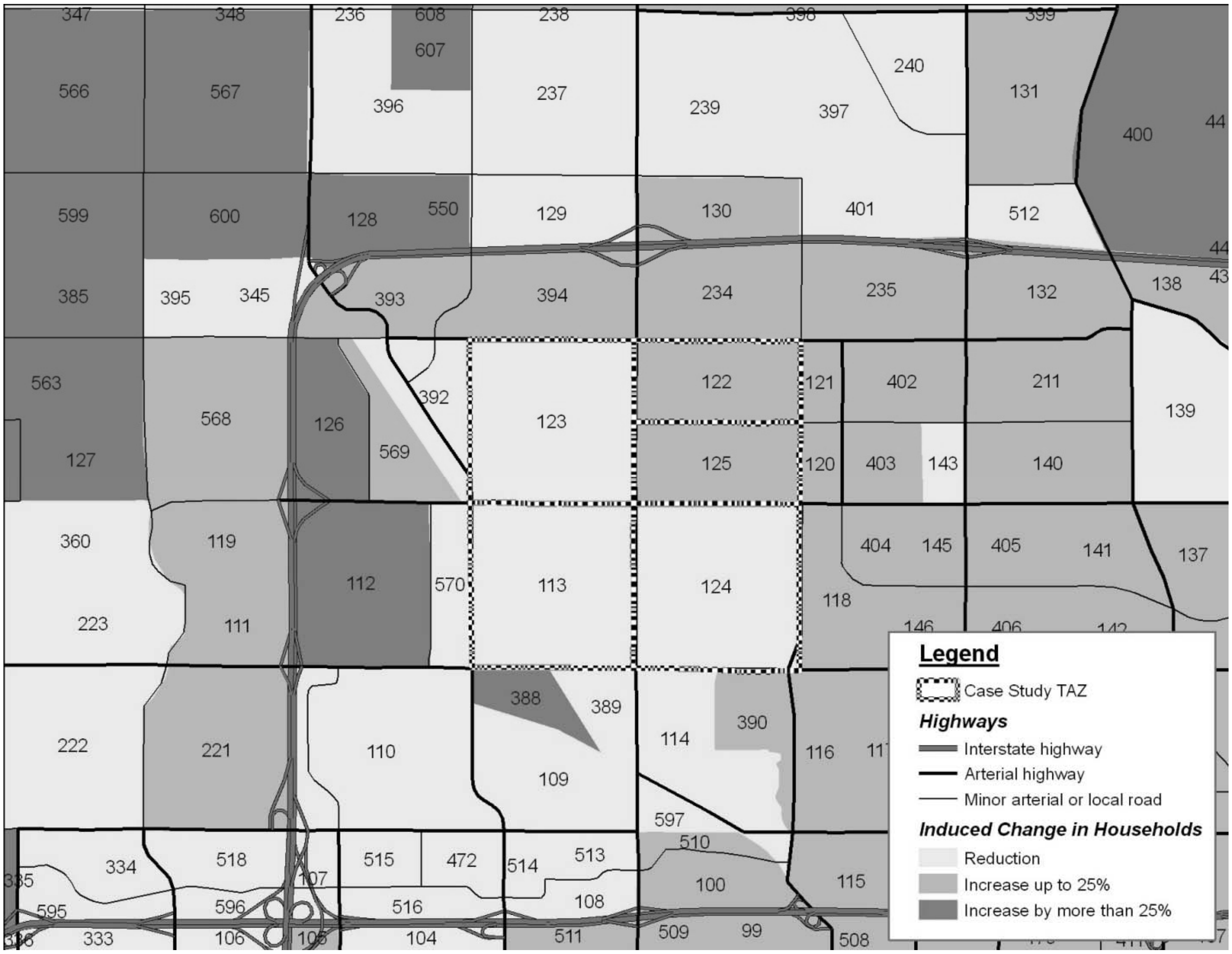

Figure I-4. Induced zonal change in number of households following the land use shift (No growth in regional employment or population is assumed.)

Scenario Induced-2 uses the same inter-zonal travel times, but allows a 9 percent growth in regional population and a 5.7 percent growth in employment in the first 5 years following the highway improvement. The TELUM model forecasted that 678 more households and 290 jobs would locate in the community as the result of this regional growth (Table I-2). After feeding the revised employment and residential locations into the trip generation module, a new run of the regional travel demand model was executed to calculate the VMT. As expected, the local traffic increased by 2,918,873 VMT (Table I-3) while additional 3.5 million VMT were added by the through-trips. The traffic conditions on the arterials traversing the community deteriorated, bringing the V/C ratio to 1.01 (Table I-1), which is the congestion level it had prior to all real estate developments and highway improvements. This means that the improved traffic conditions on the local arterials were able to accommodate the growth. However, the congestion is now at the same level where it was prior to the development.

The impact of the further increase in number of jobs and households in the community as the result of the overall regional growth was estimated for a period of 5-10 years after the development by running scenario Induced-3 in TELUM. The travel times between zones were updated with estimates from the latest run of the travel demand model and were fed into the TELUM along with regional population and employment growth estimates. The regional population growth rate was kept at 9 percent and employment growth rate at 5.7 percent in the second five-year period. The subsequent TELUM model run forecasted locations of jobs and households 10 years after land development and implementation of the highway improvements. As shown in Table I-1, Table I-2, and Table I-3, the new developments were attracted to the studied community (including 27 new households and 1,457 new jobs), generating yet more travel demand. The local traffic increased by 1,786,568 VMT while additional 1,144,978 VMT were added by the through-trips. The increase in VMT caused congestion levels to rise significantly, driving the average V/C ratio on local arterials to 1.12 (Table I-1). At this point it would be necessary to implement new improvements in the local transportation system to alleviate the growing congestion.

Allocating Cost of Capacity Improve ments to Constituents

The change in the local and through-trip[22] VMT for each phase of the model is shown in Table I-2. After the capacity improvements have been made on the arterials, the traffic has been re-routed, the existing residential and business entities re-located and the 9 percent growth in regional population and 5.7 percent growth in employment has occurred (as per modeling phase Induced-2), the two arterials would carry 56,139,828 VMT of through traffic and 29,901,400 VMT of local traffic. The change from the baseline is reflected in an increase of 10,321,344 VMT in through traffic and 10,465,495 VMT in local traffic. The local traffic represents 50.35 percent of the total[23] increase in the overall traffic between Baseline and the modeling phase Induced-2.

The VMT can be used as a proxy to allocate the cost of improvements to the users of the arterials who are the primary beneficiaries of the capacity improvement. In doing so, one may consider incremental VMT of local and through traffic following the new development and related traffic improvements. Thus, the cost of the capacity improvement can be allocated 49.65 percent to through traffic and 50.35 percent to local traffic.

The allocation of the local traffic's share could be further broken down. Analyzing the results provided in Table I-3, it can be calculated that 60 percent of the increase in local traffic (and the corresponding cost) can be allocated to the users associated with the new development.[24]

[22] Through-trip VMT is calculated as [Total VMT] – [Local VMT]; this is shown in Table I-1.

[23] Total VMT increase is a sum of increase in local traffic VMT (10,465,495) and through traffic VMT (10,321,344), and is equal to 20,786,839 VMT.

[24] This includes 36 percent associated with the development's direct traffic (3,797,996 VMT per year), 10 percent with the indirect traffic (1,002,754 VMT per year), and 14 percent with the

Additional 12 percent should be allocated to the residents and businesses that located (re-allocated) to the community as they added additional 1,294,122 VMT per year to local traffic. These entities are likely taking advantage of the new arterial capacity improvements; thus, similarly to the value capture in transit practice, they should bear the cost of the capacity improvement.

Finally, the remaining 28 percent of increase in local traffic is associated with the additional regional growth induced under scenario Induced-2 (9 percent growth in regional population and 5.7 percent growth in employment), i.e. jobs and households that decided to locate in the community. They should bear corresponding 28 percent of the cost of capacity improvements.

CASE STUDY: COLORADO SPRINGS

About the Case Study Area

The second case study takes place in the metropolitan region of Colorado Springs, Colorado. The region is located in central Colorado and, besides the City of Colorado Springs, it includes six other incorporated municipalities, and some unincorporated portions of two counties, El Paso and Teller. It is considered to be a medium-sized metropolitan area, with the resident population of 587,000 persons, according to 2005 estimates. In the same year the region was estimated to have an employment base of 332,000 jobs, including close to 40,000 active duty military personnel and support staff.

The regional highway network is dominated by the interstate highway I-25, which connects Colorado Springs with Denver, 60 miles to the north, and Pueblo, 45 miles to the south. U.S. Route 24 passes through the area in a path shaped like a broad U, from northwest (via mountain passes) to northeast (toward interstate highway I-70). The other major highway through the area is Academy Boulevard (Colorado highway 83), which connects to I-25 north and south of the city as it passes east of the central business district.

Regional planning for this region is the responsibility of the Pikes Peak Area Council of Governments (PPACG), a metropolitan planning organization (MPO) headquartered in Colorado Springs. The transportation and regional land use planning in the MPO are supported by a travel demand model and TELUM land use model. The models include all of the Teller and El Paso counties, consisting of 676 Traffic Analysis Zones (TAZ), and covering close to 2,690 square miles. The MPO area with its key roadways and cities, as well as the location of the MPO in the state of Colorado is shown in Figure I-5.

The case study development area is located in a community encompassing five (5) TAZs, namely TAZ #91, #95, #423, #607, and #608. The community ("community") has 7,931 residents living in 3,587 dwelling units or households. There are 5,434 jobs. The total land area is 978.27 acres. Of the total area, 404.09 acres are for residential and 324.76 acres are for commercial land use. The street and highway network occupies 214.34 acres, and 40.45 acres are available for development.

The community is served by several collector streets and minor arterials, and two principal arterials. The two principal arterials run north-south (Academy Boulevard) and east-west (Palmer Park Boulevard) and intersect in the middle of the community. The Academy Boulevard is a 6-lane arterial, running almost through the entire length of Colorado Springs. Palmer Park Boulevard is a 4-lane arterial. Other east-west roads are four-lane minor arterials with signalized intersections. The location of the community and the street network are shown in Figure I-6.

development's re-routed traffic (1,451,750 VMT per year).

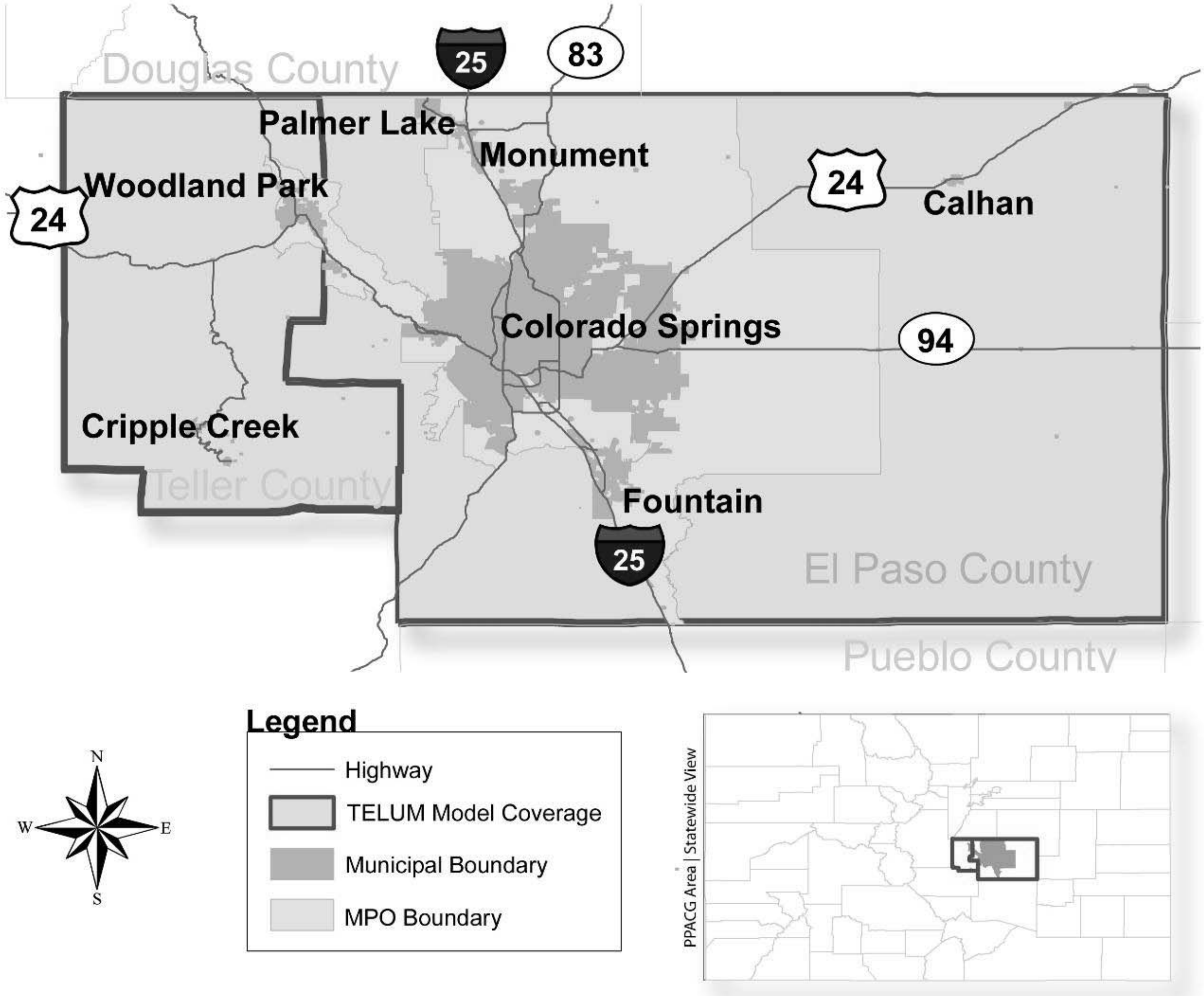

Figure I-5. PPACG regional boundaries and highway network

Figure I-6. The case study is located within the community of five TAZs – #91, #95, #423, #607 & #608; Boundaries are Constitution Ave. on the north, N. Murray Blvd. on the east, Platte Ave. (US-24) on the South and N. Chelton Rd. on the west.

Case Study Land Development and Highway Improvements

As in the Des Moines case study, the proposed residential and nonresidential developments, as well as the highway improvements described in this case study, do not represent actual (existing or planned) projects. Rather, they are hypothetical examples that should be regarded as realistic exercises whose purpose is to showcase a modeling approach for estimating cost implications of new land development. As will be outlined, the Colorado Springs case study will be based on an identical direct and indirect development example already used in the Des Moines case study.

Direct New Development

The hypothetical land development analyzed in the case study is located along the Academy Boulevard and in the vicinity of its intersection with Palmer Park Boulevard. The new development includes:

- Residential – two- and three-bedroom condominiums with 1,000 dwelling units (households) and 2,500 new residents (1,500 employed residents); and
- Commercial – three office buildings with 1,100 on-site jobs (all in Services sector).

The community's population after this direct development will grow to 10,431, and number of households to 4,587. Employment will grow to 6,534 jobs.

Indirect New Development

As a result of the new development, additional jobs in the retail sector will be created in the same community. The new employee households (supported by jobs in direct development) will also locate in the new housing in the community. The indirect development will add:

- 120 dwelling units (households),
- 360 new residents (180 employed residents), and
- 250 jobs (all in the retail sector).

These additional residential and commercial developments are referred to as indirect new development, as they come as a result of initial direct development.

Total New Development

Ultimately, after both direct and indirect development, the community will have 10,791 residents occupying 4,707 households. There will also be 6,784 jobs in the community.

Highway Improvements

To support the new development's transportation needs, the arterials serving the community are upgraded. The upgrades include intersection signalization improvements, construction of left-turn lanes, and lane widening at several locations. The improvements are implemented on sections of the two arterials within the community. These improvements increased road capacity by 25 percent on all of Academy Blvd. and Palmer Park Blvd. in the development area, and by 25 percent on the connector E. La Salle St. between the two one-way sections of Academy just south of Constitution Ave. Road improvements were as follows:

- Palmer Park Blvd. – road capacity increase from 17,000 to 21,250 vehicles/day;
- E. La Salle – road capacity increase from 14,000 to 17,250 vehicles/day;
- Academy Blvd. north of San Miguel – road capacity increase from 25,500 to 31,875 vehicles/day
- Academy Blvd. south – road capacity increase from 27,000 to 33,750 vehicles/day

Induced Development

The highway capacity improvement increased the attractiveness of the community as a location

for new jobs and households. As in the previous case study, the capacity increase is expected to attract more through-traffic to the arterials. Some of those traveling through the community on their way between home and work may decide to relocate their households and jobs near or even within the analyzed community. These are considered to be induced effects of the new land development and related transportation system improvements.

Direct and indirect developments, as well as induced relocation of jobs and residencies and rerouting of trips, will put a burden on the local highway network. In order to estimate the transportation infrastructure costs associated with each component of the demand (direct, indirect, induced), it is necessary to identify the corresponding amount of travel, usually expressed in vehicle-miles traveled.

Case Study Results

The results are summarized in Table I-4, Table I-5, and Table I-6. The summary in Table I-4 provides the daily local traffic VMT as well as the total daily VMT (including both local and through traffic) on all arterials providing access to the community in each phase of the modeling process (referred to as scenarios in the table and the analysis that follows). As defined in the Des Moines case study the local traffic consists of trips with either trip end (origin and/or destination) in one of the five zones comprising the analyzed community. Conversely, through-traffic consists of trips that have neither trip-end within the community.

Relatively low average V/C ratio on arterial sections traversing the community before and after the development (ranging between 0.356 and 0.368) suggests an absence of traffic congestion. The increased percentage of local traffic on arterials following the direct and indirect development (going from 24.03 percent to 27.53 percent) is a logical and expected result thereof. The percentage falls slightly (to 27.05 percent) after introducing the highway improvements in the model, which suggests that through-traffic increasingly uses the routes traversing the community, taking advantage of improved traffic conditions. This can be further analyzed and in more depth using the data provided in Table I-5 and Table I-6.

Table I-5 shows incremental changes in population, households and employment in the community, while Table I-6 provides an overview of incremental increases in total and local VMT between different scenarios. The addition of new development with 2,500 people, 1,000 households and 1,100 jobs added 3,920 VMT per day, a 2.4 percent increase in the total VMT over the baseline. At the same time, however, VMT of local traffic increased by 5,616. This means that the number of through-trips was displaced and thus decreased (by 1,696 VMT/day) as the local trips occupied more of the available capacity. Indeed, the local traffic, including the traffic generated by the direct development, accounted for 26.83 percent of the total VMT, up from 24.03 percent in the baseline. Because the highway improvements have not been made, the travel conditions became worse (i.e. travel times increased), thus causing through-trips to shift to other, more efficient (i.e., faster) routes than those traversing the community.

Adding the indirect development in the community of 360 people, 120 households and 250 jobs, and without any highway improvements, generated another 920 VMT/day, a 0.6 percent increase over the VMT inclusive of direct impacts. All of the increase came as a result of the indirect development, with a continuing decline of the through-traffic VMT (decrease of 512 VMT/day, or 0.3 percent) caused by a relative worsening of traffic conditions on the local arterials under the added pressure of local trips (Table I-6). Despite the increase in VMT, the average V/C ratio on local arterials remained moderate at 0.368.

Table I-4. Annual VMT for different scenarios in Colorado Springs case study

Phase	Scenario	Total VMT	Local VMT	Local VMT as % of Total	Average V/C
1	Baseline[25]	163,247	39,230	24.03%	0.356
2	Direct Development[26]	167,167	44,846	26.83%	0.366
3	Direct and Indirect Development[27]	168,087	46,278	27.53%	0.368
4	Direct and Indirect Development with Highway Improvement[28]	173,651	46,970	27.05%	0.343

Table I-5. Change in population, households, and employment in the community

Development[29]	Added Population	Added Households	Added Jobs
Direct	2,500	1,000	1,100
Indirect	360	120	250
Induced-1: immediate change in land use	175	77	44
Total	**3,035**	**1,197**	**1,394**

[25] ***Baseline*** = This is the highway network and zonal trip tables before any new development
[26] ***Direct*** = Direct development in the community produced new trips. Highway network remained unchanged.
[27] ***Direct + Indirect*** = Indirect development was added in the community. Together with the direct development, it generated additional local trips. Highway network remained unchanged.
[28] ***Direct + Indirect + Hwy upgrade*** = Travel demand remained the same as in the previous scenario. The highway capacity on two principal arterials serving the community increased by approximately 25 percent.
[29] Direct and Indirect change in population/households and jobs is known and is an external input, while induced changes (immediate and 5 years following the development) are calculated using TELUM.

Table I-6. Change in daily VMT between modeling phases

Phase	THROUGH (REGIONAL) TRAFFIC			LOCAL TRAFFIC			
	Total VMT	Incremental Increase	Cumulative Increase	Total VMT	Incremental Increase	Cumulative Increase	Incremental Increase as a % of Total Increase
Baseline	124,017	-	-	39,230	-	-	-
Direct Development	122,321	-1,696	-1,696	44,846	5,616	5,616	143%
Direct and Indirect Development	121,809	-512	-2,208	46,278	1,432	7,048	156%
Direct and Indirect Development with Highway Improvement	126,681	4,872	2,664	46,970	692	7,740	12%

After introducing both direct and indirect development in the analyzed community, the PPACG transportation model network was updated by increasing the capacity of the arterials by 25 percent. The results of the updated model run show that as the capacity of the arterials increased, travel conditions improved (i.e., travel times decreased) and thus more traffic was attracted to the newly upgraded roads. The model recorded an increase of nearly 5,564 VMT/day in total, a 3.3 percent increase compared to the level before the highway improvements took place. The local traffic increased by 692 VMT/day, making up 27.05 percent of the new total traffic. The fact that the local traffic slightly increased after the highway improvements without any additional developments indicates that a small portion of the trips that would have used the adjacent arterials before the improvements, avoided these roads due to availability of better alternatives. More importantly, many through-trips (that do not have either origin or destination within the community) switched to the improved arterials as well, as they provided faster travel than alternative routes. Through-traffic VMT increased by 4,872 VMT/day, a 2.9 percent increase compared to the scenario without highway improvements.

Ascertaining direct, indirect, and induced transportation implications

Using the data provided in Table I-6 it is possible to ascertain the direct, indirect, and the first two components of the induced traffic impacts of the new development. Similar to the approach taken in the Des Moines case study, the results show that the direct traffic impact of the new development is equal to the additional local traffic generated after introducing the direct development: in this case this would be 5,616 VMT/day. Here again it can be noted that the pressure of the local traffic "chased out" some of the through-traffic, reducing it by 1,696 VMT per day. The indirect traffic impact can be estimated as the additional (incremental) traffic recorded after the indirect development was added to the network. This is 1,432 VMT/day. It can be noted that additional traffic generated by the indirect development made the traffic conditions in the vicinity marginally worse for the through traffic as well, reducing it by 512 VMT per day.

The first component of the induced traffic, capturing the new trips attracted by the direct or indirect development, is estimated as a difference in local VMT before and after the introduction of highway improvements. This induced traffic captures the trips that were attracted to the community after the capacity on local arterials had been added. They account for 692 VMT/day. The second component of the induced traffic includes the through-trips that were re-routed to the arterials traversing the community after the roadway improvements were implemented. This impact, in terms of VMT increase, can be estimated as a difference between the total increase in traffic after the introduction of highway improvements and the combined increase in traffic due to direct and indirect development and the first component of the induced traffic. This is calculated as 2,664 VMT/day. The calculation is shown below:

(1) Total increase in traffic on the two arterials: 173,651 - 163,247		=	10,404 VMT
(2) Direct impact:		=	5,616 VMT
(3) Indirect impact:		=	1,432 VMT
(4) Induced local trips:		=	692 VMT
Induced through-trips:	(1) – [(2) + (3) +(4)]	=	2,664 VMT

In this case study, the induced traffic attributed to through-trips shifting to newly improved roadways accounts for approximately 25.6 percent of the overall increase in traffic following the roadway improvements. This is relatively smaller impact than that observed in the Des Moines case study, where the contribution of this component of induced demand accounted for 52 percent of the overall increase in total VMT. This was a result of a severe highway congestion observed in the Des Moines case study, where increase in capacity on improved roadways in the community caused a large portion of through traffic to take advantage of the new capacity. The average V/C ratio on analyzed highways in the Des Moines case study dropped from 1.07 to 0.91, even with the additional traffic. In the PPACG case study, this is not the case, as improvements in the highway network within the community do not generate such a large effect on the regional highway capacity. The V/C ratio before the highway improvement was 0.368, only to drop to 0.343 following the improvements. Still, both before and after the improvements, the network did not show signs of traffic congestion measured by the average V/C ratio.

Impact of land use changes on induced development

In this phase of the analysis the TELUM land use model was used to estimate the relocation of jobs and households (i.e. change of land use) as the result of the community development, as well as the growth in regional population and employment.

As in the Des Moines case study, the baseline TELUM model captures the moment after the direct and indirect development has taken place and the highway improvements have been completed. It uses the inter-zonal travel time impedances from the travel demand forecasting model as a measure of interaction intricacy between the regional zones. In model scenario Induced-1 there were no changes in the regional population, number of households, and employment. However, their location was allowed to change from one zone to another.

The TELUM model estimated the 5-zone community would attract additional 175 residents in 77 households, as well as 44 additional jobs (Table I-5). The additional jobs are in the Services and Retail sectors. This seems to indicate that the improved mobility increased the attractiveness of the community for both commercial and residential development. Consequently, the trip attractions and productions in the community increased. Graphical interpretation of TELUM outputs, showing the relative zonal changes in employment and number of households in zones adjacent to the highway improvement, is provided in Figure I-7 and Figure I-8. As shown in Figure I-7, four TAZs in the community (all but TAZ #95) attracted additional jobs; Figure I-8 shows that all five development TAZs gained population, as did most of the neighboring TAZs.

In order to quantify the impact of the changes in land use (i.e., regional relocation of jobs and households) on the analyzed highways within the community, it is necessary to repeat the run of the travel-demand model with the updated socioeconomic inputs (as per TELUM results). Since this analysis phase could not be completed for the PPACG case study due to technical difficulties in integrating the land use and travel-demand model, it is possible only to estimate the impacts using the analogy from previous phases, as well as the Des Moines case study.

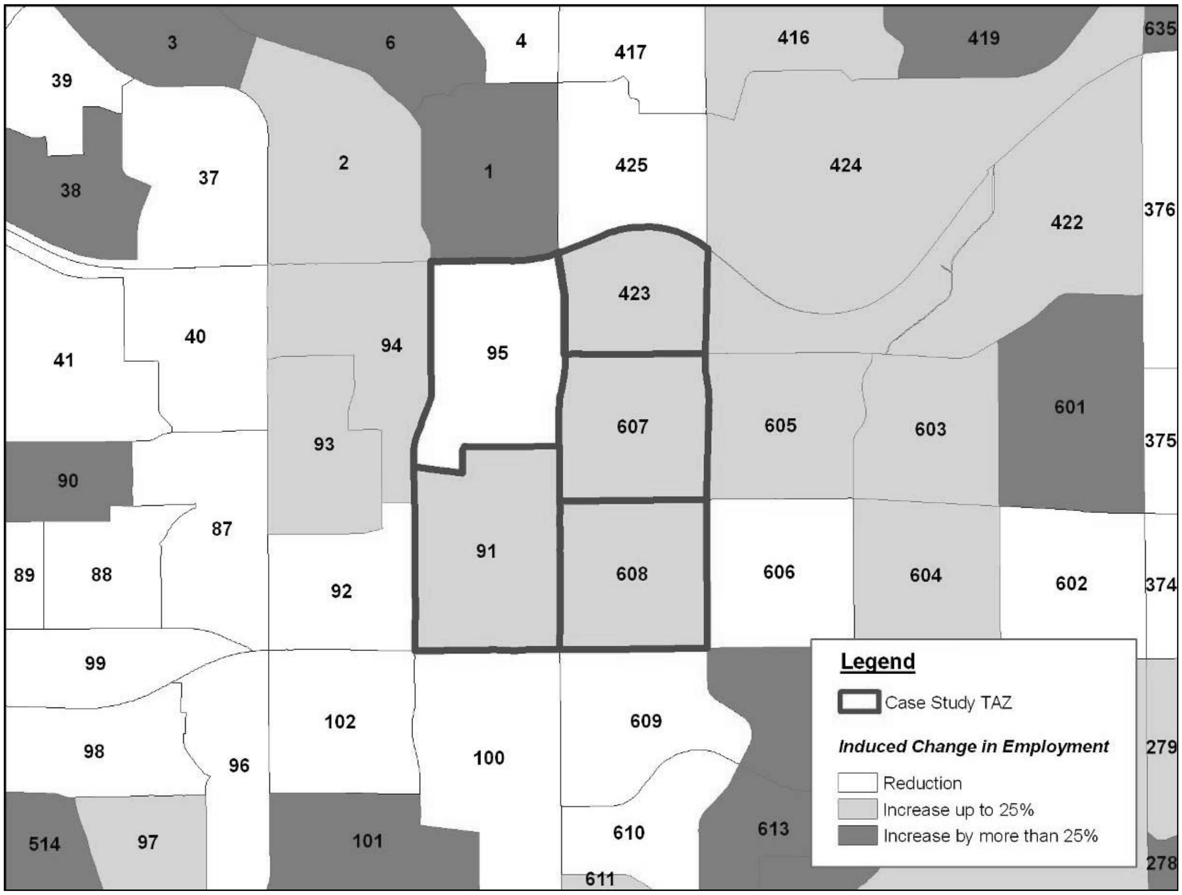

Figure I-7. Induced zonal change in employment following the land use shift (No growth in regional employment or population is assumed.)

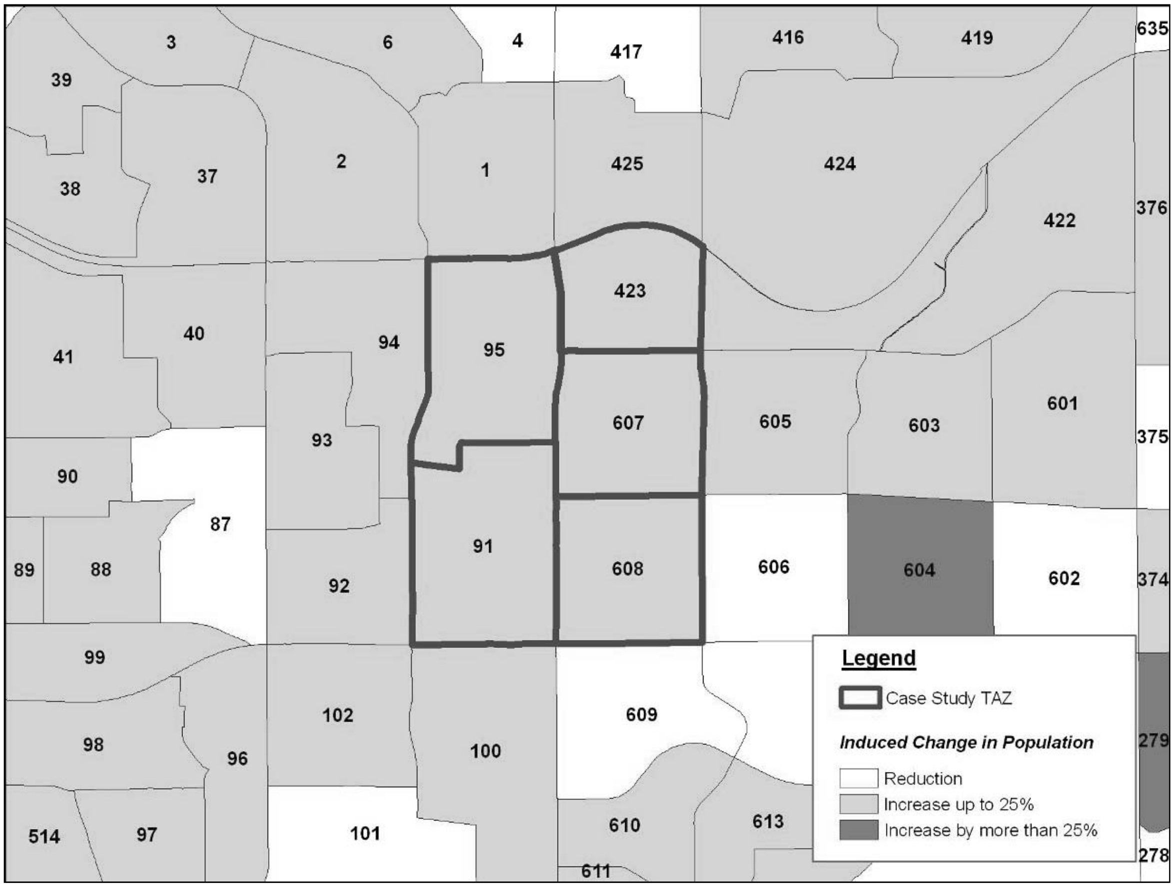

Figure I-8. Induced zonal change in population following the land use shift (No growth in regional employment or population is assumed.)

Knowing that both population and employment were attracted to the community following the highway improvements, it can be expected that they will generate additional trips and thus (local) VMT on analyzed highways. Assuming that same rates of travel are maintained as in the previous phase of the analysis, it can be expected that induced development resulting from land changes (around 1.6 percent increase in population and 0.6 percent increase in number of jobs) would generate rather moderate increase in VMT. From Figure I-7 and Figure I-8 it can also be concluded that most of the neighboring TAZ's attracted jobs and households, who are likely to utilize the arterials within the community as through routes. It is likely that these trips will also have impact on the overall VMT on arterials traversing the community

Allocating Cost of Capacity Improve ments to Constituents

The change in the local and through-traffic[30] VMT for each phase of the model is shown in Table I-6. After the capacity improvements have been made on the arterials and the traffic has been re-routed, the analyzed arterials would have had 173,651 daily VMT, including 46,970 local VMT and 126,681 through-traffic VMT. The relative change compared to the baseline is reflected in an increase of 2,664 VMT/day resulting from the through-traffic, and 7,740 VMT/day resulting from the local traffic. Thus, local traffic represents almost 74 percent of the

[30] Through-traffic VMT are calculated as [Total VMT] – [Local VMT] and they are shown in table 5.1

total[31] increase in the overall traffic between baseline and the modeling phase following the highway improvements.

Using the VMT as a proxy to allocate the cost of improvements, as explained in section 4.4 of this report, one could allocate 74 percent of the cost to local traffic and 26 percent to through-traffic. Of course, these percentages should be revised after completing the analysis for phases Induced-1 and Induced-2.

CASE ST UDY: BR OWNTOWN A REA I N OLD B RIDGE T OWNSHIP, MIDDLESEX COUNTY, NEW JERSEY

About the Case Study Area

The study area selected for this case study is located in the southeast portion of the Middlesex County in New Jersey. It is one of the most populated and most developed counties in New Jersey, with population of approximately 750,000 people, and an employment base of approximately 370,000 jobs[32]. Middlesex County covers an area of about 208,000 acres. It is situated in the central part of New Jersey, relatively close to both State's administrative center Trenton in the south and regional commercial centers: New York City in the north and Philadelphia in the south. This makes it a great location for both businesses and households looking for a quick and efficient access to these centers. The regional highway network is dominated by interstate highway I-95 (a toll-road, New Jersey Turnpike), and U.S. highways US-1 and US-130, all being a part of the I-95 corridor, the busiest highway corridor in the Northeast. This north-south corridor is complemented by equally busy US-9 and Garden State Parkway (a toll-road), which are especially congested during summer months as they provide access to New Jersey's shore resorts and beaches. The east-west traffic is predominantly served by Interstate I-287 and State Route NJ-18, also very busy and congested highway corridors. The regional highway network is shown in Figure I-9.

The case study development is located in a community in the southeastern part of the Middlesex County (Figure I-10). The current community in the area has 11,956 residents living in 4,719 dwelling units or households. There are 1,826 jobs in the community, most of which are in education and various service industries (government, financial, and trade). The total land area is 1,733 acres. Of the total land area, approximately 600 acres are for residential and 200 acres are for commercial use. The street and highway network occupies 280 acres, and approximately 200 acres are available for development.

[31] Total increase of daily VMT is a sum of increase in local traffic daily VMT (8,017) and through traffic daily VMT (2,416), and is equal to 10,433 VMT.
[32] Based on the 2000 U.S. Census.

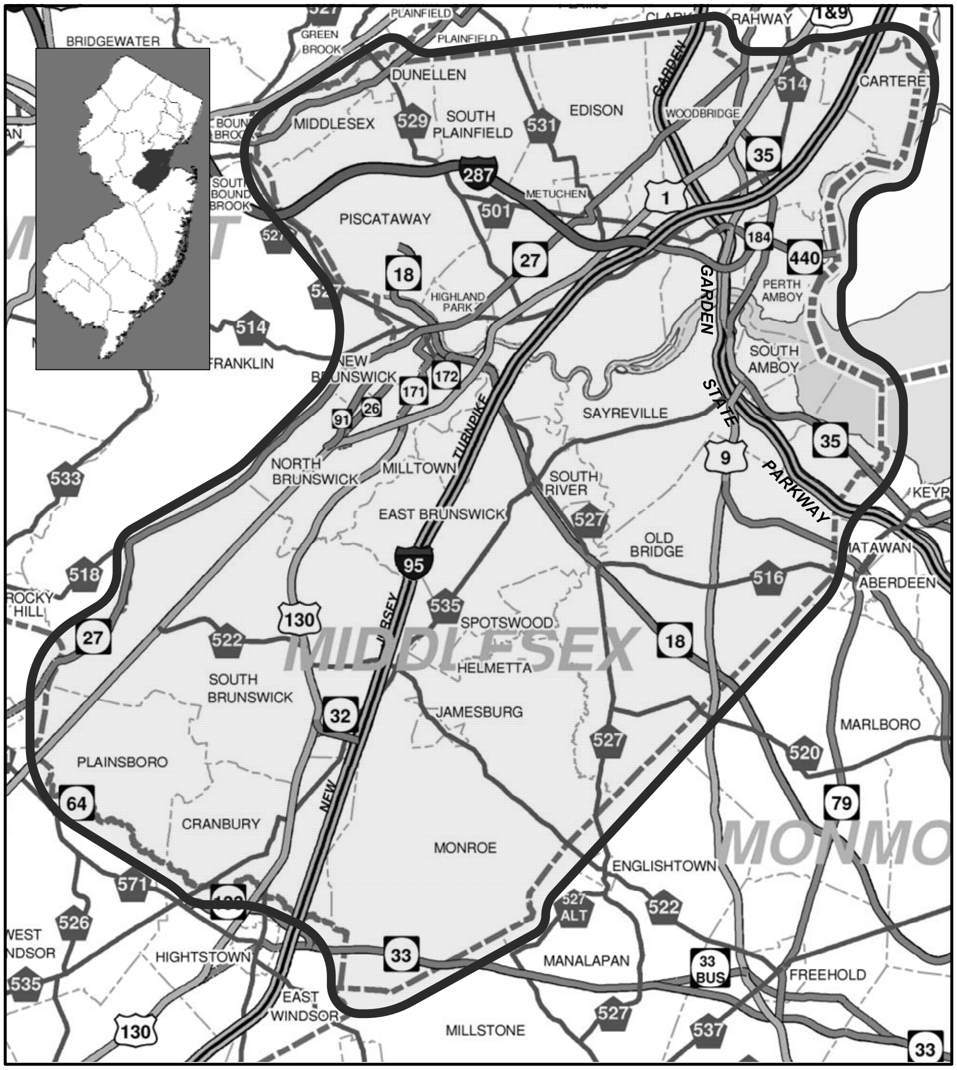

Figure I-9. Middlesex County, NJ boundaries and highway network

The community is served by a principal arterial (US-9), a minor arterial (County Road 516), and several collector streets and a network of residential and commercial access roads. As shown in Figure I-10, US-9 runs north-south, and County Road 516 east-west. The length of each arterial through the community is approximately 1.5 miles. The two roads intersect in the middle of the community via a grade separated interchange. US-9 is a divided three-lane per direction highway with limited access. The County Road 516 is a two-way two-lane road, but it expands to two lanes per direction at the interchange with US-9. Intersections of the County Road 516 with other roads within the community are all signalized. The US-9 has another grade-separated interchange south of the one with County Road 516; otherwise, intersections with other roadways within the community are signalized. The AADT (Average Annual Daily Traffic) at US-9 is around 70,000 vehicles per day, and at County Road 516 around 20,000 vehicles per day. The average baseline V/C (volume-to-capacity) ratio of the roadways in the community exceeds 1.0 during morning and afternoon peak hours.

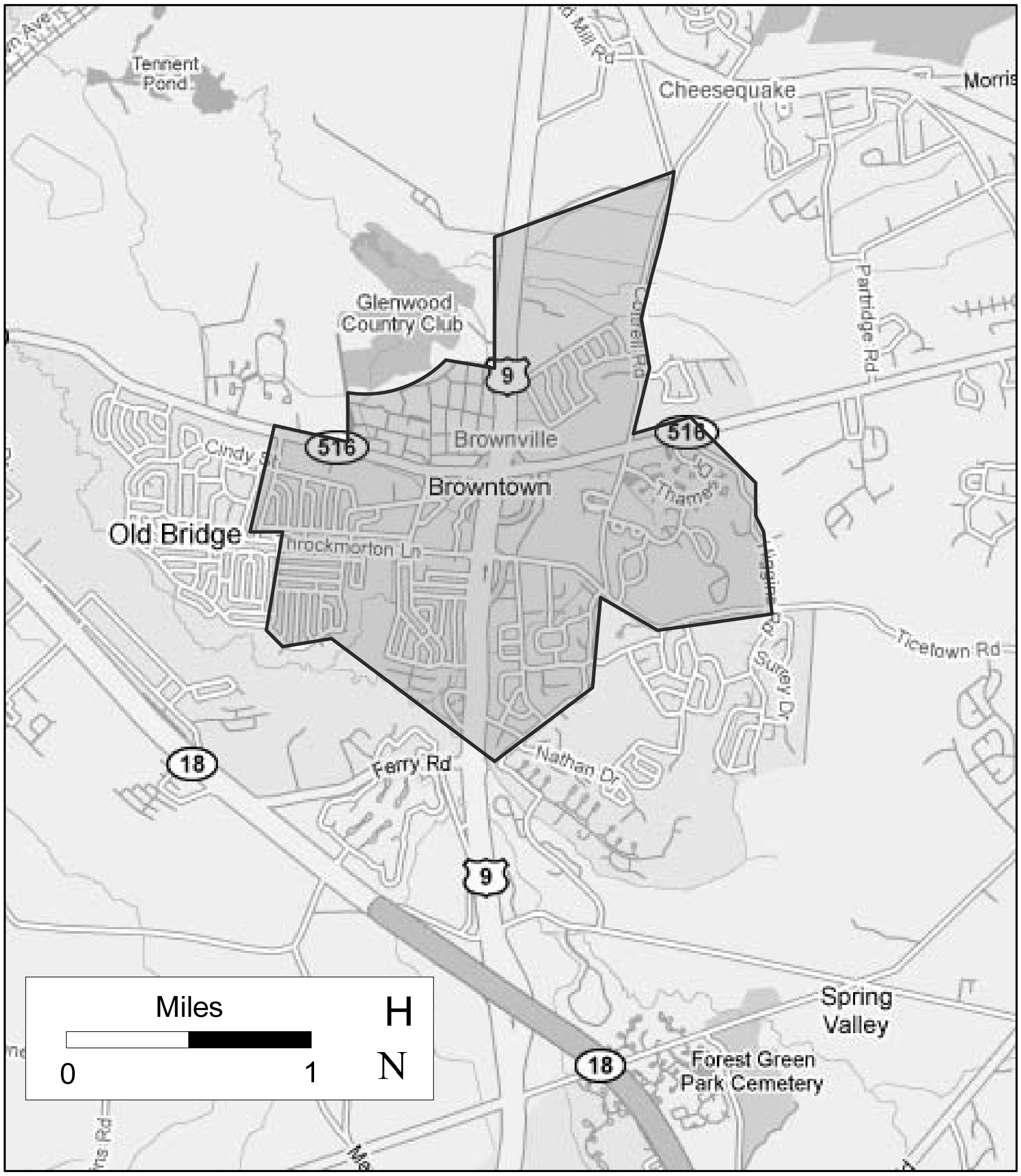

Figure I-10. The location of the case study community

Case Study Land Development and Highway Improvements

As in the previous two case studies of Des Moines, Iowa and Pikes Peak, Colorado, the proposed residential and non-residential developments, as well as the highway improvements described in this case study do not represent actual (existing or planned) projects. Rather, they should be regarded as realistic exercises whose purpose is to showcase a modeling approach for estimating cost implications of new land developments.

Direct New Development

Land development analyzed in the Middlesex, NJ case study is located in the vicinity of the interchange and along the two arterials in the community. The new development includes:

- Residential – two- and three-bedroom townhouses with 880 dwelling units (households) and 2,200 new residents (1,050 employed residents); and
- Commercial – three office buildings with 710 on-site jobs (all in professional services and education sectors).

The community's population after this direct development will grow to 14,156, and number of households to 5,599. The employment will grow to 2,536 jobs.

Indirect New Development

As a result of the new development, additional jobs in the retail sector will be created in the same community. In addition, new employee households (supported by jobs in direct development) will locate in the new housing in the community. The additional development will add:

- 120 dwelling units (households),
- 291 new residents (180 employed residents), and
- 192 jobs (all in Retail sector).

These additional residential units and commercial space are referred to as indirect new development, as they come as a result of initial direct development.

Total New Development

Ultimately, after both direct and indirect development, the community will have 14,446 residents occupying 5,719 households. There will also be 2,728 jobs in the community.

Highway Improvements

To support the new development's transportation needs, the arterial highways (US-9 and County Road 516) are upgraded. The upgrades include intersection signalization improvements, construction of left-turn lanes where needed, lane widening at several locations, and adding a lane in each direction on the County Road 516 east of the interchange. The improvements are implemented on sections of the two arterials within the community. These improvements increase the overall road capacity by approximately 20 percent on these two roadways.

Induced Development

The highway capacity improvement increased the attractiveness of the community as a location for new jobs and households. The capacity increase will attract more through-traffic to the arterials. Some of those traveling through the community on their way between home and work may decide to relocate their households and jobs near or even within the analyzed community. These are considered to be induced effects of the new land development and related transportation system improvements.

Direct and indirect developments, as well as induced relocation of jobs and residencies and rerouting of trips, will put a burden on the local highway network. In order to estimate the transportation infrastructure costs associated with each component of the demand (direct, indirect, induced), it is necessary to identify the corresponding amount of travel, usually expressed in vehicle-miles traveled.

Integrated Travel Demand and Land Use Model for Middlesex County

The modeling of regional travel in this case study was done using the TRANSIMS modeling software. TRANSIMS (Transportation Analysis and Simulation System) is an activity-based transportation modeling package developed by Los Alamos National Laboratory with the funding from the FHWA. It is an integrated system of travel forecasting models that generate trips based on activities at specific locations within the region, and then simulate second-by-second movements of every person and every vehicle in the transportation network. The simulation considers the interactions between

vehicles rather than applying deterministic traffic operations equations. The TRANSIMS model for the Middlesex County was developed as part of two recent research projects conducted at NJIT and Rutgers University. The land use modeling part of analysis was realized using the TELUM land use model.

For the modeling purposes the entire Middlesex County was divided into 576 zones (coinciding with US Census Block Groups). The model has 14,154 activity locations. The community, which was the focus of the new development and this case study, consists of nine zones and 75 activity locations.

The feedback loop between TRANSIMS and TELUM was implemented to estimate induced demand resulting from changes in land use patterns, similar to the modeling approach used in the previous two case studies. Mode details about integration of TRANSIMS and TELUM is provided in Appendix III-C.

Case Study Results

The results of the analysis are summarized in Table I-7, Table I-8, and Table I-9. The annual local traffic VMT, as well as the total annual VMT on two arterials and collector streets within the community are summarized in Table I-7. The VMT is summarized for each phase of the modeling process (referred to as scenarios in the table and the analysis that follows). Similar to the previous case studies, the local traffic consists of trips with either trip end (origin and/or destination) in one of the nine zones comprising the analyzed community. Conversely, through-traffic consists of trips that have neither trip-end within the analyzed community. The table also provides the average V/C (volume-to-capacity) ratio on the arterial sections within the community as the measure of traffic congestion.

As shown in Table I-7, the local arterials were operating almost at capacity and were congested even before the new development was introduced. The Baseline case had a V/C ratio of 0.9. The local traffic accounted for 17.16 percent of all VMT on local sections of two arterials and collector streets. The incremental changes in population, households and employment in the community are summarized in Table I-8, while Table I-9 provides an overview of incremental increases in total and local VMT between different scenarios. The addition of new development with 2,200 people, 880 households and 710 jobs added 831,019 VMT per year, a 3.4 percent increase in the total VMT over the Baseline. At the same time, however, VMT of local traffic increased by almost 1.5 million. This means that a fairly large number of through trips was displaced and thus decreased through-traffic VMT as the local trips occupied more of the available capacity. Indeed, the local traffic, including the traffic generated by the direct development, accounted for 22.48 percent of the total VMT, compared to 17.16 percent before the direct development. Because the highway improvements have not been made, the travel conditions deteriorated as more VMT were added, increasing the average V/C ratio to 1.01.

Table I-7. Annual VMT for different scenarios Browntown case study

Phase	Scenario	Total VMT	Local VMT	Local VMT as % of Total	Average V/C
1	Baseline[33]	24,589,179	4,218,923	17.16%	0.90
2	Direct Development[34]	25,420,198	5,713,559	22.48%	1.01
3	Direct and Indirect Development[35]	25,584,356	5,925,577	23.16%	1.19
4	Direct and Indirect Development with Highway Improvement[36]	26,603,108	6,240,729	23.46%	0.95
5, 6	Induced-1: land use shift[37]	26,683,401	6,927,836	25.96%	0.99
7, 8	Induced-2: regional growth (5 yr.)[38]	28,654,401	8,240,444	28.76%	1.07

Table I-8. Change in population, households, and employment in the community

Development[39]	Added Population	Added Households	Added Jobs
Direct	2,200	880	710
Indirect	290	120	192
Induced-1: immediate	813	301	0
Induced-2: 5 years	1,085	478	48
Total	**4,388**	**1779**	**950**

33 *Baseline* = This is the highway network and zonal trip tables before any new development

34 *Direct* = Direct development in the community produced new trips. Highway network remained unchanged.

35 *Direct + Indirect* = Indirect development was added in the community. Together with the direct development, it generated additional local trips. Highway network remained unchanged.

36 *Direct + Indirect + Hwy upgrade* = Travel demand remained the same as in the previous scenario. The highway capacity on two principal arterials serving the community increased by approximately 30 percent.

37 *Induced-1: land use shift* = There is a relocation of population and employment and thus existing travel demand (relocation of zonal trip productions and attractions) as a result of providing additional capacity on two arterials. No growth in the regional population and employment was assumed. The changes in locations of jobs and households are calculated using the TELUM land use model.

38 *Induced-2: regional growth (5 yr.)* = 9 percent growth in regional population and 5.7 percent growth in employment after the highway improvement. TELUM is used to forecast allocation of portion of the households and jobs in the Community. This allocation creates new future travel demand (new zonal trip productions and attractions). This is calculated by implementing TELUM land use model for the first 5-year increment.

39 Direct and Indirect change in population/households and jobs is known and is an external input, while induced changes (immediate, 5 years and 10 years following the development) are calculated using TELUM.

Table I-9. Change in VMT between modeling phases

Phase	THROUGH (REGIONAL) TRAFFIC			LOCAL TRAFFIC				
	Total VMT	Incremental Increase	Cumulative Increase	Total VMT	Incremental Increase	Cumulative Increase	Incremental Increase as a % of Total Increase	% Increase Compared to Induced-2 Cumulative [40]
Baseline	20,370,256	-	-	4,218,923	-	-	-	-
Direct Development	19,706,639	- 663,618	-663,618	5,713,559	1,494,637	1,494,637	180%	37%
Direct and Indirect Development	19,658,778	-47,860	-711,478	5,925,577	212,018	1,706,655	129%	5%
Direct and Indirect Development with Highway Improvement	20,362,379	703,601	-7,877	6,240,729	315,151	2,021,806	31%	8%
Induced-1: Land Use Re-allocation	19,755,565	-606,814	-614,691	6,927,836	687,107	2,708,913	856%	17%
Induced-2: Regional Growth (5 yr.)	20,413,957	658,391	43,701	8,240,444	1,312,609	4,021,522	67%	33%

[40] These percentages are calculated as ratios between incremental increase in local traffic in each phase and cumulative VMT increase in local traffic after Induced-2 phase (10,465,495 VMT).

A similar outcome is recorded after introducing the indirect development. As one can see in Table I-7, annual local VMT increased by 212,018, while overall VMT increased by 164,168. This means that more through traffic shifted away from the roadways traversing the community (creating a decrease of 47,860 VMT) under the pressure of the newly generated local traffic.

After introducing both direct and indirect development in the analyzed community, the TRANSIMS model network was updated to reflect the transportation improvements and upgrades. This was done by appropriately increasing capacity of the mainline arterials, intersections, and approaches from collector streets. The model was then re-run to obtain new travel patterns.

As the capacity of the arterials increased, travel conditions improved (i.e. travel times decreased) and thus more traffic was attracted to the newly upgraded roads. The lower travel time on the arterials caused that a portion of local traffic that used alternative routes in and out of the community switched to the arterials. In addition, many through trips (that do not have either origin or destination within the community) switched to the improved arterials as well, as they provided faster travel with less congestion.

The model recorded an increase of nearly 1.02 million VMT in total, a 4 percent increase compared to the level before the highway improvements took place. At the same time local traffic increased by 315,151 VMT and made up 23.46 percent of the total traffic. The average V/C ratio dropped to 0.95, indicating somewhat better traffic conditions.

The fact that the local traffic increased after the highway improvements without any additional developments indicates that a portion of the trips that have used the adjacent arterials before the improvements, avoided these roads due to congestion. After the improvement was implemented these trips switched onto the arterials, in addition to the new trips that were attracted to the community by local households and businesses.

Ascertaining direct, indirect, and induced transportation implications

As in the previous two case studies, the direct, indirect, and the first two components of the induced traffic can be ascertained using the results of the transportation demand and land use modeling exercise. As shown in Table I-7, the direct traffic impact is equal to the additional local traffic generated as the result of introducing the direct development: 1,494,637 VMT per year. With already very congested street network, the additional local traffic made the traffic conditions even worse, effectively causing the through traffic to reroute to avoid the community. This resulted in a reduction of through traffic by 663,618 VMT per year. The indirect traffic impact can be estimated as the additional (incremental) traffic recorded after the indirect development was added to the network. This is 212,018 VMT per year. It should also be noted that after introducing the indirect development, and an increase in local VMT resulting from it, the through travel further decreased (by 47,860 VMT), as travelers making these regional trips looked for better travel options away from the congested roadways traversing the community.

The component of the induced traffic that captures new trips attracted by the direct or indirect development is estimated as a difference of local VMT before and after the introduction of highway improvements. This induced traffic captures the trips that were attracted to the community after the capacity on local arterials has been added. They account for 315,151 VMT annually. The second component of the induced traffic includes the through trips that were re-routed to the arterials traversing the community after the roadway improvements were implemented. This impact, in terms of change in VMT, can be estimated as a difference between the total increase in traffic after the introduction of highway improvements and the combined increase in traffic due to direct and indirect development and the first component of the induced traffic. It appears that this change in VMT is negative as shown in the calculation below:

(1) Total increase in traffic:	26,603,108 - 24,589,179	=	2,013,929 VMT
(2) Direct impact:		=	1,494,637 VMT
(3) Indirect impact:		=	212,018 VMT
(4) Induced local trips:		=	315,151 VMT
Induced through trips:	(1) – [(2) + (3) +(4)]	=	- 7,877 VMT

This result reveals that, due to congestion on the roadways in the vicinity of new developments and newly created local trips, the net impact of highway improvements on the through trips is negative. This means that through trips that were shifted to roadways traversing the community after the transportation improvements did not compensate for the through trips that re-routed away from the community under the pressure of local traffic following the direct and indirect development. Of course, local trips have less flexibility than through trips to utilize different routes, and are forced to use the local arterials and collectors. Through trips have more routing options, and in congested networks such as the one analyzed in this case study they would be re-routed quicker to “make room” for local trips.

Impact of land use changes on induced development

The analysis so far did not consider the relocation of jobs and households (i.e. change of land use) as the result of the community development, as well as the growth in regional population and employment. The TELUM land use model was used to estimate regional land use changes and to calculate the changes thereof in the analyzed community.

The baseline TELUM model captures the moment after the direct and indirect development has taken place and the highway improvements have been completed. It uses the inter-zonal travel time impedances generated by TRANSIMS model to adjust the attractiveness of each zone and predict change in location of jobs and households accordingly. Two scenarios were developed for this exercise. In scenario Induced-1 there were no changes in the regional population, number of households, and employment. However, their location was allowed to change from one zone to another.

The TELUM model estimated the 9-zone community would attract additional 301 households with 813 residents, but would not attract any new jobs (Table I-8). This seems to indicate that, the improved mobility increased the attractiveness of the community for residential rather than commercial development. Consequently, the trip attractions and productions in the community changed, increasing home-based trips. This is illustrated by the results of the TRANIMS model run after updating the trip generation attributes for all zones in the Middlesex County regional model based on the TELUM outputs. The total increase in traffic on analyzed roadways was 80,293 VMT annually, while the local VMT increased by 687,107 (Table I-9). This means that all additional VMT was generated by the new development in the community, which also caused certain number of through trips to disappear.

The increase in number of households locating in the community and associated increase in traffic suggest that these households were taking advantage of capacity improvements on the arterials and approaches to the arterials, providing better access and mobility than potentially other zones in the region. Consequently, the share of local traffic measured as a percentage of total VMT increased from 23.46 percent to 25.96 percent, and because more traffic used the same facility the V/C ratio increased from 0.95 to 0.99 (Table I-7).

Graphical interpretation of TELUM outputs, showing the relative zonal changes in employment and number of households in zones

adjacent to the highway improvement, is provided in Figure I-11 and Figure I-12. As shown in Figure I-11, none of the zones within the community attracted new jobs. Additional households were attracted in some of the zones within the community, while some of the households relocated out of other zones. Overall, there was a net increase of 301 households in the community resulting from a greater attractiveness of the area following the highway improvements.

Scenario Induced-2 uses inter-zonal travel times generated by TRANSIMS model assuming induced development (additional households locating in the community following the highway improvements). This scenario also assumes 3 percent growth in regional population and a 2 percent growth in employment in the first 5 years following the highway improvements. The TELUM model forecasted that 478 more households and 48 new jobs would locate in the community as the result of this regional growth (Table I-8). After feeding the revised employment and residential locations into the trip generation module, a new run of the regional travel demand model was executed to calculate the VMT. As expected, the local traffic increased by 1,312,609 VMT per year (Table I-9) while additional 658,391 VMT were added by the through trips per year. The traffic conditions on the arterials traversing the community deteriorated, bringing the V/C ratio to 1.07 (Table I-7), which is the congestion level worse then prior to any development. This means that the improved traffic conditions on the local arterials were not able to accommodate the local and regional growth and sustain the resulting traffic. It would therefore be necessary to implement new improvements in both local and regional transportation system to alleviate the growing congestion.

Figure I-11. Induced zonal change in employment following the land use shift. (No growth in regional employment or population is assumed)

Figure I-12. Induced zonal change in number of households following the land use shift. (No growth in regional employment or population is assumed)

Allocating Cost of Capacity Improvements to Constituents

As in the first two case studies, results of the analysis can be used to ascertain the shares of local traffic and regional through traffic as they relate to consumption of highway infrastructure capacity, and consequently cost for highway maintenance and improvements. The VMT can be used again as a proxy to allocate the cost of improvements to the users of the arterials who are the primary beneficiaries of the capacity improvement. In doing so, one may consider incremental VMT of local and through traffic following the new development and related traffic improvements.

The changes in the local and through-trip VMT for each phase of the model are shown in Table I-9. After the capacity improvements have been made on the arterials, the traffic has been re-routed, the existing residential and business entities re-located and the 3 percent growth in regional population and 2 percent growth in employment has occurred (as per modeling phase Induced-2), the two arterials and collector approaches would annually carry 20,413,957 VMT of through traffic and 8,240,444 VMT of local traffic. The change from the Baseline is reflected in an increase of only 43,701 VMT in through traffic and 4,021,522 VMT in local traffic. In fact, local traffic VMT doubled as a result of direct, indirect, and induced development within the community. The local

traffic represents 99 percent of the total[41]F increase in the overall traffic between the Baseline and the modeling phase Induced-2. Thus, the cost of the capacity improvement can be allocated 99 percent to local traffic and only 1 percent to through traffic.

Looking at the components of the local development that contributed to this significant increase in local traffic, approximately 50 percent of the cost can be allocated to the users associated with the new development[42]F, and 17 percent should be allocated to the residents and businesses that located (re-allocated) to the community. These entities are likely taking advantage of the new arterial capacity improvements, thus, similarly to the value capture in transit practice, they should bear the cost of the capacity improvement.

Finally, the additional regional growth demand that was induced under scenario Induced-2 (3 percent growth in regional population and 2 percent growth in employment) that decided to locate in the community should bear 32 percent of the cost of capacity improvements. The constituents that are going to be responsible for this cost are shown in Table I-8.

CONCLUSIONS

The presented methodology for calculating transportation impacts of new residential and nonresidential development applies integrated regional travel demand and land use modeling. The methodology calculates incremental VMT associated with each element of transportation impact (direct, indirect, and induced) and thus can ascertain corresponding transportation costs if the cost of VMT is known.

Induced travel demand includes both rerouting of through-trips, as well as additional trip-making due to an increase in attractiveness of the studied community as a result of direct and indirect development.

The implementation of the methodology was demonstrated using three case studies located in Des Moines, Iowa; Colorado Springs, Colorado; and Middlesex County, New Jersey. The direct, indirect, and induced transportation cost implications for the local community are estimated by multiplying the respective VMT, as the measure of traffic demand, by the estimated cost per VMT, including capital and maintenance costs. Using the appropriate formula, each cost component (direct, indirect, and induced) can be allocated to either the local community (to be paid from local taxes and development fees) or the general traveling public (to be paid from the gasoline tax, for example).

The premises and assumptions of the modeling methodology are somewhat different from those of the calculation procedure presented in the Procedural Guide. Nonetheless, it is worth comparing the induced demand estimates calculated using the two calculation approaches. This can be done by comparing the estimates obtained in the three case studies and the illustrative example presented in the Procedural Guide. To be able to do that, the size of the new development relative to the size of the original community should be comparable among the case studies and the illustrative example. In developing the modeling case studies, it was attempted to be consistent in keeping the proportion of the new development relative to the original community size (in terms of population, housing units, and employment). The size of the hypothetical direct and indirect developments relative to the original community size in the Des Moines and Middlesex County was proportionate to that used in the illustrative example (approximately one-half). In the Colorado Springs case study it was very difficult to maintain this proportion, mainly because the character of the existing community (in terms of household, population, and employment densities) was much different from that of the hypothetical new development. However, to be able to make a meaningful comparison of the Colorado Springs analysis with the other two modeling case studies, the assumed type and size of the hypothetical new development in the

[41] Total VMT increase is a sum of increase in local traffic VMT (4,021,522) and through traffic VMT (43,701), and is equal to 4,065,222 VMT.

[42] 37 percent is associated to the development's direct traffic, 5 percent to the indirect, and 8 percent to the development's re-routed traffic.

Colorado Springs case study was identical to the one used in Des Moines case study.

The comparison of the results is presented in (Table I-10). To be consistent with the definition of induced demand outlined in the Procedural Guide, the comparison is made between the induced demand calculated in the illustrative example and estimated 5-year cumulative induced demand obtained using the modeling methodology in the three case studies. The exception is the Colorado Springs case study where a 5-year estimate was not produced by the land use model. Instead, the immediate (short term) induced demand was multiplied by 5 to obtain the surrogate 5-year estimate, assuming the "immediate" induced growth rate would not be dramatically impacted by the overall regional growth.

Interestingly, the estimated induced population and employment in Colorado Springs case study are almost identical to the estimates in the illustrative example when adjusted for the size of new development (i.e. multiplied by 2). In similar fashion, the induced population in Middlesex County case study is somewhat comparable to illustrative example, but the number of induced jobs is much smaller. On the other hand, both induced population and employment in the Des Moines case study are much higher than the corresponding estimates in the illustrative example (when case study numbers are multiplied by 2 to adjust for the relative size of new development).

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Table I-10. The transportation costs of new development (Model Testing)

	Procedural Guide Example	Des Moines	Colorado Springs	Middlesex County
Original Community Size				
Population	23,530	15,758	7,931	11,956
Housing Units	9,870	6,402	3,587	4,719
Employment	10,000	4,797	5,434	1,826
Direct Growth	Exhibit I-B.3			
Population	4,956	2,500	2,500	2,200
Housing Units	2,000	1,000	1,000	880
Employment	2,625	1,100	1,100	710
Indirect Growth	Exhibit II-2			
Population	675	360	360	290
Housing Units	263	120	120	120
Employment	500	250	250	192
Induced Growth	Exhibit III-3	5-year growth	5-year growth (extrapolation)	5-year growth
Population	1,536	1,649	875	1,085
Housing Units	613	666	385	478
Employment	653	1,285	220	48
New Total Community Size				
Population	30,697	20,267	11,666	15,531
Housing Units	12,746	8,188	5,092	6,197
Employment	13,778	7,432	7,004	2,776

These differences can be explained by the capability of the land use and travel demand models used in the case studies to ascertain the regional aspect of changes in attractiveness of the studied communities. In other words, the changes in these communities in terms of improved transportation infrastructure and associated improvement in accessibility and attractiveness are considered relative to the adjacent communities. The transportation improvement in the Des Moines case study significantly improved the traffic conditions on local arterials relative to the highly congested neighboring area. In fact, the V/C ratio on the local network was reduced by 10% following the improvements, and remained slightly lower than the baseline even with the induced demand. This resulted in more significant increase of accessibility and attractiveness of the studied community, which in turn resulted in higher number of induced jobs and households to gravitate towards this area. In the case of the Browntown area in Middlesex County, the highway improvement was much less successful. While it did reduce the V/C ratio that would be experienced by adding the direct and indirect traffic to the existing highway facilities, the V/C with direct and indirect traffic was still

higher then baseline (0.95 compared to 0.90). Thus, the induced demand was to a certain degree (perhaps mostly) the result of regional repositioning of jobs and households, rather than just a function of the improved transportation facility. This can explain the big difference between the attractiveness levels for induced jobs and households in the Middlesex County case study.

DIRECTIONS FOR FUTUR E T ESTING: LESSONS FROM COLORADO SPRINGS

Modeling the impact of direct and indirect development, as well as highway improvement on VMT, was completed using the travel demand model. Trip productions and attractions were based on a baseline regional land use (expressed in terms of number of jobs and households by type, and other socioeconomic statistics). The results of this analysis are complete and make sense. The next step involved attempting to estimate induced demand and associated VMT. This would come about from changes in land use induced by improved travel times due to highway improvements.

The TELUM model was used to generate new land use. It was calibrated using the same baseline land use employed in the travel demand model, and impedances as found before the highway improvements. The changes in land use were then modeled by updating the impedances using the new travel times after all the new development and highway improvements were in place.

One would expect that better travel times would attract new developments within or in close proximity to the studied community. This in turn would generate more traffic on the highway network in the vicinity of the community, expressed in terms of VMT. However, in Colorado Springs case study, when the travel demand model was updated with the new land use patterns produced by the TELUM model, the resulting VMT in the studied community actually decreased by 5 percent, mostly due to reduction in through-traffic. This would suggest that highway improvements actually deterred traffic, which is contrary to both theory and practice.

In reviewing the TELUM model outputs it was found that the area of new development, including the studied community, ended up with a reduced number of jobs and households. Further review revealed that the model moved substantial numbers of jobs and households out of the central metropolitan area (where the studied community is located) and pushed them into the surrounding suburban county area. This explains the reduction in traffic: fewer jobs and households result in fewer trips, which in turn result in reduced VMT.

In conversations with Pikes Peak Area planners, it was determined that baseline land use was developed considering numerous constraints on development in rural suburban zones to reflect the observed conditions and certain development limitations in the outer zones. However, the same constraints were not used in developing land use projects in this case study—the model was allowed to run unrestrained, producing unrealistic future land use patterns.

The only way to resolve this problem was to again identify and implement a better set of constraints in the TELUM model and re-run it to obtain more realistic land use patterns, which would then be fed into the travel demand model. This would require a significant amount of additional work for Pikes Peak Area MPO planners, and the research team concluded that at that time it was not feasible for them to re-constrain the model, given other commitments they had. They did acknowledge this was something they would have to do when they start developing the Long-Range Plan.

APPENDIX III-A

DMAMPO Travel Demand Forecasting Model

The travel demand forecasting model used in the case study was a traditional four-step highway-only model. (The mode split step was not considered as all the demand was realized using the highway mode). The model was implemented in TransCAD modeling software. The TransCAD flow diagram for the DMAMPO travel demand forecasting model is shown in Figure I-13.

In the case study presented in this report, underlying direct, indirect, and induced demographic and socio-economic changes were coded in the spreadsheet model set-up to calculate balanced trip productions and attractions. The trip generation step considered three types of households by size (with 1, 2, and 3 or more residents per household) and car ownerships (with 1, 2, and 3 or more cars per household). For each combination of household size and car ownership, trip production rates are shown in Table I-11. The trip attraction rates are shown in Table I-12. In addition, trips tied to special generators such as airport, hospitals, shopping malls, and recreation centers were also considered, as well as internal-external trips.

The trip productions and attractions are balanced to satisfy the requirements of the balanced trip assignment model. The balancing was done by adjusting the non-home-based trip attractions and productions, excluding special generators. The adjustments were made using linear scaling on productions. The resulting balanced trip productions and attractions were input into the travel demand model in Step 7 shown in Figure I-13. The changes in the link capacity reflecting road improvements were coded in the network file and input into the modeling process in Step 1 in Figure I-13.

Table I-11. Trip production rates by household size and car ownership

Trip Purpose	Household Size	Autos Owned		
		1	2	3+
Home-based Work	1	0.64	0.78	0.46
	2	0.74	1.53	1.90
	3+	1.10	1.93	2.29
Home-based Other	1	1.97	2.49	1.84
	2	2.85	3.07	3.12
	3+	4.51	4.40	5.54
Non-home-based	1	1.57	1.81	0.54
	2	1.83	2.14	1.83
	3+	5.96	2.47	3.01

Table I-12. Trip attraction rates by trip purpose

Trip Purpose	Variable	Rate
Home-Based Work	Total Employment	0.830
Home-Based Other	Retail Employment	2.330
	Other Employment	1.630
	School Enrollment	0.800
Commercial Vehicles	Dwelling Units	0.357
	Retail Employment	0.263
	Other Employment	0.034
Internal-External	Dwelling Units	0.060
	Total Employment	0.259

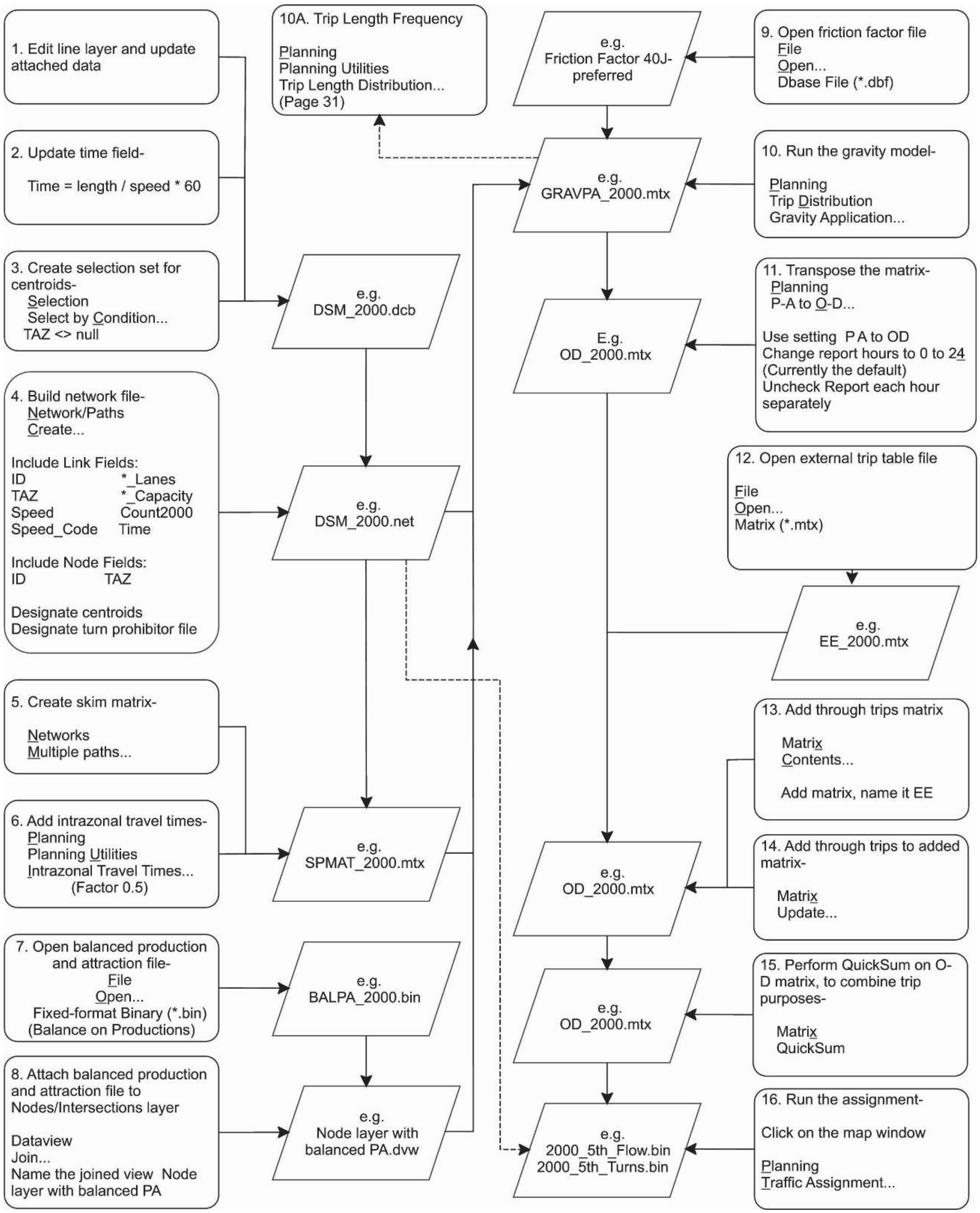


Figure I-13. TransCAD file flow diagram for the DMAMPO travel demand forecasting model

APPENDIX III-B

Principles of TELUM Land Use Model

TELUM land use modeling software was used to ascertain land use impacts of new residential and nonresidential developments in the case studies presented in this Procedural Guide. TELUM is an interactive software package for evaluating the land use impacts of changes in the underlying transportation network. In combination with travel demand models it is used for integrated land use and transportation modeling, providing the ability to evaluate impact of transportation improvement projects on future location of jobs and households in a region. In the core of the TELUM software are Disaggregated Residential Allocation Model (DRAM) and Employment Allocation Model (EMPAL). Both DRAM and EMPAL employ sophisticated mathematical models to quantify the interactions between the regional employment and population location patterns and the underlying transportation network performance.

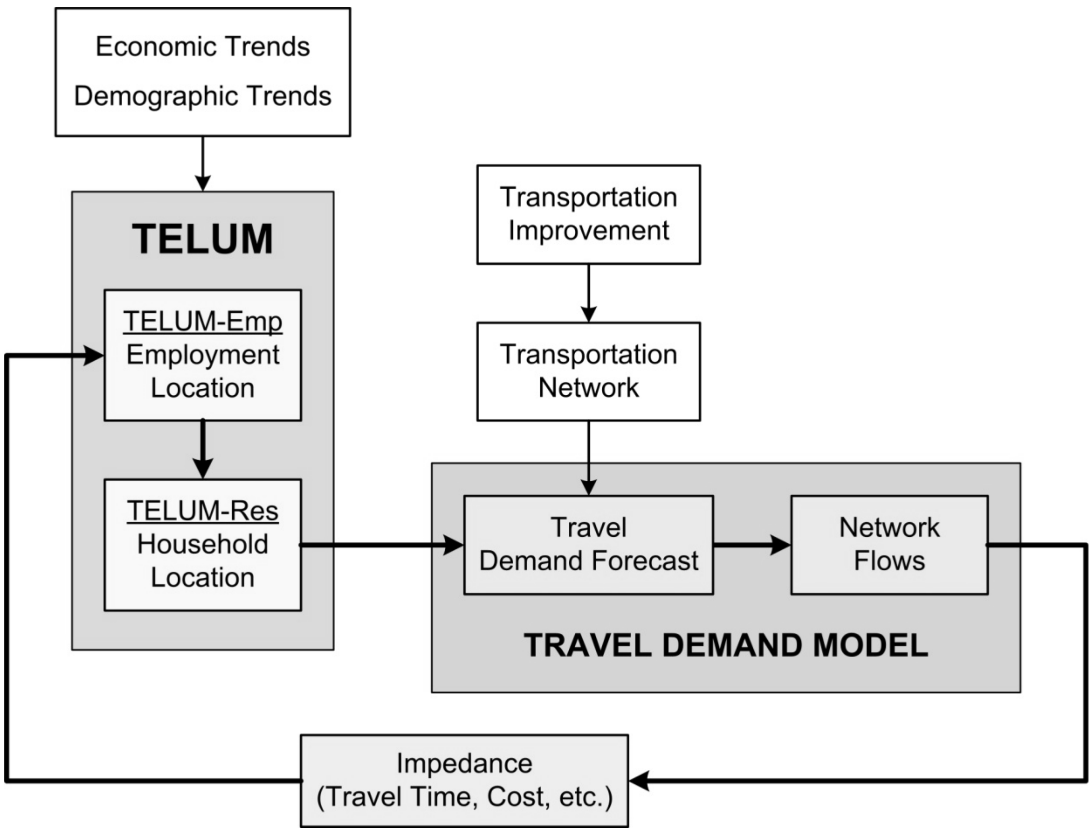


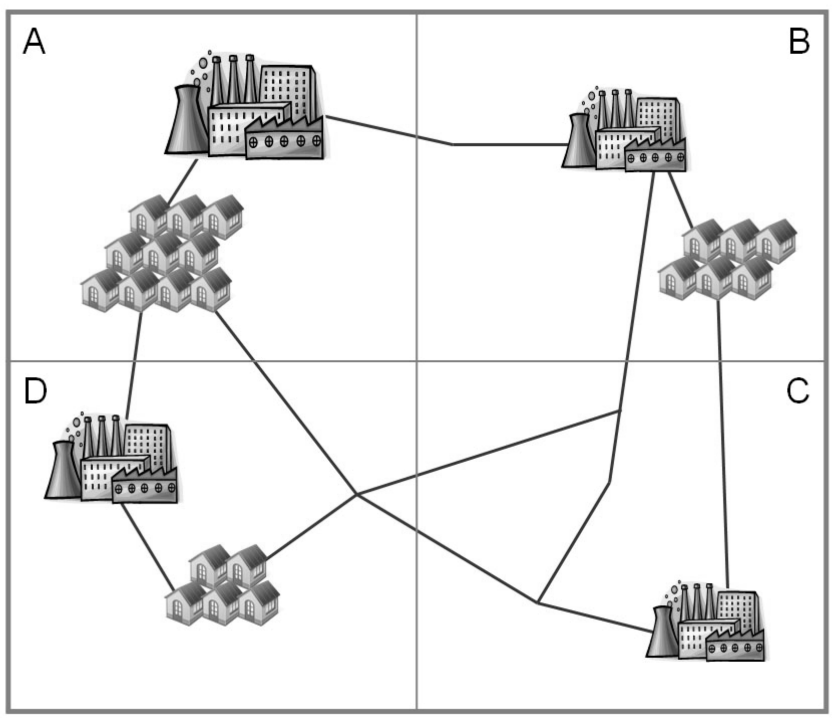
Figure I-14. The feedback loop between TELUM and a travel demand forecasting model. (The feedback loop is represented by the bold arrow-lines.)

TELUM was developed in a collaboration of the New Jersey Institute of Technology (NJIT) and Dr. Stephen Putman, developer of the DRAM/EMPAL models. Development and deployment of TELUM, including technical support to users, is provided as part of the Transportation, Economic and Land Use System (TELUS), a FHWA Cooperative Agreement DTFH61-07-H-00020. The objective of the TELUS program is to provide an information-management and decision-support system solutions to assist metropolitan planning organizations and state departments of transportation in preparing their Transportation Improvement Programs. TELUM is the land use component of TELUS.

The first step in TELUM modeling process is calibration. TELUM calibrates each of the two location prediction models (employment and household models) based on user-defined and supplied historical information about the zonal employment and household locations, inter-zonal travel times, and regional socio-economic and demographic parameters. After the models are calibrated they are used to predict the future allocation of regional jobs and households into a specific zone within the region. The principle of how TELUM does this can be illustrated by the example shown below.

Figure I-15

The region in this example consists of four zones (A, B, C, and D). Current locations of jobs and households in each zone are known, as well as travel times between zones on the existing highway network.



 - households

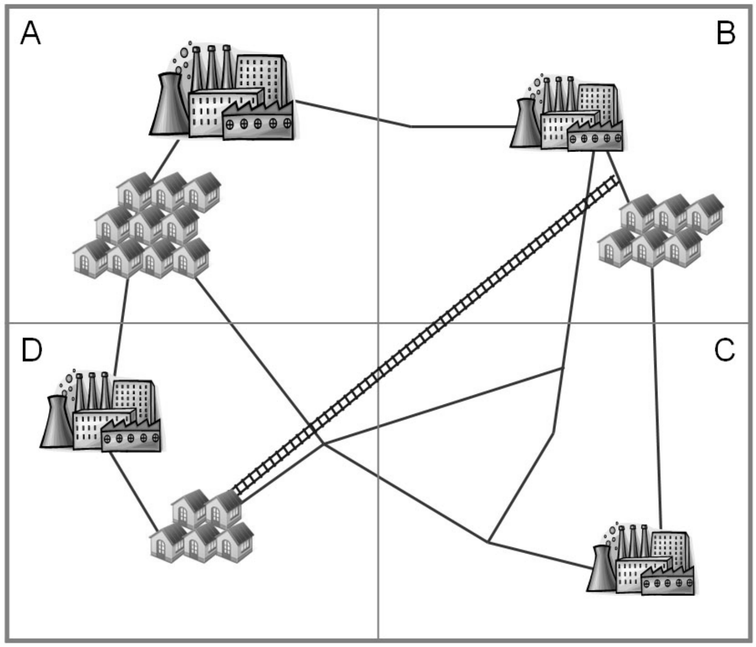
 - jobs (employment)

______ - highway links

Figure I-16

A new light rail line (LRT) is planned that will connect zones B and D. The shorter travel times on the line will improve regional mobility and impact commuter patterns. As a result of the line the attractiveness of the zones within the region will change.

- light rail



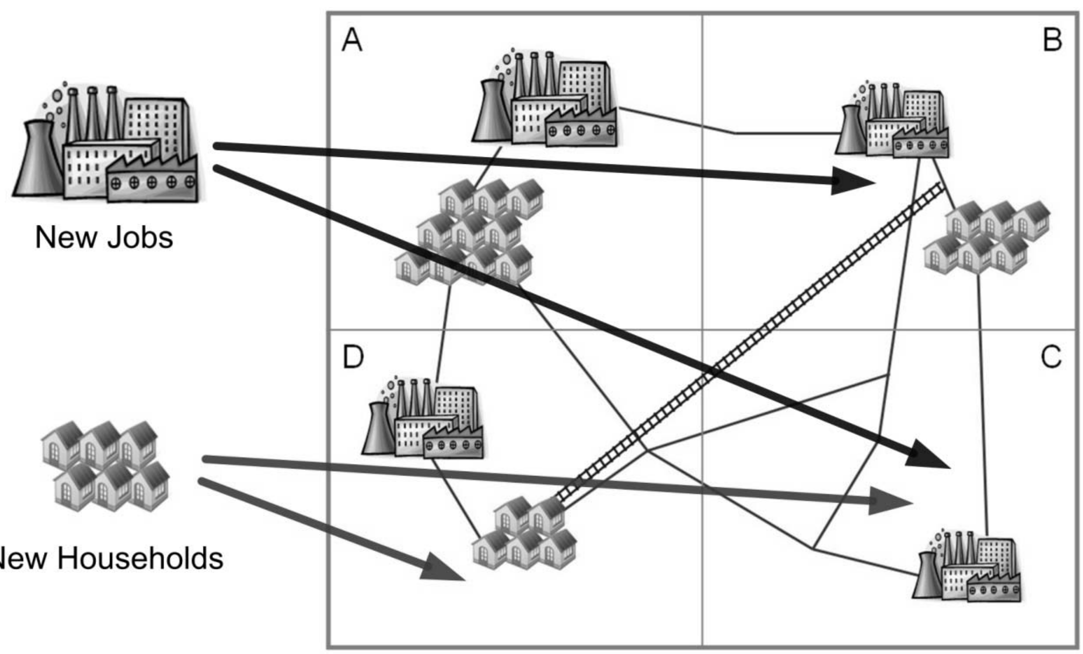


Figure I-17

The region is expected to grow. New jobs and households will be locating in the regional zones depending on their attractiveness and land availability. Based on the calibrated model and new inter-zonal travel times (resulting from the addition of the light rail), TELUM determines in which zones those jobs and households will be locating.

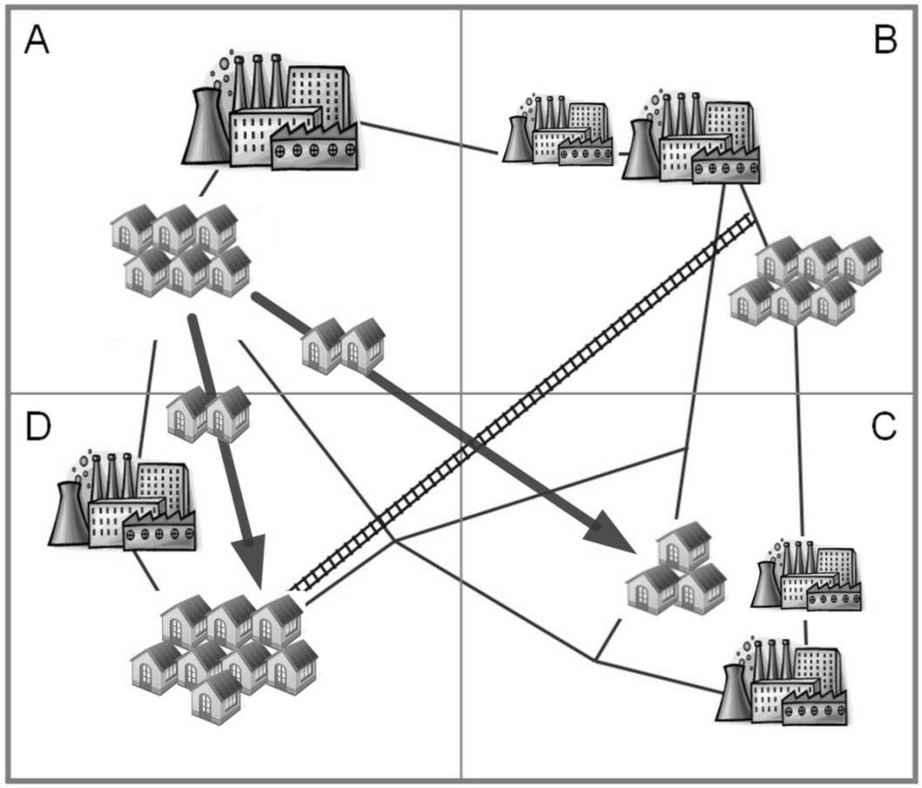


Figure I-18

Finally, the LRT's capacity and improved travel times will cause the re-location of existing jobs and households.

APPENDIX III-C

Integrated Travel Demand and Land Use Model for Middlesex County

The modeling of regional travel in this case study was done using the TRANSIMS modeling software. TRANSIMS (Transportation Analysis and Simulation System) is an activity-based transportation modeling package developed by Los Alamos National Laboratory with the funding from the FHWA. It is an integrated system of travel forecasting models which generates trips based on activities at specific locations within the region, and then simulates second-by-second movements of every person and every vehicle in the transportation network based on the interactions between vehicles rather than deterministic equations. The TRANSIMS model for the Middlesex County used in this analysis was developed as part of two recent research projects conducted at NJIT and Rutgers University. The land use modeling part of analysis was realized using the TELUM land use model.

For the modeling purposes the entire Middlesex County was divided into 576 zones (coinciding with US Census Block Groups). The model has 14,154 activity locations. The community, which was the focus of the new development and this case study, consists of nine zones and 75 activity locations.

The feedback loop between TRANSIMS and TELUM was implemented to estimate induced demand resulting from changes in land use patterns, after the new development and transportation improvements occur. The first step in this integration is generation of an impedance skim file in TRANSIMS. This impedance file captures composite travel times between each pair of 576 zones and serves as an input for the TELUM land use model. The iterative modeling procedure for creating the skim file for TELUM input is shown in Figure I-19. The traffic equilibrium process is achieved through a stabilization of the router and microsimulator modules. The role of the router module is to produces route plans, based on a time-dependent shortest path algorithm, for every individual in the system according to previously generated list of their activities.

The microsimulator module executes travel plans generated by router module and computes the overall intra- and inter-modal transportation system dynamics. It is updated every second and continuously computes the operating status, including speeds, acceleration, and deceleration of all vehicles throughout the simulation period. The output of the microsimulator module is a detailed, second by second history of every traveler in the system over a 24-hour period. TRANSIMS examines the travelers whose travel plan duration and the current travel time for the plan path are significantly different. The process re-routes the travelers trying to minimize the travel time gap until the traffic flow equilibrium is achieved. Once the equilibrium is reached, the outputs are summarized and formatted in an impedance skim file that can be forwarded to TELUM.

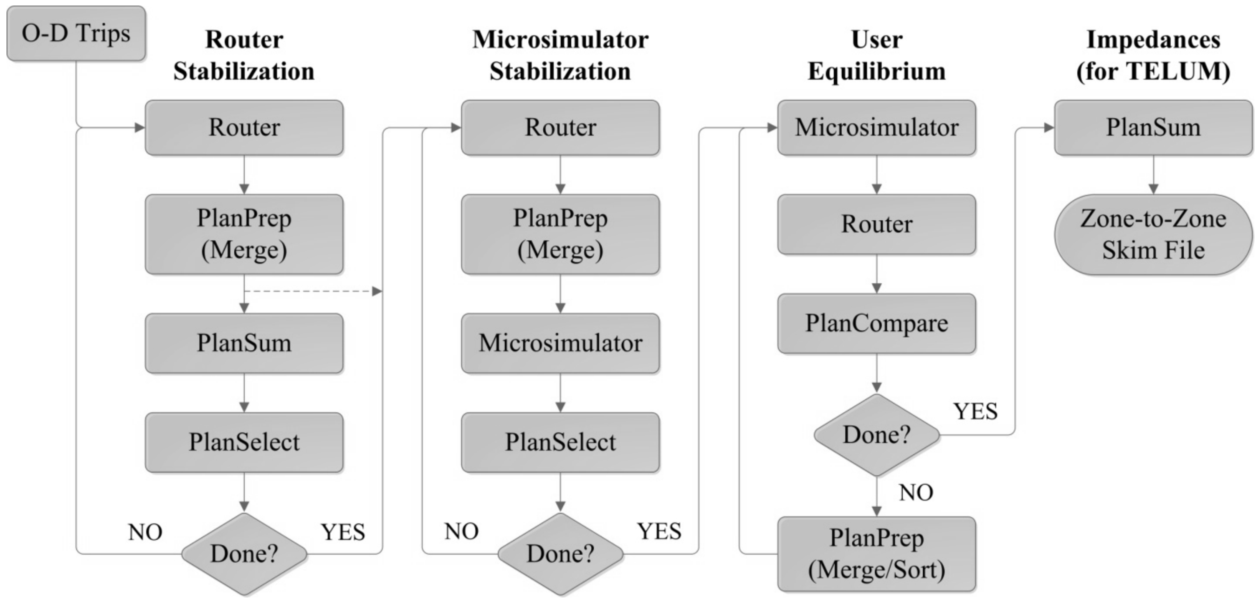


Figure I-19. TRANSIMS Modules Feedback Process

After the skim file is generated, it is fed into TELUM model. Based on the changes in travel times between the baseline and scenario after developments, TELUM produces new (future) locations of jobs and households. TELUM outputs are then translated into trips for the same time period and used to adjust the existing O-D trip matrices used in TRANSIMS. Finally, the adjusted O-D matrices are fed into TRANSIMS model to produce forecasts of future traffic flows in the study area, and new impedance skim file. The graph shown in Figure I-20 illustrates the feedback loop integrating TRANSIMS and TELUM.

Since stabilization of the TRANSIMS Router and microsimulator, and calibration of the traffic flow in TRANSIMS require a great amount of time and effort, it was decided that for the purposes of this analysis these steps could be skipped without losing a great deal of accuracy. Thus, the TRANSIMS feedback process was replaced with a single sequence of model runs through the router and simulator, as well as data summary procedures, as shown in Figure I-18.

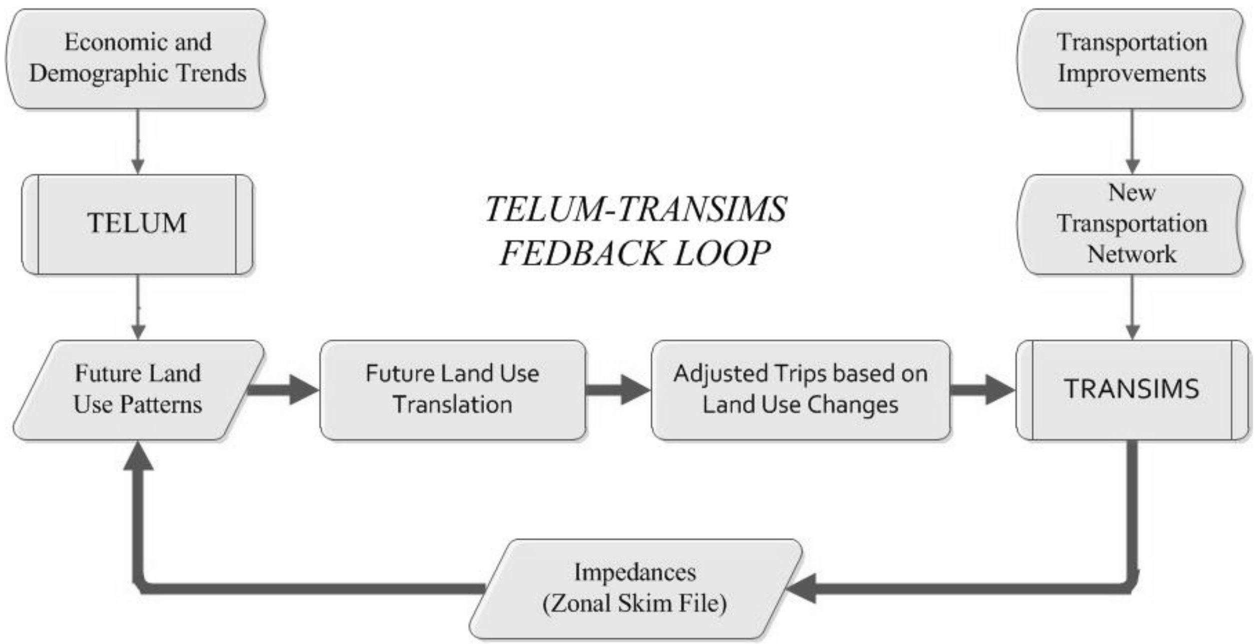


Figure I-20. Interaction Process between TRANSIMS and TELUM

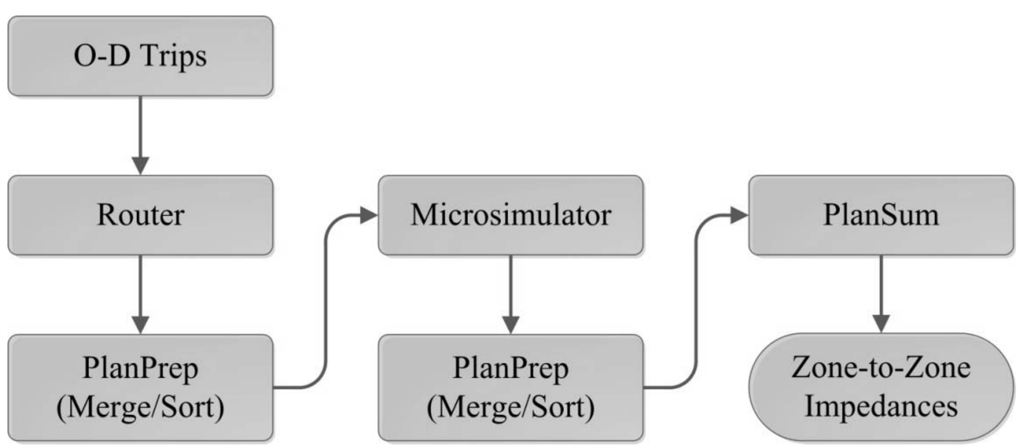


Figure I-21. Modified Skim File generation process (without stabilization and user equilibrium)

GLOSSARY

AD VALOREM
A tax or duty levied in the form of percentage of value of property.

AMORTIZATION
The systematic reduction of debt through use of serial bonds or term bonds with actuarial basis sinking fund.

ASSESSED VALUATION
The value at which property is appraised for tax purposes.

AUTHORITY
A governmental unit or public agency created to perform a single function or a restricted group of related activities. Usually such units are financed from service charges, fees, and tolls, but in some instances they also have taxing powers.

AVERAGE COSTING
Costs assigned to a future growth increment according to the existing average cost of present government services. Cost assignment does not consider existing excess or deficient capacity that might exist for particular services or the possibility that a new development might fall at the threshold level, calling for major new capital construction to accommodate increased growth.

BEDROOMS
The count of rooms used mainly for sleeping, even if also used for other purposes. Rooms reserved for sleeping such as guest rooms, even though used infrequently, are counted as bedrooms. Rooms used mainly for other purposes, even though used also for sleeping, such as a living room with a hideaway bed, are not considered bedrooms. A housing unit consisting of only one room, such as a one-room efficiency apartment, is classified, by definition, as having no bedroom.

BOND (MUNICIPAL OR PUBLIC)
Certificates of indebtedness issued by a state or local government authority as a promise to repay money over a period of time. They are used to finance the costs of public capital facilities, i.e., roads, schools, hospitals, and other projects that cannot be financed out of current revenues.

BUDGET
An estimate of receipts and expenditures needed by the government to carry out its program in some future period, usually a fiscal year.

CAPITAL BUDGET
A plan for capital expenditures, including commitments, to be incurred during the budget year from funds subject to appropriation by the governing body of the concerned government for projects scheduled in a given year of the capital program.

CAPITAL IMPROVEMENT
An improvement with a useful life usually of at least three years or more, by new construction or other action, which increases the service capacity of a public facility.

CAPITAL IMPROVEMENTS PROGRAM
A document approved by local government that sets out projected needs for system improvements (see definition below) during the planning horizon, which provides a schedule of capital improvements that will meet the anticipated need for system improvements, and also provides a description of anticipated funding sources for each required improvement.

CAPITAL OUTLAY
Expenditures by ordinance or budget appropriation for the construction, purchase, or improvement of fixed assets such as buildings and equipment, parks and playgrounds, vehicular equipment, streets, roads, sidewalks, storm sewers, etc.

CAPITAL PROGRAM OR PLAN
A plan for capital expenditures, including commitments, to be incurred each year over a fixed period of years to meet capital needs arising from the long-term work program. It thus sets forth each project or other contemplated expenditure in which the local government is to have a part, and specifies the full resources estimated to be available to finance the projected expenditures.

CAPITALIZATION
The process of estimating the present investment value of a property by reducing anticipated future income to present worth.

COMMERCIAL
(When used in the impact fee schedules)
All retail and service activities as well as all activities within shopping centers and other structures not intended for permanent residential use.

CONDOMINUM
Residential attached structures of single or multifamily construction in which occupants hold legal title to an apartment and a communal interest in the land and all improvements.

CONVENIENCE GOODS
Goods from grocery, drug, liquor, and hardware stores; services from beauty, barber, and bake shops; and services from laundry and dry cleaning establishments.

COST
Municipal, county or school district actual cash disbursement (plus amounts reserved to meet bills incurred during the year but unpaid at the close of the calendar year) incurred as a result of providing a local public service. As used in this handbook it is synonymous with the term expenditure.

COUNTY FUNCTIONS
Expenditures (except for education) necessary to operate the county and provide required public services.

COUNTY
The major unit of local government in the United States, except in Alaska, Connecticut, and Rhode Island.

CREDIT
A revenue credit in capital charges is against the cost per service unit and is given for outstanding debt, for past road improvements, and for motor fuel taxes and vehicle license fee revenues that are generated by new development and used to make capital improvements.

DEBIT
An outstanding charge.

DEBT LIMIT
The maximum amount of debt that a governmental unit may incur under constitutional, statutory, or charter requirements. The limitation is usually a percentage of assessed valuation.

DEFICIENT CAPA CITY (also known as deficiency)
The portion of the capacity of a public facility or system of public facilities that is below that necessary to provide adequate service at the then-existing level of service.

DEMOGRAPHIC MULTIPLIER
Estimate of average household size and students for various sizes and configurations of housing.

DEVELOPER
Any person or legal entity undertaking development.

DEVELOPMENT
Any construction or expansion of a building, structure or use, any change in use of a

building or structure, or any change in the use of land requiring the issuance of a building permit, which creates additional demand on, or need for, public facilities.

DIRECT COSTS AND REVENUES.
The costs and derivative revenues to provide capital and operating services (municipal/county and school) to a new increment of population (persons, students, and employees) arriving as a result of new development in a community.

DWELLING UNIT (or RESIDENTIAL UNIT)
A room or rooms that are connected, constituting a separate housekeeping establishment for a family, for owner occupancy or rental or lease on weekly or longer terms, physically separate from any other rooms or dwelling units which may be in the same structure, and containing independent kitchen and sleeping facilities. When in multifamily buildings, dwelling units may be referred to as apartments.

ECONOMIC SYSTEM
A process by which scarce productive resources are transformed into goods and services, and allocated to consumers.

EDUCATION
Public schools, institutions of higher education, and other educational institutions and services; support of private educational activities; supervision of education; and any other activities and facilities related to education that are administered by school boards, systems, or commissions.

ELASTICITY
The ratio of the percentage change in one variable to the percentage change in another variable. It is a tool for measuring the responsiveness of a function to changes in parameters in a unit-less way. Generally, an "elastic" variable is one which responds "a lot" to small changes in other parameters. Similarly, an "inelastic" variable describes one that does not change much in response to changes in other parameters. Frequently used elasticities include price elasticity of demand, price elasticity of supply, income elasticity of demand, elasticity of substitution between factors of production and elasticity of intertemporal substitution.

ELDERLY HOUSING
Housing developed for major or exclusive occupancy by adult households with or without specific age or occupancy restrictions.

ENTROPY
A measure of how evenly energy is distributed in a system. In a physical system, entropy provides a measure of the amount of energy that cannot be used to do work.

EQUALIZATION RATIO
Ratio of assessed value to true (market) value of real property.

EQUALIZED TAX RATE
The local tax rate multiplied by a county- or state-recognized ratio of assessed value by the equalization ratio.

EQUALIZED VAL UATION. *See* Assessed valuation.

EXCESS CAPACITY
The portion of the capacity of a public facility or system of public facilities that is beyond that necessary to provide adequate service at the then-existing level of service.

EXECUTIVE
Office of the chief executive and central staff services other than financial administration. Includes office of the chief executive, legal activities, recording and general public reporting, overall planning and zoning, central personnel, and other staff executive and administrative services.

EXPENDITURE *See* **Cost**.

EXPENSE RATIO
The relationship of total expenses to gross income, expressed as a decimal.

EXPLANATORY VARIABLE
Quantitatively derived entities that describe or interpret what is to be measured.

EXTERNALITY
The unintended side effects of any action on a person (or persons) not directly involved in an original action. These effects may be on the persons themselves, on their holdings, or on unowned things (natural resources).

FEE PAYOR
That person or entity who pays an impact fee, or its legal successor in interest.

FINANCIAL ADMINISTRATION
Office of the finance director, auditor, comptroller, treasurer, and other central accounting, budgeting, and purchasing activities; tax administration; and other finance services not included under other functional headings. Includes tax assessment and collection, custody and disbursements of funds, state supervision of local government finance, debt management, and administration of investment, employee retirement, and other trust funds.

FIRE PROTECTION
Includes fire-fighting organization and auxiliary services, fire charges, support of volunteer fire forces, rescue squads, and related fire protection activities; includes any identifiable amounts for services rendered by other agencies of the government for the fire protection function, including water and other utility services.

FISCAL IMPACT ANALYSIS
An evaluation of the net public costs or revenues resulting from actual or planned growth.

FUNCTIONAL POPULATION
The effective population of the city, including residents and nonresidents, during a given period of time, as used in the calculation of development impact fees and as described in the impact fee study.

GENERAL CONTROL
Judicial, legislative, executive, and staff agencies of the government. Includes office of the chief executive, legal activities, recording and general public reporting, overall planning or zoning, central personnel and other staff and executive or administrative services.

GENERAL GOVERNMENT
A collective term for municipal, administrative, executive and tax functions. As used here, it includes financial administration and general control.

GENERAL REVENUE
All revenue of a government except utility revenue, liquor store revenue, and insurance trust revenue. The basis for this distinction is not the fund or administrative unit established to account for and control a particular activity, but rather the nature of the revenue sources involved. Three primary categories of general revenue are recognized in Census reporting: taxes, charges and miscellaneous general revenue, and intergovernmental transfers.

GENERAL TAX RATE
The rate applied to net taxable assessed valuation of a municipality to yield the required tax levy.

GEOGRAPHIC INFORMATION SYSTEM (GIS):
A computer-generated mapping system for collecting, storing, analyzing, and integrating information about physical and man-made features on a map.

GRIDIRON PATTERN:
A street and block system of formal, regular rectangular blocks and resulting four-way intersections.

GROSS FLOOR AREA
The sum of the gross horizontal area of the several stories of a building measured from the exterior faces of the exterior walls or from the center line of walls separating two buildings or different uses, including attic

space with headroom of seven feet or greater and served by a permanent, fixed stair, but not including enclosed off-street parking or loading areas.

GROSS INCOME MULTIPLIER
A figure that, when applied to the annual rent and miscellaneous income of a building, projects its true or market value.

GROWTH MANAGEMENT
Techniques used by government to control the rate, amount, location, timing, and types of development.

GOVERNMENT AGENCY
Any department, commission, independent agency, or instrumentality of the United States, of a state, county, incorporated or unincorporated municipality, township, authority, district or other governmental unit.

HEALTH AND WELFARE
Establishment and operation of hospital facilities, provision of hospital care, support of other public or private hospitals, and conservation and improvement of public health.

HIERARCHICAL LINEAR MODELING
Modeling also know as multilevel analyses is a more advanced form of simple linear regression and multiple linear regression.

HIGHWAYS
Expenditure for streets and highways and related structures (including highway garages and highway agency administration buildings), snow and ice removal, and street or highway lighting. Includes street and highway planning and engineering, and related traffic engineering administered by highway or public works agencies. For cities, includes snow and ice removal performed by the city's sanitation or street cleaning agency, when identifiable; and cost of street lighting services furnished by an electric utility operated by the city, when identifiable. (An identical amount is excluded from utility current operation expenditure).

HOUSEHOLD SIZE
The total number of persons, both related and unrelated, residing in a housing unit.

HOUSING AND URBAN RENEWAL
Construction and operation of housing and redevelopment projects and other activities to promote or aid housing and urban renewal. Housing projects include constructing, furnishing, and operating housing projects administered by the city government concerned. Urban renewal projects include land clearance and urban renewal projects administered by the city government concerned.

HOUSING UNIT
A house, an apartment, a group of rooms, or a single room occupied or intended for occupancy as separate living quarters.

IMPACT F EE (also known as development impact fee, systems development charge, or variations thereof)
The payment of money imposed upon and paid by new development as a condition of development approval as its proportionate share of the cost of system improvements needed to serve such development.

INCOME APPROACH TO VALUE ESTIMATION
Estimate of the market value of a property by capitalizing the net income produced from the application of a market rate of interest and a rate reflecting the return on investment.

INCOME TAXES, CORPORATION NET
On incorporated and unincorporated businesses (when taxed distinctively from individual income), measured by net income. May be called "license" or "franchise" taxes. Includes net income taxes on special kinds of corporations, such as financial institutions.

INCOME TAXES, INDIVIDUAL
Taxes on individuals measured by net income and taxes distinctively imposed on special types of income (e.g., interest, dividends, income from intangibles, etc.).

INDIRECT COSTS AND REVENUES.
The costs and derivative revenues to provide capital and operating public services (municipal/county and school) to a new increment of population (persons, students and employees) arriving as a result of: (1) new commercial or industrial employees of direct development choosing to live within the community as residents or (2) the expenditures of direct residents locally which generates additional nonresidential structures and their employment.

INDUCED COSTS AND REVENUES.
The costs and derivative revenues to provide capital and operating public services (municipal/county and school) to a new increment of population (persons, students, and employees) arriving as a result of a transportation improvement on the regional road or transit system. This is a component of the new increment of service capacity in the transportation component that is neither diverted nor a mode change.

INPUT-OUTPUT (I/O) ANALYSIS
A form of economic analysis in which the interdependence of an economy's various productive sectors is observed by viewing the product of each industry both as a commodity demanded for final consumption and as a factor in the production of itself and other goods. The analysis usually involves constructing a table in which each horizontal row describes how one industry's total product is divided among various production processes and final consumption. Each vertical column denotes the combination of productive resources used within one industry. Input–output tables can be constructed for whole economies or for segments within economies.

INTERGOVERNMENTAL TRANSFERS
Includes grants, shared taxes, and contingent loans and advances for support of particular functions or for general financial support; any significant and identifiable amounts received from other governments as reimbursement for performance of governmental functions; and any other form of revenue representing the sharing by other governments in the financing of activities administered by the receiving government. Intergovernmental transfers exclude amounts received from the sale of property, commodities, and utility services to other governments.

JUDICIAL
Courts and activities associated with courts (e.g., law libraries, medical and social service activities, juries, etc.). For cities, includes registrar of wills and similar probate functions.

LAND-USE REGULATIONS
Zoning official maps, and subdivision regulations to guide or control land development.

LEGISLATIVE
Legislative bodies, research and investigation agencies, and committees responsible to the legislature.

LEVEL OF SERVICE (LOS)
A measure of the relationship between the ratio of service capacity and service demand for specified public facilities in terms of demand-to-capacity ratios or the comfort and convenience of use or service of such facilities, or both.

LIBRARIES
Includes libraries operated by the government concerned, support of privately operated libraries, and any intergovernmental expenditure for library purposes.

LICENSE TAXES
Taxes exacted either for revenue raising or for regulation, for a business or nonbusiness privilege, at a flat rate or measured by such

bases as capital stock or surplus, number of business units, or capacity.

MARGINAL COSTING
Costs assigned to a growth increment. They represent the sum of all immediate expenditures undertaken by the jurisdiction that otherwise would not have occurred.

MARKET APPROACH TO VALUE ESTIMATION
Estimate of the market value of a property based on a comparative analysis of sales of similar properties.

MEAN [Value]
The average value.

MEDIAN
The value of the middle case.

META ANALYSIS
Combines the results of several studies that address a set of related research hypotheses. The general aim of meta analysis is to more powerfully estimate the true "effect" size as opposed to a smaller "effect" size identified in a single study. Statistical methods of combining evidence such as that from multiple qualitative studies.

METROPOLITAN AREAS
A group of whole counties surrounding a major city or twin cities of 50,000 population or more. They were formally termed standard metropolitan statistical areas.

MILL
A unit of monetary value equal to one-thousandth of a U.S. dollar, or one-tenth cent. A fifty mill local tax rate is equivalent to a five dollar tax levy per one-hundred dollars of property valuation.

MIXED-USE DEVELOPMENT (MXD)
The development of a neighborhood, tract of land, building or structure with a variety of complementary and integrated uses such as, but not limited to, residential, office, manufacturing, retail, public, and recreation.

MODEL
A theoretical construction designed to represent a situation in the real world.

MUNICIPAL FUNCTIONS
Expenditures (except for education) necessary to operate the municipality and provide the required public services.

MUNICIPAL
Any governmental unit below or subordinate to the county and the state.

NET OPERATING INCOME
The annual net income remaining after deducting all operating expenses, fixed expenses, and reserves for replacement but before deducting financial charges such as recapture or debt service. Net operating income may also be referred to as net income before recapture.

NET RENTABLE AREA
The net rentable area of a multiple tenancy floor, whether above or below grade, is the sum of all rentable areas on that floor. The rentable area of an office on a multiple tenancy floor is computed by measuring to the inside finish of permanent outer building walls, or the glass line if at least 50 percent of the outer building wall is glass, to the office side of corridors and/or other permanent partitions, and to the center of partitions that separate the premises from adjoining rentable areas. No deductions are allowed for columns and projections necessary to the building.

NONRESIDENTIAL USE
Local use of land for the primary purpose of commercial or industrial facilities.

OCCUPATION AND BUSINESS PRIVILEGE TAX
Taxes commonly regarded as licenses levied on individuals engaged in particular occupations, on owners of businesses, and on corporations either at a flat amount or at a variable amount such as a percentage of gross receipts.

OPERATING EXPENSES

All out-of-pocket costs involved in providing services to tenants and maintaining the income stream—for example, administration, utilities, payrolls, supplies, and contracted services such as cleaning, and so on.

ORDINANCE

A legislative enactment by a local governing body. Ordinances are issued under authority granted by the state and must comply with state constitutions, charters, and general laws.

ORDINARY LEAST SQUARES REGRESSION (OLS)

Method for estimating the unknown parameters in a linear regression model. The method minimizes the sum of squared vertical distances between the observed responses in the dataset versus the responses predicted by the liner approximation.

OUTCOME VARIABLE

The specific circumstance or entity that is attempted to be measured.

OVERAGE CAP ACITY. *See* **Deficient Capacity.**

OWN-SOURCE REVENUE

Revenue raised either through a municipality's, county's, or school district's taxing powers or through locally imposed user charges.

PARCEL

A piece of property entered on the tax map as one unit and carried on the tax rolls for assessment and tax collection purposes as one unit.

PER CAPITA MULTIPLIER METHOD

A method to project the fiscal impact of a proposed development, annexation, land use alternative, etc. It expresses current average educational and noneducational costs per pupil and per resident, respectively, and subsequently assigns them as impact costs to a growth increment based upon detailed demographic profiles of constituent housing types.

PER PERSON

A means of expressing total municipal expenditures by dividing them by the total user or resident populations.

PER STUDENT

A means of expressing total school district expenditures by dividing them by the total user or student population.

PERSONAL PROPERTY TAX

A tax levied on personal possessions such as automobiles, jewels, silverware, fur coats, pianos, and the like.

POLICE PROTECTION

Preservation of law and order and traffic safety, whether administered as part of a police department or by a separate agency. Includes regular police services, detention and custody of persons awaiting trial; traffic control and traffic safety activities, including related traffic engineering activities (but not highway planning and engineering); vehicular inspection; and buildings used exclusively for police purposes.

PROJECT IMPROVEMENTS

Site-specific improvements or facilities that are planned, designed or built to provide service for a specific development project and that are necessary for the use and convenience of the occupants or users of that project, and that are not system improvements. The character of the improvement controls the determination of whether an improvement is a project improvement or a system improvement, and the physical location of the improvement on-site or off-site is not considered determinative of whether an improvement is a project improvement or a system improvement. No improvement or facility included in a plan for public facilities approved by a jurisdiction's council is considered a project improvement. If an improvement or facility provides or will

provide more than incidental service or facilities capacity to persons other than users or occupants of a particular project, the improvement or facility is a system improvement and is not to be considered a project improvement.

Direct access improvements to the particular development project are project improvements. Direct access improvements include but are not limited to the following: (1) site driveways and local residential and nonresidential streets, (2) median cuts made necessary by those driveways or local residential and nonresidential streets, (3) right turn and left turn, and deceleration or acceleration lanes leading to or from those driveways or local residential and nonresidential streets, (4) traffic control measures for those driveways or local residential and nonresidential streets, (5) local residential and nonresidential streets that are not shown as publicly owned roads on the jurisdiction's long-range road classification map, (6) local residential and nonresidential streets or intersection improvements whose primary purpose at the time of construction is to provide direct access to the development project, and (7) necessary right-of-way dedications required for those items set forth in (1)–(6) above.

PROPERTY TAXES
Taxes conditioned on ownership of property and measured by its value. General property taxes relate to property as a whole, real and personal, tangible or intangible, whether taxed at a single rate or at classified rates.

PROPORTIONATE SHARE
The portion of the cost of system improvements that is reasonably and fairly related to the service demands and needs of a project.

PUBLIC SAFETY
Collective term for municipally provided protective services. As used here, it includes police and fire.

PUBLIC SECTOR
The part of the economy that comes within the scope of the government.

PUBLIC USE MICRODATA SAMPLE (PUMS)
One percent sample of housing and demographic characteristics, counties and regions, as reported by the U.S. Census.

PUBLIC UTILITY
An agency created to perform specific functions within a municipal, county, or regional area. Operations are separate and distinct from the local unit, but not autonomous with respect to it.

PUBLIC WORKS
A collective term for municipal maintenance and repair services. As used here, it includes highway, sewerage, sanitation and water supply.

RATABLE
A taxable parcel of real property.

RATIONAL NEXUS
In capital cost charging, a concept wherein only direct costs actually attributable to new development are assigned to a direct charge to that development.

REAL ESTATE TRANSFER TAX
A tax on the turnover of real property, usually based on market value and taxed at the rate of one percent of the sales price.

REAL PROPERTY
Land and appurtenances and man-made improvements attached thereto.

RECREATION AND CULTURE
Provision by the city of recreational and cultural–scientific facilities and activities except those operated as part of a school system.

RENT
Regular periodic payments by a tenant to a landlord for the use of real property.

RESIDENTIAL USE
Local use of land for the primary purpose of housing accommodations.

REVENUE
All amounts of money received by a government from external sources, excluding refunds and other correcting transactions—other than from issuance of debt, liquidation of investments, and agency and private trust transactions. Excludes any amounts transferred between funds or agencies of the same government.

SALES AND GROSS RECEIPTS TAXES
Taxes (and licenses levied at more than nominal rates) based upon the volume or value of transfers of goods or services, upon gross receipts therefrom, or upon gross income; and related taxes based upon use, storage, production, importation, or consumption of goods.

SCHOOL DISTRICT FUNCTIONS.
See **Education**.

SCHOOL DISTRICT
A governmental unit for the maintenance of schools.

SCHOOL CHILDREN
All persons aged 5 to 18 residing in the housing unit.

SERVICE AREA
A geographically defined area of a city, town, or county, in which a defined set of public facilities provides services to development within the area or in which development potential creates the need for the additional services.

SHOPPING GOODS
Goods from variety, department, and general merchandise stores—toys, hobbies, sporting goods, small appliances, household, textile, garden and lawn supplies, luggage and leather, music, books, housewares, children's apparel, candy, radios and televisions, and gasoline.

SINGLE-FAMILY HOUSES
Single, detached structures of one unit.

SPECIAL DISTRICTS
Independent governmental corporations created within a local municipal unit to provide definite functions, and having power to tax, impose service charges, and incur debt. About half of the special districts in the United States are for fire protection, soil conservation, and drainage.

STATE AID
Revenues received from the state under various programs authorized by the state legislature. Includes state road aid, highway lighting, building allowances for schools, etc.

STATUTORY
Rules that have been formulated into law by legislative action.

SYSTEM IMPROVEMENTS
Capital improvements that are public facilities designed to provide service to more than one (1) project or to the community at large, in contrast to **Project Improvements**. System improvement costs means costs incurred to provide system improvements needed to serve new growth and development, including the costs of planning, design and construction, land acquisition, land improvement, design and engineering related thereto, including the cost of constructing or reconstructing system improvements or facility expansions, including but not limited to the construction contract price, surveying and engineering fees, related land acquisition costs (including land purchases, court awards and costs, attorney's fees and expert witness fees), and expenses incurred for qualified staff or any qualified engineer, planner, architect, landscape architect, or financial consultant for preparing or updating the capital improvement program, and administrative costs. Projected interest charges and other finance costs may be included if the development impact fees are to be used for the payment of principal and interest on bonds, notes, or other financial obligations issued by or on behalf of the city to finance system improvements, but such costs do not

include routine and periodic maintenance expenditures, personnel training, and other operating costs.

TAX RATE
A percentage applied to all taxable property to raise general revenues. It is derived by dividing the total tax levy by the taxable net property valuation.

TAXES
Compulsory contributions exacted by a government for public purposes.

TOTAL DEVELOPMENT COSTS
All costs associated with new construction, including construction costs, land costs, and soft costs.

TOWN HOUSE
Attached residential structure of one unit.

TRANSPORTATION FACILITIES
Roads, streets, and bridges, including rights-of-way, traffic signals, sidewalks and landscaping, and any local components of state or federal highways.

UNIT OF DEVELOPMENT (also known as impact unit)
The standard incremental measure of land development activity for a specific type of land use upon which the rate of demand for public facilities is based.

UTILITY REVENUE
Amount received from the sale of utility commodities or services to the public or to other governments. Includes receipts from sales of commodities and services, rentals from operating property, customers' forfeitures and penalties, and charges received for installing and servicing connections and meters.

VMC
Vehicle-miles of capacity.

VMT
Vehicle-miles of travel.

VOLUME TO CAPACITY RATIO (V/C RATIO)
The ratio of demand flow rates to capacity for a given type of transportation facility.

ZONING
The partitioning of land parcels in a community by ordinance into zones and the establishment of regulations in the ordinance to govern the land use and the location, height, use and land coverages of buildings within each zone. The zoning ordinance usually consists of text and a zoning map. The districts or zones shown on the zoning map are usually identified as to the permitted type of land use.

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