Traffic and Earnings Studies

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The determination of traffic and earnings which are to be anticipated for a proposed revenue bond highway project involves many standard traffic engineering techniques, supplemented by special investigations of economic and sociological factors. Traffic considerations also play an important role in preliminary studies to determine the most feasible location for the facility, whether it be a toll turnpike, an urban expressway, or a new bridge or tunnel.

PROJECT LOCATION

Legislation

For a typical revenue bond highway project, the general route of the road or approximate location of the bridge or tunnel, is fixed by legislation. This legislation usually establishes the type of facility and its termini in very general terms which leave considerable latitude to the Civil Engineer and the Traffic Engineer to determine the most feasible location. For example, the Code of Virginia contains an Article* which authorizes the Richmond-Petersburg Turnpike Authority to construct a controlled access express highway or super highway "from a point or points not exceeding five miles north of the corporate limits of the City of Richmond to a point or points not exceeding five miles south of the corporate limits of the City of Petersburg . . ." In many cases some intermediate control points are also established by legislation but the specific locations remain for the engineer to determine, based primarily upon traffic, physical and economic considerations.

The legislation fixing the approximate location of a proposed highway facility often is itself based upon traffic considerations. For example, the most desirable location for a proposed bridge or tunnel crossing may be located by a Traffic Centroid Study. The centroid of traffic desires is determined in much the same way that the civil engineer

* Article 11, Sections 33-255.24 through 33-255.44 of Title 33 of the Code of Virginia, as approved by the General Assembly of Virginia on April 8, 1954.

determines the centroid of the various forces acting upon a body in space. In actual practice, the best location for traffic service often must be compromised due to cost considerations.

Preliminary Traffic Studies

Preliminary traffic studies to determine the best location and the approximate traffic and earnings potential of a proposed toll facility generally include field reconnaisance and the collection of available statistics which are obtained from the appropriate State Highway Department, local Municipal officials concerned with traffic and planning, the State Highway Patrol, local police, and other sources. Data indicating annual average daily traffic flow for the primary and secondary State highway routes are usually readily available from the State Highway Department; this information is most significant since the magnitude and location of the existing traffic in the area must be considered if this traffic is to adequately be served by a new highway facility. The traffic flow map also indicates to the traffic engineer the principal routes which would serve or compete with the proposed facility.

The existing travel pattern, as illustrated by a traffic flow map obtained from local authorities, is not sufficient indication of travel desires. Travel desires based on traffic volumes alone can be very misleading. Knowledge of these desires is essential if future use of a new highway facility is to be determined accurately. For preliminary studies, it is often possible to make use of data concerning the origins and destinations of existing traffic in the area which may have been collected for other purposes. For example, the Bureau of Public Roads has assisted State Highway Departments to conduct many comprehensive Metropolitan area, origin-destination surveys which make use of established sampling techniques. The internal studies are supplemented by an external origin-destination survey to determine the travel patterns of people entering and leaving the area.

The urban or metropolitan survey can provide origin-destination data regarding trips involving the particular city or area for which the survey was made. If portions of the proposed facility are to be located outside this metropolitan area, additional data must be obtained regarding travel not involving this area but which might be potential to the new facility. Sometimes this is already available from roadside origin-destination data obtained by the State Highway Department at stations along existing routes carrying traffic potential to the new route. If not available, travel desires can be estimated, for preliminary studies, by the traffic engineer based upon known factors including the size and location of the population centers to be served along the route,

motor vehicle registration data for these centers, the travel distance and time between these centers and information regarding land use characteristics for the area. Population data are available from the census report of 1950 for all counties and incorporated towns of 1,000 or more persons. The Bureau of Public Roads annually publishes statistics on the amount and use of motor vehicles by states. Local planning agencies usually have maps or other data indicating the present land use characteristics of the area, categorized at least according to residential, commercial, industrial and public uses. Time and distance data are obtained in the course of making route evaluations of all highway facilities serving or competing with the proposed facility. Local authorities may already have some of these data as well as classified traffic counts, records of landmeter studies, accident records, strip maps showing physical features of existing routes, aerial photographs, and other useful highway planning survey data.

Route Selection

Preliminary data enables the Traffic Engineer to select the route which would provide the optimum traffic service and to select points of interchange to serve existing traffic and to make accessible undeveloped area. Coordination with the Civil Engineers is essential at this stage of planning, since physical or economical factors may necessitate a modification of the desired alignment. Preliminary studies of alignment should be undertaken by the Civil Engineers after the considerations of traffic service have been investigated to determine the most desirable route with modifications made in this alignment as required. All too often the procedure is reversed with economic and practical (physical) alignments investigated without regard for the service which they provide.

Design standards are dictated as general by legislation and in detail by the results of preliminary studies of traffic and topographical limitations. Cost estimates for the alternate routes are made and the most desirable routing, considering all factors, is selected by the responsible agencies.

TRAFFIC POTENTIAL

Field Studies

When the desired location of the proposed facility has been established, comprehensive field studies can effectively be undertaken to provide a sound basis for estimates of traffic and earnings. Basic techniques are alike whether it be a toll road or expressway or a bridge or tunnel; certain details do differ, however, and the following dis-

cussion deals primarily with the field studies necessary for toll roads. The principal field study is the roadside origin-destination survey which is undertaken to determine the current origin-destination pattern of trips made by users of the existing facilities in the area. The extent of this survey depends largely on the availability of suitable recent origin-destination data from local authorities. Generally a screen line is established near one of the larger traffic generators to be served, consisting of roadside interview stations located on all the significant roads and highways leading from this area which carry traffic potential to the proposed facility. These stations should be located close enough to the large traffic generator to economically intercept substantially all of the traffic movements which are long enough to be made via the toll road, which ordinarily is a controlled access facility, and yet far enough from the generator to exclude local city traffic which is not likely to be potential.

The basic screen line may be supplemented by a secondary screen line located near another large traffic generator served by the facility; in many cases where the facility would be of great length, intermediate interview stations may also be necessary. These secondary stations are located to intercept traffic which does not pass through the basic screen line although a certain amount of duplication always results because of the presence of long distance "through" traffic which may pass through both the basic and secondary screen lines. A certain amount of duplication of this nature is not undesirable, however, since traffic movements intercepted by two stations provide an excellent opportunity for checking the accuracy and stability of the sample.

For revenue bond financing, the origin-destination surveys are conducted for from one to seven days depending upon the magnitude of variations in traffic patterns, the amount of current data available to determine these variations, and the anticipated use of the data. Many traffic and earnings studies for toll roads are based upon five-day origin-destination surveys; interviews may be obtained for three weekdays, a Saturday and a Sunday at the basic screen line. Intermediate screens may be studied for only a typical weekday and a Sunday if reliable statistics are available to determine weekly traffic variations.

The roadside origin-destination survey determines the places of origin and destination of each trip intercepted. Near large cities, street addresses may be required to adequately identify the origins and destinations, but ordinarily town names are adequate. In addition to this data, interviewers also record the classification of each vehicle according to a predetermined code, the state of registration of passenger cars and, sometimes the number of occupants if tolls will be based upon vehicle

occupancy. If it is not practical to obtain a 100 per cent sample of any station, as is often the case, each vehicle class must be sampled at random; indiscriminate by-passing of commercial vehicles or other types of vehicles may lead to biased conclusions. Interviews are recorded by directions and by hourly periods so that accurate adjustments can be made for periods during which all vehicles are not interviewed. These adjustments are based upon manual classified traffic counts conducted simultaneously with the interviewing at each station. If a 100 per cent sample is obtained, these counts are not necessary.

To facilitate the analysis of this data, each origin and destination determined by interview is coded according to zones. These zones are carefully determined in consideration of land uses, population concentration, the locations of main highways serving the areas and the proximity to the proposed facility. Generally, the closer to the facility studied, the more detailed must be the zoning.

It is usually not economical to conduct interview stations to intercept all traffic in the area served by a proposed facility. It has been found by traffic engineers that local traffic constitutes the predominant portion of toll road usage; experience on the New Jersey Turnpike indicates that the average trip length is little more than the average distance between interchanges. Where cities and towns or generally built-up areas are located along a toll road route—which is the typical situation—interview stations would be required at intervals of about the distance between interchanges, if all potentials are to be sampled. An alternate, more economical but satisfactory, method has been developed, however, to synthetically determine the magnitude of this local potential which cannot be economically sampled in the main field studies. By this alternate approach, travel patterns are determined from several known factors—population magnitude and distribution, vehicle registration and use, travel distance and time between areas of homogeneous land use characteristics and various economic factors. Years of research have indicated that very consistent relationships exist between the number of trips generated between certain areas and the populations and effective distances between the areas. These relationships may easily be determined from the origin-destination data obtained from field interviews or from previously obtained home-interview, origin-destination data. A synthetic origin-destination pattern may be developed for any local area in this manner; a check station or screen line may be operated to check actual patterns against the synthetic pattern and adjustments in the latter made as required.

For use in developing synthetic origin-destination patterns, and particularly for use in estimating potential diversion to a proposed

facility, all principal highway routes either serving or competing with the facility are evaluated as to the condition and general all-around service provided to the motorist. In addition to physical evaluations, speed and delay studies are conducted by competent engineers who attempt to determine average travel times between the zones established for the analysis of the field data. Usually, a floating car method is employed, if volumes are heavy enough, whereby the test vehicle passes only as often as it is passed by other motorists. Some engineers prefer to simply drive the test car according to average speeds as estimated by judgment. Research has shown that either method is satisfactory if enough field observations are made. Certainly several test runs are essential for each route for both off-peak and peak-hour conditions. Accident experience on the routes in the area, special attractions such as nightclubs, shopping centers, etc., and the magnitude of pedestrian and heavy truck traffic are also reviewed in the field as elements affecting usage of the several facilities available to the motorists.

Analysis

While the coding of the basic origin-destination data is done manually, the adjusting, tabulating and summarization of the data may be done either mechanically or manually, depending upon the number of interviews obtained and details desired.

Adjustment and expansion factors are based upon manual classification counts made during the survey and sustained counts made through the years by local authorities. The adjustments to 24 hour levels are usually made individually for each vehicle classification; adjustment of data for the survey period to annual average daily traffic levels—the basic unit for all traffic estimates in revenue bond feasibility studies—is based upon seasonal variations in traffic. Thus it is seen that accurate statistics regarding seasonal traffic variations are essential for traffic and earnings studies.

Traffic Assignments

Whether summarized and tabulated manually or mechanically, the annual average daily traffic movement between the various zones in the study area are obtained for each interview station. Trips passing through more than one station are eliminated from double consideration. Estimates are then made of the proportion of each individual movement which is potential to the new facility.

A motorist's selection of routes of travel is influenced by many factors, some of which are tangible and others which are very difficult to measure accurately. To determine the amount of diversion of existing

traffic to a new route, it is necessary to weigh the *service* provided by this new route against the service provided by alternate competitive facilities. The principal tangible elements involved are travel distance, travel time and costs which include toll charges. Intangible factors include the effects of congestion, interrupted movement, accident hazards, general driving tension, etc., all of which influence a driver's selection of route.

Travel time has been found to be the single factor which has greatest influence on route selection; consideration of travel distance alone leads to wide variances from actual driving habits and is not an acceptable criterion. Experience and detailed studies have shown that best results are obtained by making economic evaluations of relative trip cost by way of the various alternate facilities. Both intangible and tangible factors are involved in these economic evaluations. The costs of vehicle operations are directly related to the length of trip, the average speed of travel and the size and weight of the vehicle. The amount of time consumed in making trips may also be given an economic value which can be determined from empirical studies.

A study of travel time and distance values was made in 1954 in developing feasibility of the Hampton Roads Bridge-Tunnel Project in Virginia.* Origin-destination data for the study area were analyzed and the relative usage of the existing facilities determined for each of numerous traffic movements. Travel times and distances were computed for these movements via each of the alternate routes and travel costs derived based on various economic values for travel distance and time. Curves relating facility usage to economic savings or losses were prepared based upon the assumption that equal usage of alternate routes occurs when total travel costs including toll charges are equal. The curve which agreed with actual habits under present conditions in the area studied was based upon values of two cents per minute for the average motorist's time and four cents per mile of travel distance. Truck movements were similarly analyzed and it was determined that operators of commercial vehicles in the area placed a value of about 5½ cents per minute on travel time and about 9 cents per mile of travel distance. These values are only typical of the area studied and may be quite different for other localities. In any case, the fact that travel time has economic value is evident. The study also revealed that assign-

* "Traffic and Revenues for the Proposed Hampton Roads Bridge and Tunnel System," Wilbur Smith and Associates and Deleuw-Cather Company; a report for the Commonwealth of Virginia, State Highway Commission, August, 1954.

ments based primarily on time and distance factors can be made in accord and with curves statistically developed.

Toll charges must be considered in computations of relative travel costs since they inhibit facility usage; the degree of inhibition is dependent upon the amount of the toll charges and the total travel costs for a particular trip. The longer the trip, the less will be the influence of tolls on route selection. Even small tolls may reduce considerably facility usage for short local trips.

Extensive analyses of impartial data obtained from origin-destination surveys have resulted in a reliable technique to determine the relationship between relative costs of travel and facility usage or diversion to a new facility. In general it was found that the attraction of traffic to either of two routes may be considered approximately equal if total travel costs are equal. Where travel costs is less by one route than another, the least expensive route will attract the greater proportion of travel. These relationships do not account for capacity limitations or the intangible elements in route selection. It has been found however, that where travel times between zones are equal, speed differentials indicate to some degree the effects of congestion and other negative factors which reduce the attractiveness of a route. Where speed differentials are particularly great, many drivers elect to use the faster route even at the expense of travel distance and time.

Economic evaluations must be made for both passenger cars and commercial vehicles since the benefits derived by these classes of vehicles from time and distance savings vary considerably. Assignments of existing traffic to the proposed facility are made by class and type, making use of data regarding the composition of traffic obtained in the roadside interviews. For certain areas, assignments for peak hours may be justified as well as for off-peak periods in cases where peak hour capacity problems are serious. Experience on the existing toll roads indicates that the composition of traffic using these facilities varies somewhat. New Jersey Turnpike traffic consists of about 88 per cent passenger cars where only 84 per cent of Pennsylvania Turnpike traffic was of this type during the last six months of 1954. Passenger car traffic comprised 82 per cent of West Virginia Turnpike traffic and 91 per cent of Turner Turnpike (Oklahoma) traffic in 1954, although latest information indicates an increasing proportionate truck usage.

Detailed assignment methods of different consultants and highway agencies vary considerably. Some involve "opinions" and "experienced judgment" more than others in the derivation of diversion factors. Some methods involve a travel time ratio as the basic criterion in traffic assignment and others weigh both time and distance factors as compared

with the method described herein whereby travel costs, including toll charges, and intangible factors are evaluated as well as time and distance relationships. One method sometimes used in making traffic assignments for a toll facility involves assignments based upon the facility being free after which an arbitrary reduction is made to account for the effect of the tolls. If economic evaluations are made for each individual traffic movement, however, the relative influence of the toll charges, which varies with trip length and vehicle type, is accounted for. Regardless of the influencing factors considered in making traffic assignments, there is general concurrence that assignments must be made for *each* principal trip *movement* which involves a very detailed process.

Generated Traffic

A new highway facility which substantially will improve the facility of travel over previous levels always generates considerable additional traffic. This traffic is in addition to that diverted from the existing roads and is in addition to normal growth in the area. Generated traffic (sometimes called induced traffic) accounts for a very substantial part of a new facility's use during the first year of operation. Smaller amounts of generation may also occur during the next two or three years after which normal growth conditions must be expected to prevail.

Several studies have been undertaken to measure this generation for existing facilities. For example, in Maine the annual average daily traffic on US 1, the principal parallel route to the Maine Turnpike, was determined for several years prior to the opening of the Turnpike. Annual average daily traffic on US 1 during the last year before the Turnpike opening was 6,400 vehicles per day; the following year there were 4,200 vehicles per day on US 1 and 3,400 vehicles per day on the Turnpike, representing a total increase of 1,200 vehicles per day. Of this total increase, it was estimated that 400 vehicles per day represented normal growth for the year leaving 800 vehicles per day as generated traffic. Similarly on US 1 in Newark, N. J. during 1951 the annual average daily traffic was 86,600 vehicles per day. Normal growth was expected to increase this traffic to 91,000 for 1952 without the opening of the New Jersey Turnpike. Actually, during 1952 about 30,000 vehicles per day used the Turnpike and 75,000 used US 1, representing about 14,000 vehicles per day more than the 1952 estimate for US 1. Thus, at least 14,000 vehicles per day were generated by the new facility.

Land use characteristics and potential developments which may occur due to the presence of a new facility of high-type design stand-

ards have much to do with traffic generation, both in the first year of operation and later years. In heavily built-up areas, not adequately served by modern transportation facilities, travel may be suppressed to such an extent that a high degree of generation may result as occurred on the New Jersey Turnpike. Reductions in the travel time between two areas, caused by the presence of a new facility, will cause increased travel between the two areas. Although more research is necessary in the subject, we have found that the magnitude of this generated traffic is approximately in proportion to the relative time savings realized. Other factors such as increased safety, continuity of movement, greater overall speed of travel, more esthetic surroundings, etc., may also cause the generation of new traffic but relative time savings are the best single index.

The presence of new modern transportation facilities may also cause industrial expansion in new, outlying areas near the cities which may cause traffic to develop which did not exist before. Much of this "Land Development Traffic" is already beginning to take place near interchange locations of the Indiana East-West Toll Road even before it is completed.

Research is progressing toward practical application of a synthetic development of traffic generation as well as the synthetic development of existing travel patterns. We have developed relationships between the population of areas and the magnitude of traffic between them in consideration of various other factors easily determined. Where it is possible to develop reasonably accurate predictions of future populations and their distribution, the magnitude and patterns of future traffic can be estimated based upon travel distance and times by the anticipated new high speed facilities. This traffic pattern inherently includes what we now call traffic generation or inducement since existing conditions are not the basis for assignments. Traffic-generation would, therefore, appear to vary for each individual traffic movement—as diversion of existing traffic does—depending upon the degree of service provided by the new facility. These are new approaches to a perplexing problem which remain to be checked through comprehensive field research projects.

Future Traffic

Normal traffic growth in future years of operation of toll facilities is usually estimated on the basis of long term trends developed for past years. Of fundamental importance are population trends, vehicle ownership and use trends and trends concerning the general stability and

growth of the local economy, as well as vehicular traffic trends available for the primary highways in the area.

During the last two decades, nearly every state has experienced population increases. From 1940 to 1950 only Arkansas, North Dakota and Oklahoma lost appreciable population and Mississippi lost a very small number. All states have experienced substantial natural increases in population which in most cases offset any loss due to migration. Migration has taken two forms—interregional migration, which is westward in direction, and rural-to-urban migration. The latter phenomenon takes on significance in making estimates of future use of a transportation facility since, although the region may continue to grow in population, the migration to the large cities may affect the amount of usage of the facility or at least the portion of the facility used. Thus the trends in total population and its distribution both must be analyzed carefully.

Vehicle ownership trends also provide a basis for estimates of future traffic. Total motor vehicle registration for the nation has reached an all-time high of over 55 million vehicles, representing about one vehicle for every 3.3 persons. The ratio of persons per passenger car has decreased since the war in nearly all areas of the country and all indications point toward continued decreases in this ratio until a saturation point is reached. Several western states have already reached the level of about 2.6 persons per passenger car or about 2.3 persons per motor vehicle. Assuming a maximum passenger car ownership of one car for every two persons, a total which is expected to be approached but never quite reached, realistic estimates of future ownership can be made. Large, densely-populated eastern urban areas probably will never support the degree of ownership already obtained in portions of the West. Relating the anticipated population in an area to the probable future ownership ratio provides a realistic estimate of future passenger car registrations.

Growth in truck registrations also varies with population, although many other factors are also involved. Truck types which provide a direct service to the individual family unit will tend to be more affected by population changes than the large, long-haul trucks which serve the community as a whole or the entire region. Prospective industrial growth also has a direct bearing upon growth in truck registrations and must be carefully evaluated.

The annual mileage driven per vehicle has increased substantially during recent years and is partly responsible for our present-day traffic problems. In some areas this trend is continuing; where the numbers of two and three car families are increasing, the average mileage per

vehicle may actually decrease. Investigation into all local development factors is essential to intelligently forecast motor vehicle usage.

In most states very basic data are available indicating long term traffic trends which are of considerable use in anticipating future growth. This is usually in the form of State Highway Department records of automatic traffic recorder stations on primary highways but may be the annual financial records of an existing toll facility.

General economic conditions in the area served by a facility are also of great importance to its future use. Even mild economic recessions have great impact upon vehicular travel; especially affected are commercial traffic and passenger car traffic for pleasure purposes. Generally, a diversified economy is less vulnerable to these recessions than one less diversified.

A basic change in transportation method for certain commodities may also result from new express facilities. This may involve a change from rail to truck hauling which might entail additional traffic in the future for the express facility. The shift from rail to truck is no longer so pronounced as it has been in recent years but the pattern is never constant. Possibilities for changes such as these are very difficult to predict, however.

REVENUES

Toll Rates and Revenues

The toll charges used on the various existing and planned toll roads in the country vary somewhat. The rates per mile for a full length trip for some of these facilities are tabulated on the following page. Passenger car tolls range from a low of 1.0 cents per mile on the original portions of the Pennsylvania Turnpike to 1.6 cents per mile in the Turner Turnpike in Oklahoma. Light commercial trucks with operating capabilities similar to passenger cars, such as panel and pickup trucks, are usually charged the same rate as passenger cars. Tolls for heavy single unit trucks average over 3.0 cents per mile, ranging from 1.9 to 5.0 cents per mile, and large combination tractor-trailers or full truck-trailers are charged tolls up to and exceeding 6 cents per mile.

Tolls for bridge and tunnel crossings are usually higher on a per-mile basis. High volume bridges or tunnels in urban areas generally require lower toll rates for successful financing than crossings in urban areas where passenger car tolls may be as high as $1.00. If toll rates are selected to provide the greatest possible revenue, authorities must consider that the greater the toll, the less will be the total usage.

After assignments have been made by class of vehicle, it is a simple matter to determine the toll revenues by application of the toll rates

TOLL RATES

EXISTING AND PLANNED TURNPIKES

Vehicle Classification	Dallas-Houston Turnpike	Oklahoma Northeastern Turnpike and Existing Turner Turnpike	Kansas Turnpike	Indiana East-West Toll Road	Ohio Turnpike	New Jersey Turnpike	Pennsylvania Turnpike	
							Existing System	North-eastern Extension
Passenger Car or Motorcycle	1.5	1.6	1.6	1.25	1.2	1.5	1.0	1.3
Light Commercial Trucks	1.5	2.2	1.6	1.25	1.2	1.5	1.0	1.3
Heavy Single Unit Truck	3.4	3.4	2.8	2.0 to 4.6	2.0 to 5.0	3.0 to 4.2	1.9 to 4.7	2.0 to 4.9
Combination Truck (3-4-or 5-axle)	4.5	4.5	3.8 to 4.2	2.0 to 6.8	2.0 to 6.7	3.8 to 4.2	1.9 to 6.3	2.0 to 6.5

selected for each vehicle class. Where extra charges are to be made for passengers, determinations of average occupancy per vehicle are made from the field interview data. Traffic and revenues are calculated for the first full year of operation of the facility. Construction of a typical toll road project may require about two years although planning and financing problems may necessitate additional lead time. Bridge or tunnel projects may take even longer depending upon the size of the project and the construction difficulties encountered.

Toll highway facilities usually carry more than twice as many passenger cars as commercial vehicles; many urban bridges and tunnels carry traffic consisting of over 90% passenger cars. The proportion of the total toll revenues provided by commercial vehicles is usually about twice the proportion of commercial vehicles in the total traffic flow. On the New Jersey Turnpike, revenue from commercial traffic comprised over 22% of the total toll revenue for 1954 while only 11.9% of the total traffic was of commercial types. The Turner Turnpike commercial traffic provided 9.1% of the total volume; provided 19.4% of the total toll revenues. Pennsylvania and West Virginia Tunpike revenues from commercial vehicles have exceeded 50% of the total toll revenues.

Concession Revenues

Vehicle tolls are not the only source of revenue for some toll facilities. Today's modern, limited access toll road features restaurants and service station facilities which serve the public around the clock. Emergency road service is available at all times. These facilities are operated by carefully selected concessionaires since the service they provide adds greatly to the attractiveness of the facility and also develops a supplemental source of revenue. Concession revenue can be a very substantial part of the total earnings of a toll road, especially where the facility is very long. The Turner Turnpike has experienced revenues from these sources of almost 10% of the toll revenues and some existing turnpikes have experienced even greater concession revenues.

Estimated vs. Actual Revenues

Annual revenues estimated by engineers for revenue bond toll road projects have proven to be overconservative in many cases. Traffic carried by nearly every toll road has far exceeded original estimates. It is hoped and expected that new approaches and techniques being developed will eliminate the necessity for arbitrary assumptions and provide more accurate determinations of traffic usage of the modern facilities of today.

FEASIBILITY

The economic feasibility of a proposed revenue bond project is largely the job of fiscal advisors to decide, using the Traffic and Earnings Report and the report of the Civil Engineer. The measure of feasibility is the degree to which total costs of a project are met or covered by net earnings.

Annual maintenance and operation costs include costs for administration, insurance, engineering and auditing, as well as the usual maintenance and operation items such as salaries, utilities, equipment and material costs. These costs increase each year and reduce the net income available for debt service considerably.

Capital costs for construction are estimated by the Civil Engineer. Other costs must also be considered with revenue bond projects, however. These include financing, legal and other miscellaneous charges inherent to this means of financing, and the interest charges on the money borrowed for construction. Interest charges during construction depend upon many factors including the interest rates obtained in the area, the total amount of the bond issue, the attractiveness of the bonds to investors and the length of the construction period. Interest rates on most *revenue bond* projects, where principal and interest charges are pledged solely from toll and concession revenues, have ranged from about 2.50% to 4.00%. Where great risk is involved, rates may be higher.

Two other similar types of bonds—the *general obligation* and *limited obligation* types—usually involve less risk to the investor, since public money is pledged to meet all or part of the debt service, and therefore involve lower interest rates.

The Traffic and Earnings report generally includes a traffic and earnings summary indicating the revenues available for debt service anticipated each year for the life of the indenture. Coverage factors, the accepted indices of feasibility, are computed to indicate the coverage of interest charges during the first year of operation, the coverage of interest and amortization charges during the first year and the average coverage of interest and amortization over various periods during the life of the bonds. The higher these factors are the more attractive will be the bonds to investors.

CONCLUSION

A traffic and earnings report of the type discussed above is a preliminary requirement for all highway projects to be financed by sale of bonds secured by the toll earnings of the facility. Bond financ-

ing of transportation facilities is used more and more today as states and municipalities struggle to provide modern facilities in the face of rising costs.

Every toll road built since World War II has been bond financed and most large bridge and tunnel projects have been made possible by this financing method. The need is obvious for new and better techniques and approaches to the problems involved in the determination of the traffic and earnings potential of these facilities. Progress is now being made along these lines, but the need for more research remains.