INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

A Guide To HIGHWAY MAINTENANCE ADMINISTRATION

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HIGHWAY MAINTENANCE

ADMINISTRATION

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Department of Technical Operations

PREFACE

Good maintenance of the highway system of a country is fundamental for the continuous operation and development of highway transportation. It assures that established commercial relations between places can be carried on and developed without interruption. Good highway maintenance is therefore essential to the continuous growth of agricultural, industrial and commercial activities.

Highway maintenance work is not conspicuous. It does not materially add to what already exists. It requires constant and never ending vigilance and effort, but its results are not spectacular. Only when it is neglected does the highway user become aware of the necessity for maintenance work. For these reasons governments and engineers tend to give more attention to new construction and improvement projects, than to good and continuous highway maintenance.

At the same time highway maintenance has a number of peculiarities which make its organization and management much more difficult than any other operation in the highway field. Maintenance consists of an endless variety of activities and techniques executed simultaneously by many individuals who are spread over the entire highway system and who need direction and control. Highway maintenance is therefore one of the most difficult tasks any government has to perform, and its execution requires great skill.

Various viewpoints exist as to the manner in which maintenance should be done. The staff of the Bank is in a position to observe closely the development of highway maintenance organizations in many countries. A number of basic elements which are common to the most successful highway maintenance organizations have been compiled and are described in this guide to Highway Maintenance Administration. These elements, adapted as necessary to meet local conditions, should help to assure successful highway maintenance administration and operations.

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DEFINITION

Highway maintenance consists of those operations which are planned to keep the highway facility in as nearly as practicable its originally constructed condition, or its subsequently improved condition. In practice, the organization which is charged with the responsibility of maintaining a system of highways often accepts certain additional responsibilities, including the execution of minor improvements (betterments), seasonal work on unimproved routes and the provision of traffic aids. The organization is also responsible for emergency work, such as the repair of damage caused by floods, earth slides, and other unexpected or unpredictable occurrences. For the purpose of this report, all of these operations are considered as maintenance operations.

IMPORTANCE OF MAINTENANCE

Proper maintenance of the highway system of an area is the only means by which the public can be continuously provided with safe and economical highway transportation, and by which the large investments in previous construction and improvements can be protected.

A newly constructed or newly improved highway begins to deteriorate under the effects of the elements and of traffic loads from the moment it is placed in service. Only constant day-to-day maintenance will keep its condition up to the original standards and prevent reductions in the level of traffic service which it provides, as measured by such factors as its capacity for the movement of a certain number of vehicles, its structural capacity for traffic loads, the operating speed, and its general safety characteristics.

As examples, the roughening or breaking up of an originally smooth riding surface reduces capacity and operating speeds, increases operating costs and creates hazards. Poorly maintained shoulders decrease the effective width of the pavement surface, reducing the capacity of the highway and increasing the danger of accidents.

The lack of adequate maintenance not only affects the efficiency and safety of the movement of traffic, but also brings about a loss in the capital investment. A properly designed and constructed highway should represent a relatively permanent investment. Only by constant attention to maintenance can this permanency be attained. Pavements can be neglected to a point where complete reconstruction is needed for rehabilitation, and where even the pavement base might be damaged or destroyed.

Shoulders and ditches can be allowed to erode to an extent where the entire roadway must be rebuilt. Drainage structures, particularly large bridges, can be damaged so badly that new structures will be required if cleaning, painting, and other maintenance measures are not carried out. In all of these cases, invested capital is wasted, and the restoration of the highway facility usually requires a much larger investment than the cost of the regular maintenance which would have prevented the destruction. Gradual deterioration brings about an insidious and progressive damage, which may not be recognized in time to avoid the need for eventual replacement of parts of the highway facility. Regular and adequate maintenance operations provide the only means of preventing this waste of highway funds.

RELATIONSHIP TO OTHER HIGHWAY OPERATIONS

Maintenance constitutes one of the four principal functions of the highway department, the others being planning, design and construction. The work of all four of these major functions must be carried out in close cooperation if the various operations are to be performed in an efficient and effective manner, and if maximum benefits are to be derived from the total funds which are expended on highways.

Long-range planning of the highway department's activities is based upon both predictions of needs and estimates of total funds available for highway purposes. The projected cost of future maintenance operations will therefore directly affect the funds available for new construction projects, and consequently the programming of such projects.

Highway design should also take future maintenance into consideration. For example, pavements which are designed with inadequate width will suffer from excessive wear on the shoulders and the pavement edges could crumble from concentrated traffic loads. Maintenance considerations should influence the design of the side ditches and bank slopes to facilitate cleaning and weed control.

On construction projects a constant effort is required on the part of construction engineers and inspectors to secure good workmanship and to make sure that all parts of a new highway are constructed according to specifications. This will do much to avoid situations in which maintenance personnel is confronted with urgent problems of localized grade settlements, pavement failures and bad drainage during the first year or two after construction.

Maintenance should begin on a sector of highway as soon as construction has been completed. Therefore, a close correlation is needed between construction and maintenance operations.

MAINTENANCE MANAGEMENT

The maintenance of a highway system involves a large number of employees, an extensive inventory of equipment, the control of funds, and work which is spread over large areas. It is work which is under the constant scrutiny of almost every citizen, each with a personal interest in what is being accomplished. And often there are not sufficient funds, personnel, or equipment available to do all the things that are obviously needed. It is therefore important that the best business administrative methods be adopted to insure that this major governmental function is carried out in the most effective manner possible.

Basic requisites for proper maintenance may be listed under the following headings:

1. Adequate funds
2. Adequate labor supply
3. Adequate maintenance equipment
4. Good technical supervision
5. Good administration
6. Proper budgetary control of operations

1. Funds

It is very important that maintenance work be financed from one fiscal year to the next on an adequate and continuing basis. The need for highway maintenance arises entirely from the continuous damaging effects of weather and traffic, and unlike construction and reconstruction programs, maintenance operations cannot be arbitrarily interrupted or discontinued without serious harm to the highway system. Therefore, the provision of maintenance funds should be the first consideration in the preparation of an overall highway budget, in which construction and reconstruction funds should be residual amounts after the maintenance budget has been determined.

2. Labor

Good management must include an enlightened approach to the problem of maintaining an adequate labor force, with labor personnel policies which will provide proper wage rates, social security (retirement benefits, etc.), security of tenure, and a careful selection of qualified men for each type of work. Highway maintenance is essentially a wide spread series of local operations, and it requires skilled labor management to cope with all of the problems that can be expected to occur in a large, thinly-spread organization. It also requires loyal and trustworthy employees who will perform their work in isolated places with a minimum of supervision.

3. Equipment

The selection of proper equipment, together with provisions for its use, maintenance, repair and, as a financial policy, for its eventual replacement, are important parts of maintenance management. The effective use of maintenance equipment calls for a careful balance between hand-labor and machine methods, which will vary from one locality to another; this is one of the most important factors to be taken into account in establishing efficient maintenance operations.

4. Supervision

Highway maintenance involves the application of engineering principles and techniques. It is therefore an engineering operation calling for highway engineering skills and experience which are as great as those for new construction. Although a large amount of the work in a maintenance division is concerned with personnel management, accounting, record keeping and field supervision, a good engineering staff must be provided for overall supervision and executive control if the work is to be carried out in an effective manner.

5. Administration

The administration of an adequate highway maintenance program requires an organizational structure which has been carefully conceived and staffed with competent personnel, operating under a system of specific assignments of responsibilities and definite lines of authority.

6. Budget Control

It has been the experience of most highway administrators that adequate maintenance funds, personnel, equipment and supervision do not automatically guarantee adequate highway maintenance. Pressures are always present to encourage the use of these resources for betterments, and even for reconstruction and new construction, all to be carried out at the expense of actual maintenance work. Particularly in areas where there is a serious lack of funds and equipment for badly needed improvements and extensions of the highway system, the incentives for the diversion of maintenance efforts are often very great.

Also, it is recognized that everyone, from the top administrator on down through the ranks to the foreman in direct charge of the work, has a natural inclination to direct his efforts to some constructive project which may eventually constitute a visible addition to the highway system. Maintenance is likely to be regarded as a dull and tedious chore, admittedly important, but to be tolerated only to the extent that is absolutely necessary.

In order to counteract these influences it is necessary to exert comprehensive control over all of the operations usually carried out by maintenance forces. This control calls for a budget based upon a plan of maintenance operations. The annual budget should establish a specific amount of funds to be made available for each of the various types of operations to be undertaken by the maintenance forces, including among other items, a separate amount for routine maintenance and another for betterments. A budget so established and implemented by an effective accounting system will do much to sustain routine maintenance at a pre-established level and to confine betterment works to predetermined limits.

MAINTENANCE PLANNING

Overall highway planning is an important, although sometimes neglected, phase of highway administration. Planning should be based upon current inventories of all highways, together with condition surveys, maintenance cost records, traffic studies, accident records and economic factors, all of which are projected into some specific time in the future. Since all proposed programs must be based upon the total funds which are expected to be made available for highways, future maintenance costs become an important factor for consideration.

Maintenance administrators have a distinct advantage over those in other divisions of a highway department, in that maintenance operations continue from year to year, over a highway system which usually changes very gradually, and under conditions which in general can be anticipated with a reasonable degree of accuracy. Because of these factors, it is possible to prepare maintenance plans and budgets which are based almost entirely upon recent experience, with the expectation that the plans will be generally realistic, and that a reasonable and adequate program will result. Maintenance planning should include the development of current, short-range and long-range plans of operations.

1. Current Plans

Plans for current operations are needed for the following purposes:

a. Organization of day-to-day operations
b. Control of the progress of work
c. Distribution of funds
d. Distribution of men and equipment

Current plans should be developed and revised on a continuing basis, at all levels of administration. Reports of current operations should be analyzed and acted upon with a minimum of delay. A certain degree of flexibility in the distribution of personnel and equipment and in the allocation of specific funds constitutes an important factor in establishing good management. The day-to-day statement of actual expenditures in

relation to the budget should serve as a definite and constant guide for the proper distribution of funds between the various types of operations.

2. Short-range Plans

Plans for maintenance operations for a succeeding year are needed for the following purposes:

a. Preparation of annual maintenance budget
b. Advance planning for purchase of equipment, supplies and materials
c. Advance planning for distribution of staff members, labor and equipment

A careful appraisal of the records of expenditures for the current and previous years and the information obtained from current condition surveys provide the basic considerations for preparing these plans. Estimates of costs are usually based upon average costs per kilometer, with appropriate adjustments for the various factors which are involved. Recognized deficiencies in funds, personnel or equipment should be corrected. Extensions of the system which is being maintained, due to new construction or improvements, or by transfer of highways from another agency, must be taken into account. The standards to which the various highways have been maintained should be considered, and additional funds for any needed improvements in maintenance operations should be included. Administrative deficiencies should be recognized and corrected in the new plan. Personnel policies should be reviewed and plans made for their improvement.

3. Long-range Plans

Long-range maintenance planning is important because it forms a basic part of any overall highway operational plan, that also includes future construction and reconstruction programs. In this phase of maintenance planning, the requirements for funds and other maintenance needs are estimated by projecting the general trends, as indicated in the analysis of past and current records, and by a consideration of other factors which influence maintenance operations.

Plans for future construction and reconstruction projects are important in the planning of maintenance operations on specific routes. Maintenance expenditures on sections which are to be reconstructed or relocated in the near future should be reduced to a minimum, consistent with reasonable safety and vehicle operating costs for traffic currently using the section.

II. MAINTENANCE OPERATIONS

The work which is normally done by the maintenance forces of a highway organization can be divided into a number of categories, the most important of which are described below:

ROUTINE MAINTENANCE

Routine maintenance consists of regular maintenance operations performed on each section of a highway on a day-to-day basis by the same group of laborers and equipment. Such work includes leveling of riding surface, pavement patching, shoulder leveling, ditch cleaning, minor structure repair, weed mowing and general maintenance of the right-of-way area. Operations are carried out by both hand-labor and machine methods.

Although routine maintenance operations as a whole are carried out on a day-to-day basis, as they are needed, the work is frequently of a seasonal nature. For example, certain minor drainage corrections may be made during periods of wet weather, but the maintenance of shoulders and side ditches is logically planned as a dry weather operation.

SPECIAL MAINTENANCE

Special maintenance includes all of the regular maintenance operations on improved highways which are in addition to those normally carried out by routine maintenance forces on a day-to-day basis.

Special maintenance normally requires a greater concentration of personnel and equipment than routine maintenance. Some special maintenance operations may involve work which is the same as or similar to the work done by routine maintenance forces, but is normally more extensive in character or involves a greater amount of work on a particular section. Other operations which are undertaken by special maintenance forces require special skills and special equipment.

Most special maintenance work is seasonal. It includes bridge painting, sign renewals, guard-rail painting and similar work, which can be planned for appropriate intervals of time. It also includes such work as the general rehabilitation of shoulders and side ditches, which is planned according to needs that develop at less regular intervals. Preventive maintenance, including the construction of retaining walls and the paving of side ditches, is frequently done by special maintenance forces.

Some of the most important special maintenance operations are the major repair of pavements and base courses, bituminous resealing, and the application of surface treatments. The latter operation at times provides some addition to the original construction and, under a strict definition of the accepted terms, at least a portion of this work could be classified as "betterments."

BETTERMENTS

Betterments are localized improvements that provide either better traffic service or increased structural capacity. They include such work as localized improvements on curves and grades, localized widening of the roadway, or the replacement of small structures with more adequate installations, provided these operations are not of sufficient magnitude to permit the effective use of contractors or to warrant the use of special construction forces under direct administration. The execution of betterments frequently forms part of the normal activities of a maintenance division. Athough the magnitude of these operations cannot be precisely defined, they should never be permitted to interfere with the regular maintenance work through excessive demands for men and equipment, and they should always be financed with funds which are specifically allocated for this work.

Betterments are usually planned to provide for the improvement of isolated short sections which are deficient. Where a number of improvements are to be carried out on the same highway as part of a long-range program, it is important that the work be carefully planned in advance, in order to ensure the development of consistent standards, and to permit the scheduling of the work in a manner which will at no time hinder the regular maintenance activities.

Betterments are usually carried out by the maintenance forces which are regularly assigned to the sector, the work being done during periods when the need for regular maintenance is not great. For more extensive work, additional personnel and equipment may be assigned from other sectors or from the district headquarters.

In this connection it should be pointed out that in many areas, the maintenance division of a highway department has at its disposal an important proportion of all of the highway technicians, equipment operators and highway equipment available in the country. Where this condition exists, there are likely to be very strong pressures to use these resources for reconstruction and construction. Although maintenance programs usually include provisions for a limited amount of betterments to be carried out by the regularly assigned maintenance crews, expansion of this type of work to include reconstruction or new construction should be avoided. There have been many instances in which highway admini-

strators have assigned construction work to the maintenance division, first in limited amounts, but finally to an extent which practically destroyed the usefulness of the division as a maintenance force.

The most efficient and satisfactory method of reconstructing or constructing highways is by the use of contractors. If these are not available, the most acceptable alternative is work by direct administration, for which the highway department provides supervision, labor and equipment. This work should be completely separated from maintenance activities and should be assigned to a division other than the maintenance division.

MAINTENANCE WORK ON UNIMPROVED ROADS

It is usually assumed that maintenance operations are limited to highways which have been improved to a sufficiently high standard to permit the use of standardized maintenance methods. However, in order to permit the movement of traffic, either seasonally or throughout the year, some periodic work might be necessary on unimproved roads, which have only a natural earth surface with no regularly established standard cross-section and no continuous or consistent drainage system. This work is usually assigned to the maintenance organization.

Work on unimproved roads may include occasional levelling, drainage corrections, and other operations which are performed as an interim public service until the time that the route is improved. The work should therefore be limited to provide only for the amount of traffic service which is warranted by the current demands. Gradual improvement of a road is likely to result from corrections of localized conditions which are made as a part of the total effort to keep the road open to traffic.

Certain unimproved roads may sometimes be selected for improvement by maintenance forces, usually over a relatively long period of time. This type of operation calls for careful planning, with funds budgeted on an annual basis. The plans should include an analysis of the route to determine the sections of the existing location which will not be changed by construction to higher engineering standards at some later date. This factor should influence the amount and the type of improvements to be undertaken by the maintenance forces. The total of improvements to be carried out during each year should be limited to avoid interference with regular maintenance work on unimproved roads and on other highways in the area.

EMERGENCY WORKS

Although a large part of the future operations of a maintenance division can be predicted and included in previously-prepared programs and schedules, there are some operations which cannot be anticipated. These include emergency repairs of severe damage by floods, rock and earth slides and erosion, and of structures damaged by vehicles. In any extensive highway system a certain number of these operations can be expected every year, but it is usually not possible to predict their size, time or location.

III. ORGANIZATION OF MAINTENANCE FORCES

The successful performance of a maintenance organization depends to a large extent upon the adequacy of the administration of the entire highway department, and the manner in which the maintenance division is fitted into the overall plan of operation.

Charts I and II present a plan of organization for a highway department which has assumed all of the legitimate responsibilities and functions for the upkeep and improvement of a highway system, whether this system incorporates only the main highways in the country, or all the highways in a country, or the highways in a province. Chart I presents the major divisions of a department at the headquarters office. Chart II shows a maintenance organization at headquarters and in the districts.

For highway departments which are at the beginning of their development, all of the functions listed will not require the full-time attention of a staff member or warrant the establishment of a separate division or section. During this development stage different functions can be combined and taken care of by one person. Additional personnel should not be appointed solely for the purpose of completing an adopted organizational chart. Except when greatly expanded programs are being put into operation, a highway organization is likely to develop gradually and new personnel should be added as increased activities warrant a more extensive staff.

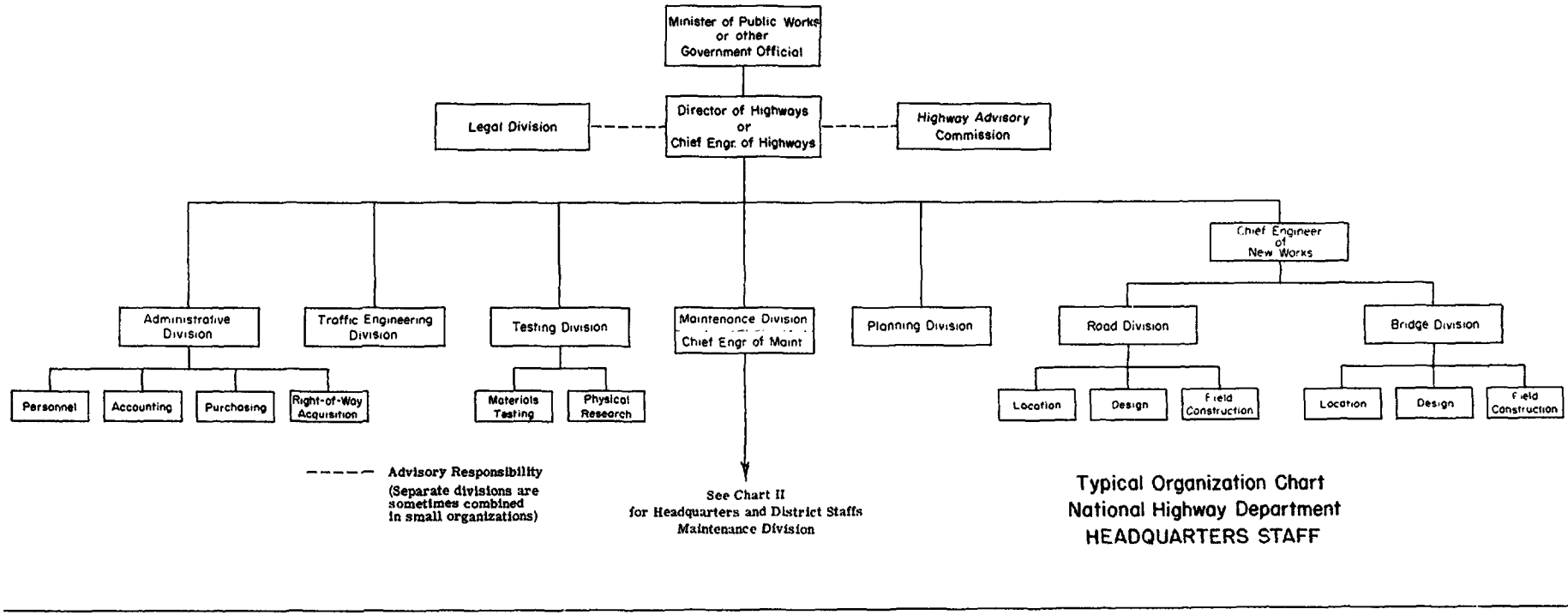
ORGANIZATION OF THE HIGHWAY DEPARTMENT

(CHART I)

Administration of the work in any highway department is a complicated and difficult task. Not only are large amounts of public funds involved, but the work is dispersed over large areas, and conditions differ from one location to another. The work includes a wide variety of operations, which are carried out by large supervisory and labor forces. It is therefore important that the organizational structure of the entire highway department be carefully designed, that the lines of authority and specific responsibilities be clearly established, and that the department be staffed with competent personnel.

Several extensive studies have been made concerning the relative merits of the various forms of administrative organization which are currently in use by highway departments. These studies indicate that no single form of organization can be selected as being ideal for all situations, but an over-all pattern has been developed which can be generally accepted as being most likely to provide good highway administration.

It is important that a single official be placed in charge of the entire Highway Department. He should not be given other governmental



Typical Organization Chart
National Highway Department
HEADQUARTERS STAFF

CHART I

responsibilities. For example, the Minister of Public Works, who is frequently responsible for highways, railways, postal service and public buildings, should not have engineers from the various divisions of the Highway Department, along with officials from other departments, reporting directly to him. Highway matters should be in the charge of a chief highway official, commonly designated as the Director of Highways or the Chief Engineer of Highways.

It is generally agreed that the Director of Highways should not be placed under the executive control of a highway commission. If this control is established, the Director may be hampered in his administrative duties by a lack of unified direction, and by a tendency of the individual members of the commission to interfere with the operation of the Department. If the commission is composed of members who represent specific regions of the country, it frequently becomes difficult, if not impossible, for the Director to carry out planning and operations on the basis of needs over the entire highway system. A good Director may welcome the aid and advice of a legally constituted highway commission, but he should not be forced to operate under the direct supervision of such a group.

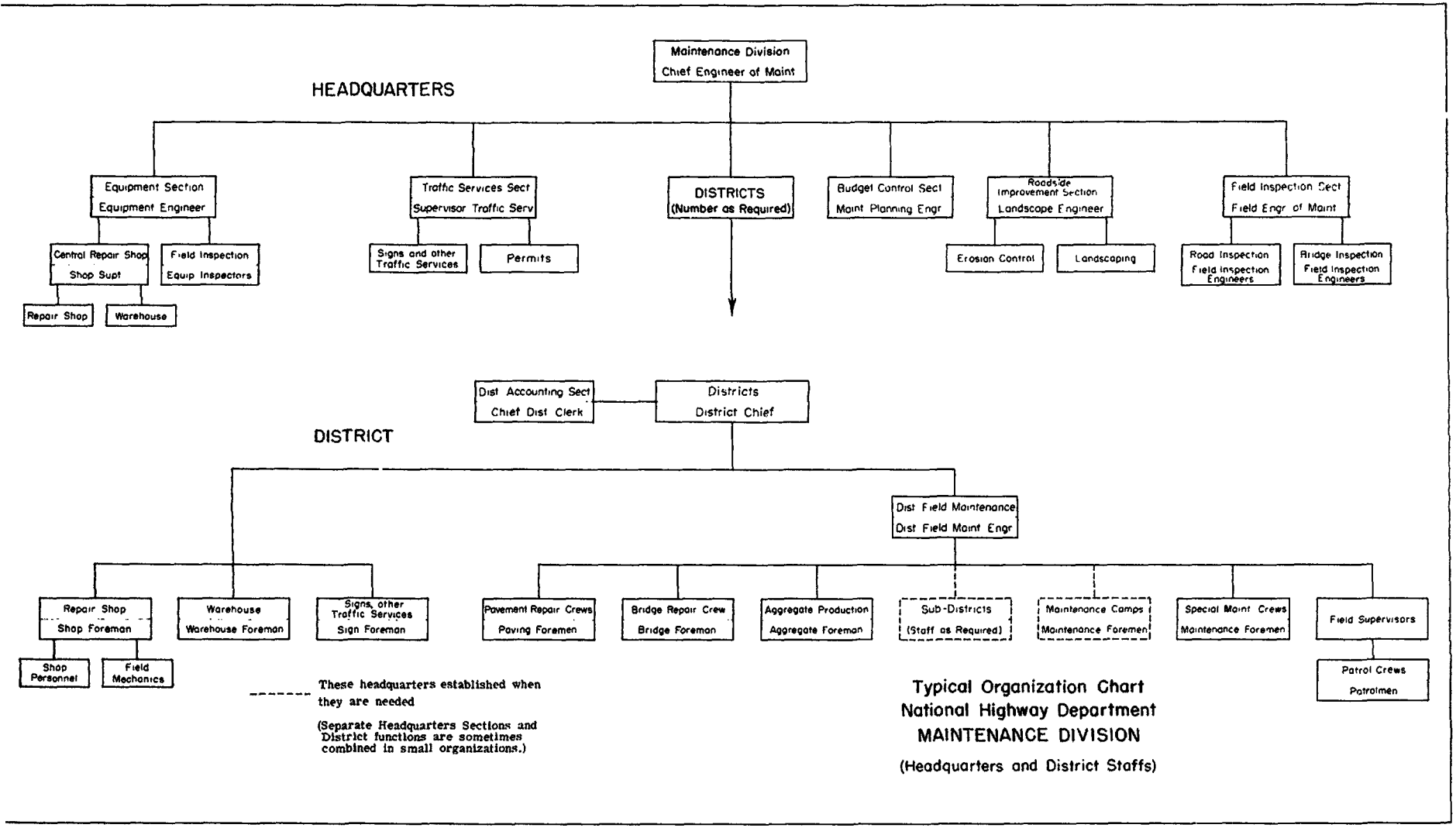
The work of the Department logically falls into general categories which can be administered by separate divisions. Each of the division heads reports to the Director of Highways. The divisions which are shown in Chart I are generally typical of highway departments in many areas. In relatively small or developing highway departments, certain divisions may sometimes be eliminated by assigning the responsibility to another division. For example, the work of the Traffic Division might be assigned to the Maintenance Division.

ORGANIZATION OF THE MAINTENANCE DIVISION (CHART II)

The Maintenance Division of the Highway Department should be established as a completely separate organization, with a Chief Engineer of Maintenance who is responsible only to the Director of Highways. The Chief Engineer of Maintenance is expected to maintain active cooperative relationships with the heads of the other divisions at the Headquarters Office.

It is usually necessary to divide a highway system into districts for the administration of maintenance operations, with the maintenance work in each district administered by a district staff.

In Chart II, the various sections of the Headquarters and District organization of the Maintenance Division are indicated, together with appropriate titles for the members of the executive, administrative and supervisory staff. The general organizational plan is discussed in the following sections of this report. A more detailed description of the responsibilities and duties of each staff position is given in Annex I.



Typical Organization Chart
National Highway Department
MAINTENANCE DIVISION
(Headquarters and District Staffs)

CHART II

1. Headquarters Office

The Chief Engineer of Maintenance is directly responsible for the work of the various sections of the Maintenance Division at the Headquarters Office. He is also in direct charge of the work in the Districts. The Headquarters sections include the Equipment Section, the Budget Control Section, the Field Inspection Section, and, in larger organizations, the Traffic Services Section and the Roadside Improvement Section.

Each maintenance section at the Headquarters Office is headed by a chief who reports to the Chief Engineer of Maintenance. The staff includes members who normally work in the Headquarters Office and also those who are assigned to field work in the districts. The members of the field group usually work as inspectors and advisors, reporting directly to the Headquarters Office, and they normally have no delegated authority in the field. They are expected to work in close cooperation with the District staff.

2. Districts

Districts are established to provide a means for more effective management and supervision of maintenance operations. No particular precedent has been developed concerning the number or size of the districts which should be established. However, it is generally agreed that each district should cover not less than 500 km (300 miles) nor more than 1,000 km (600 miles) of highways, except in unusual circumstances or in cases where sub-districts are established. Another accepted criterion which has been found to be applicable to a highway system which is under development provides that all points on the system should be within two days of overland travel from the District Headquarters. District boundaries are frequently influenced by terrain and other geographic features, by concentrations of highways within the established system, and by the location of population centers.

Districts should be reasonably uniform in size and form contiguous areas. One district headquarters is usually established in the same location as the Headquarters Office. Districts should be regarded as being permanent in nature, and adequate facilities should be provided at each of their headquarters.

Each district is under a District Chief, who is directly responsible for all of the maintenance operations in his district. He reports to the Chief Engineer of Maintenance. He is expected to work in close cooperation with members of the field staff of the Maintenance Division from the Headquarters Office.

The district organization is divided according to function into various sections. These include the Accounting Section, the Repair Shop, the Warehouse, the Sign Section and the Field Maintenance Section, each with an administrative or supervisory head who is responsible to the District Chief.

The District Field Maintenance Engineer is responsible for the operations carried out by the Field Supervisors and the Maintenance Foremen and their various maintenance crews. These crews include the Patrol Crews (Road Section Crews), the Pavement Repair Crews, the Bridge Repair Crew and the Special Maintenance Crews. He may also be in charge of the production of crushed stone or gravel. If Sub-Districts or Maintenance Camps are established, they would also come within his responsibility.

All of the functions which are indicated in the organization chart of a district are necessary for adequate maintenance. However, certain duties may be combined if the operations are not sufficiently extensive to justify a larger staff. For example, the position of Warehouse Foreman may be eliminated and the warehouse placed under the supervision of the Shop Foreman, if the combined operation can be managed by one staff member. Also, the work of the Sign Foreman can be assigned to a Maintenance Foreman, providing the amount of current work makes this practical.

3. Patrol Crews (Road Section Crews)

Patrol Crews constitute the basic element of the entire maintenance organization. Each Patrol Crew is normally made up of from two to five local employees under the supervision of a Patrolman. The Patrolman is responsible for day-to-day routine maintenance operations on a specific sector of highway, or on adjoining sectors of one or more highways, normally having a total length of from 10 to 50 km. The Patrolman reports to a Field Supervisor, who is usually assigned three or more Patrol Sectors in a general area.

4. Maintenance Camps and Sub-Districts

In the discussion of the District staff (and in Chart II) it has been assumed that all of the maintenance crews except the Patrol Crews are based at the District Headquarters, and that all members of the supervisory staff are stationed there. However, it is recognized that it may sometimes be necessary to establish work camps or other types of sub-headquarters in order to carry out certain operations in an efficient manner. In large districts, or in districts having a large number of highways, sub-districts are sometimes established. Because of the

numerous local problems which might be encountered and the wide variety of specific solutions which might be indicated, no detailed typical organizational plan below the district level of operations is included in this report.

a. Maintenance Camps

Special maintenance crews sometimes undertake operations at relatively long distances from the District Headquarters. In order to reduce the problems of transporting personnel, materials and equipment, to arrange for better equipment maintenance, and to provide more effective supervision and accounting records, sub-headquarters may be established for these operations. These sub-headquarters may include a small field office; materials, fuel and equipment storage; and facilities for equipment maintenance and minor repairs. The sub-headquarters may provide a base of operations for one or more crews which are working in the same general area.

If the sub-headquarters for special maintenance crews are located in a relatively isolated area, into which the members of the crews must be brought, living quarters may be provided and a Maintenance Camp established. A Maintenance Camp is also sometimes established in an isolated area on a permanent or semi-permanent basis to take over all of the maintenance operations in the area, including the routine maintenance work which is normally carried out by Patrol Crews.

On improved highways under regular maintenance there are frequently local sources of aggregate which have been established during previous construction or reconstruction operations. These sources may include stone quarries or gravel deposits. There are likely to be service roads already constructed, connecting the site to the nearest point on the highway. It may be expedient to establish a Maintenance Camp at one of these sites, since some of the important maintenance operations would probably be concentrated at this location.

b. Sub-Districts

In a district which contains a large area, or which has a large number of highways, one or more sub-districts may be established, covering the highways in certain areas. The sub-district may be charged with the supervision of a portion of the maintenance operations, or it may be given the responsibility for all of the maintenance work, depending upon the situation. The extent to which each sub-district is provided with facilities and staff will be determined by the needs. In some highway departments, sub-districts are established on a permanent basis, whenever the total operations of a district become too large for effective

management and supervision from the District Headquarters. It is important that the districts be retained as the primary elements in the field organizational structure of the Maintenance Division, and that the total number of districts should not normally be changed to meet the demands of the increased amount of maintenance work arising from normal conditions.

In a large district with many highways a sub-district organization may closely approximate the District Headquarters, with a sub-district shop, a warehouse, and a clerical staff, and with the various foremen performing the same or similar functions as those working directly for the District Headquarters. Usually, however, the Sign Foreman and the Bridge Foreman continue to operate from the District Headquarters. The relationship between the sub-district staff and the district maintenance staff will approximate the relationship which exists between the District and the Central Headquarters Office, with the head of the sub-district organization reporting directly to the District Field Maintenance Engineer.

5. Regional Divisions

In a country in which the highway system extends over a very large area, and particularly where there are large sections of the country which are somewhat isolated, districts are sometimes combined into groups or regional divisions, and placed under the general direction of regional division offices.

In normal circumstances, regional divisions should be established if there are more than 12 or 15 districts in the Maintenance Division. A regional division usually includes three to five districts. For example, a Maintenance Division which has 10,000 km (6,000 miles) of highways in the system might have 18 districts, representing five regional divisions, each of three or four districts.

Regional division boundaries are established to conform to the boundaries of the established districts. The grouping of districts into regional divisions may be influenced by topographic barriers, concentrations of highways within the system, the location of centers of population, and existing transportation facilities. One regional division is frequently established with the Regional Division Headquarters at the same location as the Headquarters (Central) Office, although this is not always done.

The Regional Division staff may consist of a Regional Division Engineer of Maintenance and one or more assistants. In a large maintenance organization, the Regional Division may be organized and staffed in a manner similar to the Maintenance Division in the Headquarters

Office. The Regional Division Engineer of Maintenance is responsible for all of the maintenance operations in his regional division, and all District Chiefs report directly to him. He normally receives all reports and correspondence from the districts and transmits information to the Headquarters Office. He is directly responsible to the Chief Engineer of Maintenance, and maintains the same relationship with the members of the Headquarters staff of the Maintenance Division as has been described for the District Chiefs, where regional divisions have not been established.

Since the need for a highway organization which goes beyond the typical arrangement of Headquarters and Districts depends entirely upon special local situations, particularly those of area and accessibility, this kind of organization is not indicated in the charts and no further discussion is included in this report.

COMBINED RESPONSIBILITIES FOR MAINTENANCE AND OTHER HIGHWAY WORK

Some highway systems extend over large areas, or include areas which are relatively isolated. Construction work is frequently concentrated in a few outlying or unconnected areas. Under these conditions it has sometimes been found difficult to administer the work of making surveys, preparing plans, or supervising highway and bridge construction projects from a central headquarters office. Sub-headquarters offices to direct engineering and construction activities within certain areas may be established to overcome the difficulties inherent in an administration which is completely centralized.

1. Construction Districts

Construction districts are sometimes established to supervise engineering and construction work in a certain area. The boundaries of these districts may be made to coincide with those of maintenance districts. If this is done, the representatives of the Chief Engineer of New Works may have their headquarters at the same location as the District Chief (Maintenance) and his staff. In some situations, the district established for engineering and construction may not coincide with the maintenance districts. Also, they may be established on a temporary basis, to meet the needs of a current construction program.

In any of these situations the District Chief (Maintenance), his staff and maintenance forces, will operate independently from the staff that is responsible for engineering and construction projects, and he will report directly to the Chief Engineer of Maintenance at the Headquarters Office.

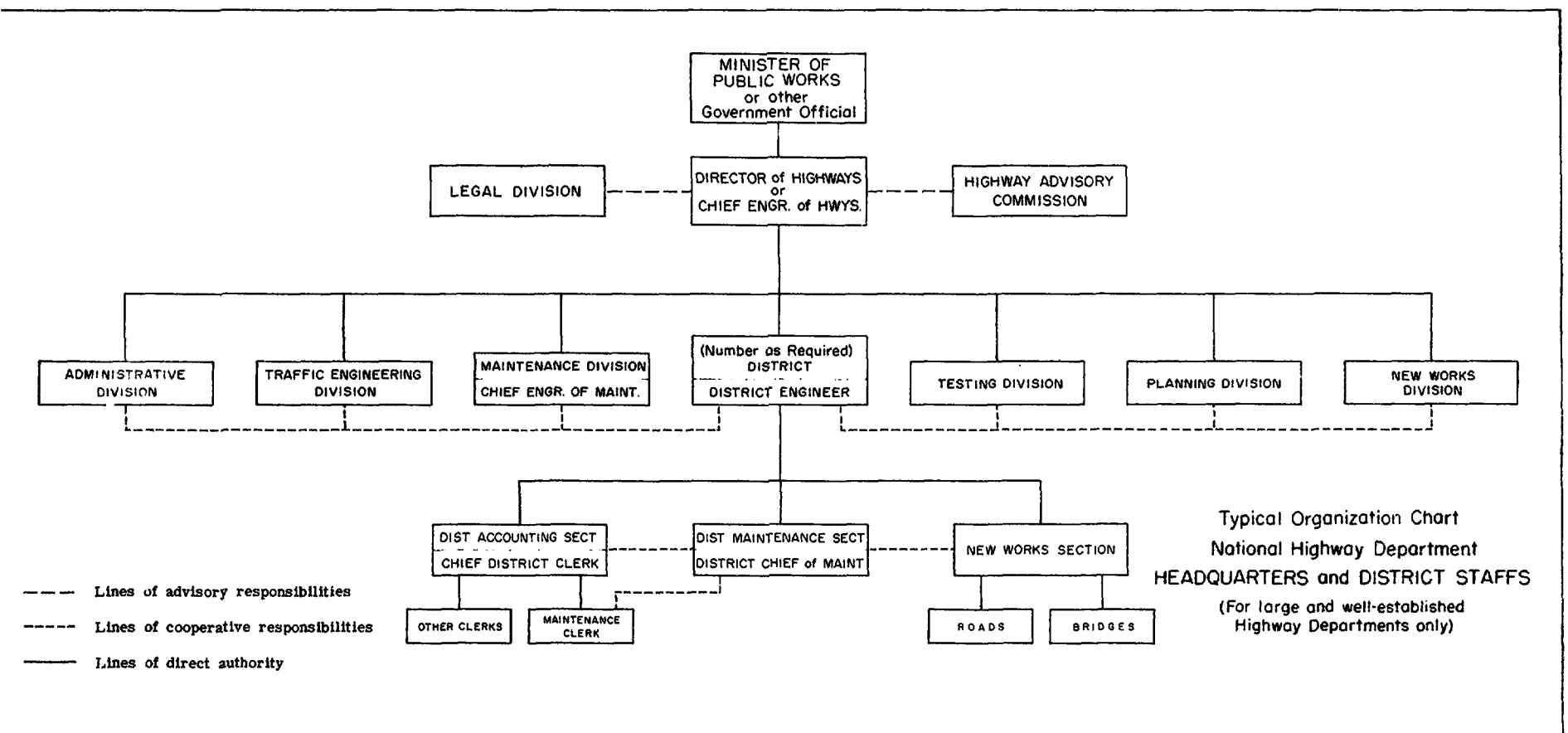
2. Districts with Combined Functions (Chart III)

Older highway departments with extensive highway systems have in some instances developed their operations to an extent which requires a degree of decentralization in the administration of all major functions. Many of these departments have established districts, with district offices each having a chief administrator who is in charge of all of the operations of the Highway Department within the district. An organization plan for this type of administration is shown in Chart III.

Under this system the District Engineer, as chief executive, is directly responsible to the Director of Highways. In practice, the District Engineer and the members of his staff work in close cooperation with each of the Headquarters' Divisions, and only in situations in which important matters of policy are involved, or in cases of disagreement, do the established formal lines of authority become operative.

The District staff is organized in a manner similar to the Headquarters organization, with the various functions being assigned to district staff members who are responsible to the District Engineer. The principal sections include Accounting, Maintenance and New Works.

The inherent disadvantage of this system of administration is that none of the Headquarters Divisions, including the Maintenance Division, has executive authority in the field. There is no direct line of authority from the Headquarters Office to the District staff, except through the Director of Highways. For example, the District Chief of Maintenance (Chart III) is responsible only to the District Engineer, and the Chief Engineer of Maintenance at the Headquarters Office has no authority over either the District Chief of Maintenance or the District Engineer, except through the Director of Highways. However, the total responsibility of the District Engineer for the area he controls insures co-operation between the members of the entire District staff and provides for the coordination of all operations. These advantages frequently warrant the adoption of this type of organization in large and well-established highway departments.



Typical Organization Chart
National Highway Department
HEADQUARTERS and DISTRICT STAFFS
(For large and well-established Highway Departments only)

CHART III

IV. PERSONNEL ADMINISTRATION

The administrative and supervisory staff of a highway department is composed of personnel representing a wide range of specialties, interest and general qualifications. The management of personnel in this kind of organization calls for the establishment and continued application of effective administrative policies, recruitment methods and training programs.

The maintenance force of a Highway Department represents an organization which is totally unlike any other group of public employees, for several important reasons.

In many countries, the highway maintenance organization is the largest single group of public employees, sometimes representing fully half of all the persons who are directly dependent upon the government payroll for their livelihood. Highway maintenance also frequently constitutes the largest single undertaking of the government in the total expenditure of government funds. The work that is done by this force directly affects a large proportion of the citizens, and it closely concerns the welfare of the entire population.

Maintenance work calls for technical knowledge, skills and capacities which are widely varied, and which are generally more closely related to the proficiencies required by private industry than those of public service. Unlike most public employees, maintenance supervisors and laborers are responsible for physical accomplishments, with the results of their labors plainly visible to themselves and to the public at large, as compared to the services usually rendered by public agencies, the results of which are impossible to see and difficult to appraise.

A maintenance organization is thinly scattered over the entire country, with the management and supervision of the work reaching down from one level of administration to another in long lines of responsibility and authority which are difficult to follow and to maintain. Its work is subject to all of the variations of climate, topography, population and other local factors that the country has to offer, but must still conform to general standards and policies established for the good of the entire country.

Maintenance forces, composed of local residents, work in almost every community, in intimate daily contact with the local population, on work which is of personal interest to almost everyone. Many of the basic operations are carried out by crews of three or four men, with a minimum of outside supervision. They may be constantly subjected to all types of pressures, political and otherwise.

Because of all of these factors, many of the management and personnel policies which have been adopted for government employees as a whole cannot be successfully applied in the Maintenance Division of the Highway Department. Many of the difficulties which have been encountered in the development of a good maintenance organization are frequently the result of failure to take these factors into account and to adopt special management procedures to meet the problems which are inherent in maintenance work. Although some of these special procedures may be subject to legal limitations which apply to all government employees, many highway departments have found it to be possible to establish certain policies and regulations which are designed especially for maintenance employees.

Personnel policies and practices which are needed for good personnel management in a maintenance organization are discussed below.

ADMINISTRATIVE POLICIES

Effective personnel administration is only possible if it is directed by staff officials who are experienced in personnel management. It includes the following basic elements:

1. Selection and Placement of Employees
2. Salaries, Wage Scales and Promotions
3. Social Benefits
4. Tenure

1. Selection and Placement of Employees

Maintenance work requires specialized training and experience, and a constant effort should be made to engage and retain experienced personnel, and to train additional employees. In order to obtain the most effective use of the persons who are available, it is important that each of them be assigned to a position in which he can work most efficiently. This requires continued attention and adjustments in the staff organization, until stability is obtained, as demonstrated by efficiency in the work.

2. Salaries, Wage Scales and Promotions

Salaries and wage scales should be established at sufficiently high levels for all grades of the organization, to prevent the rapid personnel turnover which almost always accompanies low pay. It is a difficult problem in personnel management to establish pay scales which are sufficiently high and properly proportioned to retain staff members. Not only are many classifications needed for the different kinds of work, but there may also be many variations in the economic conditions of the

different geographical areas which would require adjustments in the established scales of salaries and wages. Experience and length of service are other factors that should be considered. Good employee relations require specific base rates of pay for each position or type of work in each area of the country, with provisions for increases based upon promotions or increased experience and competency in each particular position. Experienced personnel specialists are needed to develop and administer such a system of standardized pay scales.

3. Social Benefits

Standard rates for salaries and wages cannot produce the desired results unless they are accompanied by adequate provisions for social security benefits. Private industry has found in almost all areas of the world that the benefits to employees of hospitalization insurance, compensation insurance for injuries, sick leave, vacations with pay, and retirement plans, are important factors in procuring and retaining qualified employees. In many countries minimum requirements are established by law to protect employees in private industry and to provide some form of continuing protection for their dependents. In such countries, the Highway Departments frequently follow these same regulations. However, even where these social benefits are not legally required, it is still good practice to institute them in order to secure and retain good employees, and to strengthen the morale of the organization. The cost of adequate social security benefits is frequently much less than the cost of the equivalent inducement to work, using higher pay scales without such benefits.

4. Tenure

One of the universal problems that faces highway administrators is the relatively rapid turnover among the employees of a highway department. Although administrators may increase the average length of employment by the careful selection and placement of new personnel, and by providing adequate pay scales with social security benefits and good working conditions, situations may still develop which will encourage the resignation or dismissal of employees, and their replacement by new personnel.

The organization of a highway department usually extends into every area and political province of a country. It is composed of many types of people, including engineers, technicians, and skilled and common laborers. It is inevitable that this kind of organization will be an invitation for those who have personal interests in obtaining positions for their friends, relatives, or political associates, to find ways of securing

new appointments, thereby eventually replacing members of the staff with new and sometimes unqualified persons. It is, of course, a problem which is as old as the institution of public works, but there are specific things which good highway administrators can do to control or minimize this situation.

In the first place, proper selection of qualified personnel for each position tends to discourage their eventual replacement. Actions which are obviously to the detriment of good highway operations are not popular with the public and consequently are not good politics. Administrators may find it possible to defend their refusal to replace competent employees with incompetent or inexperienced persons. Standardized classification of employees, each classification having carefully prescribed qualifications and corresponding standard rates for salary or wages, may form the basis for security in employment.

It is usually considered to be good personnel practice to centralize the authority for making new appointments, transfers and promotions. In most highway departments, the District Chief is given the authority to employ skilled and common labor personnel, and to adjust their wages according to established standards. All other appointments, transfers, reclassifications and promotions are made by the personnel office at the Central Headquarters Office. Local pressures are thereby dissipated and important personnel problems can be taken directly to the Director of Highways.

An efficient highway organization must be staffed with qualified, experienced and loyal individuals. This condition can exist only if the personnel is well paid and well treated, and if each employee has the feeling of security that comes with knowing that so long as he does his work well, he will continue as a member of the organization.

USE OF NON-ENGINEERING PERSONNEL

One of the problems that frequently confront the officials of a national highway department is the lack of engineering personnel for administrative and supervisory positions, especially in the maintenance organization.

This problem has been found to be particularly acute in obtaining competent persons to be placed in charge of the maintenance districts of developing highway departments. This position calls for a person with experience in administration and with adequate knowledge of maintenance operations, and also someone with the additional ability to manage a large organization and to conduct the entire maintenance operation on a sound and businesslike basis. Frequently, the engineers

available are too young to have acquired these additional abilities through experience. Although engineering ability is useful in this position, it may not be as important as the general executive ability which is called for. If a non-engineer is employed for the position, it is important that he have engineers on his staff, and that engineering advice be available from the Headquarters Office.

Another problem encountered, even in areas where there is a sufficient number of experienced engineers, is the tendency of many engineers to avoid maintenance work because of its routine nature. They may attempt to transfer to other divisions where the work is considered to be more creative and spectacular. For this reason, it is important that young engineers not only be assigned to the kind of maintenance work which provides a challenge to their technical ability, but also that they have the opportunity to be transferred or promoted to other positions within the highway organization. It is easier to carry out this policy if there is an opportunity for non-engineers in the maintenance organization to take over certain administrative and supervisory positions, since the engineers may then be trained and promoted to positions calling for increasing engineering competence.

In some areas, formal programs for training technical personnel have been established at schools and colleges. Although these programs are planned to produce technicians who are below the level of graduate engineers in technical knowledge, this group of trained individuals has much to offer a maintenance organization. There are several positions in any well-managed maintenance organization which should eventually be held by graduate engineers, but many other positions may be filled by personnel other than graduate engineers, who have shown themselves to be capable.

In older and well-established maintenance organizations some supervisory and administrative non-engineering employees become proficient in specific types of activities. These men should be carefully considered for promotions to more advanced positions in their specialized fields. They not only provide a source of competent persons for more difficult assignments, but the recognized opportunity for advancement is likely to lead to their better performance in the work assigned.

In a new or developing highway maintenance organization, it is sometimes necessary to obtain staff employees from outside the organization. The appointment of new non-engineering employees to positions of responsibility in the maintenance organization should be approached with caution. It is recognized that the requirement that a candidate must have an engineering degree tends to encourage the selection of personnel

strictly on the basis of technical ability. However, this specific requirement avoids some of the dangers which are inherent in the unrestricted appointment of personnel without having definitely established standards of competency.

It is also recognized that a number of young engineers should be employed in the districts to provide a source of trained employees for future promotions to higher positions.

It is usually not practical to apply the same general system of promotion for technicians and other non-engineering employees, as that which is used for graduate engineers. The non-engineering men will normally be retained in certain specific fields and will be expected to reach the terminal point in their careers at a lower organizational level than the engineers. Consequently, engineers are expected to be assigned to a variety of positions, and the training that is acquired in this way will finally lead some of them to the top positions in the organization.

TRAINING PROGRAMS

1. Engineers

The staff of the Maintenance Division should include engineers who are experienced in maintenance operations, as well as in other phases of highway engineering. Young engineers who are assigned to the Maintenance Division, and also older engineers who are assigned to maintenance operations for the first time, should be given an opportunity to learn something of the fundamentals of maintenance work as quickly as possible. Although formal lectures and discussion groups are sometimes planned, one of the most effective means for providing this training is a carefully planned and specified tour of duty, which will include assignments under the direct supervision of competent maintenance engineers who are working in various locations. In this way, the trainee can observe actual administration, methods and procedures, as they are carried on in the field. His background of experience should include the best that each of several engineers has to offer. He can then be expected to accept his first regular assignment in the Maintenance Division with more assurance than would otherwise be possible.

In addition to training engineers who are inexperienced in maintenance work, it is also important that engineers in the Maintenance Division be given the opportunity to continue their training after they have assumed their regular responsibilities. This additional training may include a deliberate effort to diversify the actual experience which is being accumulated by a staff member by transferring him from one area to another, in accordance with an established plan or schedule. In this

way, qualified men can be trained in the field under the various situations and conditions which exist in the different areas. This may be a practical method for preparing engineers for the executive positions which have eventually to be filled at the Headquarters Office, or for the higher positions in the District Office.

This system of rotation has usually been found to be more practical if it is applied principally to younger engineers. Better morale is maintained if each new assignment is accompanied by a small promotion in rank or status, or by an increase in salary. Living quarters should be supplied by the Maintenance Division in many areas, if the rotation plan is to be successful.

In many highway departments the members of the staff of the Maintenance Division are called into the Headquarters Office at least once each year for a regular meeting, which includes lectures and conferences. The lectures are usually given by maintenance staff members, engineers from other divisions of the Highway Department, and specialists who are brought in from the outside. The conferences or discussion groups are conducted by members of the maintenance staff.

During the past few years there has been an increasing trend to introduce new ideas on maintenance administration, methods and procedures, by interchanges between different countries. This is accomplished by securing experienced highway engineering consultants, by sending local engineers to other countries for formal training or temporary employment, and by establishing a regular exchange program in which local engineers are exchanged by neighboring countries for short periods of employment. Each of these methods has proved successful when properly executed.

There is no phase of highway engineering which requires more engineering skill, practical judgment and administrative ability than that of maintenance. A sound training program will do much to expedite the process of creating a competent maintenance engineer.

2. Skilled Labor

Skilled labor, including equipment operators and mechanics, is in short supply in many areas of the world. The procurement of this type of personnel by highway departments is usually difficult because of the competition from private industry, and the remote areas in which some of the employees are forced to live and work. For these reasons, most highway departments find it necessary to develop skilled operators and mechanics from partially trained personnel, or from the ranks of unskilled laborers.

Equipment operators are normally expected to operate several types of equipment, although they are likely to develop special proficiency in one or two types. Many highway departments have established regular training schools at Central Headquarters, or in selected District Headquarters, where skilled operators of tractors, graders, shovels and bituminous distributors teach trainees under actual operating conditions. General subjects, including the operation of internal-combustion engines, are usually included in the course. These schools are expensive to operate, but they have been found to be good investments. Frequently, equipment manufacturers or dealers have cooperated in these undertakings, at least to the extent of supplying trained operator-instructors for specified times.

The training of operators can be expanded by bringing experienced operators to the district headquarters, or to the site of certain operations, where trainees can receive on-the-job instruction and practice. Although this method may be practical for some types of equipment, including small graders, small tractors, stone spreaders and other small or inexpensive equipment, it must be used with caution on larger and more expensive types of equipment.

In the case of bituminous mixing plants, travel mixing plants and stone-processing plants, operators frequently receive instruction and training by representatives of the manufacturers, assigned for a sufficient period of time to train the operators and their assistants and to complete field adjustments of the equipment.

Operator training should include equipment maintenance as an important part of the work. It has been found to be much less difficult to teach a man to become a reasonably proficient operator, from the standpoint of production, than to convince him that he must be responsible for the careful operation of the machine and for daily preventive maintenance in order to prolong its useful life.

Mechanics may be trained by the same general methods that are used to train operators. In some highway departments, mechanics are trained in the schools which are used for operators. The same highway equipment can be used for both groups, with various kinds of shop equipment provided for the repair shop.

The work of a skilled mechanic in an equipment repair shop is adaptable to apprentice-type-understudy training, in which unskilled or partially trained persons work under the direct supervision of a skilled or master mechanic. In areas where there is a need for additional trained personnel, the skilled mechanics who are available as instructors should be established at locations in which maximum advantage can be gained from these training opportunities.

Highway administrators cannot afford to neglect employee training. The Chief Engineer of Maintenance is particularly concerned with developing adequate training programs for the employees in his division. The solution to the problems of establishing training centers and on-the-job training procedures will vary from one area to another, according to many local factors, including the availability of manpower and the general proficiency of the personnel already employed. An adequate solution may be expensive in terms of staff time and highway funds, but few highway departments which have established good training programs have ever deliberately abandoned them, even after the personnel situation has become more stabilized. It is a subject which should demand the careful attention of the Chief Engineer of Maintenance and his staff, and of every District Chief.

ANNEX 1

MAINTENANCE ORGANIZATION - STAFF POSITIONS AND DUTIES

The following list of staff positions is taken from Charts I and II, which present an organization plan for the Maintenance Division of a highway department. Information concerning the immediate superior, the cooperative responsibilities, the immediate subordinates and the established duties are included for each position.

CENTRAL HEADQUARTERS MAINTENANCE STAFF (CHARTS I AND II)

1. Chief Engineer of Maintenance

The Chief Engineer of Maintenance is directly responsible to the Director of Highways. He is expected to maintain an active cooperative relationship with the heads of all other divisions in the Headquarters Office. He also refers information and problems which do not concern maintenance to other divisions, as they are received from the field.

The staff members at Headquarters who are to report directly to the Chief Engineer of Maintenance include the Equipment Engineer, the Maintenance Planning Engineer and the Field Engineer of Maintenance, and, in larger organizations, the Supervisor of Traffic Services and the Landscape Engineer. These staff members have no executive authority beyond that which is established within their own sections in the Headquarters Office of the Maintenance Division. They maintain an advisory status in the field. The District Chiefs also report directly to the Chief Engineer of Maintenance.

The duties of the Chief Engineer of Maintenance include the general direction of all field maintenance operations within the Highway Department; the selection (for purchase), operation and repair of maintenance equipment; the preparation of maintenance plans for future operations, including the preparation of the budget; and the general direction of all personnel within the Maintenance Division.

2. Equipment Engineer, Shop Superintendent and Equipment Inspectors

The Equipment Engineer is directly responsible to the Chief Engineer of Maintenance. The staff members who are to report to him include the Equipment Inspectors from the field and the Shop Superintendent of the Central Repair Shop and Central Warehouse.

The duties of the Equipment Engineer include the general supervision of equipment repair and maintenance and warehouse activities at the Headquarters Office. He aids in the selection of equipment to be purchased. He also cooperates with the district organizations in all matters pertaining to equipment and equipment maintenance, and the operation of repair shops and warehouses, both directly and through the members of his field staff.

The Shop Superintendent is responsible to the Equipment Engineer. He is in charge of the management and operation of the Central Repair Shop. Since the Central Shop is usually more completely equipped than the shops in the districts, he should work in close cooperation with the District Shop Foremen, who will usually send the most difficult repair jobs to him.

The Shop Superintendent frequently is placed in general charge of the Central Warehouse, since this operation is normally closely connected to the operation of the Repair Shop.

The Equipment Inspectors report to the Equipment Engineer. Their duties include the inspection of maintenance equipment in the field and in the shops, and of district repair shops. They are usually accompanied on their inspections by district staff members. They advise and report on the condition of equipment, the adequacy of equipment maintenance, the operation of repair shops, the completeness of service reports, the scheduling of equipment operations and all other matters which concern the effective use and expected life of each item of equipment. They are expected to cooperate with the members of the staff in each district, as well as to report to the Headquarters Office. They have no delegated authority in the field.

3. Maintenance Planning Engineer

The Maintenance Planning Engineer is responsible to the Chief Engineer of Maintenance, although he must maintain close contacts with the Planning Division, with the heads of all maintenance sections at the Headquarters Office, and with the districts. His staff should include competent accountants.

The Maintenance Planning Engineer is responsible for the management of the Budget Control Section. He is charged with the duty of preparing the detailed maintenance budget, from information obtained from the Chief Engineer of Maintenance and from records of previous expenditures. He is also responsible for maintaining current records of expenditures in the various categories of maintenance operations, and for supplying the Chief Engineer of Maintenance with up-to-date information

concerning the existing balances in the various items of the budget. If the maintenance budget is to provide an effective control over the operation of the Maintenance Division, by which the various types of maintenance work are held to some predetermined balance, it is important that the Budget Control Section provide adequate and continuous information on the current status of the budget. This is the only means by which the budget can be effective in guiding maintenance administrators in their daily operations, and in the planning of work which is to be done in the immediate future.

In order to maintain current records of expenditures, and to offer direct guidance to the Districts in matters pertaining to fiscal controls, the Planning Engineer and his staff should maintain close contact with the district staffs.

4. Field Engineer of Maintenance and Field Inspection Engineers

The Field Engineer of Maintenance reports directly to the Chief Engineer of Maintenance. His staff consists of a group of Field Inspection Engineers, who work out of the Headquarters Office. His duties include the general supervision of all maintenance field inspection, and the reporting of his findings to the Chief Engineer of Maintenance. He is also charged with the responsibility of promoting close cooperation between his field engineers and the staff of the various districts, in order that operational problems may be solved in the field without delay. His Office should serve as the principal means of introducing new methods for standardizing operations in the districts, and of establishing adequate maintenance standards throughout the system.

The Field Inspection Engineers assist and report to the Field Engineer of Maintenance. Although the proper number of engineers to be assigned to this work must be determined for each situation, one Field Inspection Engineer for each two districts in the Highway Department might be considered to be average. This staff should be made up of experienced highway engineers, some of whom may be specialists in bituminous work, drainage, and structure maintenance.

Field Inspection Engineers are delegated no direct authority in their relations with the District Chief and his staff. With the help of members of the district staff, these field engineers carry out routine inspection of maintenance operations, bridges, and general highway conditions, and investigate special maintenance problems. They also may serve as general maintenance consultants to the district staff. The inspections may provide a means for rating the relative adequacy of maintenance operations on the various highway sections. These formal inspection ratings may be especially useful to the district staff, because they are prepared by engineers from outside the district.

Each Field Inspection Engineer usually works from one district to another, in order to take full advantage of his special interests and capabilities, and to promote better correlation in the work of all the districts.

5. Supervisor of Traffic Services

The Supervisor of Traffic Services is responsible to the Chief Engineer of Maintenance, and he is expected to work in close co-operation with the Traffic Engineering Division of the Highway Department and with the districts. His staff includes specialists in the field and at the Headquarters Office.

The Supervisor is responsible for the management of the Traffic Services Section. The work consists of the general planning and supervision of all operations which are required to construct (or place) and maintain traffic signals, traffic signs, pavement markings and other traffic aids. Although all or most of this work is done by district forces, it is important that the installations be carefully standardized from one district to another, according to recommendations from the Traffic Engineering Division. The efforts of the Traffic Services Section at the Headquarters Office should be directed to this end.

In some highway departments certain highly specialized operations, including the placing of pavement center-line markings, are carried out by crews who operate from the Headquarters Office. If this is done, the Traffic Services Section is responsible for these operations.

This section is also responsible for issuing permits for the use of over-loaded or over-sized vehicles in special circumstances, for the construction of private entrances to the highway, and for other roadside developments.

6. Landscape Engineer

The Landscape Engineer is responsible to the Chief Engineer of Maintenance. His staff is composed of field personnel who are competent in the use of living plants for highway purposes.

The Landscape Engineer is in charge of the Roadside Improvement Section. This section is responsible for the preparation of plans and specifications for both maintenance work and work on construction projects. In the field the members of the staff act as advisors to the District staffs and to the representatives of the Construction Division.

The work includes two general fields. The more important of these concerns the use of plant materials for the prevention of damage by erosion; the planting of grasses, vines, shrubs and trees has proved to be an effective and inexpensive method for controlling erosion on banks and in ditches. This work should be planned and supervised by specialists, whether it is to be done by the Maintenance Division, or as part of a project for new construction.

There is a growing trend for highway departments to use shrubs and trees to improve the appearance of the roadside in selected locations. This work requires skilled landscape specialists, if the results are to be satisfactory.

DISTRICT STAFF

(CHART II)

1. District Chief

The District Chief is directly responsible to the Chief Engineer of Maintenance. He is expected to maintain close cooperation with the heads of the various sections of the Maintenance Division in the Headquarters Office, and with the staff members who visit his district.

The district staff members who are responsible to the District Chief include the Chief District Clerk, the District Field Maintenance Engineer, the Shop Foreman, the Warehouse Foreman and the Sign Foreman.

The District Chief is responsible for all maintenance operations within his district. He works with his staff in preparing long-range maintenance plans and proposed maintenance budgets. He provides general supervision over the operation of the District Repair Shop, and the District Warehouse and the work of the Sign Foreman. He also maintains an active interest in all of the work which is being done by the various working crews of the district, which are under the direct supervision of the District Field Maintenance Engineer. He should inspect all of the highways in the district at frequent intervals, sometimes in the company of Field Inspection Engineers from the Headquarters Office. He is responsible for the overall administration of the personnel in the maintenance forces in the district, enforcing safety policies, securing skilled personnel, establishing training programs, and carrying out other personnel policies and regulations which have been established by the Chief Engineer of Maintenance. He is also responsible for good public relations in matters which pertain to maintenance work.

2. Chief District Clerk

The Chief District Clerk is directly responsible to the District Chief, although he is expected to maintain close contact with the Accounting Section of the Headquarters Office. His staff includes clerks and accountants, and other office personnel.

The duty of the Chief District Clerk consists of maintaining complete, accurate and up-to-date records of all maintenance appropriations and

expenditures, according to methods which are prescribed by law, by the Director of Highways, or by the head of the Accounting Section of the Headquarters Office. He usually acts also as general office manager of the District Office, supervising the general office personnel.

3. District Field Maintenance Engineer and Foremen

The District Field Maintenance Engineer is responsible to and may serve as the assistant to the District Chief. The personnel who report directly to him include the Paving Foremen, the Bridge Foremen, the Maintenance Foremen, Aggregate Foreman and the Field Supervisors.

The duties of the District Field Maintenance Engineer include the general supervision of all field maintenance operations except those which are supervised by the Sign Foreman. He is responsible for the assignments of the various operations to the maintenance crews and to the patrol crews. He is expected to make frequent inspections of all highways in the District, and to help the Foremen and Field Supervisors in establishing work schedules. He is directly responsible for maintaining discipline and good morale in the working crews. He should make regular checks on the actual working periods of the various crews, and on the amount of work which is accomplished. He should aid the Foremen and Field Supervisors in the preparation of payrolls and other reports in order that charges for expenditures can be made in the proper manner. He may assign equipment to the various crews and transfer workmen from one crew to another. In general, his primary responsibility is the promotion of well-planned, efficient field operations, co-ordinating the efforts of the various working crews throughout the district.

A Paving Foreman works under the direct supervision of the District Field Maintenance Engineer. He is in charge of a Pavement Repair Crew, normally working out of the District Headquarters.

A Pavement Repair Crew is responsible for the major repair or rehabilitation of existing pavements and for resealing and resurfacing operations. In districts which have a large amount of bituminous pavements, two or more foremen and crews may be needed.

The Bridge Foreman reports to the District Field Maintenance Engineer. He is in charge of a Bridge Repair Crew.

The Bridge Repair Crew is responsible for all work on existing bridges in the district, except for minor routine maintenance operations that can be done by Patrol Crews. Where extensive repairs are to be made and large and special equipment is needed, as for bridges which have been wrecked by vehicles or flood waters, the work may be let to contractors. Bridge painting is usually assigned to the Bridge Repair Crew.

An Aggregate Foreman is in charge of the production of highway materials which are locally available. In many areas the maintenance forces are assigned the responsibility of quarrying and crushing stone. They may also excavate gravel from pits or river banks, and process it by washing and screening. This work requires special equipment, and the locations of the sites, as well as the methods which are used, are likely to lead to a concentration of production at certain selected locations. For these reasons, it is frequently desirable to establish a special crew or crews for this work.

A Maintenance Foreman works under the direct supervision of the District Field Maintenance Engineer. He is in charge of one or more special Maintenance Crews, or a Maintenance Camp.

Special Maintenance Crews are responsible for all maintenance in the district except the special work which is done by the Sign Crew, the Pavement Repair Crews and the Bridge Repair Crew, and those routine operations which can be readily carried out by Patrol Crews. The work may include shoulder rehabilitation, drainage improvements, culvert repair, and minor reconstruction or betterments.

4. Shop Foreman

The Shop Foreman reports directly to the District Chief. His staff may include section foremen working in the District Repair Shop, a stockroom clerk, and field mechanics who are stationed at the Repair Shop but operate in the field. His duties include the direct supervision of all shop activities, the instruction of mechanics and other personnel, and the stocking of repair parts. He is also responsible for the general care of all maintenance equipment, including preventive maintenance and the procedures which are employed by equipment operators to prevent excessive wear and damage to the equipment. He is expected to cooperate in all matters pertaining to equipment repairs and maintenance with the District Field Maintenance Engineers, the Maintenance Foremen and the Field Supervisors.

5. Warehouse Foreman

The Warehouse Foreman reports to the District Chief, usually through the office of the District Clerk. His duties consist of the direct supervision of the District Warehouse and the maintaining of all records concerning receipts, disbursements and current inventories, in accordance with the accounting procedures which have been established. He is also responsible for requisitioning any standard items of materials and supplies which are normally stocked, in order to maintain a proper reserve in the inventory.

6. Sign Foreman

The Sign Foreman is responsible to the District Chief. He is in charge of the district crew which erects and maintains traffic signs and signals. He also supervises the work of placing center lines and other pavement markings. He may be assigned the responsibility of maintaining railroad grade crossings and of providing suitable signs or other safety devices at these locations. He is expected to co-operate with the District Field Maintenance Engineer, the Maintenance Foremen and Field Supervisors.

7. Field Supervisors and Patrolmen

A Field Supervisor works under the supervision of the District Field Maintenance Engineer. He is in charge of the work of three or more Patrolmen on adjacent or connecting sectors of highway. He may sometimes combine two or more Patrolmen and their Patrol Crews into a special crew to carry out a special maintenance operation on one of the Patrol Sectors.

A Patrolman is assigned those operations of routine maintenance which can be carried out effectively by a small crew (usually two to five men) and a small amount of equipment working on a specific sector of a highway. The sector is normally 10 to 50 km in length. He and the members of his crew usually live on or near the sector to which he is assigned.

His work usually includes the minor repair of pavements, the leveling of untreated aggregate and earth surfaces at frequent intervals, the grading of shoulders, ditch cleaning, and right-of-way cleaning and mowing. He is expected to be thoroughly familiar with his sector of highway and to be able to anticipate maintenance problems in time to prevent serious problems from developing. He is to discourage or prevent encroachments on the established right-of-way. He is also expected to report these general problems to the Field Supervisor, and to co-operate with the Foremen of the various Maintenance Crews from the District Headquarters. He also serves as the most direct contact which the Highway Department is expected to maintain with the general public. In this capacity he has a very important responsibility.