A Critique of the Delaware Valley Regional Planning Commission 1985 Regional Transportation Plan

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A Critique of the Delaware Valley Regional Planning Commission 1985 Regional Transportation Plan

Abstract
The 1985 Regional Transportation Plan of the Delaware Valley Regional Planning Commission (Plan Report No. 5) is one of the most detailed and informative reports published to date by a transportation planning agency. The Report reflects several advances in urban transportation planning procedures made by DVRPC. Nevertheless, the Report does contain a number of very serious deficiencies.

In an attempt to make a constructive contribution to transportation planning in the Delaware Valley Region, the authors of this Critique analyze these deficiencies and propose general and specific improvements for the Transportation Plan.

Disciplines
Engineering | Systems Engineering | Transportation Engineering

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A CRITIQUE OF THE
DELWARE VALLEY REGIONAL PLANNING COMMISSION
1985 REGIONAL TRANSPORTATION PLAN

by

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30 October 1969
SUMMARY

The 1985 Regional Transportation Plan of the Delaware Valley Regional Planning Commission (Plan Report No. 5) is one of the most detailed and informative reports published to date by a transportation planning agency. The Report reflects several advances in urban transportation planning procedures made by DVRPC. Nevertheless, the Report does contain a number of very serious deficiencies.

In an attempt to make a constructive contribution to transportation planning in the Delaware Valley Region, the authors of this Critique analyze these deficiencies and propose general and specific improvements for the Transportation Plan. The most important findings and recommendations of this Critique are:

1. The recommended public transportation plan is unacceptable since it was improperly conceived and incorrectly evaluated throughout the planning process. Even with the recent additions of rapid transit lines in New Jersey, the Plan is inadequate for the Region's needs through 1985. A major shortcoming of this plan is the lack of significant improvements in the central cities.

2. The plan evaluation procedures applied in the Report contain several errors. Necessary improvements in these procedures are: inclusion of all system costs that can be estimated (e.g. parking), limiting the role of benefit-cost analysis, and correct application of standard methods.

3. The traffic projection procedures are inadequate for multi-modal transportation planning, and should be improved so that predicted traffic volumes will be consistent with the assumed travel times.

4. The recommended freeway network raises certain questions with respect to physical design, operational feasibility, and compatibility with arterials, local streets and parking facilities. These aspects of the highway plan should be tested in more detail.

5. The scope of the transportation plan is extremely narrow. It neglects the consideration of better utilization of existing facilities and improvement of operating practices; it even omits the question of plan objectives, as for example, adoption of a minimum level of service for all income groups and parts of the Region, and the effect of transportation on the growth potential of the central business districts.

As the responsible public agency, DVRPC should perform the necessary revisions of the Plan; based on a broader view of the transportation problems and solutions, it should take initiative in the planning of a transportation system which will adequately serve all the citizens of the Region.
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This document presents the authors' opinion about the report and its conclusions about urban transportation planning. Despite some rather sharp criticism in this Critique, the authors' intention is to be constructive and contribute to the transportation planning of this Region. They are aware of many difficulties with which a public agency with such a complex task in a pioneering field is confronted. If necessary, the authors will be glad to discuss their criticisms with the Board, Committees, or staff of DVRPC. In greater detail, and will endeavor to extend and modify their recommendations as warranted by new information and changing conditions.

Both authors are active in the field of transportation. They are members of the faculty of the University of Pennsylvania.
PREFACE

The authors of this Critique are keenly interested in the transportation planning for the Delaware Valley Region as professionals in the field of transportation as well as the citizens of the area. They believe that the transportation planning performed by the Delaware Valley Regional Planning Commission (DVRPC) will have considerable impact on the Region's future transportation system and its development in general. For that reason, DVRPC 1985 Regional Transportation Plan, Plan Report No. 5, Technical Supplement (hereafter cited as the Report) is an important document and deserves a careful scrutiny, not only by the responsible public agencies, but also by professionals and interested citizen groups.

The authors responded to the invitation in the Report to offer comments and criticisms by submitting in June, 1969, "Critique of the DVRPC 1985 Regional Transportation Plan" to DVRPC. The Critique included a considerable number of technical comments, questions and criticisms. The DVRPC prepared a detailed answer "Further Clarification of the DVRPC 1985 Transportation Plan Report Number 5", for which the authors are appreciative. The answer did clarify some points about the 1985 Plan; a number of other points, however, remain unresolved and the authors believe they should be introduced into the current public discussion of the Report and plans contained in the 1985 Regional Plan in Summary.

This document presents the authors' opinion about the Report and some of their views about urban transportation planning. Despite some rather sharp criticism in this Critique, the authors' intention is to be constructive and contribute to the transportation planning of this Region. They are aware of many difficulties with which a public agency with such a complex task in a pioneering field is confronted. If necessary, the authors will be glad to discuss their criticisms with the Board, Committees, or staff of DVRPC in greater detail, and will endeavor to extend and modify their recommendations as warranted by new information and changing conditions.

Both authors are active in the field of transportation. They are members of the faculty of the University of Pennsylvania.
David E. Boyce, Assistant Professor of Regional Science and Transportation, holds the B.S. in Civil Engineering from Northwestern University, and the Master of City Planning degree and Ph.D. degree in regional science from the University of Pennsylvania. Prior to joining the University faculty in 1966, Dr. Boyce was a transportation economist and planner at Battelle Memorial Institute, Columbus, Ohio. He has also worked as a transportation planner for the Ohio Department of Highways and for several cities in Illinois. In addition to his current research on metropolitan plan evaluation methods, sponsored by the U.S. Department of Transportation, he teaches advanced graduate courses in regional transportation network and demand analysis and graduate business courses in transportation management.

Vukan R. Vuchic, Assistant Professor of Civil Engineering-Transportation, holds a Diploma from the University of Belgrade and the M.Eng. and Ph.D. degrees from the University of California—all in the field of transportation engineering. He has worked as a Planning Engineer for the Public Transport Company in Hamburg, Germany. Subsequently, for several years he worked for one of the largest transportation engineering consulting firms in this country, primarily on highway planning. As a private consultant he took part in the planning and design of stations for the Bay Area Rapid Transit System in San Francisco. Dr. Vuchic is the author of a number of publications on analysis, planning, design and operation of highway, public and urban transportation systems in general. Since coming to the University in 1967, he has been teaching courses in these fields.

There has been a tendency in recent years to give great emphasis to the modern tools and techniques of planning and evaluation, for very good reasons. These tools permit analyses based on large volumes of data and complex models which has not been feasible before. However, this has sometimes led to decreased attention to plan formulation. The DVRPC plan appears to be an example of this phenomenon. The highway networks may have certain deficiencies, while public transportation plans are in many aspects of such quality that they require a rather detailed analysis.

A. Methodology of Plan Formulation

A planning procedure consists of the development of several alternative plans which are then evaluated and compared, resulting in the selection of the preferred plan. This process involves procedures which consider only the formulation and evaluation of a single plan. DVRPC has followed this basic procedure and integrated some elements into it, although its plans are actually not alternatives but approaches.
I. INTRODUCTION

This Critique of the DVRPC 1985 Regional Transportation Plan is presented in three sections. First (Section II), Formulation of Plans, states several major criticisms of the highway and public transportation plans and policies presented in Chapters 2 and 3 of the Report. The following Section (III), Travel Projections and Evaluation of Alternative Plans, draws attention to a number of important omissions and technical errors in Chapters 4 and 5 of the Report. Section IV, Conclusions and Recommendations, treats the material in Chapter 6 of the Report and presents the authors' conclusions and recommendations to the Board of the DVRPC. A short list of references is included as Section V.

In preparing this Critique, the authors have not attempted to treat the Report comprehensively and in all details. Instead, criticisms are presented here on a selection of points that the authors believe to be of special significance.

II. FORMULATION OF PLANS

Formulation of alternative plans is one of the most important steps in the transportation planning process. Inadequate plan formulation seriously affects the final results of the study since the recommended plan can be only as good as the best among the alternative plans, regardless of the methods used for testing and evaluation.

There has been a tendency in recent years to give great emphasis to the modern tools and techniques of plan testing and evaluation, for very good reasons. These tools permit analyses based on large volumes of data and complex models which had not been possible before. However, this has sometimes led to decreased attention to plan formulation. The DVRPC plan appears to be an example of this phenomenon. The highway networks may have certain deficiencies, while public transportation plans are in many aspects of such quality that they require a rather detailed analysis.

A. Methodology of Plan Formulation

A planning procedure consisting of the development of several alternative plans which are then evaluated and compared, resulting in the selection of the preferred plan, has a number of advantages over procedures which consider only the formulation and evaluation of a single plan. DVRPC has followed this basic procedure and introduced some innovations into it, although its plans are actually not alternative but additive.
However, if a set of additive plans is examined, one has to make sure that the additions are technically feasible and sound (by whatever criteria are used), so that at any level of investment a potentially desirable plan is available for evaluation. It is therefore particularly important in formulating additive transportation networks to evaluate each additional link individually as well as within the system as to its feasibility and desirability. It is not clear how the additional links were added to the highway plans in the DVRPC study; it is apparent that there were no tests of feasibility of individual public transport improvements.

An additional problem in the procedure utilized by DVRPC is the way in which the alternative highway and transit plans were combined. Though the three highway and the three transit plans, respectively, are basically additive, their combinations, constituting the seven plans selected for evaluation, are not additive. Thus the seven evaluated plans are neither alternative nor additive. The evaluation of plans (all three methods of benefit-cost analysis) are then performed as if the plans were strictly additive, and in an order which does not really permit evaluation of additional investments from basic toward maximum plans in either group. For example, the B-M plan is followed by the M-B plan, so that it is not possible to evaluate individually the change in the size of the highway plan and the size of the transit plan.

It is not possible to find from this and preceding DVRPC reports exactly what principles and policies in network planning were followed. Apparently, the plans evaluated in the Report represent a compilation of facilities and network sections made by a number of different agencies and other bodies. While it is desirable to engage various agencies and local governments in transportation planning and take their requirements into consideration, it is also extremely important to incorporate individual plans into a system which is then refined to a higher level; system optimization should bring considerable savings and operating efficiencies over those which would be achieved by individual facilities alone.[3,5]*

B. Highway Plans

It is rather difficult to establish exactly how much system optimization or integration of individual highway proposals has been performed in this study. A superficial review of the networks indicates that at several locations problems

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*Numbers in square parentheses represent references as listed at the end of this Critique.
may occur because of unbalanced capacities, difficult geometries, etc. Provision of an excessive number of radial freeways and inadequate treatment of their terminals frequently create such problems. One of the major conclusions of the Chicago Area Transportation Study [4] was that only a limited number of radial freeways should be provided. Levinson and Roberts [7] have shown by a simulation study the difficulties, including excessive congestion, which are likely to occur because of convergence of radial freeways. Leisch [6] has also pointed out the importance of correct geometric designs and balancing capacities of freeways for operations.

With the important reservation that comments on this specific item are based on limited knowledge (mostly from the Report only), it is suggested that the highway plans be reconsidered with respect to these aspects. Specific examples of potential problems in freeway operations: the Recommended Highway Plan includes seven additional radial freeways into Philadelphia, three into Camden and three into Trenton. Freeways designated in the Report as #57 and #39 merge into #7 (I-295) and then join #32, converging into #8. Freeway sections #10 and #53 terminate on Route US 1, while #44 is terminated at #43, Girard Avenue Expressway.

The Report pays nearly no attention to the integration of freeways with arterials, local streets and parking facilities.* Even the Basic Highway Plan is of such magnitude that it would have to be accompanied by major improvements of other facilities. This need for a complete system should be emphasized and the major improvements listed.

It is quite paradoxical to discuss freeway improvements only, while the Region (and the City of Philadelphia in particular) has extremely primitive design, regulation and control of traffic on arterials and local streets, resulting in a very low utilization of the existing facilities.** A number of improvements of traffic operations would be much more cost-effective than some of the new facilities. It appears logical in such a situation to give considerable emphasis to improvements of existing facilities also.*** A statement to this effect is given only in a very general form in the Report (p. 133).

*Incorrect technical terminology in the Report may lead to some confusion. "Turnpike" is consistently treated in the Report as the highest type highway facility. By definition, turnpike implies application of tolls and not a special technical category of highways. Therefore comparison, for example, of speeds on freeways and turnpikes (Table 4.23) does not make sense.

** For example, there is presently no effort to modernize the antiquated traffic signal system. The TOPICS program can provide a major stimulus for improvements of this kind.

*** For a more detailed discussion of this aspect see references [1] and [10].
C. Public Transportation Plans

While the highway plans at least abound in mileage (even the Basic Highway Plan would result in more than doubling of the existing freeway mileage), public transportation alternatives are deficient in both quality and mileage. The deficiencies in public transportation plans are very serious. They include:

1. Lack of a systematic procedure or principles in the development or facilities to be analyzed.

2. Facilities are planned nearly exclusively for outlying areas;

3. Infeasible projects were included in tests and plans;

4. Scope of the solutions considered, including projects and policies, is very limited;

5. Incorrect items were selected for evaluation procedure.

Each of these deficiencies will be briefly discussed here, giving specific examples and including suggestions for improvements.

1. No systematic approach appears to have been used in the development of public transportation plans: there is no discussion of such basic system indicators as area coverage, frequency of service, travel speed, extent of individual systems, etc. The three analyzed plans are simply compilations of individual, disjointed, projects and are not even evaluated individually as to their absolute and relative feasibilities. As a result, large areas remain without any improvements.

2. Nearly all suggested facilities are additions and extensions of the existing lines in the outlying areas. These types of facilities have very peaked passenger volumes*, since they serve mostly as commuter facilities. Transit services in inner, high-density areas, generally have less peaked volumes and therefore higher operating efficiency. There is no doubt that the extensions of rapid transit** and railroad services in the suburbs must be provided with the growth of the Region (and many of them are overdue); however, the improvements of services in the inner areas cannot be neglected.

*For example, the Ashland Station on the Lindenwold Line has nearly 50% of directional movement within the peak one half hour.

**Terminology in the Report is again incorrect: rapid transit is a functional definition of lines with certain characteristics. It includes subway, elevated and at-grade (but on private right-of-way) facilities; therefore the title "Subway-elevated and Rapid Transit Rail Line.." (e.g. Map 2.5) is incorrect.
It cannot be considered satisfactory that, for example, large sections northwest of the CBD and the whole South Philadelphia, except in the vicinity of Broad Street, which have high transit usage, remain served by 9 - 11 mph bus lines even in 1985.

Further, it is known that the distribution of passengers within the CBD is a necessary condition for attracting patronage to public transportation. In this respect, the Philadelphia system is inadequate: rapid transit has basically two lines, and railroads have only three major terminals in the CBD. Except for the proposed extension of Lindenwold Line to Woodland Avenue - 49th St., the considered plans do not suggest any improvement of area coverage in the central or "inner ring" areas.

Another important consequence of transit improvements in suburban areas only, while virtually no improvement in transit service is provided to low-income areas, is that the bulk of the benefits are distributed to middle and higher income population groups. This is socially objectionable and will lead to further decay of the inner ring and intensification of urban problems in general.

3. A number of public transportation projects which were analyzed and included in test plans should have been immediately eliminated on the basis of known principles of public transportation planning, as illustrated by the following examples.

The Report analyzes in the Maximum Transit Plan the Belt Line subway along City Line Avenue, in contradiction to the experience and principles of public transport planning. A facility which is estimated to cost $265 million should not be considered for a circumferential route which presently does not have sufficient demand to support a reasonably frequent bus service.

Extension of the Lindenwold Line only to the 49th Street-Woodland Avenue area would be unsatisfactory with respect to demand, economics and operations, since that area neither represents an urban subcenter nor a transportation hub. Extension of the line beyond that point to Media would be a logical proposal; if Woodland Avenue-49th Street is meant to be a temporary termination for such a line, its completion to Media should be planned for a time much earlier than 1985.

4. As with the approach in highway planning, public transportation has been analyzed from a very narrow perspective. Total mileage of railroad lines is used as an argument that public transportation is sufficiently developed.
This is a major fallacy since a 30-minute or hourly service to one or two locations in the Philadelphia CBD, however important for commuting, cannot be equated with rapid transit service which offers frequent service, speed, distribution over the network and a joint fare with an extensive surface transit network. The railroad network therefore cannot be used as evidence that upgraded transit services should not be provided, particularly in the central and inner ring areas.

Gradual upgrading of surface services is given hardly any attention in the Report. Many such improvements could be highly cost-effective. For example, extension of the subway-surface car tunnel to the east of City Hall and its connection with north-south street car lines; improved operation of street cars and buses through preferential treatment at intersections; signal actuation by transit vehicles; better locations of stops; such improvements are badly needed and, in many cases, can be rather easily achieved.

Many improvements of bus services are currently being discussed in the professional literature and tested in several cities. In Philadelphia buses carry 57 per cent of public transport passengers; yet, they are hardly mentioned in the Report at all.

One of the most important and necessary improvements in public transportation operations is to change the present labor practices (particularly on railroads) and introduce automation which is standard in most cities around the world. Present operations of stations and trains, which cost the city millions of dollars in annual subsidy, cannot be continued indefinitely.

Another existing deficiency, which cannot be ignored by any agency concerned with regional transportation, is the lack of coordination of public transportation. There is presently no unified and coordinated public transportation system; rather it is a conglomeration of services which have separate fare systems and which lack service coordination. Formation of SEPTA has been the largest step in that direction, but the process of consolidation and formation of a joint fare system must be completed.

Application of benefit-cost analysis for evaluation of public transportation facilities is questionable in general. Even in the earlier periods of the highest public transportation usage in the cities like New York and Philadelphia, construction of rapid transit facilities was often supported by the city and the investment was not fully recovered from the fares. In this Report not only was benefit-cost analysis used as the main evaluation criterion, but it was applied to infeasible facilities, so that the outcome had to be quite unfavorable.
Transit, like the highway network, was analyzed mostly on a regional basis, but many detailed physical improvements to the existing facilities have also been included (see Table 2.3). While there is no doubt that these improvements are needed, most of them are of such a nature that they would not result in any quantifiable user savings. In other words, they could not be included in the model utilized by DVRPC. Some examples are construction of station concourses, shelters on streets, subway communication system, etc. It is estimated that such items amount to at least $395.40 million, which is 77.5% of the total for these improvements, or 51% of the Basic Plan; only $114.73 million will be invested in the items which may have a measurable effect and thus enter into the computed benefits. Yet the whole investment of $510.13 million has been included in the costs of all three plans and thus has an impact on the benefit/cost analyses.

In summary, a number of improperly conceived public transport facilities have been included in the plans. Many of them bear heavily on the outcome of evaluation. The Belt Line subway, which defies all theoretical and empirical principles of rapid transit planning, carries approximately 73% of the investment for Maximum Transit Plan over the Intermediate Plan. On the other hand, the whole plan is totally inadequate for the Region in terms of the number of facilities and by the scope of the suggested improvements. In addition, wrong items have been selected for the evaluation procedure, unjustifiably weakening the transit plan for the Delaware Valley Region.

III. TRAVEL PROJECTIONS AND EVALUATION OF ALTERNATIVE PLANS

Several procedures employed in the Report to project travel and to evaluate each of the alternative plans are either incorrectly applied or inadequate for the complexity of the plans. Therefore, several conclusions and recommendations of the Report are in error. In this section, the following three types of shortcomings of the procedures and their implications are examined:

(a) limitations of the state of the art of transportation planning;

(b) incorrect application of evaluation procedures;

(c) technical errors.
A. Limitations of the State of the Art

Urban transportation planning methods have undergone rapid development during the past fifteen years. Indeed, DVRPC and its predecessor (PJTS) have contributed significantly to the development of these methods in two ways. First, new methods of forecasting travel have been developed, in particular with regard to choice of mode. Second, and more important, this Report is the most systematic attempt to date to test different combinations or levels of highway and transit investment.

The Report could be criticized, however, on the grounds that the methods applied are inadequate to evaluate the alternatives considered. Such criticism would be inappropriate if DVRPC had correctly applied the best available methods; a single regional planning agency cannot be held responsible for inadequacies in the state of the art of transportation planning in the U.S. However, DVRPC must be considered responsible for identifying the limitations of its travel projections and for specifying those instances in which rigorous technical procedures must be supplemented by judgment.

A major example of the limitations on plan evaluation imposed by the existing state of the art is the finding implicit in the Report that alternative levels of investment in one mode do not affect the user costs or performance of the other mode. For example, according to the Report, highway user costs and speeds in the Basic Highway Plan remain the same when combined with each of the alternative transit plans. This result was obtained because existing methods and computer capability for projecting travel are unable to achieve equilibrium solutions in which facility speeds consistent with the projected volumes and route capacity equal the speeds assumed in projecting the modal choice and travel pattern. This inadequacy, discussed in greater detail below, has been shown by subsequent DVRPC studies to result in significant errors for transit trips. Consequently, in this situation, decisions about transit cannot be made on the basis of the travel projections and plan evaluations alone.

B. Incorrect Application of Evaluation Procedures

Methods for evaluating transportation plans must be applied with considerable care, particularly in this case in which the travel projections are known to be less than adequate. The Report presents the results of two types of evaluations - economic feasibility and performance characteristics. Evaluation of economic feasibility determines the rate of return on investment and the benefits received for a given level of investment. The three types of economic evaluation, performed to determine if savings in operating costs, travel time and accidents are sufficient to warrant the proposed investment, included most of the directly measurable user costs. However, parking charges
C. Technical Errors.

In addition to the major technical errors mentioned, two other points were not included in user costs in the evaluation stage, although they represent a significant amount. Also, they are a very important policy variable.

These evaluation methods are appropriate if the objective of public investment in transportation is to achieve a given return on investment or if there is a need to examine the relative economic feasibility of different types of public investment. However, economic evaluation has little or no bearing on other transportation objectives such as the provision of an adequate level of transportation service to all income groups and to all parts of the Region, or the maintenance and promotion of a strong central business district for the Region. The evaluation of plans with respect to these objectives must proceed on other grounds including judgment, at least until such time as the benefits of such objectives can be measured and included in an economic evaluation.

It is well known that public transportation normally cannot demonstrate a satisfactory monetary return on investment, particularly if the benefits caused by transit investment through the reduction of peak-hour congestion to the highway system cannot be demonstrated, as is the case here. Therefore, it is incorrect to base the evaluation of public transportation on economic feasibility alone. Rather, other objectives should be considered, and the performance of each alternative evaluated. It is interesting to note that a good discussion of the non-quantifiable benefits from mass transportation was given in the Penn-Jersey Report Volume 3 (pp. 86-89). Yet, despite the statement that "mass transportation analysis should be based on other factors" in the Report, cost-benefit analysis is applied and used as the major basis for evaluation of the plans.

The above discussion leads to a very significant omission of the Report and of the publication 1985 Regional Plans in Summary. This is the complete absence of any explicit objectives for the transportation plan. The lack of plan objectives leads to excessive emphasis on economic feasibility, speed and capacity of facilities in the evaluation of transportation plans. The evaluation procedures of other metropolitan transportation planning agencies, for example, Chicago[4], Milwaukee[9], and Minneapolis-St. Paul[8], are founded on a set of explicit objectives. This has in each case led to the recommendation of a large investment in public transportation, despite an unsatisfactory rate of monetary return on investment. For a more detailed discussion of evaluation methodology, see Boyce and Day[2].
C. Technical Errors

In addition to the major omissions in the evaluation procedure discussed above, serious technical errors in the application of standard methods of economic evaluation are noted in the Report in Tables 5.7 and 5.8.* Table 5.7, Evaluation Based on Marginal Cost and Benefit Method, leads to the stated conclusion that plans B-B, I-B, I-I and M-B are accepted on the basis of this method, given that the marginal rate of return should exceed 10%. Further, it is concluded that plan M-B has the highest marginal rate of return and is on this basis considered the best plan among the seven alternatives (p. 101).

The analysis upon which the above conclusions are based, however, is invalid. The reason is that plans with negative user savings are included in the calculations of the marginal rate of return of successive plans. The marginal rate of return for each plan should be based on the incremental capital cost and user savings of the preceding plan that yielded a positive required rate of return. Any plan with a negative or even small positive savings will usually result in a large marginal rate of return for the following plan. This is precisely the case with plan M-B. If the plans used in the marginal analysis are properly identified, and the rate of return correctly calculated, as shown in the following table and graph, the slope of the benefit-cost curve should be positive, but decreasing. The benefit-cost points of unsatisfactory plans lie to the right and beneath this curve, and should not be used as the basis for the marginal analysis of subsequent plans.

For this case, then, the correct ordering of plans included in the calculation is B-B, I-B, M-M and M-M. Each of the remaining three plans are less satisfactory and fall to the right and beneath the benefit-cost curve formed by the above four combinations. As can be seen from the revised Table 5.7, plans B-B, I-B and M-B meet the criterion of rate of return exceeding 10%. Plan I-I is excluded from this group, making the results consistent with Tables 5.6 and 5.8.

Table 5.7 has also been revised slightly to include annual non-user operating costs as given in Table 5.2. These costs should be included in this analysis, in particular, to achieve consistency with Table 5.8. The effect of this addition is minor for this table, but not for a subsequent table to be examined.

Proceeding to Table 5.8 of the Report, four sets of benefit-cost (B/C) ratios should be computed rather than two to carry this analysis to its proper conclusion. Since these ratios are computed on marginal costs and benefits, as in Table 5.7, the results are completely consistent with revised Table 5.7. But it cannot be properly concluded that plans I-B and M-B are "accepted alternative plans" as indicated for Table 5.8, if by this it is meant they are equally acceptable. Rather, I-B has the highest B/C ratio (2.45) for the second

* A rather serious misprint appears in these tables as well as Table 5.6. In each of these tables, the plan designations for the third and fourth lines are reversed. The designations should read: Do Nothing, 1. B-B, 3. I-B, 2. B-I, 4. I-I, etc. This is a particularly unfortunate misprint as it leaves the reader with the impression that the B-I plan is preferred to the I-B plan, whereas in fact the reverse is the case.
Table 5.7 (Revised)

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<th>Capital Increase</th>
<th>Cost Differences User**</th>
<th>Rate of Return</th>
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<td>---</td>
<td>2753.4</td>
<td>5.6***</td>
<td>2759.0</td>
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<td>2539.6</td>
<td>2427.3</td>
<td>43.5</td>
<td>2470.8</td>
<td>+ 2539.6</td>
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<td>45.0</td>
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<td>2421.6</td>
<td>43.7</td>
<td>2465.3</td>
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<td>- 44.2</td>
<td>neg</td>
</tr>
<tr>
<td>4. I-I</td>
<td>3146.0</td>
<td>2370.4</td>
<td>45.2</td>
<td>2415.6</td>
<td>+ 333.0</td>
<td>+ 5.5</td>
<td>1.7%</td>
</tr>
<tr>
<td>5. B-M</td>
<td>3256.1</td>
<td>2389.0</td>
<td>45.7</td>
<td>2434.7</td>
<td>+ 443.1</td>
<td>- 13.6</td>
<td>neg</td>
</tr>
<tr>
<td>6. M-B</td>
<td>3281.9</td>
<td>2296.7</td>
<td>48.1</td>
<td>2344.8</td>
<td>+ 468.9</td>
<td>+ 76.3</td>
<td>15.6%</td>
</tr>
<tr>
<td>7. M-M</td>
<td>3998.4</td>
<td>2258.4</td>
<td>49.3</td>
<td>2307.7</td>
<td>+ 716.5</td>
<td>+ 37.1</td>
<td>5.2%</td>
</tr>
</tbody>
</table>

* Difference between the last column of Table 5.2 and the last column of Table 5.1; this operating cost includes highway operating, maintenance and overhead costs and transit operating costs not covered by fares as implied on p. 95 and Table 5.8.

** User saving must result in a 10% return for a plan to be the basis for calculating the savings for a subsequent plan. Accordingly, Capital Increase and User Saving for plans B-I, I-I, B-M and M-B are each based on plan I-B.

*** 3.4% of 1960 freeway mileage for highways; full transit operating costs are assumed to be included in user costs for the Do Nothing system.
D. Evaluation of the Transit Alternatives

Each of the three acceptable plans was evaluated for each component. No intermediate transit plan was evaluated as a component. No intermediate plans were considered, and considerable interest was shown in the level of investment in the transit systems because of the strong economic and social implications that are comprehensively determined and found in the following tables. Some of these indicate that transit analyses occasionally yield somewhat better results than the benefits, as discussed in Section 7.

III. These findings illustrate the importance of objectives other than economic feasibility. There are to be understood that the selection of the most appropriate transit project in planning for maximum benefits as discussed in Section 7.

Evaluation Based on Marginal Cost and Benefit Method

Total Capital Cost
(in $100,000,000)

correct sequence of plans

sequence of plans shown in DVRPC Report, Table 5.7

percentages indicate marginal rate of return

0  22  24  26  28  30  32  34  36  38  40

2.20  2.40  2.60  2.80  3.00  3.20  3.40  3.60  3.80  4.00  4.20  4.40  4.60

M-M +5.2%
M-B +15.6%
I-I +348.3%
B-M -17.3%
B-I +18.2%
I-B +18.2%
B-B +11.3%

Total Annual Savings (user and non-user) over Do-Nothing
(in $100,000,000,000)

+4.00 +3.60 +3.20 +2.80 +2.40 +2.00 +1.60 +1.20 +0.80 +0.40 +0.00
ratio computed on the basis of \( B-B \); \( M-B \) has the highest ratio (2.19) for the third ratio computed on the basis of \( I-B \), and is therefore to be recommended if a level of investment is desired higher than the level of \( I-B \); the fourth \( B/C \) ratio, computed on the basis of \( M-B \), showed no plan with a ratio greater than 1.0. This finding is consistent with the revised Table 5.7 with a minimum rate of return of 10%. In summary, if the inputs to the economic evaluation were valid, the conclusion would be that each of the successive Highway Plans - Basic, Intermediate and Maximum - in combination with the Basic Transit Plan, will yield a sufficient rate of return and ratio of benefits to warrant the capital cost required.

D. Evaluation of the Transit Alternatives

Each of the three acceptable plans includes the Basic Transit Plan as its transit component. No Intermediate or Maximum Transit Plan comes even close to being a component of an acceptable plan. As noted above, it is both surprising and of considerable interest to observe that for each highway alternative, the level of investment in transit has no effect on highway user costs. One would expect that a doubling of transit investment (from the Basic to Maximum Transit Plan) would have some effect on the aggregate user costs of the highway system. A similar result is observed for the effect of alternative levels of investment in highways on transit user costs. This finding is a direct result of the limitations of the travel projection procedure followed. Because of this strict independence of highway and transit user costs, the transit evaluations can be completely separated from the highway evaluations. The results of these separate transit analyses comparable to Tables 5.6, 5.7 and 5.8 are given in the following tables. Several comments may be made with respect to these revised tables.

1. From the viewpoint of a strict economic evaluation, no transit improvements should be made at all! This clearly demonstrates inadequacies of the evaluation procedures applied. However, it is noted that the Maximum Plan does perform somewhat better than the Basic or Immediate Plans.

2. To some extent these findings are the result of inclusion of unsound projects in the alternative plans. The costs of each plan, and the Maximum Plan in particular, could be reduced considerably without significantly reducing the benefits, as discussed in Section II above.

3. These findings illustrate the importance of evaluations based on objectives other than economic feasibility, if public transportation investments are to be undertaken as recommended by DVRPC. Since the Board of DVRPC has now extended the Basic Plan to include some elements of the Intermediate and Maximum Plans, it is apparent that such objectives are believed to be important. For example, the benefits of a strong central business district without excessive amounts of land devoted to freeways and parking are a desired result that possibly contributed to this decision. The desire for orderly suburban development in conjunction with rail transit and the importance of providing transit
### Table 5.6 (Revised)

Transit Evaluation Based on Least Total Cost Method

<table>
<thead>
<tr>
<th>Plan</th>
<th>Annual Cap. Cost</th>
<th>Annual User Cost</th>
<th>Annual Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-N</td>
<td>---</td>
<td>541.3</td>
<td>541.3</td>
</tr>
<tr>
<td>B</td>
<td>81.9</td>
<td>526.4</td>
<td>608.3</td>
</tr>
<tr>
<td>I</td>
<td>105.7</td>
<td>520.7</td>
<td>626.4</td>
</tr>
<tr>
<td>M</td>
<td>133.9</td>
<td>488.1</td>
<td>622.0</td>
</tr>
</tbody>
</table>

### Table 5.7 (Revised)

Transit Evaluation Based on Marginal Cost and Benefit Method

<table>
<thead>
<tr>
<th>Plan</th>
<th>Total Cap. Cost</th>
<th>Annual Costs</th>
<th>Diff. from Preceding Plan</th>
<th>Rate of Return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cap.</td>
<td>User</td>
<td>Operating</td>
<td>Cap. Annual</td>
</tr>
<tr>
<td>D-N</td>
<td>---</td>
<td>541.3</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>B</td>
<td>772.8</td>
<td>526.4</td>
<td>27.1</td>
<td>553.5</td>
</tr>
<tr>
<td>I</td>
<td>1105.8</td>
<td>520.7</td>
<td>27.3</td>
<td>548.0 1105.8</td>
</tr>
<tr>
<td>M</td>
<td>1489.3</td>
<td>488.1</td>
<td>28.3</td>
<td>516.4 1489.3</td>
</tr>
</tbody>
</table>

### Table 5.8 (Revised)

Transit Evaluation Based on Benefit to Cost Ratio Method

<table>
<thead>
<tr>
<th>Plan</th>
<th>Annual Costs</th>
<th>Diff. from D-N</th>
<th>B/C (D-N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cap. User</td>
<td>Cap. User</td>
<td></td>
</tr>
<tr>
<td>D-N</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>B</td>
<td>81.9</td>
<td>14.9</td>
<td>0.18</td>
</tr>
<tr>
<td>I</td>
<td>105.7</td>
<td>20.6</td>
<td>0.20</td>
</tr>
<tr>
<td>M</td>
<td>133.9</td>
<td>53.2</td>
<td>0.40</td>
</tr>
</tbody>
</table>

*Operating costs for transit in the "Do Nothing" plan are assumed to be fully included in user costs.*
service to persons and households not owning autos are other unquantified benefits of public transportation. Clearly, the objectives underlying these unmeasured benefits are important to DVRPC and its constituent agencies.

E. Travel Projection Methods

The independence of highway and transit user costs is partly explained by the fact that only two combinations of plans were fully tested - Plan 5 (Maximum Transit, Basic Highway) and Plan 6 (Basic Transit, Maximum Highway). Estimates of modal choice obtained for these two plans were applied in the tests of the remaining five plans. Therefore, the effect of the interaction between different combinations of plans on the problem of modal choice was partly ignored in the analysis. It is not surprising, therefore, that there is no interaction, and in particular that, according to the Report, transit investment has no effect on radial highway congestion.

In order to indicate the level of reliability of the reported findings and the significance that should be attached to them, the authors feel obliged to call attention to some results obtained by DVRPC following the completion of the Report. * The modal split estimates in the Report are based on design or desired highway speeds rather than predicted speeds. Since the predicted speeds reflect the actual congestion in the highway system, these speeds must be the basis of any modal split estimates that will demonstrate the interdependence of highway and transit systems. In that these speeds were not used in the Report, the results are quite misleading. The subsequent study cited found that the number of transit trips for the Intermediate Highway-Basic Transit Plan using predicted speeds is about the same as the number of transit trips for the Maximum Transit-Minimum Highway Plan using design speeds. These results suggest that the level of error in the modal split estimates is approximately as large as the difference between the two extreme, transit-oriented and highway-oriented plans. Presumably, the Basic Transit Plan with the now approved additions would draw even more transit trips than were shown in this analysis.

Based on the limited information available, it is difficult to estimate the significance of this level of error. However, an estimate of its order of magnitude is possible. According to the Report, 176,000 daily person trips would be diverted to transit by the Maximum Transit-Minimum Highway Plan, as compared with the Maximum Highway-Minimum Transit Plan. Using an average auto occupancy of 1.5 persons per car, this is equivalent to 117,400 automobile trips per day. Since this is a diversion to transit, it may logically be assumed that 40 to 50 per cent are commuter trips made during the peak hour.

In other words, these trips are equivalent to perhaps 20,000 to 30,000 peak hour auto trips in each direction, or approximately 22 to 34 additional lanes of freeway for the two directions distributed over the metropolitan area, assuming a 1800 vehicle/hour freeway lane capacity. Since perhaps as one-half to two-thirds of these trips would enter the central area of Philadelphia, the highway facilities required to serve these trips diverted to transit would be equivalent to approximately 10 to 24 additional freeway lanes in the central area.

It is unlikely that such freeway capacity could be provided in central Philadelphia. In this event these persons would find destinations in locations other than the central area. If these trips were work trips, then an equivalent number of jobs (30,000 to 45,000) would not locate in central Philadelphia, but would be distributed to outlying areas, thereby significantly limiting the growth potential of the Philadelphia core.

IV. CONCLUSIONS AND RECOMMENDATIONS

It is obvious from the preceding discussion that a number of changes in the DVRPC 1985 Transportation Plan are required prior to its adoption. The major items requiring changes are summarized here; each one is followed by suggestions for improvements.

1. The recommended public transportation plan is unacceptable since it was improperly conceived and incorrectly analyzed and evaluated in all major steps of the planning process. The Plan is inadequate for public transportation needs in the Region through 1985, even with the recent addition of the rapid transit lines serving New Jersey. Among its major deficiencies is the lack of significant improvements in North, West and South Philadelphia. Neither provision of additional rapid transit lines nor upgrading of the existing street car and bus services is considered. Actually, improvements and extensions of bus services are hardly mentioned in the Report. The Plan is therefore not in accordance with the policies of several governments and public agencies in the Region which are making particular efforts to improve the high density inner city areas.

The entire public transportation plan must be revised. New proposals should be based on a systematic examination of standards for the level of service throughout the Metropolitan Area, establishment of present and future deficiencies and needs, and analysis of a wider range of possible improvements.
2. Plan evaluation procedures in the Report for both highway and public transportation plans have several conceptual and technical errors. The most important improvements require: (a) inclusion of all costs which can be estimated (parking, tolls, etc.); (b) careful definition of the role and limitations of the benefit-cost analysis in the process of plan evaluation; and (c) correction of technical errors in the procedures.

3. Traffic projection procedures should be improved so that predicted volumes will be consistent with the travel time and cost assumptions upon which these predictions are based. Particularly, peak hour operating conditions should be more adequately introduced into the model.

4. Freeway networks require additional tests of physical design and operational feasibility as well as their compatibility with the arterials, local streets and parking facilities.

5. The scope of the transportation plan is presently very narrow. Based mostly on extrapolation of trends and the present technology, it neglects examination of such alternative solutions as better utilization of the existing facilities and improvement of operational practices, for example.

Further, the Report omits the consideration of plan objectives. For example, two objectives for the Region that should be central in adopting a transportation plan are:

(a) the importance of the central business district in the Region as an employment, commercial and recreational center;

(b) the minimum level of service for both highway and public transportation to be provided to all income groups and all parts of the Region.

It should be re-emphasized here that this criticism should be somewhat moderated by the fact that many limitations in the Report are caused by the state of the art of transportation planning. The authors also fully realize that as a public planning agency DVRPC has been subjected to many external requirements and limitations. However, these factors cannot justify deficient planning procedures.
DVRPC is a responsible public agency which must operate within given constraints and cope with realistic problems. But this does not limit it to a narrow scope of its work and does not prevent it from introducing new ideas. On the contrary, to respond to its task, it must have a broad and realistic view at the urban transportation situation. It should adopt a progressive approach and initiate new concepts and actions.

DVRPC must explore the public interest and suggest required actions even if those actions adversely affect owners of parking facilities, railroad labor unions, bus company management or any other special group. In the present general urban crisis, energetic steps for abandonment of various obsolete practices and introduction of modern systems are imperative. This Plan is only the first major step in the work of the DVRPC; its further tasks lie ahead. It is therefore of utmost importance that it improves its present recommended plans, gains cooperation and respect of public and other agencies as well as citizens, contributes its special expertise and resources to the implementation of plans, and assumes a leading role in the continuing transportation planning program for the Region. The authors are convinced that DVRPC has the resources to assume this role and that it will respond to its basic task: to lead in achieving a better transportation system for the citizens of the Region.
V. REFERENCES


