BOND-ISSUE FINANCING OF ARTERIAL HIGHWAY IMPROVEMENTS

G. P. St. Clair, *Chief, Financial and Administrative Research Branch, Bureau of Public Roads*

SYNOPSIS

There are undeniable advantages in the use of credit financing to accelerate the improvement of arterial highway facilities. Only by this means can the funds be obtained to insure a maximum rate of accomplishment. Earlier completion of the arterial program will increase the savings and other benefits derived by highway users, generate increased traffic on the arterial system, and provide additional revenues for its support. For these advantages a price is paid in the form of increased total costs because of interest charges, but a program wisely conceived and executed should result in benefits to the users far in excess of the increased costs

The recently published report, "Highway Needs of the National Defense" revealed the fact that, as of 1948 and at 1948 prices, proposed improvements on the National System of Interstate Highways will cost over $11 billion, of which nearly $6 billion are needed to improve the 34,000 miles of rural sections and $5 3 billion are needed for the projected urban system of 3,500 miles When adjustments are made for predicted price levels and for additional capital outlays during the period of an improvement program, it is estimated that the proposed improvement of the Interstate System could be accomplished, and the system maintained and operated, by a 15-year program requiring average annual expenditures of $702 million. A program accelerated to completion in 12 years would cost $845 million a year; one lengthened to 20 years could be financed at $566 million a year.

Analysis of the data regarding the costs of proposed improvements on the Interstate Highway System indicates that their average investment life would be in excess of 50 years, estimated values being 50 years for the rural sections and 58 for the urban. The adoption of an 8-year construction program, financed out of bonds issued for 30-year terms at 2 percent interest, would bring the advantages of a fully improved system to the American public at an early date. The annual revenue requirements for such a program would be much less than those of current-revenue programs designed to complete the same improvements over periods of 12, 15, or 20 years. For example, under the bond-issue program, the average annual revenue requirements during the first 15 years would be $432 million, or 61 5 percent of the required annual outlay of $702 million under a 15-year program financed out of current revenues

Since the debt-service payments on the bonds will be spread over a considerable period of years beyond the date of completion of the construction program, the gradual accumulation of replacement needs will tend to increase revenue requirements during the later years. If such a bond-issue program is adopted, wholly or in part, the bond retirement schedules should be designed and managed so as to bring about a gradual transition from bond-issue financing of the initial improvement program to current revenue financing of the replacement program.

We are confronted today with many thousands of miles of deficient and outmoded arterial highways, both in rural areas and in cities. Plans for rectifying this situation are often stated in terms of a 15-yr , or even a 20-yr., program. Twenty years seem a long time to wait before we get the kind of highway service we need right now It is reasonable to ask whether there is not some means whereby the American people can move in on their arterial highway problem at a more rapid pace.

At the close of the war, the motor-vehicle industry was faced with a similar and closely allied problem. The number of motor vehicles had been reduced considerably from their 1941 peak, and, what was much more significant, nearly all of the existing motor vehicles had become about four years older than they were at the outbreak of the war Beginning in 1946, the motor-vehicle industry went to work on this problem of a deficient, inadequate mobile plant. During the three years, 1946 to 1948,

the production of motor vehicles for the domestic market was slightly under 12 million motor vehicles. An anticipated production of about six million vehicles in 1949 will push this total nearly to 18 million. Regardless of what we think about the cost of new cars, it must be acknowledged that the industry has done a job, and has made great strides toward meeting the heavy demand for replacements and additions to the motor-vehicle population. That successful effort in itself has gravely aggravated the coordinate problem of meeting the demand for improved highway facilities, particularly on arterial routes.

The building of public highways is a very different thing from the production of motor vehicles by private industry. The problems of production, administration, and financing are not at all similar; but the objective is the same—to meet the demands of the public for a commodity essential to the American economy. It is incumbent on highway officials at all levels to find the means of providing the highway facilities that are needed today—not 20 years from now, but as soon as possible in view of the physical and allied limitations upon the accomplishment. Financial and administrative problems should not stand in the way. The American people have the resources and the manpower to accomplish the desired results What is lacking is the mechanism and not the potential for such an achievement. It has been estimated that current expenditures for highway transportation amount to about $30 billion,[1] of which approximately $3 billion, or 10 percent, are spent for highways Whatever the ratio should be under going conditions, it is clear that if we are to meet the challenge of motor-vehicle production and the great increase of traffic it brings about, we must find means of greatly accelerating the rate of highway improvement in the next few years.

Current developments in the planning and building of toll roads offer one solution—a solution about which not everyone is happy, but one that presents a challenge to those who think in terms of free arterial highways. It is not intended to discuss here the pros and cons of toll roads The one most attractive feature of a toll-road project is that the floating of a loan secured by prospective tolls provides the funds for the rapid construction of an arterial facility. The limit is set by the possible rate of physical accomplishment and not by the availability of current revenues. A way is found to do the job and do it quickly.

The device of credit financing is not an exclusive patent enjoyed by the proponents of toll roads. In his address[2] at the annual meeting of the American Association of State Highway Officials at San Antonio in October, Commissioner MacDonald stated, "The only possible attack upon our current highway problems that has any hope of bringing relief must be the application of the successful and the discard of the unsuccessful policies out of our usable past . . . We know from our records that we obtained the most rapid extension of the first systems of modern roads now in service in many States by bond issues which have been comfortably carried by a fraction of the expanding revenues, and there is no valid reason why this process cannot be repeated where necessary."

An arterial facility not supported by the collection of tolls enjoys certain advantages. Construction and operating costs are less because it is unnecessary to build, maintain, and operate toll gates. Other things being equal, the traffic potential of the free facility is greater, in part because it will attract a considerable amount of short-trip traffic, and in part because the toll charges act in some degree as a deterrent to use of a toll facility. The greatest advantage, however, lies in the fact that toll-facility bonds, secured only by the anticipated revenues from tolls, are generally marketed at a considerably higher effective rate of interest than general obligation bonds, to the security of which the full faith and credit of the issuing government is pledged It is well to add also that the field of usefulness of highway toll facilities is limited. For obvious reasons, tolls have not been seriously proposed as a means of financing urban expressways; and toll roads are certain of success in rural areas only when they enjoy in generous measure the combined advantages of strategic location and high traffic potential.

One fact is undeniable, however—toll roads

[1] "Automotive Transportation Trends and Problems," by Wilfred Owen, Brookings Institution, Washington, D C , 1949, p. 5

[2] "Status and Relative Progress of the Federal-aid Highway Program," by Thomas H. MacDonald, Commissioner of Public Roads, presented at the 35th Annual Meeting of the American Association of State Highway Officials, San Antonio, Texas, October 11, 1949

produce revenues applicable to debt service on the bonds. The problem of credit financing of free arterial facilities is one of finding the necessary revenues to provide for debt service on the loan, as well as maintenance and perpetuation of the facilities once they are built. This is the challenge presented by the toll-road enthusiasts for the sober consideration of highway officials and legislators.

ADVANTAGES AND DISADVANTAGES OF BOND-ISSUE FINANCING

The advantages of a bond-issue program for the construction of arterial highways may be briefly stated as follows:

1. Through the medium of borrowing an improvement program may be greatly accelerated, without a great increase in immediate revenue requirements
2. Payment for the improved facilities will be spread over a period during which they are earning increased revenues as a result of their improvement.
3. In contrast to the pedestrian pace of a current revenue program, acceleration through a bond-issue program produces the following effects:
   a. As a result of earlier completion, users of the facilities derive greatly increased benefits through savings in operating costs, reductions in accident costs, and other factors.
   b. Because the traffic-generating capacities of improved facilities come into play at an earlier date, these benefits are realized by a greater number of users, with a resulting multiplication of their total value.
4. Earlier occurrence of increased traffic on the improved facilities produces increased annual revenue earnings, with the result that the State is better able to support the cost, while the users, through savings realized, are better able to pay.

Offsetting these very real advantages of bond-issue financing, the following disadvantages may be cited:

1. Other things being equal, the total capital cost of the improvement program is increased by the amount of interest payment on the bond issues.
2. Since the debt-service payments will be spread over a considerable period of years beyond the date of completion of the program, the gradual accumulation of replacement needs combined with continuing debt-service payments, may result in an embarrassing increase in revenue requirements in the later years. Shrewd management of a bond-issue program should avoid this contingency, but the possibility of its occurrence should not be ignored.

In general terms, the use of credit financing for the building of highways may be said to be justified if it can be shown that the benefits realized by the users from earlier completion of the project or program are greater than the increased cost caused by the necessity to pay interest It is customary now to make such estimates of economic justification, by calculating the mileage-element and time-element benefits resulting from the improvement, and balancing the net sum of annual benefits against the estimated annual costs. While there is still much controversy about these procedures, it is now commonly acknowledged that the savings in motor-vehicle ownership and operating costs, even if they could be computed with the greatest accuracy, would not tell the entire story of the benefits received from improved highway facilities.

The reductions in the strains, hazards, and inconveniences of driving over inadequate and congested facilities have an economic value that is demonstrated by the willingness of highway users to pay for such relief. In particular, it may be noted that toll charges imposed or proposed for private automobiles generally run to one cent or more per mile of travel on the toll facilities. It should be borne in mind that this one cent is a charge over and above the cost in gasoline taxes and pro-rated registration and other fees, which the user will pay whether the facility is free or subject to tolls. A passenger-car charge of one cent a mile is equivalent to a gasoline tax of about 15 cents per gallon. This means that a successful toll facility has something to offer the motorist for which he is willing to pay a remarkably high premium. Not all motorists are willing to make such a payment; but the fact that we have some important toll facilities operating at the present time at such rates, suggests at least a rough measure of the value which relief from unsafe and congested traffic conditions has for the motor-vehicle user.

Credit financing is particularly applicable to arterial improvements, which are generally of high initial cost. Since the demand for them is so urgent that they must be provided at the earliest possible date, bond issues are the only

ready means for making the funds immediately available. Because of the necessarily high standards to which they are built—including surfacing and structures of the most durable types, separation of the traffic streams, separation of grades and, on the most heavily traveled facilities, control of access—the life span of arterial improvements is likely to be much longer than that of lower-type roads. The relatively large expenditures for right-of-way and structures, particularly in urban areas, introduce cost elements of long investment life. Extensive relocations may require large outlays for grading—another long-lived element of cost. Furthermore, it is unlikely that arterial highways of modern design will be subject to the rapid obsolescence that has occurred in the case of many highway facilities in the past. If the capacities of expressways built today are found in the future to have been exceeded, the probability is that supplementary routes will be built, rather than that the earlier facilities will be replaced.

The prospect that arterial improvements built to adequate standards will remain in service for a long time is an assurance that the issuance of bonds to finance their initial cost will be a prudent investment. Recognition of the desirability of bond-issue financing for arterial road improvements led to the recommendation in the report, "Highway Needs of the National Defense,"[3] "That the Federal law permit future allotment of Federal funds to be applied to the retirement of the indebtedness incurred for such improvements." This recommendation was endorsed by the American Association of State Highway Officials at its November meeting in Chicago.

A realistic appraisal of the situation must take cognizance of the fact that some States are very unlikely to undertake the bond-issue financing of arterial highways. In a number of States, the issuance of bonds for public improvements is forbidden by the State constitution. In others, limitations on the magnitude of the State debt may act as a deterrent; and in still others the policy of financing highways out of current revenues is of long standing and unlikely to be changed. The making of financial plans for arterial improvements is a matter of State policy, although in some instances the policies and practices of individual cities may affect decisions regarding the financing of expressways. In this discussion it is intended only to canvass the situation in general terms, without implying that credit financing should or should not be adopted by individual States.

[3] "Highway Needs of the National Defense," House Document No 249, 81st Congress, 1st Session, Government Printing Office, 1949, p. 4.

ROAD-USER TAX EARNINGS AND THEIR SIGNIFICANCE

The earnings of highways or highway systems in the form of road-user tax revenues generated by the traffic have a significant bearing upon the problem of financing their costs. Dr. L. I Hewes, Chief of the Western Headquarters, Bureau of Public Roads, in a paper[4] before the Western Association of State Highway Officials in 1948, discussed the problem of financing arterial highways, particularly in cities, and advanced the idea that bonds issued to finance such improvements should be secured by a pledge of their annual earnings in road-user taxes. Said Dr. Hewes, in part:

"When the need of new urban facilities thus becomes clear their financing is of first importance It is quite evident that at this point the volume of business also is clear If we take a conservative unit of revenue of 6 mills per vehicle-mile there results $2.19 per vehicle-mile-year. This is an important operating revenue. It is worth nearly $2,200 yearly for each 1,000 vehicles. It would seem that when traffic is sufficient to require urban expressways many of them could be financed with such operating revenues pledged to service a loan. Many needed urban expressways would carry daily in excess of 10,000 vehicles and some of them up to 50,000 vehicles. At an operating revenue of even ½ cent per vehicle-mile the corresponding annual user revenue runs from $18,250 to $91,250 per mile. At a rate of 5 percent for total debt service such revenues indicate permissible investments of reasonable terms in expressways that cost from $365,000 to $1,825,000 per mile."

Mr. Jorgensen of Connecticut expressed himself along similar lines in a paper[5] pre-

[4] "Some Present Highway Problems," by Dr. L. I. Hewes, Chief of the Western Headquarters, Bureau of Public Roads, presented at the meeting of the Western Association of State Highway Officials, Portland, Oregon, July 26, 1948

[5] "Financing the Highway Program," by Roy E Jorgensen, Deputy Commissioner and Chief Engineer, Connecticut State Highway Department, published in "Proceedings, Con-

sented at the annual meeting of the American Association of State Highway Officials at Salt Lake City in September 1948. Following is a pertinent quotation from Mr. Jorgensen's paper:

"The road users have shown a willingness—in fact a strong desire—to pay more if they see the additional funds going into express highways What we must do, as I see it, is to propose bond-issue financing for a specific network of expressways. And, further, to advocate the carrying of the bonds by an additional increment of road user revenue, definitely earmarked for that purpose Such a setup should have all of the appeal of the toll financing—knowing what one is paying for and getting major improvements now. It will have marked advantages over toll financing The credit of the State or of earmarked road user revenue would reduce the interest rate on bonds There would be no overhead to cover toll collection costs. The free highways and the access roads thereto could be located to afford the best service to traffic. On toll highways there must be compromises made to provide a minimum of competition with free roads, and to limit access points to those that will bring enough traffic to pay the cost of maintaining the access and toll station "

Under the procedure suggested by these two quotations, the pledge of the road-user tax earnings of a highway or group of highways would be analogous to the dedication of the toll revenues of a toll facility to the same purpose The bonds issued to finance free arterial highways would enjoy the further security of a pledge of the faith and credit of the State.

Certain definitions and qualifications are necessary to the discussion of earnings in the form of road-user tax revenues, and the policy of pledging them to the service of highway-bond issues In calculating such earnings the ordinary procedure is to evaluate the traffic on a given road or group of roads in terms of the annual amount of gasoline-tax revenues generated, by the use of reasonable values of miles per gallon for the different types and sizes of vehicles of which the traffic is composed To this may be added a pro rata of annual registration fees and miscellaneous motor-vehicle receipts

Legal provisions for the allocation of road-user tax receipts do not run parallel to the amounts of travel occurring on different road and street systems; nor is there any general agreement among students of the subject that generated earnings should be the sole or principal basis of such allocations. One highway system may receive more than its share of the revenues on an earnings basis and another system less. In general, the cities have received less than the amount of tax earnings generated by urban traffic, although the expenditure of State highway funds on the urban connections of State highways has tended to mitigate this situation in recent years. In any event it is necessary to take cognizance of the actual availability of road-user tax revenues in relating the generated earnings to the financing of a given system or group of highway facilities.

The calculation of highway-revenue earnings need not be restricted to State imposts on highway users. A road or road system eligible for Federal aid may be said to "earn" Federal funds; and, for arterial improvements at least, it is reasonable to calculate those earnings in proportion to traffic volume, or in a manner parallel to the calculation of earnings of State road-user revenues. It is not uncommon to speak in terms of the Federal excise taxes generated by motor-vehicle travel, although there is no legal connection between such payments and Congressional authorizations of Federal aid The receipts from Federal excise taxes paid by highway users in 1948 are estimated at $1,151 million, of which $432 million came from the 1½-cent gasoline tax The current regular Federal-aid authorizations amount to $450 million, which is less than half of the amount received from Federal excise taxes and only slightly in excess of the Federal gasoline-tax earnings It would be imprudent, therefore, in devising a financial plan for partial support of an arterial facility or system out of Federal funds, to make calculations based on the total earnings of Federal motor-vehicle excise taxes It is reasonable, however, to base such calculations on the current Federal authorizations.

It is also true that revenues other than those of the State and Federal governments may be available for arterial improvements, particularly in cities. Where this is the case, the availability of such revenues should be taken into account in making the financial

vention Group Meetings, Papers and Discussions, Salt Lake City, Utah, 1948," American Association of State Highway Officials, 1949.

plans, although it is doubtful that such funds would be subject to pro rating in proportion to traffic volumes.

In most instances it would probably be unwise as well as unnecessary to pledge the tax earnings of a specific facility—such as a given expressway route—to the service of bonds specifically issued to finance its construction. Such a procedure might have publicity value with respect to the construction of a major transstate route, but it would have no particular legal or security significance. If general obligation bonds are issued, the full faith and credit of the State is a sufficient pledge. The further pledging of road-user tax earnings or revenues is, in effect, a direction that certain funds shall be used for debt service, rather than a security pledge to the bondholders. Perhaps the most sensible policy would be to make a financial plan for an entire arterial system, such as the rural and urban sections of the Interstate Highway System within a State; and then to provide by law that amounts equal to the predicted road-user tax earnings of the system, or such portion thereof as may be needed, shall be set aside each year for debt service on the bonds. As a matter of fact, the plan must provide for the entire support of the system, including maintenance, operation, and replacement, whether or not the calculated revenue earnings are sufficient for this purpose. This consideration points to the fact that it is of more significance to determine what earnings of a system must be—and thus what the rates of taxation must be—in order to provide for its support, than it is simply to say that the earnings at existing rates shall be dedicated to that purpose.

CHARACTERISTICS OF NEEDED IMPROVEMENTS ON THE INTERSTATE SYSTEM

The recent publication of the report, "Highway Needs of the National Defense," describing the requirements for improvement of the National System of Interstate Highways and the estimated costs of meeting them, has focused attention on the problem of arterial road financing There are many other routes of major importance, particularly in the populous and highly industrialized States. The Interstate System, however, is so well known and constitutes so clearly an integrated system of arterial routes that a study of the facts relating to its improvement needs and the problems of financing them may well serve to illustrate the corresponding problems of other arterial programs.

The determination of needs and the costs of proposed improvements on the Interstate Highway System was a cooperative Federal-State effort, the general outlines of which were agreed upon by the Bureau of Public Roads and a committee appointed by the American Association of State Highway Officials. The State Highway Departments were asked to determine, for each section of the Interstate System, rural and urban, the extent and character of the improvement needed to make it adequate to serve its potential 1948 traffic volume, and to estimate the cost of such an improvement at 1948 prices. The standards agreed upon for making these estimates were substantially the same as those adopted by the Association in 1945, to govern the design of highways included in the Interstate System The compiled results of this study indicate that the total cost of proposed improvements would, at 1948 price levels, amount to $11,266 million.

Reported improvement needs on the 33,638 miles of rural Interstate highways amount to $5,973 million; for the projected urban system of 3,521 miles the total is $5,293 million. For the average State these estimated needs indicate a program of $124 million for rural improvements and $108 million for urban work. Although the character of the deficiencies and the costs of eliminating them vary widely from State to State, it is necessary here to confine the discussion to the Nation-wide totals, and to visualize the problem in terms of a single program of arterial highway improvement. Some facts about these needed improvements and their costs are set forth in the first few tables and figures

Tables 1 to 6 give Nation-wide summaries of costs of needed improvements, costs per mile, and percentage distribution of costs. Table 1 gives a classified summary of the costs of needed improvements insofar as they could be subjected to classification. The total accounted for in this summary is $11,212 million, or 99.5 percent of the grand total of $11,266 million This total, however, is not fully classified because not all States submitted figures susceptible of division into the two-way classification, (a) by type of improvement, and (b) by

cost element, which formed the scheme of analysis.

Needed improvements were classified by type into relocation, reconstruction, and classification With respect to type of improvement, relocation accounts for the greatest share of the cost On rural sections, the relocation of 9,716 mi. of road is estimated to cost

TABLE 1

NATIONAL SYSTEM OF INTERSTATE HIGHWAYS SUMMARY OF REPORTED IMPROVEMENT NEEDS BY TYPES OF IMPROVEMENT AND BY ELEMENTS OF COST

Item	Dimension	Type of Improvement Required			Total, Classified by Type of Improvement	Unclassified by Type of Improvement[a]	Total Requiring Immediate Improvement	Adequate, No Immediate Improvement Required	Grand Total
		Relocation	Reconstruction	Widening					
Rural Sections									
Total mileage	Miles	9,716 4	13,403 4	7,825 2	30,945 0	906 0	31,851 0	1,787 0	33,638.0
Classified mileage[a]	Miles	8,994 5	11,895 8	7,810 6	28,700 9		28,700 9		
Average daily traffic	Veh per day	4,505	2,870	2,848	3,378	4,525	3,410	4,193	3,452
Vehicle-miles per day	Thousand	43,769	38,462	22,286	104,517	4,100	108,617	7,493	116,110
Vehicle-miles per year	Million	15,976	14,039	8,134	38,149	1,496	39,645	2,735	42,380
Elements of cost	$1,000								
Construction [a]									
Grading		854,161	604,435	169,370	1,627,966		1,627,966		1,627,966
Surfacing		822,531	621,931	227,571	1,672,033		1,672,033		1,672,033
Structures		700,398	327,722	175,789	1,203,909		1,203,909		1,203,909
Unclassified		314,353	279,794	2,325	596,472	113,809	710,281		710,281
Total		2,691,443	1,833,882	575,055	5,100,380	113,809	5,214,189		5,214,189
Right-of-way		356,058	233,427	94,638	684,123	25,425	709,548		709,548
Total cost		3,047,501	2,067,309	669,693	5,784,503	139,234	5,923,737		5,923,737
Urban Section									
Total mileage	Miles	1,887 6	815 7	366 8	3,070 1	159 4	3,229 5	291 4	3,520.9
Classified mileage[a]	Miles	1,730 9	768 1	366 4	2,865 4		2,865 4		
Average daily traffic	Veh per day	17,988	11,140	10,465	15,270	13,434	15,179	17,326	15,357
Vehicle-miles per day	Thousand	33,953	9,087	3,839	46,879	2,141	49,020	5,049	54,069
Vehicle-miles per year	Million	12,393	3,317	1,401	17,111	781	17,892	1,843	19,735
Elements of cost	$1,000								
Construction [a]									
Grading		650,340	145,993	27,369	823,702		823,702		823,702
Surfacing		437,686	141,968	25,923	605,577		605,577		605,577
Structures		1,400,983	207,002	118,134	1,726,119		1,726,119		1,726,119
Unclassified		282,646	154,570	2,100	439,316	138,191	577,507		577,507
Total		2,771,655	649,533	173,526	3,594,714	138,191	3,732,905		3,732,905
Right-of-way		1,190,812	213,249	38,956	1,443,017	112,013	1,555,030		1,555,030
Total cost		3,962,467	862,782	212,482	5,037,731	250,204	5,287,935		5,287,935
Summary, All Sections									
Total mileage	Miles	11,604 0	14,219 1	8,192 0	34,015 1	1,065 4	35,080 5	2,078 4	37,158 9
Vehicle-miles per year	Million	28,369	17,356	9,535	55,260	2,277	57,537	4,578	62,115
Elements of cost	$1,000								
Construction ..		5,463,098	2,483,415	748,581	8,695,094	252,000	8,947,094		8,947,094
Right-of-way ..		1,546,870	446,676	133,594	2,127,140	137,438	2,264,578		2,264,578
Total		7,009,968	2,930,091	882,175	10,822,234	389,438	11,211,672		11,211,672

[a] The classification of construction needs was incomplete in three States One failed to segregate reconstruction costs from relocation costs, another failed to segregate relocation, reconstruction and structures, the third failed to classify with respect to either types of improvment or elements of construction cost The amounts entered against the items "Grading," "Surfacing," and "Structures" are the totals for the 45 States and District of Columbia which reported a complete classification of improvement needs with respect to types of improvement and elements of cost Additional cost items are shown as "Unclassified"

widening. The major cost elements are right-of-way and construction, the latter being subdivided into grading, surfacing, and structures. Figure 1 gives in bar-diagram form a summary of the costs of proposed improvements to the extent that they are subject to this double

$3,048 million. Reconstruction, a less expensive effort, is required on 13,403 mi. at a cost of $2,067 million. A total of 7,825 mi. will have to be widened at a cost of $670 million. Nine hundred six miles, costing $139 million were unclassified with respect to type of improve-

ment. On the rural sections costs of right-of way account for $710 million; grading $1,628 million, surfacing $1,672 million, and structures $1,204 million, with $710 million in construction costs unclassified with respect to cost element.

Out of 3,521 mi. of urban sections, 1,888 mi are estimated to require relocation, at a cost of $3,962 million The reconstruction of 816 mi in cities will cost $863 million, and the widening of 367 mi will cost $213 million. The acquisition of expensive right-of-way in cities presents a bill of $1,555 million, as against

day; and the sections requiring widening had an average of 2,848 vehicles per day. A similar comparison for the urban sections gives the following figures:

	Miles Needing Improvement	Vehicles per Day
Relocation	1,888	17,988
Reconstruction	816	11,140
Widening	367	10,465

These relationships are not surprising, but they do serve to emphasize the urgency of the arterial highway problem. To a large extent

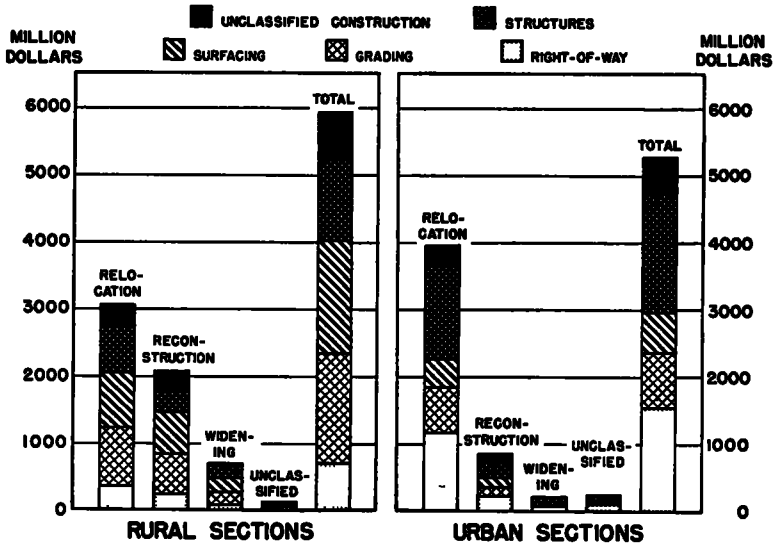

Figure 1. Distribution of Costs of Needed Improvements on the Interstate System

$824 million for grading, $606 million for surfacing, and $1,726 million for structures. The extremely high expenditures required for right-of-way and structures are features of the urban program which contrast noticeably with the cost requirements of the rural sections.

Table 1 also gives, for each type of improvement (relocation, reconstruction, and widening) the daily and annual vehicle-miles and the average daily traffic on the sections needing improvement, these values referring to the potential 1948 traffic had the sections been improved to standard The 9,716 mi. of rural roads proposed for relocation had a potential average 1948 traffic of 4,505 vehicles per day On the 13,403 mi. proposed for reconstruction the corresponding value was 2,870 vehicles per

those facilities that carry the heaviest traffic are to the greatest degree substandard, and demand the most drastic and expensive treatment.

A similarly classified summary of costs per mile is given in Table 2, and illustrated in Figure 2. The great contrast in costs per mile between rural and urban sections is readily apparent. As would be expected, relocation is by far the most costly type of improvement on both rural and urban sections. Since a relocation constitutes a complete new job of work, the breakdown of average costs per mile on relocation projects is of perhaps more significance than in the case of reconstruction and widening. The average cost per mile of all proposed rural relocation projects is

$314,000 of which $277,000 is accounted for by construction costs and $37,000 by the acquisition of right-of-way The average for fully classified construction costs is $264,000, this total being made up of $95,000 in grading, $91,000 in surfacing, and $78,000 in the cost of structures. It should be noted that the costs per mile of structures as given in Table 2 represent the average cost of structures per mile of road improvement of the given type.

On urban sections, the average cost per mile of proposed relocation projects is $2,099,000, of which $1,468,000 is required for construction, and $631,000 for right-of-way. The average cost of fully classified construction on urban relocation projects is $1,438,000, of which $376,000 is required for grading, $253,000 for surfacing, and $809,000 for structures.

The average cost per mile of needed recon-

TABLE 2

NATIONAL SYSTEM OF INTERSTATE HIGHWAYS: COSTS PER MILE OF REPORTED IMPROVEMENT NEEDS, CLASSIFIED BY TYPES OF IMPROVEMENT AND BY ELEMENTS OF COST

Item	Type of Improvement Required			All Types of Improvement	Unclassified by Type of Improvement	Total Requiring Immediate Improvement	Adequate—No Immediate Improvement Required	All Mileage and Costs[1]
	Relocation	Reconstruction	Widening					
Rural Sections								
Total mileage	9,716 4	13,403 4	7,825 2	30,945 0	906 0	31,851 0	1,787 0	33,638.0
Classified mileage[a]	8,994 5	11,895 8	7,809.9	28,700 2		28,700 2		
Unclassified mileage[a]	721 9	1,507 6	15 8	2,244 8	906 0	3,150.8		
Costs per mile								
Construction [a]								
Grading	$94,965	$50,811	$21,687	$56,723		$56,723		
Surfacing	91,448	52,282	29,139	58,258		58,258		
Structure[b]	77,870	27,549	22,508	41,948		41,948		
Total classified	264,283	130,642	73,334	156,929		156,929		
Unclassified	435,452	185,589	151,961	265,713	125,617	225,429		
All construction	277,000	136,822	73,488	164,821	125,617	163,706		
Right-of-way	36,645	17,416	12,094	22,108	28,063	22,277		
All costs	313,645	154,238	85,582	186,929	153,680	185,983		$176,103
Urban Sections								
Total mileage	1,887 6	815 7	366 8	3,070 1	159 4	3,229 5	291 4	3,520 9
Classified mileage[a]	1,730 9	768 1	366 4	2,865 4		2,865 4		
Unclassified mileage[a]	156 7	47 6	.4	204 7	159 4	364 1		
Costs per mile.								
Construction:[a]								
Grading	$375,723	$190,070	$74,697	287,465		$287,465		
Surfacing	252,866	184,830	70,751	211,341		211,341		
Structures[b]	809,396	269,499	322,418	602,401		607,683		
Total classified	1,437,985	644,399	467,866	1,101,207		1,106,489		
Unclassified	1,803,740	3,247,269	5,250,000	2,146,146	866,945	1,586,122		
All construction	1,468,349	796,289	473,081	1,170,878	866,945	1,155,877		
Right-of-way	630,860	261,431	106,205	470,023	702,716	481,508		
All costs	2,099,209	1,057,720	579,286	1,640,901	1,569,661	1,637,385		$1,501,870
Summary, All Sections								
Total mileage	11,604 0	14,219 1	8,192 0	34,015 1	1,065 4	35,080 5	2,078 4	37,158 9
Costs per mile								
Construction	$470,794	$174,653	$91,379	$255,625	$236,531	$255,044		
Right-of-way	133,305	31,414	16,308	62,535	129,001	64,554		
Total	604,099	206,067	107,687	318,160	365,532	319,598		$301,722

[a] See Table 1, footnote a The amounts entered against the items "Grading," "Surfacing," and "Structures" are the average costs per mile for the 45 States and District of Columbia which reported a complete classification of improvement needs with respect to types of improvement and elements of cost. The "unclassified" costs are naturally erratic, but have relatively little effect on the total costs per mile.

[b] The amounts entered against this item are to be interpreted as the average costs of structures per mile of road improvement of the given type

struction projects is $154,000 on rural sections, and $1,058,000 on urban sections. Indicated costs of widening projects are $86,000 per mile on rural sections and $579,000 per mile on urban sections.

It should be recognized that the costs per mile given in Table 2 are stated in terms of 1948 prices, which were more than twice those of the prewar period, 1937 to 1941. There is reason to believe that average costs over a long-range construction period would be very materially below the 1948 level.

Table 3 gives the percentage distribution of costs of needed improvements by elements of cost, i.e., grading, surfacing, structures and

costs of needed improvements by type of improvement, i e., relocation, reconstruction, and widening There is a further subdivision as between construction and right-of-way. As in Table 3, two percentage distributions are given, one which includes the unclassified items and one which includes the classified items only. Classified construction costs on rural sections divide 53 percent to relocation, 36 percent to reconstruction, and 11 percent to widening. The distribution of right-of-way costs is not dissimilar, with the result that the distribution of total costs is approximately the same as that of construction costs. In urban sections relocation takes by far the

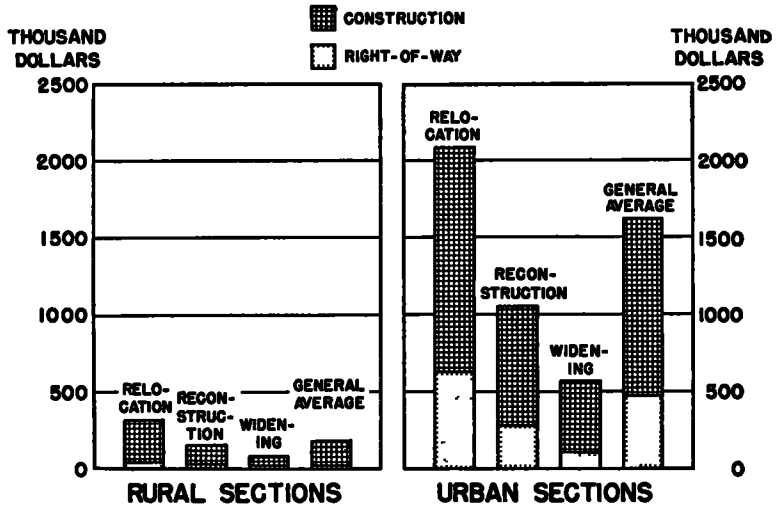

Figure 2. Average costs Per Mile by Types of Needed Improvements on the Interstate System

right-of-way. The percentages of unclassified items are also given. Under the heading for each improvement type there are two columns, one giving the percentage distribution of all items, and the other giving that of classified construction items only. For example, it is found that on fully classified rural relocation projects, 36 percent of the cost is required for grading, 35 percent for surfacing, and 29 percent for structures. The corresponding distribution for urban relocation projects gives 26 percent for grading, 18 percent for surfacing and 56 percent for structures This distribution emphasizes the extremely high costs frequently incurred for structures in building urban expressways

Table 4 gives the percentage distribution of

lion's share of the cost, absorbing 77 percent of the construction cost as against 18 percent for reconstruction, and only 5 percent for widening Relocation on urban projects absorbs 83 percent of the costs of right-of-way. The division of total costs on urban projects allots 79 percent to relocation, 17 percent to reconstruction and 4 percent to widening.

Tables 5 and 6 were made up by distributing to the several cost elements and types of improvement the unclassified items which are accounted for separately in Tables 1 to 4. These tables, therefore, give approximate percentage distributions fully classified. Table 5 gives for the rural and urban sections separately the percentage distribution by cost elements and improvement types, with the

total cost of all improvements taken as the percentage base. Thus, it is shown that grading on rural relocation projects constitutes 17 percent of the total cost of all rural projects; and that structures on relocation projects right-of-way for 12 percent. On urban sections relocation will absorb 79 percent of the cost, reconstruction 17 percent, and widening 4 percent. By cost elements, the indicated distribution of urban costs allots 19 percent

TABLE 3
NATIONAL SYSTEM OF INTERSTATE HIGHWAYS PERCENTAGE DISTRIBUTION OF COSTS OF NEEDED IMPROVEMENTS, BY ELEMENTS OF COST

Item	Relocation		Reconstruction		Widening		Total Classified by Type of Improvement[a]		Total All Costs[a]	
	All Items	Construction Items Only	All Items	Construction Items Only	All Items	Construction Items Only	All Items	Construction Items Only	All Items	Construction Items Only
	%	%[b]	%	%[b]	%	%[b]	%	%[b]	%	%
Rural Sections										
Construction										
Grading	28 03	35 93	29 24	38 89	25 29	29 57	28.14	36 15		
Surfacing	26 99	34 60	30 08	40 02	33 98	39.74	28 91	37 12		
Structures	22 98	29 47	15 85	21 09	26 25	30 69	20 81	26 73		
Unclassified	10 32		13 54		35		10 31			
Total	88 32	100 00	88.71	100 00	85 87	100 00	88 17	100 00	88.02	
Right-of-way	11 68		11 29		14 13		11 83		11.98	
Total cost	100 00	[b]	100 00	[b]	100 00	[b]	100 00	[b]	100 00	
Urban Sections										
Construction:										
Grading	16 41	26 13	16 92	29 50	12 88	15 97	16 35	26 11		
Surfacing	11 05	17 58	16 45	28 68	12 20	15 12	12 02	19 19		
Structures	35 36	56 29	23 99	41 82	55 60	68 91	34 27	54 70		
Unclassified	7 13		17 92		99		8.72			
Total	69 95	100 00	75 28	100 00	81 67	100 00	71 36	100 00	70 59	
Right-of-way	30 05		24 72		18 33		28 64		29 41	
Total cost	100 00	[c]	100 00	[c]	100 00	[c]	100 00	[c]	100 00	
Summary, All Sections										
Rural construction	38 39	49 27	62 59	73 85	65 19	76 82	47 13	58 66	46 51	58 28
Rural right-of-way	5 08		7 96		10 73		6 32		6 33	
Total rural	43 47		70 55		75 92		53 45		52 84	
Urban construction	39 54	50 73	22 17	26 15	19 67	23 18	33 22	41 34	33 29	41.73
Urban right-of-way	16 99		7 28		4 41		13 33		13.87	
Total urban	56 53		29 45		24 08		46 55		47 16	
Total construction	77 93	100 00	84 76	100 00	84 86	100 00	80 35	100 00	79 80	100 00
Total right-of-way	22 07		15 24		15 14		19 65		20 20	
Total cost	100 00		100 00		100 00		100 00		100 00	

[a] See Table 1, footnote a
[b] In these two parts of the table the percentages listed in these columns refer to the classified items, grading, surfacing and structures
[c] In this part of the table the percentages listed in these columns refer to all items of construction, including those unclassified

consume 31 percent of all urban costs. The totals are perhaps the most significant items in this table. Those reading across indicate that on the rural sections 53 percent of the cost is accounted for by relocation, 36 percent by reconstruction, and over 11 percent by widening. Similarly, grading accounts for 32 per cent of the rural cost, surfacing for 33 percent, structures for 23 percent, and to grading, 14 percent to surfacing, 38 percent to structures, and 29 percent to right-of-way.

The most significant contrast between the cost requirements of the rural and urban sections lies in the fact that right-of-way and structures, which absorb only 35 percent of rural costs, account for nearly 68 percent of urban costs Surfacing comprises nearly 33 percent of the rural costs, but less than 14

percent of the urban costs. Very high initial costs are imposed on urban projects by the necessity to make expensive acquisitions of occupied land, and to provide for the separation and interchange of the traffic streams

Table 6 gives a similar percentage distribution with the total cost of all improvements, rural and urban, taken as the percentage base. The rural sections account for 53 percent of the cost and the urban sections 47 percent. Relocation absorbs 65 percent of all improvement costs, reconstruction 27 percent, and widening 8 percent. Of the greatest interest perhaps is the summary of cost distribution by cost elements, in which it is shown that grading accounts for 26 percent, surfacing for 24 percent, structures for 30 percent and right-of-way for 20 percent

For both rural and urban sections, and for the system as a whole, Figure 3 illustrates the percentage distribution of costs of needed improvements with respect to the major cost elements—right-of-way, grading, surfacing and structures.

ANNUAL AMORTIZATION CHARGES

The indicated distribution of costs of proposed improvements on the Interstate Highway System has a message for those who are inclined to become terrified at the magnitude of the program which is set forth in the report "Highway Needs of the National Defense" If we think in terms of the annual cost of owning and perpetuating a road system, we must reduce the indicated capital costs to terms of annual amortization costs over the predicted life of the investment. If again, we are thinking in terms of credit financing, it is of great importance to know, or to predict with reasonable accuracy, the life of the investment we

TABLE 4
NATIONAL SYSTEM OF INTERSTATE HIGHWAYS: PERCENTAGE DISTRIBUTION OF COSTS OF NEEDED IMPROVEMENTS, BY TYPE OF IMPROVEMENT

Item	Type of Improvement Required			Total Classified by Type of Improvement	Unclassified by Type of Improvement[a]	Total All Costs
	Relocation	Reconstruction	Widening			
	%	%	%	%	%	%
Rural Sections						
Construction						
All items	51 62	35 17	11 03	97 82	2 18	100 00
Classified items only	52 77	35 96	11 27	100 00		
Right-of-way						
All items	50 18	32 90	13 34	96 42	3 58	100 00
Classified items only	52 05	34 12	13 83	100 00		
Total cost						
All items	51 45	34 90	11 30	97 65	2 35	100 00
Classified items only	52 68	35 74	11 58	100 00		
Urban Sections						
Construction						
All items	74 25	17 40	4 65	96 30	3 70	100 00
Classified items only	77 10	18 07	4 83	100 00		
Right-of-way						
All items	76 58	13 71	2 51	92 80	7 20	100 00
Classified items only	82 52	14 78	2 70	100 00		
Total cost						
All items	74 93	16 32	4 02	95 27	4 73	100 00
Classified items only	78 65	17 13	4 22	100 00		
All Sections						
Construction						
All items	61 06	27 75	8 37	97 18	2 82	100 00
Classified items only	62 83	28 56	8 61	100 00		
Right-of-way						
All items	68 31	19 72	5 90	93 93	6 07	100 00
Classified items only	72 72	21 00	6 28	100 00		
Total cost						
All items	62 52	26 14	7.87	96 53	3 47	100 00
Classified items only	64 77	27 08	8 15	100 00		

[a] See Table 1, and footnote a thereof.

propose to finance, wholly or in part, by means of bond issues.

Unless a location is abandoned, costs of right-of-way and grading are not lost, whatever happens to the surfacing and structures. It is reasonable and prudent, therefore, to assign to these two cost elements an average investment life of 100 years. It is true that some of the cost of grading may be lost in regrading, but such losses are unlikely to be an important factor in high-type construction such as is contemplated for the Interstate Highway System.

TABLE 5
NATIONAL SYSTEM OF INTERSTATE HIGHWAYS: APPROXIMATE PERCENTAGE DISTRIBUTION OF COSTS OF NEEDED IMPROVEMENTS, WITH RESPECT TO TOTAL COSTS ON RURAL AND URBAN SYSTEMS, TAKEN SEPARATELY[a]

Item	Relocation	Reconstruction	Widening	Total
	%	%	%	%
Rural Sections				
Construction:				
Grading	16 69	12 31	2 93	31 93
Surfacing	16.07	12 67	3 94	32 68
Structures	13 69	6.67	3 05	23 41
Total	46 45	31 65	9 92	88.02
Right-of-way	6 23	4.09	1 66	11.98
Total cost	52 68	35 74	11 58	100 00
Urban Sections				
Construction:				
Grading	14 22	3 76	55	18 53
Surfacing	9 57	3 66	51	13 74
Structures	30 64	5 33	2 35	38 32
Total	54 43	12 75	3 41	70 59
Right-of-way	24 27	4 35	.79	29 41
Total cost	78 70	17 10	4 20	100.00

[a] Based on pro-rata distribution, to the several cost elements and types of improvement, of the unclassified items shown in Tables 1 to 4

It would be possible to select a predicted average investment life for each item listed in Table 6, i.e , grading on relocation, grading on reconstruction, surfacing on relocation, etc , and to further subdivide as between rural and urban facilities. Because much speculation would be involved in such a procedure, the much more simple method has been adopted of assigning for purposes of illustration in this paper a predicted average investment life to each of the several elements of cost, regardless of type of improvement. This assignment is as follows:

Cost Element	Years
Right-of-way	100
Grading	100
Surfacing	30
Structures	50

The assignment of a 100-yr. life to right-of-way and grading has been discussed. The selection of 30 yr. for surfacing and 50 yr. for structures was made in the light of experience as indicated by road-life studies of past construction It should be borne in mind that facilities constructed according to the standards set for the Interstate Highway System are not likely to suffer obsolescence to anywhere near the degree that has occurred with respect to past construction on State highway systems generally. Although the values of

TABLE 6
NATIONAL SYSTEM OF INTERSTATE HIGHWAYS: APPROXIMATE PERCENTAGE DISTRIBUTION OF COSTS OF NEEDED IMPROVEMENTS, WITH RESPECT TO TOTAL COSTS ON RURAL AND URBAN SECTIONS COMBINED[a]

Item	Relocation	Reconstruction	Widening	Total
	%	%	%	%
Rural Sections				
Construction:				
Grading	8.85	6.53	1.55	16.93
Surfacing	8.52	6.72	2.09	17.33
Structures	7 26	3.53	1.62	12.41
Total	24 63	16 78	5 26	46.67
Right-of-way	3 30	2.17	.88	6.35
Total cost	27.93	18.95	6 14	53.02
Urban Sections				
Construction:				
Grading	6.68	1.76	26	8.70
Surfacing	4 49	1.72	.24	6 45
Structures	14.40	2.51	1.10	18.01
Total	25 57	5 99	1 60	33.16
Right-of way	11.41	2 04	37	13.82
Total cost	36 98	8 03	1.97	46 98
All Sections				
Construction				
Grading	15 53	8 29	1 81	25 63
Surfacing	13 01	8 44	2 33	23.78
Structures	21 66	6 04	2 72	30 42
Total	50 20	22 77	6 86	79 83
Right-of-way	14.71	4.21	1 25	20 17
Total cost	64 91	26 98	8 11	100 00

[a] Evaluated by application of percentages given in Table 5 to total cost of needed improvements on rural sections, $5,972,900,000, and on urban sections $5,293,500,as given in report "Highway Needs of the National Defense," Table 1, p 54

average investment life given above are used solely for purposes of illustration, it is believed that they are reasonable and prudent.

In Table 7 there is given a calculation of the annual amortization charges on proposed improvements of the Interstate Highway System, calculated on the basis of the average investment lives listed above. For the rural and urban sections separately, and for all sections, the percentage distributions by cost elements given in Tables 5 and 6 are applied to the total cost of proposed improvements as given in Table 1 page 54, of the report, "Highway Needs of the National Defense" Division by the average investment life of each cost element gives the annual amortization charges relating to that element and these are added

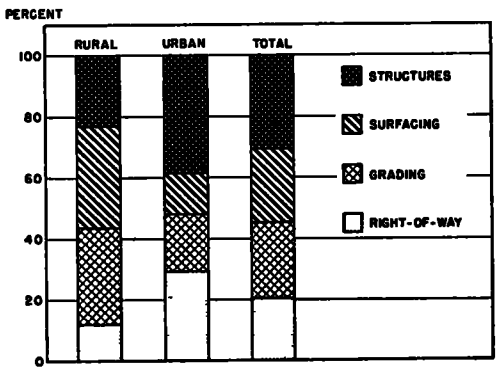

Figure 3. Approximate Percentage Distribution of Elements of Cost of Needed Improvements on the Interstate System

to the totals. It will be observed that the annual charge for the rural sections is $119 million, and that for the urban sections is $90 million, making a total of $209 million for the entire system Annual amortization costs per mile of road on this basis are $3,545 for the rural sections, $25,615 for the urban sections, and an average of $5,636 for the entire system This calculation indicates an average investment life of 50 yr for the rural sections, 58 yr for the urban sections, and 54 yr for the entire system

In order to obtain at least a rough idea of the annual amortization costs per mile of travel, it was assumed that the average travel on the Interstate System over a 20-yr. period would be 20 percent above the 1948 estimate of potential travel on the system In the report "Highway Needs of the National Defense" it was estimated that, if the system had been in the desired state of improvement in 1948, the rural sections would have carried 42,380 million vehicle-miles and the urban sections 19,735 million vehicle-miles, the total for the system being 62,115 million. This amount was considerably in excess of the estimate of actual travel on designated Interstate Highways in 1948, which was 54,705 million vehicle-miles. The calculation of amortization charges assumes the existence of the improved system at the beginning of the period. It is, therefore, not unreasonable to assume an average, over a 20-yr period, 20 percent above the 1948 potential traffic Application of this procedure indicates that on rural sections the annual amortization costs per vehicle-mile of travel would be 2 345 mills; that on the urban system would be 3.808 mills; and the average for the entire system would be 2 810 mills. These figures tend to indicate that the cost of owning an improved Interstate System is not likely to be prohibitive.

Lest undue optimism be aroused, it should be pointed out that Table 7 gives only the amortization cost of the capital investment over its life span. Items omitted from the calculation are as follows: (1) the annual interest charge which would be present if the cost were financed out of borrowed funds; (2) costs of maintenance and operation, including a pro rata of administrative costs; and (3) amortization of the prior investment in existing highways now on the Interstate System. The purpose of the calculation set forth in Table 7 is to put the magnitude of the capital costs for proposed improvements of the Interstate System into proper perspective and to suggest that it will not be beyond the reach of the American pocketbook to own such a system

Figure 4 gives in bar-diagram form the amortization costs per mile and per vehicle-mile for the rural and urban sections and for the system as a whole

ANNUAL EXPENDITURE REQUIREMENTS

In order to gain a more practical idea of the cost and revenue requirements involved in the proposed improvement of the Interstate Highway System, it is necessary to think in terms of a definite program and a definite

program period. What would it cost us each year if we were to spread the accomplishment of the proposed improvements over a period of 20 years? How much would the annual bill increase if we were to reduce the program to 15 or 12 years? Again, how would our revenue requirements be affected by the alternate choice of current revenue financing or credit financing? If we should adopt a bond-issue program, we would expect to accelerate the accomplishment, and therefore would reduce

tained. The results of these calculations may serve as indicators of the annual revenue requirements for current-revenue financing of the Interstate program over the three different program periods.

Certain initial steps are required in such a calculation. It is first necessary to add to the stated costs of needed improvements, amounting to $11,266 million, allowances for stop-gap improvements and replacements occurring over the duration of the program period.

TABLE 7

ILLUSTRATIVE CALCULATION OF ANNUAL AMORTIZATION CHARGES ON PROPOSED IMPROVEMENTS OF THE INTERSTATE HIGHWAY SYSTEM, AND CORRESPONDING COSTS PER MILE AND PER MILE OF TRAVEL

Item	Cost of Needed Improvements at 1948 Prices		Estimated Average Life of Investment	Annual Amortization Cost	Miles in System	Amortization Cost per Mile of Road	Estimated Average Annual Travel over a 20-yr Period[a]	Amortization Cost per Vehicle-Mile of Travel
	Percentage	Amount						
		thousand dollars	*years*	*thousand dollars*		*$*	*million vehicle miles*	*mills*
Rural Sections								
Right-of-way	11 98	715,600	100	7,156				
Grading	31,93	1,907,100	100	19,071				
Surfacing	32,68	1,951,900	30	65,063				
Structures	23 41	1,398 300	50	27,966				
Total	100 00	5,972,900	(50)	119,256	33,638	3,545	50,856	2 345
Urban Sections								
Right-of-way	29 41	1,556,800	100	15,568				
Grading	18 53	980,900	100	9,809				
Surfacing	13 74	727,300	30	24,243				
Structures	38 32	2,028,500	50	40,570				
Total	100 00	5,293,500	(58)	90,190	3,521	25,615	23,682	3 808
All Sections								
Right-of-way	20 17	2,272 400	100	22,724				
Grading	25 63	2,888,000	100	28,880				
Surfacing	23 78	2,679,200	30	89 306				
Structures	30 42	3,426,800	50	68,536				
Total	100 00	11,266,400	(54)	209,446	37,159	5,636	74,538	2 810

[a] The report "Highway Needs of the National Defense," previously cited, indicates 42,380 million rural and 19,735 urban vehicle-miles as the potential 1948 travel on the system, had it been improved to the desired standards The above calculation assumes that average travel over the 20-yr period would be 20 percent above the 1948 estimate of potential travel.

the program period to 10 years, 8 years, or even less. The outlay of revenue would be reduced, since the capital costs would be defrayed out of bond issues, but the payment of debt service would carry on far beyond the program period.

As a first step in the attempt to answer some of these questions, Table 8 gives an illustrative calculation of the average annual expenditure requirements for 12-, 15-, and 20-yr. programs, respectively, under which the proposed improvements would be put into effect and the system operated and maintained. Some roads, scheduled for improvement late in the program period, will require minor treatment at an early date, in order to preserve them in operable condition. Other roads, not scheduled today as needing improvement, will necessarily come up for replacement during the course of a 12-, 15-, or 20-yr. program. The longer the period lasts, the greater will be such expenditures. Procedures for estimating stop-gap improvements and replacements have been established in the highway-needs studies conducted by numerous States; and a similar procedure, although a necessarily

speculative one, was adopted in this case. This adjustment increases the respective cost estimates to $12,060 million for the 12-yr. program, $12,415 million for the 15-yr. program, and $13,108 million for the 20-yr. program.

The costs of proposed improvements on the Interstate System are expressed in terms of 1948 prices The experience of recent months indicates the probability of a considerable reduction of unit prices in the highway field during the next few years. It is necessary, therefore, to reduce the costs expressed in 1948 prices to a predicted price level structure. This adjustment was made on the basis of an assumed price structure declining from the 1948 high of 209.3 percent of prewar prices (1937 to 1941) to a stabilized value of 150 percent in 1953. There may be some disposition to question this predicted price-level structure on the ground of undue optimism. Such predictions are highly uncertain, although there is reason to believe that, whatever the course of general prices, better competitive conditions and improvements in road-building equipment will result in more than proportionate reductions of unit costs in the highway field.

The capital costs adjusted to the predicted average price levels of the three program periods amount to $9,154 million for the 12-yr. program, $9,311 million for the 15-yr. program, and $9,713 million for the 20-yr. program. Reduced to annual charges, these figures become $763 million, $621 million, and $486 million respectively.

Estimates of maintenance costs are rather speculative. The values used were $2,000 per mi. for rural sections, and $4,000 per mi. for urban sections, at the average price level of the 15-yr. period. These unit values should be liberal enough to allow for cost of operation and policing, and a pro rata of administration. On this basis, the annual required expenditures for maintenance and operation amounts to $81 million, $67 million on the rural sections and $14 million on the urban sections, with minor changes for the 12- and 20-yr periods. With these costs added, total annual expenditure requirements amount to $845 million for the 12-yr program, $702 million for the 15-yr program, and $566 million for the 20-yr program. For the 15-yr. program, expenditure requirements on the rural system are $396 million, and on the urban system $306 million. If these programs were

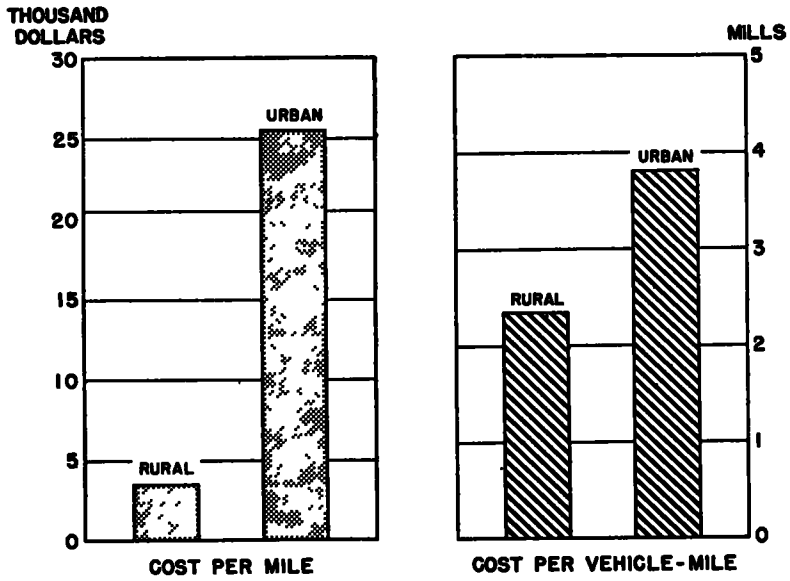

Figure 4. Annual Amortization Charges on Proposed Improvements of the Interstate System, Based on Assumed Average Investment Lives of Cost Elements

TABLE 8

ILLUSTRATIVE CALCULATION OF AVERAGE ANNUAL EXPENDITURE REQUIREMENTS FOR IMPROVEMENT AND MAINTENANCE OF INTERSTATE HIGHWAY SYSTEM, UNDER CONDITIONS OF 12-, 15-, AND 20-YR IMPROVEMENT PROGRAMS, RESPECTIVELY[a]

Item	12-Yr Program	15-Yr Program	20-Yr Program	Percentage Distribution, Rural and Urban
	million dollars	*million dollars*	*million dollars*	
Capital costs at 1948 prices:				
Immediate needs as found in study.				
Rural	5,973	5,973	5,973	53 02
Urban	5,293	5,293	5,293	46 98
Total	11,266	11,266	11,266	100 00
Additional needs, stopgap and replacement	794	1,149	1,842	
Adjusted total	12,060	12,415	13,108	
Capital costs adjusted to predicted average price level of program period[b]	9,154	9,311	9,713	
Average annual expenditure requirements.[b]				
Capital outlay.				
Rural	405	329	258	53 02
Urban	358	292	228	46 98
Total	763	621	486	100 00
Maintenance and operation[c]				
Rural	68	67	66	82 69
Urban	14	14	14	17 31
Total	82	81	80	100 00
Total expenditure requirements·				
Rural	473	396	324	56 41[d]
Urban	372	306	242	43 59[d]
Total	845	702	566	100 00
Estimated average annual travel during program period in million-vehicle-miles[e]				
Rural	46,618	47,678	48,737	68 23
Urban	21,708	22,202	22,695	31.77
Total	68,326	69,880	71,432	100 00
Estimated average annual expenditure per mile of travel				
Rural	$0 0101	$0 0083	$0 0066	
Urban	0171	0138	.0107	
Total	0124	0100	0079	
Estimated average annual expenditure per mile of road or street, in $1,000				
Rural (33,638 miles)	14	12	10	
Urban (3,521 miles)	106	87	69	
Total (37,159 miles)	23	19	15	

[a] A similar calculation is given in Table 10b of the Preliminary Report of the Special Subcommittee for Study of Highway Finance Problems, American Association of State Highway Officials, September 1949 Review of the data indicated the desirability of a number of minor changes which are emodied in the above calculation

[b] Values given are based on the assumption of a price structure declining from the 1948 high of 209 3 percent of prewar (1937 to 1941) to a stabilized value of 150 percent in 1953.

to be financed out of current revenues the expenditure requirements given in Table 8 could be taken to represent the average annual requirements for revenues to support the improvement program.

In order to put these estimates into terms of annual expenditure (or revenue) requirements per vehicle-mile of travel, it was necessary to estimate what the average annual volumes of travel on the Interstate System would be during the course of each of the three indicated program periods The problem is somewhat different from that of calculating the annual amortization charges per vehicle-mile, which assumes existence of the improved system at the beginning of the amortization period.

During a given program period, the Interstate System will be in a process of transition from the existing state of inadequate improvement to the proposed state of adequate improvement. Since the system as existing in 1948 carried considerably less traffic than the estimated potential 1948 traffic, we should not be unduly optimistic in estimating what the travel volumes would be during the interim conditions of the three program periods. For purposes of illustration, values of the average travel volumes were taken as 110, 112 5 and 115 percent of the potential traffic in 1948 (42,380 million rural and 19,735 million urban) Calculations on this basis indicate that the 12-yr. program could be financed out of current revenues by an annual expenditure of 12.4 mills per vehicle-mile of travel. The 15 yr. program could be financed at 10 mills, or one cent, per vehicle-mile, and the 20-yr. program could be supported by an annual expenditure of 7.9 mills per mile of travel. For the 15-yr. period, expenditures on the rural system would be 8.3 mills per mile of travel and on the urban system 13 8 mills.

Annual required expenditures per mile of road or street were also calculated. For the system as a whole, the 12-yr. program would

[c] The estimates of costs of maintenance and operation were based on assumed average costs, at the average price level of the 15-yr program period, of $2,000 per mi. on the rural sections and $4,000 per mi on the urban sections

[d] Values given are for the 15-yr. program period. The rural percentages for the 12- and 20-yr. program periods are 55.98 and 57 24 percent, respectively.

[e] For the 12-, 15-, and 20-yr program periods, respectively, values were taken as 110, 112.5, and 115 percent of the potential travel in 1948 (42,380 million rural and 19,735 million urban).

require an annual expenditure of $23,000 per mi. The 15-yr. program would require $19,000, and the 20-yr. program $15,000. The 15-yr. program would require an average expenditure on the rural sections of $12,000 per mi., and on the urban sections an expenditure of $87,000 per mi.

The annual expenditure requirements of the 15-yr. program period are illustrated in Figure 5. The actual amounts are shown in the left-hand panel, and required expenditures lper vehicle-mile of travel in the right-hand panel.

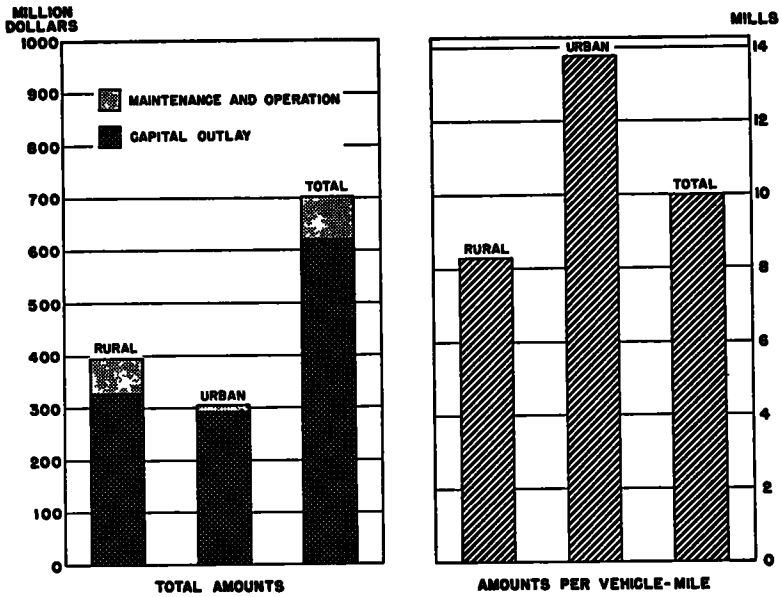

Figure 5. Estimated Annual Expenditure Requirements for a 15-Yr. Program of Improvement of the Interstate System

THE INTERSTATE SYSTEM REQUIREMENTS IN RELATION TO CURRENT MOTOR-VEHICLE TAX PAYMENTS AND HIGHWAY EXPENDITURES

The estimated total travel of motor vehicles in the United States in 1948 was 397.6 billion vehicle-miles The amount of State road-user taxes paid was $2,105 million, or about 5.3 mills per mile of travel If the Federal excise tax payments of 1,151 million dollars are added it is found that State and Federal motor-vehicle tax payments in 1948 amounted to approximately 8.2 mills per mile of travel.[6] These values may be compared with the estimated annual revenue requirements of the Interstate Highway System, shown in Table 8 to be 12.4 mills per mile of travel for the 12-yr. program, 10.0 mills for the 15-yr program, and 7.9 mills for the 20-yr. program. It is evident that the current scale of special motor-vehicle tax payments is within the range of indicated needs for support of the Interstate System program.

It is perhaps more appropriate to make a comparison with actual highway expenditures in 1948, since, on the one hand, not all special motor-vehicle taxes are used for highway purposes, and on the other hand, motor-vehicle taxes do not supply all of the funds used for the support of highways. Estimated expenditures on all roads and streets in 1948 were $3,142 million, or 7 9 mills per vehicle-mile of travel[7] The indication of this comparison

[6] See Public Roads tables VM-1, "Classified Estimate of Travel by Motor Vehicles in the United States in the Calendar Year 1948," DF, "Disposition of Receipts from State Imposts on Highway Users—1948," and E-4, "Estimated Amounts of Federal Motor-Vehicle Taxes Paid by Highway Users—1948"

[7] See "Preliminary Report of Special Subcommittee for Study of Highway Finance Problems," American Association of State Highway Officials, September 1949 (mimeographed), Table 1B, Part III.

is that, if we were to be satisfied with the slow progress of a 20-yr program, the proposed improvements of the Interstate System could be financed out of current revenues at the scale of expenditures prevailing in 1948—provided that expenditures were directed to the Interstate system in proportion to the traffic volumes occurring on it.

It is obvious that this condition is not being met today. In his recent address[8] before the American Society of Civil Engineers, Commissioner MacDonald pointed out that, out of the primary and urban funds authorized by the Federal-aid Highway Acts of 1944 and 1948, $362 million had been assigned by the end of September 1949, to programmed projects on the Interstate System, having an estimated total cost of $793 million. This is a creditable achievement; but it represents progress to date of a program that began in 1944. Table 8 indicates that a 20-yr. program of improvement of the Interstate System would require capital outlays of $486 million *per year*. Such a program would only give us, at the end of 20 years, an Interstate System adequate for its potential traffic in 1948 If the program were accelerated to completion in 12 years, annual capital outlays of $763 million, or 12 4 mills per vehicle-mile, would be required.

The indicated requirements for improvement of the Interstate System are by no means out of line with the estimated needs of other highway systems. Students of the subject have estimated that annual expenditures of

Annual Expenditure Requirements

	Amount	Amount per Vehicle-Mile of travel
	million dollars	*dollars*
Primary rural roads	1,660	0 0093
Secondary and local	1,228	0219
City streets	1,525	0065
Total	4,413	0094

$4 to $4.5 billion would be required to bring all roads and streets to a condition of adequacy within a reasonable period of years. One such estimate, prepared in the Bureau of Public Roads, was set forth and discussed in the recent report of the AASHO Special Subcommittee for Study of Highway Finance Problems.[9] The estimate was made in terms of a 15-yr. program. Its findings are summarized above.

It will be observed that, according to this estimate, primary rural roads would require an annual expenditure, over a 15-yr. program period, of 9.3 mills per mile of travel on them. This value is materially greater than the 15-yr. program requirement of the rural sections of the Interstate System, shown in Table 8 to be 8 3 mills per vehicle-mile. The requirements of the urban sections of the Interstate System, 13.8 mills per vehicle-mile, are greater than those of primary rural highways, and very much greater than those of city streets as a whole. On the other hand the requirements of secondary and local rural roads, 21.9 mills per mile of travel, are far in excess of those of the other systems. This finding illustrates a tendency, often observed in the analysis of highway expenditures and costs, for light-traffic roads, of which the costs per mile are low, to have the highest costs per mile of travel.

Regardless of these comparisons among systems, it is evident that the Interstate Highway System is not alone in requiring outlays greatly in excess of those made in recent years. The annual requirement of $4,413 million, given above, is 40 percent greater than the 1948 expenditures on all roads and streets of $3,142 million It is of considerable importance, therefore, to determine the extent to which credit financing of major improvements may reduce the immediate requirements for increased revenue, while at the same time accelerating the rate of accomplishment

CHARACTERISTICS OF A BOND-ISSUE PROGRAM FOR IMPROVEMENT OF THE INTERSTATE HIGHWAY SYSTEM

The primary purpose of bond-issue financing is to provide for the accelerated completion of an improvement program. Limitations on the rate of progress are naturally set by the availability of contractors' organizations and road-building equipment, the rates of production of essential materials, the number of trained engineering personnel, the labor supply, and other factors. Considerations of prudence and economy may further limit the rate of accomplishment. For example, it may be

[8] "The National System of Interstate Highways," by Thomas H MacDonald, Commissioner of Public Roads, presented at the fall meeting of the American Society of Civil Engineers, Washington, D C , November 3, 1949.

[9] Op cit., Part III, Table 3B.

decided that certain highways, judged inadequate by the most modern standards but still reasonably satisfactory according to so-called tolerable standards, should be preserved in their present status of improvement for some years to come. Once the dimensions of the accelerated program have been fixed, however, the engineering and financial planning should be geared to a schedule of maximum production, in order that the benefits of the improved system may be realized by the public as soon as possible.

For purposes of illustration a bond-issue construction program period of 8 years has been selected, as one which would insure a rate of progress far more rapid than that of the 12-yr. current-revenue program previously discussed For simplicity of comparison it is assumed as applicable to the entire program of improvement of the Interstate System. It can be visualized, however, in proportionate dimensions, as applicable to a part of the Interstate System in a given State, selected for accelerated improvement because of the urgency of the needs.

The calculation of amortization charges given in Table 7 indicates, on the basis of the values assumed, a probable average investment life of 50 yr. for the rural sections of the Interstate System, 58 yr. for the urban sections, and 54 yr. for the system as a whole. The issuance of bonds at 30-yr. terms would provide a comfortable factor of safety, with assurance that the investment in arterial facilities would far outlive the debt incurred. Experience with highway bond issues in recent years and during the period preceding the war indicates that general obligation bonds of the States, issued to finance Interstate improvements, should be marketable at interest rates no greater than 2 percent. If Congress should implement the recommendation of the Interstate report that Federal Interstate funds be made available for retirement of such bond issues, their attractiveness as a strongly secured investment should be increased

The most common form of highway bond issue in recent years has been that of serial bonds with equal annual maturities. On such an issue the debt service payments decline each year as the amount of unpaid principal is reduced. Although this procedure tends to reduce the sum total of interest charges in comparison with other types of retirement schedule, there is a disadvantage in that the heaviest charges for debt service occur during the early years, when the revenue earnings of the system are likely to be much lower than in subsequent years. Annuity bonds, issued under terms not unlike those providing for monthly payments on a home mortgage, have the advantage that the sum of interest and principal payments is equalized over the entire life of the issue. Figure 6 illustrates the schedule of interest and principal payments on an annuity bond issue of $1 billion, with a term of 30 years at 2 percent interest. The annual charge for debt service on such an issue is 4 465 per cent of the principal. The effect of steadily decreasing in-

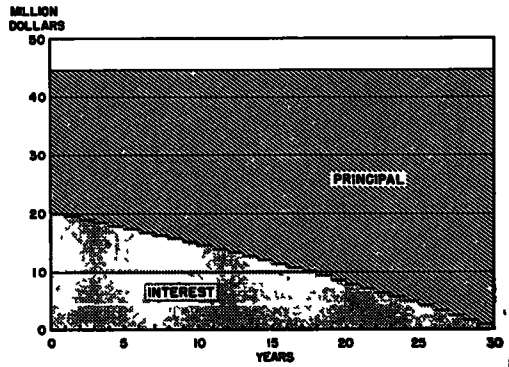

Figure 6. Debt Service on a 30-Yr. Annuity Bond Issue of $1 billion at 2 Percent

terest payments and steadily increasing retirements is readily observed on the chart. In the illustrative calculations discussed in the following paragraphs, debt service charges were computed on the annuity basis.

On the assumption that the entire cost of proposed improvements on the Interstate System would be financed by the issue of bonds, the magnitude of the required issue was computed as follows:

	million dollars
1. Total improvement needs at 1948 prices	11,266
2. Stopgap improvements and replacements during 8-yr construction period	392
3 Total capital outlay at 1948 prices	11,658
4 Total capital outlay, reduced to average price level of 8-yr. period	9,105

Bonds for an 8-yr. construction period would not be sold all at once, but would be marketed

over the entire 8-yr. period as the need for additional construction funds arose. For simplicity of calculation it was assumed that the sequence of bond issues would be as follows:

	million dollars
7 successive annual issues at $1,200 million each	8,400
1 issue, in the 8th year, of $705 million	705
Total	9,105

Each issue would be sold on January 1 of the year of issue, with interest at 2 percent and equalized debt service payments over a period of 30 yr. Table 9 summarizes the debt service requirements under these terms of issue Payments would be made over a period of 37 yr, at a total interest cost of $3,091 million, making the entire capital cost, $12,196 million, 8 25 percent above the reported amount of immediate needs at 1948 prices Average annual debt service charges over the entire amortization period would be $330 million, $246 million in principal payments and $84 million in interest

TABLE 9

ILLUSTRATION OF A PROGRAM FOR FINANCING THE IMPROVEMENT OF THE INTERSTATE HIGHWAY SYSTEM ENTIRELY OUT OF BOND-ISSUE FUNDS, IN COMPARISON WITH 12-, 15-, AND 20-YR. CURRENT-REVENUE PROGRAMS[a]

Item	Capital Requirements				Maintenance and Operation	Total Annual Charges[c]
	Principal	Interest	Direct Outlays	Total		
	million dollars	million dollars	million dollars	million dollars	million dollars	million dollars
Total capital cost, 37 annual payments	9,105	3,091		12,196		
Average per year, entire period	246	84		330		
Debt service, individual years						
5th	154	114		268		
10th	252	155		407		
20th	307	100		407		
30th	374	33		407		
35th	134	5		139		
Average annual expenditure requirements.						
1st 8 yr (construction period) .	138	100		238	85	323
1st 12 yr.	176	118	24[b]	318	82	400
1st 15 yr.	196	121	34[b]	351	81	432
1st 20 yr	220	119	49[b]	388	80	468
Average annual expenditures under program financed out of current revenues[c]						
12-yr. program			763	763	82	845
15-yr program			621	621	81	702
20-yr. program			486	486	80	566

Ratios of average annual requirements, bond-issue to current-revenue programs

12-yr program	0 473
15-yr program	0 615
20-yr program	0 827

[a] Terms of bond issue $1,200 million issued in each of 7 successive years and $705 million in 8th year, annuity bonds, with total debt-service payments on each issue equalized over a period of 30 years

[b] Estimated values, averaged over the 12-, 15-, and 20-yr periods, respectively, of replacements occurring after the termination of the 8-yr bond-issue construction period During the early years most of these expenditures would be made for replacements of presently existing construction not scheduled for replacement during the course of the bond-issue program.

[c] See Table 8

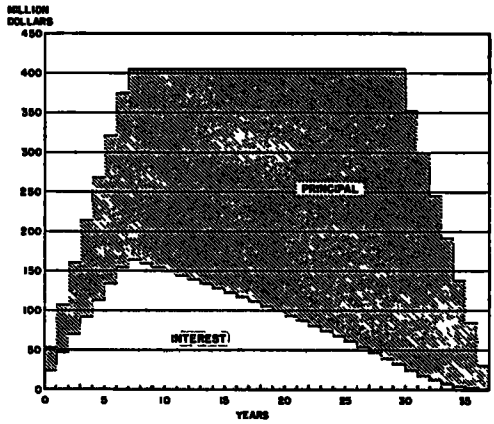

Figure 7. Debt Service for $9,105 Million Bond Issue to Finance 8-Yr. Construction Program on Interstate System

The schedule of debt service payments is also illustrated in Figure 7 Because of the staggering of the issues over the 8-yr. construction period, the required payments would gradually rise to the maximum (and thereafter constant) value of $407 million in the 8th yr. after the date of the first issue After the 30th yr the payments begin to drop, as each of the successive issues becomes fully retired. Under this scheme of issues and retirements the annual interest payments take the

general form of a skewed curve, maximum payments occurring in the 8th year.

It is a frequent practice to defer the initial retirements on a bond issue until several years after the date of issue. In the case at hand it might be a wise procedure to defer all retirements until after the 8th year, and use for direct capital outlay the revenues available for retirement, thereby cutting down the total amount of the bond issue On the other hand the practice of beginning retirements one year after the date of issue has been rather common in the case of highway bond issues, because of the availability of road-user revenues for debt service. The latter procedure has been used in this instance, for the sake of simplicity.

COMPARISON OF BOND-ISSUE AND CURRENT-REVENUE PROGRAMS

It is of interest to compare the annual expenditure requirements under such a bond-issue program with corresponding requirements under the 12-, 15- and 20-yr. programs illustrated in Table 8, on the assumption that the latter would be financed entirely out of current revenues. In the three lower sections of Table 9 the average annual expenditure requirements for the first 12, 15, and 20 years, respectively, of the bond issue program are compared with the annual requirements of the current-revenue programs of corresponding periods A graphic comparison is presented in Figure 8.

In order to make the comparison truly indicative, estimates (necessarily very rough) were made of the cost of replacements occurring, under the bond-issue program, during the years following the close of the 8-yr construction period, i e., from the 9th to the 12th, the 9th to the 15th, and the 9th to the 20th yr., respectively. These replacement requirements include: (1) replacement of presently existing construction not scheduled for improvement under the bond-issue program; and (2) replacement of new (bond-issue) construction, which would accumulate very slowly in the early years, but would be subject to upgrading upon replacement, because of increased traffic requirements These estimated replacement costs were averaged over the 12-, 15-, and 20-yr., periods respectively; and added to the debt service charges to give the total capital requirements for the three periods. The amounts so added were $24 million for the 12-yr. period, $34 million for the 15-yr. period, and $49 million for the 20-yr. period.[10]

Average annual revenue requirements during the first 12 years of the bond-issue program would include $318 million of capital costs in the form of debt service and replacements, and $82 million for maintenance, making a total of $400 million. Under a 12-yr. program financed out of current revenue, the corresponding requirements would be $845 million, more than twice the indicated needs under the 8-yr. bond-issue program. For the first 15 years the average annual requirement under the bond-issue program would be $432 million, or 0 615 times the requirement under a 15-yr. current-revenue program. The corresponding comparison with a 20-yr. current-revenue program gives a ratio of 0.827.

These comparisons need some interpretation. For example the advantage, in annual revenue requirements, of the bond-issue program over the 20-yr. current-revenue program seems relatively small. The fact is, however, that the bond-issue program would have accomplished the complete improvement of the Interstate system in the first 8 years. Motor-vehicle users would have been enjoying the benefits of an improved system for 12 years; whereas, under the 20-yr. current-revenue program, this condition would prevail only after the 20th year. Under the bond-issue program the users would derive much greater benefits from savings in operating costs and other factors; and the States, because of the traffic-generating capacities of high-grade improvements, would be in a much better position with respect to revenues.

There is another side to the picture, however. Debt-service charges would remain at the constant level, $407 million, through the 30th year, and would continue in decreasing amounts for another 7 years. Replacement costs, already of significant magnitude in the 20th year, would continue to climb. Because of the long-lived character of the proposed im-

[10] Estimated replacement requirements after the 8th yr. range from $66 million in the 9th yr. to $101 million in the 20th yr Averaging over the entire 12-, 15-, and 20-yr. program periods, respectively, accounts for the apparently low values given in Table 9

provements it is unlikely that replacement costs would become embarrassingly large before the liquidation of the bonded debt. In planning a bond-issue program, however, it is the part of prudence to estimate probable costs of replacement over a considerable period in the future With the aid of this information the maturity schedule can be so arranged that, after completion of the bond-issue construction program, debt service charges will diminish each year in amounts approximately equal to the predicted increase in replacement charges, thus equalizing total capital requirements (rather than interest and principal only) over the entire period. This scheme could be modified by providing for gradually increasing capital payments supported out of increased revenues. Its essential feature is that it insures a gradual transition from bond-issue financing of the initial improvement program to current-revenue financing of the replacement program.

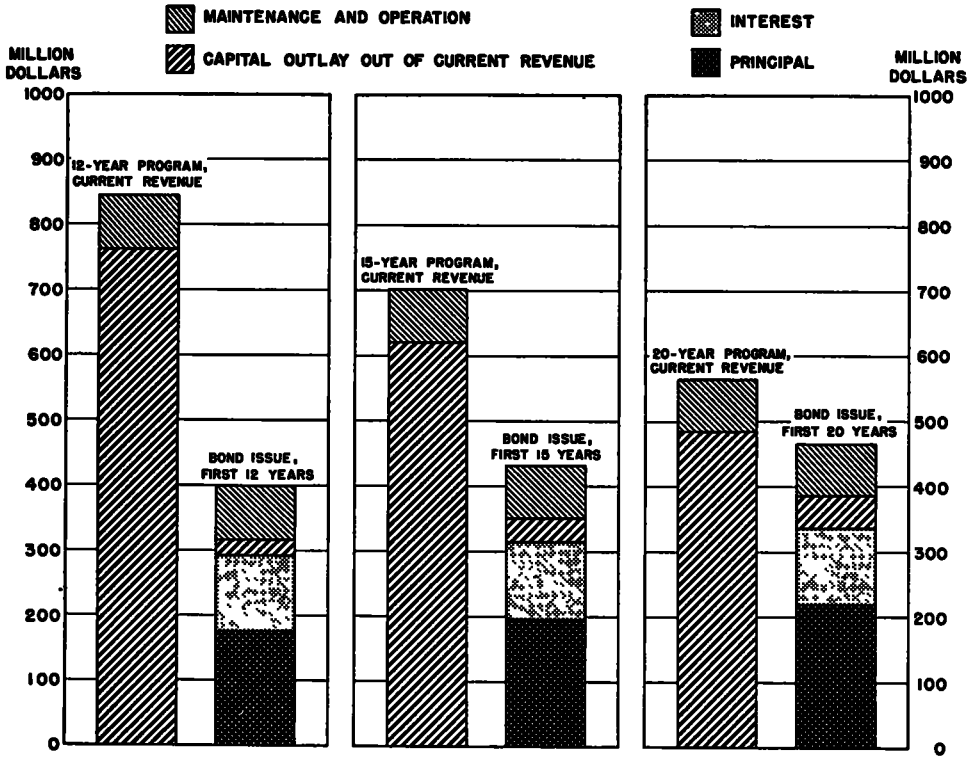

Figure 8. Comparison of Current Revenue and Bond Issue Programs for Financing Improvement of Interstate System

COMBINATION OF BOND-ISSUE AND CURRENT-REVENUE PROGRAMS

As has been mentioned, a number of States are restrained by constitutional provisions from incurring debt for public improvements; and others, for one reason or another, are unlikely to look with favor on credit financing of their improvement programs on the Interstate Highway System. If the Congress, in response to the recommendation of the Interstate Report, should enact legislation designed to encourage and facilitate borrowing for Interstate improvements, a fairly wide-spread adoption of this policy may be expected. It is unlikely, however, that there will be anything like 100 percent bond-issue financing of the Interstate System.

It is somewhat difficult to visualize the effect on annual revenue requirements of a combination of borrowing and current-revenue financing. The example given in Table 10

is based on the assumption that one-half of the program would be financed out of bond issues, under the same terms as those illustrated in Table 9; and the other half out of current revenues on the basis of the 15-yr. program outlined in Table 8. The items of each of the two programs are halved, and added to totals in the righthand column of the table. The indicated annual revenue require-

TABLE 10

ILLUSTRATION OF A 15-YR PROGRAM FOR IMPROVEMENT OF THE INTERSTATE HIGHWAY SYSTEM, FINANCED 50 PERCENT OUT OF BOND ISSUES AND 50 PERCENT OUT OF CURRENT REVENUES[a]

Annual Revenue Requirements	Bond-Issue Program	Current-Revenue Program	Total
	million dollars	*million dollars*	*million dollars*
Principal payments	98		98
Interest payments	60		60
Direct capital outlays	17[b]	311	328
Total capital requirements	175	311	486
Maintenance and operation	41	40	81
Total revenue requirements	216	351	567

[a] See Tables 8 and 9

[b] Average annual value, over the 15-yr period, of cost of replacements occurring after the close of the 8-yr. bond-issue construction period

ments, $567 million, are 80 8 percent of the corresponding requirements of $702 million under a 15-yr. program financed entirely out of current revenues It will be noted also that annual Federal authorizations of $250 million would finance the Federal share of a 50-50 construction program, with a small margin for contingencies.

SUMMARY

There are undeniable advantages in the use of credit financing to accelerate the improvement of arterial highway facilities. Only by this means can the funds be obtained to insure a maximum rate of accomplishment. Earlier completion of the arterial program will increase the savings and other benefits derived by highway users, generate increased traffic on the arterial system, and provide additional revenues for its support. For these advantages a price is paid in the form of increased total costs because of interest charges; but a program wisely conceived and executed should result in benefits to the users far in excess of the increased costs.

Analysis of the data regarding the costs of proposed improvements on the Interstate Highway System indicates that their average investment life would be in the neighborhood of 50 years The adoption of an 8-yr. construction program, financed out of bonds issued for a term of 30 years, would bring the advantages of a fully improved system to the American public at an early date. The annual revenue requirements for such a program would be much less than those of current-revenue programs designed to complete the same improvements over periods of 12, 15 or 20 years. If such a bond-issue program is adopted, wholly or in part, the bond retirement schedules should be designed and managed so as to bring about a gradual transition from bond-issue financing of the initial improvement program to current revenue financing of the replacement program

ACKNOWLEDGEMENTS

Most of the data presented in this report were derived from the cooperative Federal-State study of needed improvements on the national system of interstate highways, which resulted in the publication of the report "Highway Needs of the National Defense" The assistance of Mr. Fred W. Haxton, Division of Design, Bureau of Public Roads, and of Messrs. Fred B Farrell, C. A. Steele, H. C. Duzan, H. R. Paterick, and others in the Financial and Administrative Research Branch is gratefully acknowledged.