fees as development occurs, and account for the fees used to fund improvements in specific areas. Finally, serious equity issues are raised by exacting a hidden fee for public facilities from newcomers.

Local officials should address all of these issues when considering whether to institute impact fees. Planners have a responsibility to raise these issues in the decision-making process. Impact fees are appropriate and desirable as part of a broader growth management strategy for a community. They are less appropriate and desirable when viewed strictly as an alternative source of revenue. A dedicated local add-on fuel tax, for instance, is administratively simpler, more flexible, and more equitable in distributing the cost of highway improvements among the general local population that uses all public roads. It is neither feasible nor appropriate from a public policy viewpoint to expect impact fees to be the primary source of funds for highway improvements. State and local governments should rely on a mix of revenue sources—both traditional use fees and more contemporary sources—to support future transportation improvements.

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Impact Fee Assessment Using Highway Cost Allocation Methods

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Although local governments have traditionally borne the cost of local roadway improvements to accommodate traffic growth, there has been a growing interest in the assessment of impact fees on developers to finance such improvements. Impact fees have been assessed as flat fees based on the size of the development; variable fees depending on the type and location of the development; and negotiated fees determined by the required investments, the interests of the local communities, and the resources of the developer. Variable fees are analogous to roadway user taxes in that roadway costs vary with traffic and a desired revenue target is to be met. Techniques used in highway cost allocation studies can be directly applied to the design of equitable variable impact fees. Because highway cost allocation studies have received considerable attention and have been widely applied, these allocation methods might be usefully adopted for impact fee assessment. Economic implications of roadway cost allocation methods for impact assessment are discussed.

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Historically, municipal and county governments have borne the cost of providing transportation infrastructure. More recently, infrastructure has been financed by imposing impact fees on developers (*1, 2*). To withstand challenges in court from developers and citizens and to effectively finance road improvements before traffic from developments affects the local area, impact fees must be equitable, consistent between developers and over time, and administratively feasible. Furthermore, impact fee revenues together with available public funds should be sufficient to cover the cost of required improvements. Impact fees should also be economically efficient and occasion as little cost and resource misallocation as possible (*3, 4*). This latter objective has received greater attention in the theoretical literature than in practice. The objectives of governing bodies in setting impact fees have been primarily

to cover costs and ensure equity among developers, whereas an economist's objective might be to set efficient impact fees that might not cover costs and might or might not necessarily be equitable.

TYPES OF FEES

Impact fees paid by developers to finance off-site improvements have evolved as local governments have been unable to finance improvements through special assessments and tax increments or in lieu of dedications and exactions. Following Vaughan *(5)*, an impact fee is viewed herein as an extension of a user fee. In this framework, there are three types of impact fees, as defined by Palomino *(2)*: a flat fee, a variable fee, and a negotiated fee. Although the emphasis in this paper is on variable fees, each type of fee is briefly described. An example application is also given to illustrate the use of such fees by municipal or county governments.

Flat Fee

The flat fee is based on a unit related to the size of the development such as dwelling units, square feet of space, or number of employees. The developer is charged a fixed dollar amount per unit for off-site improvements. For example, the Boston Redevelopment Authority charges a flat fee of $6 per square foot of office space to developments of more than 100,000 ft^2 for neighborhood improvements and housing *(6)*. This fee has recently been overturned as an illegal tax in court and the city of Boston is appealing the ruling *(7)*.

Flat fees may be levied on a developer in proportion to the traffic generated by the development. Typically, the expected traffic generated is determined from the Institute of Traffic Engineers *(8)* generation rates and the size of the development.

The flat fee has some serious drawbacks. Such fees do not demonstrate a cause and effect relationship between development and the need for improvements. For example, a development next to an interchange on an uncongested freeway is given no credit for the location of the site. Nor do these fees give credit for large-scale mixed development including residential, office, and retail space on one site in which much of the traffic is internal.

Variable Fee

Variable fees are analogous to roadway user taxes in that roadway costs vary with traffic and a desired revenue target is to be met. The design of equitable variable impact fees can be achieved through the direct application of highway cost allocation methods such as attribution of costs to vehicles by "incremental assignment" or "uniform removal" *(3, 9, 10)*.

The variable fee varies with amount of traffic generated by the development and its origin and destination. Such fees have been implemented in Broward County, Florida *(1, 11–13)*. Although the details of implementation may differ from place to place, the fee charged to a developer is typically determined using the sequential urban transportation planning process. The area affected by the development is modeled as a network and the following six tasks are undertaken:

1. Identify developments: the location, type, and size of potential developments over a specified planning horizon are determined.
2. Determine required improvements: the urban transportation planning process is applied to forecast future traffic, design improvements to add capacity for the increased traffic volumes, and estimate the cost of improvements. The process is applied as follows *(12, 14)*:

   Step 1: Traffic generated at and attracted to each development site is estimated. Typically, historical average generation rates *(8)* are used. For example, a residential development is assumed to have 0.9 trips per single-family dwelling unit generated in the morning peak hour.

   Step 2: Traffic generated at (both into and out of) each site is then distributed to origins and destinations throughout the network either using a gravity model *(14)* or according to existing trip distributions determined from a survey.

   Step 3: Traffic is then assigned for all potential developments from each origin in the network to the development sites, and to each destination from the sites. The assigned volume on each link in the network after the developments are completed is equal to the existing volume plus that generated by the developments determined in the preceding step. In practice, traffic from developments is added to existing traffic ignoring other developments. Commonly, all-or-nothing assignment is used.

   Step 4: Improvements are designed for links or intersections on which the level of service falls below a specified minimum level. For example, the intersection level of service may be required to be C or better *(15)*. Estimated costs are obtained for each improvement. Alternatively, a predetermined set of improvements is reviewed to determine which improvements should be implemented.
3. Attribute costs: any improvements, such as site accesses, that can be attributed to a particular development are determined.
4. Allocate remaining costs to developers: for each improvement, costs are prorated to developers in proportion to the amount of traffic using the intersection or link in the network that was generated by the development. This traffic may be determined by repeating Steps 1–3 of Task 2 and omitting or adding a development at each site. In practice, developments are often viewed in isolation in this allocation.
5. Allocate any costs attributed to more than one development.
6. Aggregate improvements costs for each development and each improvement.

Implementations differ primarily in the method used to prorate improvement costs to developers. The process is particularly sensitive to the technique used to assign traffic to the network. Different methods will assign different proportions of total traffic using a given improvement to the traffic that is generated by the development. For example, the nature of equilibrium assignment *(14)* is such that little traffic from a development site may use a particular intersection initially, but when improvements are implemented the development-gener-

ated traffic that uses the intersection may increase significantly. On the other hand, the results are consistent among developers because the process is usually implemented as a computer model *(11)*.

Negotiated Fee

With a negotiated fee the developer and the community bargain to determine the amount of the fee. For example, the developers of the Coal Creek Station power plant in North Dakota agreed to provide $40,000 for local public works, improved local roads, and housing development, all with citizen participation *(5)*. This process is slow because many actors are involved in the negotiation. It is also difficult to ensure consistency; results often depend on the abilities or political influence of the parties involved. However, Vaughan *(5)* argues that the negotiating process sidesteps unreliable models and data that do not permit the trade-offs necessary to coordinate a large-scale development.

In sum, the current practice of impact fee assessment ensures that the revenue target is met, except in the case of negotiated fees. However, because fee assessment procedures are usually static and provide little accounting for the spatial variation in traffic, there is no guarantee that the resultant fees are equitable. In the following sections are discussed the use of highway cost allocation procedures and transportation planning models for setting impact fees that satisfy the objectives described in this section.

HIGHWAY COST ALLOCATION METHODS

Highway cost allocation studies have received considerable attention from both state and federal legislators and have been widely applied *(9, 12, 16, 17)*. The objective of highway cost allocation studies is to determine equitable charges to the various vehicle classes that use a set of transportation facilities.

The application of highway cost allocation methods to the assessment of impact fees assumes that a class of vehicle users defined in highway cost allocation studies by axle weight and vehicle size may also be defined as traffic generated (or attracted) by a development. The methods used in roadway cost allocation allow flexibility to design tolls *(18)* or to assess impact fees.

Two highway cost allocation methods have been widely used: proportional allocation and incremental allocation. In the latest federal highway cost allocation study *(9)*, the uniform removal method was used *(10)*. Other methods, such as modified incremental methods and optimization *(19)*, have not been widely applied in practice. The uniform removal method was preferred in the latest federal study because it proved to be administratively feasible and did not unduly favor one vehicle class or another.

Proportional allocation methods assess the cost responsibility of each vehicle class in proportion to its use of the highway facility. Use of a facility may be measured by number of vehicles, vehicle miles of travel, equivalent single axle loads, or vehicle weight. Proportional allocation is closely related to uniform traffic removal.

Incremental allocation methods determine cost responsibility by sequentially introducing or removing vehicle classes to or from the traffic stream. Total amounts allocated differ when vehicles are added or removed in a different order. This problem, and the use of highway cost allocation methods in general, is illustrated by applying the incremental allocation method as follows. Required improvements are designed and costs are estimated assuming all developments are completed. Developments are then "removed" sequentially and the required road improvements are costed. The difference in these costs when the development is and is not executed is obtained. The difference is allocated to that development. The process is repeated until all developments are "removed." Due to the "lumpy" nature of highway improvements, such as adding an additional lane, it is possible that some developers will not be allocated any costs. However, if the order in which developments are considered is changed, a different set of allocated costs is obtained. To overcome some of these difficulties the uniform removal method has been used.

The uniform traffic removal procedure involves removing equal proportions of traffic from each class until all costs have been allocated. The method as applied to highway cost allocation is described elsewhere *(9, 10)*. Uniform traffic removal can be derived from a set of axioms originally developed in the context of game theory *(10, 20, 21)*.

Highway cost allocation methods would relate a developer's responsibility to the traffic that uses an improvement to go to or from a site. This traffic is commonly estimated using the Urban Transportation Planning System (UTPS) *(14)* or a similar approach. The UTPS approach for determining impact fees can be shown to be equivalent to the application of attribution techniques under different assumptions. As an illustration, costs are commonly allocated to developers as an impact fee, in proportion to the ratio of estimated development traffic to total traffic using the improvement. This is equivalent to the uniform removal method under the assumption of a continuously differential cost function with no fixed costs and to the incremental assignment techniques under the assumption of a linear cost function.

The remainder of this paper is devoted to the description and application of the uniform traffic removal method to the assessment of impact fees. The proportional and incremental allocation methods are shown to be equivalent to the uniform removal method with specific assumptions.

UNIFORM TRAFFIC REMOVAL COST ALLOCATION

The uniform removal technique is based on a cost function that relates the required improvement costs to the traffic from each development using the improvement. The cost function used for highway cost allocation typically includes agency costs; for impact fee assessment, it includes only construction costs. In the latter case, facility operating and maintenance costs are ignored and other general costs such as vehicle operating costs and pollution are disregarded.

The uniform removal technique exhibits four properties *(10)*:

1. The sum of allocated costs equals total costs. This property ensures that the primary objective of meeting agency costs

by assessing an impact fee is met. User costs including congestion and vehicle operating costs may also be included.

2. Costs allocated to any class of users are nonnegative. This property prevents any developer from receiving payments.

3. The cost allocation procedure is additive. Additivity ensures that, if the cost function is separable, identical allocations are obtained if the procedure is applied to the total cost or the separate parts. This property is important because development usually involves improvements at many different locations, and total improvement costs are the sum of the costs at individual links or intersections.

4. Cost allocation is consistent. If vehicle volumes are identical in their effect on cost, allocated costs are proportional to the volumes of the classes. This property is consistent with the equity objective expressed earlier.

Billera and Heath *(21)* show that the cost allocation procedure exhibits these properties and is unique.

To apply the uniform removal method, assume that the traffic using the improvement is a vector (x) of traffic from each of n development sites

$$x = (x_1, \ldots, x_i, \ldots, x_n)$$

where x_i is the traffic to or from developer i's site. Let $f(x)$ be the long-run cost of serving volume x, and assume that there are no fixed costs [$f(0) = 0$]. Furthermore, assume that the cost function is continuous and has a nonnegative first derivative, that is $\partial f(x)/\partial x_i > 0$ and continuous.

For roadway improvements, the cost function relates the cost of improvement to the additional traffic using the improvement. This is commonly a step function but may be approximated by a function such as the logistic curve, which is appropriate when it is recalled that the actual traffic volume is only forecast not known.

Also, assume that the present capacity is adequate for the existing traffic and existing traffic is therefore ignored in the analysis. According to the uniform removal procedure, equal portions of each developer's traffic are removed until all of the costs have been attributed. The uniform removal cost allocation to developer i is given by *(10)*

$$c_i(x) = x_i \int_0^1 f(t \cdot x_1, \ldots, t \cdot x_i, \ldots, t \cdot x_n) dt \tag{1}$$

where x is a vector of traffic using the improvement. Assuming direct equivalency between each developer's traffic, it can be shown *(10)* that the cost allocated to developer i is proportional to use:

$$c_i(x) = f(x)\, x_i/x_t \tag{2}$$

where x_t = total traffic = $x_1 + \ldots + x_n$.

As is demonstrated elsewhere *(10)*, this allocation exhibits the four properties described previously and is unique. Similar results can also be obtained for many improvements and developments.

This method is also equivalent to a proportional allocation procedure with respect to the number of vehicles using the improvement and is equivalent to an incremental allocation procedure assuming constant returns to scale for construction. Furthermore, these allocated costs, and prices that equal marginal costs, are identical for a cost function that has constant returns to scale. The results obtained here are similar to those obtained by the methods used in Broward County *(11)*.

The uniform traffic removal technique can still be used with scale economies of construction, although it will not be equivalent in this case to proportional assignment. Also, it is possible to include allocation of costs to existing roadway traffic or, alternatively, to existing plus forecast growth in roadway traffic up to the point at which improvements are desirable. For additional traffic growth due to specific developments or to regional changes, cost allocations can be performed using uniform traffic removal.

A difficulty with the cost allocation methods described here occurs in cases in which route choice for new traffic is ambiguous. Standard equilibrium traffic assignment methods simply indicate equilibrium flows but do not indicate the specific origin-destination (O-D) flows that will use a particular link. Thus the proportion of traffic that uses a particular link cannot always be immediately identified as coming from a particular origin. Several alternative methods of estimating the origin or destination of traffic on a link may be employed, although each requires additional assumptions. First, by reducing specific O-D travel volumes and observing the reduction in flows on particular links, it may be possible to infer the contribution of particular developments to specific link flows and then to proceed as described previously. Second, the actual traffic assigned might be used as part of a traffic assignment algorithm *(22)*. This would require keeping an account of the origin or destination of traffic flows at each iteration of the assignment algorithm. Although it does not represent an explicit model of route choice, this procedure is relatively simple and can be readily replicated. Third, an analyst could employ a secondary algorithm to distribute specific O-D flows among minimum travel time paths on the basis of a criterion such as entropy maximization and subject to the actual volumes identified in the assignment phase. Finally, all-or-nothing assignments avoid such distribution problems. Each of these methods would estimate the proportion of the volume on a facility orginating from or destined for new developments.

Another problem arises in considering developments that are scheduled for later implementation. In this case, cost allocations could be made for each year in the planning horizon, and the equivalent uniform annual cost of improvements could be allocated in each year.

IMPACT FEE ASSESSMENT USING UNIFORM TRAFFIC REMOVAL: EXAMPLE WITH NETWORK ASSIGNMENT

The six tasks usually applied to assess variable impact fees were presented in the first section of this paper. The uniform removal method presented in this section represents a procedure for allocating costs to developers as required in Task 4. As Equation 2 indicates, the allocation of costs requires knowledge of the volume of traffic that is generated by each development ($i = \ldots n$) and uses each improvement (j). This volume is estimated using an urban transportation planning approach described in Steps 1–3 of Task 2. The process is crucial to the

application of any allocation method and is described more fully elsewhere *(14)*.

The process is usually applied with existing traffic, anticipated growth outside the study area, and potential developments as inputs. Generation rates and gravity models, common in many computer implementations of the process [UTPS *(14)*, MINUTP *(23)*, MicroTRIPS *(24)*], are often supplemented by or replaced with local data from surveys. The assignment of traffic to the network may be all-or-nothing or equilibrium assignment *(22)*. In the former, all traffic from each origin and to each destination is assigned to the shortest path between the origin and the destination. Equilibrium assignment is based on the principle that "a stable condition is reached only when no traveler can improve his travel time by unilaterally changing routes" *(22)*. In practice several methods, including incremental, iterative, and stochastic assignment, are used to approximate equilibrium assignment. Clearly, the consistency and equity of the allocation are dependent on the accuracy of the estimated traffic volumes.

The following hypothetical example demonstrates the application of the uniform removal method for allocating costs and the UTP approach for estimating volumes for the afternoon peak flow. The hypothetical study area is shown in Figure 1 with two potential developments sites. Site A (located in Zone 5) is 10 acres and has a proposed 500,000-ft^2 office complex. Site B (located in Zone 6) is 15 acres and a 800,000-ft^2 office complex is proposed. Zones 5 and 6 are the only internal origins and destinations and the numbers 1 through 4 represent external origins and destinations. Intersections are numbered 7 through 11. Finally Link 1-3 represents an Interstate highway; Link 2-4 a major road; and Links 5-10, 6-11, and 7-8 access roads. All links are two way and existing traffic, capacities, and lengths of links are as given in Table 1. The tasks described previously are performed to determine and allocate improvement costs.

1. Developments: two developments, A and B, have been identified.

2. Determine improvements.

Step 1: ITE rates are used to determine the traffic generated by the site on the basis of square footage of development *(8)*. Generation rates and traffic are given in Table 2.

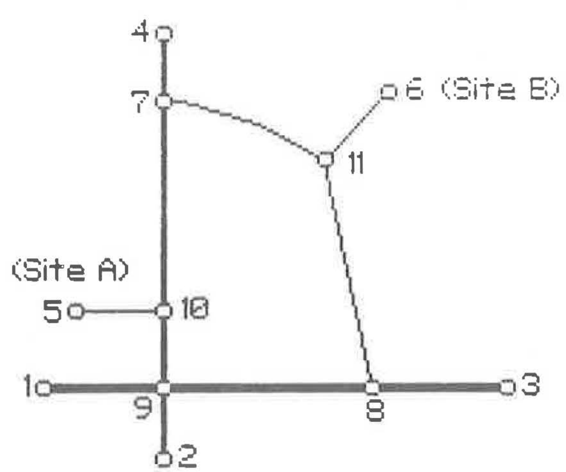

FIGURE 1 Hypothetical study area.

TABLE 1 INPUT LINK DATA FOR EXAMPLE SITE

Link	Length (mi)	One-Way Capacity (vph)	Existing Volume
1-9	0.8	4,000	2,000 3,700
2-9	0.6	1,700	700 1,500
3-8	0.2	4,000	3,200 1,500
4-7	1.1	1,900	1,900 1,100
5-10	0.3	1,700	0 0
6-11	0.3	1,700	0 0
7-10	1.0	1,900	1,800 800
7-11	0.1	1,400	100 300
8-11	1.4	1,700	300 100
9-10	0.3	1,900	800 1,800
8-9	0.6	4,000	2,900 1,400

Step 2: For this example, distributions are assumed to be known and as given in the O-D matrix of Table 3.

Step 3: The O-D matrix is then assigned to the network and the resultant link volumes are obtained. All-or-nothing and incremental assignment (using increments of 0.4, 0.3, 0.2, and 0.1) are used and the link volumes are as given in Table 4. The results obtained using the two assignment techniques differ for alternate routes to Site B from the Interstate.

Step 4: If intersection capacities are ignored, Links 9-1, 9-2, 8-3, 4-7, 7-10, and 9-10 are overcapacity and require additional capacity. Proposed improvements and estimated costs are given in Table 5.

3. None of the links that require improvement are site accesses, so this task may be skipped. Links 5-10 and 6-11 are site accesses, but they are not overcapacity.

4. Table 5 gives the proportion of each developer's traffic on each of the links found using incremental assignment. Costs are allocated according to these values using the uniform removal method and incremental assignment. The allocated costs for Developer A are also given in Table 5. Remaining costs are allocated to Developer B. Column I represents allocated costs using the uniform removal method. They are the proportion of additional traffic that belongs to Site A and uses the improvement times the estimated cost. For example, for Link 9-1, 5/13

TABLE 2 TRIP GENERATION (afternoon peak)

	Traffic Volume	
	In[a]	Out[b]
Site 5 (500,000 ft^2)	197	930
Site 6 (800,000 ft^2)	312	1,488

[a]Generation rate per 1,000 ft^2 = 0.39.
[b]Generation rate per 1,000 ft^2 = 1.86.

TABLE 3 TRIP DISTRIBUTION

From	To 1	2	3	4	5	6	Total
1		300	1,200	500	100	160	2,260
2	200		200	300	25	40	765
3	2,800	100		300	40	80	3,320
4	700	1,100	100		2	32	1,964
5	500	90	250	90			930
6	800	160	400	128			1,488
Total	5,000	1,750	2,150	1,318	197	312	

of the costs are allocated to Developer A. Columns II and III represent allocated costs using incremental assignment. For Column II, Development A's traffic is added to the existing traffic first, and, for Column III, Development B's is added first. For example, for Link 9-1, Developer A's traffic alone puts the link overcapacity; therefore Developer A pays the full cost of improvement. If Development B's traffic is added first, Developer B pays the full cost of the improvement. In cases in which only one direction requires improvements, costs are allocated accordingly, but in practice improvements would usually be made in both directions.

5 and 6. Costs allocated to Developer A are $1,859 and those allocated to Developer B are $5,291 using uniform removal. In this example incremental allocation was also used to determine the costs allocated to Developers A and B to demonstrate the differences among the allocation methods and the effect of different orderings on incremental allocations. Allocated costs using incremental allocation with Site A developed first are $3,850 and $3,300 for Developers A and B, respectively. If Site B is developed first, the developers' costs are $300 and $6,850, respectively. These results demonstrate that different allocation methods result in quite different costs to developers.

An incremental method was used to determine how much of the traffic increase on each link should be attributed to each developer. It should be pointed out that there are two different incremental methods for attributing traffic to two different developers. One would be to add Developer A's trips to the base trip table and assign the volumes to the network, then assign the total trip table (including trips from both developers). Developer A would be assigned the traffic increase in the first assignment over the base assignment, and Developer B would be assigned the difference between the total development assignment and the assignment including base plus Developer A's trips. A second way of attributing traffic would be to apply the same procedure reversing the order of the developers—adding Developer B's trips to the base table first.

A different amount of traffic on a link could be attributed to each developer under each of the two orderings using the incremental allocation method because of the nature of equi-

TABLE 4 LINK VOLUMES

Link	Existing	Volume with Proposed Developments (all-or-nothing)	Incremental	One-Way Capacity (from Table 1)
1-9	2,000	2,260	2,260	4,000
	3,700	5,000	5,000	
2-9	700	765	766	1,700
	1,500	1,750	1,750	
3-8	3,200	3,320	3,320	4,000
	1,500	2,150	2,150	
4-7	1,900	1,968	1,968	1,900
	1,100	1,318	1,318	
5-10	0	930	930	1,700
	0	195	195	
6-11	0	1,488	1,488	1,700
	0	316	316	
7-10	1,800	2,792	2,696	1,900
	800	1,090	1,090	
7-11	100	336	336	1,400
	300	1,388	1,292	
8-9	2,900	2,940	3,036	4,000
	1,400	1,650	1,650	
8-11	300	380	380	1,700
	100	500	596	
9-10	800	1,165	1,166	1,900
	1,800	3,600	3.504	

TABLE 5 ALLOCATION OF COSTS

Link	Improvement	Estimated Cost ($000s)	Traffic Volumes for Developer A	Traffic Volumes for Developer B	Cost Allocated to Developer A[a] ($000s) I	II	III
9-1	Additional lane	2,400	500	800	925	2,400	0
4-7	Widen lane and shoulder	550	32	32	275	550	0
9-2	Widen lane and shoulder	300	90	160	108	0	300
7-10	Additional lane	3,000	32	864	107	C	0
10-9	Additional lane	900	840	864	444	900	0
Total		7,150			1,859	3,850	300

[a]I = uniform removal, II = incremental assignment with Developer A's traffic first, and III = incremental assignment with Developer B's traffic first.

librium (or incremental capacity restraint) assignment. This result occurs because as traffic increases on a network link, travel time increases. Thus trips loaded subsequently onto the network are less likely to use the link. The differing capacities of the various links cause different sensitivities to volume increases. The proportion of Developer A's trips that might use the link if Developer B's trips were loaded first is different from the proportion of Developer A's trips that might use the link if Developer A's trips were loaded first.

Other ways of attributing traffic can also be used. These include averaging the results of the two incremental method orderings and allocating the total development traffic (difference between the assignments of the total and base trip tables) proportionally to the trips generated by each development. The former method involves increasingly more computation as the number of developments grows. The number of different possible orderings of developments equals the factorial of the number of developments under consideration.

The simplicity of the network used in the example resulted in assignments that were identical under both possible orders of development when incremental traffic allocations were used. Thus the assignment results from any of the methods mentioned would yield the same apportionments of traffic between the two developers. The impact fee assessments obtained using any of the allocation methods are therefore, in this case, unique to the method. Further research is currently being done to determine an assignment method that is independent of the ordering of the developments in more realistic networks. Such a method would conform to the objective of consistency in the assessment of impact fees.

This illustration demonstrates a rational approach to determining impact fees using the uniform removal method. The impact fees cover costs and are consistent among developers.

CRITIQUE OF COST ALLOCATION METHODS

The example demonstrates some of the problems with the cost allocation approach. Problems include the dynamic nature of development and its relationship to the economies of scale that are inherent in roadway improvement and the practice of ignoring user costs in assessing impact fees.

There are significant unresolved technical problems with these analytical techniques:

- It is assumed that existing demand does not vary with the improved facility; therefore induced demand and changes in user costs and their effects on level of service are ignored.
- These techniques represent a snapshot or static view of development. Although they may account for future development, they do not account for the staging of projects and the time value of money. This problem is exacerbated by the desire of local governments to capture economies of scale and construct projects larger than required to accommodate future development without doing any economic analysis to justify the project.
- There is an ill-defined relationship between investment planning principles and the size and nature of the required improvement. Improvements are implemented to ensure a minimum level of service for users. The allocation process does not evaluate the cost-effectiveness of achieving this objective. It may be that greater net social benefit, assuming the project is economically feasible, may be attained by implementing a smaller or a larger project.
- User costs are ignored. The allocation process includes improvement cost, but reduced or increased levels of service for existing users are not accounted for.
- These methods depend on uncertain estimates of traffic volume and improvement costs and identification of the origin and destination of traffic that will use an improvement. This can lead to "double counting" of traffic if there are significant traffic volumes from one site to another or diversions from existing traffic patterns.

The issues involved in determining road user fees and impact fees are equity, economic efficiency, consistency, and the need to cover costs. In this paper the uniform removal technique was used to demonstrate the use of highway cost allocation methods to assess impact fees in a way that ensures that such fees are unique and consistent.

Practical problems with the application of these techniques include determining the traffic that will use the improvement to go to and from the developer's site. However, this type of analysis and empirical evidence indicate that it is possible to develop a rational technique for determining impact fees.

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Economic Arguments on Tool Roads

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From the economic point of view, tolling is an instrument that can be uniquely suited to the collection of efficient road use prices. Because they affect resource allocation, toll rate levels need to be considered when decisions are made about the appropriateness of a toll scheme. It is argued that tolling (at rates above marginal costs) is equitable—those who benefit should pay—but beneficiaries may not pay in full or at all if they are not users of the toll road. Nevertheless, tolls are generally imposed for the purpose of raising additional net revenue, and they appear to be a suitable instrument if the object is revenue earmarking or private financing and management of roads. However, investment lumpiness and increasing returns make roads a commercially viable enterprise only occasionally. Means other than explicit tolls may be better for attracting private intervention. High associated costs are a disadvantage of tolling; in some cases the cost of distortions introduced by tolling may make incompatible the objectives of revenue generation and efficient resource allocation. It is important to ensure that effects on the economy at large, not only on the toll agency, are included in toll road analysis. This is not generally done and is the reason for this paper. There are, however, a number of conditions under which tolling may be appropriate (i.e., not worsen resource allocation or even improve it over untolled roads despite higher costs inevitably entailed in tolling with current technologies). Examples of results from tolling in two developing countries are provided. In this paper only tolling of interurban roads in discussed.

Toll roads are generally equated with high-standard roads, and nontoll roads with low-standard roads. Most analyses are limited to cash-flow considerations of the agency in charge. Such analyses, which may be appropriate for the toll agency, leave out economic costs to society at large. Such costs may be important enough to change the outcome of the analysis and the

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