

Estimating Maintenance Needs

The amounts allotted for highway and street maintenance in preparing annual programs is a substantial amount of the total annual highway program for states, cities, counties, and other local jurisdictions. If accuracy for the total annual program is to be attained, the same careful approach to maintenance needs must be used as the approach in appraisal of the improvement needs. Because of existing defects in definitions and accounting and lack of standards, existing maintenance records are usually insufficient for development of maintenance amounts for study programs. To supplement existing records and provide information where no records exist, several methods have been used to develop maintenance costs for annual programs. These methods are examined and discussed for state, city, and county jurisdictions.

Part 1: Rural State Highways

JOHN J. LAING, Supervising Highway Maintenance Engineer
Bureau of Public Roads

● **HIGHWAY AND STREET MAINTENANCE** is a substantial part of the total highway program. In 1956, the outlay for highway and street maintenance approached the \$2 billion level. If accuracy of the total annual program is to be attained, maintenance needs must be determined as accurately as improvement needs. If excessive amounts are expended on maintenance, the improvement program is deprived of usable revenues. If maintenance allotments are inadequate, improvement needs are greatly accelerated.

Several factors make it difficult to obtain accurate maintenance costs. A prime factor is the lack of a definite and uniform definition of maintenance itself. Items of maintenance are generally not uniformly defined between the several states or between the several jurisdictions within a state. The inclusion of small capital improvements and betterments as maintenance cost items, without proper identification, is a real handicap. It precludes the use of historical cost data which otherwise would be of considerable assistance in projecting future maintenance needs.

Nonuniformity in accounting procedures also makes it difficult to arrive at the total outlay for annual maintenance. In addition, if the accounting procedure does not provide for the distribution of costs to the various operations, there can be no thorough appraisal of the efficiency of such operations.

Definite standards of maintenance adequacy are also necessary. Without such standards, it is difficult to judge whether reported expenditures are an accurate measure of what should have been spent to provide proper maintenance service. Where there are no standards of adequacy, the sufficiency of maintenance expenditures is usually judged by past expenditure levels without considering the adequacy or economy of the maintenance performance.

Because of this lack of exact definitions, uniform accounting practices, and standards of adequacy, existing records of maintenance are usually not suitable for use in the development of maintenance requirements. To supplement existing records and to provide information where records do not exist, several methods have been used to develop maintenance costs for annual road and street programs. An examination of these methods, together with comments on their advantages and limitations, may aid in the determination of the best method or methods.

Of all the jurisdictions engaged in highway or street maintenance, the state highway departments have the greatest amount of usable background information to assist in developing representative maintenance costs for program purposes. Many states have been following the proposed cost accounting breakdown of the American Association of State Highway Officials for a number of years. Usually, however, the available maintenance cost data of state highway departments cannot be used without some modification or amplification. It is necessary to know the volume of work performed, the adequacy of the maintenance performance, the economy of the manpower and equipment

combinations used, and many other pertinent factors that affect the over-all maintenance costs.

The work of the Committee on Maintenance Costs of the Highway Research Board has been most beneficial. They have obtained average annual maintenance costs on a substantial mileage of the nation's highways, published a maintenance cost index, developed unit costs for various maintenance operations, and are promoting efficient operations on a national scale through proper mechanization and progressive methods and practices.

The "performance budget" is one of the best methods of estimating annual maintenance expenditures. Under this plan, the maintenance workload is developed in appropriate quantitative terms. Knowing the frequency and unit cost of each operation, it is possible to develop an annual maintenance cost for each functional activity. This workload method may also be used to good advantage in allotting operating funds to work subdivisions in the field.

Experience in conducting maintenance analyses, however, has shown that the complete maintenance workload is seldom available. As a rule considerable care is exercised in keeping current data on the type, width, and thickness of pavements but little or no effort is expended in keeping up-to-date records of the other highway improvements. Rural state highway pavement maintenance costs on the average comprise only about half of the total outlay for highway maintenance. On urban extensions and expressways, the cost of pavement maintenance is usually a very small portion of the total cost of providing highway service. No criticism is offered for the accuracy with which pavement data is kept. However, it is equally important to know such quantities as the acreage of right-of-way that must be mowed, the tons of steel that must be painted, the number of signs, and the amount of pavement marking.

As new facilities are added to the system, the maintenance engineer should be able to estimate their net effect on the annual maintenance budget. This can only be done by considering all of the physical and operational requirements of the new improvement. For example, the placing of a new interchange in operation may have little or no effect on pavement maintenance expenditures but may require substantial amounts for lighting and for structural upkeep.

The unit costs which are applied to the various work quantities should provide for an acceptable standard of work and reflect reasonable efficiency of operations. To illustrate, a durable reflectorized pavement marking should be applied at a rate of not less than one gallon of paint for 330 ft of 4-in. line. If proper equipment is used, it should be possible to paint such markings at a cost of 1.2 to 1.6 cents per linear foot. This unit cost, however, cannot be used unless the actual amount of line is known. One southeastern state which keeps an accurate record of pavement marking requirements has found that on the average it takes the equivalent of 5,000 ft of single solid line per mile of highway for the prevailing sight conditions. The amount varied from 4,000 to 6,000 ft per mile between the districts.

As a general rule, unit maintenance costs will vary between states. It should be possible, however, to develop representative unit costs in regions having comparable maintenance problems if proper weights are given to the variables.

In maintenance needs studies conducted to date, some rather broad guides have been developed for judging the adequacy and justification for reported maintenance expenditures. Traffic volumes affect both the upkeep of the physical elements of the highway and the extent to which operation services must be furnished. Studies show that the average annual cost per daily vehicle (365 vehicle miles per year) for high-traffic highways is about half of that experienced in the low traffic group. The range is from \$0.82 per daily vehicle for highways carrying 6,000 vpd to \$1.68 per daily vehicle for highways carrying an average of 500 vpd. The cost per daily vehicle provides a yardstick by which it is possible to determine within broad limits if the summation of the maintenance costs developed by the work unit-performance methods are reasonable.

Although some progress has been achieved in developing techniques for determining highway maintenance needs at state levels, much remains to be done to simplify procedures in the future. Action along the following lines would facilitate the determination of highway maintenance needs in the future and would also assist materially in the

over-all administration of the nation's primary highway plant:

1. Adoption of uniform definitions for maintenance, traffic services and minor capital additions.
2. Completion of maintenance manuals (four chapters of AASHO Maintenance Manual have been completed to date).
3. Full adoption of proposed AASHO accounting system with such additions and revisions as are required for modern maintenance activities.
4. The compilation of complete records of the maintenance workload in suitable quantitative units.
5. Development of the most efficient labor and equipment combinations for various maintenance functions.

Part 2: City Streets

TERRY J. OWENS, Automotive Safety Foundation

● PREVIOUS STUDIES have not developed city street maintenance costs with adequate consideration to the many factors that make up the total city street maintenance needs. It has not been possible to assemble comparative costs from various cities according to pavement types and widths, because of variations in the organizational structures of cities. In some cities, as many as six different departments perform street maintenance functions. Another serious obstacle is the variation in accounting procedures among departments and among cities. A further complication is the considerable confusion in opinions as to what are maintenance operations vs capital improvements. Frequently, street maintenance, water works, sewers, parks and recreation operate out of the maintenance budget with no clear-cut accounting of expenditures between them.

Obviously the daily production per man and per truck will have a profound effect on maintenance costs. In most needs studies time has not permitted a city by city evaluation of personnel and equipment efficiency.

In some cases where reasonably reliable accounting was available the maintenance costs were adjusted to compensate for the difference between the desirable and the present level of maintenance. These figures were then applied to all streets involved in the study. This method assumes a continuation of the existing degree of efficiency.

In the absence of reliable accounting it is usually necessary to discuss the maintenance activities in relation to the maintenance budget. Non-maintenance activities are estimated and deducted from the budget. The resulting figure is then adjusted to provide for an adequate level of maintenance. The adjusted figure is then readjusted according to surface types and traffic volume so that the total cost for all streets equals the adjusted maintenance total. Although the average cost may be fairly determined, it is doubtful that the costs assigned to different surface types and traffic volume groups carry the same degree of accuracy.

Both of the procedures have existing costs or budget for their basis. When applied to other cities in the state the costs may be wide of actual requirements because of variations in the frequency of flushing and sweeping, general age and condition of pavements, differing policies on snow removal and ice control, varying degrees of drainage adequacy, lighting costs, and efficiency of operation.

The cost for performing various maintenance functions should be developed and segregated in broad categories. For example, the cost of maintaining the pavement should be in one category while sweeping, drainage, lighting, and snow removal would be in other categories. In this way appropriate elements can be added together to arrive at the cost of performing needed activities. The development of these costs is, of course, the difficult part of any analysis.

The subcommittee has circulated a street maintenance questionnaire to six cities. Its purpose is to test the format and instructions of the questionnaire through these cities. As soon as its adequacy can be tested, the questionnaire will be sent to some 200 cities for their participation. The National Committee for Urban Transportation, the American Public Works Association, the American Municipal Association and the

United States Conference of Mayors have joined this effort.

The questionnaire has been simplified to the greatest extent possible. More detailed information would be desirable but the introduction of such detail would greatly narrow the response from the cities. Although the questionnaire is concise, past experience makes a satisfactory response doubtful. If a satisfactory response is not received, even a negative result may be of value. Knowledge that cities generally do not know the cost of maintaining their streets will be a strong argument for acceptance of the National Committee for Urban Transportation's maintenance accounting procedures now being developed.

Part 3: County and Local Roads

HOWARD BUSSARD, Automotive Safety Foundation

● IN COUNTY AND LOCAL road areas, yearly maintenance costs consume a large share of the total road budget. The reported national maintenance expenditure is about one-half the total road budget for all local road purposes.

If valid maintenance accounting were widely practiced, these records would provide basic information on which future maintenance expenditures could be projected. In some states a few counties have maintenance records but these may not reflect state-wide amounts. In other states there are no records of maintenance costs available and, further, in many states, there is no distinction or record made between funds expended for maintenance and construction.

Even in the partial or complete absence of valid maintenance records, estimates must be established to reflect the maintenance needs in the annual programs. Four methods of estimating have been used. The choice of method is dependent on a general appraisal of the maintenance activity, including an examination of existing records and their accuracy.

Present Maintenance Expenditures Method

A source of factual information in each state is the highway planning division, with its tabulation of reported expenditures by agencies and the breakdown of these expenditures for construction and maintenance. In some states the counties record total expenditures broken into these two divisions. A study of the information available will determine what material can best be utilized.

Where possible, even though a limited sample must be used, reported costs are tabulated by surface type and by systems so that differences in maintenance costs between types and systems can be reflected. Different kinds of maintenance with different costs can be expected on bituminous and gravel surfaces, and larger maintenance costs can be expected on county primary roads than on local access roads.

The expenditures are scrutinized to determine if items such as betterments, improvements, or special maintenance are included. If so, it becomes necessary to eliminate them because these specific items will be covered in the improvement programs. The accounting method may allow extraction of these items; if this is not possible, they should be removed on a percentage basis. The percentage of these items to the total maintenance budget will be determined by examination of records and estimates of engineers, or a combination of both.

The adequacy of the present operation must be appraised to evaluate the service provided and to determine its efficiency. Observation of results and consultation with maintenance employees aid in this evaluation. During this portion of the appraisal, the organization of maintenance management should be studied and evaluated.

In the development of needs programs the existing inventory by surface types is gradually changed by the improvements resulting in a changed inventory at the end of the program. If the reported yearly expenditure is not recorded by surface type it can be determined by assuming a cost-per-mile for each surface type and adjusting until the cost for total miles by surface types is equal to the total expenditure. Once this is done, the accuracy can be decided and future projections more readily made.

The determination of what items of maintenance are deficient and what costs are too high is now necessary. The cost per mile for each surface type is adjusted to represent this appraisal. These final estimated costs must represent a true picture of maintenance necessary over the program length and should reflect what should be, rather than what is now being done.

This method can be used only in states where existing records can furnish the necessary information with reasonable accuracy. A disadvantage is that it uses existing costs with only a general appraisal to determine operational efficiency and the necessity of the present operation according to established standards for traffic and service.

Use of Detailed Maintenance Studies

These studies have been made in states where existing maintenance records were non-existent or inaccurate, and they arrive at program costs by building up costs by systems, based upon the frequency of each operation necessary for the upkeep of each surface type and other features. Known values of labor and equipment rental are applied to the operation to arrive at field costs. A 10 percent overhead allowance is usually added to these field costs.

This method approaches maintenance costs not on the basis of what is being done, but rather what should be done to provide maintenance service. It assumes a certain amount of efficiency of operation, including proper organization and mechanization, creates some standard of performance, and furnishes limits of time of these operations. For this reason, this method has the advantage of encouraging a new look at maintenance in general and operations in particular.

This type of study is useful when conducted by a specialist in this field, who is able to obtain data and interpret their implications. It requires considerable time, effort and talent. Funds may or may not be available when this information is needed. In county studies, where costs by regions are advisable, much time would be necessary for a special maintenance study. Even if representative unit costs can be developed, it is impossible to apply them if the physical and operational work loads are unknown.

Sample Method of Estimating Maintenance

Scientific samples and statistical methods for their selection are the basis for this procedure. Maintenance estimates, for the selected samples, are compiled in the same manner as in the detailed maintenance studies. Each sample is appraised to estimate the cost resulting from each operation and its annual frequency. The detail work of estimating sample costs is performed by a member of the staff with the aid of each district maintenance engineer.

The sample size is dependent upon the statistical approach to the problem; variations of terrain, road mileage, and degree of accuracy are controlling factors. In one state, 10 percent of the state trunk system and 4 percent of the county primary system were sampled. Generally, sampling to determine estimates by surface types within the different systems is desirable.

Estimated costs for the samples are expanded by surface types for each system to give the estimated state totals. These totals over a program period should be adjusted to reflect changes which will occur through improved surfaces and also those required by increased traffic demands.

This type of appraisal approaches the problem in light of what should be done and what it should cost. It should stimulate operations to obtain performance at the estimated costs.

This method requires a skilled statistician and enough factual information must be assembled to determine a basis of sample selection. The detail work of estimating operations, their frequency and cost also requires skill by employees with practical experience in maintenance operations. The time required is considerable, and in state studies this often is an important factor.

Consultation Method

Special maintenance committees composed of engineers estimate maintenance

amounts. Starting with a system, an estimated annual cost per mile for each maintenance item is made for roads of various ADT and for each surface type. This is carried out for regions into which counties are grouped to reflect similar conditions.

The costs per mile of each function are added together, resulting in a total estimated cost per mile for each system and by surface type. Snow removal costs, if available, can be added for each system or they must be estimated. The amounts computed for each system are compared to existing expenditures and adjusted to provide for traffic increases with resulting maintenance demands during the program period.

This system is rapid, but it does lack factual background since the costs are largely a matter of judgment. It would not be practical to use consultation unless engineers or superintendents were competent or qualified to make these decisions.

Counties in some states have realized the value of reliable records in estimating maintenance needs for programming and are revising their accounting methods to obtain better facts. These revisions include:

1. Definite distribution between construction and maintenance functions by the use of uniform definitions;
2. Reporting and accounting to provide costs by surface types; and
3. Evaluation of maintenance operations to establish standards of maintenance.

Such counties are providing a sound basis for future maintenance estimates by a planned method of providing maintenance facts. This will allow maintenance estimates to be made with the same accuracy as construction estimates.