COMMUNITY AND ENVIRONMENTAL IMPACT OF HIGHWAY INVESTMENT DECISIONS

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

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PREFACE

In October 1960, K. M. Wilkinson, the Virginia Department of Highways' metropolitan transportation planning engineer, requested the Virginia Highway Research Council to develop methods of predetermining the environmental impacts of proposed highways. In responding to this request, Jack H. Dillard, state highway research engineer, appointed an environmental task force composed of several members of the Council staff. As the task force grappled with the problem of defining the scope of the proposed study, two major points became readily apparent; first, that to ensure the methodology would not merely justify what departments have been doing for years, it would be advisable to include on the task force persons who were unfamiliar with highway departments and their philosophy; and secondly, that persons trained in disciplines other than those represented on the Council staff would be needed.

To obtain the benefit of a new viewpoint and to supplement the Council staff, the environmental task force was expanded to include three members of the University of Virginia faculty: James E. Lewis, associate director for community health planning; Wallace Reed, associate professor of environmental sciences; and J. Ronald Saroff, associate professor of city planning in the School of Architecture. The task force was also supplemented by several graduate students.

The results of this research effort are being published in three separate reports. The first, "Citizen Participation in Public Hearings in Virginia," by L. Ellis Walton, Jr., and Jerome R. Saroff, gives an analysis of the socioeconomic characteristics of persons attending public hearings, the concerns expressed by those who testified, and the basic format for highway hearings.

The second, "A Manual For Conducting Environmental Impact Studies" by L. Ellis Walton, Jr. and James E. Lewis gives a detailed methodology for conducting Environmental Impact Studies.

The third is the present report.

TABLE OF CONTENTS

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2463

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CHAPTER I

INTRODUCTION

Background

Hardly a week goes by that does not see a newspaper item concerning the public's questioning of opposition to, or outright halting of the construction of projects that highway planners conceive to be vital links in the highway network, whether on interstate or local roads. The most publicized projects have been those proposed for the major metropolitan areas. In these areas, the construction of essential links in the interstate system has met with a great deal of well organized (and unorganized) opposition, which in some cases has found strength and substance in the areas of racial unrest, poverty, and urban blight. More probably, however, civic officials have viewed interstate highway construction — particularly since local expense is insignificant compared to the federal-state outlay — as an additional scalpel to be used in their attempts to excise blights and slum areas from their cities, and they have encouraged highway planners to select routes that would help accomplish that goal.

But, the questioning and opposition are not limited to metropolises; indeed, questions and conflicts are numerous in the relatively rural areas of Virginia. The context is different, the basic issues may be different (if, indeed they are known), yet often the opposition is as vocal and the arguments are as heated as in the metropolises.

Because of the pervasive nature of the effects of highway investments on communities the Virginia Department of Highways actually does much of the physical planning for the state's counties and smaller urban areas under the guise of highway planning. There is very close coordination between the Highway Department staff and representatives of local governments, and proposed route locations have to have the approval of local officials. Yet, when conflict arises, the Highway Department often finds itself the lone proponent of an alignment that has had "official" approval for months or even years. By the time of the conflict, of course, realignment of the route segment is immensely more expensive, if not downright impossible.

In some cases, the support of local officials for purposes of construction has evaporated at the first hint of controversy leaving the Highway Department, from the community viewpoint, in the position of an outsider forcing an unwanted facility in an undesirable location on an unwilling community. For the most part, Highway Department representatives at public hearings are performing that role in addition to their normal day's work as district or resident engineers. They do not have the time to plan and rehearse a presentation which attempts to supply answers to all possible questions and, being technically trained individuals, they may be unable to understand or relate to conflicts caused by social, economic, or environmental impacts.

In September 1969, the Virginia Highway Research Council began planning a research program which, over a period of years, is expected to supply answers leading toward the elimination or amelioration of highway related conflicts. The researchers hope to achieve this by improving the ability of highway planners to foresee potential conflicts and to deal with them before they develop into full-scale battles. In January 1970, an interdisciplinary research team began developing a state-of-the-art report on the methodology for conducting "community and environmental" impact studies. The term "community and environmental" is explicitly recognized by the team members as the most inclusive label for the "economic" and "social" impact studies of recent years, and it also encompasses aesthetic and psychological impacts as they affect both individuals and groups.

The long-term goal of this research program is to develop and institute within the Department an "early warning" system which will identify potential and probable community and environmental conflicts resulting from highway impacts. Realistically, of course, human nature if not the limits of science preclude the attainment of this goal; still, it is worth striving for. Along with this early warning system, a unit should be established to conduct studies of problems that are arising and will continue to arise out of projects planned in the past; to anticipate new problems and attempt to solve them; and to serve in a "fire-fighting" role with respect to the inevitable problems that just seem to occur regardless of the precautions taken to anticipate or prevent them.

These suggestions are based on the view that the need for community and environmental impact studies may derive either from conflicts foreseen at the network planning stage or from unforeseen conflicts that arise in the right-of-way acquisition or construction stages. From a long-term standpoint, the team believes, too, that the real worth of community and environmental factors studies will be appreciated only in the larger context of the measurement and evaluation of the effectiveness of transport systems.

As a guide toward these goals, the project team has established three objectives for this obviously preliminary study.

1. To determine the state-of-the-art of procedures for the investigation and evaluation of the community and environmental impact of investment in highway facilities.

2. To develop in detail those investigative and evaluative procedures which are appropriate to or which may be adapted to the use of the Virginia Department of Highways.

3. To establish a methodology for determining the probable impact of an urban highway on the environment it traverses.

These are the primary objectives of this study. It is expected, however, that they will lead to such problems as: establishing a competent and effective community and environmental factors unit in the Department, developing methodologies for rural environmental impact studies; testing, refining, and improving methods and techniques for conducting environmental studies; developing means of enhancing the value and acceptance of a highway facility through design features; and making community and environmental studies influential elements in highway investment planning and decision making.

CHAPTER II

TRANSPORTATION SYSTEM PLANNING

Until 20-25 years ago, transportation system planning could be described fairly as the relatively easy days when a decision such as "connect all towns over 2,000 population with a two-lane paved road" could be reached by a legislature or a highway commission and then turned over to an engineering staff for execution, leaving the decision makers secure in the knowledge that the engineers would select routes that, overall, would provide the best service at the lowest possible cost. However, the initiation of the interstate highway system after 1956 and other work focused the attention of highway planners on the negative as well as the positive impacts of highway investments and broadened the understanding of their social and economic impact. The development of environmental impact studies is seen as the logical culmination of these studies which attempt to meet the expressed need for understanding the interaction of the highway and its surroundings. But, more importantly for the purpose of this chapter, the recognized need for conducting environmental studies in the Highway Department illustrates just how much the transportation planning process in general, but specifically the highway planning process, has changed in the past two decades.

In this chapter, the authors will take a look at the highway planning process and then discuss some of the possible strategies for planning, particularly as they display different levels of community involvement.

The Highway Planning Process

In its fundamentals, the planning process consists of seven elements or steps, which are then followed by implementation of the plan. The steps are:

(1) Study organization and design;

(2) Inventory;

(3) Analysis and forecast;

(4) Formulation of development objectives and standards;

(5) Plan design;

(6) Plan test and evaluation; and

(7) Plan selection and evaluation.

In the Virginia Highway Department, the wide majority of the planning is carried out in the Metropolitan Transportation Planning Division and the Urban Division. The process followed is roughly that outlined above. In the planning stage, community input is solicited from municipal officials and the elected representatives of the community. Following completion of the metropolitan transportation plan, the next official contact with the community comes at the hearings on the location and the design of a specific facility segment.

This pattern of Department-community relationships represents the midpoint in the evolutionary development of the highway planning process. The early stage of this process saw the highway planner operating in his role as a professional with the traditional lay attitude that his professional judgements were accepted with little question. The second stage, and the one where Virginia is now, involves the elected decision makers of the community in the highway planning process as reviewers and legitimators of the highway planner's efforts.

The third stage would put the community — through elected or appointed representatives — in the role of decision makers with the highway planner in the role of a technical advisor or staff. Obviously, most highway departments and highway planners look with suspicion on the rapid approach of this stage. It should be noted, however, that their suspicion is not based on a lack of desire to be responsive to the community's perception of its needs but rather in the anticipated additional time that will be required for an already lengthy process.

There is legitimate question, too, of whether the majority or even a significant number of community residents want this level of improvement in highway planning. Wachs[1] has reported a 1968 study in which a sample of community residents was asked which of six approaches to transportation planning they would prefer. First of all, this sample group would have given the planners even stronger powers than they already possess. The most favored approach to planning would leave the decisions to the planners, but require them to consult with a group of leading citizens throughout the planning process. The second highest rating was assigned to the approach which would leave the decisions to a staff of trained professionals. Reflecting the traditional American distrust of government and politicians, the approach which would leave the planning decision to elected officials was least favored. The second lowest score was assigned by the sample group to the approach which would let the citizens decide on the location and nature of transportation projects through a referendum.

Bishop, et al[2] reported the results of a California survey in 1970 that bears out many of the same conclusions. Citizens preferred to leave the decision in the hands of the highway engineers and planners as the best of the six choices they were given. Least desirable of the six was to leave the decision to local officials. This study also reported findings for a sample group of community officials and employees. This group most favored a high level review board appointed by the governor (the method presently used in California). Least acceptable to this group was to place each alternative route on the ballot in a referendum.

Citizen attitudes toward methods of highway planning may have changed in the time since these studies were completed and one set of findings was for citizens in the Chicago suburbs while the other was for community officials and employees and citizens in California. Whether these findings are transferable to the Virginia situation is not known. Similar studies should probably be conducted in Virginia with the suggested modification that samples be drawn from urban, suburban, and rural populations, and from attendees and nonattendees at highway location and/or design hearings.

Along with the evolutionary development of the planning process, there has occurred an evolutionary growth in the way in which transportation plans are evaluated Four phases in this evolution have been identified by Einsweiler:[3]

(1) In this phase, the critical factor was construction cost;

(2) In phase 2, which is the predominant evaluation technique in use today, construction costs are still employed but decisions are based primarily on user benefit-cost analyses;

(3) The third phase, which is now emerging, encompasses the earlier two and adds evaluation of the impact of the highway on the community; that is, non-highway user benefit-cost analyses; and

(4) "Although the third phase is only beginning . . . the fourth phase is already overdue. . . . This phase views a transportation facility as an investment of scarce resources in competition with other needs. This gets to the question not only of where the route should be built; but whether it should be built at all."

Citizen Participation in Highway Planning

Although the findings of the Wachs and Bishop studies indicate that citizens apparently prefer highway planning to be conducted in much the same way that it is presently, it is clear the Highway Department will be under more and more pressure to increase the citizen participation in the highway planning process. Then the question will be: How to accomplish this in a realistic and meaningful way?

Some ideas might be gained from the following review of possible approaches which were identified by Bishop and his co-workers.[2] These six strategies are arrayed in order of increasing complexity and increasing citizen involvement. The first strategy is essentially the approach used in Virginia at the present time.

1. Strategy of Information (Figure 1a): In using a strategy of information, the highway planner controls and conducts the study and only contacts community groups to present findings or gather information or data.

2. Information with Feedback (Figure 1b): In the strategy of information with feedback, the highway planner controls the studies. He develops alternatives and makes planning decisions. Alternatives are presented to community officials and employees and other groups during the studies. Comment and feedback are obtained. Proposed plans may or may not be adjusted based on these inputs.

3. The Coordinator (Figure 1c): Acting as a coordinator, the planner places himself in contact with the important elements of the local communities, assesses their objectives, tests alternatives as they develop, and receives feedback. Interaction among different community interests is not encouraged. A possible way to implement this approach is for the Department of Highways to establish a field office in the local area where local officials or citizens could come with questions, suggestions, and information.

4. The Coordinator-Catalyst (Figure 1d): As a coordinator and catalyst, the highway planner would promote participation in the planning studies. The affected parties confront and interact with one another. Under this strategy, highway planners of the Department of Highways would supply methodological and technical skills and serve as the mechanism for synthesizing objectives, coordinating interests, and working out compromises in areas of conflict. The vehicle for such a planning approach might be a workshop group composed of representatives of the community such as elected officials, city planning and engineering staff members, business, commercial, and industrial interests, school districts and homeowner groups. The Department would provide the engineering services and technical expertise.

5. Community Advocacy Planning — The Ombudsman (Figure 1e): As an advocate, the ombudsman, a specially appointed expert, works directly with highway planners on behalf of community groups. The affected parties would supply him with data and information, and inform him of their desires and preferences. He would represent these views in working with the planner of the Department to develop alternatives.

6. Arbitrative Planning — A Hearing Officer (Figure 1f): This strategy places an independent hearing officer between the highway planner and community groups to act as an arbitrator. He would come to the community at important stages during the planning period, for example, at initiation of studies when study alternatives are being developed. In each instance, the Department would present its current proposals. Groups in the community would present criticism, suggestions, or other alternatives. The hearing officer would evaluate the testimony and recommend appropriate changes in the studies. Possibly he would make the final choice among alternatives.

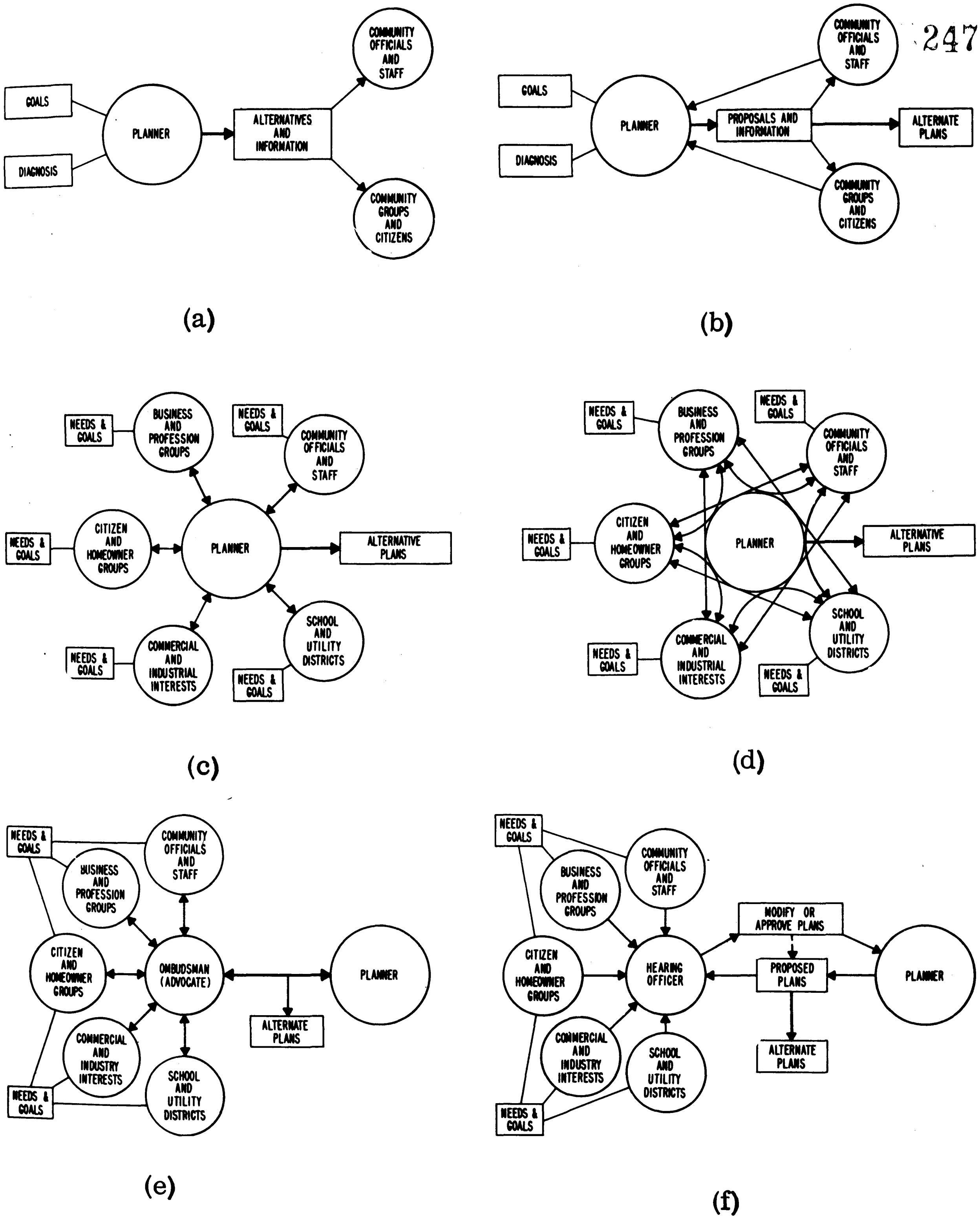

Figure 1. Six planning strategies.*

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*After Bishop, Oglesby, and Willeke, "Community Attitudes Toward Freeway Planning: A Study of California's Planning Procedures", Highway Research Record Number 305 (1970), pp. 41-52.

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CHAPTER III

SYSTEMS EVALUATION AND IMPACT STUDIES

This section of the report presents a review and summary of a selected group of studies representative of techniques and methodologies which have been used in part or developed for the purposes of evaluating alternative plans for transportation investment and evaluating the impact of these investments on the environment. As used here, "environment" refers to the complete social, economic, political, and physical setting; however, a given study may emphasize one or the other of these aspects of the environment and only a few attempt a more holistic approach to the environmental complex.

The evaluation of transportation plans is identical with the broad concept of environmental impact studies being employed in this report. In other words, the purpose in conducting these environmental impact studies is to broaden the basis for evaluating alternative proposals for highway investments.

Boyce and Day, in their review of plan evaluation methodologies,[(1)] identified two basic approaches: (1) Methods applied to each alternative separately, and (2) methods for comparison of alternatives. The former is comprised of formal methods of analysis, such as transportation network analysis, and less formal analyses of public facility-service systems and private activity systems.

The methods for comparison of alternatives include:

(1) Efficiency analysis, such as benefit cost;

(2) Effectiveness analysis in relation to plan objectives; and

(3) Methods for ranking alternatives and aggregating rankings.

The purpose here is not to attempt to fit the review studies into these or any other categories, rather it is to determine how well they meet these purposes and whether they, or elements of them, are adaptable for use in the studies of environmental impacts that will be conducted by the Virginia Department of Highways.

It is appropriate to note, however, that these studies can be categorized by another rule, and that is whether they are based on maps, matrices, or mathematical models. The following summaries are arranged in this order, which also follows the rule of increasing cost and complexity.

Review of Previous Studies

Methodologies and techniques for conducting environmental impact studies range from the very simple and often subjective to the very complex and as close to totally objective as it is possible to get. Very few methodologies for complete environmental studies are represented in the literature, yet there is a great number of techniques and approaches that could be brought together to form an overall methodology.

Ian McHarg[2] has developed a very simple map-based method of route selection which includes social, resource, and aesthetic criteria and attempts to balance them against traditional engineering considerations. In McHarg's opinion: ". . . the best route is that which provides the maximum social benefit at the least social cost."

The method consists of identifying the relevant parameters (McHarg suggests a list) and allocating three values — high, intermediate, and low — to each. The presumption is that the corridor of maximum social utility will transect the zones of lowest social value and provide the maximum social benefit.

A transparent overlay is prepared for each parameter with the three values indicated by shades of darkness. The highest value of obstruction, whether social or physical, is represented by a dark tone, the intermediate value by a light tone, and the lowest category is fully transparent. When all of the parameters are overlaid on a base map of the study area, it is presumed that the maximum density of shade represents the greatest total social and engineering obstructions. In contrast, the light areas representing the least obstruction offer prospective corridors for construction.

McHarg recognizes that this is not a precise method for highway route selection, but he insists that it does have the merit of incorporating all existing parameters, adding new and important social considerations, revealing their locational characteristics, permitting comparison, and revealing aggregates of social values and costs.

In the early 1960's, Alexander and Manheim[3] embellished the basic technique described by McHarg. First, they used a photographic enlarger to assist in selecting out the more darkly shaded areas of the overlays. Secondly, they devised a computer decision-tree to help them determine the order in which the overlays should be arrayed on the base map. For all practical purposes, however, the technique is the same as McHarg's.

The matrix-based methods are represented by the <u>Dover By-Pass Project</u>[4] and the impact studies of the Baltimore Rapid Transit System.[5] The evaluation matrix is employed to place the parameters into their proper perspective and to equate quantifiable and non-quantifiable values to common units for comparison. The matrix enables the introduction of weights to the parameters and offers the attraction of yielding a single, dimensionless number which indicates the ranking of each alternative route segment.

Any number of parameters can be included in the matrix for any number of alternative routes. Weights can be assigned to individual parameters, e.g., a scenic valley is "4" and an industrial slum is "0". Further, the individual parameters can be weighted again for each alternate route, e.g., the scenic valley is "2" on Route A and "0" on Route B. Of course, both tangible and intangible parameters can be included.

It is important to note the subjectivity involved in the matrix-based methods. Both parameters and weights are based on subjective considerations that may reflect the personal biases of the highway planner or engineer rather than the consensus of the community affected by the highway investment. To be sure, the judgements on many parameters, of necessity, will be subjective but the basis for the subjectivity can be broadened. For example, Schimpeler and Grecco[6] propose to do this by having professional planners and community "decision-makers" develop the list of parameters and the weightings to be applied to them.

The mathematical modeling category is represented by CONSAD Research Corporation's[7] studies of the Northeast Corridor Transportation Project. CONSAD'S task in this project was to develop impact models and measures of indirect benefits and costs constituting the impacts of changes in the regional transportation network. The objective of the studies was to determine the interaction between alternative transprotation facilities and the economic, demographic, physical, and social environment of the Northeast Corridor.

Three mathematical models were developed around the concept of altered comparative advantages for the locations of people and business interests, at successively smaller geographic areas, as these are affected by changes in transportation facilities. The mathematical models are used to make "conditional forecasts" of the redistributions and changes in population and economic activity that might occur as a consequence of alterations in the transportation network. The system of models makes possible reliable forecasts of a large variety of indirect impacts of a vast array of possible transportation alternatives.

The mathematical models are the most objective of the methods discussed here. This is not to say, that subjective considerations do not enter the system in one way or another.

Summary

As the preceding brief summaries have shown, system evaluation techniques vary widely in cost and mathematical sophistication. At the simplest level is the type of analysis suggested by McHarg. In effect, this is an old geographical technique for locating regional boundaries which long ago fell into disfavor among geographers owing primarily to its failure to yield significant cases of boundary coincidence and, secondarily, to its lack of precision. It remains an essentially non-quantitative technique which does not yield directly comparable values for alternative route locations.

At the opposite extreme, the CONSAD type approach involves developing a mathematical model of the socioeconomic system of the area being studied. In theory, such a model would permit every change in the region — in the transport system, the economy, the population, and the like — to be introduced into the model so that the impact of its interactions and feedback relationships can be measured.

If this kind of model could be made operational, the 98 counties and 35 independent cities of Virginia could be subjected to this kind of analysis. Of course, while a model of this type could be exceedingly valuable to many state agencies, it is very expensive to establish and maintain. Before any effort of this magnitude should be undertaken by the Highway Department, agreements for financial assistance with the effort should be reached with the Division of Planning and Community Affairs and the Department of Industrial Development.

One final observation may be worth noting. Each of the analytic approaches — maps, matrices, and mathematical models — appears to be most useful at a particular scale of analysis as shown below. It may be useful to study this relationship further in order to devise the best procedure for making environmental impact studies in Virginia.

Figure 2

	MAP	MATRIX	MODEL
Network	X	X	X
Metro Area or Planning Region	X	X	-
Small City or Neighborhood	X	-	-

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CHAPTER IV

DEVELOPMENT OF METHODOLOGY FOR ASSEMBLING AND PRESENTING IMPACT DATA

This chapter sets forth the methodology for conducting environmental impact studies which is proposed for implementation by the Environmental Quality Division of the Virginia Department of Highways. For the purposes of this chapter, "methodology" refers to an intellectual approach or way of thinking about a problem, while the word "technique" is used to describe the step-by-step analysis of a given problem. The technique for conducting environmental impact studies has been developed and is being tested, and is published in a manual entitled "A Manual for Conducting Environmental Impact Studies". The in-depth literature reviews and studies from which both this methodology and the investigative techniques have evolved are being published as separate studies.

The preceding three chapters have focused on (1) the evolutionary development of transportation system planning over the past 50 years, and (2) approaches to the evaluation of transportation plans and the measurement of the impact of transportation investment decisions. The present chapter focuses on the identification of relevant classes of impacts and on consideration of appropriate methodological approaches to their analysis.

In policy and procedure Memorandum 20-8 published by the Bureau of Public Roads (FHWA) in January 1969, twenty-three specific social, economic, and environmental factors were identified, and a checklist procedure was established to ensure that these factors were considered for each highway construction project. As is the case with most lists of this type there have been two standard responses. One has been to interpret the 23 factors as an all-inclusive standard rather than as a suggestive minimum. The second response has been to continue adding specific factors until the list was expanded to an unworkable size. In the eyes of the inter-disciplinary environmental team of the Virginia Highway Research Council neither of these was a satisfactory response.

The research team is wary of any listing of minimum requirements, because they almost always undergo a subtle transformation into standards of performance. Further, anyone with a little thought and imagination can expand such a list until it becomes a seemingly endless array of trivial points which ultimately becomes cumbersome and unworkable. In either case, the original purpose of the list is either subverted or lost in the shuffle. Hence, the study approach has been to identify broad categories of considerations rather than specific factors. This approach recognizes that it is impossible to list all of the specific factors that might possibly impinge on a project, and it also gives the individual conducting an environmental study the flexibility to determine the critical impacts in a given community so that he can concentrate his efforts on them. Of course, the ideas presented here are being tested now, and they will be subject to continuing evaluation and appropriate revision as the Environmental Quality Division moves into full operation.

2480

At this point, it seems appropriate to introduce some fundamental problems facing the development of environmental quality studies in general. The two major problems — lack of knowledge and lack of manpower — go hand in hand. There is a lack of a cohesive body of knowledge on environmental studies, indeed on the environment. Yet, we find ourselves in the position of attempting to employ people qualified to undertake such studies.

It is in recognition of this need for an environmental education effort within the Highway Department generally, that the research team has planned the three levels of reports mentioned earlier. This overview will provide a broadly readable report for wide distribution. The manual which is to be published will serve as a technical handbook for environmental analysts in the Environmental Quality Division. And the several in-depth reports will provide resource material for the practitioner as well as for other readers who desire greater detail on one or more of the classes of impact.

During the course of its discussions in the spring of 1970, the environmental team identified numerous environmental impacts which, based on their combined experience and the literature which had been reviewed at that time appeared potentially worthwhile to consider. As the discussions continued, however, there seemed to be ten basic classes of impacts into which all of the others could be placed. And, of course, owing to the very nature of environmental studies, there was some overlap between those classes.

The impact classes finally identified and approved for study are as follows:

1. Change in tax base.

2. Change in value of land adjoining the highway facility.

3. Costs and benefits of each alternative location.

4. Relocation of information.

5. Influence of unavailability of service facilities, both public and private.

6. Influence of pollution.

7. Traffic impact on other roads.

8. Economic influence on businesses.

9. Consequences to open spaces, historical areas, etc.

10. Assessment of opportunities for multiple use of rights-of-way.

Now, after a year's study and after beginning to implement some of the results of our work, we have found that we can successfully combine Nos. 1 and 2 and Nos. 5 and 8 so that we have just eight classes of impacts. The rationale for reducing the number of classes is one of limiting the possibility of factors being analyzed out of context. Land value and tax base, for example, are linked inextricably. Indeed, land value and real estate tax base are simply the individual's and the local government's sides of the same coin. Further, since land value is related directly to land use (either existing or potential) it is a good indicator of the yield of other kinds of taxes, e.g., sales and employment, from a given piece of property.

A similar rationale applies to the combination of public and private services and business. All are located at a point, and their products are distributed to a population located in a service area. In the case of retail business, the customer, himself, usually provides the distribution linkage; whereas in other kinds of business and services the linkage is provided by the activity. Thus, in their essential characteristics, businesses and private and public services are quite similar.

The remainder of this chapter presents a brief discussion of the eight classes of environmental impacts listed below. As the discussion proceeds, appropriate references will be made to the interrelationships between the categories. At the same time, an attempt will be made to point out how a given highway project may have both positive and negative impacts. And, further, that given impacts are almost never wholly negative or positive. The eight classes of environmental impact are:

1. Change in tax base/land value.

2. Costs and benefits of each alternate location.

3. Relocation.

4. Influence on availability of tertiary services.

5. Influence of pollution.

6. Traffic impact on other roads.

7. Consequences to open spaces, historical areas, etc.

8. Assessment of opportunities for multiple use of rights-of-way.

Change in Land Values/Tax Base

The "value" of land is generally agreed to be the amount that would accrue to a willing seller if the land were sold to a willing buyer. The real property tax base of a local government is based on the expected sales price of the taxable real property within its jurisdiction. Hence, any change in the value of land which results from changes in the transportation system also affects the local tax base.

It is beyond the purpose of this report to give a detailed analysis of the creation and structure of urban land values. However, it does seem important that their relationship to transportation be outlined and, further, that an attempt be made to show the relationship of real property taxes to other components of the tax base. The following material has been adapted from an unpublished paper by James E. Lewis entitled "A Transportation Theory of Land Rent."

A given piece of land derives its value through the site rent which the activity occupying the land can pay to the owner. In the case of vacant land, the owner is willing to forego present returns in the expectation of increased future returns. The ability of a piece of land to yield site rent is a function of its location relative to all other pieces of land. This idea, of course, is in direct opposition to classical Ricardian rent theory, which says that the yield of site rent is related to the productivity of the land. In that case, the owner of the poorest quality land which has been brought into production to satisfy the demands of the market for a specific commodity receives no site rent because his total costs of production are equal to his total revenues.

It is commonly accepted now, however, that the yield of site rent derives from accessibility, i.e., the location of the given piece of land relative to other pieces of land, including those occupied by the transportation system. Thus, the site producing the most rent would be the one located at the point most accessible to the area in question. However, not all economic activities are equally able to make use of the most accessible site and, through a competitive bidding process, economic activities eventually reach a point where the degree of accessibility and the ability of the economic activity to turn that accessibility into site rent are in equilibrium.

This brief review of several decades of research can only lead to the conclusion that increased accessibility created by improvements in the transportation system leads to an improvement in the capacity of economic activities to yield site rent and, thus, to an increase in the value of land.

There is a direct analogy to Ricardian rent theory here. Differential accessibility has been substituted for differential productivity but the principle is the same. As the transportation system is extended and intensified, the accessibility of all sites is enhanced and their site rent yielding capability is increased.

It follows, then, that if the land value is increased, real property taxes will in time follow suit. There can be no separation of land values and real property taxes. There may be significant time lags between the change in value and the change in tax levels, but the relationship is nonetheless real.

Because site rents can only be paid by economic activities and they are the ultimate source of all other kinds of local taxes, the extension of these relationships to sales, employment, utility, personal property, and other kinds of taxes is readily apparent.

How do the considerations discussed thus far relate to the common plaint of local governments that highway construction adversely affects their tax base because the highways occupy land that potentially could yield tax revenues? There is no question that highways do occupy potentially taxable land, however, the real question is how do the lost revenues compare with those gained from other land whose value, therefore tax yield, has been enhanced? So much effort has been expended in attempting to prove the validity of one or the other of these arguments that little attention has been given to determining the net difference. And, it is the only truly significant point.

Another factor that enters these arguments is the near chauvinism of local governments; a particularly difficult problem given the independent cities of Virginia. Most local officials are not as shortsighted as they often appear, but envisioning a tax-yielding activity relocating across a local government boundary is usually sufficient to put the blinders on them. The point is, of course, that most local governmental boundaries are simply artifacts of the horse and buggy era which illustrate the failure of local governments to keep up with the changes in the transportation system. No independent city in Virginia exists, in an economic sense, by virtue of the activities or population encompassed by its boundaries, no matter how much the governing bodies may want to believe it does. In the strict sense of the word, there is no longer a local economy wholly separate from the state, regional, national, or even world, economy. Knowing this does not always enable one to counter successfully the arguments of local governing bodies, based as they are on false premises. Yet, this knowledge should ease the conscience of the highway department representatives who have been told that a project will destroy a local economy.

Cost-Benefit of Alternative Locations (Trade-off Analysis)

Traditionally, highway economics were based on cost-benefit analysis. In essence this is a comparatively simple technique of comparing the expected costs and the expected benefits of a project; if the value of the benefits exceed the costs, the project is assumed to be a good investment and construction proceeds. This simplicity did not extend to actual practice, however, for although construction costs can be computed rather easily, the value of benefits can never be calculated accurately for a variety of reasons. More importantly, it offered no means of comparing the costs and benefits of alternative routes for a given project, or for admitting the possibility that a project should not be built at all.

Over the past decade, a new technique called cost effectiveness has been developed to assist decision making where there is a number of intangible variables. Cost effective analysis permits the decision maker the knowledge of the return or "effectiveness" of each dollar of expenditure. Thus, alternatives can be evaluated because the costs and consequences of each of them can be stated.

Relocation

Relocation involves the alteration of existing political, social, economic, and physical systems through the removal of residences, businesses, industrial plants, and other land uses. Because highway investments in urban areas only rarely can be located on unoccupied land, the problem of relocating people and activities has become significant. And, in cities where the local officials see highway construction as a tool for excising blighted or slum areas, the Department may be forced into untenable positions.

The critical impacts of relocation relate primarily to the disruption of social and physical linkages and to the availability and suitability of replacement structures. Many lessons have been learned from the urban renewal experience as well as from highway related relocation, but there is still much to be learned. The current pressure for citizen involvement in the highway planning process is a response to these lessons. However, no matter how sincerely the Department may attempt to develop citizen participation, basic human nature can be relied on to work to push "undesirable" projects off on other areas and to pull "desirable" projects to their own areas. And no matter how well informed or well intentioned the members of citizen's advisory groups may be, in urban areas it will be virtually impossible to have highway construction without some relocation being necessary.

The problem is complicated, indeed exacerbated, in urban areas not so much because neighborhoods may be disrupted (certainly an important aspect), but because "decent, safe, and sanitary housing" and other structures either are not available or are not available at a price the relocatees can afford. For the Department, the potential problem in this is that relocation will not be permitted or the Department will be forced to develop or assist in the development of residential areas for relocatees at prices (which may need to be subsidized) they can afford.

This statement does not mean to imply that the Department should shirk its responsibility to persons displaced by highway construction; indeed, this responsibility is implied in the traditional right of government to take private property for the public good. It should be clear, however, that this is a big responsibility which can easily occupy several staff people full-time. On the other hand, some agencies may already be involved in relocation to the point that it would be easier, cheaper, and more logical for the Department to contract with them for relocation services. Such a pattern has been recommended in the studies of centralized relocation agencies for major cities.

Relocation impacts can be generalized into three categories which apply broadly to residential, commercial, and industrial activities.(1)

A. Losses owing directly to displacement.

1. Disruption of established social and economic relationships;

2. Losses due to the taking of real property;

3. Losses due to mortgage arrangements;

4. Cost of seeking out alternative, comparable locations;

5. Cost of paying for alternative locations;

6. Moving costs;

7. Higher operating costs in alternative locations.

B. Losses owing to uncertainty and delays connected with clearance and construction.

8. Deterioration of the neighborhood;

9. Inability of property owners to receive a fair price for their property;

10. Declines in property value because of neighborhood deterioration in the period between project announcement and actual taking of land;

11. Losses of rental income;

12. Cost of maintaining property after appraisal for taking.

C. Losses in areas adjacent to the right-of-way or clearance area.

13. Higher taxes because of greater costs of public services;

14. Disruption of local communications owing to blockage of local streets;

15. Reduction in the quality and quantity of commercial and other local services;

16. Reduced employment opportunities and increased costs of commuting;

17. Increased competition for housing and jobs among low-income households;

18. Changes in relative accessibility;

19. Losses resulting from the construction process;

20. Losses resulting from heightened ugliness, noise, air pollution, or other adverse environmental changes.

2486 It can be anticipated that the costs and difficulty of relocation will increase over the next decade. The amount of the increase will be greater than that of ordinary cost increases because the criteria for adequate relocation will be revised upward.

Influence on Availability of Tertiary Services

The impact of highway investments on the availability of tertiary services is one of the groups of factors identified as significant for study. Initially, the team separated public and private services from businesses in this discussion. As the study progressed, however, it became clear that the fundamental similarities of these activities overshadowed their differences. Stripped to their essential nature, all of these activities provide goods or services from a point to a population distributed throughout a service area. In other words, each type of establishment (point), whether retail store, church, police station or what have you, has a "market" area upon which it depends for its existence. From this viewpoint, there is no real difference in whether an impact problem involves a merchant severed from his market area, a neighborhood from its fire station, or a hospital from its patient service area. Because of these basic similarities and for convenience of terminology, these services are referred to collectively as "tertiary activities."

It is important to note that highway related impacts, in almost all cases, can be either positive or negative. With respect to tertiary activities, they can appear as changes in the size or shape of an establishment's service area as well as in severance of a portion of the area from the service in question. Also, there can be changes in the character of the service area, e.g., a change in the level of disposable income or the number of school age children.

Five classes of tertiary activities should be considered.

1. Business -- retail, wholesale, service;

2. Manufacturing;

3. Governmental services -- police, fire, education;

4. Quasi-public institutions and services (hospitals, churches, etc.); and

5. Public utilities.

The methodological approach to this class of impacts is based on an understanding of the several types of tertiary activities and on the specific forms the impact may take. For example, discontinuance or relocation could be a potential impact problem to any tertiary activity. In contrast, only the residents of a specific area may have their fire insurance rates raised if access to their area from the fire station is cut off. The team has attempted to identify the potential impacts and to relate them to specific analytic techniques, e.g., on-site investigation. (See Tables I and II.)

TABLE I

IDENTIFICATION AND MEASUREMENT OF HIGHWAY RELATED IMPACTS

Impacted Tertiary Activity

Impacts	Business	Manufacturing	Fire	Police	Education	General Hospital	Religious Institute	Rescue Squad	Sewerage	Water	Electric	Gas	Telephone	Museum, Libraries	Non-highway Transportation	Recreation
1. Displacement (discontinuance or relocation)	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
2. Severing of service areas	•		•	•	•	•	•				•	•	•			
3. Reshaping, expansion, or shrinkage of trade areas	•					•	•				•	•	•			
4. Change in composition of service areas	•				•	•	•		•	•	•	•	•			
5. Change in site access	•		•		•	•	•		•	•	•	•	•			
6. Change in general accessibility	•	•					•				•	•	•			
7. Storm drainage									•	•						
8. Change in local slope angles									•	•						
9. Change in revenue									•	•						
10. Change in demand									•	•						
11. Noise	•				•	•	•									
12. Air pollution	•				•	•	•									
13. Effect on emergency room activity						•										
14. Effect on emergency access routes			•			•		•								
15. Police patrol routes				•												
16. School bus routes					•											
17. Insurance rates			•	•												
18. Change in accessibility to labor supply		•				•										
19. Severing campus or campus fringe areas					•											
20. Effect on visibility from highway	•	•					•									

Measurements	Business	Manufacturing	Fire	Police	Education	General Hospital	Religious Institute	Rescue Squad	Sewerage	Water	Electric	Gas	Telephone	Museum, Libraries	Non-highway Transportation	Recreation
1. On-site investigat ion	•	•	•	•	•	•	•	•	•	•	•	•	•			
2. Maps and aerial photpgraphs	•		•	•	•	•	•		•	•	•	•	•			
3. Sales records	•															
4. Business characteristics	•	•														
5. Change in length of travel (time/distance)			•	•	•		•									
6. Count discontinuance and relocations	•	•	•	•	•	•	•	•	•	•	•	•	•			
7. Noise measurements	•				•	•	•									
8. Air pollution measurements	•				•	•	•									
9. Emergency room records					•											
10. Membership records						•										
11. Count disconnects and connects									•	•	•	•	•			
12. Length of re-routes or new links									•	•	•	•	•			
13. Change in volume or storm drainage									•							
14. Change in volume off take or effluent									•	•						

2488

TABLE II

RELATIONSHIP OF MEASUREMENT OF IMPACTS

Impacts	On-site investigation	Maps and aerial photographs	Sales records	Business characteristics	Change in length of travel (time/distance)	Count discontinuance and relocations	Noise measurements	Air pollution measurements	Emergency room records	Membership records	Count disconnects and connects	Length of re-routes or new links	Change in volume or storm drainage	Change in volume off-take or effluent
1. Displacement (discontinuance or relocation)	●	●	●	●	●	●								
2. Severing of service areas	●	●	●		●									
3. Re-shaping, expansion, or shrinkage of trade areas	●	●			●				●	●				
4. Change in composition of service areas	●	●			●									
5. Change in site access	●	●												
6. Change in general accessibility	●	●			●									
7. Storm drainage	●	●										●	●	
8. Change in local slope angles	●	●										●	●	●
9. Change in revenue											●		●	●
10. Change in demand											●		●	●
11. Noise	●						●							
12. Air pollution	●							●						
13. Effect on emergency room activity									●					
14. Effect on emergency access routes	●	●			●									
15. Police patrol routes		●			●									
16. School bus routes		●			●							●		
17. Insurance rates					●									
18. Change in accessibility to labor supply	●	●												
19. Severing campus or campus fringe areas	●	●												
20. Effect on visibility from highway	●													

Influence on Pollution

The particular concerns in this phase of the study are air and noise pollution; contributions to soil erosion and water pollution from highways and highway construction sites are under investigation in ongoing studies which have developed out of this one. Although literature reviews have been completed and methodologies have been developed for analyzing these impacts, it is important to note that the environmental team believes that the long-run solutions to them are in the hands of the Federal government, the automobile and truck manufacturers, the oil companies, and the tire manufacturers. Trees, shrubs, and other vegetation can be planted along roadsides; sound absorptive structures can be erected; and earth mounds can be built; and all of these will effect some reduction in the noise and air pollution as measured a given distance from the roadway.

Because of its concern with highway related noise and air pollution, the Federal Highway Administration is asking the Department to apply short-term patches to these problems until long-term solutions can be found and put into effect. Highway critics, however, must be brought to the realization that the components of highway noise -- engine sounds, tire sounds, and wind rush -- can only be reduced permanently by the people who design and build engines, tires, and motor vehicle bodies. The same applies to highway related air pollution except that here it is the oil company chemists and engineers and the automotive engineers who hold the key to the permanent solutions.

Until these achievements are in hand, however, the Department is the prime target of critics and "eco-nuts" and it is attempting to identify and use design elements which will help lower both noise and air pollution levels.

The methodologies are the same for both impacts. The ambient noise or air pollution level is measured with instruments at selected points along the right-of-way and compared with the additional load expected on the basis of planned highway-type, design configuration, vehicle volume, and vehicle mix.

The environmental team is also working with computerized models which can relate the numerous variables to each other and generate a predicted value for noise and air pollution levels at any point along an existing or proposed right-of-way. The use of these models enables the team to evaluate the comparative effect of different means, e.g., plantings, walls, etc., of reducing noise and air pollution so that the most effective ones can be designed into the highway from the beginning rather than tacked on at some later date.

Traffic Impact on Other Roads

Construction of new highways (or substantial improvement on existing roads) affects existing highways in addition to the other environmental considerations that have been listed. To take only a simple case, it is well known that on roads parallelling new highways traffic volume will decline for at least a short time after the new road is opened. However, on roads perpendicular to the new facility volume increases to or beyond their capacity are common.

The general problem is a classic in the analysis of flows in transportation systems because, if unrestrained, the increased volumes eventually work down through the entire highway system and create demands for increased capacity in every segment. Furthermore, as traffic volumes increase, the street develops a greater potential for commercial development, more traffic is attracted, and the cycle continues on.

Given this type of analysis, the removal of a specific bottleneck in the traffic pattern may create more problems than it solves. The traffic which now avoids the route because of the bottleneck may be attracted to the improved route and thus create capacity problems on other segments of the route.

The methodology involved in analyzing the traffic impact on other roads depends largely on the application of existing traffic forecasting techniques. More work needs to be done on the possible constraints on traffic flow and on their usefulness in maintaining volumes at or below design levels.

A detailed review of the general problem and of traffic forecasting models can be found in the Council report "The Impact of New Urban Highways on Community Traffic" by Michael J. Demetsky and Frank D. Shepard.

Consequences on Open Spaces, Historical Areas, and the Like

Virginia, because of its important role in the early development of the nation and its great natural beauty, has even more than the usual reasons for protecting and enhancing the quality of its environment. A strongly developed sense of history among the state's citizens is reinforced by the knowledge that tourist oriented activities form an important part of the state's economic base.

Highway planners are well aware of those facts and they appreciate their importance. Yet there is no master list or master map which includes the historical sites (developed or not), the significant open spaces (and reasons for their significance), and the scenic vistas in each of the state's physiographic regions (including those in "typical" areas as well as the more striking or unique).

This kind of map, at appropriate scales for both urban and rural areas, accompanied by a descriptive inventory would provide highway planners with an early warning system that will enable the planner when a route layout may adversely affect an area; conversely, minor changes in a route layout may enhance the development and utilization of certain sites.

Multiple Use and Joint Development of Rights-of-Way

Any realistic analysis of the long-range future for highway development in the United States, particularly in its urban areas, will find multiple use and joint development of rights-of-way the dominant concept. Indeed, it can be anticipated that over the long run, prescribed solutions to highway environmental impact problems will involve multiple use or joint development projects as a matter of course. Both of the concepts envision the highway not solely as a transportation link but also as a means of enhancing the community's livability.

The difference in meaning of the two terms is largely a matter of convention. "Multiple use" tends to be used to describe projects primarily sponsored by highway departments and usually tending toward open space (often "beautified" with plantings) or outdoor recreation areas for more or less passive activities, located within expanded rights-of-way. "Joint development", on the other hand, is used to refer to projects in which the highway department may be a major or minor partner working with local government or private developers in the development of large-scale buildings for commercial or residential use. In less precise terms, joint development tends to be vertical while multiple use tends to be horizontal.

With the exception of the Washington suburban areas of Northern Virginia, the Richmond area, and the Hampton Roads cities, there appears to be little potential for significant joint development projects in the state. However, these "exceptions" offer enough potential for joint development to warrant the highway department's serious effort to keep up with the complex array of legal, administrative, engineering, and socioeconomic factors relating to joint development.

On the other hand, multiple use applies in rural as well as in urban areas and if the projects are imaginatively conceived and carried out they can have many positive carry-overs for the Highway Department. These carry-over benefits could include improved driver safety as well as enhanced public image of the Department. The Colonial Parkway linking Jamestown, Williamsburg, and Yorktown is a good local example of what can be done with highways in a rapidly urbanizing area.

Many local problems presently limit the joint development or multiple use of highway rights-of-way in Virginia. An important first step in the consideration of these concepts should be a legal analysis and interpretation of the relevant statutes. This would give the Commission a basis for the recommendation of legislation to change or add to these statutes.

CHAPTER IV — REFERENCES

1. Downs, Anthony, Uncompensated Non-Construction Costs Which Urban Highways and Urban Renewal Impose Upon Residential Households. Prepared for a Conference on Economics of Public Output at Princeton University, April 1968.