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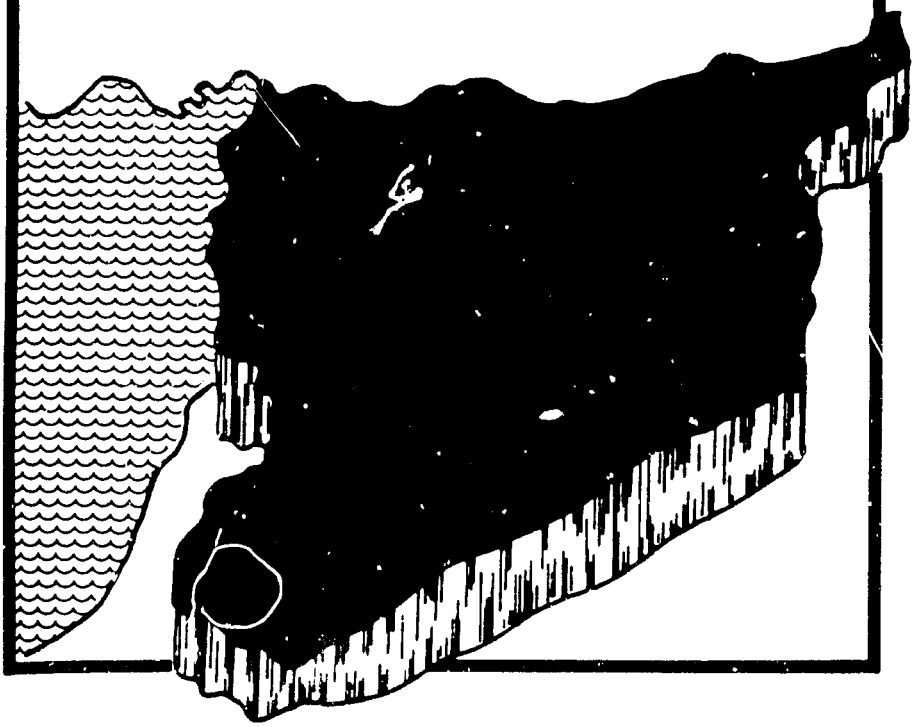

VOLUME IV

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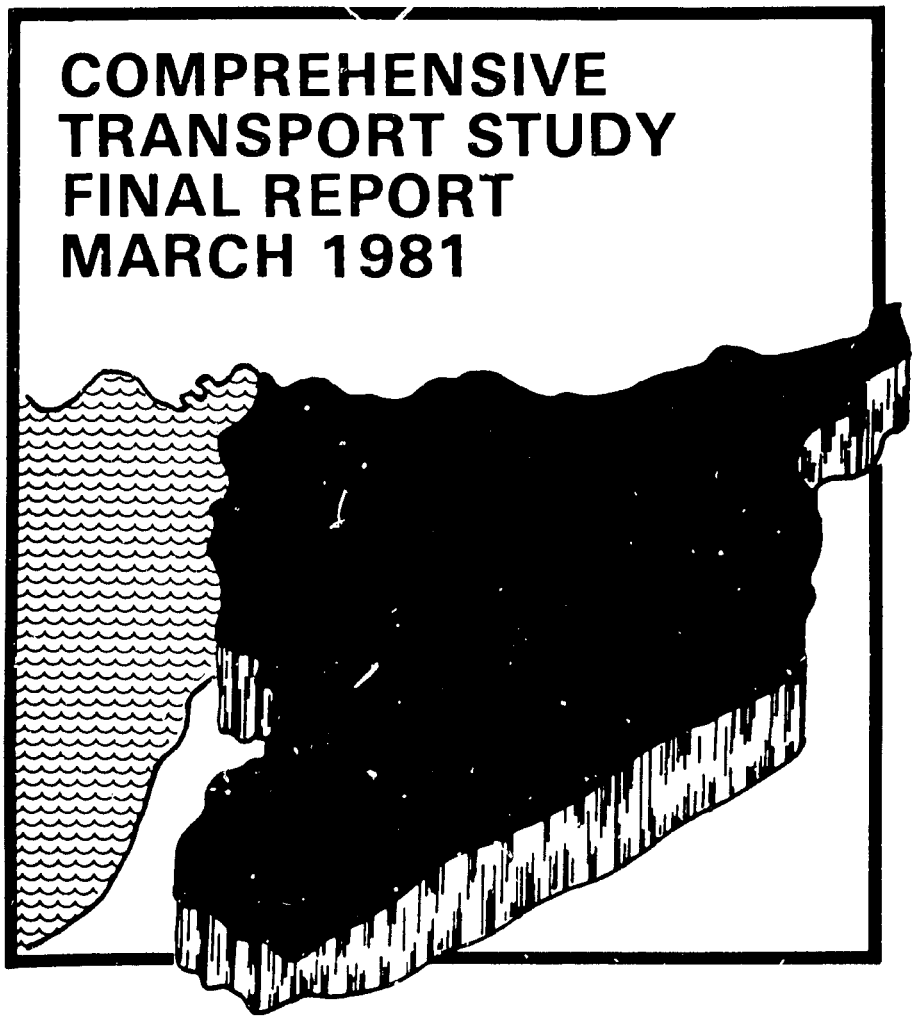

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This volume is one of seven produced as the Final Report for the Syrian Comprehensive Transport Study. The complete set of volumes is as follows:

Volume I	–	Executive Summary
Volume II	–	Transport Demand
Volume III	–	Railways
Volume IV	–	Roads and Road Transport
Volume V	–	Ports and Shipping
Volume VI	–	Other Modes and Related Industries (Aviation, Pipelines, and Construction and Storage Industries)
Volume VII	–	Transport Sector Plans

Volume IV

ROADS AND ROAD TRANSPORT

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CHAPTER 1

SUMMARY AND RECOMMENDATIONS

Chapter 1

SUMMARY AND RECOMMENDATIONS

The Consultants have analyzed the organizations that administer the roads and road transport systems, the existing road infrastructure, the ongoing investments, the proposed construction schedules, the maintenance funding levels, the transport industry operations, the vehicle fleet composition, and the rules and regulations which govern these. The analyses are based on inspections of pertinent documents, discussions with responsible officials, visual inventories, and systematic surveys of existing systems. Details of the investigations and findings are provided in this volume. The following is a brief summary of the findings and recommendations with references to the section of the text where the details are provided.

1.1 NETWORK ANALYSIS

The Paved Network

The Syrian paved road network has expanded four-fold during the past 20 years, doubling in length during the last 10 years alone to its current length of 12,570 kilometers. An analysis of the existing network, the investment plans, the proposed construction schedule, and the maintenance funding levels show that they appear to be adequate in scope but unlikely to provide for the fast, safe, and efficient transportation of people and goods through the year 2000. The details of the analysis leading to these conclusions and recommendations to rectify identifiable deficiencies are contained in Chapter 3 and summarized below.

- The estimated traffic is under 400 vehicles per day, approximately, on 42 percent of the paved secondary and tertiary roads and 11 percent of the primary roads. Roads in this traffic range require only a gravel surface and one traffic lane. Therefore these paved roads are over-designed for present traffic.

- Virtually all of the paved road system, except Class A roads, has a surface type that is equal to or better than the type recommended for that particular class of road.

- Twenty-six percent of the primary and one-half of the paved local roads are narrower than the standards normally applied to similar traffic volumes.

- Eighty-three percent of the entire paved road network has a fair or poor surface condition. Twenty-one percent of all roads need immediate reconditioning (resurfacing) and the remainder will require reconditioning during the early years of the next five-year plan.

The preliminary conclusions drawn from these findings indicate that: the construction of new paved roads is surpassing the traffic demand for all but very high volume roads; traffic on 40 percent of the existing paved roads is exceeding the capacity of these roads to move people and goods safely, quickly, and efficiently; and deteriorated surface conditions on 83 percent of the roads are resulting in a loss of benefits to the road users.

Unpaved Rural Roads

The Consultants also inventoried 30 percent of the estimated 5,200 kilometers of earth and gravel roads. Very low traffic volumes were observed. In addition, the data indicate that approximately 67 percent of the roads inventoried are wider than the Consultants' recommended standard for this class of road and 12.4 percent of the roads are more than standard. Forty-five percent of the roads are earth surfaced and should be upgraded to a gravel surface, and 24.5 percent are paved to a higher standard than is justified by present traffic volumes.

Most significant is the obvious lack of maintenance on these roads: 95.5 percent have surfaces in fair to very poor condition. The existing rural roads and tracks are rather extensive, but the neglect of maintenance is obvious on practically all the network. In a number of instances, the deterioration of roads has caused the villages to be partially abandoned and the terraced fields fallowed.

1.2 INVESTMENT ANALYSIS

The Consultants evaluated 12 rail/road scenarios, and investment recommendations are based on the least cost system alternative (see Chapter 7, below). In summary, the following conclusions have been drawn from the analysis.

- The proposed highway betterment program will yield high economic benefits, regardless of rail operations.

- Recommended marginal cost pricing by 2000 for passenger transport would result in substantial total system cost savings.

- The rail mode is more efficient than road, even when double tracking of the Damascus-Aleppo line is involved, if forecast rail efficiencies can be achieved.

5th Five-Year Development Plan

The paved road network for 1985 includes the present system plus 23 committed projects, the additional Hama-Saraqueb carriageway, and the Lattakia-Ariha highway. Road investments, including the extensive road betterment program and rural access roads, total SP 3 billion (see Table 7.5.1, Chapter 7). In addition, an estimated 90,000 new and replacement vehicles will be required at a total cost of SP 8 billion in foreign exchange (see Chapter 4).

1986-2000

Between 1986 and 2000, three new primary roads have been found to be feasible: Hama-Salemieh-Al Raqqa, the Aleppo Bypass, and Tadmur-Albu Kamal. The betterment program will continue, and an estimated 1,250 kilometers of unpaved road will require upgrading to Class C paved standards and 2,670 kilometers of new rural access roads will be built. Forecast investments total SP 3.2 billion over the 15-year period (see Table 7.4.4, Chapter 7). Over the 10-year period new and additional vehicles required will cost an estimated SP 44 billion.

User Charges

Depending on the Government policy regarding the import of automobiles, user charge revenues from 1981 to 2000 are estimated to total between SP 16 and 36 billion (Chapter 7, Section 7.6).

1.3 ROAD ENGINEERING

Design Standards

Tentative geometric design standards are recommended in Section 3.1. The design standards proposed specifically for Syrian conditions were selected from recommended international standards and are considered the minimum acceptable for the fast, safe, and efficient operation of motor vehicles. The pavement design methods currently being used are considered proper; however, it is recommended that the adequacy of the design be verified by soils material surveys, laboratory tests, and axle load studies. In addition, it is recommended that an immediate evaluation be undertaken of the bitumen base course designs currently in use with a view towards the possibility of returning to a crushed granular aggregate base course where

this is found to be practical. Advisory assistance to review design and construction procedures is recommended. A road deflection testing program in support of design and maintenance is also recommended (see Section 2.3).

Construction Practices

A number of construction practices that are contrary to Syrian specifications have been observed. These are discussed in Section 3.3. Such practices have been allowed to go unchecked by the normal process of construction inspection. The rules governing the responsibility for construction inspection have changed a number of times during the past few years and should be clarified and enforced.

Maintenance

The preliminary findings regarding road maintenance indicate that the funds allocated for maintenance are adequate to maintain the road network but that the network is badly deteriorated and continues to deteriorate at a faster than normal pace. The preliminary conclusions are that the efficiency of the maintenance units must be improved significantly through training, that they are not adequately equipped or staffed to maintain both local and primary roads, and that they need greater technical support from the Minist / of Communications and administrative support from all levels of Government. The Consultants recommend an advisory services contract to help establish one Mohafaza as a model road maintenance training and production unit. These factors are discussed in more detail in Sections 2.1, 2.3, and 3.4.

1.4 ROAD TRANSPORT

Motor vehicle registrations have expanded four-fold during the past 15 years. During this period, the number of passenger cars has almost doubled, while the number of commercial freight vehicles has expanded six-fold. In 1963, the vehicle ownership per 1,000 persons was 4.5 passenger cars versus 5.7 in 1978. For buses it was 0.37 versus 0.90, and for trucks 2.1 versus 3.2. Details are provided in Chapter 4.

Scrapping Rate and Vehicle Age

No scrapping rate has been established in Syria because vehicle withdrawals are not recorded on the registration forms. When a vehicle is withdrawn from circulation, the date should be noted on the registration form. Thus, the vehicle age will be known, an accurate scrapping rate could be established, and the actual number of vehicles on the road would be ascertained. This subject is discussed in Section 4.2.

Import Statistics

Customs entry points should be required to manifest imported vehicles by type, category, and class. At present, import statistics record vehicles only in total number, total weight, and value. By disaggregating imported vehicles by type, axle configuration, and unit, it would be feasible to know the age of the fleet by type and the category of vehicle. With such data readily available, future forecasts of the vehicle fleet could be made without a series of assumptions. This subject is discussed further in Section 4.2.

Motor Vehicle Department

Statistical data on vehicle registration by Mohafaza should be available on a timely basis. For example, in early 1980, the Mohafaza vehicle registrations for the years 1978 and 1979 were not yet finalized - let alone available for printing by the Central Bureau of Statistics. It is recommended that each Mohafaza report registration change every three months rather than waiting until the end of the year. By having regional registration statistics available on a timely basis, planning (based on existing trends) and forecasting could be significantly improved and the computer planning programs would have essential input information. See Section 4.2 for more details.

Vehicle Operating Costs

The methodology used to develop vehicle operating costs is provided in Chapter 6. It is a Delta L cost development method, which translates STET data into a linear measure reflecting the cost of operating typical vehicles over local pavement types and through various terrain conditions and geometric design characteristics. The periodic updating of these data is recommended to serve as a continuing, effective, and useful tool for the Government in future planning for economic development in the transport sector.

1.5 ORGANIZATION AND COORDINATION

Decentralization of responsibility for the road network has been underway since 1975 and has undergone many changes in the process. The three areas of planning, budgeting, and technical guidance continue to be problem areas that require further reorganization.

Planning

Planning is fragmented between the primary and local road network even within the State Planning Commission. These networks

should be integrated. The background for this problem is discussed in Section 2.1.

Budgets

The road network allocations are similarly fragmented. A Mohafaza Directorate of Communications may receive funds in six separate categories from four different sources. The funds are allocated by project by the central Government. A rationalization of the budgeting systems seems to be in order.

Technical Guidance

The Mohafaza Directorates of Communications have been directed to organize separate units for the primary and local roads located within each Mohafaza. Furthermore, they are supposed to receive technical guidance from the Ministry of Communications. To date, there are no separate units and apparently very little technical direction. The division of responsibility seems both uneconomical and impractical, while the need for technical guidance is absolutely essential. This situation is discussed in Section 2.1, which recommends that all road responsibilities be recentralized in the MOC, with the Mohafaza administrations and the Ministry of Local Administration participating in the budget and planning process.

Organization and Staffing

The Ministry of Communications has had a large number of positions unfilled, and those that are filled result in a skewed distribution within the Ministry. In addition, the Ministry is overorganized; i.e., there are an excessive number of organizational units. These facts, coupled with the Ministry's changing overall role, have contributed to a situation in which the de facto functions of some MOC directorates varies greatly from their prescribed functions. A proposed alternative organization, with functions divided among four Deputy Ministers, is discussed in Section 2.2.

CHAPTER 2

ORGANIZATION

Chapter 2

ORGANIZATION

2.1 GENERAL

Background

Following the creation of the Ministry of Transport in 1974 and in recognition of the newly created administrative units at the Mohafaza level, the Ministry of Communications (MOC) was reorganized on 9 July 1975 by Decree Number 1832/T. This decree provided for the transfer of the Directorates of Communications in the Mohafazat to the local Government to be administered at the national level by the Ministry of Local Administration (MLA) through the local Mohafez.[1] The new local directorates, under the MLA, were to be responsible for the "local" road network, while the MOC retained authority over the "main" road network. The decree defined the main road network as comprising "the set of roads that serve public transport between Mohafazat and the roads that link the country to neighboring countries." The length of the main network was estimated to be 4 000 kilometers. The local road network included all other roads except those within the administrative limits of the municipalities.[2]

The decree provided for a transition period, not to extend beyond 31 December 1976, during which the Mohafaza directorates were to retain responsibility for supervision of the affairs of the main network until a separation of responsibilities could be clearly defined. In May 1976 this separation of responsibility was described in detail and codified in a study entitled "Distribution of Functions and Responsibilities between the Ministry of Communications and the Ministry of Local Administration after the Issuance of the Local Administration Law." The study specified the number of personnel to be provided to

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[1] In March 1979 the Homs Communications Directorate was merged into the Technical Services Directorate as an experimental test.

[2] The term "main network" corresponds to the Consultants' classification of "primary" roads with a current inventory of 3,930 kilometer. The term "local network" includes the Consultants' classifications of "secondary" and "tertiary" roads. In this section of the report the terms main network and local network are retained.

the Mohafaza directorates from the MOC and the MLA. It also provided that the MOC and its five regional maintenance centers should be responsible for all aspects of the main network. For the local network the MOC was to be responsible for:

- general policy for developing the network,

- coordination among Mohafazat with regard to long-term and annual plans and programs,

- rules and procedures for the study and maintenance of the local road network,

- helping the Mohafazat establish laboratories and train personnel, and providing technical advice and assistance,

- exercising technical supervision and quality control.

According to reliable MOC officials these responsibilities are yet to be assumed and carried out.

In contrast, and in apparent conflict, the Mohafazat, under the supervision of the MLA, were assigned responsibility for:

- preparing the five-year and local plans "consistent with the planning regulations in the state,"

- preparing designs for the local road network and the execution of projects,

- routine, periodic, and emergency maintenance and spot improvements.

A further major fragmentation of responsibility for road maintenance took place in September 1978. By decision of the Prime Minister (Decision No. 306 of 16 September 1978) the regional offices of the MOC at Lattakia, Aleppo, Hama, and Homs were transferred to the General Company for Road Construction (RODCO) and the southern regional office was transferred to the Kassioun Mountain Company. The transfers included all personnel, equipment, and funds and made RODCO and Kassioun responsible for construction of service roads and for periodic maintenance involving a concrete-bitumen coat of more than 10 kilometers. "Quick maintenance" of main roads was assigned to the respective Mohafaza Communications Directorates. This was followed in May 1979 by the MOC's Organizational Instruction No. 6425/16. This instruction provides that the Mohafaza directorates, under the supervision of the MOC, will exercise functions and authorities over the main road network, including preparation and execution of maintenance programs and projects,

expropriation of land, and control of encroachments of the rights-of-way. A separate department was to be established in each Mohafaza directorate to perform these functions and additional personnel were to be provided. (As of December 1979 no Mohafaza has established such a separate department.) Funding was to be provided by the MOC and the instruction stipulates specific controls and reports on funds, bid awards, and progress payment accounting.

The process of decentralizing and fragmenting responsibilities formerly concentrated in the MOC has created serious gaps and conflicts in the construction and maintenance of the road network in Syria. They result in part from the underlying assumption that the road network is readily divisible into main and local networks, in part from the nature of the decisions themselves and in part from the execution, or lack of execution, of the decisions. The main problems are highlighted in the following subsections.

Program and Budget

By definition, a road network is an interconnected whole and parts of it cannot be planned separately. For example, the economic alternative to a proposed improvement of a main road link may be to upgrade an adjoining secondary road to attract short haul traffic away from the main road. Similarly, basic data, such as traffic counts, must be collected on an integrated basis for the network as a whole.

Under the present organizational arrangements, this kind of integrated programming cannot take place without the Ministry of Finance (MOF) and the State Planning Commission (SPC). The MOC is responsible for programming the main roads, while short- and long-term programming of all other roads are the responsibility of the Mohafazat. The review of the local road programs and budgets at the center is conducted by the MLA, MOF, and SPC. The MOC is not a participant in this process. Although it is charged with coordinating long-term and annual plans among the Mohafazat, it does not have the means to do so. Moreover, the division between the main and local road network planning also occurs within the State Planning Commission. (This is analyzed more fully in Volume VII.)

The division of responsibility is also reflected in the budget process. A Mohafaza Directorate of Communications may receive road funds in six separate categories from four different sources. All of these funds are budgeted and allocated from the central Government by project, and a Mohafaza does not have authority to transfer funds from one project to another without central Government approval.

In addition, as discussed in Chapter 3, there is a need to further categorize road work. Currently, all road work is classified as either construction or maintenance. It would be advantageous in planning, scheduling, budgeting, controlling funds, and specifying contractual work to categorize work as construction, maintenance, or betterment upgrading and rehabilitation. This system applies to all categories of roads.

There is also some evidence that maintenance of local roads is being underfunded, possibly due to the diversion of funds budgeted for maintenance to upgrading of new construction (see Section 3.4, Chapter 3).

Technical Direction for Local Roads

When responsibility for local roads was assigned to the Mohafazat, a clear distinction was drawn between the administrative (including planning and budgeting) control to be exercised by the MLA and the technical direction and assistance to be provided by the MOC. In practice, there is almost no technical direction or assistance for local roads. The MOC's Directorate of Road and Bridge Design is concentrating its limited resources on feasibility studies and design and supervision of main roads, principally those involving foreign assistance funds. Similarly, the Directorate of Road and Bridge Construction and Maintenance concentrates on the main road network. Only in equipment maintenance and repair is the MOC currently providing technical guidance and assistance to the Mohafaza directorates.

The MLA does not have the technical capability to fill the void. The result is the application of different construction methods and standards, even under similar conditions, and a substandard quality of local road construction that is compounding maintenance costs and problems.

Technical Direction for Main Roads

If the recent assignment of responsibility for maintenance of main roads to the Mohafaza directorates results in the creation of main road departments in each of them, the MOC, which is to supervise them, will have the means for technical control. Whether this proves true in practice remains to be seen, but the experience with the local network is not promising. Moreover, the organizational separation of main road and local road maintenance at the Mohafaza level does not appear to be economical or practical. The supervisors, crews, and equipment for both are interchangeable and should be used that way. They should be scheduled to do the current year's maintenance work in the most efficient way, without distinction as to the classification of the road to be repaired.

The Role of Local Administration

The concept in Decree 1832/T of changing the Mohafaza Communications Directorates from field branches of the MOC to elements of the local administration operating under the general policy guidance of the central Government is an attractive one, but in practice it has not been operational. Each Mohafez has more say over local road construction and maintenance, but basically the Communications Directorates have merely changed from a field branch of the MOC to a field branch of the MLA. If the proposed main road departments are implemented, they will be branches of both.

The Organizational Alternative

The problems of varying standards and construction methods and inadequate road maintenance are discussed in detail in Chapter 3 below. In large part they have their roots in the failure of the way the present organization does or does not function. There are three apparent organizational alternatives that should be considered.

- establishment of a technical capability in the MLA and the transfer of technical responsibility for local roads to that organization,

- maintenance of the present organizational division, perhaps strengthening the MOC's technical role,

- recentralization of responsibility for road construction, improvement, and maintenance in the MOC.

The first alternative is very unattractive. The Directorates of Communications and the MOC are already short of qualified technical personnel and these shortages pervade the transport sector. Diluting these scarce personnel resources further cannot be justified. Moreover, this alternative is not in keeping with the concept of managing a road network as a whole. Decisions on construction, improvement, and maintenance should be based on the type and amount of traffic roads carry, not on an arbitrary division between national and local roads.

There is no theoretical reason why the present organizational arrangement should not work. Organizational separation of technical and administrative responsibilities are not uncommon around the world, but the present arrangement is not working. The MOC is not issuing policy and technical guidance nor reviewing proposed projects to be certain that they conform with the standards set. (By policy guidance, the Consultants mean definitive guidance, such as specific traffic thresholds for

upgrading roads to set standards.) Nor is there any apparent organizational change that would remedy this situation. Adequate authority and responsibility exist and are not being exercised.

The Consultants conclude that the present division of technical and administrative responsibility cannot work effectively in Syria as long as Government agencies remain as strongly centralized as they are at present. The kind of day-to-day direction required to set and enforce standards would have to take place below the ministerial level, and inter-Ministry dealings at such subordinate levels are not practical in the present administrative climate.

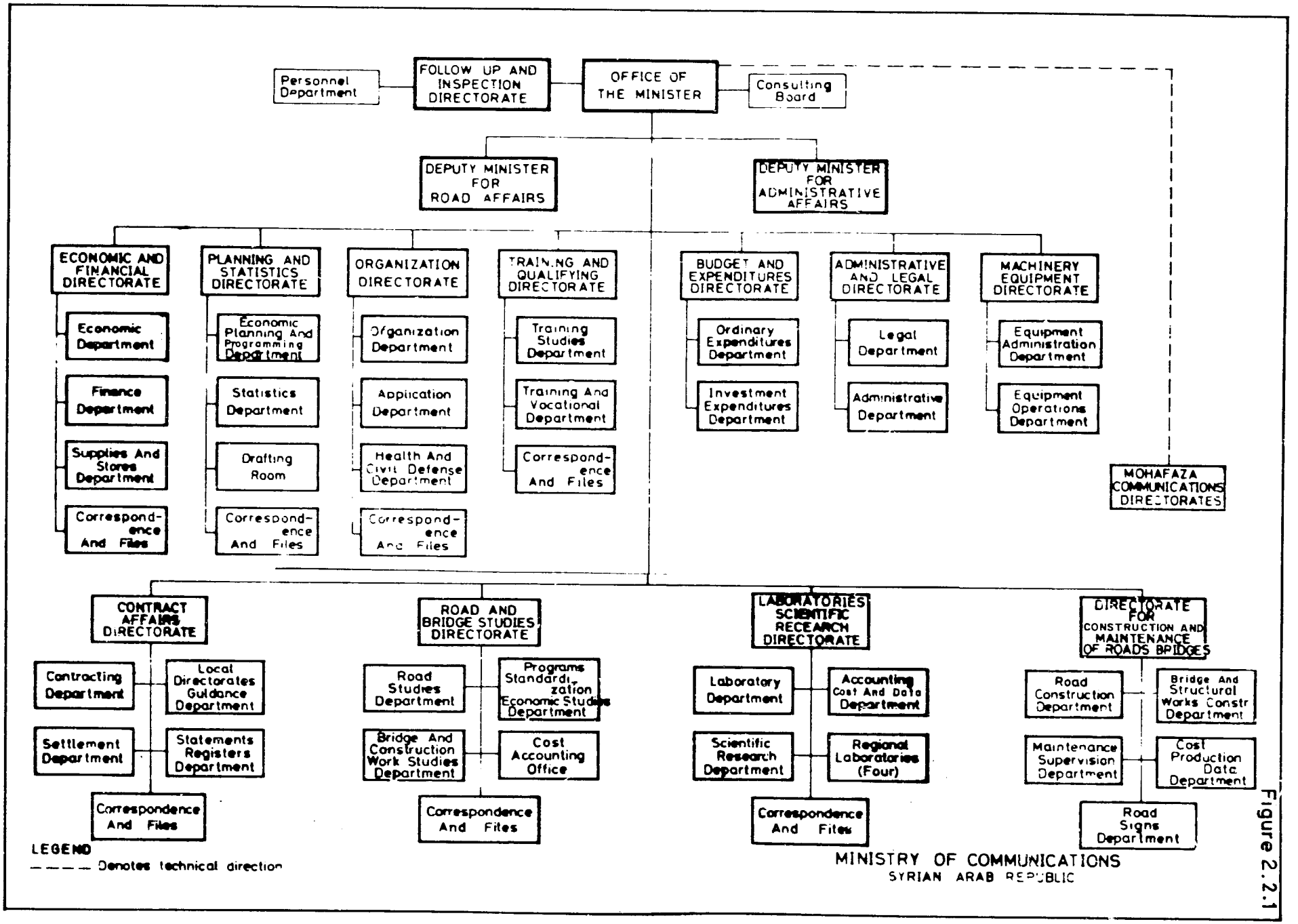
Thus the preferred alternative and the one recommended by the Consultants is to recentralize responsibility for the planning, budgeting, and technical supervision for construction, improvement, and maintenance of all roads in the Ministry of Communica ions. This recentralization will allow the MOC to manage the network as an integrated whole; enable the MOC to create the systems for collecting and analyzing the data required for such management; and enhance the MOC's capability to attract, train, and retain the qualified personnel that are required.

The major disadvantage of this alternative is that it diminishes the role of the local administration authorities. To minimize this, the Consultants recommend that road plans and budgets for each Mohafaza be submitted to the Mohafez for review and comment, but not change, before they are submitted to the Ministry of Communications. A committee, under the chairmanship of the MOC, should review all five-year and annual road plans and budgets. In addition to representatives of the Ministry of Finance and the State Planning Commission, the committee should include a representative of the Ministry of Local Administration to ensure that Mohafaza interests and the comments of each Mohafez are fully considered in the review process.

2.2 MINISTRY OF COMMUNICATIONS ORGANIZATION

The Present Organization

The Ministry of Communications (MOC) has overall national responsibility for telecommunications and postal services in addition to its responsibility for roads. However, the MOC's internal organization structure is directed entirely to its road responsibilities. The formal organization structure is shown down to the department level in Figure 2.2.1. (This chart does not show the General Organization for Telecommunications or the General Post Organization, both of which report directly to the Minister.) There are 12 separate directorates reporting



MINISTRY OF COMMUNICATIONS
SYRIAN ARAB REPUBLIC

Figure 2.2.1

to the Minister. The Consultants consider this to be an excessive span of control, but the fact that Figure 2.2.1 does not show sections conceals the real extent of overorganization in the MOC.

As of early December 1979, the number of separate organizational units was greater than the actual number of Mouazafeen personnel. If Mouazafeen and Mustakhdameen personnel are both counted, then the MOC had 2.2 persons per organizational unit. This overorganization also shows itself in statements of functions for the various units that exceed their capabilities or their current operations and thus have limited utility as a basis for managing the Ministry. In 1979, with 41 percent of the Mouazafeen positions filled, the distribution among the directorates was very skewed. The two major operating directorates, Road and Bridge Design and Road and Bridge Construction and Maintenance, had 66 percent of Mouazafeen positions filled, compared to 25 percent for the remaining directorates. The distribution also differed between non-engineer and engineer positions, with 71 percent of the engineer positions filled as of June 1979. This distribution probably results from the requirement that engineers work five years for the Government and from the special pay provisions for engineers.

The MOC does not have an effective personnel system. Responsibility for Mouazafeen and Mustakhdameen personnel is separated from that for Omal. Job descriptions and performance standards do not exist. However, before an effective system could be installed the organization would have to be consolidated and functions delineated to reflect the present situation and reasonable expectations for the future.

The limited number of personnel, their skewed distribution within the organization, the overorganization of the MOC, and its changing overall role have contributed to a situation in which the de facto functions of some MOC directorates vary greatly from their prescribed functions. These differences were described in Section 2.2 of Volume IV of the Final Phase I Report.

The Proposed Organization

The number of directorates, departments, and sections that are established within an organization depends not only on the number of functions required to support the operations, but also on the relative importance of the functions at any given period of time, the volume of workload, and the number of employees needed or available to accomplish the work and fulfill the needs. The Consultants' proposed organization for the MOT, shown in Figure 2.2.2, has been developed in this context. It

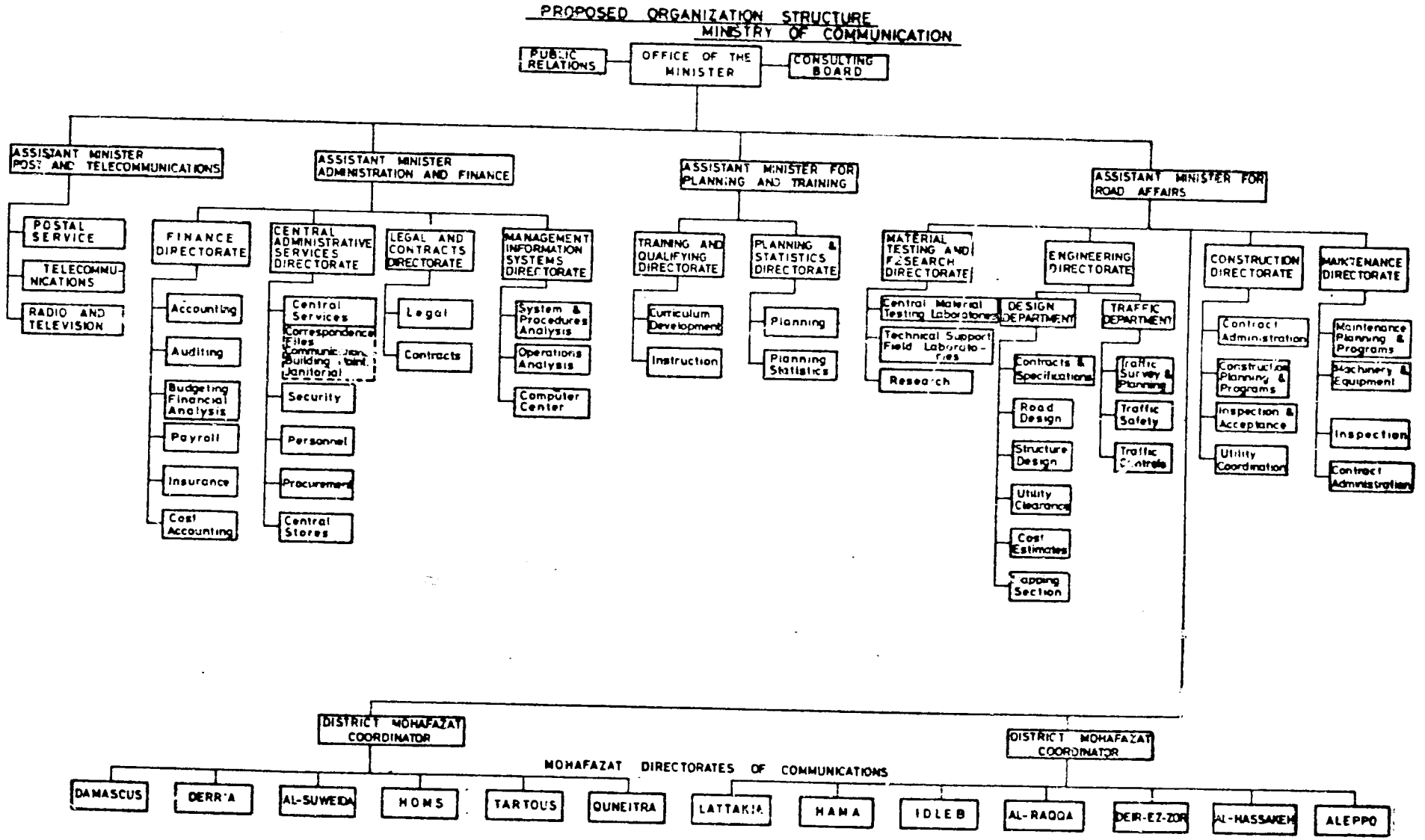

PROPOSED ORGANIZATION STRUCTURE
MINISTRY OF COMMUNICATION
PUBLIC RELATIONS
OFFICE OF THE MINISTER
CONSULTING BOARD
ASSISTANT MINISTER POST AND TELECOMMUNICATIONS
POSTAL SERVICE
TELECOMMUNICATIONS
RADIO AND TELEVISION
ASSISTANT MINISTER ADMINISTRATION AND FINANCE
FINANCE DIRECTORATE
Accounting
Auditing
Budgeting Financial Analysis
Payroll
Insurance
Cost Accounting
CENTRAL ADMINISTRATIVE SERVICES DIRECTORATE
Central Services
Correspondence Files
Communication
Building Maint.
Janitorial
Security
Personnel
Procurement
Central Stores
LEGAL AND CONTRACTS DIRECTORATE
Legal
Contracts
MANAGEMENT INFORMATION SYSTEMS DIRECTORATE
System & Procedures Analysis
Operations Analysis
Computer Center
ASSISTANT MINISTER FOR PLANNING AND TRAINING
TRAINING AND QUALIFYING DIRECTORATE
Curriculum Development
Instruction
PLANNING & STATISTICS DIRECTORATE
Planning
Planning Statistics
ASSISTANT MINISTER FOR ROAD AFFAIRS
MATERIAL TESTING AND RESEARCH DIRECTORATE
Central Material Testing Laboratories
Technical Support Field Laboratories
Research
ENGINEERING DIRECTORATE
DESIGN DEPARTMENT
Contracts & Specifications
Road Design
Structure Design
Utility Clearance
Cost Estimates
Mapping Section
TRAFFIC DEPARTMENT
Traffic Survey & Planning
Traffic Safety
Traffic Controls
CONSTRUCTION DIRECTORATE
Contract Administration
Construction Planning & Programs
Inspection & Acceptance
Utility Coordination
MAINTENANCE DIRECTORATE
Maintenance Planning & Programs
Machinery & Equipment
Inspection
Contract Administration
DISTRICT MOHAFAZAT COORDINATOR
DISTRICT MOHAFAZAT COORDINATOR
MOHAFAZAT DIRECTORATES OF COMMUNICATIONS
DAMASCUS
DERR'A
AL-SUWEIDA
HOMS
TARTOUS
QUNEITRA
LATTAKIA
HAMA
IDLEB
AL-RAQQA
DEIR-EZ-ZOR
AL-HASSAKEH
ALEPPO

Figure 2.2.2

is based on the assumption that the responsibility for construction, improvement, and maintenance of roads will be recentralized in the MOC, as recommended in Section 2.1 above.

The organization is an ultimate organization to be achieved over time, as staff and growing importance of functions permit. For example, the proposed organization shows a Management Information Systems Directorate. If the MOC is to discharge its responsibilities it must develop the capability to collect, analyze, and use large volumes of data covering such subject areas as original road design, inventories of existing roads, and traffic. Potentially the MOC could also realize significant benefits from the use of computers in support of accounting, budgeting, and inventory control. In time the systems can be developed and the computer used to maintain personnel records, MOC payroll, equipment maintenance records, and cost accounting.

As the MOC moves toward this type of utilization of data processing equipment a Management Information System Directorate will be justified. However, the MOC has not used its Hewlett Packard computer in the past and has only recently transferred the computer function to the Planning and Statistics Directorate, where work is underway to begin to utilize the present computer capability. This arrangement should not be changed now. As utilization increases, and after a detailed study of long-term needs, consideration should be given to activating the Management Systems Information Directorate.

In order to reduce the Minister's span of control and improve the coordinated management of the Ministry's functions, the Consultants recommend that the following four positions be created:

- Assistant Minister for Post and Telecommunications,
- Assistant Minister for Administration and Finance,
- Assistant Minister for Planning and Training,
- Assistant Minister for Road Affairs.

The grouping of responsibilities under the recommended Assistant Minister positions is shown in Figure 2.2.2. The major operating functions are grouped under the Assistant Minister for Road Affairs, who would also be the Chief Engineer. In keeping with the recommendation that the Mohafaza Directorates of Communications be reassigned to the Ministry of Communications they would be responsible to the Minister through the Assistant Minister for Road Affairs. Considering the extent of the area, which includes the thirteen Mohafazat, it is proposed that two District Coordinator positions be established in the central office to provide support, direction, and continuity to

the Mohafaza operations. One District Coordinator would be responsible for the northern section of the country and the other would have responsibility for the southern section. As shown in Figure 2.2.2 the Northern District would include the Lattakia, Hama, Idleb, Al Raqqa, Deir Ez Zor, Al Hassakeh, and Aleppo Mohafazat. The Southern District would encompass the Damascus, Dera'a, Al Suweida, Homs, Tartous, and Quneitra Mohafazat.

The District Coordinators, Assistant Chief Engineers, will be responsible for coordinating the activities between Mohafaza Directorates of Communications; ensuring that the policies and directives are being followed and that standards and specifications are being adhered to; and providing technical support to the Mohafaza directorates.

Although the Directorates of Communications are under the direct administration of the Assistant Minister for Road Affairs, there is a need to recognize the interorganizational relationships. The directorates' financial, legal, training, and planning activities will receive the direction in system, procedures, and policy from their respective counterpart organizations at the central ministry level of the organizations.

The Assistant Minister for Planning and Training will be responsible for long-range planning; the analysis and compilation of the five-year road plan; preparation of the annual projects and programs of work; research and evaluation of the technology and advancements made in road transportation; liaison with foreign investment sources; and arranging the training necessary to keep experienced personnel abreast of advancements in technology and to provide personnel with the knowledge and skills required within the organization. The importance of and needs for training are discussed in Section 2.3 below.

The Assistant Minister for Administration and Finance should be responsible for all financial functions, legal functions, and central administrative support activities. In addition, it is recommended that an organizational unit be set up to undertake studies and analysis of management systems and procedures for the purpose of developing and implementing improved information systems and administrative controls. The proposed Management Information Systems Directorate has been discussed earlier. The duties and responsibilities within the span of control of the Administration and Financial Division are appropriately assigned to and executed by Financial, Legal, Central Administrative, and Management Directorates and the future Management Information Systems Directorate.

2.3 TRAINING AND ADVISORY SERVICES

Road Maintenance

The Consultants recommend that the efficiency of the road maintenance program be improved through the training of all levels of Government personnel involved in the process. What is needed is a set of comprehensive standards and procedures covering all aspects of road maintenance, including:

- annual work planning,
- work scheduling,
- supervision of operations,
- procedures of road maintenance operations,
- inspection,
- equipment allocation,
- equipment maintenance and repair,
- inventory control,
- records system.

These standards are necessary to ensure consistent high quality work and to eliminate present variations in both work level and quality among the Mohafazat.

Development of such standards/procedures and their implementation in the Mohafazat requires an expanded road maintenance training program. The Ministry of Communications (MOC) has the nucleus of an adequate training capability already in existence in its Directorate of Training and Qualifying. No changes in responsibilities of this directorate are required to allow it to perform its overall training function. The current need is to expand the existing capability of the directorate to meet its responsibilities and, by doing so, help solve the problem of poor road maintenance.

The MOC's Vocational Training Center at Dwair, near Damascus, is modern and well equipped and has a small but competent staff. Supported by the International Labor Organization, the training center is already conducting middle level skills and foreman training for mechanical and electromechanical maintenance and repair of equipment. The center also conducts a short course in road maintenance practices. At present this facility is underutilized, although road construction companies are beginning to send trainees for skill upgrading.

The nucleus of an effective and coordinated road maintenance training program already exists within the Ministry of Communications. A logical solution to the problem of poor quality and lack of standards of road maintenance in the Mohafazat, taking into account this existing capability, is to develop one

Mohafaza as a pilot or model road maintenance Training and Production Unit (TPU).

The TPU would consist of a fully-equipped and self-sufficient road maintenance organization in one Mohafaza that is capable of work planning, scheduling, and administration and would conduct actual road maintenance operations assigned to it. It would also have its own administrative staff and budget and the necessary facilities and equipment. It could do routine maintenance on its own road maintenance equipment and would have a small stock of parts and materials for servicing and minor repairs.

The TPU would also be staffed, however, to conduct training in all aspects of road maintenance. Most of this training would be on-the-job. However, it would be supplemented by well-planned classroom work. Instructors would be carefully chosen persons qualified in each aspect of road maintenance who have received additional training as trainers.

This TPU would be assigned the same network of roads to maintain as a production Mohafaza; however, its time schedule for operations would necessarily be longer than for the normal production unit. Costs of maintenance per kilometer would also be higher. Both actions would be necessary to ensure that the roads in the TPU were adequately maintained.

The TPU, once it was functioning after training its own staff, would continue to train Mohafaza personnel in modern methods of road maintenance. These trainees would then transfer to other Mohafazat. Alternatively, personnel already in the other Mohafazat who require upgrading would be rotated into the TPU.

This combination of training and production is less costly than training done separately. It is also particularly effective because it is done in the actual work environment under the supervision of highly qualified instructors.

Implementation of such a TPU will not be a simple process when qualified staff are in as limited supply as they are in Syria. The Consultants recommend that a small advisory team of experts be obtained via a technical assistance program to help the MOC set up the unit and implement the program.

Terms of Reference

The Terms of Reference of this advisory team would include:

- development of a detailed plan for the TPU jointly with the MOC's Training and Qualifying Directorate, the Road Maintenance Directorate, and a selected Mohafaza,

- appraisal of existing skills in the selected Mohafaza and Vocational Training Center and preparation of job descriptions for needed TPU support in terms of qualified production experts/trainees,

- training of selected Syrian instructors using the same approach as will be used when the unit is fully activated,

- development of road mairtenance training materials, technical manuals, and syllabi in cooperation with the Vocational Training Center,

- preparation of a Road Maintenance Manual containing standards and guidelines for planning, supervising, and conducting road maintenance work,

- pilot road maintenance training/production operations using standard guidelines developed jointly with the Road Maintenance Directorate,

- development of improved cost accounting procedures for the road maintenance function so that costs can be related to work elements,

- a series of seminars in the Ministry and Mohafazat to explain the objectives of the TPU and plans for future operations,

- development of a recruitment plan for additional trainees and identification of future candidates for instructor positions,

- ensurance by the end of the support period that the TPU is an on-going and institutionalized entity capable of continuing without further external assistance.

The Advisory Team

The proposed advisory team would consist of road maintenance experts with the following skills:

- management/planning/scheduling,

- training (both classroom and on-the-job),

- implementation of work plans (foreman level),

- supervision and inspection (foreman level),

- road equipment scheduling, maintenance, and repair,

- spare parts management and control,

- cost accounting and budgeting,

- road equipment requirements (type, sufficiency, procurement specifications).

The team project manager should arrive four months before the rest of the team to plan and set up the overall program. During this period he should:

- schedule the advisory team,

- select the Mohafaza most appropriate for cooperation with the MOC,

- select counterparts in cooperation with the MOC,

- develop a detailed operational plan,

- develop equipment and supply requirements.

The project manager for this effort of setting up a prototype TPU should have at least 15 years experience in all aspects of highway engineering and road maintenance, from overall planning to actual operations. He should also be knowledgeable in the use, maintenance, and repair of road equipment. A civil or mechanical engineering degree is required. At least six years of road maintenance experience in developing countries would be mandatory. Knowledge of Arabic would be desirable.

Staffing Schedule

Figure 2.3.1 shows a tentative manning schedule for these advisory services. It is estimated that once the team is mobilized it will take two years to develop the entire program and fully implement it in the chosen Mohafaza. Total man-months are estimated to be about 150, allocated as shown in Figure 2.3.1.

The exact composition of the team may necessarily be adjusted depending upon the qualifications of its staff and specific job needs. In particular, some of the work of the short-term specialists could be handled by a long-term team member who was qualified in the particular specialty.

It is also important to note that each team member will be chosen on the basis of both his technical ability as well as his ability to tutor his assigned counterparts. Each should have experience in on-the-job training. The counterparts should be carefully selected from the MOC and the Mohafazat and must be committed to carry on the work after the team leaves.

PROPOSED STAFFING SCHEDULE
ROAD MAINTENANCE ADVISORY SERVICES

MONTHS

Nº	TITLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	TOTAL MAN-MONTHS
1	PROJECT MANAGER / CHIEF PLANNER	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28
2	TRAINING EXPERT					—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
3	ROAD MAINTENANCE MANAGEMENT EXPERT PLANNING/SCHEDULING OPERATIONS					—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
4	ADMIN. / FINANCIAL / COST CONTROL EXPERT									—	—	—	—	—	—	—	—	—												9
5	EQUIPMENT MAINTENANCE SPARE PARTS CONTROL EXPERT						—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23
6	ROAD MAINTENANCE SUPERVISOR / FOREMAN						—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23
7	EQUIPMENT OPERATIONS EXPERT							—	—	—	—	—	—																	6
8	SHORT-TERM SPECIALISTS										*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		12
	Curriculum Development (4)																													
	Procedures & Manuals (2)																													
	Inspection (2)																													
	Records Systems (2)																													
	Manpower Planner (2)																													
																												TOTAL		149

* NOT CONTINUOUS

FIGURE 2.3.1

Applied Road Design and Construction

The Consultants have found considerable variation in road design and construction practices in the various Mohafazat. Each Mohafaza or road construction company appears to set its own standards. Most claim to use the American Association of State Highways Officals (AASHO) standards as a guideline but often modify them to fit their own situation without adequate testing, materials analysis, or other necessary adjustments for altered conditions.

The following examples of poor design or construction were identified by the Consultants. They demonstrate the various types of problems that could be corrected by national standards and proper controls:

- Not enough attention is paid during the design phase of a road to investigation of subsoil characteristics with and without their relationships to available construction material.

- Designs are not necessarily changed although local materials may not be those specified by AASHO.

- Improper material is placed in embankments.

- Compaction of embankment fills and subbase and base course lifts is often inadequate.

- A high type of pavement surface is used on roads with little or no data on vehicle counts or projections of traffic on those roads.

- Completely distressed roads are resurfaced without proper repairs and preparations.

It is therefore recommended that the services of a road and bridge design and construction expert be obtained to further evaluate existing design and construction procedures and to prepare recommendations covering the following:

- standards and procedures for road design based on Syria's environment,

- a road and bridge design manual that takes into account terrain and use of local materials,

- a standard construction practice manual,

- a training program to educate road and bridge construction engineers in applied engineering problems,

- if required, preparation of the Terms of Reference for an advisory services program to accomplish the above.

One expert in road and bridge design and construction should be able to conduct this preliminary study in about 10-12 man-months.

The expert should be a graduate civil engineer with at least 15 years experience in all aspects of road and bridge design and construction. He should be familiar with road inventory methods, the analysis of deflection measurements, and how these data influence design. He should be familiar with construction techniques and practices as they relate to varying terrain, subsoil, and climate factors. He should have experience in developing countries and a demonstrated capability to work effectively with national counterparts. Knowledge of Arabic would be a favorable factor.

Road Deflection Measurements of the Syrian Road Network

Section 3.2 of this volume describes the variation in quality and design that exists among different Mohafazat. It also notes the overall conditions of the road network based on visual inventory. This inventory elucidated, in part, the following critical points:

- Ninety percent of the entire network is in fair or poor condition based on recommended standards.

- Twenty-five percent of the network needs immediate reconditioning.

- Seventy percent of the primary roads are substandard. In particular those roads with high average daily traffic (ADT) are poor.

- Fifty percent of all secondary and tertiary roads are also substandard by recommended criteria.

- Plastic deformation exists in numerous links due to improper design or construction.

Specifically, improper drainage and poorly placed and compacted material in fills, subbase, and subgrade are major causes.

This road inventory data have been computerized and, along with the average daily traffic (ADT) for each link and Mohafaza, are readily retrievable from the Consultants' inventory and traffic count programs.

Data on road deflection throughout the entire Syrian primary ne work, coupled with sampling measurements of secondary and tertiary roads, are now required to make the road inventory and traffic count data of maximum value. The data are also required to support the recommended TPU and the road design and construction programs, high priority betterment programs, long-range planning of future betterment and reconstruction programs, and the design and construction of new roads.

Data from deflection tests will therefore complement the existing road inventory data base and provide the following:

- correlation of deflection with other inventory characteristics such as surface condition, shoulder, drainage, terrain, etc.,

- identification of road links or sections requiring immediate betterment or reconstruction,

- a basis for assigning priorities to road improvement work based on sound engineering criteria (e.g., road condition vs ADT),

- inputs to improve design and construction standards for new roads.

It is therefore recommended that the MOC retain an expert highway engineer to plan a comprehensive road deflection survey of Syria's road network.

Terms of Reference for this expert should include:

- Study of existing road inventory information to gain full understanding of design related problems in the Syrian road network.

- Development of a plan to conduct road deflection tests on all primary roads and a predetermined percent of secondary and tertiary roads. Density of testing should be based on MOC rehabilitation and design needs. Selection of links should be based on road inventory data and these inputs from the MOC.

- Specification of procedures for storing/retrieving deflection data.

- Specification of procedures and frequency for taking core samples.

- Specification of test procedures for analyzing core samples.

- Setting up a plan to conduct analyses (in cooperation with the MOC) of deflection measurements as they correlate with other road inventory data (including terrain, drainage, surface, and shoulder conditions) and with the average daily traffic.

- Setting up guidelines for the MOC and Mohafazat to conduct inspection and road maintenance planning based on the analyses of deflection data.

- Preparation of recommendations for the type of deflection equipment to be used based on costs vs benefits.

- Preparation of a detailed manning and cost schedule for the work based on verification of MOC contributions in terms of laboratory, computer, and support services.

- Preparation of a long-range road deflection measurement program that will permit the MOC to periodically update the data base obtained from the initial deflection program.

- Investigation of costs vs benefits of buying a mobile road deflection measuring device as compared to renting one to periodically update the data base.

The period of time estimated as necessary to plan this program by an expert is about six man-months.

Deflection Measuring Equipment

There are several types of pavement deflection measuring devices available for rental or purchase. The option between rental and purchase of one of these depends upon the MOC's long-term needs. The Consultants recommend that deflection tests be conducted on primary roads at least every five years and on samples of secondary/tertiary roads every seven or eight years. If these tests are properly scheduled, one deflection measuring device and crew could be kept relatively busy. This point, however, needs further study.

There are several different mobile deflection measurement devices that are manufactured and used in various countries. Each has unique characteristics and advantages and disadvantages. Type and accuracy of data, data parameters, speed of coverage, and costs vary among them. The selection of the equipment best suited for use in Syria would have to be based on a careful study of the data required, how it would be used, and the costs of collection and processing. The highway engineering specialist would be expected to conduct this study and to recommend the preferred mobile device for Syrian conditions.

2.4 MOHAFAZA ORGANIZATION

Figure 2.4.1 depicts the de facto Damascus Directorate of Communications organization. Currently, because of the shortage of qualified personnel, several positions, such as the Assistant Director of Technical Affairs, and the Material Testing Laboratory are not staffed. All the Mohafaza organizations are similarly set up, although most of them do not have as many functioning units. The Mohafaza directorates are understaffed in the key functional areas that require qualified experienced personnel.

For example, the Damascus Directorate, which has 15 engineers authorized, has 12 assigned and only four actually working for the organization. Eight engineers on loan or leave are working for other agencies. In Dera'a as of June 1980, the Director is the only trained graduate engineer within the Directorate, and at Al Suweida the engineering staff includes only the Civil Engineer. Fortunately, at each directorate there are a few personnel who, through a combination of work experience and interest, have acquired knowledge of road construction and maintenance, but the number of such personnel cannot make up for the deficiency of fully qualified personnel. The shortage of skilled personnel has critically curtailed material testing and consequently the laboratories located at four of the Mohafazat are either not being used or are underutilized. Such shortages have seriously hampered the directorates in their efforts to accomplish the work required to construct and maintain roads to the standards and specifications called for and to develop plans for new local roads.

Figure 2.4.2 presents a recommended prototype Mohafaza Directorate of Communications organization. The Consultants recognize that the prototype would need to be modified to take into account the varying road workload in different Mohafazat. This modification would generally take the form of consolidating subordinate functions and, subject to it, the proposed organization should serve as a pattern for all Mohafazat. The Consultants have not reviewed the test Technical Services Directorate at Homs, but believe that it is incompatible with the concept of management of the road network as a whole and that the engineering skills involved are too disparate to justify consolidation on the grounds of economy.

In the proposed Mohafaza organization the three prime areas of maintenance and construction, engineering and planning, and administrative affairs are assigned to three departments. The Department for Maintenance and Construction has been assigned the responsibility for contract administration and inspection, maintenance and construction, materials testing, and vehicle

and equipment maintenance. This department employs the majority of the personnel and encompasses the primary activities. It is responsible for construction and maintenance of roads and for the maintenance of the vehicles and equipment required in support of the road construction and maintenance activities. The functions include:

- planning the scheduling, maintenance, and construction work,

- maintaining liaison with contractors and overseeing their work,

- maintenance inspection of the roads to identify work requirements,

- materials control,

- scheduling and maintenance of vehicles and equipment,

- material testing and acceptance,

- operation of support workshops.

The Engineering Department is responsible for all the functions associated with planning and executing the design of roads assigned to the Mohafaza. Because a primary function of the Directorates of Communications is servicing the Mohafazat's needs for local roads, the Engineering Department, working in conjunction with local officials, develops the plans and programs for construction and maintenance of these roads. Five-year and annual plans and programs are developed in accordance with projections of the availability of funds, manpower, and equipment.

As a specialized adjunct engineering function, it is proposed that within the Engineering Department a separate Traffic Engineering Division be established to undertake studies of traffic and safety conditions, compile traffic and accident statistics, and design and implement traffic controls and road safety devices. The Engineering Department will also be responsible for the expropriation of land for road rights-of-way.

The Administrative Affairs Department has been delegated the responsibilities for the administrative functions required in support of the primary activities of the organization. The functions are appropriately assigned to the Financial, Legal, Central Services, and Training Divisions.

PROPOSED MOHAFAZA DIRECTORATE OF COMMUNICATIONS ORGANIZATION

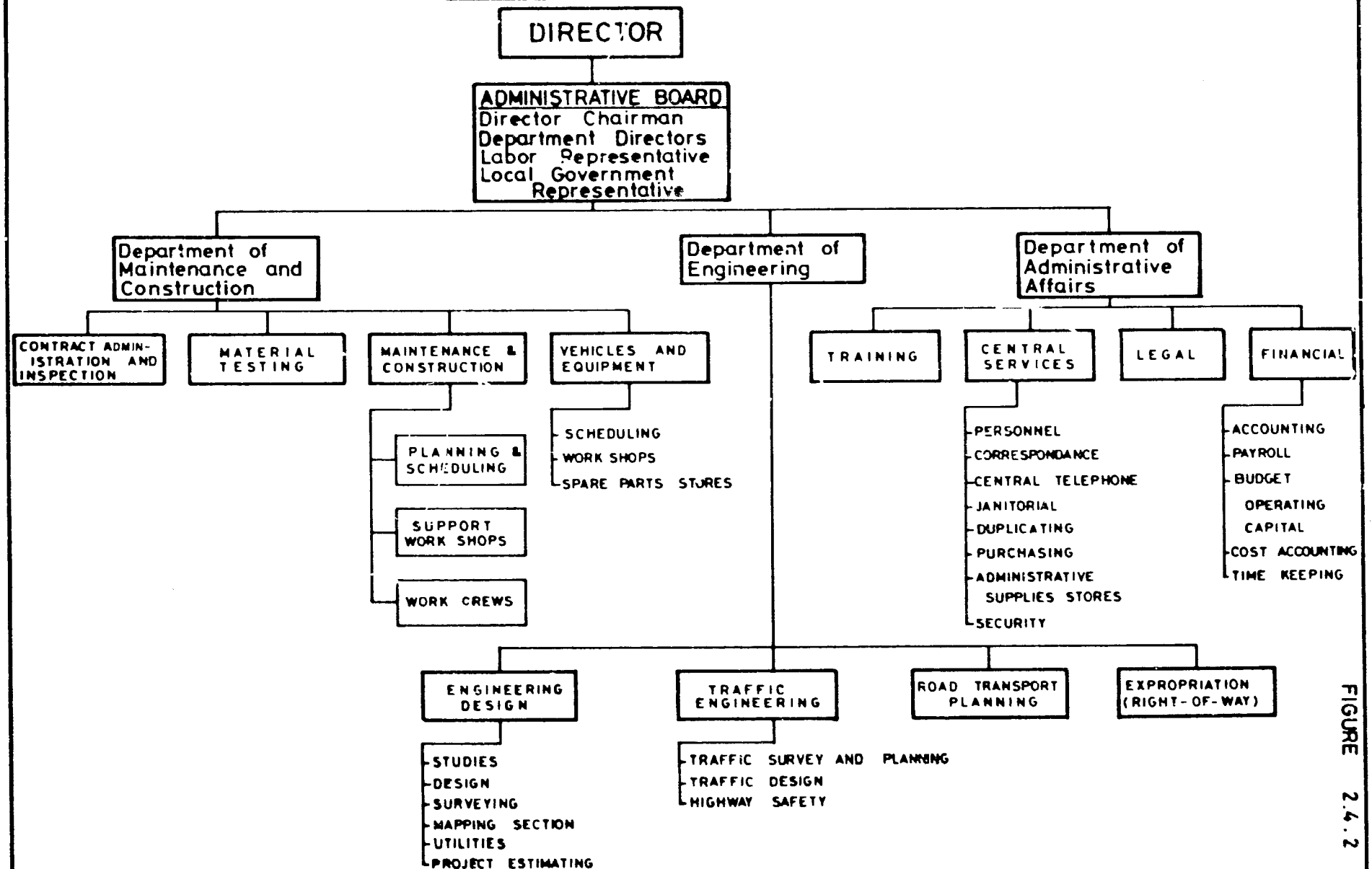


FIGURE 2.4.2

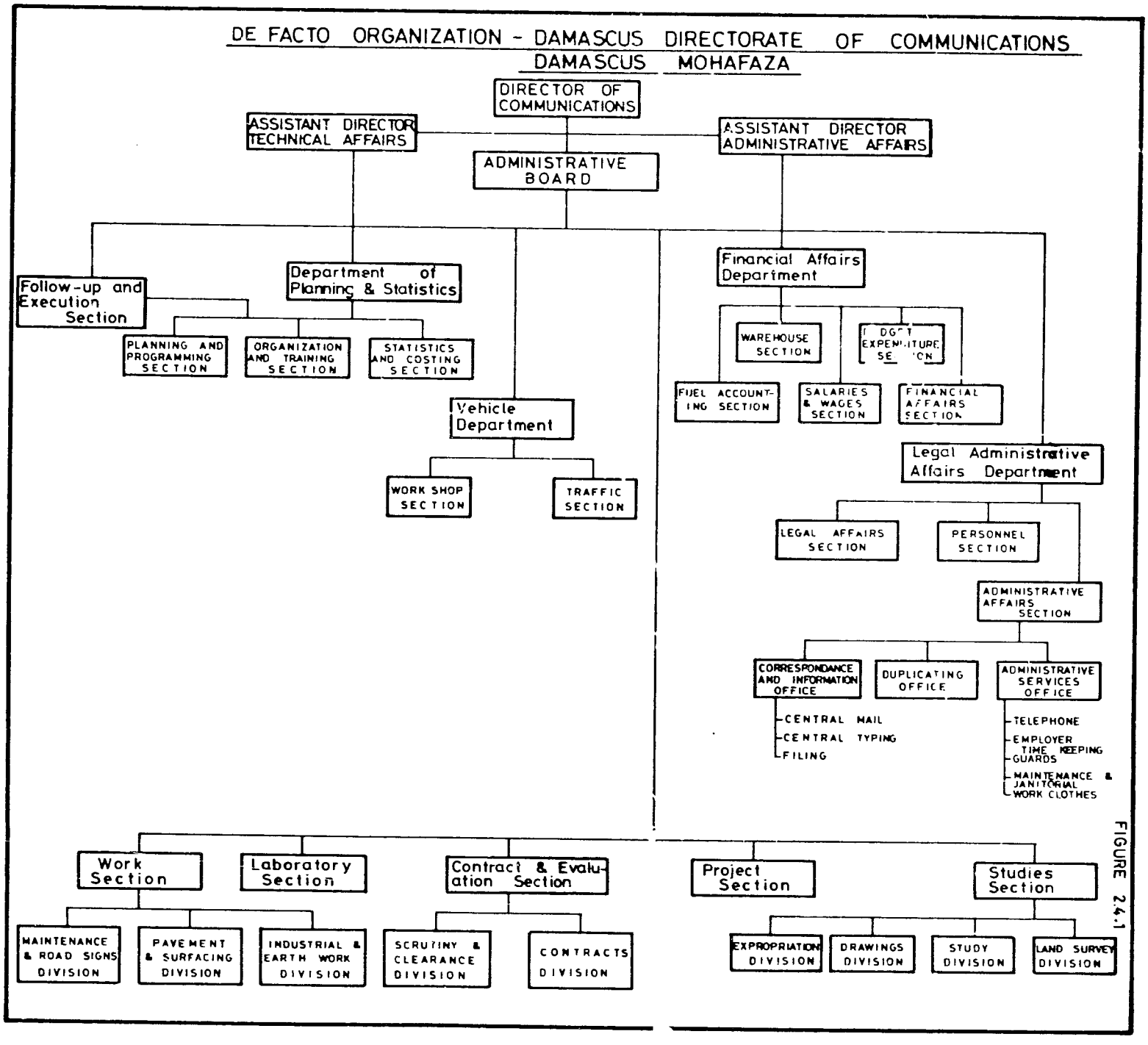

DE FACTO ORGANIZATION - DAMASCUS DIRECTORATE OF COMMUNICATIONS
DAMASCUS MOHAFAZA
DIRECTOR OF COMMUNICATIONS
ASSISTANT DIRECTOR TECHNICAL AFFAIRS
ASSISTANT DIRECTOR ADMINISTRATIVE AFFAIRS
ADMINISTRATIVE BOARD
Follow-up and Execution Section
Department of Planning & Statistics
PLANNING AND PROGRAMMING SECTION
ORGANIZATION AND TRAINING SECTION
STATISTICS AND COSTING SECTION
Vehicle Department
WORK SHOP SECTION
TRAFFIC SECTION
Financial Affairs Department
WAREHOUSE SECTION
FUEL ACCOUNTING SECTION
SALARIES & WAGES SECTION
FINANCIAL AFFAIRS SECTION
Legal Administrative Affairs Department
LEGAL AFFAIRS SECTION
PERSONNEL SECTION
ADMINISTRATIVE AFFAIRS SECTION
CORRESPONDANCE AND INFORMATION OFFICE
DUPLICATING OFFICE
ADMINISTRATIVE SERVICES OFFICE
CENTRAL MAIL
CENTRAL TYPING
FILING
TELEPHONE
EMPLOYER TIME KEEPING
GUARDS
MAINTENANCE & JANITORIAL
WORK CLOTHES
Work Section
Laboratory Section
Contract & Evaluation Section
Project Section
Studies Section
MAINTENANCE & ROAD SIGNS DIVISION
PAVEMENT & SURFACING DIVISION
INDUSTRIAL & EARTH WORK DIVISION
SCRUTINY & CLEARANCE DIVISION
CONTRACTS DIVISION
EXPROPRIATION DIVISION
DRAWINGS DIVISION
STUDY DIVISION
LAND SURVEY DIVISION

FIGURE 2.4.1

CHAPTER 3

INFRASTRUCTURE

Chapter 3

INFRASTRUCTURE

3.1 THE NETWORK

The Syrian paved road system has expanded four-fold during the past 20 years, doubling in length during the last 10 years alone, to its current length of approximatey 12,570 kilometers. Construction of new roads continued at the same accelerated pace at the end of the 4th Five-Year Plan period. Today virtually all administrative centers down to the Mantika center level are served by the 3,930 kilometer main paved road network. Mantika center populations are 4,000 and greater. In addition, other smaller villages are served by the 8,640 kilometer local paved road network and an estimated 5,200 kilometers of gravel and earth rural access roads.

The Consultants have assessed the capacity of the system to meet present and projected traffic requirements and to recommend guidelines for future investments. The assessment and some of the findings are summarized below and are followed by a detailed discussion of the study activities which led to these assessments and findings

The assessment is based on an extensive visual inventory of road infrastructure and an evaluation of the deficiencies that deter the fast, safe, and efficient movement of people and goods. The inventory documents the physical features (geometry) of the existing system The evaluation is based on a correlation of physical features and present and projected traffic volume. Traffic volume reflects the relative population and economic importance of the centers served by each road link. Therefore, the evaluation process reflects the relative population and economic importance of the centers served by each road link and includes an analysis of all aspects of the system, such as route location and markets served, road geometry and pavement condition, traffic demand volumes, and vehicle mix. Table 3.1.1 summarizes the 1979 Syrian road network.

A correlation of three physical features of the infrastructure (surface type, pavement width, and pavement condition) with traffic volume and geometry classification (basic standards) provides an indication of the magnitude of the deficiencies in the existing infrastructure and a preliminary indication of future needs. The results of the correlation are provided in Tables 3.1.2 and 3.1.5. The definitions and methodologies used to establish these are discussed in detail in various parts of this chapter.

Table 3.1.1

1979 ROAD NETWORK SUMMARY

Road Classification	Average Daily Traffic Volume	Length (km)
Primary	9,000-30,000	280
	5,000- 9,000	340
	1,500- 5,000	1,440
	400- 1,500	1,450
	under 400	420
Secondary (Paved)	1,500- 5,000	200
Tertiary (Paved)	400- 1,500	4,780
	under 400	3,660
Rural Access Roads (Gravel and Earth)	under 400	5,200

Sources: For paved roads, Consultants' inventory and traffic counts; for earth and gravel roads Consultants'estimates based on Central Bureau of Statistics data.

Table 3.1.2

SYRIAN ROAD NETWORK DEFICIENCIES
(Based on 1979-1980 ADT and Road Condition)

Classification	Total KM	INFRASTRUCTURE DEFICIENCIES In Surface Type km	In Surface Type % of Total	In Pavement Width km	In Pavement Width % of Total	In Surface Condition[1] Poor km	Poor % of Total	Fair km	Fair % of Total
Primary Network									
Autostrad	280	6	2	114	41	1	0	10	4
Class A	340	275	81	82	24	9	3	204	60
Class B	1,440	286	20	553	38	246	17	1,015	70
Class C	1,450	1	0	286	20	518	36	696	48
Class D	420	0	0	0	0	148	35	220	52
Sub Total Primary	3,930	568	14	1,035	26	921	23	2,145	55
Secondary Network									
Class B	200	6	3	190	95	116	58	55	28
Tertiary Network									
Class C	4,780	0	0	4,178	87	994	21	3,285	69
Class D	3,660	0	0	64	2	1,203	33	2,289	63
Sub Total Secondary & Tertiary	8,640	6	0	4,432	51	2,313	25	5,629	65
Total Paved	12,570	574	5	5,467	43	3,234	26	7,774	62
Rural Access Roads	5,200	0	0	0	0	1,800	35	3,165	61

Source: Consultant Inventory and Traffic Counts, and recommended Standards.

[1] "Poor" condition requires immediate reconditioning and "Fair" condition is estimated to require reconditioning (resurfacing) within the next two and one-half years, depending on traffic volume.

A number of trends and conditions resulting from the correlation are noted below:

- The estimated traffic is under 400 vehicles per day, approximately, on 42 percent of the paved secondary and tertiary roads and 11 percent of the primary roads. Roads in this traffic range require only a gravel surface and one traffic lane. Therefore, these paved roads are overdesigned for present traffic.

- Virtually all of the road system, except Class A roads, has the surface type that is equal to or better than the type recommended for the particular class of road.

- Twenty-six percent of the primary and one-half of the paved local roads are narrower than the standards normally applied to similar traffic volumes.

- Eighty-three percent of the entire road network has a fair or poor surface condition. Twenty-one percent of all roads need immediate reconditioning (resurfacing) while the remainder will require reconditioning during the early years of the next five-year plan.

The preliminary conclusions drawn from these findings indicate that the construction of new paved roads is surpassing the traffic demand for all but very high volume roads; traffic on 40 percent of the existing paved roads is exceeding the capacity of these roads to move people and goods safely, quickly, and efficiently; and deteriorated surface conditions on 83 percent of the roads are resulting in a loss of benefits to the road users.

Location and Classification

The Syrian paved road system is classified into primary, secondary, and tertiary networks. The primary network serves mainly the transportation needs of internationally important traffic, whereas the secondary and tertiary networks serve mainly regional and local needs. Initially, road locations and classifications were identified from the existing data in order to organize the field inventory and traffic survey programs. They were later modified based on the outcome of field work and the analysis of the field data.

The location of the road networks for 11 Mohafazat are shown on Plates 3.1 through 3.11.[1] The locations are based on data

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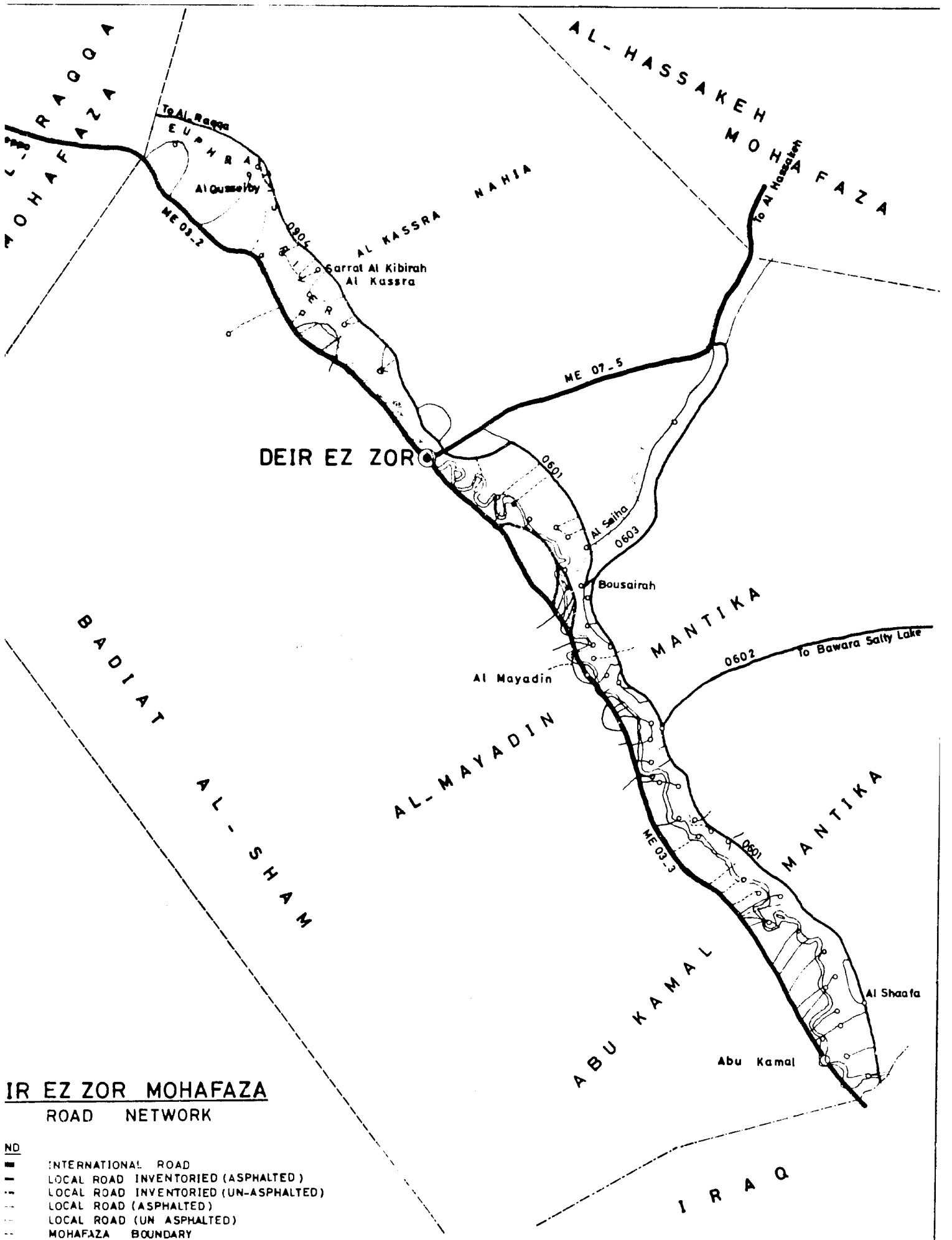
[1]Data for Lattakia and Quneitra were not available.



IR EZ ZOR MOHAFAZA
ROAD NETWORK

ND
- INTERNATIONAL ROAD
- LOCAL ROAD INVENTORIED (ASPHALTED)
- LOCAL ROAD INVENTORIED (UN-ASPHALTED)
- LOCAL ROAD (ASPHALTED)
- LOCAL ROAD (UN ASPHALTED)
- MOHAFAZA BOUNDARY

Plate 3.1

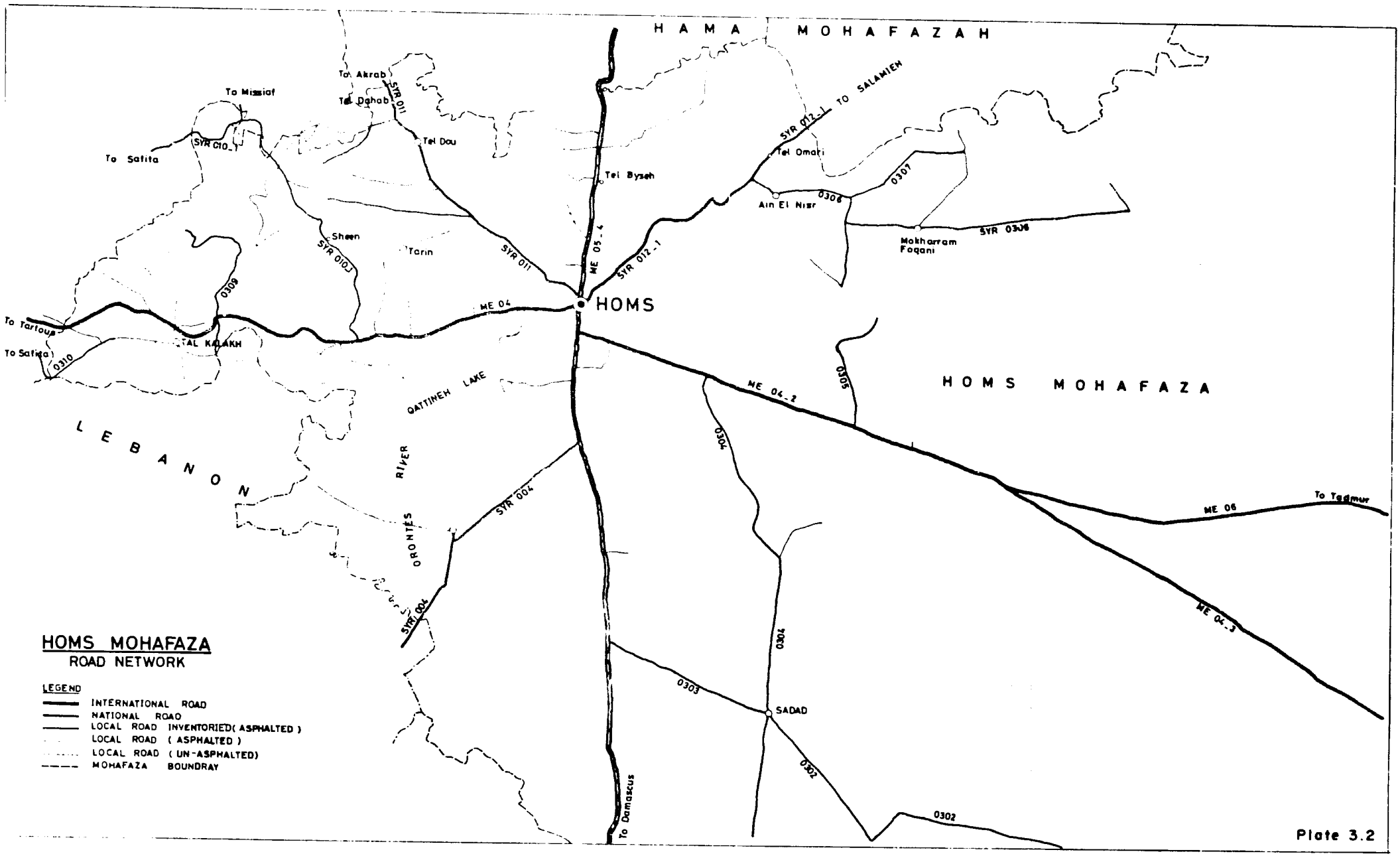

HAMA MOHAFAZAH
HOMS MOHAFAZA
LEBANON
HOMS
To Salamieh
To Akrab
Tel Dahab
To Missiaf
To Salita
Tel Dou
Tel Byseh
Tel Omari
Ain El Nisr
Mokharram Foqani
Sheen
Tarin
To Tartous
To Salita
TAL KALAKH
QATTINEH LAKE
ORONTES RIVER
SADAD
To Damascus
To Tadmur
SYR 010_1
SYR 011
SYR 012_1
SYR 004
ME 04
ME 05_4
ME 04_2
ME 04_3
ME 06
0302
0303
0304
0305
0306
0307
0308
0309
0310
HOMS MOHAFAZA
ROAD NETWORK
LEGEND
INTERNATIONAL ROAD
NATIONAL ROAD
LOCAL ROAD INVENTORIED (ASPHALTED)
LOCAL ROAD (ASPHALTED)
LOCAL ROAD (UN-ASPHALTED)
MOHAFAZA BOUNDRAY

Plate 3.2

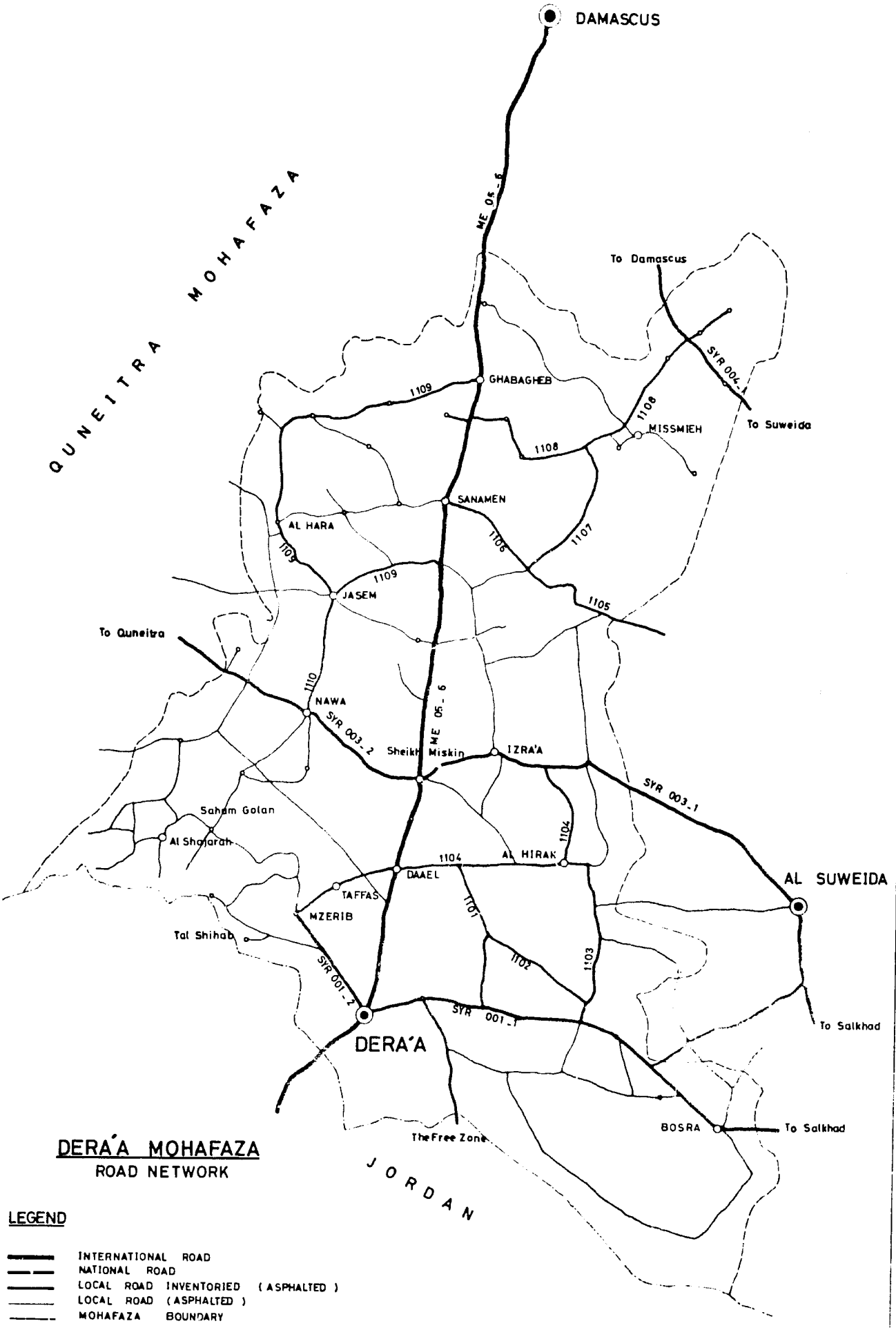

DAMASCUS
QUNEITRA MOHAFAZA
ME 05-6
To Damascus
SYR 004-1
To Suweida
GHABAGHEB
1109
1108
MISSMIEH
SANAMEN
AL HARA
1107
1106
1105
JASEM
To Quneitra
1110
NAWA
SYR 003-2
Sheikh Miskin
IZRA'A
SYR 003-1
Saham Golan
Al Shajarah
1104
AL HIRAK
DAAEL
TAFFAS
MZERIB
1101
1102
1103
Tal Shihab
SYR 001-2
SYR 001-1
AL SUWEIDA
To Salkhad
DERA'A
BOSRA
To Salkhad
The Free Zone
JORDAN
DERA'A MOHAFAZA
ROAD NETWORK
LEGEND
INTERNATIONAL ROAD
NATIONAL ROAD
LOCAL ROAD INVENTORIED (ASPHALTED)
LOCAL ROAD (ASPHALTED)
MOHAFAZA BOUNDARY

Plate 3.3

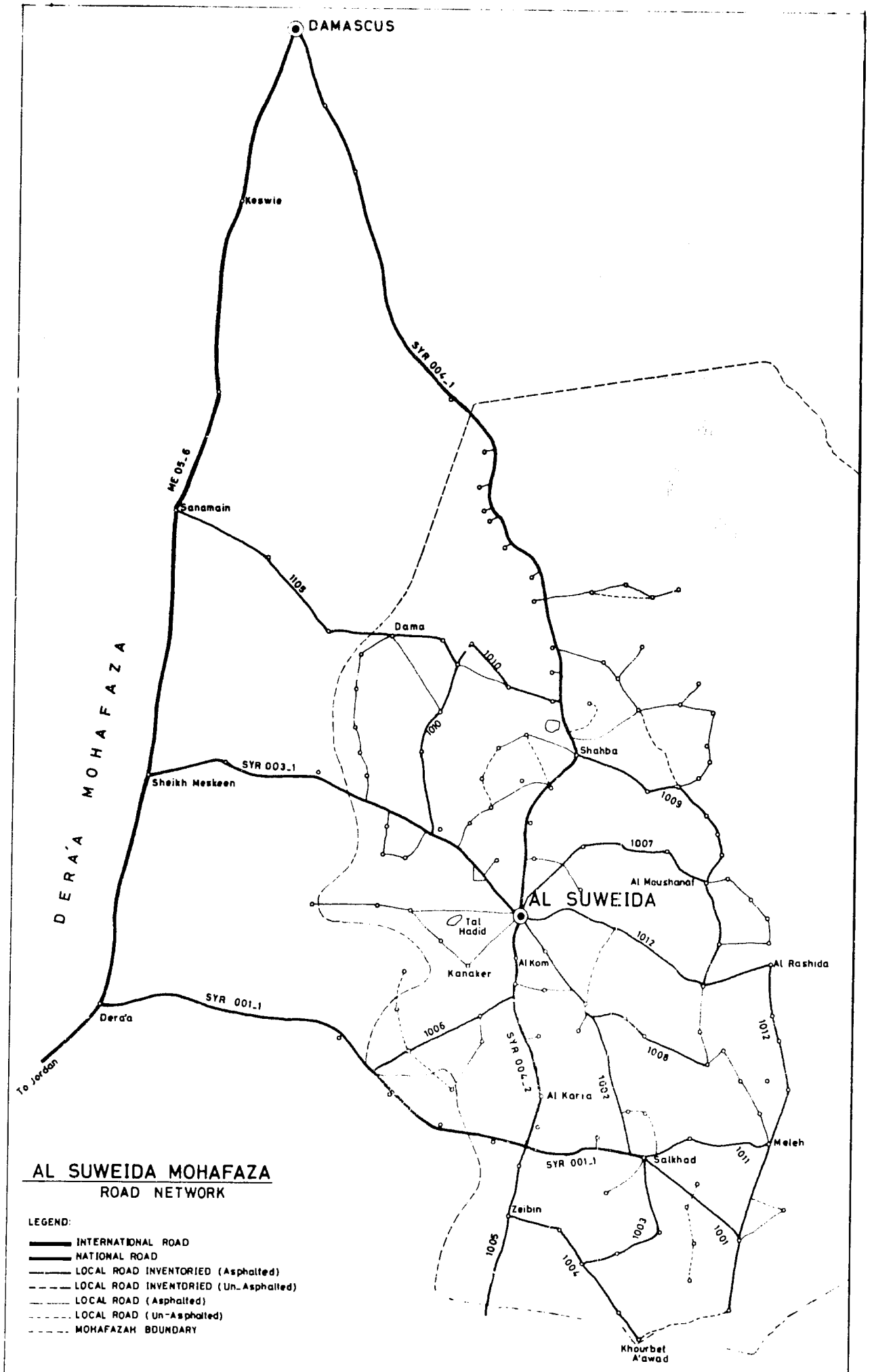

DAMASCUS
Keswie
SYR 004_1
ME 05_6
Sanamain
1105
Dama
1010
1000
Shahba
SYR 003_1
Sheikh Meskeen
1009
1007
Al Moushanaf
AL SUWEIDA
Tal Hadid
1012
Al Kom
Kanaker
Al Rashida
DERA'A MOHAFAZA
SYR 001_1
Dera'a
1006
SYR 004_2
1008
1012
To Jordan
Al Karia
1002
Meleh
SYR 001_1
Salkhad
1011
Zeibin
1003
1001
1005
1004
Khourbet A'awad
AL SUWEIDA MOHAFAZA
ROAD NETWORK
LEGEND:
INTERNATIONAL ROAD
NATIONAL ROAD
LOCAL ROAD INVENTORIED (Asphalted)
LOCAL ROAD INVENTORIED (Un_Asphalted)
LOCAL ROAD (Asphalted)
LOCAL ROAD (Un-Asphalted)
MOHAFAZAH BOUNDARY

Plate 3.4

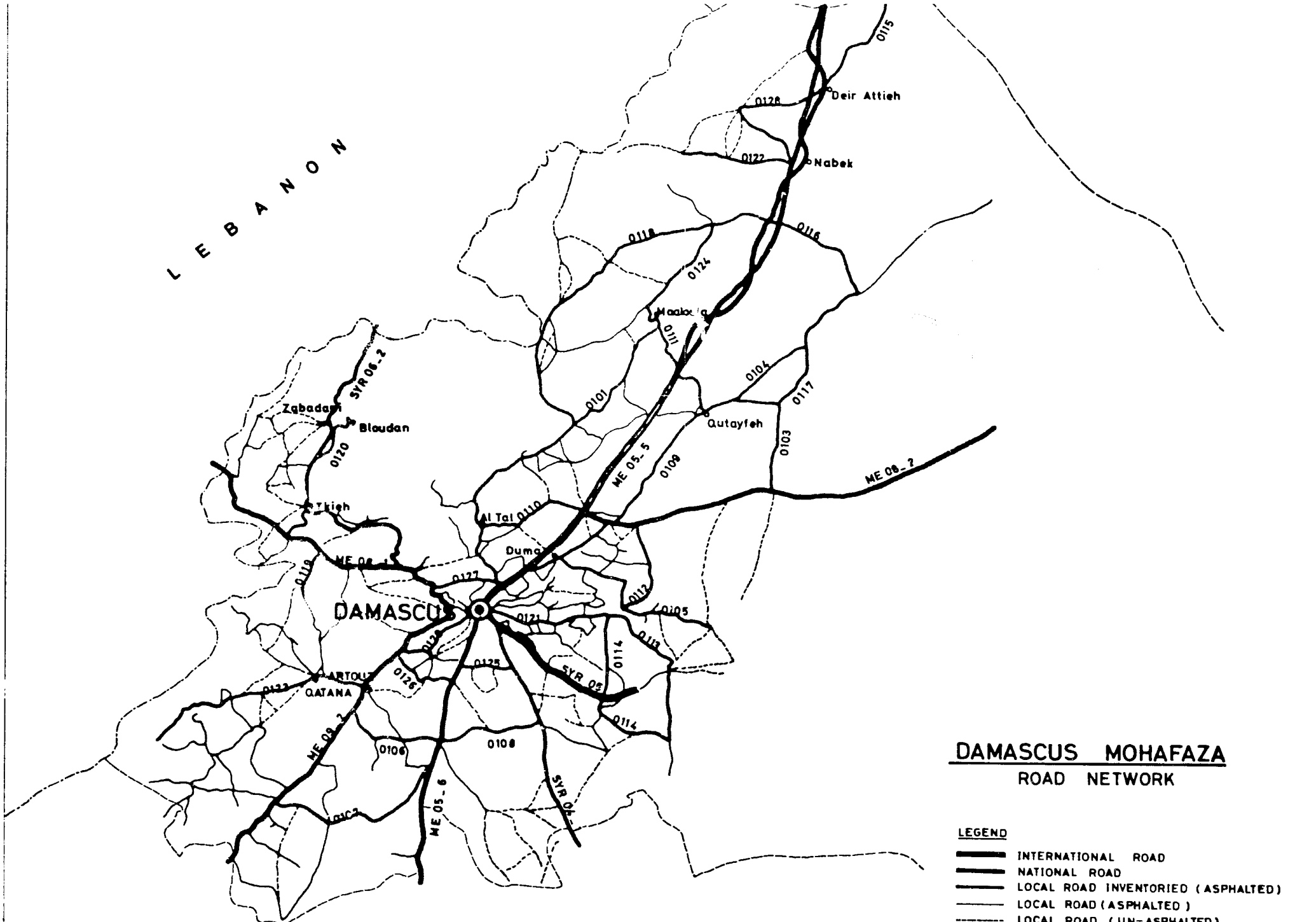

LEBANON
DAMASCUS
Deir Attieh
Nabek
Maalaoula
Qutayfeh
Zabadani
Bloudan
Thieh
Al Tal
Duma
QATANA
ME 05_5
ME 05_6
ME 06_2
ME 09_2
SYR 06_2
SYR 05
0101
0102
0103
0104
0105
0106
0107
0108
0109
0110
0111
0112
0113
0114
0115
0116
0117
0118
0119
0120
0121
0122
0123
0124
0125
0126
0127
0128
DAMASCUS MOHAFAZA
ROAD NETWORK
LEGEND
INTERNATIONAL ROAD
NATIONAL ROAD
LOCAL ROAD INVENTORIED (ASPHALTED)
LOCAL ROAD (ASPHALTED)
LOCAL ROAD (UN-ASPHALTED)
MOHAFAZA BOUNDARY

Plate 3.5

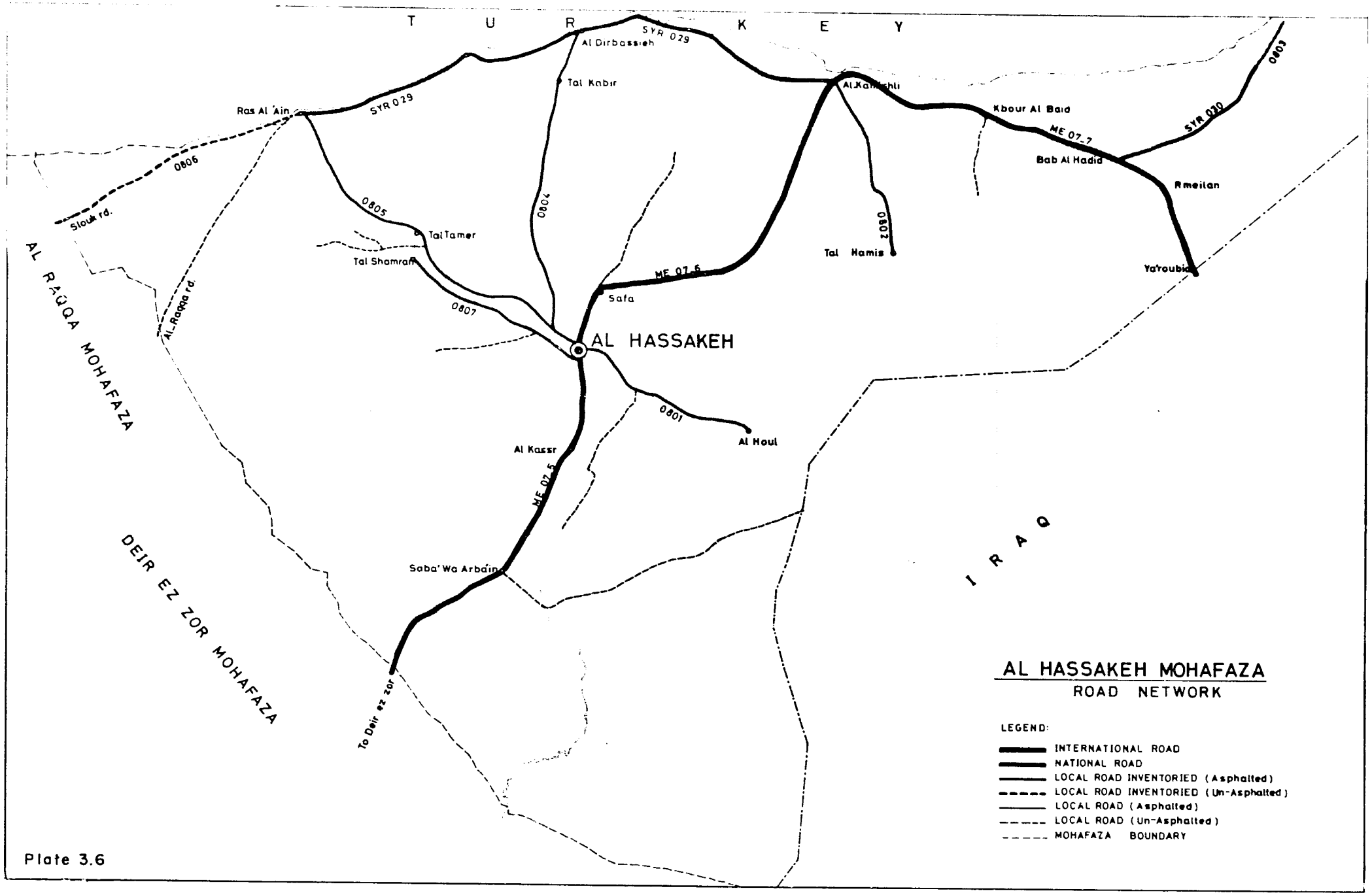

T U R K E Y
SYR 029
Al Dirbassieh
Tal Kabir
Ras Al 'Ain
SYR 029
0806
Slouk rd.
0805
Tal Tamer
Tal Shamram
0804
0807
Al-Raqqa rd.
AL RAQQA MOHAFAZA
ME 07-6
Safa
AL HASSAKEH
Al Kamishli
Kbour Al Baid
ME 07-7
Bab Al Hadid
SYR 020
0809
Rmeilan
0802
Tal Hamis
Ya'roubia
0801
Al Houl
Al Kassr
ME 07-5
Saba' Wa Arbaïn
To Deir ez zor
DEIR EZ ZOR MOHAFAZA
I R A Q
AL HASSAKEH MOHAFAZA
ROAD NETWORK
LEGEND:
INTERNATIONAL ROAD
NATIONAL ROAD
LOCAL ROAD INVENTORIED (Asphalted)
LOCAL ROAD INVENTORIED (Un-Asphalted)
LOCAL ROAD (Asphalted)
LOCAL ROAD (Un-Asphalted)
MOHAFAZA BOUNDARY

Plate 3.6

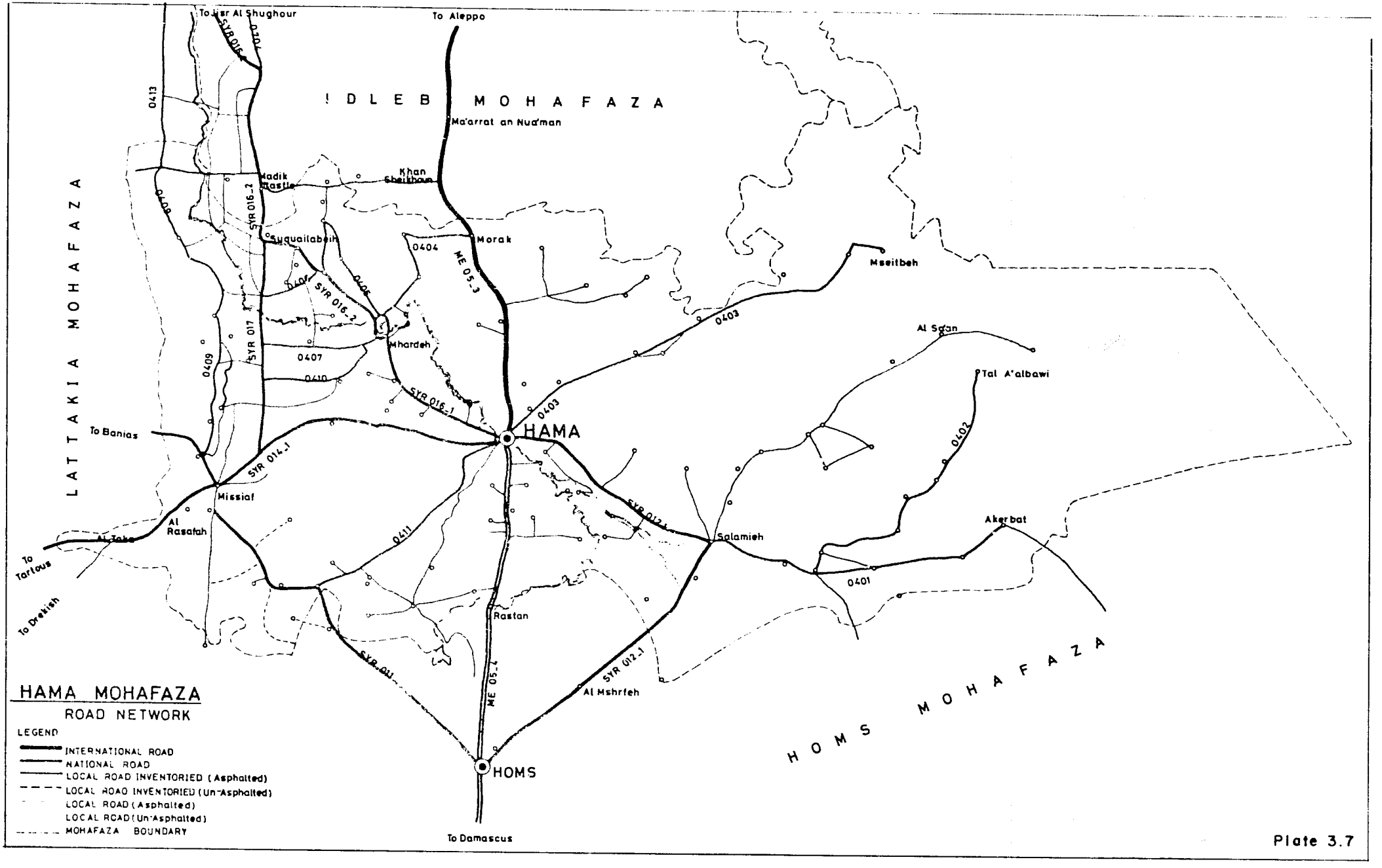

HAMA MOHAFAZA
ROAD NETWORK
LEGEND
INTERNATIONAL ROAD
NATIONAL ROAD
LOCAL ROAD INVENTORIED (Asphalted)
LOCAL ROAD INVENTORIED (Un-Asphalted)
LOCAL ROAD (Asphalted)
LOCAL ROAD (Un-Asphalted)
MOHAFAZA BOUNDARY
IDLEB MOHAFAZA
LATTAKIA MOHAFAZA
HOMS MOHAFAZA
To Jisr Al Shughour
To Aleppo
Ma'arrat an Nu'man
Khan Sheikhoun
Madik Mastle
Suqualabeih
Morak
Mhardeh
Mseitbeh
Al Sa'an
Tal A'albawi
HAMA
To Banias
Missiat
Al Rasafah
Al Taka
To Tartous
To Drekish
Salamieh
Akerbat
Rastan
Al Mshrfeh
HOMS
To Damascus
SYR 016.2
SYR 017
SYR 016.2
SYR 016.1
SYR 014.1
SYR 012.1
SYR 011
SYR 012.1
ME 05.3
ME 05.4
0413
0408
0409
0407
0410
0404
0403
0402
0401
0411

Plate 3.7

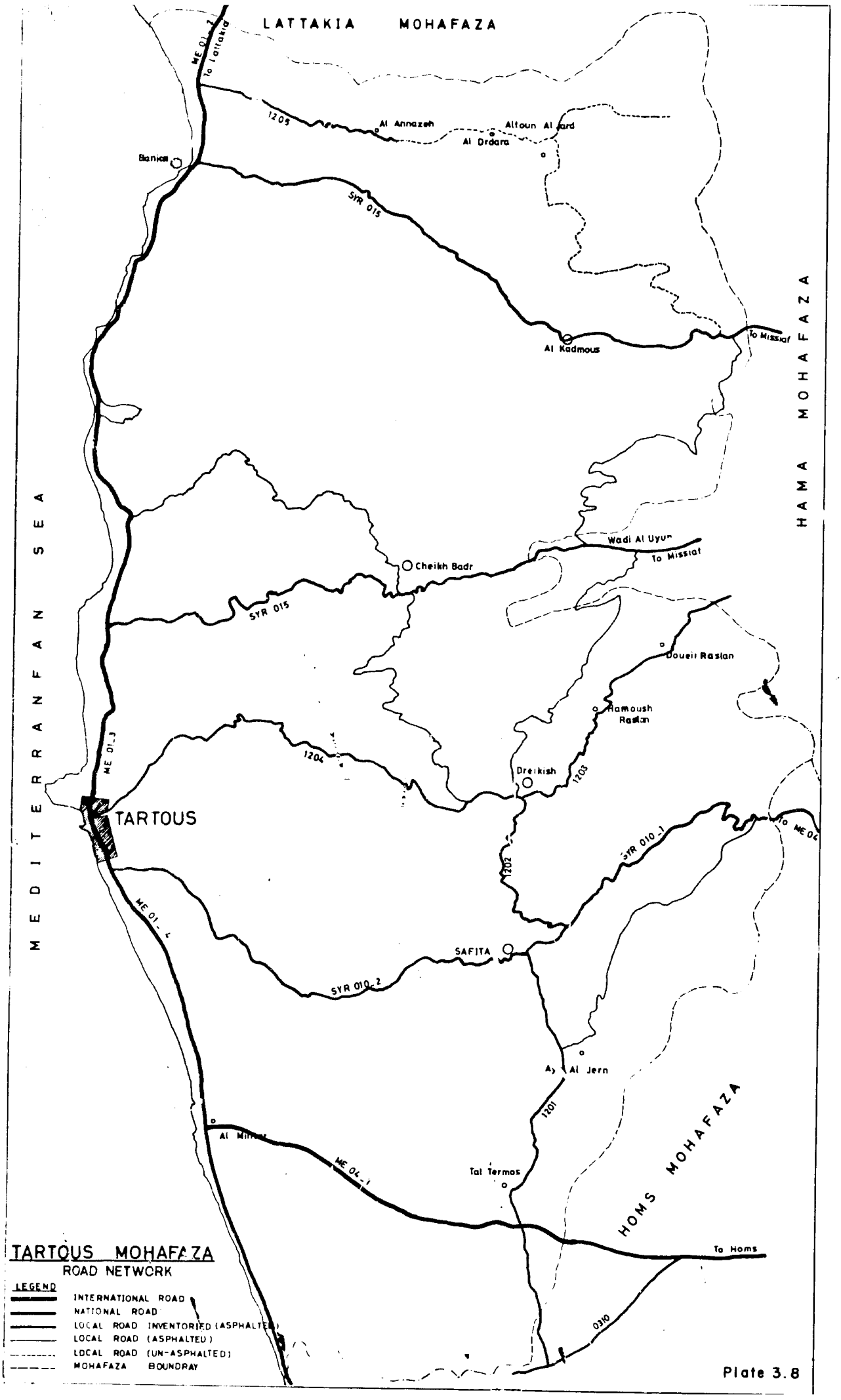

LATTAKIA MOHAFAZA
ME 01-2
To Lattakia
1205
Al Annazeh
Altoun Al Jard
Al Drdara
Banias
SYR 015
Al Kadmous
To Missiat
HAMA MOHAFAZA
MEDITERRANEAN SEA
Wadi Al Uyun
To Missiat
Cheikh Badr
SYR 015
Doueir Raslan
Hamoush Raslan
ME 01-3
1204
Dreikish
1203
TARTOUS
To ME 04
SYR 010-1
1202
ME 01-2
SAFITA
SYR 010-2
Al Jern
1201
Al Mirsat
ME 04-1
Tal Termos
HOMS MOHAFAZA
To Homs
0310
TARTOUS MOHAFAZA
ROAD NETWORK
LEGEND
INTERNATIONAL ROAD
NATIONAL ROAD
LOCAL ROAD INVENTORIED (ASPHALTED)
LOCAL ROAD (ASPHALTED)
LOCAL ROAD (UN-ASPHALTED)
MOHAFAZA BOUNDRAY

Plate 3.8

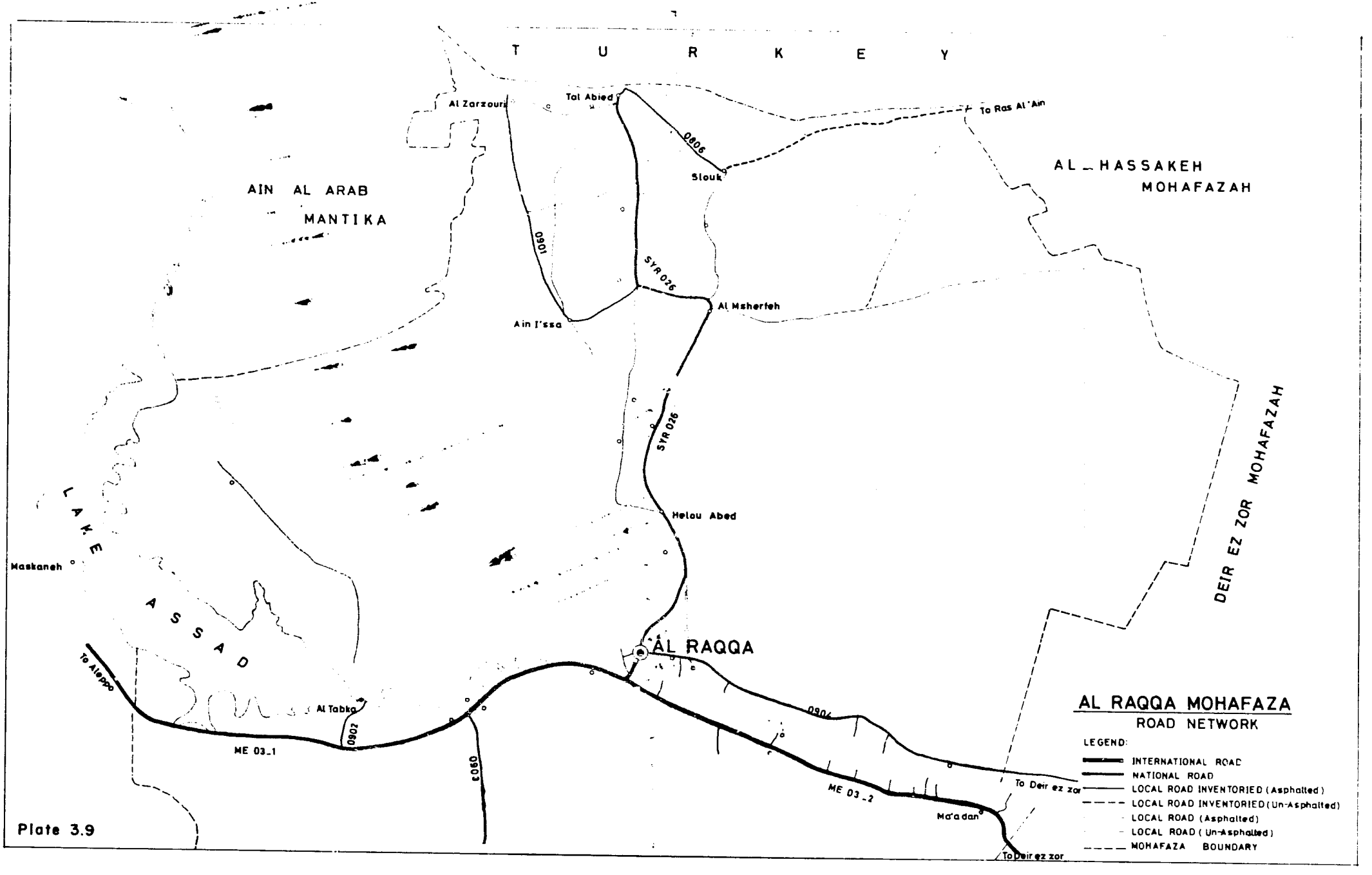

T U R K E Y
AIN AL ARAB
MANTIKA
AL_HASSAKEH
MOHAFAZAH
DEIR EZ ZOR MOHAFAZAH
LAKE ASSAD
Al Zarzour
Tal Abied
To Ras Al'Ain
0806
Slouk
1060
SYR 026
Al Msherfeh
Ain I'ssa
SYR 026
Helou Abed
Maskaneh
AL RAQQA
To Aleppo
Al Tabka
1060
ME 03_1
0903
0906
ME 03_2
To Deir ez zor
Ma'adan
To Deir ez zor
AL RAQQA MOHAFAZA
ROAD NETWORK
LEGEND:
INTERNATIONAL ROAD
NATIONAL ROAD
LOCAL ROAD INVENTORIED (Asphalted)
LOCAL ROAD INVENTORIED (Un-Asphalted)
LOCAL ROAD (Asphalted)
LOCAL ROAD (Un-Asphalted)
MOHAFAZA BOUNDARY

Plate 3.9

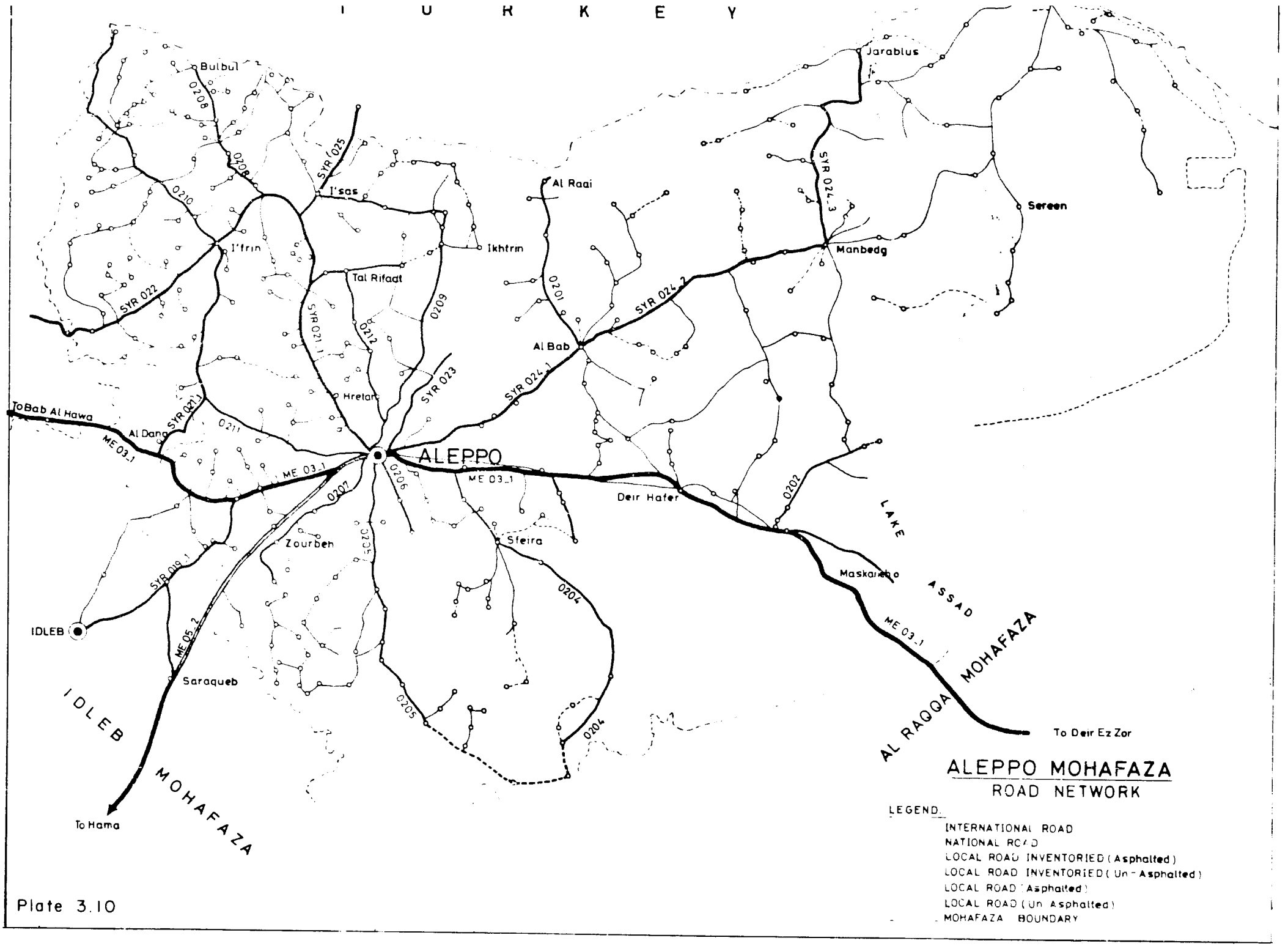

T U R K E Y
Bulbul
Jarablus
Al Raai
I'sas
I'frin
Ikhtrin
Tal Rifaat
Hreiar
Al Bab
Manbedg
Sereen
ALEPPO
Deir Hafer
Sfeira
Zourbeh
Maskaneh
Saraqueb
IDLEB
To Bab Al Hawa
Al Dana
To Hama
To Deir Ez Zor
LAKE ASSAD
AL RAQQA MOHAFAZA
IDLEB MOHAFAZA
SYR 025
SYR 022
SYR 021.1
SYR 023
SYR 024.1
SYR 024.2
SYR 024.3
SYR 019.1
ME 03.1
ME 05.2
0208
0210
0209
0201
0211
0207
0206
0205
0204
0202
ALEPPO MOHAFAZA
ROAD NETWORK
LEGEND
INTERNATIONAL ROAD
NATIONAL ROAD
LOCAL ROAD INVENTORIED (Asphalted)
LOCAL ROAD INVENTORIED (Un-Asphalted)
LOCAL ROAD (Asphalted)
LOCAL ROAD (Un Asphalted)
MOHAFAZA BOUNDARY

Plate 3.10

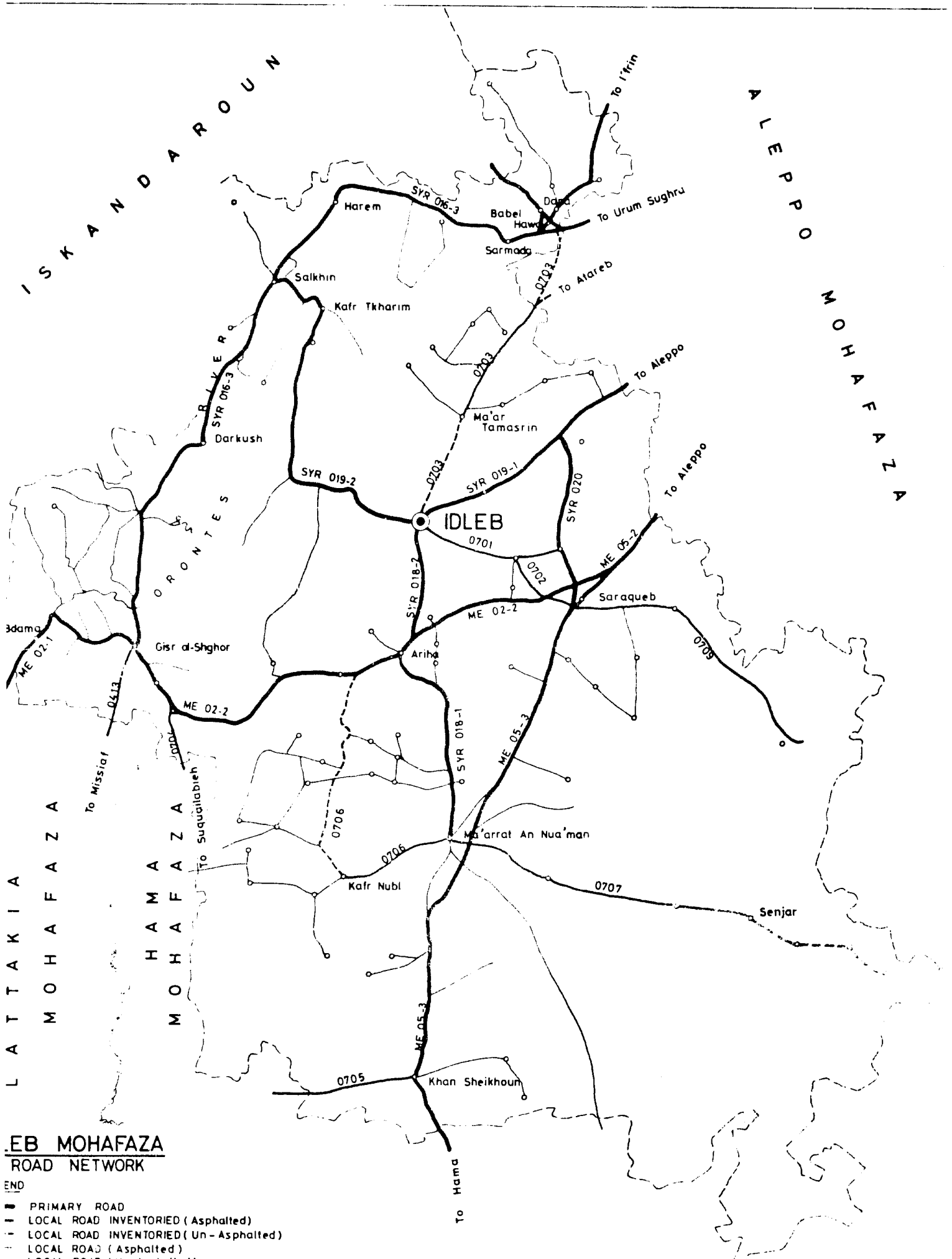

ISKANDAROUN
ALEPPO MOHAFAZA
To I'frin
Harem
SYR 016-3
Babel
Hawa
Dana
To Urum Sughru
Sarmada
0703
To Afareb
Salkhin
Kafr Tkharim
0703
To Aleppo
Ma'ar Tamasrin
SYR 016-3
Darkush
SYR 019-2
0703
SYR 019-1
SYR 020
To Aleppo
IDLEB
0701
ME 05-2
0702
Saraqueb
ORONTES
SYR 018-2
ME 02-2
Gisr al-Shghor
Ariha
0709
ME 02-1
0413
ME 02-2
SYR 018-1
ME 05-3
To Missiat
To Suqailabieh
0706
Ma'arrat An Nua'man
0706
Kafr Nubl
0707
Senjar
LATTAKIA MOHAFAZA
HAMA MOHAFAZA
ME 05-3
0705
Khan Sheikhoun
To Hama
.EB MOHAFAZA
ROAD NETWORK
END
PRIMARY ROAD
LOCAL ROAD INVENTORIED (Asphalted)
LOCAL ROAD INVENTORIED (Un-Asphalted)
LOCAL ROAD (Asphalted)
LOCAL ROAD (Un-Asphalted)
MOHAFAZA BOUNDARY
HAMA MOHAFAZA

Plate 3.11

acquired from the 1966 Master Plan for the Syrian Road System, existing Mohafaza maps, and discussions with Mohafaza engineers, supplemented with data acquired during visual inventories.

Designation of a road link as primary, secondary, or tertiary depends on one's perception of the road's relative importance as an international, national, regional, or local road link. They can be judged based on an analysis of the areas served and/or by the volume of traffic carried. Consequently, road classifications are difficult to establish.

This difficulty can be illustrated by the fact that there are actually two road classification systems in use in Syria. The first was established by a 1957 law governing road classifications, but it is not generally used on existing maps or in existing documents. The second system was established for the study conducted by the firm Societe Central pour l'Equipment du Territoire (SCET). The latter altered the classification nomenclature of the former but generally holds to traffic volumes as a parameter for classifying roads. Both are awkward and cumbersome.

Table 3.1.3 shows the road network classification system used in this study. The Consultants have drawn upon both the 1957 law and the Master Plan but have further clarified the definitions by adding specific traffic volumes as an element of the classification. Generally, the resulting network classifications illustrate the importance of the area served, i.e., terminals are defined, and they illustrate the significance of traffic volume, i.e., limits are specified.

The addition of a traffic volume element permits the upgrading or downgrading of roads in the network to reflect changes in the volume of the movement of people and goods. For example, a new road link often has a secondary effect of reducing traffic on a distant but parallel road while increasing traffic on certain connecting roads. The traffic volume modification permits reclassification of the roads to reflect the relative changes in service and demand as the network road length grows and coincides with changes in geometric classifications, which are discussed later in this section. The classification of roads on Plates 3.1 through 3.11 shows international roads as established by the 1966 SCET Master Plan. The national road network shown has been modified from the Master Plan to reflect changes in service since 1966.

Because the law of 1957 and the SCET, which also generally followed the 1957 administrative standards, represent existing legislative parameters, the Consultants necessarily conformed to those standards in defining classification and coding

Table 3.1.3

CLASSIFICATION OF PAVED ROAD NETWORK

Primary Network		
International Roads	-	Major road connections to neighboring countries.
National Roads	-	Roads that connect major Mohafaza centers, or major areas and principal cities; or minor road connections to neighboring countries; or other major roads that carry over 5000 vehicles per day, on the average.
Secondary Network		
Major Local Roads	-	Roads that carry between 1500 and 5000 vehicles per day on the average.
Tertiary Network		
Minor Local Roads	-	Roads which carry under 1500 vehicles per day.
Rural Access Roads	-	Earth and gravel roads which carry under 400 vehicles per day.

Table 3.1.4

1979-1980 TRAFFIC RANGES

Network	Average Daily Traffic (Vehicles per day)	
	Low	High
Primary		
International	50	10,050
National	193	10,510
Secondary	1,500	4,690
Tertiary	14	1,500

systems for the road inventory and traffic counting programs. However, because of the importance of traffic volumes in analyzing the road network, the resulting networks have been subclassified according to average daily traffic (ADT).

Because of the importance of traffic, the Consultants recommend that a new and less unwieldy system of classification be considered, based primarily upon the ADT count (see Table 3.1.4). Such an alternative system would require legislative action to amend the 1957 law.

Criteria for the proposed road network classification are as follows:

Classification	Average Daily Traffic
A. Primary Road	Over 5,000
B. Secondary Road	1,500-5,000
C. Tertiary Road	400-1,500
D. Low-Volume Traffic Rural Road	Under 400

Plate 3.12 shows the roads inventoried and classified on the basis of the proposed highway classifications. The proposed system would have to be modified periodically to reflect changing traffic patterns and the corresponding upgrading of individual roads.

Table 3.1.5 shows the length of road for 1979, 1985, and 2000 based on the recommended classification system and the Consultants' recommended design standards (section 3.2 below).

Route Numbering System

A simplified, but significantly modified, route numbering system is also recommended. This system is not to be confused with the road classification system described above, which is used for inventory and administrative purposes. The route numbering system is intended for highway identification on maps and route markers.

Although legislative action may be required as a means of adoption, the system's simplicity would be of distinct advantage to both Syrian and tourist motorists and effect savings through reduced usage of sign materials and less labor on map preparation.

Primary highways, including international and domestic roads, would be prefixed by the letter "M" and followed by a number

identifying the link. Secondary roads would be prefixed by the letter "S" and followed by a number identifying the link. Table 3.1.6 identifies the proposed route number system for primary and secondary roads.

Tertiary routes would be identified on signs and maps by a simple numerical designation without a letter prefix. Each Mohafaza would, however, identify internal Mohafaza routes by having the first number (or numbers) of the route correspond to the Mohafaza identification number shown in Table 3.1 7.

Traffic

A one-year nationwide traffic counting program was initiated in August 1979 in order to determine the volume of traffic carried on the primary, secondary, and tertiary paved road networks. The traffic counting program included collection of data concerning type and mix of vehicles.

A detailed description of the traffic counting program and the results were presented in Chapter 5, Section 5.2 of the Final Phase I Report.

The results of the traffic count indicate that there is a wide traffic range in the primary network, because by definition the area served is emphasized, whereas the secondary and tertiary network is actually defined in terms of the traffic range. However, links on both the primary and tertiary networks are carrying less than 400 vehicles per day, which is the Consultants' lower designated limit for a paved road network.

Assessment

Geometric classifications have been established for Syrian conditions in order to assess the capacity of the network. The classifications are derived, only as a reliable base, from international standards. Visual inventories of the road, pavement condition, traffic volume analysis, capacity and safety criteria, and Syrian conditions were evaluated. The Consultants analyzed data collected during the study with the aid of the Zilog Computer. First, the inventory data were synthesized and reproduced to illustrate the characteristics and condition of the existing roads. Second, the computer correlated existing conditions and proposed standards to illustrate, link by link, the deficiencies in the existing system.

Inventory Program

A comprehensive visual inventory of the road infrastructure was completed during the summer of 1979 and the spring of 1980. All

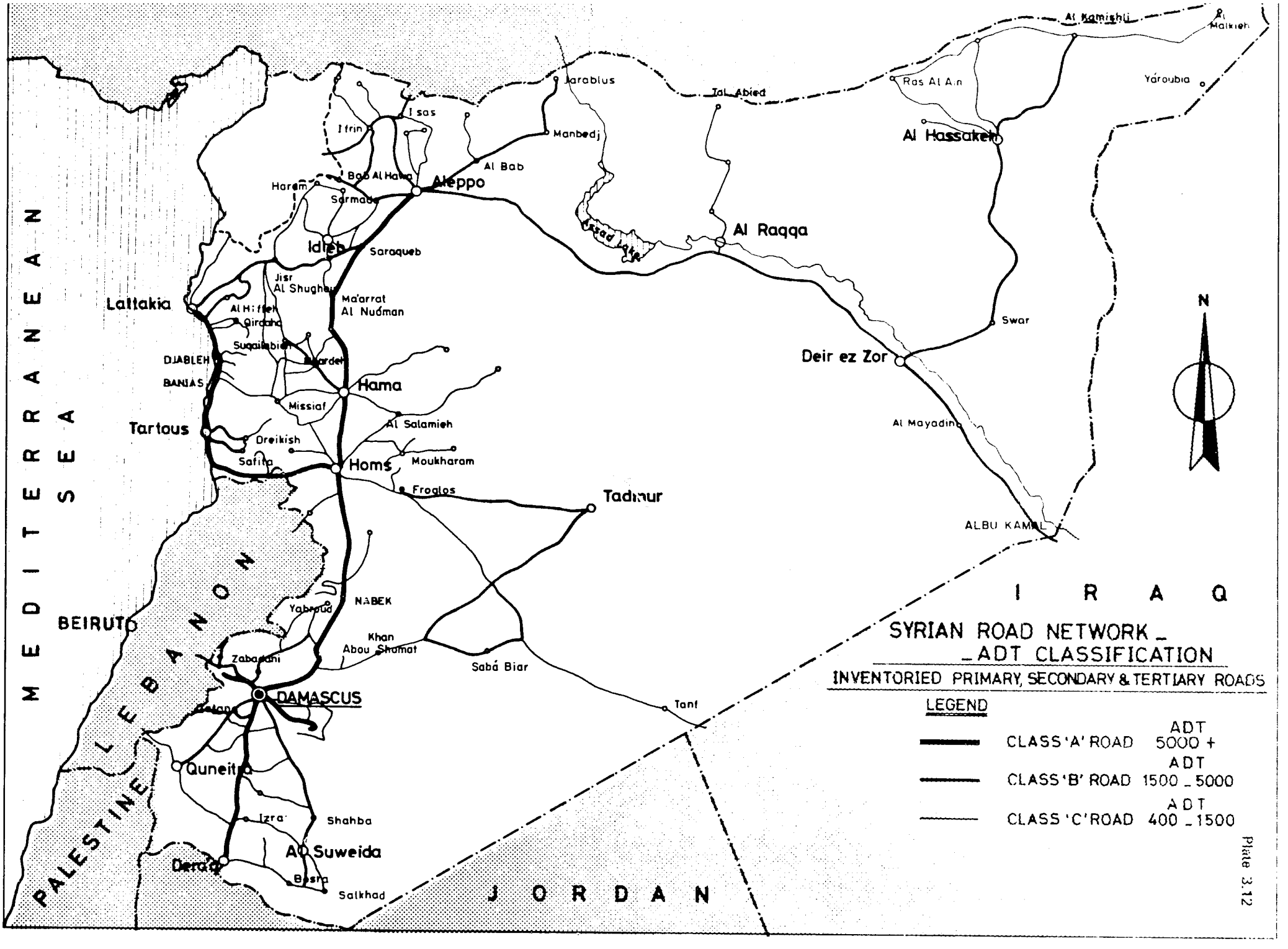

SYRIAN ROAD NETWORK _
_ADT CLASSIFICATION
INVENTORIED PRIMARY, SECONDARY & TERTIARY ROADS
LEGEND
CLASS 'A' ROAD ADT 5000 +
CLASS 'B' ROAD ADT 1500 _ 5000
CLASS 'C' ROAD ADT 400 _ 1500
N
MEDITERRANEAN SEA
LEBANON
PALESTINE
JORDAN
IRAQ
BEIRUT
Lattakia
Tartous
DJABLEH
BANIAS
Al Hiffeh
Qirdaha
Sugaibieh
Jisr Al Shughur
Ma'arrat Al Nuóman
Idlib
Harem
Sarmada
Bab Al Hawa
Aleppo
Saraqueb
Ifrin
Isas
Al Bab
Manbedj
Jarablus
Tal Abied
Al Kamishli
Al Malkieh
Ras Al Ain
Yaroubia
Al Hassakeh
Al Raqqa
Assad Lake
Swar
Deir ez Zor
Al Mayadin
ALBU KAMAL
Hama
Missiaf
Al Salamieh
Dreikish
Safita
Homs
Moukharam
Froglos
Tadmur
NABEK
Yabroud
Khan Abou Shamat
Zabadani
Sabá Biar
DAMASCUS
Tanf
Quneitra
Izra'
Shahba
AD Suweida
Deraa
Basra
Salkhad

Plate 3.12

Table 3.1.5

SYRIAN ROAD NETWORK CLASSIFICATION BASED ON ADT

Classification		Traffic Volume (ADT)	Surface Standards		Length (kms)		
Road	Geometric		Width Meters	Type	1979	1985	2000
Primary	Autostrad Y	over 30,000	21.9[1]	Asphaltic Concrete	-	-	90
	Autostrad X	9,000-30,000	14.6[1]	Asphaltic Concrete	280	320	780
	Class A	5,000- 9,000	7.3	Asphaltic Concrete	340	480	1,260
Secondary	Class B	1,500- 5,000	6.7	Low Grade Hot Mix	1,640	3,060	5,340
Tertiary	Class C	400- 1,500	6.2	Double or Single Bituminous Surface Treatment	6,230	6,100	6,130
Rural Roads	Class D	under 400	3.5	Gravel	9,280	10,035	9,245
Total					17,770	19,995	22,845

Source: Consultants' Inventories, Traffic Counts and Traffic Projections.

1 Dual Carriageway.

Table 3.1.6

PROPOSED ROUTE DESIGNATIONS - PRIMARY AND SECONDARY ROADS

PRIMARY ROADS

Route No.	Terminals		
	From	Via	To
M-1	Damascus	-	Jordan Border
M-2	Damasucs	-	Lebanese Border
M-3	Damascus	-	Homs
M-4	Homs	-	Hama
M-5	Hama	-	Aleppo
M-6	Homs	-	Tartous
M-7	Tartous	-	Lattakia
M-8	Damascus	-	Airport

SECONDARY ROADS

Route No.	Terminals		
	From	Via	To
S-1	Damascus	-	Kariat
S-2	Damascus	-	Sa'sa'
S-3	Intersection S-2	-	Irneh
S-4	Damascus	Al Tkeih	Lebanese Border
S-5	Intersection S-4	-	Al Srghaya
S-6	Damascus	-	Ma'Loula
S-7	Intersection M-7		Safita
S-8	Tartous	-	Dreikish
S-9	M-7	Heffe	Intersection S-10
S-10	Lattakia	Jisr Al Shughour	Intersection M-5
S-11	Aleppo	Bab Al Hawa	Turkish Border
S-12	Aleppo	Isas	Intersect S-11
S-13	Intersection S-12 (Afrin)		Turkish Border
S-14	Aleppo	-	Garablus
S-15	Aleppo	-	Al Raqqa
S-16	Al Raqqa	-	Deir Ez Zor
S-17	Deir Ez Zor	-	Al Hassakeh
S-18	Al Hassakeh	-	Al Kamishli
S-19	Deir Ez Zor	-	Albu Kamal

international, national, and major local roads were inventoried except those located in urban and militarily restricted areas. In addition, more than one-third of the local paved road network was inventoried.

A total of 3,930 kilometers of primary road links were identified for inventory based on an analysis of the 1966 Master Plan maps, Mohafaza maps, and other statistical data. An additional 3,700 kilometers of paved secondary and tertiary road links and 1,537 kilometers of gravel and earth roads were identified and inventoried, using the above data and additional data provided directly by Mohafaza engineers.

The Consultants designed a detailed road inventory recording form, prepared a road inventory manual, and conducted visual observations. The form, titled Syrian Comprehensive Transport Study Primary and Secondary Inventory, was shown in Appendix 3.1 of the Final Phase I Report.

The form provided space for identification and/or description of the route within the network, road geometry and surface condition, surrounding terrain, design speeds, structural elements, and traffic characteristics. These data yielded information for all primary and major secondary roads regarding the geometry and type of construction; type of subbase; width of platform; base, width, and type of surfacing; capacity of structures; mileage; geographic distribution; present state of maintenance; and general adequacy for present traffic. In all, the form provided space for 56 entries, 47 of which were recoded in the field, when applicable, and nine that were provided in the office based on evaluations of engineering drawings and traffic data.

Data for local roads were recorded on the same form. However, the only data logged were those required to identify substantial changes in the type of surface, width and surface condition, geometry standards, and category of structures.

The inventory was conducted by three teams, each headed by a Syrian engineer who received training from the Consultants, and a member of the Consultants' staff.

3.2 DESIGN STANDARDS

Parameters and History

During this study very little information has been made available regarding pavement designs, making it necessary to study road cross-sections in the field in an effort to determine the original design. Where pavement structures had been

Table 3.1.7

PROPOSED MOHAFAZA NUMBER PREFIXES FOR INTER-MOHAFAZA ROADS

Prefix	Mohafaza
1	Damascus
2	Aleppo
3	Homs
4	Hama
5	Lattakia
6	Deir Ez Zor
7	Idleb
8	Al Hassakeh
9	Al Raqqa
10	Al Suweida
11	Dara'a
12	Tartous
13	Quneitra

exposed, either due to failures or excavation for placing drainage pipes and water lines, the exposed sections were evaluated.

These attempts to determine pavement designs were undertaken only as a final resort. Repeated requests for standard or specific designs were unproductive; construction specifications were not available; and permission to cut inspection trenches across completed sections was denied.

The results of the majority of such appraisals indicate that approximately 90 percent of the paved roads investigated, including the primary, secondary, and tertiary networks, consist of a Telford subbase, a penetration Macadam base, and a surface that varies from a rock asphalt surface to asphaltic concrete.

As in other countries, the greater part of the Syrian road network was originally constructed when traffic volumes were very low. Many such road links began as trails and generally were constructed along contour lines; geometric standards were minimal to nonexistent.

With increases in traffic, it became necessary to upgrade highway requirements. The geometric standards were developed and subsequently upgraded to meet the needs of high traffic volume roads. Such standards, however, greatly restricted the allowable gradient and minimum radii of the curves, which necessitates new construction using larger embankment fills and excavations. Such earth fills require far greater compactive effort and inspection, which in turn caused a drastic revision of construction practices in Syria.

Historically, the Syrian trend paralleled that experienced by other nations worldwide. During the early and developing phases of highway construction, many designs were initiated and tested prior to their acceptance. As a result, highway departments throughout the world may now benefit from these basic design criteria. Such benefits, however, do not materialize from altering any part of the design, or utilizing only segments of the design, without prior testing to determine long-range results and implications.

Existing Conditions

Significant data from the road inventory were entered into one of three computer files. The first file covers the 5,000 kilometer main road network, i.e., all primary and major secondary roads. The second file contains all inventoried paved secondary and tertiary (local) roads. The third file contains all inventoried rural access earth roads, which are by definition

tertiary roads. The computer coding for the primary file is more extensive than for the secondary and tertiary file; however, the files are cross-referenced so that data developed in one file can be transferred to the second during evaluations.

The 1979-1980 traffic volumes obtained from the traffic counting program were also entered into the computer. Road links that were inventoried, but for which no actual counts were available, were analyzed and assigned ADT counts based on their similarity to roads where ADT counts were available. This was done on both the main road file and the local road file

The computer sorted the road links into geometric classes based on their actual or estimated ADT. The road links were further sorted into Mohafazat, so that the existing condition by class could be retrieved on command for each Mohafaza. Finally, in addition to all primary and secondary roads being inventoried, more than one-third of the tertiary roads (Class C and D roads in the local road file) were inventoried. The total length of paved tertiary roads in each Mohafaza was entered into the computer and a program was developed to expand the data to all paved tertiary roads, using an appropriate expansion factor.

Three elements of the network infrastructure have been retrieved by class, by Mohafaza, for this analysis. These are surface type, road width, and surface condition. The results for each Mohafaza, in terms of road affected, are included in Appendix 3.1. A country-wide summary for the primary road network is shown in Table 3.2.1 and for the paved secondary and tertiary road network in Table 3.2.2.

The acceptable or recommended appropriate standards are boxed in each table in order to show the length of road with standard conditions. Surface types to the left of the box in each class are substandard, while those in the right exceed standards. Conversely, road widths to the right of each box in road width analysis are substandard while those to the left exceed standards. Finally, poor and very poor surface conditions indicate substandard and unacceptable driving conditions, while the fair condition indicates a marginally acceptable condition. The results are summarized in Table 3.2.3.

This section describes trends indicated in the above findings and correlates these trends with the Consultants' findings regarding road engineering practices in Syria. This section deals with the paved road network only. An analysis of gravel and earth roads is contained in Section 3.5 below.

Table 3.2.1

PRIMARY ROAD LENGTH STATISTICS - NATIONAL SUMMARY

SURFACE TYPE

Recommended Class	Earth	Gravel	S.B.S.T.	Hot Mix	Asphalt Concrete	Total
X	0.00	0.00	0.00	6.30	274.35	280.65
A	0.00	0.00	0.00	275.10	61.10	336.20
B	0.00	0.00	285.60	1,126.50	23.10	1,435.20
C	0.70	0.00	414.40	1,031.00	0.00	1,446.10
D	0.00	24.40	97.00	295.40	0.00	416.80
Total	0.70	24.40	797.00	2,734.30	385.55	3,914.95

ROAD WIDTH IN METERS

Recommended Class	Autostrad	Over 7.0	6.2 - 6.9	5.6 - 6.1	Below 5.6	Total
X	167.15	113.50	0.00	0.00	0.00	280.65
A	61.10	193.40	60.90	20.00	0.00	336.20
B	1.30	670.70	210.10	318.20	234.90	1,435.20
C	0.00	640.70	108.40	410.70	286.30	1.446.10
D	0.00	79.50	56.80	193.50	87.00	416.80
Total	229.55	1,697.80	436.20	943.20	608.20	3,914.95

Table 3.2.1 (continued)

PRIMARY ROAD LENGTH STATISTICS - NATIONAL SUMMARY

Recommended Class	SURFACE CONDITION Good	Fair	Poor	Total
X	270.45	9.70	0.50	280.65
A	123.60	204.05	8.55	336.20
B	174.30	1,014.80	246.10	1,435.20
C	231.60	696.40	518.10	1,446.10
D	48.60	220.10	148.10	416.80
Total	848.55	2,145.05	921.35	3,914.95

Table 3.2.2

SECONDARY AND TERTIARY PAVED ROAD LENGTH STATISTICS - NATIONAL SUMMARY

SURFACE TYPE

Recommended Class	Earth	Gravel	S.B.S.T.	Hot Mix	Asphalt Concrete	Total
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	6.20	195.60	0.00	201.80
C	0.00	0.00	2,068.48	2,715.51	0.00	4,783.99
D	0.00	0.00	1,878.63	1,775.58	0.00	3,654.21
Total	0.00	0.00	3,953.30	4,686.70	0.00	8,640.00

ROAD WIDTH IN METERS

Recommended Class	Over 6.6	6.4-6.0	5.4-5.9	4.5-5.3	3.5-4.4	Below 3.5	Total
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	11.90	25.70	72.70	84.90	6.60	0.00	201.80
C	139.20	466.73	978.28	2,774.99	424.80	0.00	4,783.99
D	110.49	993.00	334.31	1,566.94	585.80	63.66	3,654.21
Total	261.59	1,485.43	1,385.29	4,426.83	1,017.20	63.66	8,640.00

Table 3.2.2 (continued)

SECONDARY AND TERTIARY PAVED ROAD LENGTH STATISTICS - NATIONAL SUMMARY

Recommended Class	SURFACE CONDITION					
	Very Good	Good	Fair	Poor	Very Poor	Total
A	0.00	0.00	0.00	0.00	0.00	0.00
B	11.90	19.40	54.80	115.70	0.00	201.80
C	100.71	351.00	3,284.88	794.32	253.09	4,783.99
D	0.00	162.27	2,288.64	643.45	559.85	3,654.21
Total	112.61	532.67	5,628.32	1,553.47	812.94	8,640.00

Table 3.2.3

ANALYSIS ONE - EXISTING PAVED NETWORK

PERCENT OF TOTAL LENGTH

Classification	Total Km	Surface Type			Pavmt. Width			Surface Condition		
		Under Design	STD.	Over Design	Under Design	STD.	Over Design	Good	Fair	Poor
Primary Network										
Autostrad	280	2	98	0	41	59	0	95	4	1
Class A	340	81	19	0	24	76	0	37	60	3
Class B	1,440	20	78	2	38	15	47	13	70	17
Class C	1,450	0	29	71	20	28	52	4	48	36
Class D	420	0	6	94	0	0	100	13	52	35
Secondary Network										
Class B	200	3	97	0	95	15	0	14	28	58
Tertiary Network										
Class C	4,780	0	43	57	87	10	3	10	69	21
Class D	3,660	0	0	100	2	16	82	4	63	33

Road Surface

An analysis of the surface type data in Tables 3.2.1 and 3.2.2 indicates that 70 percent of the primary network and 57 percent of the paved secondary and tertiary networks are surfaced with a low type hot mix. The international standards indicate that optimum use of this surface type is for traffic volumes between 1,500 and 5,000 ADT (Class B road). In 1979-1980 only 13 percent of the network carried traffic in this ADT range. Higher traffic ranges perform better on asphaltic concrete (AC) surfaces and lower traffic volumes perform as well on less expensive single or double bituminous surface treatment (SBST and DBST) surfaces.

Measured against the Consultants' recommended standards, the Syrian paved road network is substandard on the higher traffic volume roads (Class A), properly designed on the medium traffic volume roads (Class B), and exceeds standards on the lower traffic volume roads (Classes C and D). This is illustrated in Table 3.2.3.

Table 3.2.3 also shows that 88 percent of the existing surfaces are in either fair or poor condition, which indicates that the higher surface standards are not resulting in an overall improved riding quality. This is of particular concern because over half of the paved road network is less than 10 years old.

The deterioration appears in an undulating "wash board" surface, broken pavement, and generally poor riding quality. In a few instances there are indications of plastic deformation, but generally the fault may be laid to a consolidation deformation. This should not be exclusively laid to faulty design, excessive traffic volumes, or over-weights becase it may be that poorly placed and compacted material in embankment fills, subgrade, subbase, bituminous base course, and asphaltic concrete surface course are now merely being consolidated by traffic loads that exceed the minimal compactive efforts made during the construction phase. A few instances of plastic deformation have occurred in areas of low volume traffic where improper drainage structures caused isolated soaked subgrade conditions. In these instances the bituminous base course pavement did not hold up for the exact condition for which it was designed. The effects of substandard construction practices are discussed in more detail in Section 3.3.

At the present time approximately 50 percent of the roads constructed using the AASHO Pavement Design Method are being reinforced by the application of two overlays with a combined average thickness of 35 centimeters.

In contrast, the Consultants have observed that earlier paved roads constructed with a rock subbase (Telford) and a Macadam surface (usually the wearing surface consisted of single or double bituminous surface) are holding up exceptionally well and form the backbone of the present network. Therefore, the selection of the costlier bituminous base course pavement over the apparently more effective crushed granular base course pavement is questionable.

Accordingly, it is suggested that the Government evaluate their pavement designs with a view toward returning to the use of crushed granular aggregate base course. Also, in the sectors where the expensive overlay is presently underway or planned, tests should be conducted to determine whether or not the consolidation from heavy traffic has improved the compaction of the roads and to determine the overlay thickness required to sustain the traffic for the remaining design period of the road.

Road Width

Road widths appear to be evenly divided between being substandard, standard, and exceeding standards in the primary network except for Class D roads, virtually all of which exceed standards. However, it appears that almost 85 percent of the secondary and tertiary network, except Class D road, is substandard for the traffic volume carried, based on recommended standards. This is also illustrated in Table 3.1.3.

In the field, the Consultants have observed that most roads follow the terrain, and often the width of a road may vary as much as two or three times in a single kilometer.

Summary

In summary, it appears that the lowest traffic volume roads generally exceed standards, the higher volume roads generally are substandard, while the middle volume range is generally mixed. Lower traffic volume ranges (Class D), which represent 30 percent of the entire paved road network, exceed pavement width and surface type standards, but the advantage of this benefit is partially lost because the surface condition is deteriorating. On the other hand, the lower middle traffic volume roads (Class C) are divided between standard and 40 percent and 60 percent greater than standard surface types, but are significantly substandard in road width. The upper traffic volume roads (Class B) are standard in surface type and 45 percent substandard in road width. Finally, Class A roads are substandard in surface type and three-fourths standard in width.

Geometric Design Standards

The geometric design standards are primarily a function of traffic volume, terrain, and the level of service desired. However, these standards vary within narrow limits worldwide because of other unquantifiable factors. The Consultants have reviewed the inventory data and determined that the existing standards used in Syria vary throughout the country.

Highway design should be based upon a series of basic design standards that are formally adopted, as much as possible, before the design is started. In recent years there has been a trend towards a greater use of specific standards of proven design that have been established by various highway agencies. These standards have been developed through the application of basic highway engineering principles, taking into consideration the level of traffic service that is to be provided and the cost of construction or the availability of funds. Such standards are then moddified slightly to satisfy specific needs.

Various international standards have been established based upon the results of numerous years of study under a variety of conditions, such as the anticipated traffic volumes, geography, topography, climatic conditions, proper construction and maintenance capabilities, and financing potential. All of these various conditions tend to make a 100 percent acceptance of any international highway standard a very complicated proposition for any one country.

Therefore, it is not the Consultants' intent, nor is it considered professionally objective, to simply extract existing design standards from international criteria and apply them to Syria. Such internationally recognized standards have proven value and, under applicable circumstances, represent an unquestionable foundation upon which adaptations may be based. Each country has its own unique circumstances with equally unique materials, traffic, economic, and load problems, which demand solutions applicable to those conditions and not simply solutions designed for other countries and their particular circumstances.

The Consultants have utilized the following international standards as a base condition against which Syrian requirements were measured:

- a Policy on Geometric Design of Rural Highways, 1954, American Association of State Highway Officials (AASHO) - now the American Association of State Highway and Transportation Officials (AASHTO),

- a Guide to Highway Design Standards, 1957, International Bank for Reconstruction and Development (World Bank),

- Low-Cost Roads, Design, Construction and Maintenance, 1967, United Nations Educational Scientific and Cultural Organization (UNESCO),

- Highway Capacity Manual, 1965, Highway Research Board Special Report 87.

Because similarities exist among the above standards, they were all considered satisfactory as a base condition. A composite was derived from them, taking into account available existing design criteria, evaluation of conditions at road construction sites throughout Syria, and the need to avoid over-design at this stage of Syria's development. Specific modifications were made in the geometrics for mountainous terrain where sight distance gradients and radii that are more suitable to local conditions have been selected. Gradients have been increased slightly for hilly terrain and radii have been slightly reduced. Virtually no changes were made for desert areas. In each instance, however, no geometrics were selected that would create unsafe conditions or overstress truck capability.

The Consultants' recommended geometric standards are shown in Table 3.2.4. The standards are within the lower recommended limits for each geometric classification as set forth in the international publications listed above. Nonetheless, the standards provide for stable flow for the proposed average daily traffic (ADT) range in each classification.

As indicated in Table 3.1.2, 43 percent of the existing paved road network is substandard in width, based on the proposed standards and measured by 1979-1980 ADT. However, substandard conditions at the lower traffic volumes (say under 1,500 ADT) are less critical than at higher ranges. Because over 80 percent of the paved roads surveyed carry less than 1,500 vehicles per day, Syrian road width conditions, although substandard, are tolerable until traffic volumes increase.

The following concepts lie behind the Consultants' recommended geometric standards. A safe and efficient highway must provide a consistent level of traffic service throughout the length of a sector. It is recognized that a sharp curve, located in level terrain or at the end of a long tangent, is many times more dangerous than the same type of curve located in mountainous terrain, or in any sector containing many curves. In the same way, variations in pavement widths, or even in shoulder widths, may often produce undue hazards.

Table 3.2.4

GEOMETRIC CLASSIFICATIONS

	Standards														
ADT:	Autostrad Over 9,000			Class A 5,000-9,000			Class B 1,500-5,000			Class C 400-1,500			Class D Under 400		
Surface Type:	Asphaltic Concrete			Asphaltic Concrete			Low-Type Hot Mix			Surface Treatment			Gravel		
Terrain:	Flat	Rolling	Mountain	Flat	Rolling	Mountain	Flat	Rolling	Mountain	Flat	Rolling	Mountain	Flat	Rolling	Mountain
Design Features															
Design Speed (Kms/Hr)	120	112	100	120	112	100	100	90	70	90	80	50	80	65	40
Maximum Gradient (%)	3.0	4.0	6.0	3.0	4.0	6.0	4.0	5.0	7.0	5.0	6.0	8.0	6.0	7.0	9.0
Surface Width															
2 Lane				7.3	7.3	7.0	6.7	6.7	6.2	6.2	6.2	6.0	3.5	3.5	3.5
4 Lane	14.6	14.6	14.0												
6 Lane	21.9	21.9	21.0												
Outside Shoulder Width	3.0	2.5	2.0	2.5	2.5	2.0	2.0	1.5	1.5	1.5	1.0	1.0	1.0	1.0	1.0
Median Width[1]	10.0	5.0	1.0												
Minimum Radius	450	330	265	450	330	265	265	240	125	240	165	75	165	100	50
Stop Sight Distance	180	150	130	180	150	130	150	110	80	130	95	50	95	75	30
Bridges															
Width[2]		13.0 to 13.3			13.0 to 13.3			10.0 to 10.7			8.5 to 9.2			3.5 to 4.0	
Between[3]		9.0 to 9.3			9.0 to 9.3			7.8 to 8.2			7.0 to 7.7			3.5 to 4.0	
Design Live Load		HS 20-44[4]			HS 20-44			HS 20-44			HS 20-44			HS 15-44	

Source: Consultants' estimates.
Notes: All measurements in meters.
ADT = Average Daily Traffic.
HS = Highway Speed.

[1] Includes shoulders.

[2] Width if length over 20 meters.

[3] Between curbs if length under 20 meters.

[4] American Association of State Highway Officials (AASHO) live load HS 20-44 will safely support a 36-ton 3 axle truck/semitrailer combination.

Although general standards must be changed to meet changing conditions and situations, the number of these changes should be kept to a minimum, and they should occur only in logical locations. Different sets of design standards are normally used in mountainous, hilly, and level terrain, but the proper application of even these different standards on the same project will produce fewer hazards than those that would result from indiscriminate changes in the geometric dimensions that localized situations might indicate.

Design Speed

The design speed is the maximum speed at which a vehicle can traverse a section of highway safely, under normal conditions. Changes in the design speed are predicated upon the changes in the type of terrain, and reductions in speed, in certain sectors, may impede the flow of traffic. Additionally, restricted speed sections must be kept large so as not to disrupt the continuity of the flow of traffic. Speed changes for small sections of the road will greatly alter the standard design of the road.

Horizontal Alignment

Horizontal alignment is based upon the terrain and the design speed. In level and rolling terrain, long sweeping curves, to accommodate high speeds, are easily justifiable, whereas in hilly and mountainous terrain the topography should take precedence. The super-elevation of the road at the curves is important, but due to the topography, the minimum radius of the curve should be the governing factor. A curve with a short radius must be compensated by a reduction in speed.

Vertical Alignment

Vertical alignment is also dependent upon the terrain. In level and rolling terrain the relatively flat topography is not too much of a problem. Minor excavations and embankment fills are not costly and result in a fairly level road. In hilly and mountainous terrain any attempt to maintain a fairly level road, however, will either have to be accomplished by deep through or side-hill cuts, which are relatively expensive to construct and maintain. Alternatively, the design must revert to following contours of the terrain, which may result in a serpentine type of road. The ideal solution is a moderate combination of both types of design. This may be accomplished by increasing the gradient and reducing the speed. The length of the vertical curves at the crest of the hill should be as gentle as possible so as to increase the sight distances.

Shoulder Width

Shoulder width is greatly dependent upon the terrain. In level and rolling terrain the shoulder width is important not only for disabled-vehicle parking and psychological purposes, but also for drainage of the pavement structure. The further that rain water is shed from the pavement structure the less that ponding water will damage the road foundation. Shoulders also serve as parking spaces in case of emergencies and a passageway for pedestrians and animal traffic. In hilly and mountainous terrain, due to excessive costs, the shoulders are normally reduced although the road widening at sharp outside curves may permit a parking area for vehicles. All shoulders should provide required sight distances and give a feeling of being impeded.

Pavement Surface

Pavement surface greatly depends upon the design speeds and ADT. On level and rolling terrain where the horizontal and vertical alignment is generally not a difficult problem, the surface of the road should be of a higher quality than in hilly and mountainous terrain. This is due to the higher speeds at which traffic flows and also due to the effects of rain water. Water runoff from the road surface in level and rolling terrain is generally slow, which allows water to soak into and through the previous base course and subbase into the usually much inferior subgrade. In hilly and mountainous terrain the road gradient prevents the ponding of water, but traction on the road surface is important, especially as applied to horizontal alignment.

Pavement Surface Width

Pavement surface width is dependent upon several factors. The actual design width required for the passage of two vehicles is not always the major factor. Considerations, such as the psychological hazards presented by obstructions close to the edge of the road and the speed of oncoming and passing vehicles must be made. Generally, the required width of the road is greatly influenced by the design speed, i.e., greater speeds generate a wider pavement requirement. Conversely, reduction in speed will greatly reduce the psychological effect of an oncoming vehicle and may allow a surface-width reduction.

Drainage Structure

The importance of the proper drainage design and properly maintained drainage structures cannot be over-emphasized. This is particularly true in level and rolling terrain where water

tends to pond in the vicinity of the road and where embankments may block the natural drainage flows. In hilly and mountainous terrain the nature of the terrain ensures adequate drainage of pavement surface, although cross drains are of paramount importance. Drainage structures are generally constructed on the inside curves where the swales are natural drainage formations.

Pavement Standards

Previous pavement designs in Syria have also been theoretically based on a variety of internationally acceptable methods. A properly designed and constructed pavement should guarantee a long life and a fairly maintenance-free road. Like geometric standards, however, there is no single economic design for all highway pavements.

A study of the function of each component part of a pavement is essential for each new design, and design is fundamentally dependent upon the bearing value of the subgrade, which often is the natural soil. Under extreme conditions these natural soils are plastic or semi-plastic. This type of material, when dry, has a fairly high inherent stability; however, pavement designs are based upon the support value of the subgrade soils when they are saturated, which is the soil's most adverse condition. Safety factors, therefore, are built into the design so that the pavement, when constructed properly, will function throughout its design life regardless of natural external factors.

In addition, the load-carrying capacity of flexible pavements is determined by the load distributing characteristics of the pavement layering system. Flexible pavements consist of a series of layers, with the highest quality materials at or near the surface. Therefore, the strength of a flexible pavement is a result of building up layers and distributing the load, by virtue of the layers' shear strength, over the subgrade.

The primary function of a pavement structure is the distribution of wheel loads so that the supporting capacity of the subgrade soil is not exceeded.

The subgrade soil is the material upon which the pavement structure rests, whether embankment or excavation, and the characteristics and functions of the pavement structural layers are as follows:

- The wearing surface may be a bituminous pavement mixture, a slab of Portland cement concrete, or granular material. The principal functions of the wearing surface of an asphaltic paved road or a concrete road are to protect the base course

from the wear and abrasive effects of traffic, to protect the base against the penetration of surface moisture, to distribute load, and to be sufficiently stable to prevent the surface from being displaced under traffic loads.

- The base course may consist of untreated, crushed, well-graded gravel or stone. The base course is a layer of very high stability and density. The principal functions of the base course are to withstand the high shearing stresses that may be imposed by wheel loads, to distribute the loads to the subbase or to the subgrade, and to prevent capillary intrusion of moisture from the ground water table.

- The subbase consists of pit run (sometimes classified material) sand and gravel and any selected material that produces a specified California Bearing Ratio (CBR). The bottom layer of subgrade prevents the intrusion of the more highly plastic subgrade from entering the granular subbase and base course material, and thereby contaminating them.

Class A roads, where the traffic volumes are over 5,000 vehicles per day, will require an asphaltic concrete surface. This high type hot mix will better transmit the load to the base and subbase courses.

Class B roads also require a hot mix surface, but of a lower type mix, which is somewhat less expensive and may permit use by local contractors, who do not have access to asphalt plants with associated dryer gradation control units and sophisticated crushers. The use of medium curing bitumen (MC 60-70 penetration) required in the high-type hot mix, has too high a temperature range for current local contractor methods. The use of a lower-type hot plant mix product on Class B roads will permit the use of aggregates and temperature requirements less than 300°F or 150°C.

The Class C roads will require either a single or double bituminous surface treatment when the traffic volumes are less than 1,500 but more than 400 vehicles per day.

Consultant studies indicate that pavement design for international roads in Syria constructed during the last two plan periods and those planned for construction during the coming period is based upon the AASHO Pavement Design Method. In this method, the thickness of all component parts of the pavement, i.e., surface course, base course, and subbase course, are determined based on the structural coefficients assigned to the materials used in each course. In the U.S., where this method was developed, these coefficients are determined by tests conducted by each State Highway Department. Tests are mandatory

because these coefficients vary from region to region and must be established for each area in which this design method is used.

Therefore the AASHO Pavement Design Method should not be used unless the following steps are taken:

- the adequacy of the design is verified by soils material surveys, laboratory tests, and axle load studies,

- the construction methods used will actually attain the construction quality required to achieve the designed strengths.

Although the international highway network pavements in Syria are based upon the structural coefficients established in the U.S., pavements are designed utilizing a bituminous base course in lieu of a crushed granular base course. The reasons for this are not clear because:

- There is an abundance of inexpensive base course material in Syria. If the available base course materials are found to be unsuitable there are stabilizing materials that can be used to make them suitable.

- Although bituminous base course pavement, due to the higher structural coefficient of 0.34, versus 0.14 for crushed granular base course, requires a greatly reduced pavement thickness, it costs approximately 30 percent more per square meter than a crushed granular base course pavement design.

3.3 CONSTRUCTION STANDARDS

The general success of any engineering design used in Syria depends upon the construction industry's ability to perform uniform and high quality work within applicable specifications.

The construction practices used in Syria have not always been consistent with project specifications or design intent, where the latter are known. Some specific practices observed in Syria are discussed below under the heading Execution of Work. It is necessary to inspect the work of the public and private contractors to ensure that the work is being properly executed. Recommendations for improving the overall engineering capabilities of the Government are discussed below under the heading Engineering.

Syria is in an advantageous situation regarding most of the necessary materials required for highway construction: most are indigenous. There is an abundance of satisfactory sources of

rock, sand, and gravel, which are suitably located throughout the country, and the subgrade conditions are generally ideal for pavement construction with the exception of a few low-lying areas. Limestone sources are available for the production of cement; petroleum products and bitumen are processed from oil sources within the country. Occasionally, there are shortages in the production of petroleum products, cement, and bitumen, but facilities are being expanded to overcome these shortages.

Skilled and semi-skilled labor is readily available, although key personnel must often be transported to areas that do not have personnel with the appropriate background and training.

Any design of a major road is the end product of extensive laboratory studies, combined with empirical charts that are the result of extensive research and many hours of study and observations.

The design is based on ideal laboratory conditions, and it is unrealistic to assume that the field work can be carried out identically with the design criteria thus established. Because of this, certain safety factors are built into the design, and specifications are prepared that stipulate the control of construction items for each project. By following such specifications, design intents are ensured within planned tolerances.

It is realistic to require that maximum efforts be made in the field to ensure conformance to specifications that are directly related to design criteria. Inspection of construction practices on international roads in Syria indicate that construction operations are not always of professionally acceptable quality levels, specifications are not always in evidence or being followed, and designs are not always known.

Execution of Work

Comments on common construction practices noted during the Consultants' field studies are as follows:

Embankments

The embankment of a road is the portion that is constructed over the existing ground level up to the bottom of the structure. The height of the embankment may vary, but to ensure that there is no settlement of embankment materials from subsequent consolidation of high soil volumes, the density must be properly controlled during construction, otherwise it may distort the pavement and eventually destroy it or cause maintenance reconstruction costs.

There are two basic control procedures for assuring correct embankment density. The first is control of the compaction through field density tests to determine that the required compaction has been achieved. The second is to state in detail in the contract documents the manner and method for constructing an embankment. The latter procedure is specified in the General Specifications for International Highways in Syria. As a matter of expediency, however, the specifications for embankment construction are not available or followed. Embankment fills are often constructed with lifts of two meters or more in depth and with little or no compaction effort applied. The minor exception is when bulldozers are used to make a level surface for dump trucks, which then desposit succeeding lifts of material, but this does not produce adequate compaction.

Side-hill embankment fills are being constructed by dumping and bulldozing loose material over unprepared slopes. Prior to constructing embankments on side slopes, steps or benches must be cut in the slope to ensure a bond between the slope and the fill. Vertical compaction cannot be accomplished where the base is not on a level plane.

Rock side-hill embankment fills are being placed in a manner similar to that described above. The stepping operation in rock fills on rock slopes is similar to that employed for earth fills on earth slopes. Usually there can be no bond between the rock fill material and the talus or scree covering the side of the rock slope, and steps or benches are of prime importance.

Embankment culvert construction is often improper. The culvert constructed within an embankment under the road surface to permit the passage of water from one side of the road to the other must, in reality, become a part of that embankment. If the embankment fill is not correctly and densely compacted around the culvert pipe, settlement may occur at some future date, or water may seep through and cause piping, the process in which water will carry away much of the fine soil that goes into suspension. Eventually, serious damage to the embankment and the culvert occurs.

Generally, when constructing a road, and particularly when constructing an embankment, selected fill material is used to build up the platform. The selected fill in all cases should be of a higher quality than the subgrade. In many instances in Syria, plastic clayey soils, with inferior characteristics that are indicated by the plastic index of the soil, have been placed over superior subgrade, or lowbearing in situ material is simply covered with similar adjacent material.

Although the natural angle of repose for most soils is approximately 45 degrees, or a slope of 1:1, some soils will hold temporarily on a steeper slope. For safety purposes, however, the maximum fill slope should be 1:1. In many instances in Syrian road construction, fill slopes have been built as steeply as 3:2. These have precipitated embankment failures.

Excavation

In many instances, excavation practices contrary to the concepts of correct excavation procedures have been noted. Two such deviations are as follows:

- Material is disposed of over the side of the embankment slope, not only surcharging the slope but also blocking the natural drainage.

- Blasting is done in folded limestone, where the stratum of rock dips deeply into the cut. Because of the transmission of seismic vibrations produced by the blasting, translational sliding is likely to occur.

Culverts

The following culvert construction practices are found to be common on road construction in Syria:

- Corrugated metal pipes are being placed in embankments after the embankment has been constructed. The excavation often is too narrow and restricted for the proper seating of the culvert and for the lateral compaction needed to counter any deformation of the culvert. The camber and seating of the pipe is unsatisfactory because of improper compaction.

- Multi-plate bolts are not being tensioned to the required specifications.

- Reinforced concrete box culverts, cast in situ, are often formed with the reinforcing steel poorly tied. The water cement ratio in the concrete mix is extremely high, as indicated by evidence of segregation of the coarse aggregates. Also, the lack of proper vibration has resulted in a great amount of honeycombing, which results in exposed steel. In a few cases, the 28-day compressive concrete strengths have been in the vicinity of 80 kilograms per square centimeter in lieu of the 210 kilograms per square centimeter required by the specifications.

- At several locations, the length of corrugated culvert pipe was too short and ended under high embankment fills. The impeded flow of water will cause failure of the embankment.

Subbase

The Syrian general specifications indicate that subbase material should be placed in 15 centimeter lifts and compacted to a prescribed minimum density. However, the lifts being placed greatly exceed the specified thickness, often by up to 200 percent.

The current use of a vibratory compacter to compact the subbase lifts that are thicker than those specified has an adverse effect on the subbase. One of the characteristics of the vibratory compactor is that there is a tendency to compact and lock in the top of the layer. The result is the bridging of the subbase course. The top 10 to 15 centimeters is then hard and firm and the underlying material is uncompacted. This will result in a consolidation and deformation of the pavement.

Base Course

In the recent past, the Syrian International Road Design did not utilize the standard crushed rock base course but rather a bituminous base course. Some poor practices with the latter are described below:

- Generally, the base course consists of an open grading with a small percentage of course aggregates. This results in a very poor, unstable combination where approximately 60 to 70 percent of the mix consists of bitumen and fine aggregates.

- The placing temperature of the bituminous base course should be 130°C minimum. However, material is being placed at much lower temperatures, sometimes as low as 70°C. At low temperatures it is difficult, if not impossible, to compact this lift to the necessary density.

- The coarse aggregate portion of the bituminous base course is often screened river gravel, which is usually spherical in shape. Additionally, because of its low melting point, the 80-100 penetration bitumen will tend to lose its viscosity at high moderate temperatures. This may result in a base course that consists of lubricated, ball-bearing-type aggregates.

- In numerous instances the bituminous base has cracked and has been removed. One major reason for the cracking is that the bituminous base course was placed over an unprepared or improperly primed subbase, which resulted in a lack of adhesion between the two structural members of the pavement.

Conclusion

The disparities cited above between actual and good construction methods practiced on the international highway construction program are not isolated cases. They are widespread in the road sectors being constructed by public contractors. Part of the reason is that control and inspection by supervisory personnel appear to have been inadequate or nonexistent.

Unless immediate action is taken to improve the standard of road construction to comply with proper specifications and designs, the accumulated substandard work will result in major failures and excessive future costs.

These problems could be prevented by enforcing the requirements set forth in correct specifications and designs. Laboratory testing for compaction and approval of the work by the inspection teams should be mandatory. These teams should be given authority to reject improperly completed work.

Current practices are wasting significant quantities of the resources allocated to road construction because of poor construction practices. In addition, road user costs will increase if action is not taken to eliminate the problems that have been identified.

Because these practices are widespread, it is possible that even a standard road maintenance program would not provide Syria with the fast, safe, and efficient transportation system that is required for the projected movement of people and goods. Because of these practices, it is apparent that newly constructed links of the international road network will fail, or will require major rehabilitation in the near future.

Engineering

Primary Network

The engineering responsibilities for inspection and supervision of construction of primary roads are assigned to the Ministry of Communications and are discussed in Chapter 2.

Secondary and Tertiary Networks

The responsibility for the engineering, construction, and maintenance of the secondary and tertiary networks is at the Mohafaza level. There is a Directorate of Communication in each Mohafaza to oversee this work. These directorates are under the administrative supervision of the Ministry of Local Affairs,

but are supposed to receive technical direction from the Ministry of Communications. This is also discussed in Chapter 2.

The degree of Mohafaza level engineeing participation in construction work varies markedly throughout the nation. At some Mohafazat the engineering and construction is carried out by Mohafaza personnel. At others, the engineering are carried out by the Mohafaza engineers, but the actual construction work is carried out by local construction companies. At other Mohafazat, government personnel perform only the design engineering, leaving both construction and quality control to the contractor.

One reason for these differences is that some Mohafazat are poorly equipped and understaffed with qualified personnel. Only three of the Mohafazat have operating laboratories adequate to perform the tests required, although much of the construction is being performed by private construction firms. In a few instances the construction firms perform the tests, but the Mohafaza personnel are often unaware of the results.

A review of the basic road design and the unit cost shows that they vary, but it appears that this may be in part because soils and aggregates vary widely as do the hail distances. Similar problems are often treated differently by the personnel of various Mohafazat because there is little or no communication between Mohafazat during which these differences could be discussed and general experience could be compared.

The recommended functions of Directorate of Communications personnel at the Mohafaza level are summarized below:

- designing new roads,

- preparing specifications for the projects,

- advertising new work, qualifying contractors, and evaluating bids;

- performing all the tests required during construction and determining if work is being done properly,

- inspecting the work and certifying work performed properly.

In this regard one of the first priorities should be to set up proper laboratories and training centers. The laboratories should be equipped and staffed to perform the following functions:

- laboratory maximum density tests,
- field density tests,
- Atterberg limit determinations,
- concrete compression tests,
- gradation tests,
- bituminous extraction tests.

Other tests, such as the CBP (California Bearing Ratio) test and the Los Angeles Abrasion Test, should be performed at the Ministry of Communications' laboratory in Damascus or the regional laboratories. It will not be necessary at this time to perform the Marshal tests for the secondary and tertiary roads because they are designed to be surfaced with bituminous surface treatment and low type hot mix (Miller Mix).

At least once every three months a meeting of the Directors of the Directorates of Communications should be convened for the exchange of ideas and discussion of work to be performed; the objective should be the standardization of approach. Additionally, personnel assigned by the Directorates of Communications should be highly skilled and they should be responsible for coordinating and guiding all Mohafaza level engineering activities.

3.4 MAINTENANCE

General

The responsibility for road maintenance has been reassigned a number of times in the last decade. Currently, maintenance of all intercity roads (primary, secondary, and tertiary) is the responsibility of the Directorate of Communications in each Mohafaza, except for periodic resurfacing projects exceeding 10 kilometers in length, which are the responsibility of two public sector construction companies (see Chapter 2 for details of this division of responsibility).

The Consultants' review of the Government's budget for road maintenance indicates that the allocation levels may be sufficient to properly maintain the primary road network. The adequacy of maintenance funding for secondary and tertiary roads is less clear. Accurate information on maintenance funding for these two classes of roads is not available at the central Government level. The Ministry of Local Administration estimated that in 1979 48 percent of the development budget and 80 percent of the independent budget were spent for road maintenance. This provided an estimated 125 million SP for maintenance expenditures in 1979, a low but reasonable level. However, an examination by the Consultants' staff of detailed expenditure records in Lattakia Mohafaza for 1978 and 1979

showed that the Mohafaza spent no development funds for maintenance, and the amount of the independent budget spent for maintenance in the two years was 27 percent and 5 percent, respectively.

Whatever the true level of funding is, road inventory data indicate that the road network is not being maintained properly. This has been verified by visual inspection.

This condition is not uncommon in developing countries where highway authorities have a tendency to place high priority on expanding the road network and low priority on road maintenance, which is generally the least glamorous of the highway authorities many functions, and even if properly executed, is often unrewarded.

This tendency to place low priority on road maintenance has reached a critical level in Syria where 90 percent of the road surface condition is now in only fair to poor condition. An intensive maintenance program, begun immediately and observed faithfully, would not only improve the general serviceability of the existing network but would also greatly decrease the cost of periodic reconditioning.

Basic road maintenance guidelines, including objectives, applications, methods, and frequency, are considered in this study. Such parameters are considered to be a first step to identifying maintenance needs in Syria.

The Consultants believe that there are people involved with road maintenance in all levels of Government who require some training in the significance of maintenance operations, the scope of maintenance work, and the technical procedures required to plan, equip, staff, and execute maintenance programs.

There are a number of technical, administrative, and organization observations that have led to this conclusion. First, the information received to date regarding road maintenance has proven to be incomplete, although such information was requested and should have been available in all the appropriate organizations' files. Secondly, it was observed that maintenance work recently completed was failing, indicating that either improper diagnosis of the problem was made or the repairs were made using improper procedures. The little maintenance work actually observed to be in progress was being executed improperly. For example, potholes were patched without cleaning and preparing the damaged area prior to patching. Third, a review of maintenance equipment lists and shop facilities indicate that the serviceability of existing equipment is questionable, considering the variety of equipment models and

the accompanying difficulty in keeping spare parts stocked for such a variety. Finally, discussions with responsible officials indicated that they are unaware of the extent of their responsibility, were not being properly funded to carry out their obligations, or were spending their budgets on upgrading old roads or building new ones.

Basic Guidelines

Good maintenance means that minor defects are observed early, diagnosed properly, and repaired immediately. Early and proper diagnosis is important, because defects that appear on the surface may have their roots in the base or subbase course. Both neglected and improperly repaired defects will inevitably result in a major and more costly repair at a later date.

Proper scheduling of maintenance is essential to the efficient operation of the network, and traffic volume is a major consideration. For example, a lone pothole on a road used extensively for heavy traffic should be repaired quickly even if the remainder of the road is in relatively good condition.

Generally then, the two essential elements of good maintenance are early detection of problems by experienced maintenance personnel and speedy repairs. These can be accomplished by regular inspection, especially of high traffic volume roads where defects can significantly affect the proper operation of motor vehicles and unrepaired defects will rapidly worsen.

Maintenance activities that should be routinely undertaken to ensure that the network does not deteriorate faster than necessary under normal conditions of traffic uses are:

- patching asphaltic concrete and hot mix pavements,
- skin patching bituminous pavements,
- base repairs,
- shoulder repairs,
- reshaping and machining ditches,
- hand ditching,
- erosion control,
- cleaning culverts and drains,
- cutting grass and brush,
- minor repair of structures,
- repairing and installing signs and markers,
- line painting.

Current Practice, Observations, and Comments

Patching is required on asphaltic concrete roads, hot mix roads, and multiple surface treated roads where the thickness

of pavement under periodic resealing has increased the depth of pavement to over 3.5 centimeters or where additional strength is required of the patch, as in the following circumstances:

- to replace pavements that have become broken into such small pieces that they cannot be otherwise repaired,

- where base or subgrade failure is the cause of distress and the base or subgrade has to be corrected,

- where surface correction by skin patching is impractical or uneconomical, or where the depth of surface deformation dictates the use of a patch,

- where pavement edges are ravelling,

- where utility cuts have been made through the pavement.

Pothole repairs observed during inspections indicated that holes were simply being filled with premix material without first repairing the base courses, removing loose adjacent material, or applying a tack coat.

Because patching is a reaction to pavement breakup, no specific frequency can be established. Every road should be inspected at least once per month for signs of distress, incipient breakup, and the formation of potential driving hazards. Temporary patching is the minimum reaction to such inspection.

Temporary bituminous patches should be placed when the weather will not permit permanent patching, or when the crew schedule and extent of patching required do not allow for the immediate placement of permanent patches.

The amount of patching required on bituminous paved highways can vary considerably from road to road. It has been established that pavement maintenance requirements vary primarily as a function of:

- type of pavement (including base and subbase),

- traffic volume, particularly the volume of heavy vehicles using the road,

- width of the pavement or traffic lanes, particularly for light pavement,

- the percentage of steep grades and curves in the road alignment, again, particularly for light pavements.

Additionally, all bituminous roads should be subject to a more detailed examination and assessment of pavement defects twice a year: once before the start of the rainy season in order to put the pavement into the best possible condition for the rains, and once prior to a regular scheduled season for major patching works. The time chosen should afford the best weather for such work, usually shortly after the rains.

Subsequent to any inspection, it is very important that correct maintenance procedures be selected and executed promptly so as to keep down excessive costs and prevent further damage under traffic. In the case of asphalt pavements in particular, which are generally highly dependent on dry subgrade and base for their strength, prompt maintenance to exclude excessive water infiltration throughout a damaged pavement is of the utmost importance.

Additionally, it is important that all paved surfaces be inspected at least once a month for signs of distress, incipient breakup, and the formation of potential driving hazards. Temporary patching of an emergency nature is the reaction to such inspection.

Base repair is required when:

- structural failure has occurred or is occurring in the pavement surface due to inadequate support,

- the pavement has been cut in order to install or repair a utility or a drainage pipe.

Many different types of base and subbase may be encountered, each requiring different remedial action and repair techniques, but certain procedures are common to all base repair operations:

- Before repair is started a study should be made to determine the cause of failure and the remedy required.

- The remedy selected should be structurally equal to or better than the surrounding material in the same layer.

- The remedy should also duplicate as closely as possible the drainage characteristics of the surrounding material, and must never constitute a potential water pocket or create one by blocking drainage.

Common to all base repairs, however, is the importance of thorough compaction of all layers of the reconstruction. This can only be achieved with desired uniformity by close attention

to layer thickness and compactive effort. The use of mechanical or pneumatic compactors is essential to realize the quality of compaction required.

Present base repair methods include the filling of ruts, holes, depressions, or other areas of failure with locally-available material and allowing the vehicular traffic to provide compactive effort.

Base repair should normally be carried out at the same time as pavement patching. It should be noted that base repairs are sensitive to weather conditions and the timing of such repairs is critical.

Reshaping is required on shoulders when:

- the surface is becoming rutted or distorted so that cross-shoulder drainage is impeded or channelized,

- the shoulder surface is washboarded, distorted, or ponded and soft, and therefore unattractive to drivers.

The only shoulder-reshaping maintenance operation noted in Syria has been in an area where traffic has completely ripped up the shoulders. The surface course of the pavement has ravelled extensively on much of the network because there is no shoulder maintenance. Repairs, when made, are executed by dumping truck loads of river run gravel on the shoulder and filling the ruts with this material. Little compactive effort is attempted, nor are the repaired shoulders being properly sloped to allow drainage of water away from the edge of the pavement.

Ditch maintenance has been neglected on all road classes with visible evidence or actual practice noted only in conjunction with new construction or overlay projects.

Generally, ditch cleaning and shaping is done simultaneously with shoulder maintenance and involves both machine and labor methods. Machine applications are self-evident, while hand operation may be best for:

- interceptor ditches (toe-of-cut slope),

- toe-of-fill ditches,

- paved toe-of-cut ditches,

- channels or streambeds leading to or from cross culverts,

- exit channels where underdrains emerge into daylight,

- fill slope flumes,

- turn-out ditches or lead-off ditches from cuts.

Some hand ditching is also necessary in conjunction with cleaning and reshaping ditches with machines, and in periods between machine operations, particularly during the rains, when ditches must be kept free from obstruction.

Erosion control measures are needed to avoid severe channeling, ravelling, and erosion on uncompacted surface of fill slopes. Characteristically these take the following forms:

- planting grass,
- turfing the slopes,
- paving high erosion shoulder areas.

Other erosion control measures such as riprap or ditch checks are usually found in drainage ditches and channels and should be maintained concurrently with hand ditching operations.

Cut slopes often require benching to increase slope stability and decrease slope erosion. The benches can be destroyed by run-off, especially if surface and slope erosion is allowed to channel water over (and later through) the edges of the benches and must therefore be properly drained to prevent erosion from starting.

Field observations noted that some reconstruction effort has taken place in areas of extreme erosion, but effective erosion control, as a form of maintenance, does not occur.

Miscellaneous cleaning operations are also a vital part of a well-functioning maintenance organization. Culverts and drains must be cleaned, for example, when:

- they begin to fill up with silt or sand,

- rocks, branches, or other foreign matter are deposited or sucked in or along the length of the culvert.

Additionally, bridge deck gutters must be cleaned when silted and deck drains should be kept open. There is no evidence that this maintenance is being done on a regular basis.

Roadside maintenance includes cutting to reduce weeds, grass, and young woody and grassy growths on the highway right-of-way and, to a limited extent, along drainage ditches and canals leading to and from the highways.

Cutting is necessary when:

- the driver's sight distance is being reduced by vegetation,

- drainage channels and ditches or culvert openings are being, or may be, obstructed by vegetation,

- the neat and orderly appearance of roundabouts, traffic islands, medians, and side areas is being lost.

There is no evidence that cutting is done in the western part of Syria where rainfall makes this a problem.

Although power mowing is commonly used in countries where labor rates are relatively high, the Consultants recommend the use of hand tools in Syria for the immediate future.

Minor structural repairs should be made to all broken, badly cracked, malfunctioning, spalling, or otherwise damaged concrete or masonry works to preserve the structural and functional integrity of the works and to prevent a spread of the damage to the structure or damage to other highway elements.

Generally, culvert head walls throughout Syria have deteriorated, allowing cracks and separations between the entrance slab and the head wall, and considerable water is piping under many pipes. Additionally, exposed reinforcing steel on bridge structures has been noted in an advanced stage of oxidation.

Traffic signs are subject to damage by traffic and vandalism, to deterioration due to weather, and to being obscured by coated dust and dirt and growing vegetation. Most Syrian network signs are oxidized and in poor condition with little or no indication of maintenance.

Signs that are badly damaged or disfigured should be replaced and the damaged sign taken to the district shop for repair. Concrete markers such as kilometer stones will need repainting periodically to keep them legible.

Center lines should be provided along the full length of all paved highways, and no-passing guidelines should be provided to indicate locations where passing is not safe. Where there is little demarcation between the roadway and shoulder surface, edge lines should also be provided.

Lines are marginally adequate on primary-road center lines but nonexistent on both the edges of roads demarking shoulder areas and on secondary and tertiary roads. Maintenance of existing lines should be a periodic function of a maintenance operation.

Mohafaza Maintenance

The inspection of the Mohafaza organizations and their potential for maintaining the roads at necessary levels indicate that there is considerable variation among them. The Consultants believe that although all of the Mohafazat inspected can marginally maintain the roads at their present levels, the majority are not capable of fulfilling their obligations because of their limited maintenance capacities.

Accordingly the Consultants have made an analysis of Mohafaza conditions and capabilities and the needed remedial measures, upon completion of the road inventory when all data were available.

The road inventory was completed in July 1980. At the conclusion of the inventory, the surface width and the type and condition of the roads were established. During the inventory, it was noted that the exceptionally heavy rains during the fall of 1979, winter of 1979-1980, and early spring of 1980 have greatly changed the road conditions in some areas where drainage facilities were insufficient to cope with the excessive water.

In order to more accurately ascertain the capability of each Mohafaza to perform the maintenance of its roads, a questionnaire was prepared for the Directorate of Communications at each Mohafaza, with the exception of the Damascus Mohafaza, which was not considered to be representative, and Al Quneitra Mohafaza, which was inaccessible.

It was initially expected that the questionnaire would be circulated to the Mohafazat to be completed and returned. After it was determined that this would be impractical, some further delays were caused by the limited availability of required counterpart personnel. A minimum of two trips were made to each of 11 Mohafazat, however, and in all but two cases the information requested was supplied.

In the questionnaire, information was requested regarding the numbers and classes of roads that were the responsibility of each Directorate of Communications for both major and minor maintenance. The number of kilometers by classification that were physically maintained by the Mohafazat and what portion, by class, that was delegated to contractors under Mohafaza supervision were also requested.

Additionally, each Mohafaza was asked to designate whether or not laboratory facilities were available to the Directorate of Communications personnel.

Pertinent results of the questionnaire from nine of the eleven Directorates of Communications follow. An average has been taken where indicated. The average number of each piece of equipment and the average number of brands are shown in Table 3.4.1. The number of kilometers that the Directorates of Communications are responsible to oversee or physically maintain is shown in Table 3.4.2. The Consultants assume that all maintenance not performed by Mohafaza personnel is performed by the MOC for international roads and by private contractors for national, secondary, and tertiary roads.

Only three of the Mohafazat studied-Hama, Deir Ez Zor, and Al Suweida - have laboratories.

The equipment operational at the time of the questionnaire is generally sufficient to maintain the roads indicated by the directorates.

It is to be emphasized, however, that the number of kilometers indicated in Table 3.4.2 are those assigned for maintenance, but they are not necessarily being maintained even though the maintenance capability exists. Equipment is being used for other purposes. Although maintenance sufficiency is there, it can only be utilized if non-maintenance operations are undertaken by contractors, or if additional equipment is obtained.

Internationally recognized parameters and definitions of maintenance represent only part of maintenance as viewed by the directorates, which include upgrading, betterment, and resurfacing to a higher standard as part of maintenance. Taken in the directorates' context, available equipment in each Mohafaza will not suffice.

Additionally, as discussed in Section 2.3 above, the Consultants recommend a maintenance advisory service and training contract that would commence for approximately two years.

3.5 RURAL ROADS

Functions and Needs for Rural Roads

Rural roads have been defined by the Consultants as being earth or gravel with a low volume of traffic averaging less than 400 vehicles per day.[2] The Consultants estimate (based on Central Bureau of Statistics data) that the total length of such earth or gravel rural roads in Syria in 1979 was 5,200 kilometers.

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[2]It is recognized that some roads with a traffic volume below 400 vehicles a day are not specially for rural use.

Table 3.4.1

AVERAGE NUMBERS OF PIECES OF MOHAFAZA EQUIPMENT BY TYPE

Type	Average Numbers of pieces	Average Numbers of Brands
Bulldozer	4	3
Front-end loaders	4	3
Dump trucks	14	5
Motor graders	3	3
Compactors (static)	15	1
Compactors (vibratory)	1	1
Asphalt mixers (miller)	4	1

A total of nine in nine Mohafazat

Table 3.4.2

AVERAGE KILOMETERS OF ROAD AND PERCENT MAINTAINED BY MOHAFAZAT PERSONNEL

Class of road	Kilometers of roads	Percent Maintained by the Mohafazat
International	76	0
National	93	24
Secondary	714	57
Tertiary	482	100

Source: Consultants' estimates.

Such roads link farms to markets, population centers, and local points of health, educational, and social services, and to the primary, secondary, and tertiary road networks. In as much as rural roads vary greatly by cross-section and include tracks, classification is necessary for purposes of planning and development. The criteria adopted by the Ministry of Local Administration for priority upgrading and construction during the 4th Five-Year Plan were:

- The road must connect to an existing all weather road that leads to markets, agricultural collection centers, processing centers, or social service centers.

- The road will have a potential for increasing agricultural production in the area and will provide an assured access to markets for production.

- The road will serve a significant number of small farmers within the road's area of influence.

- The area of influence of the proposed road must be substantial.

The rural areas of the country are diverse. They differ in physiographic features and in existing infrastructure facilities, such as transport and social services. Many areas do not have all weather rural roads. These deficiencies hamper development in agricultural production and animal husbandry. In many instances there is either inadequate accessibility by road or the transport costs in terms of time, capital, and convenience are too high for intensive agricultural activity.

During the Consultants' visual inventory, all road links investigated were anchored to terminals previously located on existing secondary and tertiary roads. It was noted that as the progression from terminals increases the surface quality and condition decreases till the midpoint of the link. As the farther terminal is approached the surface type and condition improves. At the point of deepest penetration the roads are practically impassable.

Physical access is a necessary step to bring those areas, previously remote and isolated, into the orbit of the market economy. Detailed quantification and location of the requirements of all these areas for rural road upgrading and construction are not possible without a detailed nationwide rural survey. However, with the data available, such requirements can be gauged on the basis of broad socioeconomic factors in the rural areas.

The requirements have to be considered in terms of benefits and costs. In broad terms, the major benefits fall into the following specific categories:

- increase in agricultural production,

- enlargement of market radius for agricultural products,

- facilitation of long-distance transportation and trade of agricultural commodities,

- provision of increased access to consumer facilities, services, and goods in rural areas,

- employment and income effects of increased construction and investment in local roads.

Rural Road Inventory

The Consultants inventoried a total of 1,537.8 kilometers of rural roads. The results of the road inventory, by Mohafaza and surface type, are shown in Table 3.5.1.

Of 1,537.8 kilometers of rural road inventoried, 24 percent (375.9 kilometers) have a bitumen surface, 31 percent (469.8 kilometers) a gravel surface, and 45 percent (692.1 kilometers) have an earth surface. The inclusion of bitumen roads in the inventory, which appears to conflict with the definition of rural roads given above, is the result of two main factors. The first is that earth or gravel rural roads often are paved with bitumen near their terminals with other roads. The second factor is that roads that would otherwise be classified as rural roads have been paved with bitumen even though the higher type surface would not be justified by the low traffic volumes.

The very low traffic volumes observed on most of the roads during the inventory indicate that expensive upgrading may not be required, especially in areas where the natural drainage is good and the soils are not too plastic. In such areas, a proper maintenance program will suffice for the immediate future.

In areas of poor natural drainage and highly plastic soils, such as the Mohafazat of Dera'a, Al Suweida, Al Raqqa, Al Hassakeh, and Deir Ez Zor, some sort of an all weather surfacing is needed. The highly clayey soils in these areas are subjected to deep rutting during the rainy seasons and are difficult to traverse during the dry season due to the now permanent ruts. A gravel road will suffice in these areas if the grade of road is raised above that of the natural terrain. In this case, culverts would still be required to allow the free passage of water.

Table 3.5.1

RURAL ROADS INVENTORIED
BY MOHAFAZA AND SURFACE TYPE
(Kms)

Mohafaza	Earth	Gravel	Bitumen	Total
Damascus	37.10	-	-	37.10
Aleppo	156.19	125.30	30.51	312.00
Homs	104.00	-	-	104.00
Lattakia	132.04	79.44	64.52	276.00
Deir Ez Zor	20.00	-	-	20.00
Idleb	16.20	79.60	-	95.80
Al Hassakeh	49.73	57.20	9.07	116.00
Al Raqqa	68.60	124.04	90.36	283.00
Al Suweida	21.75	-	111.25	133.00
Dera'a	71.01	4.71	46.17	122.00
Tartous	15.50	-	23.40	38.90
Total	692.12	469.75	375.92	1,537.80

Source: Consultants' inventory.

In the Al Suweida and Dera'a Mohafazat good use has been made of the rock-strewn terrain. The rocks are used for constructing Telford base or macadam-rock roads and the rocks are either stabilized by mineral filler or bitumen. These roads have withstood traffic much better than the average gravel road or one covered with a single bituminous surface treatment (SBST).

On the hilly terrains of Aleppo, Lattakia, and Tartous, a limited number of roads with very steep gradients that are presently paved with gravel are recommended for a pavement (SBST). This impervious layer, if properly constructed, will drain the water and prevent loss of fines in the gravel material.

Table 3.5.2 summarizes the results of the Consultants' rural road inventory in terms of surface type, road width, and surface condition. The data in Table 3.1.2 indicate that approximately 67 percent of the roads inventoried are wider than the Consultants' recommended standard for this class of road and 12.4 percent of the roads are narrower than standard. Forty-five percent of the roads are earth surfaced and should be upgraded to a gravel surface, and 24.5 percent are paved to a higher standard than is justified by present traffic volumes.

Most significant is the obvious lack of maintenance on these roads; 95.5 percent have surfaces in fair to very poor condition. The existing rural roads and tracks are rather extensive, but the neglect of maintenance is obvious on practically all the network. In a number of instances, the deterioration of roads has caused the villages to be partially abandoned and the terraced fields fallowed.

The earth surfaced roads have suffered most and in many instances become impassible even for farm tractors. This situation is worse in areas on clayey soils and better in hilly and mountainous terrain. Most of the gravel rural roads inventoried have lost their fine binder and have a surface of large stone with no cohesion. Drainage is virtually nonexistent. The road surface deterioration increases as the roads penetrate deeper into the rural areas. The earth roads which traverse the wheat fields often lose their identity of alignment and width. In some areas, sections of minimal traffic were covered by growing wheat plants. There is little doubt that to ensure traffic passage to many of the rural areas an active effort must be made to maintain the rural roads. Upgrading the majority of the roads will eventually be required, if for no other reason than to reduce maintenance costs.

Table 3.5.2

RURAL ROAD LENGTH STATISTICS

(All roads recommended class D)

Surface Type

	Earth Type	Gravel	Single Bituminous Surface Treatment	Total
Kms	692.12	469.75	375.92	1,537.80
Percent	45.0	30.5	24.5	100.0

Road Width in Meter

	Over 6.6	6.4-6.0	5.4-5.9	4.5-5.3	3.5-4.4	Below 3.5	Total
Kms	199.44	298.97	96.68	435.56	315.87	191.29	1,537.80
Percent	13.0	19.4	6.3	28.3	20.5	12.4	100.0

Surface Condition

	Very Good	Good	Fair	Poor	Very Poor	Total
Kms	0.00	69.00	936.45	523.92	8.44	1,537.80
Percent	0.0	4.5	60.9	34.1	0.5	100.0

Rural Roads in the National Road Network

The 1979 Syrian road system comprised a total length of 13,510 kilometers of paved roads plus an estimated 5,000 kilometers of local earth and gravel roads. The total length of the paved road network has expanded fourfold during the last 20 years and two times during the last 10 years. Today virtually all administrative centers down to Mantika centers with a population of 4,000 or more are served by the main paved network. In recent years, there has been a marked bias in road investment to paved roads, with emphasis on urban, inter-urban, and inter-regional roads, and only limited attention to rural roads. From 1965-1977, while the asphalted roads increased annually by 6.7 percent in total length, that of non-asphalted roads increased by 4.1 percent, and that of earth roads by 1.0 percent. All the earth and gravel roads are rural roads.

When the growth figures of rural roads are compared with those of agricultural production, land area under crops, and rural population, the lag of rural road extension is obvious and tends to accelerate as agricultural development progresses.

The international, interregional, and inter-Mohafaza roads are main lines of substantial traffic. The rural roads are local, village, and farm routes, which should cover the rural areas extensively and densely. They play a feeder and base level transport infrastructure role for agricultural activities. The artery roads are essentially linear or corridors of traffic flows with increasing alternate routes as the system expands. The rural roads are to a significant extent areal in coverage. Therefore, the total length of rural roads should be proportionate to agricultural area if rural road density remains constant, and their ratio may decrease as the road system expands more than the expansion of agricultural area. This is the case in Syria, where this ratio consistently declined since the 1960s.

As shown in Table 3.5.3, the ratio between earth roads and asphalted roads fell from 0.67 in 1960 to 0.26 in 1970 and to 0.21 in 1977. Meanwhile, the ratio between the combined length of earth and gravel roads also declined from 1.49 in 1960 to 0.74 in 1970 to 0.59 in 1977.

It should be pointed out, however, that during the decade 1967-1977, the rural roads increased at a much faster rate in the northeast than for the country as a whole. This applies to both earth and gravel roads. For the nation as a whole, while the asphalted roads doubled their total length during this period, the earth and gravel roads combined increased by 63 percent.

Table 3.5.3

LENGTH OF ROADS 1960 -1970

(Km)

Year	(1) Earth Roads	(2) Non-Asphalted Paved Roads	(3) Asphalted Roads	Ratios (1)/(3)	Ratios (1)+(2)/(3)
1960	2,780	3,440	4,170	0.67	1.49
1965	2,179	3,278	5,914	0.37	0.92
1970	2,091	3,864	8,096	0.26	0.74
1975	2,263	4,288	10,740	0.21	0.61
1977	2,596	4,787	12,437	0.21	0.59

Source: Compiled from Central Bureau of Statistics data.

Projected Requirements for Rural Roads

The overall projection of requirements for rural roads requires consideration of a number of factors. For a given Mohafaza these include:

- The density of the present network. The better a Mohafaza is presently served with rural roads, the less the future requirements will be.

- The relationship between cultivable land and total land area. The more dispersed a Mohafaza's land is, the greater the length of roads that are required to serve it. An example can be found in Deir Ez Zor, which presently has an estimated 6.65 kilometers of rural road per hectare of cultivable land, 7.5 times the national average.

- Increases in agricultural productivity and area of cultivable land.

As noted, the primary economic purpose of rural roads is increased agricultural production through better access to inputs, markets, and information. The roads also serve social purposes by providing rural people with better access to education, medical care, entertainment, and consumer goods. Indeed, studies in other countries have shown that all weather rural roads help reduce outmigration from previously isolated rural areas. The increased economic and social opportunities reduce the attractiveness of the urban areas, particularly for young people.

It is obvious that increased agricultural production is not a function of roads alone. Increasing yields due to greater use of fertilizer and new varieties, increased extension services, and other infrastructure are also important factors, but based on experience outside Syria, the Consultants estimate that from one-fourth to one-third of increased agricultural production can be attributed to rural roads. The lower figure has been chosen for Syria to be used as an elasticity of demand for rural roads because of the relative density of the present Syrian Class D road network.

The one exception to this elasticity is the Euphrates Basin site, which is by far the most extensive agricultural project in Syria. Ultimate plans to utilize the waters of Lake Al Assad call for the irrigation of a total of 645,000 hectares; divided by Mohafaza this amounts to approximately two-thirds in Al Raqqa, one-fourth in Deir Ez Zor, and the remainder in Aleppo.

Based on the Highway Development Study for Northeast Syria[3] and interviews with officials in the northeast, the Consultants estimate that a total of 125,000 hectares will have been brought under irrigation by 1985 and an additional 409,000 will be irrigated by the year 2000. At that time, only the Rasafeh and Mayadeen basins will remain, and they may come into the system in the next 20 years if the major salinity problems can be solved. Because of the substantially greater intensity of cultivation and the smaller average farm size in these irrigated areas, greater elasticities of demand for roads have been assumed. The assumed elasticities for Al Raqqa are .3 in 1985 and 1.0 in 2000. For Aleppo and Deir Ez Zor they are unchanged for 1985, since they will be little affected by then, and the elasticities for the year 2000 are .3 and .5, respectively.

To take into account the factors discussed above, the Consultants have projected rural road requirements for each Mohafaza for the years 1985 and 2000 using the following equation, with elasticities adjusted as noted above:

$$RR^a = LA \times RD^b \times (GDAH^a \div GDAH^b)^{.25}$$

where:

RR^a = Rural road requirements in kilometers.

LA = Total land area in thousands of hectares.

RD = Rural road density expressed in terms of kilometers per 1,000 hectares of land. (Because there is no precise, clear present inventory of rural roads, the kilometers of road used for this calculation were all earth and gravel roads plus all Class D paved roads - that is, all paved roads with less than 400 ADT.)

GDAH = Gross domestic product for the agriculture sector in millions of Syrian pounds, divided by the area of cultivated land in thousands of hectares.

a = The year of the projection.

b = The base year, in this case 1979.

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[3]Dar Al Handasah Consultants, April 1980.

The resulting projected requirements for new gravel rural roads in terms of kilometers and costs are shown in Table 3.5.4. The assumed cost per kilometer of new gravel roads is SP 98,650, based on an overall embankment 4.5 meters wide and .8 meters high, with a .15 meter crowned gravel surface.

An examination of Table 3.5.4 shows highest rural road requirements in Al Raqqa, Deir Ez Zor, and Aleppo, reflecting the demands created by the Euphrates Basin development and the relatively large cultivated land area in Aleppo. Sharply declining requirements in Homs, Hama, and Damascus between 1985 and 2000 reflect the relative stage of road development in those Mohafazat, plus the effect of a forecast decline in agricultural production in Damascus as the city expands. Total costs for new gravel roads are estimated to be SP 103 million for the 5th Plan period and SP 264 million for the period 1986-2000.

In addition to new gravel roads, the Consultants recommended that the present earth road network be studied with the intent to upgrade earth roads to gravel road standards. This recommendation is not based on an economic analysis. There are no traffic data for these roads, and proxy data, such as cultivable land and number of villages within the roads' area of influence, are not available. Even if the requisite data were available, the Consultants would expect that upgrading most of these roads would not be justified on the basis of pure economic criteria, such as first-year benefits on internal rate of return. There would be some theoretical savings in maintenance if the roads were currently being maintained, which they obviously are not. There would be an economic benefit to the areas served, even though it probably would not be enough to justify the costs. In the final analysis, the justification for upgrading these roads is one of social benefits. If Syria is to achieve its objective of reducing the trend to urbanization, then villages must have all weather access to social services.

Moreover, the total costs are minor in relation to overall road construction costs. The costs of upgrading a given earth road will vary from a cost equivalent to building a new gravel road to a minor amount of earthwork and a gravel surface. Based on the visual inventory of rural roads, the Consultants estimate that on the average the cost of upgrading earth roads to gravel standards will be 40 percent of the cost of constructing a new gravel road, or SP 39,000 per kilometer. Thus it would cost an estimated SP 107.6 million to upgrade the entire earth road network to gravel standards. This is roughly equivalent to one year's expenditure for construction of secondary and tertiary roads. These unit costs are conservative and the total cost may be underestimated somewhat. However, the actual amount could

Table 3.5.4

RURAL ROAD REQUIREMENTS - BY MOHAFAZA

Mohafaza	1979-1985 Additional Road (Kms)	Costs (SP 000)	1985-2000 Additional Road (Kms)	Costs (SP 000)
Damascus	35	3,450	45	4,435
Aleppo	90	8,870	310	30,554
Homs	65	6.406	25	2,464
Hama	160	15,770	30	2,957
Lattakia	75	7,392	160	15,770
Deir Ez Zor	135	13,306	325	32,632
Idleb	50	4,928	105	10,349
Al Hassakeh	65	6,406	220	21,683
Al Raqqa	235	23,162	860	84,762
Al Suweida	70	6,899	175	17,248
Dera'a	20	1,971	190	18,726
Tartous	45	4,435	90	8,870
Quneitra	-	-	135	13,306
Total	1,045	102,995	2,670	263,756

Source: Consultants' estimates.

only be determined on a link by link analysis, and there will be links in areas with little or no rainfall, where an earth road, adequately maintained, will suffice. The basic criterion for determining whether or not an earth road is to be upgraded to gravel standards should be the provision of all weather access to the area served by the road.

A related problem in determining rural road requirements is to identify the losses to the system - that is, the rural roads that will need to be upgraded to paved roads. This is a function of average daily traffic, and, as noted previously, the current ADT is not known. There are, however, two factors that can help in arriving at an empirical judgment. The first is that the present Syrian paved road network is seriously overbuilt. Thirty-two percent of the paved roads (42 percent of the secondary and tertiary roads) do not carry sufficient traffic to justify asphaltic pavement. The second factor is the extremely low traffic volumes observed during the Consultants' road inventories. If one assumes that traffic is spread evenly over the day, then the ADT on the roads inventoried is certainly less than 100, and probably less than 50. Given these factors, it is difficult to conclude that any of the existing gravel road network will need to be upgraded during the 5th Plan. However, for the period 1986-2000, some part of the network will reach ADT in excess of 400 and thus require upgrading to Class C standards. In the absence of an accurate ADT count, the Consultants have assumed that from 1986-2000, 20 percent of the gravel road network will have to be upgraded to single bituminous surface treament pavement. This assumption is based on the expected growth in local traffic and the assumed relatively low present ADT on the gravel network. The cost per kilometer for upgrading Class D gravel roads to Class C standards has been calculated based on the road width distribution shown in Table 3.5.2 and the unit costs used to calculate the paved road betterment program, assuming that the terrain distribution for rural roads and secondary and tertiary roads is the same. The resulting total cost to upgrade 1.250 kilometers is SP 114.6 million.

The most urgent problem with rural roads in Syria is the lack of maintenance and the resulting deteriorated condition of the system. This has been discussed earlier in this section of the report.

The Consultants' road inventory shows that 34.6 percent of the present earth and gravel road network is in poor condition and requires immediate rehabilitation. In addition, 60.9 percent of the network is in fair condition and will require rehabilitation within the next few years. Because of the serious deterioration, the Consultants estimate that the cost for rehabilitation will be SP 39,000 per kilometer for gravel roads. Thus it

will cost an estimated SP 90.9 million to rehabilitate the gravel road network during the 5th Plan. Of this, SP 32.9 million should be spent in the first year to rehabilitate roads in poor or very poor condition. The balance of SP 58 million should be spent over the second to fourth years of the plan.

Table 3.5.5 summarizes rural road requirements in terms of kilometers and total costs. Investments are estimated to be SP 301.6 million in the 5th Plan period and SP 126 million for maintenance costs are also shown, based on the unit costs in Section 3.4 above. Maintenance costs in the 5th Plan period have been adjusted downward to reflect the substantial rehabilitation and upgrading programs that are recommended.

Detailed planning for a rural road network is required to determine precise road links, rehabilitation, and upgrading programs as well as maintenance schedules. The targets presented in this section of the study provide the framework for determining budgets as well as annual plans for a comprehensive rural roads program.

3.6 CONSTRUCTION AND MAINTENANCE COSTS

New Construction

The cost of construction of a new road has been estimated for Class A, B, and C roads in flat, rolling, and hilly terrain for the purpose of preparing a preliminary planning budget for roads that are not already under contract or roads for which the contract price is unknown to the Consultants (see Table 3.6.1). The Class A road estimate is also used to estimate the cost of expanding an existing two-lane highway into a four-lane Autostrad or a four-lane autostrad to a six-lane autostrad.

The labor, plant, and material costs for new construction are also provided in two tables. Table 3.6.2 gives the unit cost breakdown for labor, plant, and materials while Table 3.6.3 expresses these in terms of the percent of total cost so that it can be used in conjunction with Table 3.6.1 to determine the breakdown for each class of road.

Betterment

The betterment costs have been estimated for both resurfacing and for widening existing roads. In addition, when traffic requires that full lanes be added, these cost estimates are taken from the section above.

Table 3.5.5

SUMMARY OF RURAL ROAD REQUIREMENTS

Kilometer of Road

	1981-1985		1986-2000
	Earth	Gravel	Gravel
Beginning Network	2,760	2,440	6,245
Earth to Gravel	-2,760	2,760	-
New Roads	-	1,045	2,670
Gravel to Paved Class C	-	-	-1,250
End Period Network	-	6,245	7,665

FINANCIAL COSTS

(SP millions)

	1981-1985	1986-1990	1991-1995	1996-2000
Upgrade Earth Roads	107.6	-	-	-
Rehabilitation	90.9	-	-	-
New Gravel Roads	103.1	87.8	87.8	87.8
Subtotal Rural Roads	301.6	87.8	87.8	87.8
Gravel to Paved Class C	-	38.2	38.2	38.2
Total Investment	301.6	126.0	126.0	126.0

Table 3.6.1

ESTIMATED CONSTRUCTION COSTS
(SP 000 /km in May 1980 prices)

Item	Class A Road			Class B Road			Class C Road		
	Flat	Rolling	Hilly	Flat	Rolling	Hilly	Flat	Rolling	Hilly
Construction									
Clearing and Grubbing	55	27	13	48	24	12	38	21	10
Subgrade Preparation	28	20	28	25	18	25	21	15	21
Earthwork	428	482	482	381	428	428	321	361	362
Culverts and Drainage Structures	194	213	267	173	190	238	145	160	200
Pavement including Bitumen Base Course	430	430	430	152	152	152	68	68	68
Traffic Control Devices	37	37	37	27	27	27	11	11	11
Total Cost of construction	1,172	1,209	1,257	806	839	882	604	636	672
Engineering									
@ 15 percent of Construction Cost	176	182	189	-	-	-	-	-	-
@ 10 percent of Construction Cost	-	-	-	81	84	89	61	64	68
Contigencies									
@ 15 percent of Construction Cost	176	182	189	-	-	-	-	-	-
@ 10 percent of Construction Cost	-	-	-	81	84	89	61	64	68
Right of Way Acquisition	144	144	144	144	144	144	144	144	144
Grand Total	1,668	1,717	1,779	1,112	1,151	1,204	870	908	952

Source: Consultants' estimates.

Table 3.6.2

UNIT PRICE BREAKDOWN

(in Syrian pounds including tax, May 1980 prices)

Item	Unit	Cost	Labor	Plant	POL	Bitumen	Cement	Steel
Clearing and Grubbing	M^2	0.18	0.4	1.5	0.2	-	-	-
Common Excavation	M^3	5.42	1.12	3.7	0.6	-	-	-
Soft Rock Excav.	M^3	7.48	1.28	5.6	0.6	-	-	-
Hard Rock Excav.	M^3	10.78	2.08	8.0	0.6	-	-	-
Borrow	M^3	5.24	0.64	4.0	0.6	-	-	-
Embankment	M^3	5.30	0.80	4.0	0.5	-	-	-
Overhaul/km	M^3	2.18	0.48	1.1	0.6	-	-	-
Subgrade Preparation	M^2	1.12	0.32	0.7	0.1	-	-	-
Granular Sub-base	M^3	27.4	6.4	17.3	3.7	-	-	-
Granular Base Course	M^3	32.52	6.72	21.0	4.8	-	-	-
Bituminous Base Course	M^3	137.80	20.80	50.0	5.0	62.0	-	-
Prime Coat	M^2	1.55	0.13	0.09	0.06	1.27	-	-
Tack Coat	M^2	0.61	0.03	0.05	0.03	0.5	-	-
SBST[1]	M^2	2.62	0.32	0.5	0.3	1.0	-	-
Asphaltic Concrete	M^3	167.20	19.20	60.0	13.0	75.0	-	-
Hot Mix	M^3	134.8	12.80	52.0	10.0	60.0	-	-
Concrete:								
200 kg.	M^3	195.0	40.00	80.0	10.0	-	65.0	-
300 kg.	M^3	298.0	48.0	144.0	11.0	-	95.0	-
350 kg.	M^3	351.6	57.6	162.0	20.0	-	112.0	-
450 kg.	M^3	496.8	124.8	202.0	25.0	-	145.0	-
Reinforcing Bars	Tons	2380.0	960.0	15.0	5.0	-	-	140.0

Source: Consultants' estimates.

Note: POL = Petroleum Oil and Lubricants.

[1] Single Bituminous Surface Treatment.

Table 3.6.3

PERCENT OF TOTAL COST

(May 1980 prices)

Item	Cost			
	Labor	Plant	Petroleum Oil and Lubricants	Material
Cleaning and Grubbing	22	69	9	-
Common Excavation	21	68	11	-
Soft Rock Excavation	17	75	8	-
Hard Rock Excavation	19	74	7	-
Borrow	12	76	12	-
Embankment	15	75	10	-
Overhaul/Km	22	50	28	-
Subgrade Preparation	29	63	8	-
Granular Sub-base	23	63	14	-
Granular Base Course	17	31	4	48
Bituminous Base Course	15	36	4	45
Prime Coat	8	6	4	82
Tack Coat	5	8	5	82
SBST[1]	15	24	14	47
Asphaltic Concrete	11	36	3	45
Hot Mix	9	39	2	45
Concrete:				
200 kg.	21	41	5	33
300 kg.	16	48	4	32
350 kg.	16	46	6	32
450 kg.	25	41	5	29
Reinforcing Bars	40	1	1	58

Source: Consultants' estimates.

[1] Single Bituminous Surface Treatment.

Resurfacing

The estimated cost at May 1980 rates of resurfacing a Class A road with asphalt concrete surface is approximately SP 58,400 per kilometer or SP 8.00 per square meter. The comparable estimates for Class B low type hot mix are SP 40,200 and 6.5, respectively, and for Class C single bituminous surface treatment they are SP 12,600 and 2.0, respectively. The cost breakdown for these are labor 8 percent, plant (including aggregates) 40 percent, petroleum oil and lubricants (POL) 3 percent, and bitumen 49 percent and includes all assorted operations.

Pavement surfaces deteriorate with time and the repeated movement of traffic. The rate of deterioration is directly proportional to the increase in traffic volume. The deterioration rates used in the analysis are as folows:

- Class A (asphalt concrete) Surface $Y = 0.001 X + 15.5$
- Class B (low type hot mix) Surface $Y = 0.00111 X + 9.944$
- Class C (SBST) Surface $Y = 0.00222 X + 7.555$

(where Y is the rate of deterioration and X is the ADT).

These formulas were developed for the secondary and tertiary network evaluations where surface conditions are rated from 1 to 9. The assumption is that 9 is excellent condition, 1 is the poorest condition, and 4 is the threshold condition where resurfacing is required. Therefore, a properly constructed pavement with an asphaltic concrete surface with proper maintenance should, through normal wear and tear, drop one condition level every two years in the 5,000 to 6,000 ADT range, every 1.8 years in the 6,000 to 7,000 ADT range, and every 1.6 years in the 7,000 to 9,000 ADT range.

Widening (Construction or Betterment)

The widening costs have been estimated based on the use of the trench excavation type of construction. This method was illustrated in detail in Chapter 3 of the Final Phase I Report. Based on this method of construction the existing road will be widened on each side. Separate estimates for this operation have been made for the typical soil conditions that prevail in Syria and for the poorer soil conditions that prevail in the Mohafazat of Al Suweida and Dera'a. The estimates are given in Table 3.6.4.

Annual Maintenance

The annual maintenance costs have been estimated for repairing the pavement surface and filling potholes and cracks, maintenance of the shoulders and medians, painting traffic lines,

Table 3.6.4

UNIT COST OF WIDENING

(SP per kilometer, May 1980 prices)

Road Class	Terrain	Estimated Cost (SP)			Percentage Increase for Other Work	Total Cost (Rounded)
		Pavement	Embankment	Subtotal		
A	Flat	45	25	70	14	79.8
	Rolling	45	30	75	24	93.0
	Hilly	45	47	92	34	123.3
	Mountain	45	51	96	44	138.2
B	Flat	22	18	40	14	45.6
	Rolling	22	26	48	24	59.5
	Hilly	22	40	62	34	83.1
	Mountain	22	38	60	44	86.4
C	Flat	11	15	26	14	29.6
	Rolling	11	22	33	24	40.9
	Hilly	11	35	46	34	61.6
	Mountain	11	42	53	44	76.3
C[1]	Flat	17	16	33	14	37.6
	Rolling	17	24	41	24	50.8
	Hilly	17	38	55	34	73.7
	Mountain	17	38	55	44	79.2

Source: Consultants' estimates.

[1] Estimated costs for Mohafazat of Al Suweida and Dera'a where soil conditions are poor.
Costs include cost of penetration macadam, telford base and SBST surface.

repairing guard rails, repairing signs, cleaning culverts, and repairing minor structures. The basic costs for these are given in Table 3.6.5.

The equations that have been developed from the above cost data to reflect changes in maintenance costs relative to changes in ADT are:

For A.C. $C = 2900 + 0.34T + 678 \text{ LN } \frac{T + 300}{100}$

For H.M. $C = 2520 + 0.45T + 678 \text{ LN } \frac{T + 300}{100}$

For SBST $C = 1898 + 1.13T + 678 \text{ LN } \frac{T + 300}{100}$

where:

- The first number is a constant that is independent of ADT, representing fixed costs of equipment and facilities, road side maintenance, and deterioration caused by the elements.

- The second number is a function of traffic and represents a part of the cost of wear and pavement destruction caused by vehicles passing over the surface.

- The third number is logarithmic and represents costs that are a function of pavement designs. A properly designed road for heavy vehicular traffic will have a much heavier pavement than one designed for low volumes of traffic. As pavements are constructed progressively heavier, the cost of pavement destruction by each vehicle unit becomes progressively less, and the maintenance cost per vehicle unit becomes less. A curve that represents this relationship is logarithmic in form.

3.7 ROMAN ROADS

During the Roman period in the area that now includes modern Syria, the Romans constructed approximately 9,400 kilometers of roads (see Plate 3.7.1)

The Roman road system was unlike the present-day network in that the high population areas of the northwest had few roads since mountains served to limit access through mountain passes. In the low population sections of eastern Syria, however, an elaborate series of roads criss-crossed what is now regarded as unusable arid plains. No less than 1,200 kilometers of roads crossed the expanse between Palmyra and Deir Ez Zor.

Table 3.6.5

ANNUAL MAINTENANCE COST ESTIMATES

(May 1980 Prices)

Cost Element	Hourly Rate (SP)	Class A			Class B			Class C		
		Hrs.	No.	Estimated Cost (SP/Km)	Hrs.	No.	Estimated Cost (SP/Km)	Hrs.	No.	Estimated Cost (SP/Km)
Plant Motor Grader	80	10		800	10		800	5		400
Asphalt Seater	20	25		500	23		460	20		400
Asphalt Mixer	20	25		500	23		460			
Truck	40	25		1,000	23		920	20		800
Roller	35	25		875	23		805	20		700
Subtotal				3,675			3,445			2,300
Labor										
Foreman	12	25	2	600	23	2	552	20	1	240
Laborers	5	25	8	1,000	23	8	920	20	6	600
Subtotal				1,600			1,472			840
Materials										
Bitumen				400			300			160
Aggregate				300			200			70
Subtotal				700			500			230
Total Maintenance				5,975			5,417			3,370
Overhead @ 20 percent				1,195			1,083			674
Grand Total Cost				7,170			6,500			4,044

Source: Consultants' estimates.

Of the approximately 9,400 kilometers of roads estimated to be in the original Roman network in Syria, 5,180 kilometers have been verified by various means, such as watering points or garrison locations. No less than 1,200 kilometers are visible either on the ground or from the air, while the remaining 3,020 kilometers are known only from research of museum maps.

The Mohafazat Dera'a, Al Suweida, Damascus, and Al Hassakeh have their present day networks identifiable with the Roman network. Additionally, the present alignment of the international network from Dera'a to Aleppo, through the major modern cities of Damascus, Homs, and Hama, is located on the original Roman road alignment, as is the existing road from Homs to Lattakia. Approximately 60 percent of the Roman network has been incorporated into the present network (see Plate 3.7.2).

Of particular interest is an example of a typical Roman road, still in use without great modification, on the north-south route originating at the village of Mansura on the Aleppo-Al Raqqa road, continuing to the village of Al Souhne, located on the road under construction from Tadmur to Deir Ez Zor. The first 27 kilometers to the ruins of the ancient city of Resafe have been paved in order to facilitate traffic to the famous ruins, but the road is essentially Roman. At the village of Rhoun, two watering places used by the populace during the Roman era still exist. These 43 kilometers have received a gravel surface. From Rhoun to Al Souhne, 69 kilometers, the road deteriorates into a four meter wide trail. This 139 kilometer section of road has been included in the current Syrian network and, except for 27 kilometers of pavement from the main road to the historic site at Resafe, the rest of the road has probably changed very little since Roman times.

Travelling west from Aleppo to Bab Al Hawa on the Turkish frontier on the road coded MEO5-1, a beautiful section of Roman road exists. This section of approximately two kilometers reflects the construction ability of the Romans. The stones are impeccably set and there are occasional indications that lime has been used for cementing. The width of this masonry road varies between 6.0 and 6.5 meters. Geometrics, however, were not exact. Roman engineers in Syria did not construct curves in the sweeping symmetry found elsewhere in the Roman empire.

This masonry road shows wear and, in a few instances, large blocks of rock have been removed, possibly for use in the construction of a local masonry structure. Considerations of incorporating it into a modern roadway should be disregarded. This section of road and all other such well-preserved sections of Roman roads should be preserved as prime historical features.

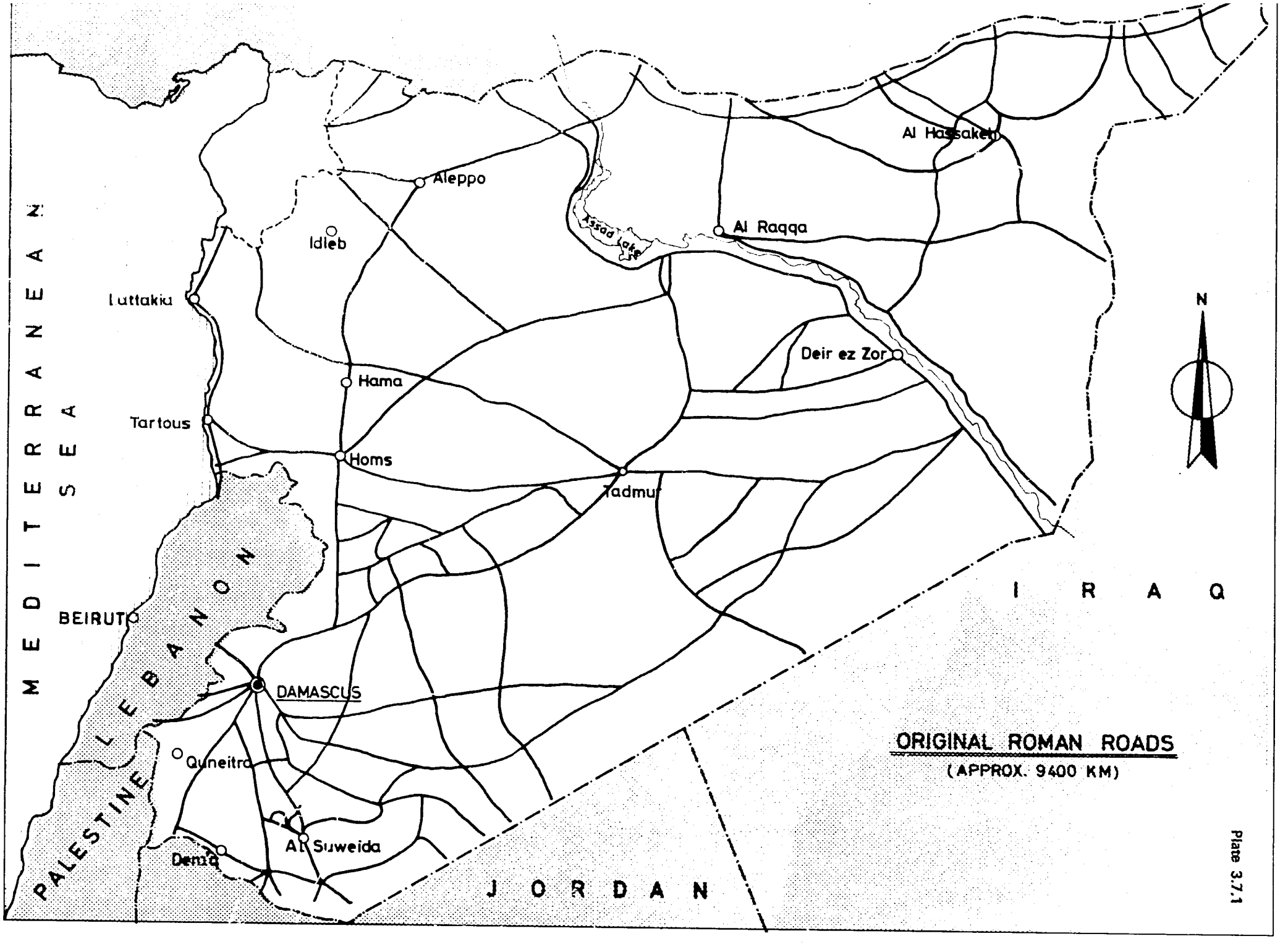
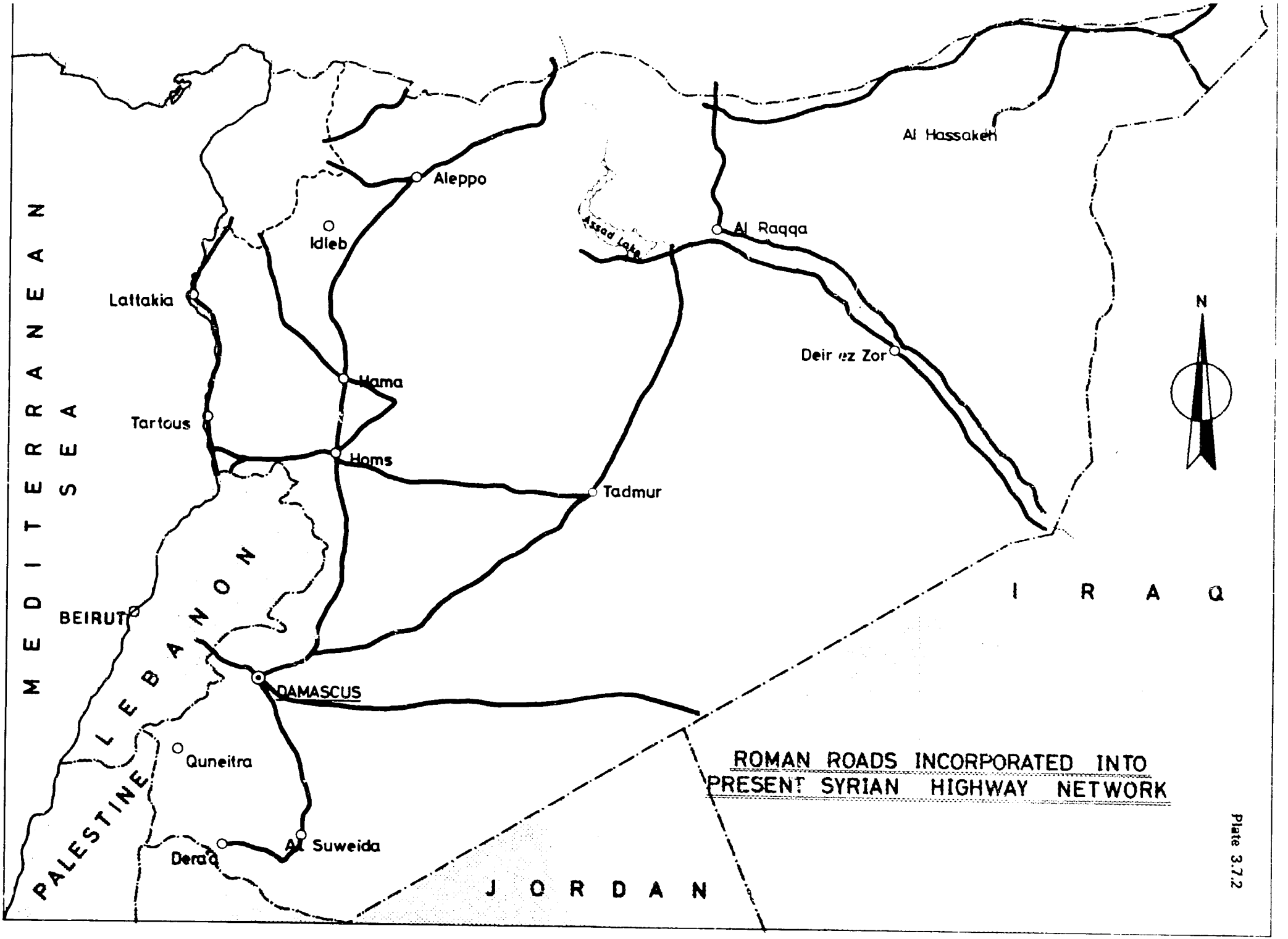

MEDITERRANEAN SEA
Aleppo
Idleb
Al Hassakeh
Al Raqqa
Assad Lake
Luttakia
Hama
Deir ez Zor
Tartous
Homs
Tadmur
N
I R A Q
BEIRUT
LEBANON
DAMASCUS
Quneitra
PALESTINE
Al Suweida
Deraa
J O R D A N
ORIGINAL ROMAN ROADS
(APPROX. 9400 KM)

Plate 3.7.1



ROMAN ROADS INCORPORATED INTO PRESENT SYRIAN HIGHWAY NETWORK

Plate 3.7.2

The road from Sarmada to the border town of Harem has indications that portions of the road may have been part of the Roman network. Much of this road is constructed on dry walls, which indicate a lack of modern road equipment. The road consists of a number of switch-backs, many of which could have been eliminated if modern day eqipment had been utilized. However, the existing road is a scenic route and should be maintained as it is for this reason.

It is apparent from the Consultants' investigation that the Roman road network has been utilized to its utmost in the present day Syrian network. The few Roman sections that are still in evidence are recommended for maintenance as historical monuments and tourist attractions. Additionally, it is recommended that modern roads that have been constructed on the Roman road alignment be so identified on roadside plaques.

3.8 PAST PLAN PERFORMANCE

Background

The Syrian paved road network is estimated to have doubled in length during the 3rd and nearly-completed 4th Five-Year Plan period. Today, virtually all administrative centers down to the Mantika center level are served by the 3,930 kilometer main paved road network. In addition, other smaller villages are served by the 8,640 kilometer local road network.

This overall accomplishment has been significant to the growth of Syria and cannot really be assessed by evaluating performance of past plans project by project. In any event, the actual performance during each plan is difficult to assess because the plans underwent revision during mid-term of the plan period, and the effective start of the 4th Five-Year Plan was delayed until the second year of the plan. However, the following overall view of the past plans can be useful in preparing for the next plan period.

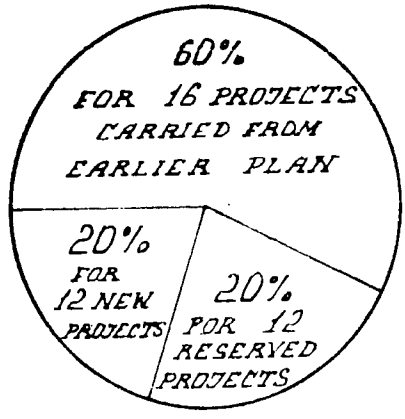
Allocated Funds

The MOC funds allocated for the plan were revised upward by 9 percent during mid-plan period, from the original allocation of SP 1,622 million to SP 1,744.5 million (see Table 3.8.1).

Approximately 60 percent of the allocated MOC funds were for 16 projects carried over from earlier plans. The funds allocated for all but four of these projects were revised upward. The net fund revision for carryover projects was revised 16 percent upward.

Table 3.8.1

STATUS 4th FIVE-YEAR PLAN PRIMARY NETWORK
(in millions of Syrian Pounds)



ALLOCATED FUNDS		EXPENDITURES						% OF REVISED FUND
		ACTUAL		ESTIMATED				
ORIGINAL	REVISED	1976	1977	1978	1979	1980	TOTAL	
1622	1774	138	222	252	292	342	1295	73%

Approximately 20 percent of the allocated MOC funds were for 14 new projects (mostly front-end engineering and early construction). As a result of the mid-plan revision, two projects were dropped while the allocated funds were increased for seven and decreased for four of the new projects. The net fund revision for new projects was 18 percent upward.

The remaining 20 percent of the allocated MOC funds were originally for five reserved projects. As a result of the mid-plan revision, two projects were dropped and nine projects were added, while the cost of three remaining original reserved projects were revised upward. However, the net fund revision for reserved projects was 12 percent downward.

The funds allocated to the Mohafazat for local roads during the 4th Five-Year Plan period were only SP 176 million.

Road Lengths

The MOC goal of the 4th Five-Year Plan was to construct or improve 1,752 kilometers of paved road in the primary and major secondary network. Included was the new construction of 289 kilometers of autostrad, 670 kilometers of two-lane highways, and 180 kilometers of military and tourist roads and the rehabilitation of 623 kilometers of the existing network. The length of road planned for the local secondary and tertiary network is not known.

Status of the 4th Plan

MOC Expenditures

The actual MOC expenditures through 1978, the third year of the plan period (60 percent of plan period), amounted to 37 percent of the allocated funds. The comparable amount, including estimated expenditures through 1979 (80 percent of plan period), was 54 percent.

The Consultants project that the total plan expenditures will be under 75 percent of the revised allocated budget. This figure is based on the assumption that the construction industry can absorb a moderate 15 percent increase in growth (in terms of expenditures) during 1980, the last year of the plan.

The expenditures of the Mohafazat from the 4th Five-Year Plan budget are expected to exceed SP 400 million, or 225 percent over the original budget.

MLA Expenditures

The transport sector, as defined in the Development Plan, does not include investments for secondary and tertiary roads under the jurisdiction of the Ministry of Local Administration (MLA). Because the Consultants' estimates of investment fund requirements include investments for secondary and tertiary roads, a separate analysis of budget fund availabilities for these roads has been prepared. The results are presented in Table 3.8.2.

In making these estimates, the division of development funds between road maintenance and construction is based on the actual 1978 percentage of the total for each (52 percent for construction and 48 percent for maintenance). For the independent budget, the MLA's estimate of 80 percent for maintenance and 20 percent for construction has been applied.

This provided an estimated SP 64 million in construction expenditures in 1979. However, an examination by the Consultants' staff of detailed expenditure records in Lattakia Mohafaza for 1978 and 1979 showed that the Mohafaza spent no development funds for maintenance, and the percent of the independent budget spent for maintenance in the two years was 27 percent and 5 percent, respectively. If these ratios apply elsewhere, MLA construction expenditures substantially exceed those in Table 3.8.2.

Execution

The mid-plan revisions resulted in the abandonment of some plans for new construction and some improvements with the addition of similar projects to replace those abandoned. Table 3.8.3 shows a breakdown of MOC roads planned, roads added, and equivalent lengths actually executed. Only 62 percent of the planned work is projected to be executed during the plan period. However, this number rises to 90 percent when the length of added projects is considered.

The actual increase in the Mohafaza secondary and tertiary paved road networks are not known, but it is estimated that the network has increased dramatically in length during the last 10 years because the emphasis has been placed on paving existing gravel and earth roads.

Analysis

Syria is dependent on external assistance to finance parts of the road program. These funds have not always been allocated in a timely fashion, resulting in slow project start-ups relative to the MOC 4th Five-Year Plan schedule.

Table 3.8.2

MINISTRY OF LOCAL GOVERNMENT ACTUAL AND FORECAST EXPENDITURES FOR ROAD CONSTRUCTION AND MAINTENANCE

(SP 000)

	Actual Expenditures at Current Prices				
	1976	1977	1978	1979-Est	1980-Est
MLA Developt. Exp.					
Road Maintenance	12,535	19,703	30,891	39,490	50,152
Road Construction	13,579	21,345	33,651	42,781	54,332
Total	26,114	41,048	64,542	82,271	104,484
MLA Independent Budget					
Road Maintenance	NA	NA	64,672	85,800	113,830
Road Construction	NA	NA	16,168	21,450	28,458
Total	-	-	80,840	107,250	142,288

Source: Ministry of Local Administration.

NA=Not Available

Table 3.8.3

EXECUTION OF EQUIVALENT LENGTHS

(MOC Roads)

Type of Road	Equivalent Lengths (Km)		
	Planned	Completed	% Completed
Autostrad	289	113	32
Two-Lane (Primary)	670	520	76
Two-Lane (Military & Tourist)	170	65	38
Overlay & Major Renewal	623	395	63
Added Projects			
Autostrad	-0-	48	-
Two-Lane (Primary	-0-	145	-
Overlay & Major Renewal	-0-	290	-
Total	1,752	1,576	90

Source: Ministry of Communications.

Another reason for the shortfalls in completing the MOC 4th Five-Year Plan is that the relatively new public sector construction companies are acquiring their experience on-the-job. This has resulted in low productivity and slow progress in meeting the goals of the plan.

There are some cases where projects undertaken by public sector companies have been completed under budget. This tends to distort the actual progress of work based on an analysis of expenditures alone, expecially since there are comparable cases of projects that have experienced overruns.

In this regard, an analysis of actual work completed versus funds spent to date would be useful. However, this is difficult to do because of the mid-plan revisions. At first appearance it seems that execution of 90 percent of the theoretical revised MOC planned length while spending only 73 percent of the budget was a very efficient operation. Two factors, however, temper this first assessment. First, it cannot be assumed that the length of projects added and executed actually replace kilometer by kilometer those lengths abandoned or dropped from the original plan. Secondly, the apparently low construction costs of the public sector companies, when coupled with their relative inexperience, may have resulted in work that will require higher outlays for maintenance and rehabilitation in coming years. Therefore, a meaningful analysis of work completed versus expenditures should be a continuous effort that includes the follow-on expenditures for maintenance, repair, and rehabilitation of completed work to obtain a better estimate of the true life of project costs.

APPENDIX 3.1

ROAD LENGTH STATISTICS

Table A-3.1.1

MOHAFAZA: DAMASCUS

PRIMARY ROAD LENGTH STATISTICS

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX	ASPH. CONCR.	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	72.95	72.95
A	0.00	0.00	0.00	47.30	22.65	69.95
B	0.00	0.00	0.00	103.60	0.00	103.60
C	0.00	0.00	8.00	82.20	0.00	90.20
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	8.00	233.10	95.60	336.70

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	51.25	21.70	0.00	0.00	0.00	72.95
A	22.65	28.20	.40	18.70	0.00	69.95
B	0.00	63.40	35.90	2.80	1.50	103.60
C	0.00	71.70	18.50	0.00	0.00	90.20
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	73.90	185.00	54.80	21.50	1.50	336.70

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	72.95	0.00	0.00	72.95
A	39.15	27.70	3.10	69.95
B	23.90	79.70	0.00	103.60
C	6.80	28.50	54.90	90.20
D	0.00	0.00	0.00	0.00
TOTAL	142.80	135.90	58.00	336.70

Table A-3.1.1 (Cont'd)

MOHAFAZA: ALEPPO

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX ASPH CONCR	TOTAL
V	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	41.05	41.05
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	41.30	266.30	0.00	307.60
C	0.00	0.00	0.00	84.10	0.00	84.10
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	41.30	350.40	41.05	432.75

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
V	0.00	0.00	0.00	0.00	0.00	0.00
X	41.05	0.00	0.00	0.00	0.00	41.05
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	119.40	8.90	64.80	114.50	307.60
C	0.00	9.40	0.00	37.50	37.20	84.10
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	41.05	128.80	8.90	102.30	151.70	432.75

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
V	0.00	0.00	0.00	0.00
X	41.05	0.00	0.00	41.05
A	0.00	0.00	0.00	0.00
B	0.00	236.50	71.10	307.60
C	0.00	80.70	3.40	84.10
D	0.00	0.00	0.00	0.00
TOTAL	41.05	317.20	74.50	432.75

Table A-3.1.1 (Cont'd)

MOHAFAZA: HOMS

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T.	HOT MIX ASPH. CONCR.	TOTAL
Y	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	52.60
A	0.00	0.00	0.00	52.80	91.25
B	0.00	0.00	0.00	95.20	95.20
C	0.00	0.00	0.00	354.70	354.70
D	0.00	0.00	1.80	187.40	189.20
TOTAL	0.00	0.00	1.80	690.10	782.95

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	52.60	0.00	0.00	0.00	0.00	52.60
A	38.45	50.70	0.00	2.10	0.00	91.25
B	0.00	52.50	0.00	42.70	0.00	95.20
C	0.00	286.00	14.90	7.80	46.00	354.70
D	0.00	48.60	1.80	101.30	37.50	189.20
TOTAL	91.05	437.80	16.70	153.90	83.50	782.95

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	52.60	0.00	0.00	52.60
A	1.15	84.65	5.45	91.25
B	15.50	42.70	37.00	95.20
C	224.80	88.80	41.10	354.70
D	48.60	138.80	1.80	189.20
TOTAL	342.65	354.95	85.35	782.95

Table A-3.1.1 (Cont'd)

MOHAFAZA: HAMA

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX ASPH CONCR	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	2.40	16.60	19.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	6.60	135.00	0.00	141.60
C	0.00	0.00	33.10	67.20	0.00	100.30
D	0.00	0.00	14.50	0.00	0.00	14.50
TOTAL	0.00	0.00	54.20	204.60	16.60	275.40

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	16.60	2.40	0.00	0.00	0.00	19.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	61.00	2.70	77.90	0.00	141.60
C	0.00	16.20	5.50	53.70	24.90	100.30
D	0.00	0.00	14.50	0.00	0.00	14.50
TOTAL	16.60	79.60	22.70	131.60	24.90	275.40

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	16.60	2.40	0.00	19.00
A	0.00	0.00	0.00	0.00
B	0.00	135.00	6.60	141.60
C	0.00	67.20	33.10	100.30
D	0.00	0.00	14.50	14.50
TOTAL	16.60	204.60	54.20	275.40

Table A-3.1.1 (Cont'd)

MOHAFAZA: LATTAKIA

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T	HOT MIX ASPH. CONCR	TOTAL
Y	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	3.90	3.90
A	0.00	0.00	0.00	35.50	35.50
B	0.00	0.00	0.00	60.70	60.70
C	0.00	0.00	0.00	53.10	53.10
D	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	153.20	153.20

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	3.90	0.00	0.00	0.00	3.90
A	0.00	0.00	35.50	0.00	0.00	35.50
B	0.00	60.70	0.00	0.00	0.00	60.70
C	0.00	0.00	0.00	22.80	30.30	53.10
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	64.60	35.50	22.80	30.30	153.20

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	0.00	3.90	0.00	3.90
A	0.00	35.50	0.00	35.50
B	60.70	0.00	0.00	60.70
C	0.00	37.60	15.50	53.10
D	0.00	0.00	0.00	0.00
TOTAL	60.70	77.00	15.50	153.20

Table A-3.1.1 (Cont'd)

MOHAFAZA: DEIR EZ ZOR

RECOMMENDED CLASS	S U R F A C E T Y P E EARTH	GRAVEL	S.B S.T.	HOT MIX ASPH. CONCR.	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	103.90	3.00	0.00	106.90
C	0.00	0.00	102.80	48.10	0.00	150.90
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	206.70	51.10	0.00	257.80

RECOMMENDED CLASS	R O A D W I D T H IN M E T E R S AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	37.70	54.10	15.10	0.00	106.90
C	0.00	101.40	9.90	39.60	0.00	150.90
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	139.10	64.00	54.70	0.00	257.80

RECOMMENDED CLASS	S U R F A C E C O ND I T I O N GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00
B	0.00	44.60	62.30	106.90
C	0.00	8.60	142.30	150.90
D	0.00	0.00	0.00	0.00
TOTAL	0.00	53.20	204.60	257.80

Table A-3.1.1 (Cont'd)

MOHAFAZA: IDLEB

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T	HOT MIX ASPH. CONCR.	TOTAL
Y	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	91.15
A	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	.70	188.80	23.10	212.60
C	0.00	0.00	0.00	78.70	0.00	78.70
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	.70	267.50	114.25	382.45

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	5.65	85.50	0.00	0.00	0.00	91.15
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	100.00	8.70	0.00	103.90	212.60
C	0.00	13.60	28.00	5.60	31.50	78.70
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	5.65	199.10	36.70	5.60	135.40	382.45

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	87.25	3.40	.50	91.15
A	0.00	0.00	0.00	0.00
B	74.20	129.20	9.20	212.60
C	0.00	78.70	0.00	78.70
D	0.00	0.00	0.00	0.00
TOTAL	161.45	211.30	9.70	382.45

Table A-3.1.1. (Cont'd)

MOHAFAZAH: AL HASSAKEH

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T	HOT MIX ASPH CONCR.		TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	73.20	7.50	0.00	80.70
C	.70	0.00	196.60	108.10	0.00	305.40
D	0.00	24.40	9.80	0.00	[illegible]	34.20
TOTAL	.70	24.40	279.60	115.60	[illegible]	420.30

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	17.30	7.10	56.20	0.00	80.70
C	0.00	90.80	31.60	180.50	2.50	305.40
D	0.00	2.90	0.00	31.30	0.00	34.20
TOTAL	0.00	111.00	38.70	268.10	2.50	420.30

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00
B	0.00	80.70	0.00	80.70
C	0.00	144.50	160.90	305.40
D	0.00	2.90	31.30	34.20
TOTAL	0.00	228.10	192.20	420.30

Table A-3.1.1 (Cont'd)

MOHAFAZA: AL RAQQA

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T.	HOT MIX ASPH CONCR		TOTAL
V	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	59.90	78.10	0.00	138.00
C	0.00	0.00	73.90	0.00	0.00	73.90
D	0.00	0.00	30.40	0.00	0.00	30.40
TOTAL	0.00	0.00	154.20	78.10	0.00	242.30

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
V	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	1.30	108.70	6.00	22.00	0.00	138.00
C	0.00	0.00	0.00	0.00	73.90	73.90
D	0.00	0.00	0.00	0.00	30.40	30.40
TOTAL	1.30	108.70	6.00	22.00	104.30	242.30

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
V	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00
B	0.00	78.10	59.90	138.00
C	0.00	73.90	0.00	73.90
D	0.00	30.40	0.00	30.40
TOTAL	0.00	182.40	59.90	242.30

Table A-3.1.1 (Cont'd)

MOUHAFAZA: AL SUWEIDA

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX ASPH CONCR.		TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	83.10	0.00	83.10
C	0.00	0.00	0.00	44.90	0.00	44.90
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	128.00	0.00	128.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	7.30	55.60	20.20	0.00	83.10
C	0.00	37.70	0.00	5.50	1.70	44.90
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	45.00	55.60	25.70	1.70	128.00

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00
B	0.00	83.10	0.00	83.10
C	0.00	43.70	1.20	44.90
D	0.00	0.00	0.00	0.00
TOTAL	0.00	126.80	1.20	128.00

Table A-3.1.1 (Cont'd)

MOUHAFAZA: DERA'A

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T.	HOT MIX ASPH CONCR	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	73.60	0.00	73.60
B	0.00	0.00	0.00	52.40	0.00	52.40
C	0.00	0.00	0.00	52.30	0.00	52.30
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	178.30	0.00	178.30

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	73.60	0.00	0.00	0.00	73.60
B	0.00	15.70	31.10	5.60	0.00	52.40
C	0.00	12.30	0.00	40.00	0.00	52.30
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	101.60	31.10	45.60	0.00	178.30

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00
A	73.60	0.00	0.00	73.60
B	0.00	52.40	0.00	52.40
C	0.00	1.60	50.70	52.30
D	0.00	0.00	0.00	0.00
TOTAL	73.60	54.00	50.70	178.30

Table A-3.1.1 (Cont'd)

MOUHAFAZA: TARTOUS

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX ASPH CONCR	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	65.90	0.00	65.90
B	0.00	0.00	0.00	25.80	0.00	25.80
C	0.00	0.00	0.00	42.60	0.00	42.60
D	0.00	0.00	40.50	20.00	0.00	60.50
TOTAL	0.00	0.00	40.50	154.30	0.00	194.80

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	40.90	25.00	0.00	0.00	65.90
B	0.00	0.00	0.00	10.80	15.00	25.80
C	0.00	1.60	0.00	2.70	38.30	42.60
D	0.00	0.00	40.50	.90	19.10	60.50
TOTAL	0.00	42.50	65.50	14.40	72.40	194.80

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00
A	9.70	56.20	0.00	65.90
B	0.00	25.80	0.00	25.80
C	0.00	42.60	0.00	42.60
D	0.00	20.00	40.50	60.50
TOTAL	9.70	144.60	40.50	194.80

Table A-3.1.1 (Cont'd)

MOUHAFAZA: QUNEITRA

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX ASPH CONCR	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	27.00	0.00	27.00
C	0.00	0.00	0.00	15.00	0.00	15.00
D	0.00	0.00	0.00	88.00	0.00	88.00
TOTAL	0.00	0.00	0.00	130.00	0.00	130.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS AUTOSTR.	OVER 7.0	6.2 - 6.9	5.6 - 6.1	BELOW 5.6	TOTAL
Y	0.00	0.00	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	27.00	0.00	0.00	0.00	27.00
C	0.00	0.00	0.00	15.00	0.00	15.00
D	0.00	28.00	0.00	60.00	0.00	88.00
TOTAL	0.00	55.00	0.00	75.00	0.00	130.00

RECOMMENDED CLASS	SURFACE CONDITION GOOD	FAIR	POOR	TOTAL
Y	0.00	0.00	0.00	0.00
X	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00
B	0.00	27.00	0.00	27.00
C	0.00	0.00	15.00	15.00
D	0.00	28.00	60.00	88.00
TOTAL	0.00	55.00	75.00	130.00

Source: Consultants: Inventory and Traffic Counts.

Table A-3.1.2

SECONDARY AND TERTIARY ROAD LENGTH STATISTICS

MOUHAFAZA: DAMASCUS

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX ASPH CONCR.	TOTAL
A	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	6.20	110.70	0.00	116.90
C	0.00	0.00	71.95	867.04	0.00	938.99
D	0.00	0.00	77.97	266.13	0.00	344.11
TOTAL	0.00	0.00	156.12	1243.87	0.00	1400.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS OVER 6.6	6.4 - 6.0	5.4 - 5.9	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	11.90	25.70	72.70	0.00	6.60	0.00	116.90
C	0.00	110.19	106.87	603.92	118.01	0.00	938.99
D	0.00	47.57	133.67	162.87	0.00	0.00	344.11
TOTAL	11.90	183.45	313.24	766.79	124.61	0.00	1400.00

RECOMMENDED CLASS	SURFACE CONDITION VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	11.90	5.20	54.80	45.00	0.00	116.90
C	0.00	37.63	747.22	154.14	0.00	938.99
D	0.00	0.00	313.70	0.00	30.41	344.11
TOTAL	11.90	42.83	1115.72	199.14	30.41	1400.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: ALEPPO

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T.	HOT MIX ASPH. CONCR.		TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	419.45	47.33	0.00	466.78
D	0.00	0.00	0.00	343.22	0.00	343.22
TOTAL	0.00	0.00	419.45	390.55	0.00	810.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS OVER 6.6	6.4 - 6.0	5.4 - 5.9	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	47.33	247.73	171.72	0.00	0.00	466.78
D	0.00	0.00	22.83	292.76	27.64	0.00	343.22
TOTAL	0.00	47.33	270.56	464.47	27.64	0.00	810.00

RECOMMENDED CLASS	SURFACE CONDITION VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	406.47	0.00	60.31	466.78
D	0.00	27.64	315.58	0.00	0.00	343.22
TOTAL	0.00	27.64	722.05	0.00	60.31	810.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: HOMS

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX ASPH CONCR.		TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	33.89	258.51	0.00	292.40
D	0.00	0.00	247.86	99.74	0.00	347.60
TOTAL	0.00	0.00	281.74	358.26	0.00	640.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS OVER 6.6	6.4 - 6.0	5.4 - 5.3	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	17.22	33.89	0.00	241.30	0.00	0.00	292.40
D	100.29	51.92	0.00	195.39	0.00	0.00	347.60
TOTAL	117.51	85.81	0.00	436.69	0.00	0.00	640.00

RECOMMENDED CLASS	SURFACE CONDITION VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	258.51	0.00	33.89	292.40
D	0.00	0.00	295.68	0.00	51.92	347.60
TOTAL	0.00	0.00	554.19	0.00	85.81	640.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: HAMA

RECOMMENDED CLASS	SURFACE TYPE: EARTH	GRAVEL	SBST	HOT MIX ASPH CONCR.	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	14.20	0.00	14.20
C	0.00	0.00	595.81	289.99	0.00	885.80
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	595.81	304.19	0.00	900.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS: OVER 6.6	6.4 - 6.0	5.4 - 5.3	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	14.20	0.00	0.00	14.20
C	52.58	0.00	367.59	429.81	35.82	0.00	885.80
D	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	52.58	0.00	367.59	444.01	35.82	0.00	900.00

RECOMMENDED CLASS	SURFACE CONDITION: VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	14.20	0.00	0.00	0.00	14.20
C	0.00	160.95	609.59	0.00	115.26	885.80
D	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	175.15	609.59	0.00	115.26	900.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: LATTAKIA

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX ASPH. CONCR.		TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	70.70	0.00	70.70
C	0.00	0.00	297.10	309.23	0.00	606.33
D	0.00	0.00	316.80	76.17	0.00	392.97
TOTAL	0.00	0.00	613.90	456.10	0.00	1070.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS OVER 6.6	6.4 - 6.0	5.4 - 5.9	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	70.70	0.00	0.00	70.70
C	0.00	34.48	155.37	325.52	90.95	0.00	606.33
D	0.00	76.17	0.00	253.14	0.00	63.66	392.97
TOTAL	0.00	110.65	155.37	649.36	90.95	63.66	1070.00

RECOMMENDED CLASS	SURFACE CONDITION VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	70.70	0.00	70.70
C	0.00	44.34	475.97	86.02	0.00	606.33
D	0.00	0.00	167.12	225.86	0.00	392.97
TOTAL	0.00	44.34	643.08	382.58	0.00	1070.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: DEIR EZ ZOR

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T.	HOT MIX	ASPH. CONCR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	260.00	0.00	0.00	260.00
TOTAL	0.00	0.00	260.00	0.00	0.00	260.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS OVER 6.6	6.4 - 6.0	5.4 - 5.9	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	260.00	0.00	0.00	0.00	0.00	260.00
TOTAL	0.00	260.00	0.00	0.00	0.00	0.00	260.00

RECOMMENDED CLASS	SURFACE CONDITION VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	0.00	138.02	121.98	260.00
TOTAL	0.00	0.00	0.00	138.02	121.98	260.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: IDLEB

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T.	HOT MIX ASPH. CONCR.		TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	232.38	170.94	0.00	403.32
D	0.00	0.00	86.75	79.93	0.00	166.68
TOTAL	0.00	0.00	319.13	250.87	0.00	570.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS OVER 6.6	6.4 - 6.0	5.4 - 5.9	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	69.40	74.52	0.00	141.93	117.47	0.00	403.32
D	0.00	0.00	75.66	86.75	4.27	0.00	166.68
TOTAL	69.40	74.52	75.66	228.68	121.74	0.00	570.00

RECOMMENDED CLASS	SURFACE CONDITION VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	108.08	62.86	232.38	0.00	403.32
D	0.00	0.00	162.41	4.27	0.00	166.68
TOTAL	0.00	108.08	225.27	236.65	0.00	570.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: AL RAQQA

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T	HOT MIX ASPH. CONCR.		TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	369.80	10.20	0.00	380.00
TOTAL	0.00	0.00	369.80	10.20	0.00	380.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS OVER 6.6	6.4 - 6.0	5.4 - 5.9	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D	10.20	369.80	0.00	0.00	0.00	0.00	380.00
TOTAL	10.20	369.80	0.00	0.00	0.00	0.00	380.00

RECOMMENDED CLASS	SURFACE CONDITION VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	10.20	127.24	242.56	380.00
TOTAL	0.00	0.00	10.20	127.24	242.56	380.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: AL HASSAKEH

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	S.B.S.T.	HOT MIX ASPH. CONCR		TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	158.62	7.71	0.00	166.32
D	0.00	0.00	233.68	0.00	0.00	233.68
TOTAL	0.00	0.00	392.29	7.71	0.00	400.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS OVER 6.6	6.4 - 6.0	5.4 - 5.9	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	166.32	0.00	0.00	0.00	0.00	166.32
D	0.00	187.54	0.00	46.13	0.00	0.00	233.68
TOTAL	0.00	353.87	0.00	46.13	0.00	0.00	400.00

RECOMMENDED CLASS	SURFACE CONDITION VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	122.69	0.00	43.63	166.32
D	0.00	0.00	120.69	0.00	112.98	233.68
TOTAL	0.00	0.00	243.38	0.00	156.62	400.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: AL SUWEIDA

RECOMMENDED CLASS	SURFACE TYPE: EARTH	GRAVEL	S.B.S.T	HOT MIX ASPH. CONCR	TOTAL
A	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	32.20	62.50	94.75
D	0.00	0.00	50.13	355.07	605.25
TOTAL	0.00	0.00	82.43	617.57	700.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS: OVER 6.6	6.4 - 6.0	5.4 - 5.9	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	94.75	0.00	0.00	94.75
D	0.00	0.00	0.00	286.94	318.30	0.00	605.25
TOTAL	0.00	0.00	0.00	381.70	318.30	0.00	700.00

RECOMMENDED CLASS	SURFACE CONDITION: VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	94.75	0.00	94.75
D	0.00	134.62	322.56	148.06	0.00	605.25
TOTAL	0.00	134.62	322.56	242.82	0.00	700.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: DERA'A

RECOMMENDED CLASS	SURFACE TYPE EARTH	GRAVEL	SBST	HOT MIX ASPH CONCR.		TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	119.55	125.34	0.00	244.89
D	0.00	0.00	0.00	345.11	0.00	345.11
TOTAL	0.00	0.00	119.55	470.45	0.00	590.00

RECOMMENDED CLASS	ROAD WIDTH IN METERS OVER 6.6	6.4 - 6.0	5.4 - 5.9	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	100.71	81.63	62.55	0.00	244.89
D	0.00	0.00	102.16	242.96	0.00	0.00	345.11
TOTAL	0.00	0.00	202.87	324.58	62.55	0.00	590.00

RECOMMENDED CLASS	SURFACE CONDITION VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	100.71	0.00	24.63	119.55	0.00	244.89
D	0.00	0.00	345.11	0.00	0.00	345.11
TOTAL	100.71	0.00	369.75	119.55	0.00	590.00

Table A-3.1.2 (Cont'd)

MOUHAFAZA: TARTOUS

RECOMMENDED CLASS	SURFACE TYPE: EARTH	GRAVEL	S.B.S.T.	HOT MIX ASPH. CONCR.		TOTAL
A	0.00	0.00	0.00	0.00	0.00	**0.00**
B	0.00	0.00	0.00	0.00	0.00	**0.00**
C	0.00	0.00	107.48	576.93	0.00	**684.41**
D	0.00	0.00	235.59	0.00	0.00	**235.59**
TOTAL	0.00	0.00	343.07	576.93	0.00	**920.00**

RECOMMENDED CLASS	ROAD WIDTH IN METERS: OVER 6.6	6.4 - 6.0	5.4 - 5.3	4.5 - 5.3	3.5 - 4.4	BELOW 3.5	TOTAL
A	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
B	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
C	0.00	0.00	0.00	684.41	0.00	0.00	**684.41**
D	0.00	0.00	0.00	0.00	235.59	0.00	**235.59**
TOTAL	0.00	0.00	0.00	684.41	235.59	0.00	**920.00**

RECOMMENDED CLASS	SURFACE CONDITION: VERY GOOD	GOOD	FAIR	POOR	VERY POOR	TOTAL
A	0.00	0.00	0.00	0.00	0.00	**0.00**
B	0.00	0.00	0.00	0.00	0.00	**0.00**
C	0.00	0.00	576.93	107.48	0.00	**684.41**
D	0.00	0.00	235.59	0.00	0.00	**235.59**
TOTAL	0.00	0.00	812.52	107.48	0.00	**920.00**

Source: Consultants: Inventory and Traffic Counts.

CHAPTER 4

OPERATIONS

Chapter 4

OPERATIONS

4.1 ROAD TRANSPORT INDUSTRY

Passenger Movement

General

Road passenger movement by common carrier on Syrian highways is performed by buses, taxis, and microbuses. Passenger rates are regulated by the Ministry of Supply and Internal Trade in consultation with representatives of the operators and the Ministry of Transportation, which is responsible for licensing motor vehicles.

Bus Operation

The bus operation falls into three categories: urban, intercity, and international. Each Mohafaza center has an urban bus system that belongs to the municipality. Intercity buses are privately owned, except for the Karnak Company, which is partly Government owned. The Karnak Company accounts for less than 1 percent of the capacity and bus kilometers in Syria. Operators of the privately owned buses are only allowed to service routes for which permits have been obtained from the Mohafaza centers (for intra-Mohafaza, inter-Mohafaza, and international) and according to agreed upon service frequencies and fares.

Fares of buses are in accordance with Decision 1895, based on Decree No. 339 of 30 March 1978 and Law No. 123.

Taxi Operation

Taxis are an important complement to the bus service and are also subject to regulations regarding ownership and fares. Taxi fare rates are established by the Ministry of Supply and Internal Trade and in accordance with Decision 71 of 30 March 1978, Decree No. 339. According to Decree No. 339, taxis engaged in transport activity are authorized to charge only the rates stipulated in the decree.

Taxis with a seating capacity of five to six persons operate between cities on fixed routes as do the buses, but they charge fares that are approximately three times higher than those of the private buses.

Microbus Operation

Microbuses, which have a seating capacity of 18 to 22 passengers, operate on urban and intercity routes. Like taxis and private buses, their routes and fares are regulated by the Ministry of Supply and Internal Trade based on Decree No. 339 of 30 March 1978 and Law No. 123.

Administrative Structure

A committee is established in each Mohafaza (committee for the combined organization of passenger transport) with the responsibility of specifying routes, frequency of service, stopping places, seat availability, and the requirement for standby vehicles in the Mohafaza. In addition, for each bus route, an administration group with a maximum of five members is elected by the bus owners to coordinate the operations of the various privately owned buses on the route. The group establishes an office for the management of the route. All passenger, baggage, and other revenue from the route is deposited in a combined fund, which is used for the support of the office and payment of the committee members. The balance of the fund, after the above expenditure, is distributed monthly to the bus owners on the basis of their contributions to the total bus capacity on the route, but without consideration of the number of passengers carried by each bus.

Passenger Rate Structure

The basis for establishing the passenger rate structure is the passenger-kilometer cost. The Ministry of Supply and Interior Trade and the MOT Passenger Directorate have analyzed the operating cost of two types of taxis (Dodge Coronet and Mercedes 190), two buses (Scania and Fiat 331A), and the typical microbus, the Fiat OM. In this analysis the following cost components were considered:

- vehicle acquisition cost,
- capacity,
- actual loading capacity,
- rated horsepower (hp),
- taxable hp,
- tires,
- annual kilometers travelled,
- insurance,
- licensing and taxes,
- tax on profit,
- running cost (fuel and tires),
- maintenance and labor,
- overhead,
- amortization,
- miscellaneous running costs.

The method used by the Ministry is the total annual expenditure divided by the vehicle-kilometer productivity. Further, a percentage is added for profit, depending on the Mohafaza or area involved. Road conditions are also considered in establishing the passenger-kilometer cost of operation.

Revisions of bus, taxi, and microbus fares are worked out periodically through negotiations between the operators and the Ministry through the Mohafaza centers. Passenger fares are usually the same per kilometer for long and short distances.

Passenger Rates

Bus fares vary from SP 5.25 for 355 kilometers to SP 1.00 for 47 kilometers. An average figure of SP 0.018 per passenger-kilometer is representative of the privately owned bus. Microbus fares range from SP 10.60 for 355 kilometers to SP 1.00 for 47 kilometers. An average figure of SP 0.026 per passenger-kilometer is representative of the microbus.

Fares on the Karnak Company bus are more than double those charged by privately owned buses because of the luxury service provided by this partly Government owned firm. Regular fares for the large bus operated by the Karnak Company range from SP 15.50 for 355 kilometers to SP 2.00 for 47 kilometers distance. An average figure of SP 0.043 per passenger-kilometer is representative for this type of public bus.

Taxi fare rates vary from SP 16.50 for 355 kilometers to SP 2.25 for 47 kilometers. An average of SP 0.047 per passenger-kilometer is representative of the taxi fare.

Figure 4.1 shows the fares charged by privately owned public buses, the Karnak Company buses, microbuses, and taxis.

Commodity Movement

General

In Syria, the truck fleet is divided into the following categories:

- private: vehicles of privately owned firms and organizations,

- public: common carrier vehicles owned by private individuals and subject to Government regulations with respect to licensing and freight rates,

- Government: Government owned vehicles belonging to Government agencies and public-sector companies.

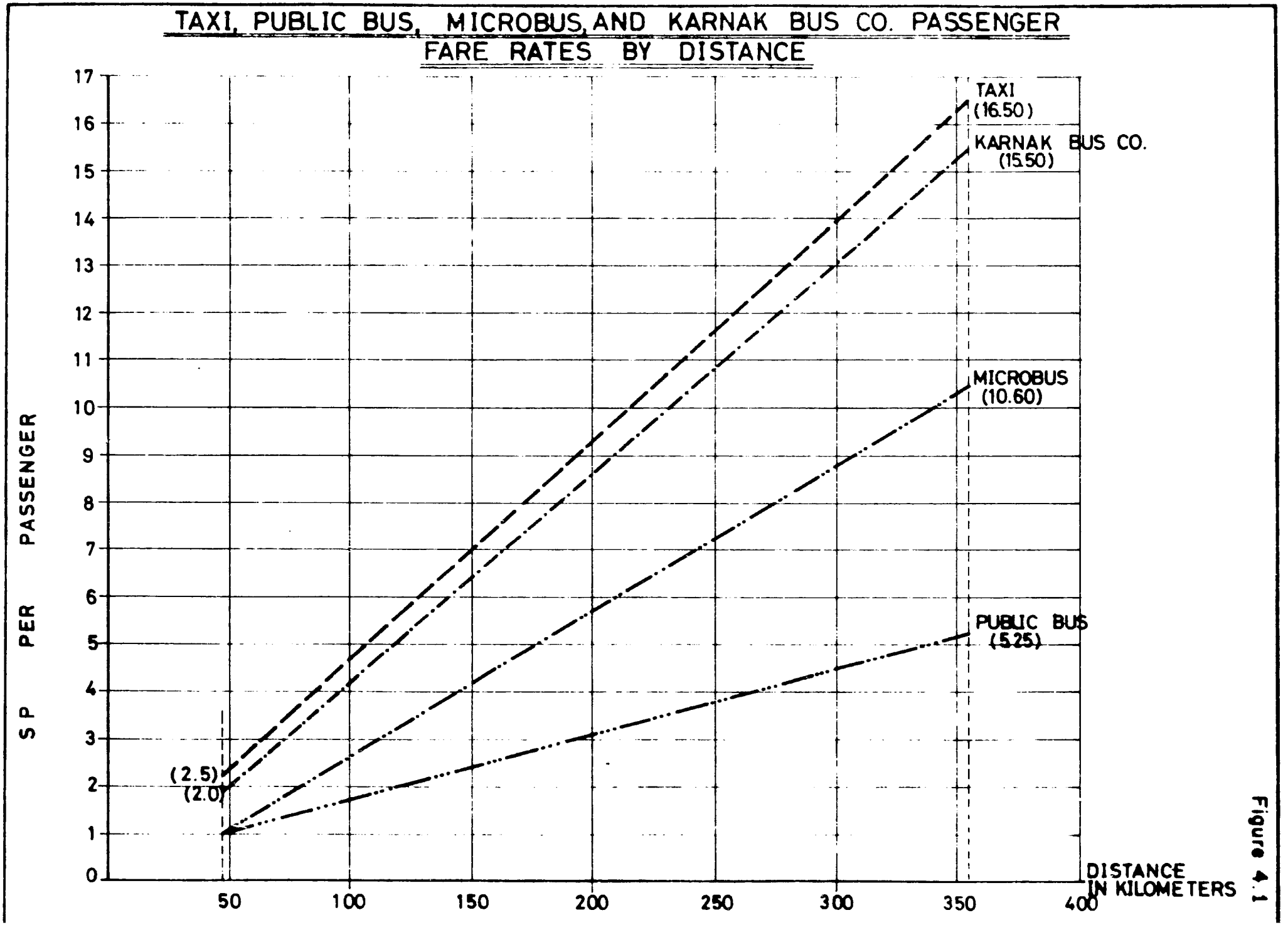

TAXI, PUBLIC BUS, MICROBUS, AND KARNAK BUS CO. PASSENGER FARE RATES BY DISTANCE
SP PER PASSENGER
DISTANCE IN KILOMETERS
TAXI (16.50)
KARNAK BUS CO. (15.50)
MICROBUS (10.60)
PUBLIC BUS (5.25)
(2.5)
(2.0)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
50
100
150
200
250
300
350
400

Figure 4.1

According to the Consultants' O & D surveys of 1979, the privately owned vehicles make up 32 percent of the truck fleet; this figure includes light pickup trucks. Privately owned vehicles are not allowed to conduct business for hire. The Consultants' O & D surveys indicate that public common carriers account for 63 percent of the fleet, and Government owned vehicles account for 5 percent. Government trucks include the fleets of such enterprises as the Phosphate Company, the Cotton Authority, and the Wheat Authority. Government institutions wishing to transport goods also do not have their own vehicles, but use common public carriers at what effectively are preferential rates compared to the private sector shippers, who pay approximately 25-30 percent more than the Government established rates. Based on output, it is estimated that 80 percent of the transported goods by common carriers are for the account of the Government.

Cargo Transport Office (CTO)

Under this system a number of Cargo Transport Offices (one in each Mohafaza, plus subsidiary offices as necessary) allocate cargo to the trucking fleet on a day-to-day basis. The system was established under Decision No. 82 of 24 February 1972, with the decision coming within the scope of Decree No. 66 of 20 April 1964. The CTOs are privately owned but all aspects of their operations are closely controlled by the Ministry of Transport, Directorate of Cargo Transport.

The system was established at a time when truck capacity in Syria was considered to be inadequate, with the apparent shortage of trucks being attributed to a combination of factors, including vehicle import restrictions, difficulty in financing vehicles, low truck tariffs established by the Government, and a regulation which required that no person could have an ownership interest in more than one commercial vehicle. The primary purpose of the CTOs was to allocate the available cargo to the trucks in the fleet in such a way as to ensure the highest possible utilization of the fleet capacity.

Operation of the CTO System

The CTO in each Mohafaza obtains information on the cargo available for transportation from a number of sources, including discussions with the officials of the publicly owned enterprises, telephone calls or delivered messages from these officials, communication with the privately owned companies such as manufacturers and importers, and through daily meetings with the Port Directorates in the cases of the CTOs in the port areas. According to the regulations, cargo is to be assigned to the common carrier trucks as follows:

- The drivers of empty trucks report to the CTO, where they are issued a serial number. The numbers are issued in the sequence in which the trucks arrive at the CTO.

- The trucks are sent to pick up the available cargo in order of their serial numbers, except when the size or type of truck is not suitable to the cargo. The driver is issued a "loading ticket," which authorizes him to proceed to where the load is located and to have the cargo loaded on his truck. The cargoes of publicly owned companies are given first priority in the assignment of trucks. A driver may refuse an assigned load but he then loses his serial number and will not be reassigned in that day.

- When the truck is loaded the driver returns to the CTO and receives a "pass ticket," which authorizes him to transport the cargo to the destination. This ticket indicates the origin and destination of the cargo, the type and volume of the commodity, and the registration number of the truck.

- When the truck is unloaded at the destination the driver collects payment from the consignee, or if necessary returns the next day for payment, and proceeds to the nearest CTO (or another if he chooses) to start the process again.

- In the case of transit trips (cargo going to other countries) the driver must have completed the transportation of four public-company cargoes inside Syria before he can qualify for a transit trip. (Only two are required in the case of a cargo for Jordan and three in the case of Iraq.)

- The Ministry of Transport may order that all trucks registered at a CTO, or any specific number of the trucks, be sent to a location having a high priority public-sector cargo. Similarly, if one CTO has a shortage of trucks, vehicles from another CTO may be sent empty to the first CTO. In this case, the truck owners are paid 25 percent of the normal loaded tariff for the trip, with this additional fee being paid by the owners of the cargoes.

- The decree implementing the CTO system specifies punishment for the contravention of the regulations. The penalty for most offenses calls for the suspension of the truck for 10 to 20 days or, in the case of a shipper, the suspension of transportation services for a similar period. The regulations require that all cargoes be transported within this allocation system and do not allow private arrangements between a shipper and a trucker for the transportation of the commodities.

The CTOs charge fees for the issuance of loading tickets and pass tickets. The schedule of fees is shown in Table 4.1.

The system appears to operate essentially as specified in the regulations, although there are some exceptions. In some cases, cargo owners and truckers make independent arrangements for the transportation of cargoes, thus circumventing the system. This normally happens on the shorter hauls within a Mohafaza where there is less chance of detection at a control point. When penalties are applied, they are most often in a form other than the suspension specified in the regulations. Given the apparent shortage of truck capacity, the avoidance of suspensions as a penalty is probably in the best interest of the economy. On the whole, there do not seem to be systematic deviations from the prescribed system.

Major Problems

The main problem in truck transportation in Syria, as noted in other parts of this volume, is the low utilization of the trucking fleet. The common carrier trucks are privately owned with the drivers normally having an ownership interest, so there is adequate incentive for the owners and drivers to attempt to achieve high utilization. The low utilization is primarily a result of various types of waiting time which are beyond the control of the driver. In some cases the waiting time can be attributed to the Offices of Cargo Transport. Major time elements are:

- Time awaiting a serial turn number on arrival at a CTO. Interviews with CTO employees and with drivers indicate that the numbers are issued almost immediately upon arrival, so that this is apparently only an occasional problem and not a serious one.

- Time awaiting the assignment of a load. This depends on the situation regarding truck and cargo availabilities at any given time, but given the apparent shortage of trucking capacity, it would not generally be expected to present a serious problem. At the Tartous CTO, which is one of the largest in terms of trucks and cargoes handled, the average waiting time is approximately one hour per truck.

- Time between the assignment of a cargo and the actual loading of the cargo on the truck. This can be one of the most significant time losses, and in some cases, it can be attributed to the operation of the CTO.

-- In some cases, trucks are sent without the cargo owner being informed or without a clear understanding of the number of trucks required and when they are required. Long waiting times then result.

Table 4.1

SCHEDULE OF FEES FOR CTO SERVICES

	Loading Ticket[1] (SP)	Pass Ticket[2] (SP)
Pickup or Light Truck	2.10	3.60
2 Axle Truck	2.10	5.60
3 Axle Truck	3.10	7.60
Truck with More than 3 Axles	3.60	9.60

1 A "loading ticket" is the authorization to proceed empty to the place where a cargo is available and to load the cargo onto the truck.

2 A "pass ticket" is authorization to transport a specific cargo from its origin to its destination.

-- In some cases, a group of about 40 or 50 trucks will be sent, even though the cargo handling facilities or other factors limit the loading rate to four or five trucks per hour. Long waiting times result for the last of the trucks to be loaded.

Both cases result from a lack of coordination and understanding between the cargo owner and the CTO, which is often the result of inadequate communication facilities. However, while the waiting time can be attributed, at least in part, to the CTO in these cases, the more significant time losses between arrival and loading are beyond the control of the CTO. They result from inefficient cargo handling, the breakdown of handling equipment, early closing hours of public-sector companies, and similar factors.

- Time between arrival at destination and time of unloading. In some cases, this delay is attributable to the CTO in that the CTO did not notify the receiving company or agency of the expected arrival of the cargo. Again, this is often the result of inadequate communication facilities. In addition, there is some question as to whether this should be the responsibility of the CTO. The more important delays, however, arise from the early closing of the receiving agencies or their inability to unload the trucks at a reasonable rate.

These are probably the most important cases of delays and time losses attributable to the CTOs. It is clear that communications should be improved between the various CTOs themselves, between the CTOs and the shippers or agencies loading the cargoes, and between the CTOs and the receiving agencies and companies. As with any agency, the performance of the CTOs could undoubtedly be improved. While privately owned, their operations and financing are closely controlled by the Government, and they have little if anything to gain in the form of profits by making additional efforts to ensure more efficient truck utilization. However, the improvement of their operations would probably have only a marginal effect on truck utilization, as the major cases of truck time losses are beyond their control. Most of the major problems have been discussed in other parts of this report, but they can be summarized here:

- In the allocation of trucks, the CTOs are required to give priority to public-sector companies. However, while tariffs are regulated and are officially the same for all companies and transport operations, the private-sector shippers and importers are willing to pay amounts considerably above the regulated tariffs, while the public-sector companies can pay only the regulated tariff. The truckers, therefore, will often refuse a public-sector load and remain idle for the rest of the

day in the hope of obtaining a more profitable cargo, either the next day or outside of the system. Chapter 6 below demonstrates that the established tariffs are below the operating costs of the vehicles, and in fact it is necessary to give the truckers an extra incentive to carry public-sector loads by giving them priority to carry a high-revenue transit cargo after they have transported four public-sector cargoes.

- The public-sector companies, the port administrations, and other agencies with cargo to be transported tend to request a large number of trucks at one time, sufficient for their daily requirement, even though they have the capability of loading only perhaps four or five trucks per hour. The remainder of the requisitioned trucks must wait for varying lengths of time until they can be loaded. Then, many of the agencies cease operations early in the afternoon, and some of the trucks are not loaded until the next day. The same problems occur at the unloading end. There is a regulation requiring that truckers be compensated for waiting time above a certain minimum, and there are regulations requiring longer hours of operation by the public-sector company facilities, but these are apparently seldom observed.

- Cargo handling methods tend to be inefficient, with a high incidence of manual handling of cargo, and it is not unusual for cargo handling equipment to break down. These factors increase the loading and unloading time of the trucks.

- Trucks are not allowed to pass through Damascus during normal daylight hours. They are restricted to the period between 8:00 p.m. and 6:00 a.m. Any trucks arriving outside of those hours must remain idle on the outskirts of the city.

- The drivers are responsible for collecting payment for the transport service. Even in cases where they are able to unload after 2:00 p.m., the offices are frequently closed and they must come back the next day for payment.

In the transportation of a public-sector company cargo from the Port of Tartous to the southern side of Damascus, the following pattern is apparently not unusual:

- Day One: Proceed from CTO parking area to the port for loading, as one of a number of assigned trucks. Unable to load, stay over to Day Two.

- Day Two: Load at Tartous, proceed to the CTO for trip ticket, proceed to Damascus. Wait outside of Damascus until 8:00 p.m., then proceed to the destination in south Damascus, which is closed.

- Day Three: Wait to unload; prior trucks not all unloaded by 2:00 p.m., warehouse no longer receiving. Wait until Day Four.

- Day Four: Unload in morning, obtain payment, proceed to the edge of Damascus. Wait until 8:00 p.m. and then return to Tartous.

Thus a trip of about 260 kilometers, with an empty return haul of the same distance, frequently requires a full four days. Based on 292 operating days per year, a vehicle following this pattern would cover only about 38,000 kilometers, of which only about 19,000 would be revenue kilometers. This hypothetical example apparently overstates the problem since Consultants' data show an annual kilometerage of 50,000 per truck per year.[1] The difference might be due to longer average trip distance; a quicker turnaround time; kilometers accumulated on trips outside Syria; or a combination of any of these. Whatever the reason for the difference, even the higher kilometerage figure represents an unusually low level of truck utilization, which is the primary reason for the apparent shortage of truck capacity in Syria although a main objective of the CTO system is to help to achieve high vehicle utilization. It is clear that main causes of low utilization are largely beyond the control of the CTOs. (The current de facto tariff differentials also present at least the opportunity for corruption. The Consultants have no means of assessing whether or to what extent it occurs.)

Possible Alternative Systems and Improvements

The Cargo Transport Offices perform what is essentially a transport organization and marketing service. In trucking, as in most other enterprises, this service is normally provided by the administrative and sales staffs of the companies. In Syria, the regulation that a person may have an ownership interest in only one common carrier vehicle precludes the formation of private trucking companies, and it is not practical for the operator of a single vehicle to maintain an administrative or sales staff. The need for the CTO system would thus appear to be primarily a result of the regulation restricting multiple vehicle ownerships. This restriction also removes the possibility of attaining the benefits of economies of scale in the trucking industry. However, removal of the restriction would probably result in the formation of relatively large trucking companies, and while this would have a number of advantages, including the attainment of economies of scale and the

[1]Truckers and Shippers Survey.

provision of administrative and marketing services, there would also be disadvantages. The drivers of the vehicles would be less likely to have an ownership interest, and they would then have considerably less incentive to attain high vehicle utilization and to drive in such a way that the vehicles could be kept in relatively good condition. Further, larger private companies with centralized ownership are less suited to the economic philosophy of the Government.

The administrative and marketing functions are extremely important in the attainment of high vehicle utilization. In Syria, these services are separated from the functions of vehicle ownership and instead are carried out, at least partly, by the CTOs. The CTOs themselves do not benefit from high vehicle utilization and thus have little incentive to attempt to achieve this objective. While the CTOs do not appear to be a major obstacle to higher vehicle utilization, it is possible that their functions could be carried out more efficiently by the truck operators themselves. In Egypt, where there is a mix of individual truck operators, private trucking companies, Government-owned common carrier trucking companies, private-sector company trucking fleets, and cooperatives of individual truck owners, the results of a recent study indicated that the most efficient form of organization was private owners organized into cooperatives.[2] This system provides the incentives which go with private ownership, the benefits of widespread ownership of the fleet, and the economies of scale in administration, marketing, financing, purchasing, and maintenance which accompany a larger organization. With this form of organization, the functions of the CTOs would be carried out by the cooperatives themselves, and if desired, the personnel of the CTOs could become part of the administrative and other staff of the cooperatives.

For this or any other scheme of cargo allocation to work effectively, it will be necessary to make the tariffs paid by public-sector companies the same as those paid by private companies, in fact as well as in law. The regulated tariffs paid by the public-sector companies are below the costs of truck operation, especially in view of the low truck utilization (which itself is partly attributable to the practices of the public-sector companies). Since truckers are obligated to carry public-sector cargoes, they must charge considerably higher tariffs on the private cargoes, well above costs, in order to break even. This in effect results in a hidden subsidy of the

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[2]Egypt National Transport Study, Interim Report, 1977, Volume II, Chapter IV, Louis Berger International Inc., in association with Dorsch Consult.

public-sector companies by the private companies, which would tend to distort the relative economies of the two types of companies and also distort the allocation of cargo among the different modes of transportation, especially between road and rail.

Other alternatives for modifying the system could include elimination of the regulation restricting truck ownership, direct Government operation of the CTOs, or direct Government operation of all or part of the trucking fleet. These, along with the formation of cooperatives, should be studied in more detail in a separate, extensive study of the whole highway transport industry. In the meantime, a brief study of the most efficient communication systems to meet the needs of the CTOs could be carried out and steps then taken to provide the required communication facilities.[3]

Conclusion

The operation of the Cargo Transport Offices is only one aspect of the truck transport situation in Syria. The major problem, which is one of unusually low vehicle utilization, involves a number of factors, including: tariff differentials between public and private cargo; the low level of the regulated tariffs; the inconsistencies between the road and rail tariff structure; the large diesel-fuel subsidy for highway transport; the inefficient loading and unloading systems in use; the early closing hours and other practices of the public-sector and some private-sector companies; and the inadequate condition of the roads in some cases.

Trucks account for more than 90 percent of total cargo transportation in Syria (excluding petroleum products and crude oil). Their utilization is very low, which results in unnecessarily high costs of transportation.

Freight Tariff System - Vehicles Over 3.5 Tons

The tariff governing truck shipments for Government customers is set by the Ministry of Supply and Interior Trade in consultation with truckers' representatives and the Ministry of Transport. The Ministry of Supply and Internal Trade issued Decision No. 1656, effective 1 October 1979, which amended

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[3]The CTO in Tartous, one of the main ports of Syria, has no means of communication other than by driving to a telephone or to meetings.

Mohafaza freight rates and certain cargo movement regulations. The new tariff system is based on ton-kilometers and distance (i.e., it is a tapering system).

Distance Rate Systems

The simplest form of rate structure is one in which rates are constructed on a distance scale. In the typical distance rate system, the rates do not change with each additional kilometer of distance. Instead, a distance "block system" is used, with blocks varying in length.

Most distance rates are constructed on the tapering principle; that is, the rates increase with distance but not as rapidly as distance increases. In other words, although the total rate is greater for longer rather than for shorter distances, the rate per kilometer is actually less for the longer distance.

There are several reasons for not making freight rates increase in exact proportion to distance. In the first place, terminal costs are the same regardless of the length of the haul. The longer the haul, the greater the distance over which the constant terminal cost can be spread. The second reason is that even the line-haul or conveyance cost is relatively lower for the longer hauls. A third reason is to prevent the rates from restricting the movement of long-distance traffic. If the rates increased in proportion to distance, they would soon become so high as to prevent the movement of traffic.

Advantages of Distance Rates

Rates constructed in accordance with the distance principle have the following advantages over other rates:

- They conform to the cost of service principle, because costs of transportation generally increase with distance.

- They tend to stabilize the rate structure. If rates are to be adjusted according to commercial and competitive conditions, manufacturers and dealers can never know when the rate system will be disturbed because of changed conditions. Rates constructed on the distance principle have a more permanent basis.

- They discourage wasteful transportation. Rates levied according to distance give an advantage to a producer in the surrounding area. On the other hand, rates that are the same, without regard to distance, lead to the invasion of one's natural markets by outside producers and allow the local producer to invade the markets of his rivals. This leads to

an enormous amount of cross-hauling and the carrying of goods for unnecessarily long distances. Rates constructed in accordance with the distance principle tend to prevent this economic waste.

Disadvantages of Distance Rates

Some of the disadvantages of the distance rate system are as follows:

- It limits the ability of producers seeking to sell goods in distant markets and thus reduces the amount of competition in the production or sale of goods.

- It disregards the conditions of demand. Distance rates are justified largely on a cost of service basis, but it is proper to adjust rates according to conditions of demand.

Tariff Structure

The following is the new tariff structure, Decision No. 1656, which applies to all types and classifications of cargo vehicles (over 3,500 kilograms) on paved roads:

Distance, Kms	Incremental Rate, Piasters per Ton-km
1 - 50	17.0
51 - 100	14.5
101 - 200	9.0
201 - over	7.5

Road freight rates are approximately 14 piasters per ton-kilometer. Thirty percent is added to the applicable tariff for cargo carriers on earth roads, and 35 percent is added to the tariff if a truck returns empty. This rate applies irrespective of road surface type.

Loading, Unloading, and Stacking Charges

These charges are borne by the cargo owner (shipper). A sum of SP 5.00 will be added to the tariff for each hour of loading/unloading if the distance is 50 kilometers or less, provided the operation period does not exceed four hours (maximum).

Special Commodities

Special commodities, such as cotton and tea, go by volume instead of weight; thus, the freight rate is based on the loading capacity of the vehicle. Under Decision No. 1656, the

freight rate for special commodities is based on the following allowances:

2-axle truck	-	13.0 tons
3-axle truck	-	19.5 tons
Combination truck	-	26.0 tons

Short Haul Movements

The following basic freight rates apply for short haul movements:

Distance, Kms	Average Rate, SP per Ton
0 - 1	5.89
1 - 5	7.58
5 - 15	8.66
16 - 25	9.38

These rates are based on a ton basis and increase with distance (see Figure 4.2). The road freight costs are approximately 47 piasters per ton-kilometer for short distances.

Freight Rates for Vehicles Less than 3.5 Tons

The light pickup truck belongs to this category and the rates below are for this type of commercial vehicle.

The Mohafaza rate system for distances up to 50 kilometers is as follows:

Distance, Kms	Incremental Rate, Piasters per Ton-km
1 - 10	28.0
11 - 50	17.0

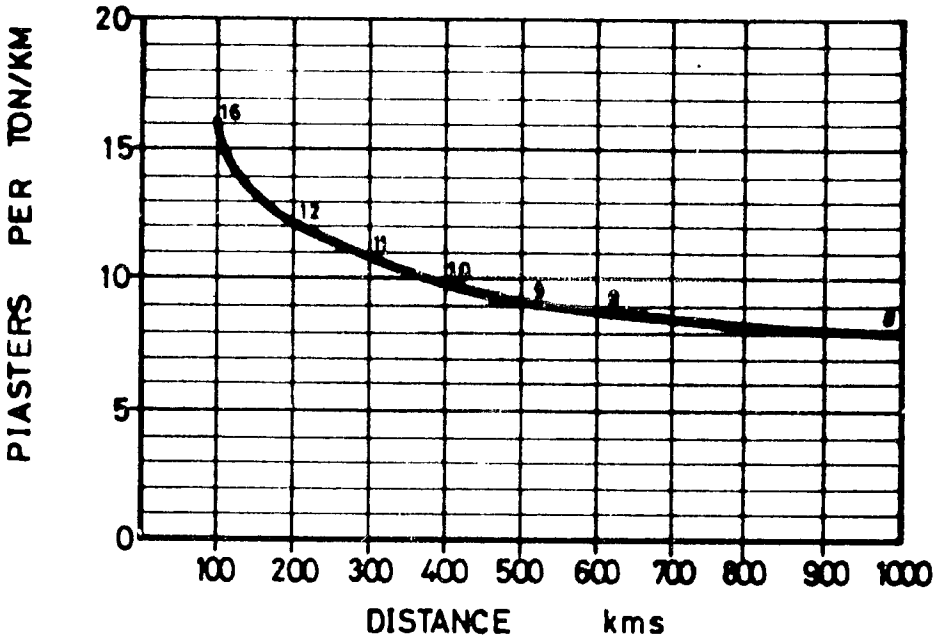
Therefore, for distances of 50 kilometers within the Mohafaza borders, the average transportation cost is 19 piasters per ton-kilometer.

For more than 50 kilometers, the same freight rates apply as for the heavy trucks of more than 3.5 tons, i.e., 14 piasters per ton-kilometer.

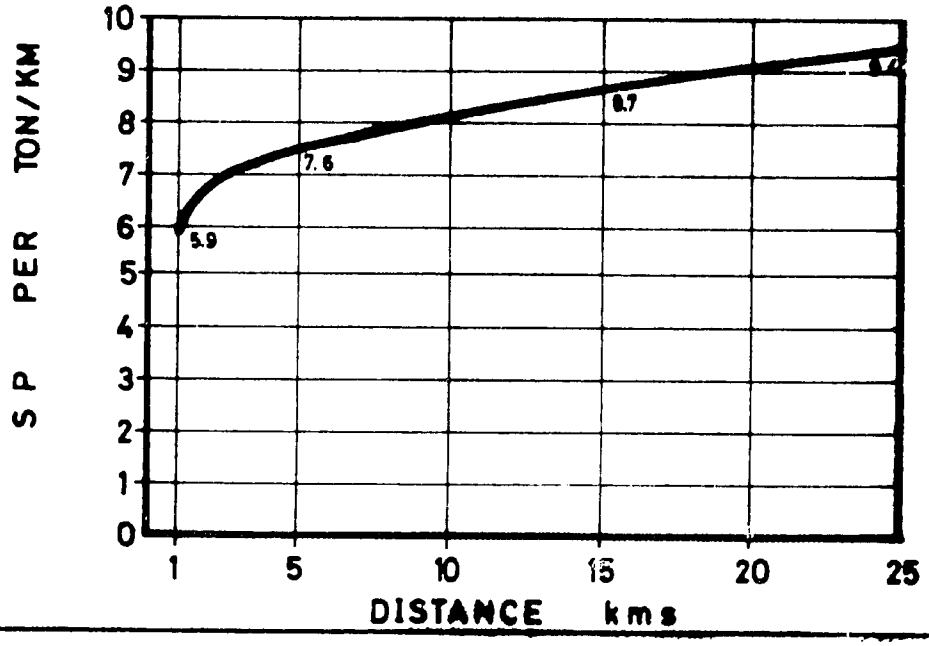
All other stipulations and charges as specified in Decision No. 1656 apply for the pickup light truck as well.

Figure 4.2

TON-KM FREIGHT RATES ON VARIOUS DISTANCES ON PAVED ROADS, HEAVY TRUCKS



SHORTHAUL FREIGHT RATES ON VARIOUS DISTANCES ON PAVED ROADS, HEAVY TRUCKS



4.2 VEHICLE FLEET

There are two basic factors that must be taken into consideration in estimating vehicle fleet size. First is the annual import of vehicles, since no domestic production is expected for at least another 10 years. Second is the average lifetime of vehicles.

This analysis addresses the total vehicle fleet over a 15-year period, 1963-1978. In addition, the vehicle fleet registered in each Mohafaza is analyzed for the period 1973-1978.

Present Vehicle Types in Syria

Based on registration data, as well as previous feasibility studies performed by other consultants, there are eight basic types currently in use on Syria's highways. A brief description of these eight types of vehicle and a discussion of their significance follows.

- Motorcycles and Tricycles: There are relatively few motorcycles in Syria. In 1978 there were 29,800 (about 14 percent of the total number of the motor vehicle fleet). Tricycles or three-wheeled vehicles generally have a steering apparatus and an engine in the configuration of a motorcycle with a covered section at the rear for transport of goods or passengers. These vehicles are not suitable for long distance trips at high speeds. In 1978 there were approximately 2,600 tricycles (about 1.8 percent of the total motor vehicle fleet in the country or 9 percent of the total number of motorcycles).

The unit operating cost of motorcycles and three-wheeled vehicles is relatively low, and they will not be included in the analyses, except for classification counts.

- Farm Tractors: Farm tractors are used for agricultural purposes although their presence on the highways is responsible for a large number of traffic accidents. Farm tractors are omitted from the operating cost analyses, but they will appear in the classification counts.

- Automobiles and Taxis: In 1978 automobiles made up about 40 percent of the total fleet (taxis - 11 percent, private cars - 29 percent). Sedans (other than taxis) are predominantly of the small European type. Land rovers, jeeps, and station wagons are also part of the fleet. Most of the taxis are European-made and are several years old.

- Buses: Buses are classified as either microbuses or large buses, which have more than 40 seats. Microbuses have a seating capacity of 20 to 22 passengers and are generally engaged in shorter trips than the larger buses. The most common type of large bus is the Mercedes-Benz 0-302; the most common type of microbus is the Fiat "OM" chassis with a locally produced body. The percentage of buses in the vehicle fleet in 1978 was 5 percent (large buses - 2 percent, microbuses - 3 percent).

- Trucks: Trucks are primarily 2-axle vehicles with six tires or 3-axle vehicles with 10 tires and are used for either construction work or for general cargo movement. In addition, single unit tanker trucks carry liquid commodities such as petroleum products and water. These Government vehicles normally have four tires on the 2-axle trucks or six tires on the 3-axle trucks.

In 1978 trucks with two, three, or more axles made up 18 percent of the vehicle fleet. This percentage includes combination vehicles and tankers of either two or three axles. Tankers totalled 1.2 percent of the total motor vehicle fleet and 6.7 percent of all trucks in 1978.

- Pickup light trucks: These are various types of pickups, ranging in capacity from 1/4 to 1-1/2 tons. Vans are generally of the closed delivery type and are classified in the pickup light truck category.

In 1978 pickup trucks made up 34 percent of the motor vehicle fleet. The ratio of pickup to trucks was 1.9 in favor of the pickups or 65 percent of all trucks.

Present Vehicle Fleet

Registration

Vehicle registration records for the entire country are kept by the Damascus Motor Vehicle Department. Vehicle information is recorded on forms that require information concerning the vehicle and owner. It is compulsory to register ownership changes when the vehicle is sold, and transfers from one Mohafaza to another must be registered. No scrapping rates exist; thus, the registrations do not show annual cancellations or withdrawals. Under these circumstances, the registered vehicle fleet does not realistically reflect the vehicles on the road. Because the 1979 registrations are not available, the analyses are complete only through 1978.

Development of the Vehicle Fleet

Vehicle registrations have been compiled for the period 1963 through 1978. Table 4.2 shows the vehicle registrations by

Table 4.2

VEHICLE REGISTRATIONS BY VEHICLE TYPE AND CATEGORY, 1963 TO 1978

Vehicle Type/Year	1963	1964	1965	1966	1967	1968	1969	1970
Passenger Car[1]	22,717	26,535	26,765	26,196	28,099	21,694	22,381	23,705
Taxi	-	-	-	-	-	5,698	5,789	6,356
Bus[2]	1,849	1,676	1,609	1,613	1,406	1,557	1,688	1,760
Pickup	1,474	1,477	3,992	4,734	4,754	3,711	4,380	4,591
Land Rover	378	384	472	471	465	467	479	469
Truck[3]	10,688	10,550	8,097	7,241	8,923	8,401	9,437	10,595
Tanker	616	675	624	764	705	929	963	1,146
Temporary Entrance[4]	-	-	-	-	-	1,206	1,612	966
Total	37,722	41,297	41,559	41,019	44,352	43,663	46,729	49,588

Vehicle Type/Year	1971	1972	1973	1974	1975	1976	1977	1978
Passenger Car[1]	23,754	23,194	25,723	27,208	38,107	49,971	56,107	47,447
Taxi	6,612	7,282	8,465	9,519	11,567	12,256	12,437	17,525
Bus[2]	1,605	2,200	2,525	2,826	4,192	5,631	6,829	7,423
Pickup	4,330	4,545	5,388	5,085	9,006	25,027	34,523	54,900
Land Rover	507	514	553	551	570	533	540	545
Truck[3]	11,095	12,176	13,248	13,622	19,184	23,471	31,522	26,717
Tanker	1,106	1,141	1,201	1,535	2,018	1,743	1,984	1,943
Temporary Entrance[4]	1,912	2,815	3,086	3,023	4,298	5,408	6,369	5,416
Total	50,921	53,867	60,189	63,369	88,942	124,040	150,311	161,916

Sources: Central Bureau of Statistics, 1963-1978, and Motor Vehicle Department, Damascus.

1 Includes jeeps.

2 Microbuses included.

3 2, 3 and more axle trucks included.

4 Includes all types of vehicles.

vehicle type and category. This table shows the predominance of private cars in the registered fleet. The pickup truck shows a considerable increase over all registered vehicles.

Figures 4.3 and 4.4 graphically present vehicle growth by type and category for the period 1963-1978.

Vehicle Imports

Unfortunately, there is no statistical information on total vehicle imports into Syria. However, the Consultants have been able to obtain vehicle import data by vehicle type and category for the period 1975-1978 for vehicles entering through the Port of Tartous. These data are not complete because vehicles are also imported by land as well as through Lattakia Port. The import statistics record value and total weight only.

Light and Heavy Vehicle Distribution

Figure 4.5 shows the total fleet and the light and heavy vehicle distribution for the 15-year period 1963-1978. The predominance of light vehicles over heavy vehicles is evident throughout the period. The ratio of light to heavy vehicles was 1.9:1 in 1963 and it had risen to 3.5:1 in 1978. In intervening years the rate was never less than 2.1:1.

Growth of the Vehicle Fleet

General

Motor vehicle registrations in Syria have increased at an annual average rate of nearly 10.2 percent for the period 1963-1978. Much of this growth, however, has occurred over the last four years. Prior to the 1973 war, the Government had held down the growth rate of imports to about 5 percent per year because of foreign exchange and also because of the emphasis placed upon developing the railways. After the 1973 war, import quotas were discontinued as a result of increased earnings from higher oil prices and an influx of foreign capital. The response to the ending of the quotas was an immediate and vigorous growth. In the four-year period 1970-1974, the entire fleet almost doubled.

Growth Rates

Table 4.3 presents the average annual percentage growth rate for all vehicle types for a period of 15, 10, and 5 years, respectively. Average annual percentage growth rates for light and heavy vehicles are also indicated.

For the 15-year period, the total fleet's growth was 10.21 percent. For the 10-year period, the overall average annual percentage growth rate was 14.03 percent. For both periods, pickup trucks show the highest growth rate followed by commercial trucks in general.

Figure 4.3

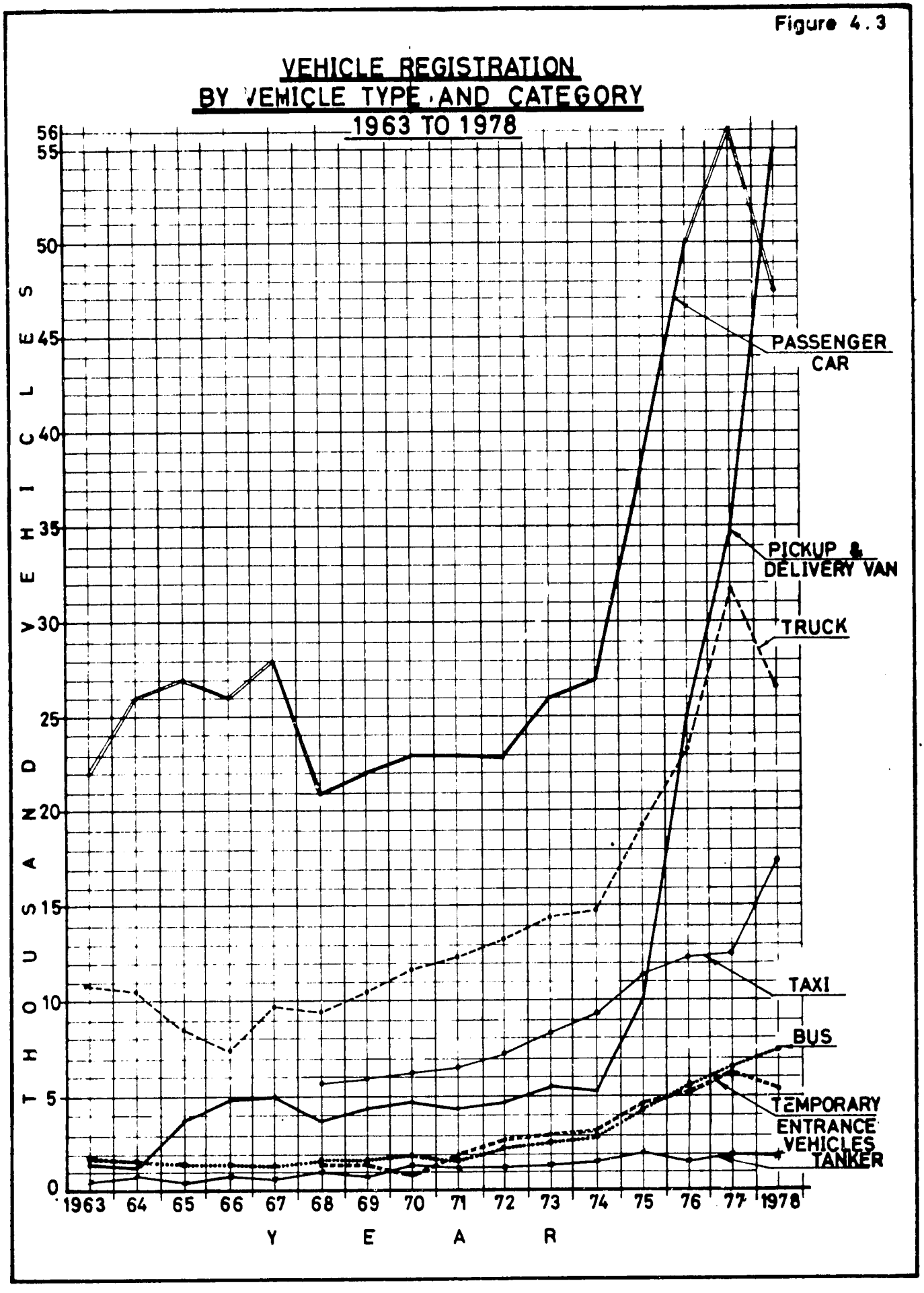

VEHICLE REGISTRATION
BY VEHICLE TYPE AND CATEGORY
1963 TO 1978
THOUSAND VEHICLES
56
55
50
45
40
35
30
25
20
15
10
5
0
1963
64
65
66
67
68
69
70
71
72
73
74
75
76
77
1978
YEAR
PASSENGER CAR
PICKUP & DELIVERY VAN
TRUCK
TAXI
BUS
TEMPORARY ENTRANCE VEHICLES
TANKER

Figure 4.4

VEHICLE REGISTRATION - ALL VEHICLES

1963 - 1978

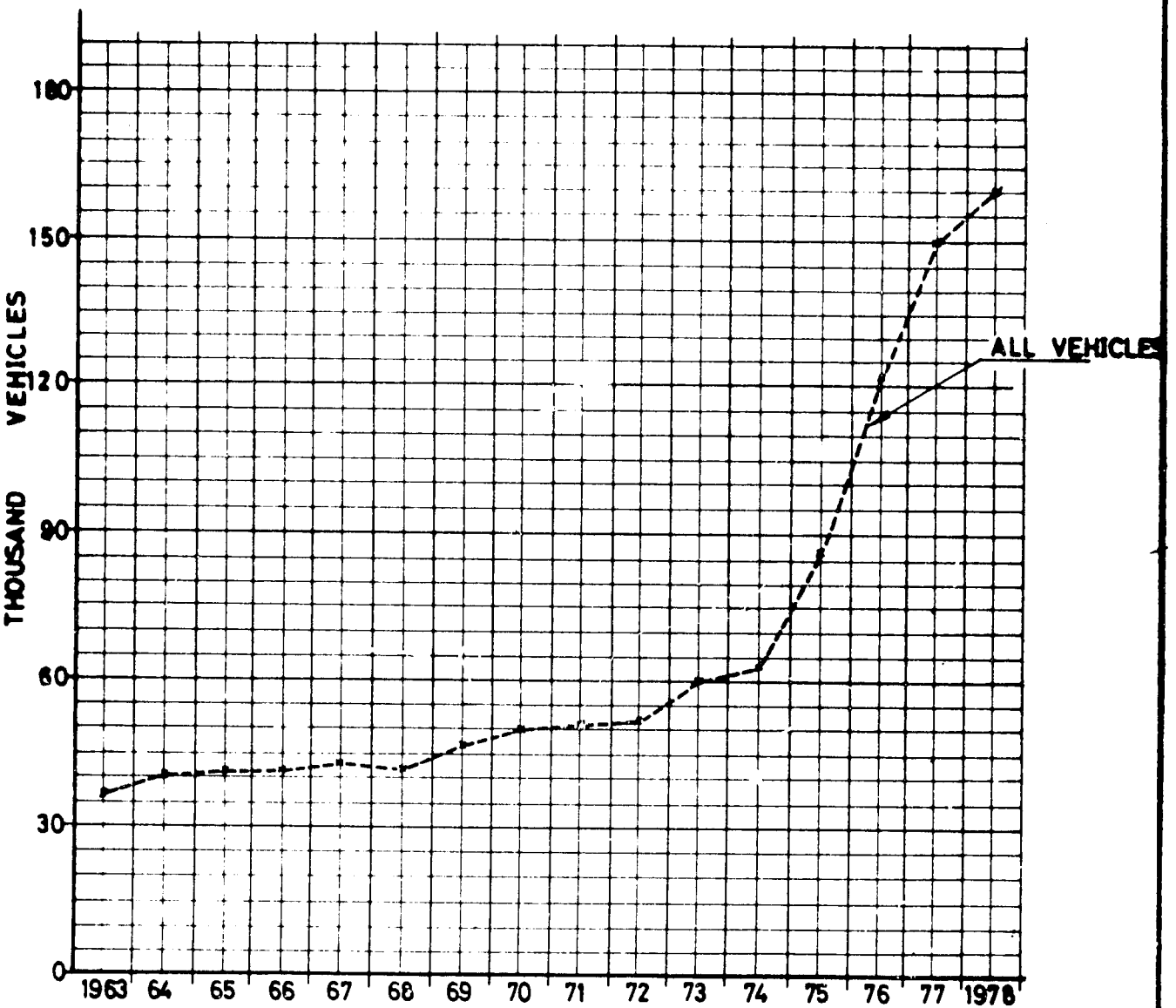


Figure 4.5

VEHICLE REGISTRATION
LIGHT AND HEAVY
VEHICLE DISTRIBUTION
1963 TO 1978

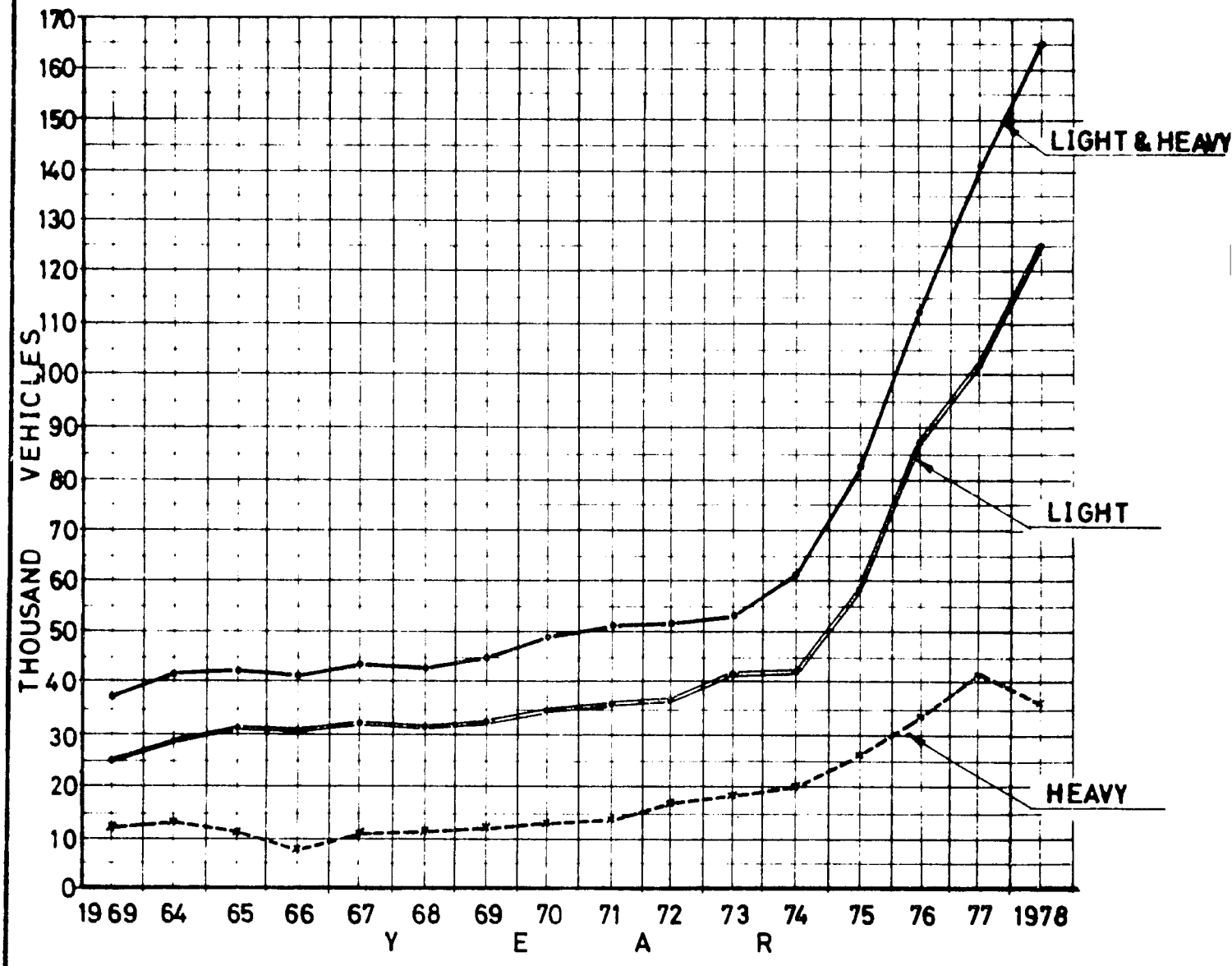


Table 4.3

VEHICLE REGISTRATION GROWTH RATE PERCENTAGE 1963-1978

BY VEHICLE TYPE AND CATEGORY

Vehicle Type	Growth Rate Percentage		
	1963-1978	1968-1978	1973-1978
Passenger Cars[1]	5.03	8.14	13.03
Taxis	-	11.89	15.67
Buses[2]	9.71	16.90	24.07
Pickups	27.27	30.92	59.08
Land Rovers	2.47	1.56	0.29
Trucks	6.30	12.27	15.06
Tankers	7.96	7.66	10.10
Temporary Entrance Vehicles	-	16.21	11.91
Total Fleet	10.21	14.03	21.93
Light Vehicles	11.52	14.43	23.89
Heavy Vehicles	6.96	10.62	16.28

Source: Table 4.2.

1 Includes Land Rovers and Jeeps.

2 Includes microbuses.

For the five-year period 1973-1978, the overall average annual percentage growth rate was nearly 22 percent. The pickup light truck again presents the highest growth rates, followed by buses and heavy trucks. The passenger car growth rate is almost double for the five-year period, compared to the 15- and 10-year period growth rates.

Fuel Consumption

A review of vehicle fuel consumption is an additional indication of the number and kinds of vehicles in operation in the country. Table 4.4 shows the consumption of motor gasoline and diesel oil for the years 1973 to 1977 and the annual percentage growth rate for gasoline and diesel.

Table 4.4

DOMESTIC CONSUMPTION OF MOTOR FUEL, 1973-1977
(1,000 Metric Tons)

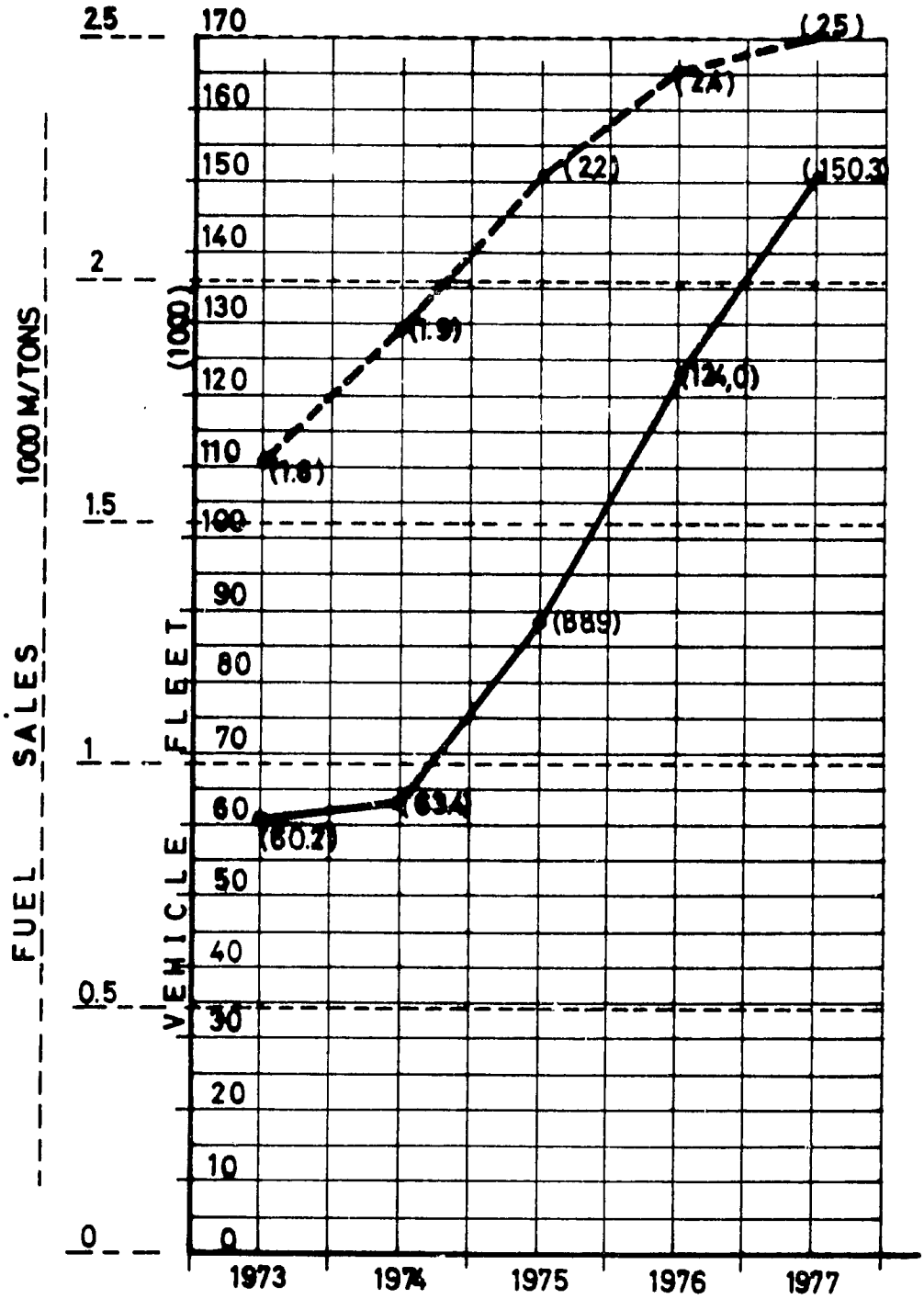
Product	1973	1974	1975	1976	1977	Annual % Growth Rate
Gasoline	281	332	399	456	482	14.4
Diesel	1,253	1,563	1,758	1,944	1,981	12.1

Source: SADCOP, Damascus.

The domestic consumption figures fit closely with the present estimates of the 1977 vehicle fleet size and composition, assuming an average consumption for light vehicles, operating on all types of roads an average of 25,000 kilometers/year on 0.25 liters/kilometer. Heavy vehicles are assumed to consume an average of 0.34 liters/kilometer at an average of 65,000 kilometers/year. These calculations cover 98 percent of motor gasoline consumption and 40 percent of diesel consumption. The figure of 40 percent for the diesel is somewhat low. However, the consumption of diesel for agricultural purposes, building heat, generators, and military vehicles must be considered. Figure 4.6 graphically presents the vehicle fleet and fuel sales for the period 1973-1977.

Figure 4.6

VEHICLE FLEET AND FUEL SALES



Present Fleet by Region

General

The geographical distribution of the present fleet in numbers of vehicles and percentage distribution, by Mohafaza, is shown in Table 4.5. Figure 4.7 depicts total Mohafaza vehicle registrations, with and without the motorcycles and tricycles, for the period 1972-1978. The percentage distributions by Mohafaza are depicted in Figures 4.8 and 4.9.

Regional Distribution Patterns

The Consultants have prepared a detailed analysis of vehicle registrations, by year and by type of vehicle, for each Mohafaza for the period 1972-1978. These data were used in the Trip Generation Model of the SYRTRANS transport planning system during Phase II. The detailed data are available in the Consultants' offices. Table 4.5, which summarizes the percentage distribution of vehicle registrations by Mohafaza in 1978, was derived from these data. Significant data to be noted follow.

Damascus: This Mohafaza, the center of the country's economic activity, employment opportunity, and consequently, higher per capita income, has:

- 49 percent of the total registered vehicles in Syria,
- 23 percent of the country's taxi fleet,
- 54 percent of the total bus fleet in Syria,
- 43 percent of all pickups and trucks in Syria,
- 48 percent of the total number of motorcycles,
- 52 percent of the total tanker fleet in Syria.

The fact that 41 percent of the commercial truck fleet is registered in Damascus Mohafaza indicates that Damascus is also the main distribution point and most likely the highest consumption center in Syria.

The predominance of the Damascus Mohafaza (including the metropolitan area) is apparent. Almost 50 percent of the total vehicle fleet is registered in this area, with the Aleppo Mohafaza having the second highest percentage of the fleet. The percentage of distribution pattern of other Mohafazat has not changed except for Aleppo, where its share declined.

Aleppo: The Aleppo Mohafaza ranks the second highest with about 17 percent of the total registered motor vehicles. It is obvious that a polarization exists between Damascus and Aleppo, although with a large difference in vehicle population.

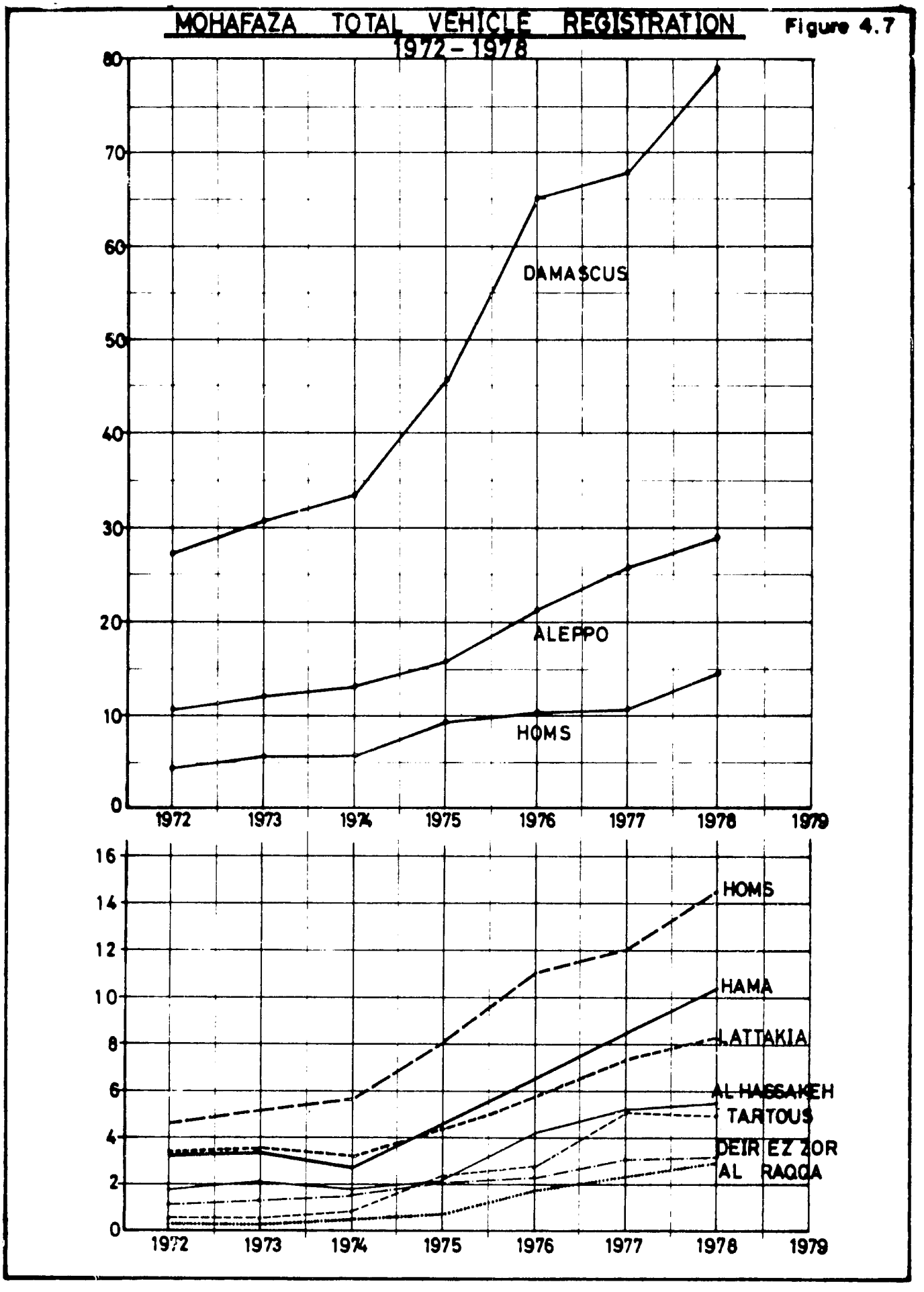
Table 4.5

MOHAFAZAT VEHICLE REGISTRATIONS, 1972-1978

	Number of Vehicles in (000)						
	1972	1973	1974	1975	1976	1977	1978
Damascus	27.7	30.7	33.7	47.0	65.0	77.0	79.3
Homs	4.7	5.7	5.8	8.4	11.0	12.4	13.7
Hama	3.0	3.5	2.7	4.8	6.7	8.7	10.5
Tartous	0.5	0.6	0.9	2.3	3.0	5.2	5.3
Lattakia	3.5	3.7	3.2	4.3	6.0	7.5	8.2
Idleb	0.4	0.4	0.5	1.2	1.9	3.2	4.1
Aleppo	10.9	12.1	13.1	15.7	22.1	25.8	28.2
Al Raqqa	0.3	0.4	0.4	0.6	1.9	2.7	3.1
Al Hassakeh	1.9	2.0	1.9	2.4	4.1	5.3	5.8
Deir Ez Zor	1.0	1.1	1.1	2.2	2.4	3.0	3.4
Total	53.9	60.2	63.3	88.9	124.1	150.8	161.6

	Percentage Distribution						
	1972	1973	1974	1975	1976	1977	1978
Damascus	51	51	53	53	52	51	49
Homs	8	9	9	9	9	8	9
Hama	6	6	4	5	5	6	6
Tartous	1	1	1	3	2	3	3
Lattakia	6	6	5	5	5	5	5
Idleb	1	1	1	1	2	2	3
Aleppo	20	20	21	18	18	17	17
Al Raqqa	1	1	1	1	1	2	2
Al Hassakeh	4	3	3	3	3	4	4
Deir Ez Zor	2	2	2	3	2	2	2
Total	100	100	100	100	100	100	100

Source: Central Bureau of Statistics, Statistical Abstracts.


MOHAFAZA TOTAL VEHICLE REGISTRATION
1972 - 1978
Figure 4.7
DAMASCUS
ALEPPO
HOMS
HOMS
HAMA
LATTAKIA
AL HASSAKEH
TARTOUS
DEIR EZ ZOR
AL RAQQA
0
10
20
30
40
50
60
70
80
2
4
6
8
10
12
14
16
1972
1973
1974
1975
1976
1977
1978
1979

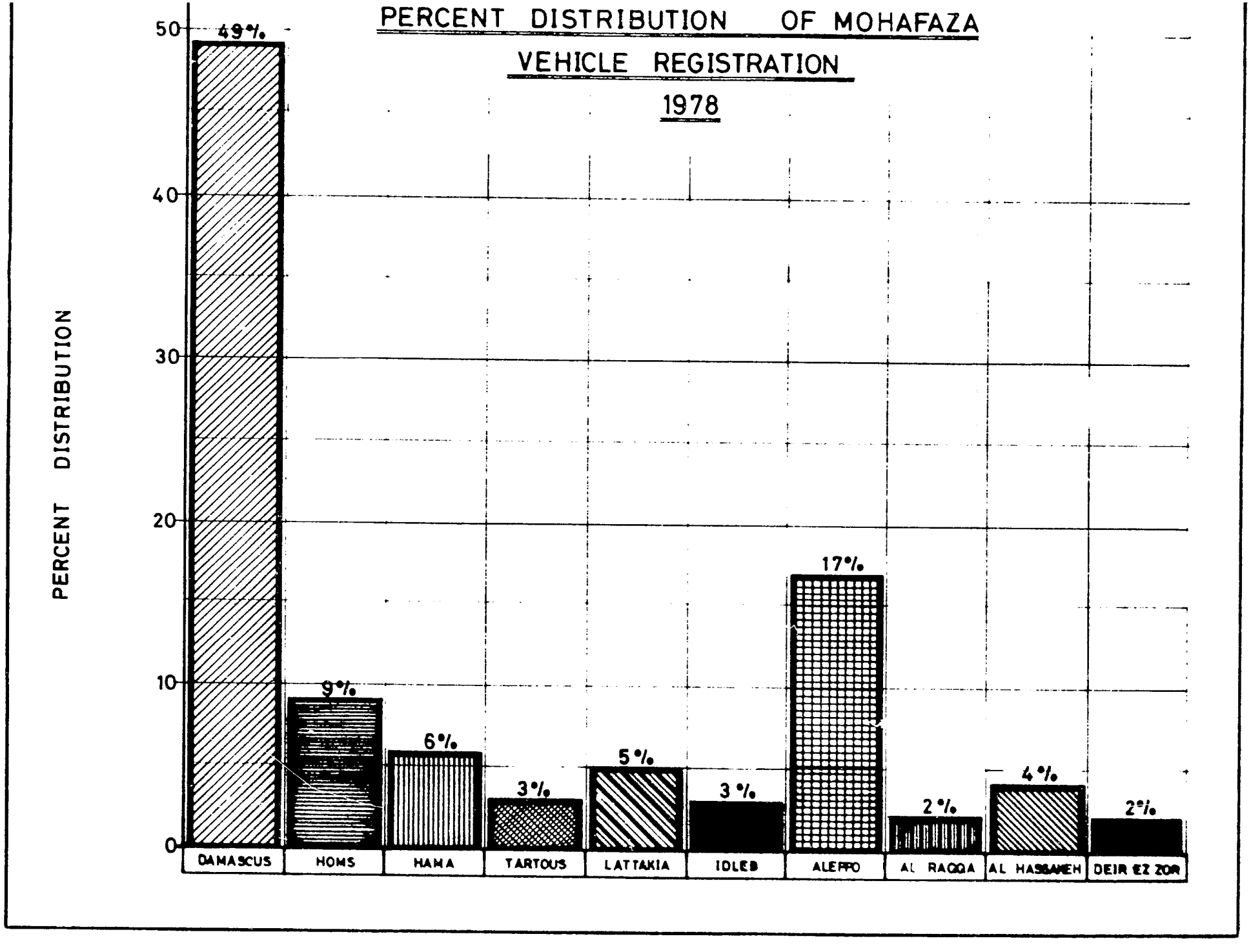

PERCENT DISTRIBUTION OF MOHAFAZA
VEHICLE REGISTRATION
1978
PERCENT DISTRIBUTION
50
40
30
20
10
0
49%
9%
6%
3%
5%
3%
17%
2%
4%
2%
DAMASCUS
HOMS
HAMA
TARTOUS
LATTAKIA
IDLEB
ALEPPO
AL RAQQA
AL HASSAKEH
DEIR EZ ZOR

Figure 4.8

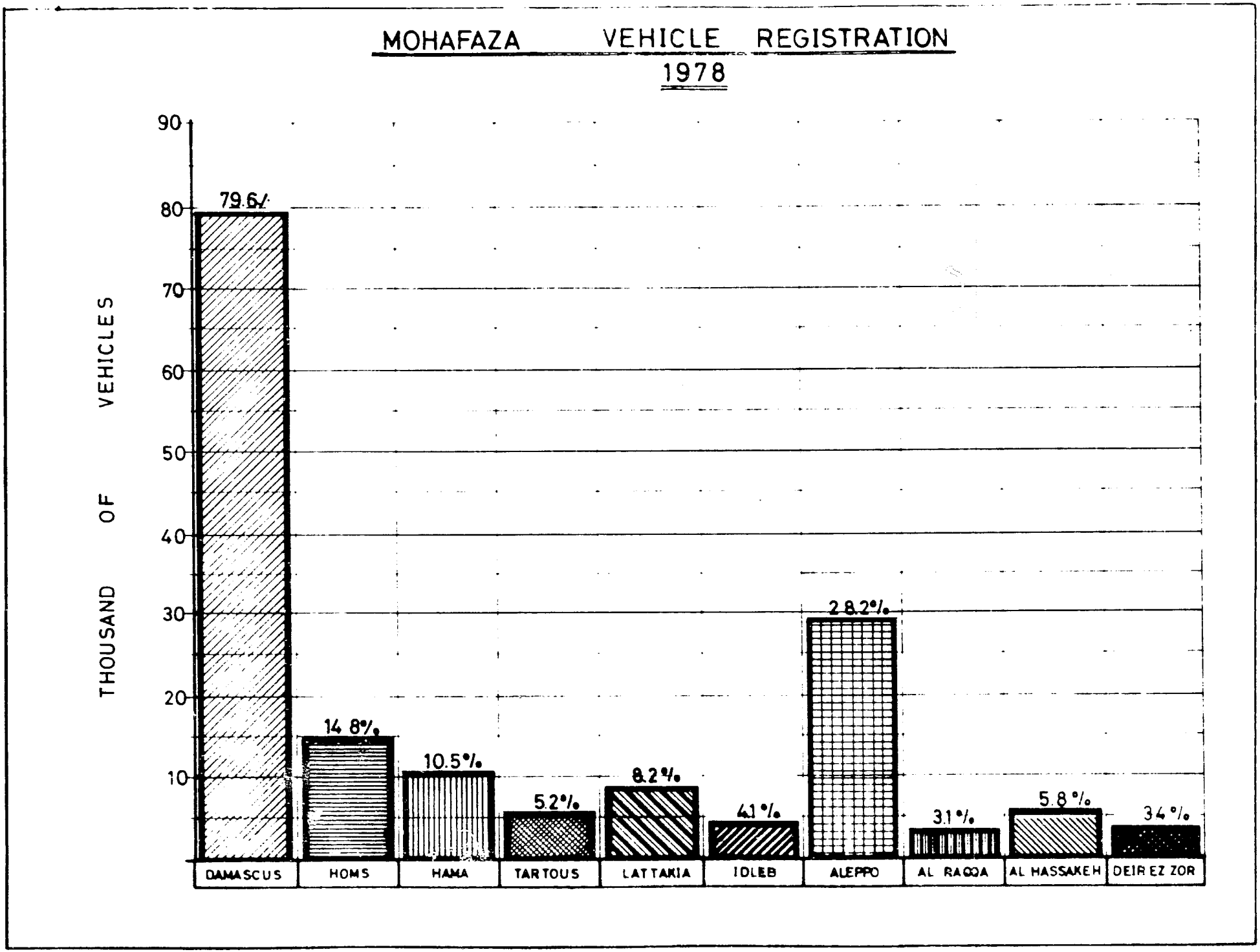

MOHAFAZA VEHICLE REGISTRATION
1978
THOUSAND OF VEHICLES
90
80
70
60
50
40
30
20
10
79.6%
14.8%
10.5%
5.2%
8.2%
4.1%
28.2%
3.1%
5.8%
3.4%
DAMASCUS
HOMS
HAMA
TARTOUS
LATTAKIA
IDLEB
ALEPPO
AL RAQQA
AL HASSAKEH
DEIR EZ ZOR

Figure 4.9

Homs and Hama: Homs and Hama Mohafazat have the third or fourth highest percentage of vehicles in Syria, indicative of their agricultural importance. Almost 30 percent of the registered vehicles in Homs are passenger cars and 36 percent are trucks. Almost 16 percent of the 1978 fleet consisted of trucks, followed by pickups (59 percent) and passenger cars (14 percent). The pickup light truck consisted of about 60 percent of the total registered fleet. Table 4.6 shows the Mohafaza light and heavy vehicle percentages and ratios for the year 1978.

Vehicle Densities

General

It has been estimated that in 1978 Syria possessed a passenger car fleet of about 47,992 vehicles, or approximately six vehicles per 1,000 inhabitants. The transport vehicle fleet of 1978 (54,900 pickups, 27,046 trucks, and 1,943 tankers) corresponds to 10 vehicles per 1,000 inhabitants. The bus fleet (7,423) in 1978 corresponds to 0.90 per 1,000 inhabitants. Taking into consideration the entire vehicle fleet in 1978 - excluding the motorcycles and the temporary entrance vehicles (156,810) - the corresponding amount is 19 vehicles per 1,000 inhabitants.

Vehicle Densities

Vehicle densities are estimated for the various regions of the country and are shown in Table 4.7.

Future Vehicle Fleet

The size of the future road vehicle fleet has been estimated by means of the SYRTRANS computer model system. The model is outlined in Volume VII, Chapter 1. The model predicts vehicle-kilometers in future years for each of eight vehicle types and then converts them into the required vehicle fleet by applying forecasted vehicle utilization conditions.

An important indicator of vehicle utilization is the overall load factor. For passenger vehicles no changes were assumed for load factors from those at present. Demand for each of five passenger vehicle types was estimated individually. For freight vehicles changes in shares of each of three truck types and improvement in load factors were forecast as shown in Tables 4.8 and 4.9.

Other important indicators of vehicle utilization are the annual kilometerage per vehicle and the vehicle scrapping rates. For a given amount of total vehicle kilometers, these two factors determine the necessary additional vehicle fleet.

Table 4.6

MOHAFAZAT LIGHT AND HEAVY VEHICLE PERCENTAGE AND RATIO, 1978

Mohafazat	Light Vehicle[1] No.	Light Vehicle[1] %	Heavy Vehicle[2] No.	Heavy Vehicle[2] %	Light to Heavy Vehicle Ratio
Damascus	62.9	79	16.6	21	3.8
Deir Ez Zor	2.5	73	0.9	27	2.8
Al Hassakah	4.2	74	1.5	26	2.8
Al Raqqa	2.5	83	0.5	17	5.0
Aleppo	21.7	77	6.4	23	3.4
Idleb	3.5	87	0.5	13	7.0
Lattakia	6.7	82	1.5	18	4.2
Tartous	4.5	86	0.7	14	5.2
Hama	8.4	80	2.0	20	1.4
Homs	8.5	57	6.3	43	1.3
Country	125.4	77	36.9	23	3.4

Source: From all compiled Mohafaza tables.

Note: Excludes motorcycles but includes temporary entrance vehicles, which are all assumed to be light vehicles.

1 Includes passenger car, taxi, pickup, Land Rover and temporary entrance vehicles.

2 Includes bus, truck, and tanker.

Table 4.7

ESTIMATED VEHICLE DENSITIES PER 1,000 INHABITANTS

Mohafaza	Passenger Car	Bus	Truck	All Vehicles
Damascus	14.0	1.6	14.0	32.0
Aleppo	1.8	0.8	7.9	16.0
Homs	5.1	0.7	12.3	20.0
Hama	2.2	0.4	11.4	12.0
Tartous	3.4	0.4	6.8	13.0
Lattakia	5.1	0.3	5.7	16.0
Idleb	0.7	0.3	6.5	8.0
Al Raqqa	0.6	0.5	6.3	10.0
Al Hassakah	0.9	0.2	8.0	10.0
Deir Ez Zor	0.8	0.4	7.0	9.5
Country	5.7	0.90	10.1	19.5

Source: All compiled Mohafaza tables.

Notes: Passenger cars include Land Rovers. Buses include microbuses. Trucks include tankers and pickups. All vehicles exclude motorcycles, tricycles and temporary entrance vehicles, and include taxis.

As noted in the above tabulation, the regional distribution of vehicles and ownership levels are very uneven, ranging from 2 to 3 per thousand persons in the south, to 32 in Damascus, and 9 to 10 in the northeast. The average for Syria in 1978 was 19.5 vehicles per 1,000 inhabitants.

Table 4.8

PROJECTED GOODS TRANSPORT VEHICLE SHARES AND OVERALL LOADING FOR 1985

	Vehicle Types			
	Pickup	2 Axle Trucks	3 Axle Trucks	Combination Trucks
I. Distribution of Commodity Tonnage by Vehicle Type (in percent)				
Commodity Group				
Bulk	0.9	34.2	12.1	52.8
Intermediate	4.5	33.8	24.4	37.3
High Value	4.5	22.1	20.9	52.5
II. Overall Average Loading Vehcile (in tons)				
Commodity Group				
Bulk	0.92	4.35	10.1	12.9
Intermediate	1.18	3.38	11.4	10.7
High Value	0.76	2.58	6.2	8.0

Table 4.9

PROJECTED GOODS TRANSPORT VEHICLE SHARES AND OVERALL LOADING FOR 2000

	Vehicle Types			
	Pickup	2 Axle Trucks	3 Axle Trucks	Combination Trucks
I. Distribution of Commodity Tonnage by Vehicle Type (in percent)				
Commodity Group				
Bulk	1.0	27.0	25.0	57.0
Intermediate	4.0	27.0	29.0	40.0
High Value	4.0	19.0	23.0	54.0
II. Overall Average Loading per Vehicle (in tons)				
Commodity Group				
Bulk	0.92	4.35	10.1	13.1
Intermediate	1.18	3.38	11.4	10.9
High Value	0.76	2.58	6.2	8.2

Table 4.10 summarizes the annual kilometerage per vehicle. It should be noted that annual per vehicle kilometerage figures shown in this table are only applicable to interzonal trips and are not total kilometerages of vehicles in a year. Passenger cars and pickups, therefore, show low kilometerage since they are primarily used within urban areas or in short distances. As the urbanization proceeds and the car ownership increases, the average annual kilometerage of passenger cars used crossing Mantika borders would become even less. On the other hand, annual kilometerages of goods transport vehicles would increase as the efficiency of trucking operations improves from the present low level. As shown in Table 4.10, the Consultants' estimates of future per vehicle annual kilometerages reflect such considerations.

Table 4.10 also shows vehicle scrapping rates. The 1979 rates were reduced by up to 1 percent on the basis of import restrictions and resultant longer average vehicle life.

The required vehicle fleet for the period of 1981 to 1985 is shown in Table 4.11. To satisfy the demand, the total vehicle fleet has to grow at a rate of 4 percent a year. Passenger cars and the taxi fleet would grow at a rate double that of the total fleet average, whereas the microbus fleet may decrease because more efficient regular buses would be brought in to replace microbuses as passenger demand increases. A shift to larger, more efficient trucks from inefficient 2-axle trucks would take place.

The number of additional vehicles needed to realize such fleet expansion is shown in Table 4.12. Over the five-year period, 90,000 additional vehicles would be needed costing 8 billion SP in foreign exchange.

Six alternative scenarios have been considered for the period 1986-2000. Alternative scenarios are combinations of passenger transport pricing alternatives; commodity modal split alternatives; rail infrastructure alternatives; and road infrastructure alternatives. A discussion of these alternatives is presented in Chapter 4, Section 4.4, of Volume VII.

Alternative infrastructure investments would not have a significant impact on the future road vehicle fleet. Alternative policies affecting demand level and modal split, however, would make a considerable difference. On the grounds of minimizing total economic transport costs the Consultants recommend, as detailed in Chapter 4, Section 4.4, of Volume VII, that the Government initiate policies aimed at a higher share for the railways.

Table 4.10

VEHICLE FLEET FACTORS

	Vehicle Types							
	Pass. Car	Taxi	Pickup	Micro Bus	Reg. Bus	2 Axle Truck	3 Axle Truck	Comb. Truck
1979 Vehicle Fleet in 000's	54.9	20.9	81.3	3.8	4.8	25.1	2.5	3.4
1979 Interzonal Vehicle-kilometers in millions	545.4	518.1	287.5	270.1	142.1	531.6	100.2	229.8
1979 Annual Interzonal Trip km per vehicle in kilometers	9935	24973	3540	71080	29596	21179	40078	67578
Projected Annual Interzonal Trip km per vehicle 1985	9370	25000	3540	71000	30000	23000	44000	70000
2000	8100	25000	3540	71000	30000	26000	49000	72000
Scrappage Rate in percent	6.0	3.5	2.4	4.5	4.5	5.0	5.0	5.0

Table 4.11

ROAD VEHICLE FLEET REQUIREMENTS 1981-1985

(in thousands)

Year	Passenger Car	Taxi	Pickup Truck	Micro Bus	Bus	2 Axle Truck	3 Axle Truck	Combination Vehicle	Total
1981	63.1	24.5	82.8	3.6	5.0	26.4	2.8	3.6	211.9
1982	67.6	26.5	83.7	3.5	5.1	27.1	2.9	3.8	220.2
1983	72.5	28.6	84.5	3.4	5.3	27.8	3.1	3.9	229.2
1984	77.7	31.0	85.4	3.3	5.4	28.6	3.2	4.1	238.7
1985	83.3	33.5	86.2	3.3	5.6	29.3	3.4	4.2	248.8
Annual Growth Rate in Percent Over Period 1979-1985									
	7.2	8.2	1.0	-2.3	3.0	2.6	5.3	3.6	4.0

Table 4.12

REQUIRED ADDITIONAL VEHICLES 1981-1985

(in thousands)

Year	Passenger Car	Taxi	Pickup Truck	Micro Bus	Bus	2 Axle Truck	3 Axle Truck	Combination Vehicle	Total
1981	7.8	2.4	2.8	0.07	0.35	2.0	0.27	0.30	16.1
1982	8.3	2.6	2.8	0.07	0.36	2.0	0.28	0.31	17.0
1983	8.9	2.9	2.8	0.07	0.37	2.1	0.30	0.33	18.0
1984	9.6	3.4	2.9	0.07	0.38	2.1	0.31	0.34	19.0
1985	10.3	3.6	2.9	0.07	0.39	2.2	0.33	0.35	20.1
Total	44.9	14.9	14.2	0.35	1.85	10.4	1.49	1.65	90.2

Table 4.13 shows the future vehicle fleet under such policies. As the general level of individual wealth increases the passenger car fleet is expected to increase at a high rate, as in the past. A gradual shift from microbuses to regular buses and from 2-axle trucks to larger trucks is also expected, due to the higher efficiency of the latter. The growth rate of the total vehicle fleet is 4 percent per annum for 1980-1990 and 6.1 percent per annum for 1990-2000. This accelerating vehicle fleet expansion is due to the fact that at present Syria's motorization is still at a very low level. It is expected that Syria will follow the now universal characteristics of accelerating motorization experienced in countries that fall in the category of medium per capita income.

Table 4.13

VEHICLE FLEET 1979, 1985, 2000
(in thousands)

Year	Passenger Car	Taxi	Pickup Truck	Micro-Bus	Bus	2-Axle Truck	3-Axle Truck	Combination Vehicle	Total
1979	54.9	20.9	81.3	3.8	4.8	25.1	2.5	3.4	196.5
1985	83.3	33.5	86.2	3.3	5.6	29.3	3.4	4.2	248.8
2000	319.9	33.2	192.4	3.2	15.7	32.1	5.6	6.9	609.0

It should be emphasized that motor vehicle fleet investments are susceptible to changes in the import of passenger cars and taxis. As Table 4.12 indicates, they constitute 66 percent of vehicle fleet investments, with passenger cars alone accounting for 50 percent of total investments. (This is discussed further in Section 7.6 below.)

The Consultants' vehicle fleet estimates for automobiles are based on fulfilling expected demand. The Government could reduce the foreign exchange costs by restricting the importation of automobiles, only partially offsetting investments in the buses required.

A detailed study of the road transport industry is recommended in Section 4.1 above. This separate study is necessary because the level of analysis required is beyond the scope of a comprehensive study and because required data that are not now available will have to be collected. In view of the magnitude and foreign exchange cost of potential vehicle fleet investments the study should explore policy alternatives to improve vehicle utilization and reduce imports. Measures to be analyzed would include tax, price, and tariff charges, and improved supplies of spare parts, among others.

The Goverment could use the SYTRANS model to test the effects of policy measures and the limitation of passenger car imports, once the requisite data were available.

CHAPTER 5

TRAFFIC SURVEYS

Chapter 5

TRAFFIC SURVEYS

5.1 ORIGIN AND DESTINATION (O & D) SURVEYS

Objectives

Highway facility design, performance standards, and benefit-cost relationships are affected not only by the volume of movement, but also by the particular movement pattern. Origin-destination (O & D) information, when added to volume data, permits a more precise picture of the traffic situation. O & D data are essential for determining the particular route and paths of travel, and in assessing the cost and value of travel.

The Consultants have conducted O & D surveys for two main purposes:

- to determine the percent traffic desire lines and to enable an assessment of the traffic volume that would be diverted to new or improved highways or to other modes,

- to separate the traffic into local and long distance traffic, and to establish the O & D patterns.

Survey Design

The Consultants assembled a considerable number of past studies concerning road traffic in Syria. After the careful examination of available data, the Consultants found them inadequate for the objectives of this study. The Consultants carried out a nationwide origin and destination survey during the period 19 June to 13 July 1979. The methodology used in that survey and an analysis of the results are presented in Chapter 5, Section 5.1, of Volume IV of the Final Phase I Report.

The validity of a one-time survey, such as that carried out by the Consultants, depends, in part, on the availability of prior surveys or other data to adjust the O & D survey for such factors as seasonality. Because such data were not available, the Consultants conducted three additional analyses, which were used to adjust the O & D survey data for the final passenger and commodity traffic forecasts. The three analyses were:

- an analysis of all intercity bus routes and frequencies throughout Syria,

- an analysis of data on the Cargo Transport Offices (CTO) for 1976 compiled by the Central Statistical Bureau,

- a 5 percent sample survey of all truck trip tickets issued by the CTOs in 1979.

The analyses of the CTO data are discussed in Section 5.3 below.

5.2 ROAD TRAFFIC COUNTING PROGRAM

Objectives

The Consultants conducted a continuous one-year nationwide traffic counting program from 1 August 1979 to 31 July 1980. The objectives of this program were as follows:

- to measure actual traffic volumes on the Syrian road network in order to provide a basis for the determination of the need and priority of its improvement and maintenance according to existing and expected future traffic,

- to determine hourly, daily, and monthly traffic variations and the hourly volumes for different classes of roads for planning and design purposes,

- to calibrate the computerized traffic projection model developed for the study and later use by the Government,

- to provide a basis for the continuing traffic counting program recommendations that will be developed in Phase II.

A detailed description of the methodology used in the traffic counting program was presented in Section 5.2 of Chapter 5 of Volume IV of the Final Phase I Report. The results of the full year's traffic counts were coded into the computer and were used in the SYRTRANS model to prepare the final commodity and passenger traffic forecasts.

5.3 CARGO TRANSPORT OFFICE SURVEYS

General

The Consultants made a 5 percent sample survey of all truck trip tickets issued in 1979 by the Cargo Transport Offices (CTO) throughout Syria. The purpose of the survey was to determine total tonnage moved through the CTOs in 1979, monthly variations by commodity type and commodities shipped by vehicle type; and to adjust the Consultants' origin and destination matrix at the Mantika level. In addition, statistics compiled

by the Central Bureau of Statistics (CBS) on all 1976 CTO trip tickets were analyzed, primarily to determine seasonal variations in commodity flows.

The 1976 tabulations provided monthly data, by CTO, on 13 commodity groups and 34 individual commodities. The 1979 sample survey collected data on freight shipped through each CTO, by month, by 15 commodity groups, by 49 individual commodities, by Mohafaza, and by vehicle type.

Analysis of the 1976 Data

Table 5.3.1 presents the freight transported through the CTOs in 1976 by 13 main commodity groups by month.

The most striking thing to be seen from Table 5.3.1 is the relative stability of commodity movements through the CTOs. In terms of total tonnage, the lowest month (July) was only 40 percent less than the peak in April. Ten of the 12 months fall within a range of 8 to 9.8 percent of total annual shipments, a difference for these 10 months of only 18 percent, or 76 thousand tons from the highest to the lowest month. In part, this stability results from offsetting changes among commodity groups. As can be seen from Table 5.3.1, however, the individual commodity groups themselves are surprisingly stable. Even farm products do not vary as much as one might expect.

Overall, 4.218 million metric tons were shipped through the CTOs in 1976. The monthly distribution movement was high in April and May and low in July and September. Consumer goods accounted for 19 percent of the total movement (819,000 tons) followed by manufactured construction materials (17 percent or 718,000 tons) and cement (16 percent or 670,000 tons). The high monthly peaks for these three commodities were May, June, and August for consumer goods; April, June, and December for manufactured construction materials; and March and April for cement. The low monthly movement in terms of tonnage for these commodities was observed to be during the months of January, February, and September for consumer goods; February, July, and September for manufactured construction material; and July and August for cement

The high and low monthly movements of the remaining 10 commodity groups were:

Commodity	High	Low
Wheat	August	July
Cotton	November	September
Farm Products	January	July
Animals & Meat	November	June

Manufactured Food	March	November
Fertilizer	April	June
Refined Petroleum	August	November
Producers Goods	May	October
Sand and Gravel	May	January
Rail Construction Material	September	July

Analysis of 1979 Survey Results

Table 5.3.2 presents the freight transported through the CTOs in 1979 by 15 commodity groups by month.

During 1979 a total of 6.3 million metric tons were transported through the CTOs. This represents a 49 percent increase over 1976 or an annual percentage growth rate of 14.16 percent.

If phosphate, which will be shipped by rail in the future, is excluded, 1979 shows even less seasonal variation than 1976. In terms of total tonnage, the variation from the highest month (August) to the lowest month (April) is 184 thousand tons, or 30 percent. Nine of the 12 months have a variation of only 83 thousand tons, or 17 percent from highest to lowest. However, as Figure 5.3.1 shows, the pattern by month is quite different. June, July, and September, the lowest months in 1976 are all relatively high months in 1979. Agricultural commodities appear to be an important factor, and the commodity groups in 1979 show less stability than in 1976. A comparison of Tables 5.3.1 and 5.3.2 indicates, as one would expect, that the greater the disaggregation, the greater the seasonal variation. This is clearly shown in the individual commodity tables the Consultants derived for both 1976 and 1979.

In 1979, cement accounted for 1.2 million or 19 percent of the total tonnage movements, followed by manufactured construction materials (985,000 tons or 16 percent) and consumer goods (702,000 tons or 11 percent).

The highest cement movement occurred in the months of March and July. The lowest movement was recorded in the months of April and October. The movement of manufactured construction material was almost evenly distributed throughout the year, with the exception of July and August, which were the peak months. Consumer goods movement generally presented an increasing distribution over the year with a peak during the month of November.

An analysis of commodities transported by Mohafaza shows a wide variation among them. Because of their ports, Tartous and Lattakia dominated with 26.3 percent and 20.0 percent, respectively. At the bottom end of the scale are Al Raqqa (0.7 percent), Al Hassakeh (3.9 percent), and Deir Ez Zor (4.0 percent). Because it is a destination more than an origin,

Table 5.3.1

FREIGHT TRANSPORTED THROUGH CARGO TRANSPORT OFFICES IN 1976 BY COMMODITY GROUPS

(tons in thousands)

Commodity Group		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Wheat & Barley	t	25.0	34.0	28.8	25.1	33.0	25.0	23.0	71.7	26.3	31.5	31.5	26.2	381.6
	%	6.6	8.9	7.5	6.6	8.7	6.5	6.1	18.8	6.9	8.3	8.3	6.9	100
Cotton	t	21.9	27.4	30.4	33.6	28.2	10.5	12.6	13.1	5.7	34.0	69.0	43.8	330.3
	%	6.6	8.3	9.2	10.2	8.5	3.2	3.8	4.0	1.7	10.3	20.9	13.3	100
Farm Products	t	31.4	21.1	23.5	23.1	30.9	28.5	2.7	30.0	24.8	21.4	29.2	23.4	290.1
	%	10.8	7.3	8.1	8.0	10.7	9.8	0.9	10.4	8.5	7.4	10.1	8.1	100
Animals & Meat	t	9.9	8.0	6.5	6.1	9.6	3.4	5.4	6.6	8.0	7.9	10.1	7.4	89.0
	%	11.2	9.0	7.3	6.9	10.8	3.9	6.1	7.4	9.0	8.9	11.4	8.3	100
Manuf. Food	t	45.5	61.8	67.5	49.7	55.6	35.2	42.7	65.2	50.7	55.5	30.8	31.6	591.8
	%	7.7	10.4	11.4	8.4	9.4	5.9	7.2	11.0	8.6	9.4	5.2	5.3	100
Cement	t	55.7	61.4	69.7	77.2	63.1	49.6	42.0	39.2	49.7	50.8	59.4	56.1	669.0
	%	8.3	9.2	10.4	11.5	9.4	7.4	6.3	5.9	7.4	7.6	8.1	8.4	100
Manuf. Const. Materials	t	61.9	47.5	59.8	74.1	65.9	84.1	31.7	62.3	48.1	57.2	51.9	73.6	718.0
	%	8.6	6.6	8.3	10.3	9.2	11.7	4.4	8.7	6.7	8.0	7.2	10.3	100
Fertilizer	t	13.2	16.5	25.1	34.6	17.5	4.3	8.5	5.7	6.3	16.9	12.1	10.1	170.6
	%	7.7	9.6	14.7	20.3	10.2	2.5	5.0	3.3	3.7	9.9	7.1	5.9	100
Refined Petroleum	t	.2	.4	2.4	4.4	.2	1.5	2.1	16.3	1.0	1.2	.1	2.1	31.8
	%	0.6	1.2	7.5	13.7	0.6	4.7	6.6	51.1	3.2	3.7	0.4	6.6	100
Consumer Goods	t	63.5	57.4	70.3	72.4	87.0	79.7	66.4	78.4	30.2	74.5	72.3	67.5	819.5
	%	7.7	7.0	8.6	8.8	10.6	9.7	8.1	9.6	3.7	9.1	8.8	8.2	100

Table 5.3.1 (Continued)

FREIGHT TRANSPORTED THROUGH CARGO TRANSPORT OFFICES IN 1976 BY COMMODITY GROUPS

(tons in thousands)

Commodity Group		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Producer Goods	t	5.2	5.4	6.2	8.2	8.5	3.0	3.6	3.7	3.0	2.8	4.3	4.2	57.9
	%	9.0	9.3	10.7	14.1	14.6	5.1	6.1	6.5	5.1	4.8	7.4	7.2	100
Sand & Gravel	t	2.8	2.8	4.3	4.1	4.6	3.0	4.5	3.8	4.0	3.7	4.2	3.2	44.9
	%	6.2	6.3	9.7	9.9	10.2	6.8	9.9	8.4	8.9	8.3	9.3	7.1	100
Railway Const. Materials	t							0.1		23.9				24.0
	%							0.5		99.5				100
Total Tons:	t	336.2	343.8	394.5	412.7	404.0	327.8	245.5	396.0	281.7	357.3	369.9	349.2	4,218.5
	%	8.0	8.2	9.4	9.8	9.5	7.8	5.8	9.4	6.7	8.5	8.8	8.3	100

Table 5.3.2

FREIGHT TRANSPORTED THROUGH CARGO TRANSPORT OFFICES IN 1979 BY COMMODITY GROUP

(tons in thousands)

Commodity Group		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Wheat & Barley	t	13.6	21.9	15.9	31.8	16.1	64.2	19.3	20.1	23.5	21.0	23.5	33.3	304.7
	%	4.5	7.2	5.2	10.4	5.3	21.1	6.5	6.6	7.7	6.9	7.7	10.9	100
Sugar Beets	t	0.4	0.3	0	0	0	0	7.9	49.7	19.1	0.7	0	0	78.1
	%	0.5	0.4					10.1	63.6	24.5	0.9			100
Cotton	t	21.7	16.4	20.5	12.8	7.7	7.9	9.8	5.0	12.0	48.0	64.1	36.6	263.5
	%	8.2	6.2	7.8	4.9	2.9	3.0	3.8	1.9	4.6	18.2	24.3	13.9	100
Farm Products	t	72.9	52.1	61.0	47.1	85.8	77.2	86.2	80.8	71.4	63.4	82.3	41.9	822.0
	%	8.9	6.3	7.4	5.7	10.4	9.4	10.5	9.8	8.7	7.7	10.0	5.1	100
Animals & Meat	t	16.9	8.7	10.4	9.5	9.7	10.8	19.8	18.4	15.1	17.2	14.1	12.6	163.5
	%	10.3	5.3	6.4	5.8	6.0	6.6	12.1	11.3	9.3	10.5	8.6	7.7	100
Processed Food	t	64.2	84.8	61.0	57.9	67.7	80.6	92.9	81.1	74.8	66.8	87.5	74.6	894.0
	%	7.2	9.5	6.8	6.5	7.6	9.0	10.4	9.0	8.4	7.5	9.8	8.3	100
Cement	t	95.2	98.1	134.8	73.6	100.9	92.9	131.0	106.5	98.7	73.9	105.7	87.0	1199.0
	%	7.9	8.2	11.2	6.1	8.4	7.8	10.9	8.9	8.2	6.2	8.9	7.3	100
Manuf. Constr. Materials	t	67.7	52.1	61.1	85.5	80.4	99.7	110.0	114.7	60.2	82.2	77.9	93.5	985.1
	%	6.9	5.3	6.2	8.7	8.2	10.1	11.2	11.6	6.1	8.3	7.9	9.5	100
Fertilizer	t	21.9	32.3	28.1	22.1	33.3	21.8	32.8	34.5	38.3	43.0	39.6	20.7	368.6
	%	5.9	8.8	7.6	6.0	9.0	5.9	8.9	9.4	10.4	11.8	10.7	5.6	100
Refined Petroleum	t	0.5	0.5	0.5	0.5	0.8	0.5	0.9	0.5	0	0	0	0	5.0
	%	10.9	10.9	10.9	10.9	16.7	10.9	17.9	10.9					100

Table 5.3.2 (Continued)

FREIGHT TRANSPORTED THROUGH CARGO TRANSPORT OFFICES IN 1979 BY COMMODITY GROUP

(tons in thousands)

Commodity Group		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Consumer Goods	t	46.8	44.3	53.0	48.8	51.5	65.3	66.0	66.2	63.8	61.8	74.1	60.2	701.9
	%	6.7	6.3	7.5	7.0	7.3	9.3	9.4	9.4	9.1	8.8	10.6	8.6	100
Producers Goods	t	11.1	8.7	9.4	18.8	13.3	15.2	14.1	12.4	11.5	10.8	9.2	17.0	151.4
	%	7.3	5.8	6.2	12.4	8.8	10.0	9.3	8.2	7.6	7.1	6.1	11.2	100
Sand & Gravel	t	16.9	12.8	12.3	9.4	8.4	9.5	10.4	11.8	13.4	9.8	8.9	7.9	131.7
	%	12.9	9.7	9.3	7.3	6.4	7.2	7.9	9.0	10.1	7.4	6.8	6.0	100
Containers	t	0	0.9	0.6	0.2	1.1	0	0	0.4	0	0	0	0.2	3.3
	%		27.9	16.8	5.6	32.9			11.2				5.6	100
SubTotal	t	449.7	434.0	468.7	418.4	476.8	545.7	601.7	602.1	501.8	498.7	587.8	485.4	6072.0
	%	7.4	7.1	7.7	6.9	7.9	9.0	9.9	9.9	8.3	8.2	9.7	8.0	100
Phosphate	t	1.0	0.5	0	4.2	32.5	1.0	65.3	20.7	31.3	16.3	20.6	28.8	222.2
	%	0.4	0.2		1.9	14.6	0.6	29.4	9.3	14.1	7.3	9.3	12.9	100
Total	t	450.7	434.5	468.7	422.6	509.3	546.7	667.0	622.8	533.1	515.0	608.4	514.2	6294.2
	%	7.2	6.9	7.4	6.7	9.0	8.7	10.6	9.9	8.5	8.2	9.7	8.2	100

Source: Consultants' survey.

Note: Consumer Goods includes minerals.

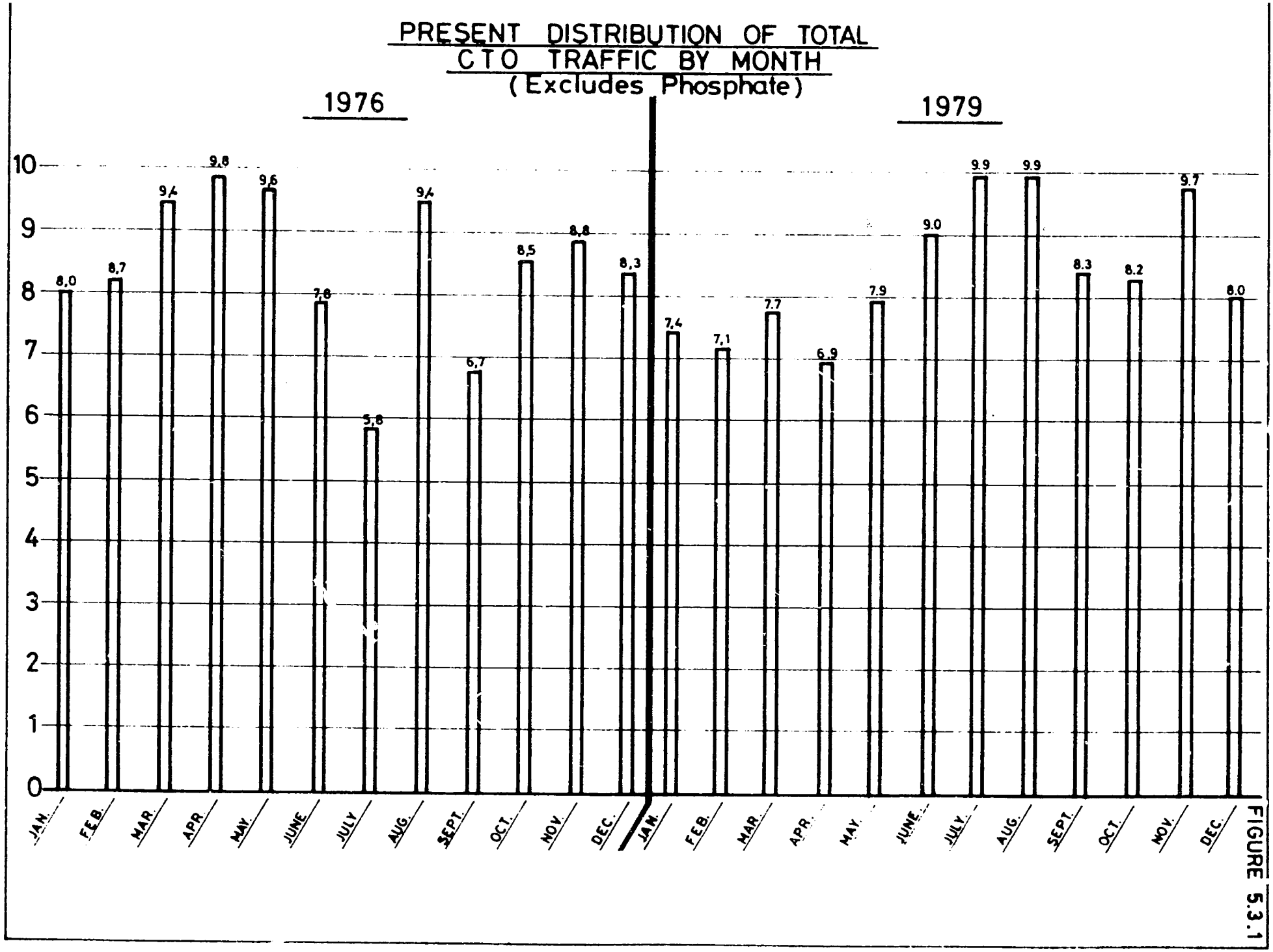

PRESENT DISTRIBUTION OF TOTAL
CTO TRAFFIC BY MONTH
(Excludes Phosphate)
1976
1979
10
9
8
7
6
5
4
3
2
1
0
8.0
8.7
9.4
9.8
9.6
7.8
5.8
9.4
6.7
8.5
8.8
8.3
7.4
7.1
7.7
6.9
7.9
9.0
9.9
9.9
8.3
8.2
9.7
8.0
JAN.
FEB.
MAR.
APR.
MAY.
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
APR.
MAY.
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.

FIGURE 5.3.1

Damascus is fourth lowest, with only 6.5 percent of the CTO cargo in 1979. The low number of pickups and the small volume they handled confirm the fact that they are used primarily for short distance hauls and that these do not go through the CTOs.

As noted earlier, the primary purpose of the CTO analyses was to adjust the Consultants' origin and destination survey data. Detailed tables developed for the purpose, including seasonal variation by commodity, commodity shipments by Mohafaza, and shipments by commodity by type of vehicle, are available in the Consultants' files.

5.4 OTHER SURVEYS

During the period 19 June through 11 July 1979 the Consultants carried out a truck axle load survey. The methodology and results of that survey were presented in Section 5.3 of Volume IV of the Final Phase I Report.

In summary, the Consultants concluded that the probable cause for the truck overloading is that the Government acts both as a regulatory agency (freight rates) and a forwarding agent (cargo transport offices).

The tariff structure, although recently revised, is still set at a very low level. The basis for the structure assumes that all vehicles are overloaded by 30 percent, that there is a 75 percent vehicle utilization rate, and that vehicle depreciation extends over 18 years.

The existing regulations encourage gross overloading, which excessively damages the road surface. Enforcement of the axle load limitations is unlikely to solve the problem because truckers would not be able to cover their real operating costs. This has been tried in many developing countries and generally does not solve the problem.

There are two possible alternatives to remedy the situation. The first alternative is to revise the existing tariff system not only by introducing a commodity classification system but also by revising tariffs to cover actual operating costs and allow a legitimate marginal profit - then enforce the axle limits. Under legal load enforcement, the number of overloads can be expected to be reduced. The second alternative is the gradual deregulation of the road transport industry to permit the truckers to set their own rates based on demand, supply, capability, efficiency, etc. This alternative assumes that overloading would continue to exist. Before it is selected, a careful analysis should be made of the economics of overloading. Data from elsewhere suggest that permitting overloading

and building roads to accommodate it may be economically the least cost solution. This would be especially attractive if overloading cannot be controlled, which is likely to be the case in Syria for some time to come.

The Consultants also carried out a shippers and truckers survey to obtain realistic data on many aspects of the road transport industry from users of this transport mode. The actual experience of users was used to verify or modify:

- theoretical vehicle operating costs,
- vehicle depreciation rates,
- tariffs paid by shippers,
- seasonality patterns,
- problem areas among shippers and operators,
- cost and consumption patterns (fuel, oil, etc.).

5.5 PROPOSED CONTINUOUS TRAFFIC-COUNTING PROGRAM

The proposed continuous traffic-counting program is designed to achieve the following objectives:

- to determine the Annual Average Daily Traffic (AADT) on the Syrian road network in order to provide a basis for determining the need and priority for maintenance and improvement according to existing and expected future traffic,

- to determine hourly, daily, and monthly traffic variations, and the design of hourly volume (DHV) for different types of roads in different areas, for planning and design purposes,

- to monitor, continuously, road usage levels to ensure that improvement programs are dynamically responsive to actual needs,

- to calibrate on a yearly basis the computerized traffic projection model developed by the Consultants,

- to determine the vehicle movement yearly growth factor.

Type of Counts

The proposed traffic-counting program employs both mechanical and manual counting methods. Traffic counts are to be taken at various pre-determined traffic counting stations, which are divided into six classes: permanent, major, minor, coverage A, coverage B, and short-count stations, depending on duration, interval, and type of counts, as shown below. The term control stations is used for permanent, major, and minor stations.

- Permanent Stations: Continuous counts by automatic, hourly, self-recording traffic-counters continuously throughout the year plus manual 48 consecutive hour counts initially once every three months. Following the first year's experience, data from these classification counts should be analyzed to ascertain the magnitude of seasonal variation in traffic composition. The results of such analysis may lead to a decision affecting the frequency of manual counts. Manual counts should be made at least once each year regardless of findings.

- Major Stations: One-week continuous counting by an automatic, hourly, self-recording traffic counter during each month throughout the year, plus manual 24-hour classification counts once a year and manual 12-hour classification counts every three months.

- Minor Stations: Forty-hour continuous counting on weekdays only, by an automatic, hourly, self-recording traffic counter once every three months, plus manual 12-hour classification counts once a year.

- Coverage A Stations: Two-day continuous counting by an automatic, hourly, self-recording traffic counter once a year on weekdays, plus manual six-hour classification counts once a year.

- Coverage B Stations: Two-day continuous counting by an automatic, hourly, self-recording traffic counter once a year.

- Short-Count Station: Six-hour manual classification counts once a year.

All manual classification counts are to be taken on an hourly basis. Eleven vehicle types are differentiated as follows:

passenger car	taxi	pickup truck
microbus	bus	2-axle truck
3-axle truck	combination truck	farm tractor
motorcycle	laden animal	

Location of Counting Stations

Locations of counting stations as recommended are shown on Plate 5.5.1 and in a tabular form on Table 5.5.1. Short-count station locations are not defined since they should be located as the program needs arise.

The following rules should be observed when the field location of a station is determined:

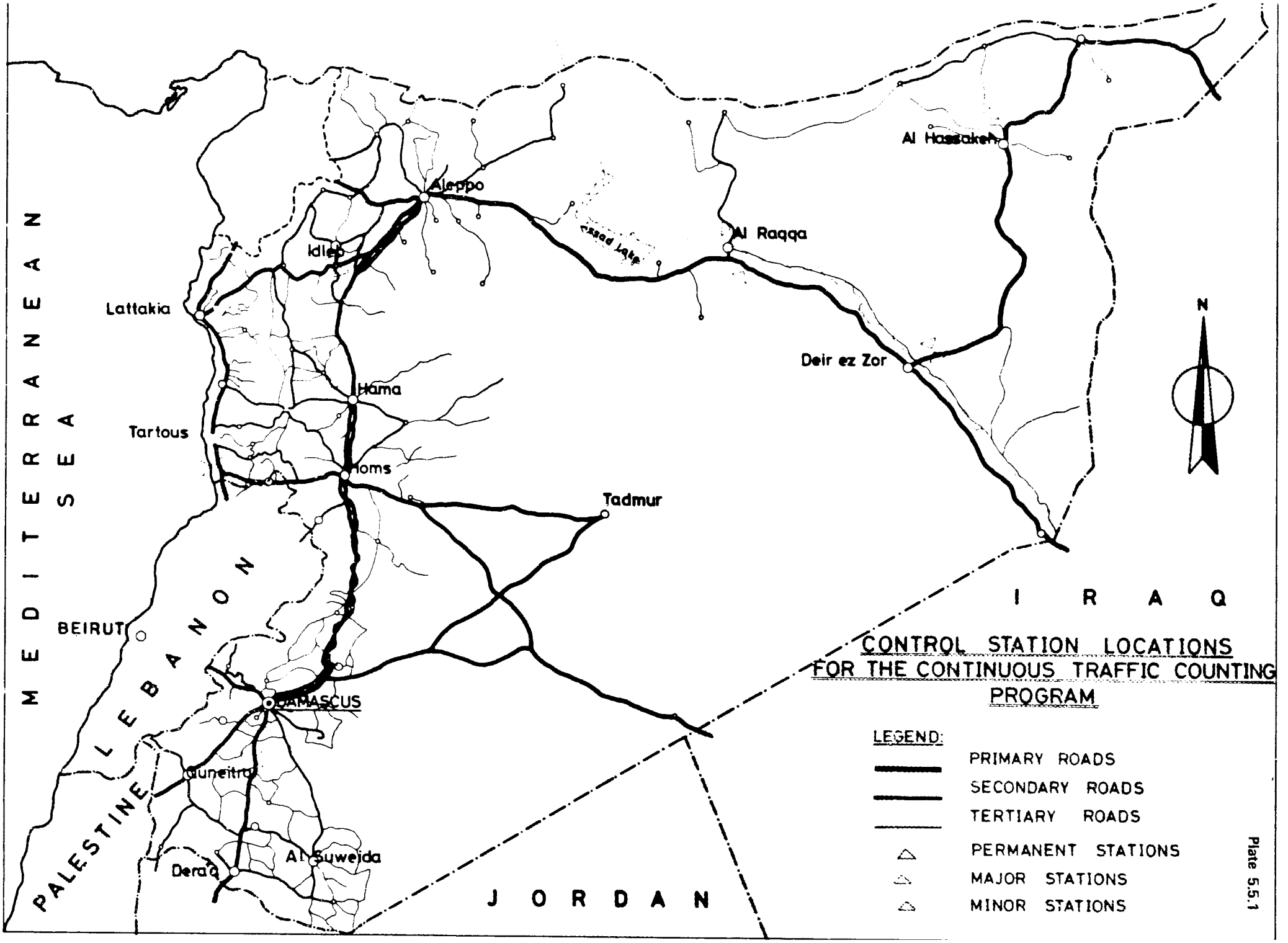

MEDITERRANEAN SEA
Lattakia
Tartous
Idleb
Aleppo
Hama
Homs
Tadmur
Al Raqqa
Al Hassakeh
Deir ez Zor
BEIRUT
LEBANON
DAMASCUS
Quneitra
PALESTINE
Dera'a
Al Suweida
JORDAN
IRAQ
N
CONTROL STATION LOCATIONS
FOR THE CONTINUOUS TRAFFIC COUNTING
PROGRAM
LEGEND:
PRIMARY ROADS
SECONDARY ROADS
TERTIARY ROADS
PERMANENT STATIONS
MAJOR STATIONS
MINOR STATIONS

Plate 5.5.1

- Each station should be located as close as it would be practically possible to the planned location.

- Count stations should be located at sufficient distance from a town or a major village so that the internal traffic within such population centers is not included in the counts.

- Automatic counters with pneumatic detectors should be located at stretches of roads where traffic is expected to move freely and where asphaltic surfaces are smooth.

- For control stations, the location of each station should be marked in the field by a small concrete post placed beside the road with a plate attached to it, displaying the Ministry's name and the station number.

Equipment

Counters

For the six permanent stations, a durable and reliable means of vehicle detection should be used, such as detectors utilized in traffic signal controls. There are many types of such detectors including magnetic, radar, ultrasonic, induction loop, and photoelectric cell devices. Because of the possibility of mechanical failure, one spare counter should be provided together with the necessary spare parts. A total of seven complete counters are therefore recommended to cover the permanent stations.

There are six major stations and 12 minor stations recommended in this program. Since minor stations will be counted for two-day periods at three-month intervals, and major stations for a one-week period each month, a total of four machines, including a spare counter, is recommended, together with the necessary spare parts.

There are approximately 52 coverage A and 65 coverage B stations recommended in this program. Since each of them will be counted for two days/year, three self-recording counters plus a spare set and the necessary spare parts are recommended.

Short counts are done manually using tally boards. A total of eight tally boards with 16 push button accumulators each are recommended to cover all manual classification counts.

Vehicles

Two pickup trucks should be assigned for full-time use in the counting program. One vehicle is to be used by the technicians assigned to handle the mechanical counters and the other to transport the manual counts crew.

Table 5.5.1

LOCATION AND IDENTIFICATION NUMBERS FOR COUNTING STATIONS

Location	Station Number	Type of Station	Mohafaza
Al Kisweh-Ghabagheb	101	Permanent	Dera'a
Quoteifeh Junction-Nabek	102	Permanent	Damascus
Tartous-Mintar	103	Permanent	Tartous
Hama-Mouhardeh	104	Permanent	Hama
Al Raqqa-Deir Ez Zor	105	Permanent	Al Raqqa
Deir Ez Zor-Al Hassakeh	106	Permanent	Deir Ez Zor
Ariha-Saraqueb	107	Permanent	Idleb
Sanamayn-Khabab	201	Major	Dera'a
Mhardeh-Mork	202	Major	Hama
Khan Sheikhoun-Mar'arat Al Nuo'man	203	Major	Idleb
Idleb-Atareb	204	Major	Idleb
Al Raqqa-Tal Abiad	205	Major	Al Raqqa
Al Hassakeh-Al Dirbassieh	206	Major	Al Hassakeh
Damascus-Barak	301	Minor	Damascus
Al Kisweh-Adelieh	302	Minor	Damascus
Damascus-Lebanese Border	303	Minor	Damascus
Adra Junction-Khan Abou Shamat	304	Minor	Damascus
Shinshar-Koussair	305	Minor	Homs
Homs-Fruqloss	306	Minor	Homs
Safita-Al Dabbousieh	307	Minor	Tartous
Banias-Missiaf	308	Minor	Tartous
Bab Al Hawa-Urm Sughra	309	Minor	Aleppo
Aleppo-I'sas	310	Minor	Aleppo
Aleppo-Al Raqqa	311	Minor	Aleppo
Al Kamishli-Tal Kojak	312	Minor	Al Hassakeh
Shahba-Al Suweida	401	Coverage A	Al Suweida
Ariha-Jisr Al Shughour	402	Coverage A	Al Suweida
Al Suweida-Rashidiah	501	Coverage B	Al Suweida
Sa had-Malah	502	Coverage B	Al Suweida
Al Suweida-Salkhad	503	Coverage B	Al Suweida
Al Suweida-Al Karia	504	Coverage B	Al Suweida
Dera'a-Bosra	403	Coverage A	Dera'a
Dera'a-Jordanian Border	404	Coverage A	Dera'a
Izra'-Sheikh Meskeen	405	Coverage A	Dera'a
Sheikh Meskeen-Nawa	406	Coverage A	Dera'a
Da'el-Al Hirak	505	Coverage B	Dera'a
Izra'-Dera'a	506	Coverage B	Dera'a
Sanamayn-Izra'	507	Coverage B	Dera'a
Habbub-Missmieh	508	Coverage B	Dera'a
Ghabagheb-Kafr Nasej	509	Coverage B	Dera'a

Table 5.5.1 (Continued)

LOCATION AND IDENTIFICATION NUMBERS FOR COUNTING STATIONS

Location	Station Number	Type of Station	Mohafaza
Jordanian Road-Gasem	510	Coverage B	Dera'a
Damascus-Barak	407	Coverage A	Damascus
Damascus-Sa'sa'	408	Coverage A	Damascus
Jordanian Road-Al Set	409	Coverage A	Damascus
Damascus-Adra Junction	410	Coverage A	Damascus
Douma-Quoteifeh	411	Coverage A	Damascus
Quoteifeh Junction-Damascus	412	Coverage A	Damascus
Jdaydeh-Al Tekieh	413	Coverage A	Damascus
Zabadani-Junction-Lebanese Border	414	Coverage A	Damascus
Al Tekieh-Zabadani	415	Coverage A	Damascus
Al Tal-Seydnaya	416	Coverage A	Damascus
Al Kisweh-Kanaker	511	Coverage B	Damascus
Al Kisweh-Quneitra Road	512	Coverage B	Damascus
Jordanian Road-Quneitra Road	513	Coverage B	Damascus
Damascus-Darayya	514	Coverage B	Damascus
Nashabieh-Uteibeh	515	Coverage B	Damascus
Zabadani-Serghaya	516	Coverage B	Damascus
Barzeh-Al Tal	517	Coverage B	Damascus
Al Tal-Hafir	518	Coverage B	Damascus
Ma'aloula-Yabroud	519	Coverage B	Damascus
Aleppo Road-Al Nassrieh	520	Coverage B	Damascus
Nabek-Quoteifeh Junction	521	Coverage B	Damascus
Nabek-Al Mshrfeh	522	Coverage B	Damascus
Al Bathm-Al Bassira	417	Coverage A	Homs
Al Bassira-Tanf Road	418	Coverage A	Homs
Tadmur-Al Bassira	419	Coverage A	Homs
Fuglos-Tadmur	420	Coverage A	Homs
Homs-Al Salamieh	421	Coverage A	Homs
Shin-Mashta Helou	422	Coverage A	Homs
Saba' Biar-Tanf	523	Coverage B	Homs
Hessieh-Sadad	524	Coverage B	Homs
Deir Atieh-Hessieh	525	Coverage B	Homs
Hessieh-Deir Atieh	526	Coverage B	Homs
Homs-Tal Kalakh	527	Coverage B	Homs
Before Tanf	528	Coverage B	Homs
Hama-Al Salamieh	423	Coverage A	Hama
Hama-Missiaf	424	Coverage A	Hama
Hama-Akrab	425	Coverage A	Hama
Akrab-Missiaf	426	Coverage A	Hama
Missiaf-Sheikh Badr	427	Coverage A	Hama

Table 5.5.1 (Continued)

LOCATION AND IDENTIFICATION NUMBERS FOR COUNTING STATIONS

Location	Station Number	Type of Station	Mohafaza
Suqailbieh-Jisr Al Shughour	428	Coverage A	Hama
Jisr Al Shughour-A'annab	429	Coverage A	Hama
Hama-Homs	529	Coverage B	Hama
Homs-Hama	530	Coverage B	Hama
Hama-Souran	531	Coverage B	Hama
Mhardeh-Tal	532	Coverage B	Hama
Salhab A'annab-Missiaf	533	Coverage B	Hama
Suqailbieh-Missiaf Road	534	Coverage B	Hama
Tartous-Safita	430	Coverage A	Tartous
Tartous-Dreikish	535	Coverage B	Tartous
Tartous-Banias	536	Coverage B	Tartous
Mintar-Arida	537	Coverage B	Tartous
Kassab-Lattakia	431	Coverage A	Lattakia
Lattakia-Jisr Al Shughour	432	Coverage A	Lattakia
Al Hiffeh-Salma	433	Coverage A	Lattakia
Banias-Djableh	538	Coverage B	Lattakia
Djableh-Lattakia	539	Coverage B	Lattakia
Sarraya-Kablia	540	Coverage B	Lattakia
Kansabbu-Slenfeh	541	Coverage B	Lattakia
Djableh-Ain Sharkieh	542	Coverage B	Lattakia
Ariha-Ma'arrat-Al Nuo'man	434	Coverage A	Idleb
Ariha-Jisr Al Shughour	435	Coverage A	Idleb
Idleb-Ariha	436	Coverage A	Idleb
Idleb-Saraqueb	437	Coverage A	Idleb
Idleb-Taftanaz	438	Coverage A	Idleb
Idleb-Salkin	439	Coverage A	Idleb
Idleb-Atareb	440	Coverage A	Idleb
Bab Al Hawa-Atareb	441	Coverage A	Idleb
Khan Sheikoun-Madik Castle	543	Coverage B	Idleb
Ariha-Saraqueb	544	Coverage B	Idleb
Taftanaz-Saraqueb	545	Coverage B	Idleb
Aleppo-Al Bab	442	Coverage A	Aleppo
Aleppo-Ifrin	443	Coverage A	Aleppo
Ifrin-Midan Ikbis	444	Coverage A	Aleppo
Aleppo-Saraqueb	546	Coverage B	Aleppo
Saraqueb-Aleppo	547	Coverage B	Aleppo
Aleppo-Tal Rif'at	548	Coverage B	Aleppo
Ifrin-Al Dana	549	Coverage B	Aleppo
Ifrin-Jandrin	550	Coverage B	Aleppo
Isas-Turkish Border	551	Coverage B	Aleppo
Al Bab-Al Ra'i	552	Coverage B	Aleppo

Table 5.5.1 (Continued)

LOCATION AND IDENTIFICATION NUMBERS FOR COUNTING STATION

Location	Station Number	Type of Station	Mohafaza
Manbedj-Garablus	553	Coverage B	Aleppo
Ain Issa-Al Zarzouri	445	Coverage A	Al Raqqa
Tal Abiad-Ras Al Ain	446	Coverage A	Al Raqqa
Al Raqqa-Al Kassra	447	Coverage A	Al Raqqa
Deir Hafer-Al Tabkah	554	Coverage B	Al Raqqa
Al Tabkah-Al Raqqa	555	Coverage B	Al Raqqa
Al Mshrfeh-Tal Abiad	556	Coverage B	Al Raqqa
Albu Kamal-Iraqi Border	448	Coverage A	Deir Ez Zor
Al Bassira-Al Hreyji	449	Coverage A	Deir Ez Zor
Al Bassira-Albu Kamal	450	Coverage A	Deir Ez Zor
Al Raqqa-Deir Ez Zor	557	Coverage B	Deir Ez Zor
Deir Ez Zor-Maydin	558	Coverage B	Deir Ez Zor
Maydin-Albu Kamal	559	Coverage B	Deir Ez Zor
Al Karia-Al Boura	560	Coverage B	Deir Ez Zor
Bab Al Hadid-Ya'roubia	451	Coverage A	Al Hassakeh
Al Kamishli-Ras Al Ain	452	Coverage A	Al Hassakeh
Al Hassakeh-Al Kamishli	561	Coverage B	Al Hassakeh
Al Kamishli-Tal Khamiss	562	Coverage B	Al Hassakeh
Al Hassakeh-Ras Al Ain	563	Coverage B	Al Hassakeh
Al Hassakeh-Tal Shamran	564	Coverage B	Al Hassakeh
Bab Al Hadid-Al Malkieh	565	Coverage B	Al Hassakeh

Manpower

The following staff should be assigned to the program on a full-time basis.

- a technician to handle, check, and relocate the mechanical counting equipment,
- an assistant to work with the technician,
- two employees assigned for the manual counting program.

Recording Forms

Samples of the forms for use in the automatic counts and classification counts and the summary forms for the classification and automatic counts for each type of station were included in Section 5.2 of Chapter 5, Volume IV of the Final Phase I Report. Copies of these forms, the related computer coding forms, and the basic data and computer printouts of the Consultants' one-year traffic counting program have been provided to the Ministry of Communications. The disc file of traffic count data was also included in the computer files turned over to the Ministry of Transport.

Coding and Updating of ADT's

The monthly Average Daily Traffic should be calculated either manually or by using auxiliary computer programs and then entered into the traffic data main file. The programs should calculate the AADT in number of vehicles and passenger car equivalent units by adjusting the ADT using the monthly variation factors and inserting the results in the defined columns cancelling the previous figures. All other links with the same updated station number should be updated accordingly. Any changes in the composition of traffic should be updated in a similar manner as above.

From control stations, the hourly, daily, and monthly variation factors can be studied and defined, for each type of road and for different areas in Syria. All other stations should be grouped with similar control stations and the corresponding factors should be used.

From the continuous traffic counting program, yearly growth factors and changes in traffic movement patterns can be observed, analyzed, established, and then calibrated as actual data become available.

The results of the traffic counting program should be used in connection with the Syrian Transport Analysis System (SYRTRANS) to define the need and priority of maintenance and road improvement.

Annual Publication of Traffic Data

In order to ensure various users easy access to update information on road traffic, the Ministry of Communications should prepare and issue an annual statistical publication covering the following information:

- A map showing the location, class, and identification number of all count stations with the AADT for each station.

- A graphic representation of AADT on the main Syrian road network for the year.

- A table showing station number, location, AADT, and composition of traffic.

- A table that shows for each count station the actual AADT and the AADT during the previous years. The same should be shown for the composition of traffic.

- The hourly, daily, and monthly variation factors developed from the central stations for different areas and types of roads.

- The average composition of traffic for different areas and types of roads.

- The estimated design hourly volume expressed as a percentage of daily traffic for different areas and types of roads.

- The actual growth factor of traffic for different areas and types of roads in Syria.

This report should be widely distributed, including to all Mohafaza Directorates of Communication. Following the first publication, a survey of users should be made to ensure that the data are of the type and format suited to the user's needs.

CHAPTER 6

VEHICLE OPERATING COSTS (VOC)

Chapter 6

VEHICLE OPERATING COSTS (VOC)

Introduction

Several steps were involved in developing highway user costs for Syria.

First, a set of base vehicle operating costs was developed for flat, paved, tangent roads under unrestricted traffic conditions. These costs were developed for different vehicle types to cover the range of vehicles in common use in Syria. Second, a set of factor cost values was employed to represent the additional costs of vehicle operations on roads where conditions are less than optimal. The effect of these less-than-optimal conditions on average operating speeds was also determined.

User costs were developed from Syrian data and then translated, using the Delta L method, into measures reflecting the costs of operating typical vehicles over local pavement types, various terrain conditions, and geometric design characteristics. A proposed road improvement may also result in substantial time savings to passengers and goods. This item was treated separately.

This chapter describes the various elements of this process and presents the summary results. Supporting details can be found in the following appendices to Volume IV of the Final Phase I Report:

The detailed elements used to develop base vehicle operating costs were presented in Appendix 6.1. of the Final Phase I Report.

The actual 1979 user costs were compared with the current commercial freight tariffs (per ton-kilometer) and charges for various passenger vehicles (per passenger-kilometer). The results were presented in Appendix 6.2.

The inputs into the development of highway user costs were presented in Appendix 6.3. This can be used as a guide in future updating of vehicle operating costs.

Appendix 6 4 presented the value of passenger time. Appendices 6.5 and 6.6 presented the development of the Speed Model and Travel Time Model.

Although several vehicle operating cost studies have been prepared in the past in Syria, it is not possible to make direct comparisons with the Consultants' results for the following reasons:

- different types of vehicles and broad vehicle group categories were analyzed by the other consultants,

- vehicle prices and vital cost components have changed,

- approaches, assumptions, and certain analytical methods used in other studies are different.

The Consultants' O & D surveys were used to derive weighted averages of vehicle types within the same vehicle group category whenever it was necessary.

Methodology

The methodology employed in developing vehicle operating costs under different road conditions embodies a step-by-step procedure. This facilitates subsequent adjustments when key assumptions are changed in light of new developments or when more or better data become available. The steps in the procedure are described below:

Selection of Road Surfaces for Analysis

Four distinct types of road surfaces were examined: asphalt concrete (AC), bitumen (B), gravel (G), and earth (E). For roads or highways which cannot be categorized in these distinct groupings, some combination of the groupings was used; as an example, a road may be considered engineered gravel for one-third of its length and existing track for the remainder.

Typical Reference Vehicles

At this stage in the growth of the vehicle fleet in Syria, the operating cost characteristics can be analyzed suitably. As was the case with road surfaces, changes in the percentage composition of the vehicle stream can be used to simulate different traffic characteristics in different parts of Syria.

Vehicle Operating Parameters

The vehicle operating parameters define the annual operating characteristics and other basic factors about typical reference vehicles. These parameters include such items as vehicle life (in economic life and kilometers of travel), average annual travel speed, and hours of operation. In a sense, the parameters set the basic hypotheses for assumed or estimated vehicle operation.

Basic Operating Cost Elements

The term cost element as used here means the current Syrian price of items such as gasoline, motor oil, and tires, which in aggregate determine the cost of operating a motor vehicle. Some of the elements, such as the one cited above, are distance related, since they relate to vehicle-kilometers of travel. Other cost elements, such as insurance, are time-related in that they represent annual charges which are only indirectly, if at all, based on actual vehicle travel.

Cost/Speed Relationships

Most operating costs vary in some proportion with the vehicle travel speed. Standard relationships can be applied to the basic cost elements to calculate, as an example, gasoline consumption at different levels of speed. The three most useful reference sources for this purpose are "Quantification of Road User Savings," Jan DeWeille, World Bank Staff Occasional Paper Number Two, 1966, and "Economic Analysis for Highways," Robley Winfrey, 1969, and "Research Study on Vehicle Speeds and DL Factors," Wehner. As appropriate, these sources will be referenced as "DeWeille," "Winfrey," and "Wehner," respectively. The Consultants attempted to use the TRRL (Transport and Road Research Laboratory) study performed in East Africa. However, it was determined that the approach and methodology used by TRRL could not be applied in Syria because of different climatic conditions (i.e., moisture content), as well as inadequate historical data.

Summation of Results

After each cost element has been computed for a level, tangent road at different speeds, the results can be summarized to provide total operating costs for the reference vehicle analyzed. Costs will be expressed in terms of financial and economic costs. Briefly, financial costs include applicable taxes and are the total cost a vehicle operator pays to operate his vehicle; economic costs exclude taxes or other transfer items and represent the real cost to the economy of vehicle operation.

6.1 SELECTION OF ROAD SURFACES FOR ANALYSIS

Vehicle operating costs at different speed levels will be developed for level, tangent paved roads. The geometric design standards are not of immediate concern in developing which represent costs on level, paved, tangent roads; the design standards used will be discussed fully. The road surfaces to be considered are the following:

- asphalt concrete (AC),
- bituminous surface treatment (B),
- gravel (G),
- earth (E).

Asphalt Concrete (AC)

Mixed bituminous or bituminous penetration road on a rigid or flexible base with combined thickness higher than 2.5 centimeters.

Bituminous Surface Treatment (B)

Bituminous surface course (less than 2.5 centimeters thick) on a base suitable to carry occasional heavy axle loads.

Gravel (G)

A graded and drained road with surface of gravel, crushed stone, etc. Surface may be stabilized.

Earth (E)

Earth road that has been graded into defined roadway and has adequate drainage to prevent serious damage by normal surface water.

6.2 TYPICAL REFERENCE VEHICLES

Description of Typical Reference Vehicles

It is a normal procedure for the representative vehicles for each vehicle category to be established by using weighted averages from the vehicle registration data. Also, vehicle operating cost items will have to be weighted by the respective percentages of each vehicle type in the total registrations.

Unfortunately, the 1971 through 1979 registration data are not disaggregated in detail. Government published statistical data do not distinguish the proportions of the various vehicle categories, such as 3- versus 2-axle trucks, number of pickup trucks, actual horsepower, displacement, vehicle age, etc. Therefore, in choosing typical reference vehicles, the Consultants also obtained information from:

- companies engaged in vehicle sales,
- companies distributing fuel and lubricants,
- goods haulage firms,
- insurance companies,
- spare parts and tires distributors,

- vehicle mantenance and repair workshops,
- previous studies performed by other consultants,
- various automobile sales publications,
- the Consultants' Fleet Operator Survey,
- bus, taxi, and trucking cooperatives.

Many types of vehicles are in circulation in Syria. The motor vehicle fleet has a wide composition, including in each category vehicles made in different European countries (Italy, Germany, France, Sweden, U.K., Soviet Union, etc.), in the U.S., and in Japan. Obviously, we cannot consider more than one type of vehicle for each category. In feasibility and transport studies the analysis of vehicle operating costs of one representative vehicle for each vehicle category is sufficient to obtain significant results.

Although the typical reference vehicles have specific characteristics, they also represent in the overall sense the entire vehicle fleet; therefore, some averaging is required. Rigid adherence to too strict limitations will tend to make the selected reference vehicle unrepresentative of the total segment of the vehicle fleet that it is supposed to typify.

Table 6.1 presents in detail the characteristics and specifications of the selected representative vehicles for this analysis. Because more than 60 percent of all taxis are six cylinder, the six-cylinder passenger car was used to represent taxis in this analysis.

It should also be noted that throughout this study the term "microbus" is used. This is not a van-type vehicle, but a small bus having a seating capacity of 18 to 22 passengers. The 2-axle, single unit tractor truck with a 1-axle trailer is in the same vehicle category as a 3-axle truck, with about a 12 percent higher operating cost. For petroleum transport, the 4-axle articulated tanker semi-trailer is most commonly used for long-distance traffic. The 3-axle semi-trailer tankers are mostly utilized within urban centers and are thus considered atypical.

6.3 VEHICLE OPERATING PARAMETERS

Vehicle operating parameters establish the basic structure of vehicle life and usage and are used to determine depreciation charges and the savings in fixed costs attributable to higher travel speeds over an improved highway network. It should be stated at the outset that estimating many, if not most, of the parameters must be judgmental because precise or even approximate data are lacking. To be discussed in this section are:

- estimated vehicle life and annual travel,
- average operating and travel speeds,
- summary of operating parameters.

In establishing the above vehicle operating parameters, the Consultants obtained information from:

- companies engaged in vehicle sales,
- previous studies performed in Syria,
- the Consultants' Fleet Operators Survey,
- goods haulage firms,
- vehicle maintenance and repair shops.

Estimated Vehicle Life and Annual Travel

As a starting point in the analysis, it is useful to review the operating parameters estimated by DeWeille. The source of the estimates in Table 6.2 is Deweille's Annex Table 15.

Because of the rapid growth of the motor vehicle fleet, it is not possible to derive reliable data on average life. Limited accident statistics (because not all accidents are reported) suggest the possibility of high vehicle accident losses.

Based principally on judgment and results from previous studies performed in Syria, the figures presented in Table 6.3 are adopted. Because of their heavy-duty characteristics, the light and heavy trucks, pickup, and bus can be expected to give longer service than that assumed by DeWeille - especially in Syria, where there are import restrictions on new vehicles and annual kilometers travelled vary substantially from DeWeille's assumption.

Data for vehicle life on non-asphalt surfaces are even more difficult to deduce. Calculations on DeWeille's depreciation tables (Tables 6a and 6b) for the different road surfaces permit estimation of the following reductions in vehicle life because of road surface type, as shown in Table 6.4. The same annual kilometers of travel per vehicle are assumed irrespective of road surface.

Average Operating and Travel Speeds

Two sets of speed criteria have been estimated to describe the operating characteristics of the reference vehicles. The first of these, based both on direct observations and the estimates, can be described as highway operating speed; it is intended to represent the sustainable average vehicle speed in travel over the road surface and is presented in Table 6.5.

Table 6.1

SPECIFICATIONS OF REFERENCED VEHICLES

Vehicle Category	Fuel Type	No. of Axles/ Wheels	Empty Vehicle (kgs)	Maximum Payload (kgs)	Total Weight (kgs)	HP (SAE)[1]	Displ. (cc)[2]	No. of Cylinders	Tire Size	Oil Capacity (kgs)
Passenger Car										
4 Cylinder	G	2/4	1,065	385	1,450	60	1,698	4	1.75x14	3.5
6 Cylinder	G	2/4	840	380	1,220	78	1,998	6	1.75x14	4.7
8 Cylinder	G	2/4	1,179	460	1,639	195	4,218	8	1.85x14	4.7
Pickup	G	2/4	1,115	1,220	2,335	90	1,587	4	1.85x14	3.9
2-Axle Truck	D	2/6	6,385	12,615	19,000	256	12,760	8	12.00x20	17.0
3-Axle Truck	D	3/10	8,270	17,730	26,000	320	15,950	10	12.00x24	20.8
4-Axle Tractor Semitrailer	D	2/6	6,440	-	38,000	320	15,950	10	12.00x24	20.8
Semitrailer	-	2/8	5,900	25,660	-	-	-	-	12.00x20	-
5-Axle Tractor/ Semitrailer	D	3/10	9,100	-	38,000	320	15,950	10	12.00x24	20.8
Semitrailer	-	2/8	5,900	23,000	-	-	-	-	12.00x20	-
5 Axle Truck and Full Trailer	D	2/6	6,385	12,615	19,000	256	12,760	8	12.00x24	17.0
Full Trailer	-	3/12	5,600	13,400	19,000	-	-	-	12.00x20	-
Regular Bus	D	2/6	9,370	6,630	16,000	210	8,720	6	11.00x20	16.0
Microbus	D	2/6	2,365	1,675	4,040	96	4,561	4	10.00x20	6.8

Source: Manufacturers' specifications.

Notes: HP = Horsepower. SAE = Society of Automotive Engineers.

[1] While the foregoing are definite specifications, there are not only many engine options but also tire sizes for most vehicles.

[2] Cubic displacement.

Table 6. 2

DATA ON VEHICLE UTILIZATION AND LIFETIME

Vehicle Type	Annual Kms	Years of Service	Lifetime Kms
Passenger Car	15,300	14	214,000
Pickup (I)	14,500	12	174,000
2 Axle, 6 Tire (II)	22,500	11	248,000
4 Axle Combination (III)	96,500	7	676,000
5 Axle Combination (IV)	112,600	7	788,000

Source: De Weille, Annex Table 15.

Table 6.3

VEHICLE UTILIZATION AND ECONOMIC LIFETIME

Vehicle Type	Annual Kms (000)	Economic Vehicle Life (Years)	Lifetime Kms (000)
Private Passenger Car	14	14	196
Taxi	96	10	960
Pickup	28	10	280
Bus	50	16	800
Microbus	65	14	910
2 Axle Truck	50	16	800
3 Axle Truck	60	14	840
Tractor Truck	65	14	910
Trailers	65	14	910

Source: Consultants' estimates for Syria derived from DeWeille.

Table 6.4

REDUCTION IN VEHICLE LIFE FOR ROAD SURFACES (GENERAL)

Vehicle Type	Road Surfaces		
	Bitumen	Gravel	Earth
	(% Reduction in Vehicle Life)		
Passenger Car	10	15	30
Taxi	10	15	30
Pickup	15	20	40
2 Axle Truck	20	25	50
3 Axle Truck	20	25	50
Bus	20	25	50
Microbus	20	25	50
Tractors-Semitrailers	20	25	50
Truck and Full Trailer	20	25	50

Source: Consultants' estimates for Syria derived from DeWeille.

Table 6.5

ESTIMATED HIGHWAY OPERATING SPEEDS FOR DIFFERENT ROAD SURFACES

Vehicle Type	Road Surface			
	Asphalt[1]	Bitumen (kms/hr)	Gravel	Earth
Passenger Car & Taxi	90	80	68	40
Pickup	90	80	68	40
Bus	60	54	50	25
Microbus	70	62	55	30
2 Axle Truck	70	64	55	30
3 Axle Truck	70	64	55	30
Heavy Truck	50	45	36	20

Source: Consultants' estimates.

[1] Based on a 2 lane width, >7 meters road.

The second set of speed criteria are the overall travel sp eds shown in Table 6.6. These speeds reflect stop and go characteristics of traffic under actual road conditions. The asphalt, bitumen, and gravel roads (the asphalt particularly because of city and arterial driving) show a significant spread between the two speed criteria. For the earth surface, the speed criteria are the same.

Summary of Operating Parameters

Table 6.7 summarizes the operating parameters discussed in this section; two derived parameters, vehicle life in years (economic for Syria) and vehicle usage in hours/day, are also shown. The vehicle usage daily hours apply to the vehicle in motion; a truck, for example, may be in use while loading and unloading but not actually travelling. In the absence of reliable data on these parameters, every effort has been made to make them mutually consistent as well as to reflect the logical effects of road surfaces.

6.4 BASIC OPERATING COST ELEMENTS

Vehicle Operating Costs

Vehicle operating costs are composed of two components: running and fixed costs. The running costs are directly related to the use of the vehicle, and the fixed costs, which are related to vehicle ownership and time, are incurred independently of the amount of use of the vehicle.

Running Costs

- motor fuel,
- engine oil,
- tires and tubes,
- vehicle maintenance.

Fixed Costs

- insurance,
- depreciation,
- interest,
- vehicle road taxes,
- drivers' wages and benefits,
- municipality transport office fees.

Depreciation is treated on a fixed cost in order to be consistent with the manner in which vehicle costs for other modes are treated in this study (such as railroad rolling stock, aircraft, ships, etc.), namely as investment costs.

Table 6.6

ESTIMATED OVERALL TRAVEL SPEEDS FOR DIFFERENT ROAD SURFACES

Vehicle Type	Road Surface			
	Asphalt	Bitumen (kms/hr)	Gravel	Earth
Passenger Car & Taxi	56	48	46	30
Pickup	56	48	46	30
Bus	40	36	30	25
Microbus	40	38	35	30
2 Axle Truck	40	38	35	25
3 Axle Truck	40	38	35	25
Heavy Truck	32	25	22	20

Source: Consultants' estimates.

Note: The running speeds when traffic volumes reach capacity are all equal and depend on road design and terrain type, since the vehicles cannot overtake one another.

Table 6.7

SUMMARY OF VEHICLE OPERATING PARAMETERS

Type of Vehicle	Annual Travel (000) Kms	Road Surface: Asphalt	Bitumen	Gravel	Earth
		Vehicle Life-Kilometers (000)			
Passenger Car	14	196	176.4	166.6	137.2
Taxi	96	960	864.0	816.0	672.0
Pickup	28	280	238.0	224.0	168.0
Bus	50	800	640.0	600.0	400.0
Microbus	65	910	819.0	773.5	637.0
2 Axle Truck	50	800	720.0	680.0	560.0
3 Axle Truck	60	840	672.0	630.0	420.0
Tractor/Semi-trailer (2+2)	65	910	728.0	682.5	455.0
Tractor/Semi-trailer (3+2)	65	910	728.0	682.5	455.0
Tractor Truck & Trailer (2+3)	65	910	728.0	682.5	455.0
		Vehicle Life-Years			
Passenger Car	14	14	12.6	11.9	9.8
Taxi	96	10	9.0	8.5	7.0
Pickup	28	10	8.5	8.0	6.0
Bus	50	16	12.8	12.0	8.0
Microbus	65	14	12.6	11.9	9.8
2 Axle Truck	50	16	14.4	13.6	11.2
3 Axle Truck	60	14	11.2	10.5	7.0
Tractor/Semi-trailer (2+2)	65	14	11.2	10.5	7.0
Tractor/Semi-trailer (3+2)	65	14	11.2	10.5	7.0
Tractor Truck & Trailer (2+3)	65	14	11.2	10.5	7.0
		Operating Speeds-Kph			
Passenger Car	14	90	80	68	40
Taxi	96	90	80	68	40
Pickup	28	90	80	68	40
Bus	50	60	55	50	25
Microbus	65	70	64	55	30
2 Axle Truck	50	70	64	55	30
3 Axle Truck	60	70	64	55	30
Tractor/Semi-trailer (2+2)	65	50	45	36	20

Table 6.7 (Continued)

SUMMARY OF VEHICLE OPERATING PARAMETERS

Type of Vehicle	Annual Travel (000) Kms	Road Surface: Asphalt	Bitumen	Gravel	Earth
		Operating Speeds-Kph (Continued)			
Tractor/Semi-trailer (3+2)	65	50	45	36	20
Tractor Truck & Trailer (2+3)	65	50	45	36	20
		Overall Travel Speeds-Kph			
Passenger Car	14	56	48	46	30
Taxi	96	56	48	46	30
Pickup	28	56	48	46	30
Bus	50	40	36	30	25
Microbus	65	40	38	35	30
2 Axle Truck	50	40	38	35	25
3 Axle Truck	60	40	38	35	25
Tractor/Semi-trailer (2+2)	65	32	25	22	20
Tractor/Semi-trailer (3+2)	65	32	25	22	20
Tractor Truck & Trailer (2+3)	65	32	25	22	20
		Vehicle Usage-Hours/Day[1]			
Passenger Car	14	0.86	1.00	1.04	1.60
Taxi	96	5.87	6.85	7.15	10.96
Pickup	28	1.71	2.00	2.08	3.20
Bus	50	4.28	4.76	5.71	6.85
Microbus	65	5.57	5.86	6.36	7.42
2 Axle Truck	50	4.28	4.51	4.89	6.85
3 Axle Truck	60	5.14	5.41	5.87	8.22
Tractor/Semi-trailer (2+2)	65	6.96	8.90	10.12	11.13
Tractor/Semi-trailer (3+2)	65	6.96	8.90	10.12	11.13
Tractor Truck & Trailer (2+3)	65	6.96	8.90	10.12	11.13

Sources: Tables 6.3,6,4, 6.5, and 6.6.

[1] Calculation based on overall travel speed and 292 working days/year

Administrative overhead cost and profit components are not included in this study. Commerical operators, being mainly owner/drivers, have very few overhead costs (no garages are used for example), and profits are included in the driver's salary component. The Consultants' O & D surveys indicated that only 5 percent of the total commercial vehicles (excluding pickups) belonged to the Government and approximately 90 percent of the commerical fleet is registered as public common carriers. Common carrier vehicles are owned by private individuals and are subject to Government regulation in respect to licensing and freight rates. In any case, overhead and profit components cannot be estimated since they vary widely according to the period of the year, to the type of vehicle operator, to the location, and many other factors. Further, no records are kept for administrative overhead and profit parameters - excluding the few organized firms, which represent less than 5 percent of the total commercial vehicle fleet. Appendix 6.1 of the Final Phase I Report contains details of the development of the basic operating cost elements.

6.5 COST/SPEED RELATIONSHIPS

In Phase I the cost/speed relationships in 1979 prices were developed for the previously itemized operating parameters. To the greatest extent possible, actual data collected as well as knowledgeable opinions obtained during personal interviews were used. Necessary assumptions, as noted, were used to complete the estimates. The estimates and the methodology used to devise them are presented in the fiist part of this section. These costs were subsequently updated to May 1980 prices. These revised costs, which are presented at the end of this section, were used to develop the investment plans recommended in this report.

Motor Fuel

Gasoline Fuel

For passenger cars and pickup light trucks, no systematic data for Syria are available for flat, paved, tangent operations at constant speeds. The Consultants' Fleet Operator Survey produced limited information on kilometerage travelled per liter of fuel. The only available data are the manufacturers' test data. These cannot be used because the tests were performed outside Syria. Previous studies of this nature in Syria quoted (and adjusted) consumption figures from other sources, such as DeWeille or Winfrey.

Under these circumstances, the Consultants used primarily DeWeille and Winfrey relationships as well as data from other

countries with similar geographic and driving characteristics. From DeWeille, fuel consumption data are available for flat, paved, tangent conditions at constant speed for the average European and American car. A linear relationship was assumed between displacement and fuel consumption for light cars with different displacements. Thus, fuel consumption at a constant speed of 80 kilometers per hour was plotted for DeWeille's light vehicles, and using the assumption of linearity stated above and DeWeille's conversion factors for differences in gasoline fuel consumption at different constant speeds, these conversion factors were applied to the considered vehicles. The pickup light truck gasoline consumption is based on the DeWeille Truck I increased by approximately 0.05 percent to reflect the greater engine displacement of the light pickup compared with the DeWeille vehicle.

For the purposes of calculating base vehicle operating costs for flat, paved, tangent roads with unrestricted traffic, the following "benchmark speeds" were utilized:

- passenger car, taxi, and pickup: 80 kilometers per hour
- buses and trucks: 72 kilometers per hour

The gasoline consumption rates adopted are shown in Table 6.8. The fuel consumption factors at constant speeds on flat, paved, tangent roads are presented in Table 6.9.

Diesel Fuel

The fuel cost per kilometer, obtained by dividing the price per liter by the estimated kilometers per liter approximate to the vehicle, is a major item of running cost, generally comprising between 25 and 30 percent of the total.

Major factors determining fuel consumption are the weight, type and class of vehicle, and its age and condition. Thus a 19-ton truck/trailer may use up to 100 percent more fuel than a vehicle one-third its size, and when the truck is overloaded, the fuel consumption will automatically rise. Again, heavier bodies and nonstandard vehicles can change the fuel consumption figures. Interviews with operators in Syria also indicate increases in fuel consumption of as much as one-third as vehicles get older, depending on how well they are maintained.

The Fleet Operator Survey carried out by the Consultants resulted in wide-ranging estimates of kilometerage travelled per liter of fuel. Again, no systematic data for Syria are available for flat, paved, tangent operation at constant speed. Two international sources were utilized as the basis for fuel consumption estimates for trucks. From DeWeille, fuel consumption

Table 6.8

GASOLINE AND DIESEL CONSUMPTION OF REFERENCE VEHICLES ON LEVEL, TANGENT, PAVED ROADS

Vehicle Type and Category	Fuel Type	Speed (kph)	Fuel Consumption in Liters Per 1,000 Kms
Private Pass. Car 4 Cyl. 1698CC	G	80	68.3
" 6 Cyl. 1998CC	G	80	91.7
" 8 Cyl. 4218CC	G	80	116.7
Pickup 4 Cyl. 1587CC	G	80	149.0
Bus 6 Cyl. 8720CC	D	72	289.7
Microbus 4 Cyl. 4561CC	D	72	204.1
2 Axle Truck 8 Cyl. 12760CC	D	72	232.9
3 Axle Truck 10 Cyl. 15950CC	D	72	268.4
4 Axle Tractor 10 Cyl. Semi-trailer 1590CC	D	72	324.0
5 Axle Tractor 10 Cyl. Semi-trailer 15950CC	D	72	302.0
5 Axle Tractor 8 Cyl. Truck+Trailer 12760CC	D	72	326.0

Source: Gasoline-powered vehicles - interpolated from DeWeille; low speed consumption from Winfrey.

Table 6.9

FUEL CONSUMPTION FACTORS AT CONSTANT SPEEDS ON FLAT PAVED TANGENT ROADS

Speed (kph)[1]	Passenger Car	Taxi	Pickup Truck	Diesel Truck and Bus
32	.95	.95	.81	1.08
40	.87	.87	.77	.96
48	.84	.84	.77	.90
56	.85	.85	.79	.90
64	.89	.89	.83	.93
72	.91	.93	.90	1.00[1]
80	1.00[1]	1.00[1]	1.00[1]	1.11
88	1.11	1.07	1.14	1.29
96	1.20	1.14	1.33	1.44
104	1.36	1.24	1.63	-
112	1.60	1.40	2.01	-

Source: Consultants' estimates derived from DeWeille.

[1] Benchmark speeds.

data are available for flat, paved, tangent operation at constant speed for an 18-ton capacity diesel truck. From Wehner, similar data are available for a 3.5-ton capacity diesel truck. Fuel consumption at a constant speed of 72 kilometers per hour was plotted for these two trucks, and according to Wehner's research, a linear relationship was assumed between capacity and fuel consumption for trucks with different capacities. (Wehner's research has shown that for diesel trucks, fuel consumption has an approximate linear correlation with gross weight.) With tare weight and gross weight closely correlated, fuel consumption can be assumed to have the same correlation with carrying capacity.

Using the assumption of linearity stated above and DeWeille's conversion factors of differences in diesel fuel consumption at different constant speeds, these conversion factors were applied to all diesel trucks.

The diesel consumption rates adopted are shown in Table 6.8 and the diesel consumption factors at constant speeds on flat, tangent roads are indicated in Table 6.9.

Engine Oil

Engine oil, as already noted, is one of the least significant costs of vehicle operation. For estimating purposes, the most straightforward assumption is that the oil in each vehicle type, when operated on asphalt and non-asphalt surfaces, irrespective of speed, will be changed as indicated below.

Vehicle Type	Surface Type	
	Paved	Non-Paved
	Kilometers	Kilometers
4-cylinder	2,000	1,200
6-cylinder	2,000	1,200
8-cylinder	2,500	1,500
Pickup	2,500	1,500
Bus	4,500	2,500
Microbus	3,500	2,000
2-axle truck	4,500	2,500
3-axle truck	5,000	3,000
4-axle truck semitrailer	5,000	3,000
5-axle truck semitrailer	5,000	3,000
5-axle truck + trailer	4,500	2,500

The economic and financial cost of an engine oil change for the reference vehicles is (in Syrian pounds):

	Economic	Financial
4-cyl. pass. car	16.16	22.05
6-cyl. pass car	21.62	29.61
8-cyl. pass. car	21.62	29 61
Pickup	17.94	24.57
Bus	68.96	87.20
Microbus	31.28	42.84
2-axle truck	73.27	92.65
3-axle truck	89.65	113.36
4-axle truck semitrailer	89.65	113.36
5-axle truck semitrailer	89.65	113.36
5-axle truck + trailer	73.27	92.65

Engine oil consumption costs in piasters per kilometer for the analyzed vehicles are shown in the Summary tables, and consumption costs in piasters per kilometer are tabulated in Table 6.10.

Tires and Tubes

Tire costs are another of the more evident out-of-pocket costs for highway vehicle users, and there are, therefore, relatively good statistics on the cost of tire use. The normal way of reporting tire use is the number of kilometers that a typical tire can endure under normal operating conditions. Average tire life is, of course, significantly less than tire life would be under ideal conditions, since a major part of tire wear comes from slowing down and stopping or turning corners.

With respect to tire consumption, since no basic controlled research data were available in Syria, the values derived by DeWeille, as presented in Table 6.11, were considered for the base vehicle operating costs.

The Consultants' Fleet Operator Survey produced a wide variety of data as far as tire consumption is concerned. Unfortunately, no use of these collected data could be made because the large majority of the domestic truckers overload their vehicles; thus, the reported tire consumption figures are distorted. It was also found that recapping is not a common practice among the truckers. Therefore, as mentioned above, under these circumstances, the DeWeille values were considered for this analysis. The truck values were then interpolated for the range of heavy vehicles under consideration. Table 6.11 gives tire consumption factors for different constant speeds.

Table 6.10

ENGINE OIL CONSUMPTION COSTS
(piasters-Km)

Vehicle Type	Surface: Paved Economic	Paved Financial	Unpaved Economic	Unpaved Financial
4 Cyl. Passenger Car	0.008	0.011	0.013	0.018
6 Cyl. Pass. Car & Taxi	0.010	0.015	0.018	0.025
8 Cyl. Passenger Car	0.009	0.012	0.014	0.020
Pickup	0.007	0.009	0.012	0.016
Bus	0.015	0.019	0.028	0.035
Microbus	0.009	0.012	0.016	0.021
2 Axle Truck	0.016	0.021	0.029	0.037
3 Axle Truck	0.018	0.023	0.030	0.038
4 Axle Trk. Semi-trailer	0.018	0.023	0.030	0.038
5 Axle Trk. Semi-trailer	0.018	0.023	0.030	0.038
5 Axle Truck+Trailer	0.016	0.021	0.029	0.037

Source: Table 6.9.

Table 6.11

TIRE CONSUMPTION FACTORS

Vehicle Type	Speed, Kph	Tire Consumption Per Tire in % per 100 Km
Passenger Car, 4 tires	80	0.175
3.91 ton truck, 4 tires	80	0.153
3.5 ton truck, 6 tires	72	0.130
15.0 ton truck, 14 tires	72	0.088
18.6 ton truck, 18 tires	72	0.091

Source: DeWeille, p.20.

Table 6.12 presents the interpolated tire consumption per tire per 100 kilometers value for the vehicles of this study. The financial and economic tire costs are in Table 6.13.

Table 6.14 presents DeWeille tire consumption factors at constant speeds on flat, paved, tangent roads. These factors were applied to the financial and economic tire consumption costs (Table 6.13).

Vehicle Maintenance (Parts and Labor)

The most uncertain of the cost items is maintenance and repair. Import figures for spare parts also include spare parts for vehicles damaged in accidents. The usage of second-hand parts is common. Part of the maintenance is performed by the owner/driver during waiting time. Repair bills do not normally specify parts and labor. The owner of the car usually negotiates a fixed price for the repair with the shop owner. Imported spare parts are very expensive in Syria due to the duties imposed upon entry. Associated with the widely apparent tendency to under-service is the number of operators who keep only rudimentary records of their running costs. As a result, there is a paucity of information on the current level of maintenance expenditures, which is particularly unfortunate in view of the widely varying cost situations that appear to exist.

Maintenance and repair costs were calculated using basic factors for both parts and labor as developed by DeWeille. The maintenance costs of both the passenger car and the taxi were based on the DeWeille passenger car; the pickup light truck was based on DeWeille Truck I; and all other diesel vehicles were based on the DeWeille IV category. An average hourly mechanic's rate of SP 9.10 (financial) and SP 8.40 (economic) were used in the subsequent calculations.

The results of the maintenance and repair costs are presented in Table 6.15. The maintenance and repair consumption factors at constant speeds are shown in Table 6.16.

Depreciation

Depreciation was considered invariant with speed and to be based on total vehicle life in kilometers. The value to be depreciated is the cost of the new vehicle less the cost of tires and residual value. The depreciation values shown in Table 6.17 divided by the vehicle life kilometerag estimated in Table 6.18 give the depreciation costs presented in the summary tables in this chapter.

Table 6.12

TIRE CONSUMPTION FACTORS PER 100 KILOMETERS

Vehicle Type	Speed, Kph	Tire Consumption Per Tire in % per 100 Kms.
Passenger Car, 4 tires & Taxi	80	0.175
Pickup, 4 tires	80	0.120
Bus, 6 tires	72	0.108
Microbus, 6 tires	72	0.124
2 Axle Truck, 6 tires	72	0.100
3 Axle Truck, 10 tires	72	0.087
4 Axle Truck, Semi-trailer, 14 tires	72	0.108
5 Axle Tractor, Semi-trailer, 18 tires	72	0.104
5 Axle Truck & Full Trailer, 18 tires	72	0.108

Source: Table 6.11

Table 6.13

TIRE CONSUMPTION COST
(sp/km)

Vehicle Type	Cost	
	Financial	Economic
Private Passenger Car & Taxi	0.018	0.014
Pickup	0.013	0.010
Bus	0.120	0.094
Microbus	0.020	0.016
2 Axle Truck	0.152	0.120
3 Axle Truck	0.228	0.179
4 Axle Tractor Semi-trailer	0.388	0.306
5 Axle Tractor Semi-trailer	0.483	0.380
5 Axle Truck & Full Trailer	0.494	0.389

Source: Table 6.12

Table 6.14

TIRE CONSUMPTION FACTORS AT CONSTANT SPEEDS ON FLAT, PAVED, TANGENT ROADS

Speed, Kph	Passenger Car and Pickup	Heavy Trucks and Buses
16	.17	.17
24	.23	.24
32	.31	.33
40	.41	.44
48	.50	.55
56	.61	.68
64	.74	.83
72	.86	1.00 [1]
80	1.00 [1]	1.20
88	1.17	1.44
96	1.36	1.74
104	1.59	-
112	1.87	-

Source: DeWeille, p.20.

[1] Benchmark speeds.

Table 6.15

MAINTENANCE AND REPAIR COSTS

(SP PER VEH-KM AT BENCHMARK SPEEDS)

Vehicle Type	Speed Kph	Veh. Maintenance, SP/Veh. Km. Financial Parts	Financial Labor	Financial Total	Economic Parts	Economic Labor	Economic Total
4 Cyl. Pass. Car	80	0.09	0.01	0.10	0.03	0.01	0.04
6 Cyl. " "	80	0.07	0.01	0.08	0.02	0.01	0.03
8 Cyl. " "	80	0.14	0.01	0.15	0.05	0.01	0.06
Taxi	80	0.07	0.01	0.08	0.02	0.01	0.03
Pickup	80	0.03	0.01	0.04	0.02	0.01	0.03
Bus	72	0.23	0.03	0.26	0.20	0.02	0.22
Microbus	72	0.08	0.03	0.11	0.07	0.02	0.09
2 axle Truck	72	0.11	0.03	0.14	0.09	0.03	0.12
3 axle Truck	72	0.15	0.03	0.18	0.13	0.02	0.15
4 axle Comb. (2+2)	72	0.18	0.03	0.21	0.15	0.03	0.18
5 axle Comb. (3+2)	72	0.23	0.03	0.26	0.18	0.03	0.21
5 axle Comb. Trk. + Full Trailer (2+3)	72	0.12	0.03	0.15	0.11	0.03	0.14

Source: Appendix Table 6.1-6 and Table 6.1-7 of the Final Phase I Report.

Table 6.16

MAINTENANCE AND REPAIR CONSUMPTION FACTORS AT CONSTANT SPEEDS ON FLAT, TANGENT ROADS

Speed Kph	Passenger Cars, Taxi, P/U		All Other Vehicles	
	Parts	Labor	Parts	Labor
16	.64	.63	.71	.63
24	.64	.68	.71	.66
32	.73	.73	.86	.69
40	.73	.76	.86	.74
48	.82	.80	.86	.79
56	.82	.85	1.00	.85
64	.91	.89	1.00	.92
72	.91	.95	1.00[1]	1.00[1]
80	1.00[1]	1.00[1]	1.14	1.08
88	1.00	1.06	1.29	1.16
96	1.09	1.11	1.43	1.25
104	1.09	1.18	-	-
112	1.27	1.26	-	-

Source: DeWeille, p. 23.

[1] Benchmark speeds.

Table 6.17

CALCULATION OF DEPRECIATION BASES
(SP)

	4 Cyl. Pass. Car		6 Cyl. Pass. Car		8 Cyl. Pass. Car	
	F	E	F	E	F	E
New Vehicle	99,725	31,975	77,200	32,800	146,300	47,700
Less Tires	1,024	808	1,024	808	1,024	808
Value Less Tires	98,701	31,167	76,176	31,992	145,276	46,892
Residual Value 10%	9,870	3,117	7,618	3,199	14,528	4,689
DEPRECIATION BASE	88,831	28,050	68,558	28,793	130,748	42,203

	Taxi		Pickup		Bus	
	F	E	F	E	F	E
New Vehicle	77,200	32,800	29,550	26,050	368,400	329,600
Less Tires	1,024	808	1,084	852	11,100	8,742
Value Less Tires	76,176	31,992	28,466	25,198	357,300	320,858
Residual Value 10%	7,618	3,199	2,847	2,520	35,730	32,086
DEPRECIATION BASE	68,558	28,793	25,619	22,678	321,570	288,772

	Microbus		2 Axle Truck		3 Axle Truck	
	F	E	F	E	F	E
New Vehicle	121,900	109,400	188,300	164,800	251,950	221,450
Less Tires	1,626	1,278	15,240	12,006	15,690	12,360
Value Less Tires	120,274	108,122	173,060	152,794	236,260	209,090
Residual Value 10%	12,027	10,812	17,306	15,279	23,626	20,909
DEPRECIATION BASE	108,247	97,310	155,754	137,515	212,634	188,181

Table 6.17 (Continued)

CALCULATION OF DEPRECIATION BASES

(SP)

	4 axle Tractor Semi-trailer		5 axle Tractor Semi-trailer		5 axle Truck + Full Trailer	
	F	E	F	E	F	E
New Vehicle[1]	329,400	266,460	404,300	327,080	233,300	205,840
Less Tires[2]	46,170	36,372	46,470	36,308	45,720	36,018
Value Less Tires	283,230	230,088	357,830	290,472	187,580	169,822
Residual Value 10%	28,323	23,009	35,783	29,047	18,758	16,982
DEPRECIATION BASE	254,907	207,079	322,047	261,425	168,822	154,840

Source: Appendix Tables 6.1-5, 6.1-8, and 6.1-15 of the Final Phase I Report.

Note: F = Financial; E = Economic

[1] Includes price of semi-trailer with 8 tires

[2] Includes price of full trailer with 12 tires.

Table 6.18

ANNUAL TRAVEL AT DIFFERENT SPEEDS FOR ALLOCATION OF FIXED ANNUAL CHARGES

(annual kilometers)

Speed (kph)	Passenger Car	Taxi	Pickup	Bus	Microbus	2-Axle Truck	3-Axle Truck	More than 4 Axle Trucks
32	12,500	85,713	25,000	47,500	61,750	47,500	57,000	65,000
40	13,000	89,142	26,000	50,000	65,000	50,000	60,000	69,063
48	13,500	92,571	27,000	52,500	68,250	52,500	63,000	73,126
56	14,000[1]	96,000	28,000	55,000	71,500	55,000	66,000	77,189
64	14,500	99,429	29,000	57,500	74,750	57,500	69,000	81,252
72	15,000	102,858	30,000	60,000	78,000	60,000	72,000	85,315
80	15,500	106,287	31,000	62,500	81,250	62,500	75,000	89,378
88	16,000	109,716	32,000	65,000	84,500	65,000	78,000	93,441
96	16,500	113,145	33,000	67,500	87,750	67,500	81,000	97,504
104	17,000	116,574	34,000	70,000	91,000	70,000	84,000	101,567
112	17,500	120,003	35,000	72,500	94,250	72,500	87,000	105,630

Source: Consultants' estimates.

[1] Basic reference point.

Interest/Fixed Annual Costs

The foregoing costs (except for depreciation) have been developed for each speed. The group of costs considered in this and subsequent sections, namely, interest, insurance, vehicle road fees, and driver salary costs, are basically annual allocable costs and could be considered invariant; that is, given the annual kilometers and the annual cost, a single cost per kilometer could be developed applicable at all speed levels. A more common, but not necessarily accurate, assumption is that these annual charges decrease on a per kilometer basis with increasing speed, since at the higher speed levels the vehicle is likely to travel more kilometers per year. To account for this possibility, it has been assumed that 25 percent of the additional travel possible at speeds above the overall travel speeds on paved roads will actually be used for economic purposes. As an example, if a passenger car travels 14,000 kilometers at an overall travel speed of 56 kilometers per hour, the possible travel at 64 kilometers per hours is 64/56 x 14,000, or 15,960 kilometers. Therefore, for allocation purposes, 25 percent of the increased kilometerage will be added to the basic kilometers to determine cost/kilometer. It should be noted that at a given speed level these annual allocable costs are the same for each road surface; the reason for this assumption is to avoid prejudicing the evaluations on the basis of arbitrary allocations of what are, in reality, annual fixed charges. Table 6.18 shows the annual travel kilometers used to estimate cost/kilometer of the annual charges at different speed levels.

In computing interest charge, a 12 percent interest charge was used and applied against half of the purchase value of the vehicle, the average amount of funds outstanding over the life of the vehicle. The annual interest charges divided by the kilometers of travel (Table 6.18) give the interest charges shown in the summary tables. Tires are a capital cost, and interest cost is definitely as applicable to them as to the motor vehicle itself.

Insurance

In these estimates, it has been assumed that compulsory insurance would be carried on each of the reference vehicles plus a specified percentage for comprehensive and third part coverages.

Annual Vehicle Road Taxes

The same rationale used for interest, insurance, etc., applies to the vehicle registration fees. It should be noted that the vehicle registration fees are not an economic cost but solely a financial cost to vehicle owners.

Annual Transport Fees - Commercial Vehicles

The same rationale used for the annual vehicle road taxes applies to the annual transport fees. These fees are not an economic cost but solely a financial cost to commercial vehicle operators.

Mid-1980 Vehicle Operating Costs

The Consultants have updated the 1979 vehicle operating costs to mid-1980 price levels. All operating cost components were evaluated along with the tax structure of those components. The resulting analyses are the financial and economic growth factors for each vehicle operating cost component, as shown in Table 6.19.

The most striking increases occurred in the motor fuels and CIF vehicle prices (and consequently in depreciation, interest, and maintenance). The tax and duty structure remained unchanged.

Tables 6.20 and 6.21 present the economic and financial vehicle operating cost by type of vehicle on asphalt roads and at benchmark speeds; i.e., on the basis of 80 kilometers per hour for passenger vehicles and 72 kilometers per hour for trucks, buses and combination vehicles, the percentage increases over the 1979 price levels are shown.

The mid-1980 economic direct operating costs on asphalt roads, at benchmark speeds, and by vehicle category are shown in Table 6.22. The weighted averages of the direct operating costs for passenger cars, buses, trucks, and combination vehicles are also shown in the same table.

Table 6.23 indicates the 1980 economic total running cost before depreciation and interest as well as the total cost per vehicle-kilometer on asphalt roads for all the vehicle types analyzed in this study. Weighted averages are also shown in the same table.

In Appendix 6.2 of the Final Phase I Report, the Consultants presented a comparison of vehicle financial operating costs and tariffs at 1979 prices. This analysis showed costs exceeding tariffs for all categories of trucks, except the 3-axle trucks, with tariff increases of from 15 percent to 64 percent required to cover costs. By mid-1980, with the substantial increase in vehicle operating costs, the situation had worsened. All trucks were operating at a deficit if the rules were followed, and the percentage increases in tariffs required ranged from 25 percent for the 3-axle truck to 75 percent for the 2-axle truck. A similar situation applied to buses and taxis, although, as

Table 6.19

FINANCIAL AND ECONOMIC VOC COMPONENT GROWTH FACTORS OVER 6/1979 PRICE LEVELS
(based on asphalt roads)

Vehicle Type	Motor Fuel		Engine Oil		Tires		Maintenance		Insurance	
	F.	E.	F.	E.	F.	E.	F.	E.	F.	E.
Pass. Car 4 cyl.	2.22	2.51	1.27	1.37	1.11	1.11	1.40	1.41	1.45	1.45
Pass. Car 6 cyl.	2.22	2.51	1.27	1.37	1.11	1.11	1.35	1.32	1.35	1.33
Pass. Car 8 cyl.	2.22	2.51	1.27	1.37	1.11	1.11	1.43	1.44	1.43	1.41
Taxi 6 cyl.	2.22	2.51	1.27	1.37	1.11	1.11	1.35	1.32	1.33	1.33
Pickup	2.22	2.51	1.27	1.37	1.11	1.10	1.30	1.27	1.33	1.32
Bus	2.00	1.36	1.38	1.48	1.07	1.07	1.61	1.63	1.62	1.60
Microbus Body	2.00	1.36	1.38	1.48	1.07	1.07	1.26	1.28	1.20	1.19
2 axle truck	2.00	1.36	1.38	1.48	1.07	1.07	1.35	1.37	1.37	1.37
3 axle truck	2.00	1.36	1.38	1.48	1.07	1.07	1.38	1.40	1.45	1.44
4 axle truck Trailer	2.00	1.36	1.38	1.48	1.07	1.07	1.46	1.45	2.06	2.04
5 axle Comb. Trailer	2.00	1.36	1.38	1.48	1.07	1.07	1.30	1.30	1.31	1.30
5 axle truck and Full Trailer	2.00	1.36	1.38	1.48	1.07	1.07	1.34	1.36	1.36	1.34

Source: Consultants' estimates based on various domestic and overseas interviews.

F = Financial, E = Economic

Table 6.19 (Continued)

FINANCIAL AND ECONOMIC VOC COMPONENT GROWTH FACTORS OVER 6/1979 PRICE LEVELS
(based on asphalt roads)

Vehicle Type	Depreciation		Wages		Interest		Fees & Road Taxis	Vehicle Prices	
	F.	E.	F.	E.	F.	E.	F.	F.	E.
Pass. Car 4 cyl.	1.41	1.44	-	-	1.41	1.44	-	1.41	1.44
Pass. Car 6 cyl.	1.34	1.36	-	-	1.34	1.36	-	1.34	1.35
Pass. Car 8 cyl.	1.43	1.46	-	-	1.43	1.46	-	1.43	1.45
Taxi 6 cyl.	1.35	1.37	1.25	1.32	1.33	1.38	-	1.34	1.35
Pickup	1.31	1.32	1.25	1.24	1.30	1.32	-	1.29	1.31
Bus	1.66	1.68	1.25	1.28	1.66	1.68	-	1.64	1.66
Microbus	1.27	1.27	1.25	1.27	1.28	1.27	-	1.34	1.35
Body								1.15	1.15
2 axle truck	1.37	1.39	1.25	1.24	1.37	1.38	-	1.35	1.37
3 axle truck	1.41	1.43	1.25	1.27	1.41	1.43	-	1.43	1.45
4 axle truck	1.49	1.48	1.25	1.27	1.49	1.48	-	1.45	1.45
Trailer								1.15	1.15
5 axle Comb.	1.30	1.30	1.25	1.27	1.31	1.30	-	1.30	1.30
Trailer								1.15	1.15
5 axle truck +	1.37	1.38	1.25	1.27	1.37	1.38	-	1.35	1.37
Full Trailer								1.16	1.16

Source: Consultants' estimates based on various domestic and overseas interviews.

F = Financial, E = Economic

Table 6.20

ECONOMIC VEHICLE OPERATING COST JUNE 1980 PRICE LEVELS, SP VEH.-KM
ASPHALT ROADS, AT BENCHMARK SPEEDS

Vehicle Type	Motor Fuel	Engine Oil	Tires & Tubes	Mainten-ance	Insur-ance	Interest	Deprecia-tion	Driver Wages	Total	Increase from 6/1979 Prices
Pass. Car 4 cyl.	126	011	016	052	152	157	207	-	721	1.55
Pass. Car 6 cyl.	168	014	016	050	121	152	200	-	721	1.51
Pass. Car 8 cyl.	213	012	016	075	193	238	314	-	1.061	1.57
Weighted Average:	159	013	016	055	144	168	221	-	776	1.54
Taxi 6 cyl.	168	014	016	050	024	022	041	198	533	1.55
Pickup	271	010	011	046	049	058	107	365	917	1.49
Bus Regular	276	022	101	377	130	486	606	558	2.556	1.50
Microbus	194	013	017	124	029	095	136	297	905	1.28
2 axle truck	222	024	128	171	048	190	239	236	1.258	1.31
3 axle truck	256	027	192	225	046	225	284	235	1.490	1.30
4 axle truck	309	027	327	252	075	216	290	564	2.060	1.30
5 axle Comb.	288	027	407	276	056	239	364	564	2.221	1.25
5 axle Truck Trailer	311	024	416	185	038	149	213	564	1.900	1.25

Source: 1979 VOCs and Table 6.19.

Table 6.21

FINANCIAL VEHICLE OPERATING COST JUNE 1980 PRICE LEVELS, SP VEH.-KM
ASPHALT ROADS, AT BENCHMARK SPEEDS

Vehicle Type	Motor Fuel	Engine Oil	Tires & Tubes	Maintenance	Insurance	Interest
Pass. Car 4 cyl.	136	014	020	146	161	485
Pass. Car 6 cyl.	183	019	020	109	130	355
Pass. Car 8 cyl.	235	015	020	215	207	724
Weighted Average:	173	016	020	140	154	463
Taxi 6 cyl.	183	019	020	109	025	052
Pickup	299	011	014	052	052	065
Bus Regular	144	026	128	414	138	535
Microbus	102	017	022	136	031	106
2 axle truck	116	029	163	177	051	214
3 axle truck	134	032	244	250	048	250
4 axle Comb.	162	032	415	307	080	267
5 axle Comb.	152	032	517	334	060	296
5 axle Truck Trailer	164	029	529	201	042	163
Weighted Average:	160	032	457	305	073	266

Source: VOCs and Table 6.19.

Table 6.21 (Continued)

FINANCIAL VEHICLE OPERATING COST JUNE 1980 PRICE LEVELS, SP VEH.-KM
ASPHALT ROADS, AT BENCHMARK SPEEDS

Vehicle Type	Depreciation	Road Taxes	Driver Wages	Fees	Total	Increase from June 1979 Prices
Pass. Car 4 cyl.	643	053	-	-	1.658	1.44
Pass. Car 6 cyl.	469	067	-	-	1.352	1.39
Pass. Car 8 cyl.	954	161	-	-	2.531	1.44
Weighted Average:	613	077	-	-	1.656	1.42
Taxi 6 cyl.	096	010	211	014	739	1.43
Pickup	119	092	386	040	1.130	1.38
Bus Regular	667	109	600	092	2.853	1.46
Microbus	151	045	314	028	952	1.28
2 axle truck	267	079	250	033	1.379	1.30
3 axle truck	357	083	250	053	1.701	1.31
4 axle Comb.	417	070	615	045	2.410	1.33
5 axle Comb.	460	070	615	045	2.581	1.25
5 axle Truck Trailer	255	056	615	045	2.099	1.25
Weighted Average Comb. Trucks:	415	069	615	045	2.437	1.31

Source: 1979 VOCs and Table 6.19.

Table 6.22

ECONOMIC DIRECT OPERATING COST JUNE 1980 PRICE LEVELS

SP VEH-KM, ASPHALT ROADS

Vehicle Type	Motor Fuel	Engine Oil	Tires & Tubes	Main-tenance	Driver Wages	Total DOC
Pass. Car, 4 cyl.	.127	.011	.016	.052	-	.206
Pass. Car, 6 cyl.	.168	.014	.016	.050	-	.248
Pass. Car, 8 cyl.	.215	.012	.016	.075	-	.318
Taxi, 6 cyl.	.168	.014	.016	.050	.198	.446
Pickup	.273	.010	.011	.046	.365	.705
Bus	.276	.022	.101	.377	.576	1.352
Microbus	.194	.013	.018	.124	.295	.644
2 axle truck	.222	.024	.128	.171	.236	.781
3 axle truck	.256	.027	.192	.225	.235	.935
4 axle truck	.309	.027	.327	.252	.564	1.479
5 axle truck	.288	.027	.407	.276	.564	1.562
5 axle truck & full trailer	.311	.024	.416	.185	.564	1.500

Note: At benchmark speeds, light vehicles 80 kph, heavy vehicles 72 kph.

WEIGHTED AVERAGES

Pass. cars	.159	.013	.016	.055	-	.243
Buses	.218	.016	.043	.200	.379	.856
2 + 3 axle trucks	.225	.024	.134	.176	.236	.795
Combination trucks	.305	.027	.350	.252	.564	1.498

Source: Table 6.19.

Table 6.23

ECONOMIC TOTAL RUNNING COST BEFORE DEPRECIATION & INTEREST AND TOTAL COST
JUNE 1980 PRICE LEVELS, SP VEH.-KM, ASPHALT ROADS

Vehicle Type	Running Cost	Depreciation	Interest	Total
Pass. car 4 cyl.	.206	.207	.157	.570
Pass. car 6 cyl.	.248	.200	.152	.600
Pass. car 8 cyl.	.318	.314	.238	.870
Taxi 6 cyl.	.446	.041	.022	.509
Pickup	.705	.107	.058	.870
Bus	1.352	.606	.486	2.444
Microbus	.644	.136	.095	.875
2 axle truck	.781	.239	.190	1.210
3 axle truck	.935	.320	.225	1.480
4 axle truck	1.479	.337	.216	2.032
5 axle truck	1.562	.373	.239	2.174
5 axle truck & full trailer	1.500	.232	.149	1.881
WEIGHTED AVERAGES				
Pass. cars	.243	.205	.168	.616
Buses	.856	.277	.212	1.345
2 + 3 axle trucks	.795	.246	.193	1.234
3 combination truck	1.498	.337	.216	2.051

Note: At benchmark speeds, light vehicles 80 kph, heavy vehicles 72 kph.

Source: Tables 6.19 and 6.22.

noted, taxis often do not observe the approved tariffs. By mid-1980, on sample routes, weighted passenger revenues per kilometer were 33 percent of financial operating costs per passenger-kilometer for buses and 38 percent for microbuses. These apparent losses may be offset to some extent by unofficial choices, overloading, and trips outside Syria.

6.6 NETWORK LINK COSTS

The vehicle operating costs developed for free flowing traffic on level, tangent, paved road surfaces are converted to operating costs for each link in the highway network through a procedure called "Delta L" analysis. The measured length of a link is "L" kilometers, to which is added a calculated "Delta L" kilometerage to obtain the estimated cost of vehicle operations given the actual physical description of the link and its traffic. The L + Delta L then becomes the effective link length for purposes of calculating vehicle operating cost under actual conditions or for a specified improvement in the link. If the actual link length is 30 kilometers and the calculated cost of operating a particular vehicle over this link is twice the cost of operating under free flow traffic conditions on a level, tangent, paved road, the L + Delta L for the link would be 30 kilometers + 30 kilometers = 60 kilometers.

Once the effective link lengths (L + Delta L) have been computed, network operating costs can be computed as the product of the vehicle operating cost and the effective link length. While manual calculations are facilitated by this method, a particular advantage of the Delta L methodology is that it lends itself readily to computer operations, particularly traffic assignment, wherein network impedences attributable to geometric or surface conditions and traffic interaction can be simulated by variations in link length.

Basic Considerations

A required prerequisite of the Delta L methodology (as well as other techniques leading to the same result) is a highway inventory of sufficient detail to identify the major geometrical features of the roads under consideration both in their existing alignment and surface condition and the resultant condition as these roads are improved, reconstructed, or replaced by an altogether new alignment.

A considerable body of literature has been developed on vehicle operating costs and, to a much lesser extent, on the effects of both road geometrics and surface conditions on such costs. None of the developed costs can be pure in the sense that no vehicle spends its entire useful life in travel at constant speed on a surface of known as well as describable condition. (Some elements of operating costs, such as motor fuel consumption, can

be more readily measured in controlled test situations than cost items such as tire wear or vehicle maintenance.) A particular problem is the differentiation between road surfaces of similar characteristics, for example, a good earth road compared with a poor gravel surface.

Delta L Values to be Considered

As has been done in the development of basic vehicle operating cost elements, the sources and assumptions associated with the development of each Delta L factor are clearly set forth.

The vehicle operating costs used herein will be direct operating costs - motor fuel, motor oil, tire wear, and maintenance. Allocated costs, such as insurance, can be included if considered necessary.

Factor costs will be developed to cover operating conditions that are less than optimal. These include factors for the following elements:

- surface type,
- surface condition,
- gradients (terrain),
- sharp curves,
- speed change cycles,
- value of passenger time,
- traffic interaction (traffic congestion).

The direct operating cost of two sample vehicles (pickup truck and 5-axle tractor semitrailer), economic and financial, on level, tangent, paved roads, was shown in Tables 6.33 and 6.34 of the Final Phase I Report.

Road Surface Type Surface Factor Costs

Factor costs for fuel by surface type are given in Table 6.24. The factors are given by vehicle type for bitumen, gravel, and earth roads. The factors for asphalt/concrete are set at a base value of 100, and factors for bitumen, gravel, and earth roads are given in terms of percentage increase from this base value.

Factors for earth and gravel costs are based on the values presented by DeWeille. Factors for bitumen are estimated based on the Consultants' evaluation of speed reduction from asphalt/concrete roads and under the assumption that the increased cost is proportional to the speed reduction.

For the fuel consumption cost component, DeWeille provides basic surface type factor costs broken down by operating speeds

Table 6.24

PERCENT INCREASE IN FUEL COST FROM ASPHALT TO CONCRETE AT BENCHMARK SPEED

Vehicle Type	Asphalt	Bitumen	Gravel	Earth
Passenger Car	100	107	122	144
Pickup Truck	100	109	128	156
Public Bus	100	114	142	184
Microbus	100	113	138	176
2 Axle Truck	100	115	146	-
3 Axle Truck	100	116	149	-
4 Axle Tractor Semi-trailer	100	119	156	-
5 Axle Comb. Tractor Semi-trailer	100	118	153	-
5 Axle Tractor Truck & Full Trailer	100	119	156	-

Source: Consultants' estimates and DeWeille.

Table 6.25

PERCENT INCREASE FROM ASPHALT TO CONCRETE AT BENCHMARK SPEED, TIRES AND MAINTENANCE

Vehicle Type	Item	Asphalt	Bitumen	Gravel	Earth
Pass. Car & P/U Trucks	Tires	100 100	133 133	200 200	350 450
Pass. Car & P/U Trucks	Maintenance	100 100	110 117	130 150	180 250
Pass. Car & P/U Trucks	Depreciation	100 100	113 117	130 150	180 250

Source: DeWeille, Winfrey, Wehner Research Study and Consultants' estimates for bitumen roads.

Note: For other than benchmark speeds, DeWeille's relationships were used - pages 20, 21, and 24.

for a passenger car and an 18-ton diesel truck. DeWeille also gives similar factors for a 3.5-ton gasoline truck and the 15-ton gasoline truck. With regard to trucks, to break these factors down into the heavy diesel vehicle categories under consideration in this study a two-step procedure was followed. First, the factors for a hypothetical 3.5-ton diesel truck were estimated by applying the ratio of the factor costs for the 3.5-ton gasoline truck and the 15-ton gasoline truck to the actual factor costs for the 18-ton diesel truck. This type of ratio technique can be used to approximate the factor costs for the diesel truck when no direct factor cost data are available. In the absence of exact comparable data, it is assumed that comparing a 15-ton gasoline truck and an 18-ton diesel truck will give an order of magnitude accuracy that can be used in highway feasibility studies. Second, the values for the hypothetical 3.5-ton diesel truck and the 18-ton diesel truck at benchmark speeds were interpolated to give values for the range of heavy vehicles under consideration in this study.

For the consumption components of tire wear, engine oil, and maintenance, the effect of surface type on the percentage increase in consumption is reported by DeWeille as fairly constant regardless of truck size. Therefore, a factor was employed as applicable to all trucks. Table 6.25 presents the tire, maintenance, and depreciation percent increase from asphalt concrete at benchmark speeds.

Surface Condition

Factor costs for surface condition are among the most difficult to derive because of the high degree of subjectivity involved. Unlike the other factor costs (grade, curvature, etc.), surface condition cannot be defined in quantifiable terms without elaborate and extensive instrumentation research. As a result, the recommended surface condition factors should not be treated as precise and rigorous values. Rather, they are intended to provide an order of magnitude assessment of the impact of various surface condition levels on vehicle operating costs. They should be considered reasonable estimates for the purpose of this study.

The adopted factor costs for surface condition are given in Table 6.26, broken down into road condition categories of good, fair, and poor for passenger cars and heavy vehicles.

An alternative approach that has been used to estimate surface condition factors is to assume that a high-grade surface in poor condition has the same impact on vehicle consumption costs as a medium-grade surface in good condition. Utilizing values derived in the Highway Engineering Handbook (K. Wood, McGraw-

Table 6.26

SURFACE CONDITION FACTORS

	Condition		
	Good	Fair	Poor
Passenger Cars			
Fuel	100	112	122
Engine Oil	100	140	190
Tire	100	180	280
Maintenance and Depreciation	100	113	140
Trucks			
Fuel	100	112	131
Engine Oil	100	115	135
Tire	100	117	137
Maintenance and Depreciation	100	114	135

Source: Highway Engineering Handbook (K. Wood, McGraw Hill, NY) and Consultants' IBRD Yugoslavia study.

Hill, N.Y.) and the World Bank financed Yugoslavia study carried by the Consultants in 1975, the following average surface condition factors were derived:

	Surface Condition Factors		
	Good	Fair	Poor
Passenger car	100	113	130
Heavy truck	100	116	134

The results from the two methods are reasonably consistent. However, the above set of factors is based on total vehicle operating costs, i.e., vehicle consumption components and vehicle time-related components. In order to convert these factors into factors for only the operating components, the individual cost factors of Table 6.26 must be utilized. For purposes of relating surface condition to operating speeds, the second methodology is satisfactory and has been used in the Highway Speed Model for this purpose.

With respect to the application of surface condition factors, it should be stipulated that the surface condition of the existing road and the proposed road must be treated as comparable. This is because surface condition is primarily a maintenance function rather than a capital investment function. To compare the operating costs on an existing road with one level of surface condition against the operating costs on a proposed road with a different level of surface condition is to confuse the maintenance function with the capital investment program. To avoid this conceptual problem, the surface condition of both existing roads and proposed roads is treated as fair considered over the whole life of the proposed investment. The costs of maintaining both roads in fair condition as traffic volumes increase are reflected in higher maintenance costs over time.

DeWeille's factor values at different speeds were adopted in this study. These values, which are presented in Table 6.27, serve to adjust consumption costs for speeds other than the benchmark speed.

Gradients (Terrain)

Tables 6.28 and 6.29 show the effects of terrain on direct vehicle operating costs as prepared from the data of Winfrey. Delta Ls for both plus and minus grades are shown. Also shown is a combined Delta L, which represents one kilometer of plus grade and one kilometer of minus grade of the same slope characteristics.

Table 6.27

SPEED FACTORS AT CONSTANT SPEEDS
FOR SURFACE CONDITION

Speed (kph)	Passenger Cars				Trucks and Buses			
		Tires				Tires		
	Fuel	Fair	Poor	Maintenance	Fuel	Fair	Poor	Maintenance
32	0.86	-	-	1.90	0.62	0.36	-	1.48
40	0.91	0.46	-	1.65	0.71	0.48	0.94	1.38
48	0.95	0.55	0.83	1.41	0.79	0.61	1.00	1.28
56	0.95	0.67	0.88	1.17	0.85	0.75	1.07	1.17
64	0.95	0.81	0.94	1.12	0.92	0.91	1.15	1.09
72	1.00	0.95	1.00	1.00	1.00	1.00	1.24	1.00
80	1.00[1]	1.00	1.07	1.00	1.08	-	-	0.91
88	1.00	1.29	-	1.00	1.16	-	-	0.82
96	1.04	1.50	-	1.00	1.24	-	-	0.73
104	1.08	-	-	0.90	-	-	-	-
112	1.12	-	-	0.90	-	-	-	-

Source: DeWeille, pages 20, 21, and 24.

Notes: Bitumen is considered as fair, and gravel roads as poor. Fuel consumption for fair and poor is the same. Depreciation, maintenance, and engine oil are constant, irrespective of speed level.

[1] Benchmark speeds.

Table 6.28

DELTA L VALUES FOR GRADE OR TERRAIN EFFECTS, METERS/KILOMETER, LIGHT VEHICLES

Base Speed (Kph)	Plus Grade, %			Minus Grade, %			Combined Grades, %[1]		
	4	6	8	-4	-6	-8	±4	±6	±8
8	136	223	334	- 80	- 67	- 32	56	156	302
16	186	301	451	-116	-102	- 65	70	199	386
24	216	349	520	-140	-127	- 91	76	222	429
32	235	380	566	-161	-149	-117	74	231	449
40	248	402	599	-178	-170	-140	70	232	459
48	258	423	623	-188	-190	-164	70	233	459
56	262	442	640	-188	-209	-185	74	233	455
64	264	432	651	-189	-229	-205	75	203	446
72	264	434	661	-196	-250	-224	68	184	437
80	262	435	676	-202	-265	-242	60	170	434
88	261	436	690	-214	-275	-262	47	161	428
96	258	436	700	-221	-278	-275	37	158	425
104	252	435	714	-227	-285	-286	25	150	428

Source: Winfrey, pages 680-700.

[1] Represents a 2 kilometer distance, 1 kilometer at the indicated plus grade and 1 at the (same) indicated minus grade.

Table 6.29

DELTA L VALUES FOR GRADE OR TERRAIN EFFECTS, METERS/KILOMETER, HEAVY VEHICLES

Base Speed (Kph)	Plus Grade, %			Minus Grade, %			Combined Grades, %[1]		
	4	6	8	-4	-6	-8	±4	±6	±8
8	139	235	368	-125	-115	-106	14	120	262
16	209	350	553	-168	-164	-148	41	186	405
24	275	452	654	-210	-194	-174	65	258	480
32	327	573	844	-222	-220	-218[2]	105	353	626[2]
40	393	646	1062[2]	-227	-239	-252[2]	166	407	810[2]
48	471	-	-	-229	-	-	242	-	-
56	506	-	-	-	-	-	-	-	-
64	537	-	-	-	-	-	-	-	-

Source: Winfrey, pages 693 to 698.

[1] Represents two kilometer distance, one kilometer at the indicated plus grade and one at the (same) indicated minus grade.

[2] Values extrapolated.

Table 6.30 presents the Delta L factors for terrain effects for light and heavy vehicles based on the assumed operating speeds indicated in the footnote of the table.

Sharp Curves

Sharp curves are reflected below in the speed change cycle section of this report. Tables 6.31 and 6.32 show the Delta L effects of horizontal curves, as computed from Winfrey. Examination of the cited tables shows that for higher vehicle speeds on sharp curves the Delta L values appear unrealistically high and their direct applicability appears questionable for present purposes. (Because there is no ice or snow on Syria's highways, curves can be banked more steeply than in other countries.) As an arbitrary basic assumption, the values of Winfrey at 32 kilometers per hour for 5° and 16° curves will be used to represent sharp and very sharp curves, as shown in Table 6.33.

Speed Change Cycle

Speed Change Cycle Values

Delta L values for speed change have been calculated from Winfrey's data and are shown in Tables 6.34 and 6.35. Tables 6.36 and 6.37 show the Delta L kilometer/occurrence for the light and heavy vehicles by speed variation.

Weighted averages have been used in order to develop data for the light and heavy vehicle categories. According to the Consultants' O & D surveys, the percentage distribution of the passenger car to the pickup light truck is 66 percent to 34 percent. Concerning the heavy vehicles, a weighted average of 88 percent was applied for buses, microbuses, and 2- and 3-axle trucks, and 12 percent was applied for the articulated vehicles.

Figures 6.1 and 6.2 show the Delta Ls for speed change cycles for light and heavy vehicles. The horizontal scale represents the minimum speed of cycle.

Interaction of Opposing Vehicles on Narrow Roads and Its Influence on Vehicle Operating Costs

Upon encountering vehicles travelling in the opposite direction on a road with only one paved lane, one or both vehicles must leave the pavement and travel at least partially on the shoulder. Invariably, these maneuvers cause speed change cycles of considerable magnitude. Within the limits between the width of a paved, one-lane and that of a standard two-lane paved

road, the magnitude of each speed change cycle will vary with traffic volumes, width of pavement, and operating speed.

A model of these relationships was developed and is illustrated in Figure 6.3. The curves shown are intended to represent average conditions as follows:

- Curve 1: Speed with a 7.2 meter wide paved road.
- Curve 2: Maximum speed with a 4.5 meter wide pavement.
- Curve 3: Minimum speed with a 4.5 meter wide pavement. (The difference between Curve 2 and Curve 3 represents the speed change cycle.)
- Curve 4: Maximum speed with an intermediate width of 5.85 meters of pavement.
- Curve 5: Minimum speed with a 5.85 meter wide pavement. (The difference between Curve 4 and Curve 5 represents the corresponding speed change cycle.)

Maximum reduction in pavement width "w" was assumed to be from 7.2 meters to 4.5 meters. Ratio of pavement width is:

$$R = \frac{7.2 - w}{2.7}$$

Hourly traffic volume was assumed to be: $\frac{ADT}{10}$

Equations for the five curves are as follows:

- Curve 1: Speed, so $= 100 - \frac{50ADT}{10,000}$

- Curve 2: Max. speed, $S_1 = So - \frac{R[So-60(1-ADT)^{2-40}]}{5,000}$
- Curve 4:

- Curve 3: Min. speed, $S_2 = S1(1 - R) + 30R$
- Curve 5:

It was assumed that an average 10 seconds headway is required for a vehicle to return to pavement and accelerate to the higher speeds. The probability of having that headway was taken to be:

$$P(h - 10) = 1-10g$$

where g = flow in vehicles/second

Therefore, the probable number of encounters that involve speed cycles was taken to be:

$$N = \frac{R(ADT \times 1 - ADT)}{10S1 \quad 3,600}$$

Table 6.30

DELTA L FACTORS FOR TERRAIN EFFECTS

(meters/kilometer)

Vehicle Category	Road Surface: Asphalt R	Asphalt H	Asphalt M[1]	Bitumen R	Bitumen H	Bitumen M	Gravel R	Gravel H	Gravel M	Earth R	Earth H	Earth M
L.V.[2]	0.02	0.08	0.21	0.03	0.09	0.22	0.04	0.10	0.22	0.04	0.12	0.23
H.V.[3]	0.08	0.20	0.41	0.05	0.18	0.31	0.03	0.13	0.24	0.02	0.09	0.20

Source: Tables 6.23 and 6.24.

Notes: Calculations assume even distribution of plus and minus grades. Values shown are based on operating speeds: 1) Light Vehicles: Asphalt 90, Bitumen 80, Gravel 68 and Earth 40. 2) Heavy Vehicles: Asphalt 40, Bitumen 32, Gravel 24 and Earth 16.

[1] R = Rolling, 4%; H = Hilly, 6%; M = Mountainous, 8%.

[2] Light Vehicles.

[3] Heavy Vehicles.

Table 6.31

DELTA L FOR HORIZONTAL CURVE EFFECTS, METERS/KILOMETER, LIGHT VEHICLES

Base Speed (Kph)	Degree of Horizontal Curve				
	2°	5°	10°	16°	25°
8	15	27	42	62	95
16	31	60	99	151	230
24	44	87	158	251	419
32	47	108	212	353	667
40	50	125	273	512	1,044
48	56	149	361	774	1,629
56	68	204	505	1,117	2,391
64	86	267	734	1,558	-
72	115	358	997	2,107	-
80	147	458	1,275	-	-
88	194	587	1,569	-	-
96	246	727	1,821	-	-
104	299	872	2,134	-	-

Source: Winfrey.

Note: Includes passenger cars and pickups. A weighted average of 66% to 34% in favor of the passenger cars was used.

Table 6.32

DELTA L FOR HORIZONTAL CURVE EFFECTS, METERS/KILOMETER, HEAVY VEHICLES

Base Speed (Kph)	Degree of Horizontal Curve				
	2°	5°	10°	16°	25°
8	22	41	63	95	141
16	48	88	153	236	357
24	67	129	244	388	618
32	68	166	321	529	973
40	71	194	387	755	1,668
48	87	216	477	1,210	-
56	90	228	752	1,719	-
64	93	349	1,073	2,301	-
72	153	502	1,407	-	-
80	214	662	1,762	-	-
88	278	828	-	-	-
96	343	-	-	-	-

Source: Winfrey, pages 682 to 703.

Note: Includes buses, microbuses, 2 and 3 axle trucks, and combination vehicles. A weighted average of 88% was applied for buses, microbuses, 2 and 3 axle trucks, and 12% for the articulated vehicles.

Table 6.33

DELTA L FACTORS FOR CURVE EFFECTS (kilometers/occurrence)

Vehicle Category	Sharp[1]	Very Sharp[2]
Light Vehicles	0.11	0.35
Heavy Vehicles	0.17	0.53

Source: Winfrey.

[1] 150 to 250 meter radius.

[2] Less than 150 meter radius.

Table 6.34

DELTA L FROM SPEED CHANGE CYCLE EFFECTS, METERS/CYCLE

LIGHT VEHICLES

Base Speed (kph)	Speed Reduced to and Returned from - Kph												
	Stop	8	16	24	32	40	48	56	64	72	80	88	96
8	24	-	-	-	-	-	-	-	-	-	-	-	-
16	68	35	-	-	-	-	-	-	-	-	-	-	-
24	133	131	75	-	-	-	-	-	-	-	-	-	-
32	216	167	118	63	-	-	-	-	-	-	-	-	-
40	317	265	212	150	82	-	-	-	-	-	-	-	-
48	435	381	325	261	187	102	-	-	-	-	-	-	-
56	573	517	459	393	319	230	125	-	-	-	-	-	-
64	733	675	616	549	473	384	280	152	-	-	-	-	-
72	912	854	794	727	650	562	459	331	181	-	-	-	-
80	1,113	1,055	995	927	850	761	661	535	388	211	-	-	-
88	1,335	1,277	1,216	1,149	1,072	982	882	760	616	444	242	-	-
96	1,567	1,507	1,446	1,378	1,301	1,213	1,112	994	855	692	498	271	-
104	1,801	1,740	1,678	1,610	1,533	1,447	1,348	1,235	1,101	945	762	548	299

Source: Winfrey, pages 680-692.

Note: Includes passenger cars and pickups. A weighted average of 66% and 34% was used.

Table 6.35

DELTA L FROM SPEED CHANGE CYCLE EFFECTS, METERS/CYCLE

HEAVY VEHICLES

Base Speed (kph)	Speed Reduced to and Returned from - Kph												
	Stop	8	16	24	32	40	48	56	64	72	80	88	96
8	33	-	-	-	-	-	-	-	-	-	-	-	-
16	116	58	-	-	-	-	-	-	-	-	-	-	-
24	225	153	78	-	-	-	-	-	-	-	-	-	-
32	363	283	211	104	-	-	-	-	-	-	-	-	-
40	524	440	355	256	139	-	-	-	-	-	-	-	-
48	706	620	533	432	314	171	-	-	-	-	-	-	-
56	908	822	735	634	516	374	205	-	-	-	-	-	-
64	1,130	1,045	960	859	743	715	440	242	-	-	-	-	-
72	1,372	1,288	1,204	1,106	994	860	700	510	280	-	-	-	-
80	1,627	1,547	1,465	1,371	1,261	1,132	980	798	579	316	-	-	-
88	1,889	1,813	1,733	1,642	1,537	1,414	1,268	1,096	898	646	348	-	-
96	2,158	2,085	2,008	1,920	1,820	1,703	1,565	1,402	1,207	977	660	400	-
104	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Winfrey, pages 693-704.

Note: Includes bus, microbus, 2 and 3-axle trucks, and combination trucks. A weighted average of 88% (bus, microbus, and 2-axle), 5% (3-axle truck), and 7% (combination trucks) was used.

Table 6.36

DELTA L SPEED CHANGE CYCLE, LIGHT VEHICLES

(kilometers/occurrence)

Base Speed (kph)	Speed Reduced to and Returned from - Kph												
	Stop	8	16	24	32	40	48	56	64	72	80	88	96
8	0.02	-	-	-	-	-	-	-	-	-	-	-	-
16	0.07	0.04	-	-	-	-	-	-	-	-	-	-	-
24	0.13	0.13	0.08	-	-	-	-	-	-	-	-	-	-
32	0.22	0.17	0.12	0.06	-	-	-	-	-	-	-	-	-
40	0.32	0.27	0.21	0.15	0.08	-	-	-	-	-	-	-	-
48	0.44	0.38	0.33	0.26	0.19	0.10	-	-	-	-	-	-	-
56	0.57	0.52	0.46	0.39	0.32	0.23	0.13	-	-	-	-	-	-
64	0.73	0.68	0.62	0.55	0.47	0.38	0.28	0.15	-	-	-	-	-
72	0.91	0.85	0.79	0.73	0.65	0.56	0.46	0.33	0.18	-	-	-	-
80	1.11	1.06	1.00	0.93	0.85	0.76	0.66	0.54	0.39	0.21	-	-	-
88	1.34	1.28	1.22	1.15	1.07	0.98	0.88	0.76	0.62	0.44	0.24	-	-
96	1.57	1.51	1.45	1.38	1.30	1.21	1.11	0.99	0.85	0.69	0.50	0.27	-
104	1.80	1.74	1.68	1.61	1.53	1.45	1.35	1.24	1.10	0.94	0.76	0.55	0.30

Source: Table 6.29.

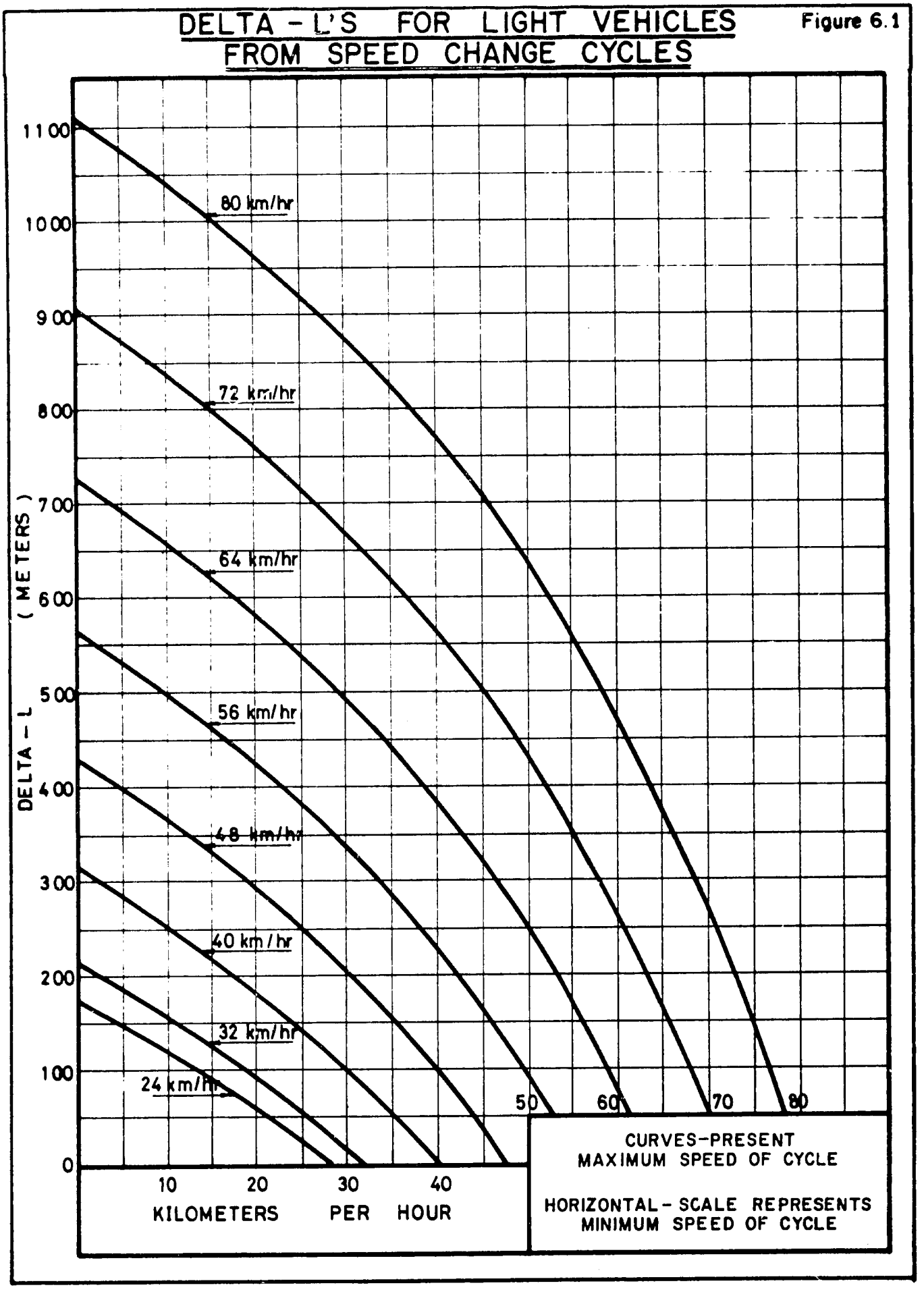
Table 6.37

DELTA L SPEED CHANGE CYCLE, HEAVY VEHICLES

(kilometers/occurrence)

Base Speed (kph)	Speed Reduced to and Returned from - Kph												
	Stop	8	16	24	32	40	48	56	64	72	80	88	96
8	0.03	-	-	-	-	-	-	-	-	-	-	-	-
16	0.12	0.06	-	-	-	-	-	-	-	-	-	-	-
24	0.23	0.15	0.08	-	-	-	-	-	-	-	-	-	-
32	0.36	0.28	0.21	0.10	-	-	-	-	-	-	-	-	-
40	0.52	0.44	0.36	0.26	0.14	-	-	-	-	-	-	-	-
48	0.71	0.62	0.53	0.43	0.31	0.17	-	-	-	-	-	-	-
56	0.91	0.82	0.74	0.63	0.52	0.37	0.21	-	-	-	-	-	-
64	1.13	1.05	0.96	0.86	0.74	0.72	0.44	0.24	-	-	-	-	-
72	1.37	1.29	1.20	1.11	0.99	0.86	0.70	0.51	0.28	-	-	-	-
80	1.63	1.55	1.47	1.37	1.26	1.13	0.98	0.80	0.58	0.32	-	-	-
88	1.89	1.81	1.73	1.64	1.54	1.41	1.27	1.10	0.90	0.65	0.35	-	-
96	2.16	2.09	2.01	1.92	1.82	1.70	1.57	1.40	1.21	0.98	0.66	0.40	-
104	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Table 6.30.


DELTA - L'S FOR LIGHT VEHICLES
FROM SPEED CHANGE CYCLES
Figure 6.1
DELTA - L (METERS)
1100
1000
900
800
700
600
500
400
300
200
100
0
80 km/hr
72 km/hr
64 km/hr
56 km/hr
48 km/hr
40 km/hr
32 km/hr
24 km/hr
50
60
70
80
10
20
30
40
KILOMETERS PER HOUR
CURVES-PRESENT
MAXIMUM SPEED OF CYCLE
HORIZONTAL-SCALE REPRESENTS
MINIMUM SPEED OF CYCLE

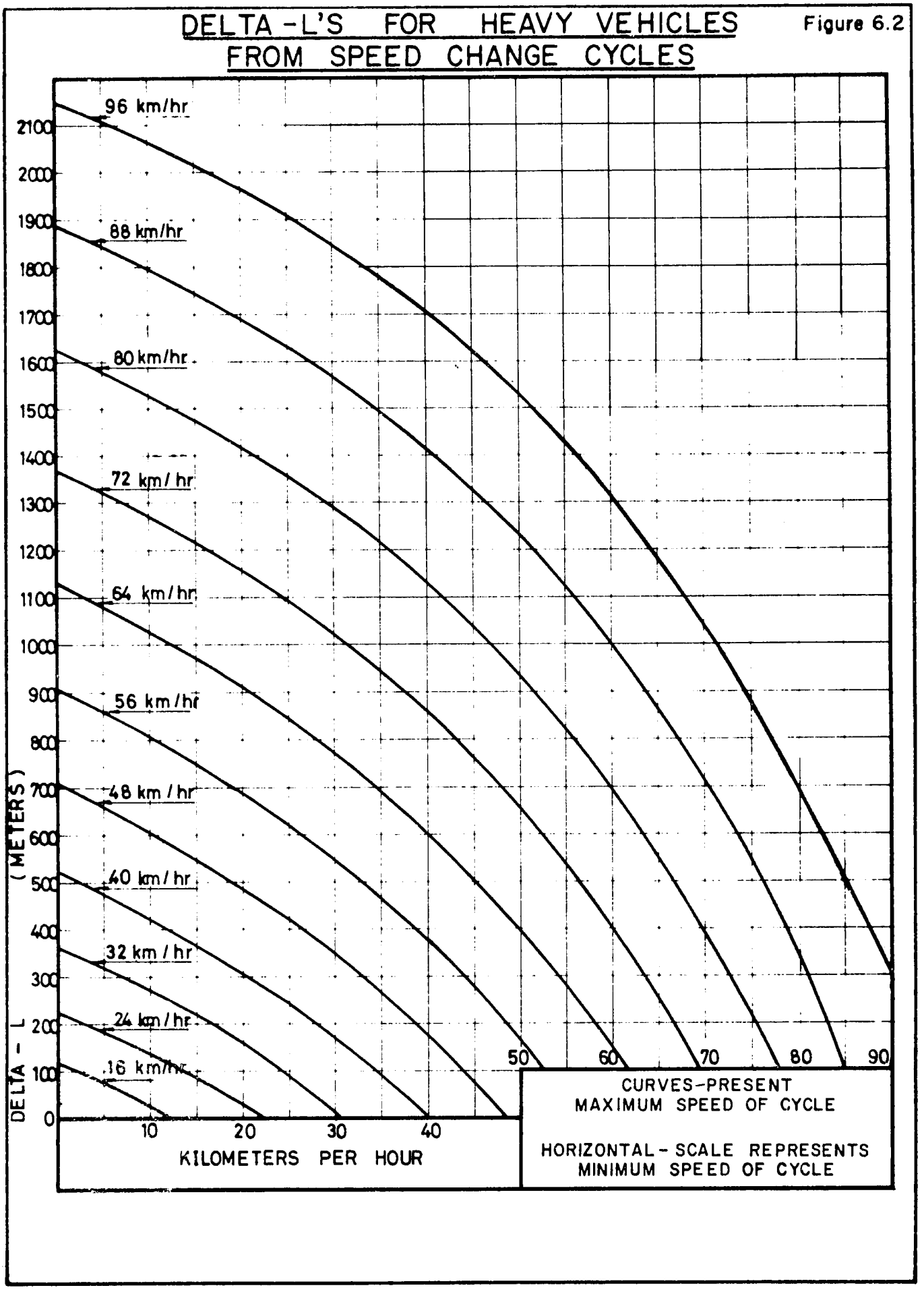
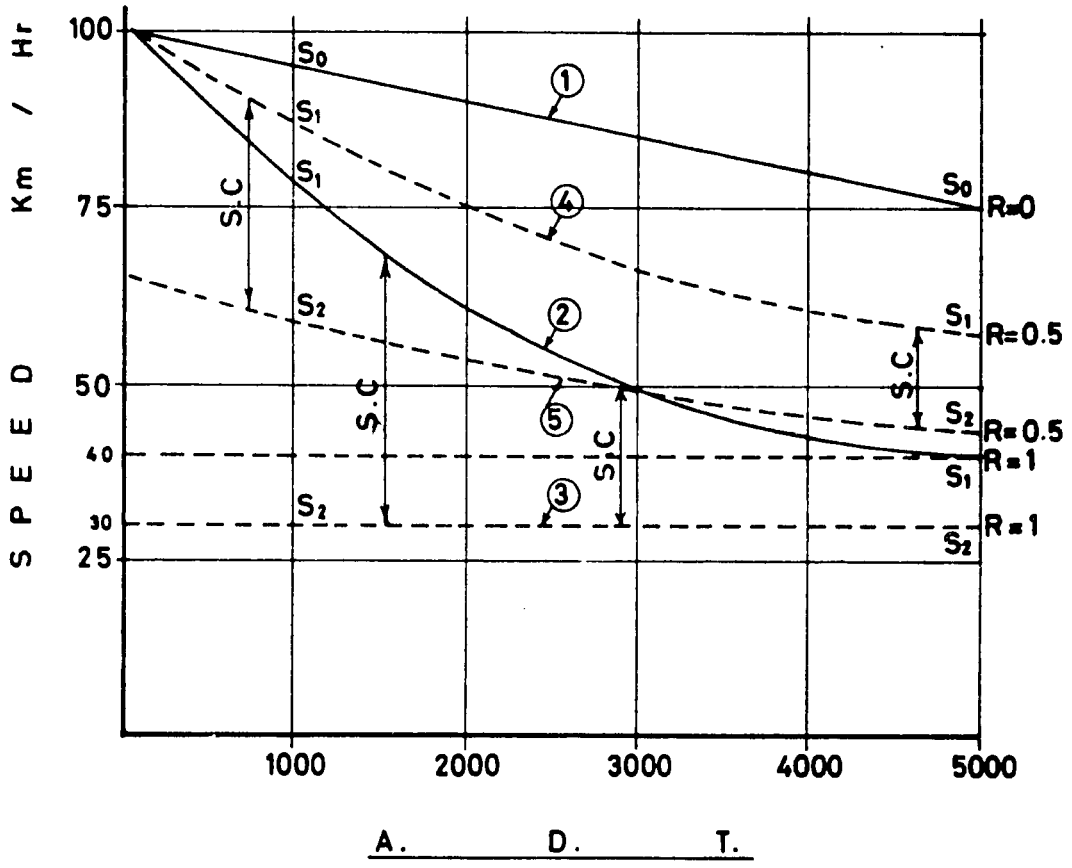

DELTA-L'S FOR HEAVY VEHICLES
FROM SPEED CHANGE CYCLES
Figure 6.2
96 km/hr
88 km/hr
80 km/hr
72 km/hr
64 km/hr
56 km/hr
48 km/hr
40 km/hr
32 km/hr
24 km/hr
16 km/hr
DELTA - L (METERS)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
10
20
30
40
KILOMETERS PER HOUR
50
60
70
80
90
CURVES-PRESENT
MAXIMUM SPEED OF CYCLE
HORIZONTAL-SCALE REPRESENTS
MINIMUM SPEED OF CYCLE

Figure 6.3

ASSUMPTION FOR SPEED CHANGE CYCLES FROM OPPOSING VEHICLES ON NARROW ROADS



$$R = \frac{7.2 - W}{2.7}$$

Where w is paved width of road

6.7 SUMMATION OF RESULTS

The economic and financial operating costs of the selected vehicles were developed for all surface types and surface conditions.

The resulting summary tables show speed levels from 8 kilometers per hour to 112 kilometers per hour by vehicle cost components, totals, and direct operating cost. Printed tables in 1979 prices, which are voluminous, are in the Consultants' files. Comparable tables in 1980 prices are in computer file form. Both will be turned over to the Government at the completion of the study.

6.8 TRAFFIC INTERACTION (Traffic Congestion)

For highway feasibility studies within Syria, economic benefits arising from reducing traffic congestion costs will become an increasingly important part of total economic benefits. It is, therefore, an area requiring careful analytic attention. Unfortunately, definitive basic research is not yet available that quantifies the effect of traffic interaction on vehicle operating costs over a range of vehicle types and operating speed conditions. In the absence of such research, provisional factor cost values have been provided. These values should be utilized until such time as basic research studies provide more definitive values.

Factor costs for traffic interactions are given by car and truck for fuel consumption in Table 6.38 and for tire consumption in Table 6.39.

These factor costs are given in terms of an average highway speed/average operating speed matrix. The factor cost matrix may be explained in the following way. Assume a passenger car to have travelled at 80 kilometers per hour on a road without traffic interaction (i.e., the average highway speed is 80 kilometers per hour) but, in fact, can travel only at 40 kilometers per hour because of traffic interaction (i.e., the average operating speed is 40 kilometers per hour). The passenger car makes numerous speed changes due to the interaction of traffic both above and below its average speed of 40 kilometers per hour. The result of these speed changes is that the consumption costs of the car are increased over what they would have been if the car were going at a constant speed of 40 kilometers per hour. The factors in the tables represent these increases in consumption costs. In other words, the factors represent the increase in consumption of an average operating speed of X kilometers per hour caused by traffic interaction

over the consumption at a constant speed of X kilometers per hour.

The factors were derived from values developed by Wehner in the World Bank Yugoslavia study. Matrix values for fuel consumption and tire consumption are broken down by three vehicle types: 1) a medium car, 2) a light diesel truck (3.5-ton capacity), and 3) a heavy diesel truck (18-ton capacity). It should be noted that Wehner's factors are expressed in terms of average highway speed. These have been converted to be expressed in terms of average operating speed, which was necessary for uniformity within the computer program preparation. It should be further noted that extrapolations on Wehner's data were made to cover a larger matrix than Wehner dealt with. The factor values for the two truck types are almost identical. Therefore, the factor value for the 18-ton truck was taken as representative of all trucks. There is no basic research data relating traffic interaction to other than other vehicle operating parameters; therefore, these were not included.

Table 6.38

FACTOR COSTS FOR FUEL CONSUMPTION - TRAFFIC INTERACTION

(percent increase from fuel consumption under unrestricted traffic conditions at given average operating speed)

PASSENGER CAR

Average Highway Speed - Kph	Average Operating Speed - Kph								
	40	48	56	64	72	80	88	96	104
40									
48	2								
56	8	5							
64	18	13	5						
72	25	20	12	6					
80	37	30	20	10	4				
88	49	40	28	17	10	4			
96	64	49	37	30	16	8	2		
104	85	62	47	35	27	18	9	3	
112	85	85	65	54	45	33	23	17	10

TRUCK

Average Highway Speed - Kph	Average Operating Speed - Kph								
	40	48	56	64	72	80	88	96	104
40									
48	2								
56	3	3							
64	9	9	4						
72	20	19	13	6					
80	35	33	26	18	9				
88	59	55	46	37	25	15			
96	79	74	64	53	41	27	11		

Source: Winfrey, Economic Analysis for Highways.

Table 6.39

FACTOR COSTS FOR TIRE CONSUMPTION - TRAFFIC INTERACTION

(percent increase from tire consumption under unrestricted traffic conditions at given average operating speed)

Average Highway Speed - Kph	PASSENGER CAR Average Operating Speed - Kph								
	40	48	56	64	72	80	88	96	104
40									
48	25								
56	46	19							
64	84	49	21						
72	121	78	46	15					
80	166	112	75	33	12				
88	223	154	108	58	29	8			
96	223	215	152	91	56	30	9		
104	223	223	192	127	83	52	26	4	
112	223	223	223	166	114	77	46	20	5

Source: Winfrey, Economic Analysis for Highways.

Table 6.39 (continued)

FACTOR COSTS FOR TIRE CONSUMPTION - TRAFFIC INTERACTION

(percent increase from tire consumption under unrestricted traffic conditions at given average operating speed)

Average Highway Speed - Kph	TRUCK Average Operating Speed - Kph								
	40	48	56	64	72	80	88	96	104
40									
48	23								
56	40	16							
64	77	45	22						
72	114	73	46	15					
80	158	109	73	35	14				
88	214	154	108	63	37	17			
96	214	214	154	103	68	43	21		

Source: Winfrey, Economic Analysis for Highways.

CHAPTER 7

FUTURE DEVELOPMENT PLANS

Chapter 7

FUTURE DEVELOPMENT PLANS

7.1 FORECAST TRANSPORT DEMAND

The Consultants' macroeconomic and population forecasts and forecasts of transport demand resulting from them are presented in Volume II. This section summarizes the resulting traffic forecasts.

Passenger Traffic

The total domestic inter-zonal passenger traffic was estimated at 137 million in number and 12 billion in passenger-kilometers for 1979. Even in terms of passenger-kilometers, by which rail and air mode show higher shares because of longer average trip lengths, shares of the rail and the air mode were only 3.1 percent and 0.4 percent, respectively, reflecting the poor service availability of the rail mode and the high cost of the air mode.

By 1985 the total number of passengers would grow by 54 percent over the 1979 level, but the total passenger-kilometers would grow by 40 percent. This discrepancy is due to the fact that by 1985 all major cities in Syria will be connected by high quality highway and railway links that shorten trip distances between major cities. With the expanded railway lines it is expected that the railway would capture 12 percent of domestic passenger traffic in terms of passenger-kilometers. Table 7.1.1 summarizes 1979 passenger traffic and projections.

Non-Transit Commodity Traffic

In 1979 an estimated 44 million tons of Syria-originated or Syria-destined commodities were moved, amounting to total ton-kilometers of 11 billion, of which 42 percent was carried by trucks, 3 percent by the railway, and 55 percent by the pipeline, as shown in Table 7.1.2

Total tonnages, as shown in Table 7.1.2, indicate only modest growth rates: 2.5 percent per annum for the period 1979-1985 and 4.4 percent per annum for the period 1986-2000. These low rates of growth are largely due to stagnant pipeline transport of crude oil. Excluding pipeline tonnage, corresponding growth rates are 3.5 percent per annum and 4.7 percent per annum, respectively. These tonnages for the combined modes of the rail and the road, however, are still misleading. Table 7.1.3 shows estimated 1979 tonnages and projected 1985 and 2000 tonnages of commodities moved between zones by major commodity groups, excluding pipelines.

Table 7.1.1

PRESENT AND PROJECTED PASSENGER TRAFFIC

(in million passengers and in billion passenger-kilometers)

	Road	Rail	Air	Total
1979				
Passengers	135.8	1.32	0.13	137.3
Passenger-Kilometers	11.55	0.37	0.05	11.97
Percent Share (Passenger-Kilometers)	96.5	3.1	0.4	100.0
1985				
Passengers	203.4	7.4	0.26	211.01
Passenger Kilometers	14.7	1.95	0.12	16.77
Percent Share (Passenger-Kilometers)	88.7	11.6	0.7	100.0
2000				
Passengers	436.7	24.6	1.3	462.6
Passenger-Kilometers	32.2	5.0	0.4	37.72
Percent Share (Passenger-Kilometers)	85.6	13.2	1.2	100.0

Source: Consultants' estimates.

Table 7.1.2

PRESENT AND PROJECTED COMMODITY TRAFFIC

NON-TRANSIT TRAFFIC

(in million tons and in billion ton-kilometers)

	Road	Rail	Pipeline	Total
1979				
Tons	30.4	1.3*	12.3*	44.1
Ton-Kilometer	4.64	0.33	6.02	10.99
Percent Share (Ton-Kilometer)	42.2	3.0	54.8	100.0
1985				
Tons	33.6	5.5	12.06	51.08
Ton-Kilometer	6.6	1.7	5.7	14.08
Percent Share (Ton-Kilometer)	47.1	12.1	40.7	100.0
2000				
Tons	64.3	13.9	18.56	96.76
Ton-Kilometer	12.5	4.7	7.57	24.81
Percent Share (Ton-Kilometer)	50.4	19.0	30.6	100.0

Source: Consultants' estimates.

*Excludes railway construction materials.

Table 7.1.3

PRESENT AND PROJECTED COMMODITY TONNAGES MOVED

(in million tons)

	1979	1985		2000	
Bulk Commodities					
Sand, Gravel, and Cement Blocks	13.8	(-0.3)	13.5	(4.0)	24.3
Refined Petroleum	4.5	(4.2	5.7	(5.0)	11.8
Cement and Wheat and Barley	3.2	(6.3)	4.6	(3.9)	8.1
Intermediate Commodities	6.2	(6.3)	8.9	(5.8)	20.[illegible]
High Value Commodities	3.1	(6.5)	4.5	(5.5)	10.1
Phosphate	1.2	(4.6)	1.5	(4.6)	3.0
Total	31.9	(3.4)	39.0	(4.7)	78.2
Total Excluding Sand, Gravel, and Cement Blocks	18.1	(5.9)	25.5	(5.1)	53.9

Source: Consultants' estimates.

Note: Figures in parentheses indicate percentage growth rates per annum for the period between the years.

In terms of total tonnage the commodity group of sand, gravel, and cement blocks is by far the largest in 1979, 43 percent of the total. However, these commodities move only for a short distance, mostly within a traffic zone (Mantika) or among neighboring zones. The amounts shown in Table 7.1.3 are mostly for these moving among neighboring zones. These movements require little line-haul transport facilities.

The production of sand, gravel, and cement blocks in the 1979 and immediately preceeding years was extraordinary. The production tonnages and transport tonnages (although short distance) were far beyond the reasonable range relative to the size of the general construction industry. This phenomenon was probably due to the intensive earthwork throughout the country for highways and railways in addition to the building boom. For 1985 and after more ordinary amounts of sand, gravel, and cement blocks were estimated in line with the construction industry estimates.

By the year 2000 total ton-kilometers of non-transit commodity traffic excluding pipelines would grow 3.5 times the 1979 level and the rail mode should capture 27 percent of the total.

Transit Commodity Traffic

Uncertainties concerning the transit traffic through Syria are indeed large. Nevertheless, the results of the Consultants' analysis presented in Chapter 5 are summarized in Table 7.1.4. Excluding crude oil, growth rates of 9 percent per annum for the period 1979-1985 and 5 percent per annum for the period 1986-2000 were estimated by the Consultants in terms of total tonnage.

7.2 PASSENGER MODAL SPLIT

The Consultants' passenger modal split methodology is described in detail in Section 3.3, Chapter 3 of Volume VII. Basically, parameters are derived from existing experience to relate the rail share of traffic between each zonal-pair to the ratio of the tariff and the travel times between the rail and bus modes. Traffic by private car and by pick-up was assumed not to be a significant market for rail competition. The resultant modal split equation was determined to be for each O & D pair:

$$\frac{\text{Public transport volume} - \text{rail volume}}{\text{Rail volume}} = 0.43e\ 1.43x\ e^{0.76y}$$

Where: x = rail tariff/bus tariff
y = rail time/bus time

Table 7.1.4

PRESENT AND PROJECTED TRANSIT TRAFFIC

(in million tons and in billion ton-kilometers)

	Road	Rail	Pipeline	Total
1979				
Tons	2.93	0.16	7.40	10.49
Ton-Kilometer	1.19	0.02	3.70	4.91
Percent Share (Ton-Kilometer)	24.2	0.4	75.4	100.0
1985				
Tons	4.5	0.7	7.4	12.6
Ton-Kilometer	1.8	0.4	3.7	5.8
Percent Share (Ton-Kilometer)	30.2	6.0	63.8	100.0
2000				
Tons	8.2	2.6	7.4	18.2
Ton-Kilometer	2.9	1.4	3.7	8.0
Percent Share (Ton-Kilometer)	36.4	17.6	46.0	100.0

Source: Consultants' estimates.

This equation implies that given equal tariffs and travel times the rail share of public transport journeys would be only 21 percent. The relatively low share is not unreasonable as an average because for the shorter journeys, which predominate, the much higher frequency of bus service is a major factor. For longer journeys the equation tends to underestimate the rail share. To allow for this downward bias no modal transfer penalty was added to the rail times and, because many rail journeys actually involve a separate trip to or from the station, this is a compensating favorable factor.

The tariff ratios for 1985 and 2000 between rail and bus were calculated on two bases: for case A it was assumed that both sets of fares would be increased by 2 percent per annum in real terms from assumed 1980 base levels; for case B it was assumed that for each mode tariffs in 2000 would be equal to marginal cost. Because the bus tariff in 1980 covers only 35 percent of marginal cost whereas the rail tariff represents 53 percent, there is a relatively greater increase in bus tariffs and consequently higher rail shares in case B. To reach marginal costs by 2000 the rail tariff would need to increase by 3.1 percent annually from 1980 and the bus tariff by 5.1 percent annually. The marginal cost assumption in case B reduces total travel compared with case A by 12 percent in 2000.

In both case A and B it was assumed that the nationwide pattern of road tariffs would be more consistent in the future than it is now. It was therefore assumed that tariffs would be linear (constant passenger-kilometer rate regardless of travel distance) and the same all over the country for taxis, microbuses, and buses. For both cases a tapered railway tariff that discourages railway travel for trips of less than 100 kilometers was adopted.

It is estimated that if the Government would subsidize the whole operating deficit of passenger transport within Syria, such subsidies would reach approximately SP 1.7 billion per year by the year 2000, of which 900 million would be for large buses alone. The regular subsidies to passenger transport would then amount to about 20 percent of the GDP of the Transport and Communications Sector (or 1.5 percent of the total GDP).

The year 2000 modal split alternatives for the most economic network (maximum road and medium rail) are shown in Table 7.2.1. Two points should be noted. The first is that the passenger car share nearly doubles between 1985 and 2000, due to rising incomes. The second is a marked shift from microbuses to regular buses as greater demand permits a greater frequency of regular bus service. The shift is less in case B because total demand is less.

Table 7.2.1

YEAR 2000 PASSENGER MODAL SPLIT ALTERNATIVES

MAXIMUM ROAD, MEDIUM RAIL NETWORK

TARIFF CASE A

	Passenger Car	Pickup	Taxi	Microbus	Bus	Rail	Total
Passenger per day (000)	227.6	70.7	198.7	81.1	686.6	66.0	1,330.7
Percent	17.1	5.3	14.9	6.1	51.6	5.0	100.0
Passenger-Km per year x 10^6	8.1	1.5	5.4	2.4	19.4	4.9	41.7
Percent	19.4	3.6	12.9	5.8	46.5	11.8	100.0
Average Trip Length (Km)	97	59	74	80	77	204	85
Total Revenues (SP) x 10^6	-	-	420.9	130.5	586.7	208.7	1,346.8
Revenue per Passenger Km (piasters)			7.84	5.50	3.30	4.97	3.28

TARIFF CASE B

	Passenger Car	Pickup	Taxi	Microbus	Bus	Rail	Total
Passenger per day (000)	200.0	62.3	151.0	98.5	590.5	67.4	1,169.7
Percent	17.1	5.3	12.9	8.4	51.3	5.8	100.0
Passenger-Km per year x 10^6	7.1	1.3	3.3	3.0	16.4	5.0	36.1
Percent	19.7	3.6	9.1	8.3	45.4	13.9	100.0
Average Trip Length (Km)	97	59	60	84	77	203	85
Total Revenues (SP x 10^6	-	-	425.5	204.8	943.4	283.1	1,856.8
Revenue per Passenger-Km (piasters)			12.78	6.75	5.59	6.24	5.12

Source: Consultants' estimates.

Note: Domestic passengers only.

In case A the necessary subsidies would still be a significant SP 800 million per year by 2000, but the proportion to GDP of the transport sector (9 percent) seems more acceptable. In case B there would be no subsidies by the year 2000.

7.3 COMMODITY MODAL SPLIT

General

Given the substantial sunk costs resulting from the committed investments in expansion of the CFS railway, the economic advantages of maximizing utilization of those railway facilities are clear. As a result, the Consultants' commodity modal split methodology (presented in Section 3.2, Chapter 3, Volume VII) is based on a determination of potential railway commodity traffic, with the residual assigned to roads. The only exception is refined petroleum products, where shipment by rail vs. pipeline can be subjected to specific economic analysis. This analysis is presented in Part II, Chapter A-6 of Volume VI.

The forecast of railway commodity traffic involved three steps: projection of the future total transport market, definition of the railway network, and estimation of the rail share of each movement. A single projection of the transport market has been made, as described in Volume II. This is a simplification in that the supply/demand interaction is taken as given whereas, in fact, the provision (or lack) of additional links or services generates (or fails to generate) new traffic, particularly transit freight. Although this can be a critical factor on a particular link, for the system as a whole the network and service assumptions will have only a marginal effect on total traffic.

The railway network in operation in 1985 was assumed to include the new and reconstructed sections of the Damascus-Aleppo line and the Deir Ez Zor-Albu Kamal line. For 2000, the Lattakia-Tartous line and a standard gauge line from Damascus to Amman are assumed to be in operation. The combined CFS and CFH system is treated as a single network from 1986 onwards.

The Consultants' forecast of freight transport by commodity given in Volume II was treated for analysis purposes as five commodity groups and transit traffic. The classification of major commodities into these groups is as follows:

Group 1 - phosphate, petroleum products,

Group 2 - bulk building materials such as sand and gravel,

Group 3 - cement, cereals, other bulk goods,

Group 4 - intermediate value items: iron and steel, fertilizer, processed food stuffs, farm products, sugar beets, non-bulk building materials,

Group 5 - high value goods: manufactured products, capital equipment, live animals, meat.

In 1979, about 56 percent of railway tonnage, excluding rail construction materials, was of group 1, 2, or 3 commodities; 24 percent of group 4; 9 percent of group 5, and 11 percent was transit traffic. The share of bulk traffic will rise with the start of phosphate movements in 1980 and with a large growth projected for other bulk commodities. The CFS freight traffic plan for 1980 gives groups 1, 2, and 3 a share of a little over 68 percent of tonnage and 71 percent of ton-kilometerage.

Rail is naturally more competitive for the bulk commodities and over longer distances. Group 5 traffic is likely in the long term to be carried in volume by rail only in containers. While high shares of bulk movements are virtually certain between rail-connected points, the share of group 4 traffic that will be attracted is highly sensitive to the relative price and service qualities of road transport.

For 1985, in general, the rail share was taken to rise with distance, and limiting shares on any one origin and destination of 70 percent for groups 1 and 3, 45 percent for group 4, 35 percent for group 2, and 15 percent for group 5 were used. For phosphate movements, fuel oil from Homs to Mhardeh, and transit traffic, specific volumes were projected based on discussions with CFS officials and other sources. The total railway traffic forecast for 1985 is 6.2 million tons, 2.1 billion ton-kilometers. Of the tonnage, 75 percent is bulk commodities (group 1, 2, and 3), 12 percent group 4, 2 percent group 5, and 11 percent transit traffic

The projection thus implies the development of some new traffic by rail, apart from that due to the opening of the line to Damascus, but far less new traffic than such a large overall growth would suggest at first sight. Rail service to Tartous and Homs has been badly affected recently by line construction and reconstruction work. Given the much-improved service to be expected by 1985 and proper attention to marketing, the forecast is considered attainable.

Projections of railway freight traffic in 2000 were made with medium and high rail share alternatives. Case A1, the medium projection, is in general lower than the high case B2 by 25 percent for group 1, 20 percent for groups 2 and 3, 30 percent for group 4, and 50 percent for group 5 commodities. The

phosphate flows, the fuel oil flow from Homs to Mhardeh, and transit traffic are the same in both cases. Transit traffic growth is projected explicitly, as described in Volume II, Chapter 5. An increase in rail shares is forecast between 1985 and 2000. The scope for increases in share is far more limited than that for passenger traffic because of the shares already obtaining in 1985.

The addition of a standard gauge Hijaz line is assumed to result in transit traffic of 0.8 million tons between Tartous and Jordan/Saudi Arabia. Fuel oil movement between Homs and Al Raqqa is by pipeline for 2000, with onward distribution from Al Raqqa to Deir Ez Zor, Al Hassakeh, and Al Kamishli by rail.

The case A1 projection for 2000 results in a total tonnage of 14.1 million or 5.14 billion ton-kilometers. Of the tonnage, 69 percent is group 2 or 3 commodities, 11 percent is group 4, 2 percent is group 5, and 18 percent is transit traffic. With case B2, the most economic system alternative, traffic is 16.5 million tons, or 6.19 billion-ton kilometers.

7.4 SYSTEM ALTERNATIVES

General

The evaluation of future transport requirements for the Syrian Transport Sector was carried out by developing alternative scenarios and comparing their likely consequences.

Alternatives for 1985 began with the identification of committed projects in the existing plans. The definition of committed projects is provided in Section III.B.2.b of the Terms of Reference (TOR). All projects currently under construction or for which financing has been received or guaranteed are defined as committed projects.

These committed projects are quite extensive. All of them are planned to be completed by 1985. Considering the necessary lead time for initiating a new major transport facility construction project, it was decided that the transport network to be analyzed for the year 1985 would consist of all existing facilities and all committed projects, plus three feasible road links integral to them.

For the year 2000 several additional transport links have been identified and alternative networks have been delineated. For the combined systems of rail and road transport, evaluation processes have been performed for each of the scenarios over the period from 1980 through 2000.

The economic effects of the alternative modal splits have been determined. Investment plans for the period 1981 through 1985 have been developed for each mode based on modal economic analyses within the framework of the preferred long-term alternatives.

For the period 1986 through 2000, probable transport projects have been identified on the basis of projected traffic and the relative economic benefits determined in the preceding analyses. A more detailed discussion of this process and its component elements is presented in Chapter 4, Volume VII.

Alternative Road Infrastructures

The Syrian paved road network has been greatly expanded in the past decade. In addition, a significant number of major highways are either under construction or construction is committed. The goal of providing high quality road connections between major cities and points of traffic generation will largely be fulfilled by the time all of these projects are completed. Thus, additional independent road links are considered for 1985, and several new links are taken into account for 2000. However, a comprehensive highway betterment and maintenance program has been analyzed. The following describes this future road network and the programs.

The 1985 Road Network

In addition to the existing roads, the 1985 paved road network includes new highways and improved highways, as shown in Table 7.4.1.

Although only one set of road connections for the year 1985 has been considered, in the evaluation of alternatives, road surface conditions and road widths are different depending on the alternative. Two alternatives have been differentiated; one alternative is based on the 1985 road connection without a highway betterment and maintenance program. Another alternative analyzes the same 1985 road connection with a highway betterment and maintenance program.

The 2000 Road Network

Given the well developed 1985 road network one possible alternative for the year 2000 is to have no more additional highway links - in other words, applying the 1985 network up to the year 2000.

An alternative network for the year 2000 has been developed and includes the following new highway links in addition to the 1985 network:

Table 7.4.1

COMMITTED HIGHWAY PROJECTS TO BE COMPLETED BY 1985

Project	Distance (Kilometers)	Planned Completion
Additional carriageway, Ma'loula-Homs	105	1981
Resurfacing, Saraqueb-Aleppo	40 x 2	1981
Resurfacing, Homs-Hama	40 x 2	1981
Resurfacing, Ma'loula-Homs	105	1985
Resurfacing, Damascus-Ma'loula	50 x 2	1981
Autostrad, Damascus-Lebanese Border	40	1982
Diversion Road, Tal Kalakh	33	1981
Highway, Damascus-Jordanian Border	110	1983
Highway, Nasired-Quaryatein-Phosphate Mine	57	1981
Autostrad, Homs-Lobide	20	1980
Resurfacing, Damascus-Iraqi Border	215	1985
Highway, Tadmur-Deir Ez Zor	200	1981
Highway, Al Ghab-Ain Sharkieh-Djableh	50	1982
Highway, Akkari-Tartous	48	1981
Resurfacing, Furglus-Phosphate Mine-Swani	123	1982
Highway, Aleppo-Tal Kojak	460	1983
Bypass, Hama	10	1982
Highway, Hazano-Idleb	20	1981
Bypass, Homs	20	1985
Widening and Resurfacing, Damascus-Dera'a	110	1980
Highway, Lattakia-Tartous	90	1985
Additional Carriageway, Hama-Saraqueb[1]	97	1985
Highway Spur, Tal Abiad	30	1985
Highway, Lattakia-Ariha[1]	100	1985
Damascus Bypass	22	1985

Source: 4th Five-Year Plan, State Planning Commission, and interviews with Government officials.

1 The additional carriageway, Hama-Saraqueb, and the Lattakia-Ariha Highway are not committed under the TOR definition. However, both have been preliminarily found to be economically feasible. The economic analysis for each is set out in Volume VII.

- Hama-Al Salamieh-Al Raqqa Highway (260 kms): Growing transport needs of the northeast region will be met by the improved rail operation, the Aleppo-Tal Kojak Highway, and the Tadmur-Deir Ez Zor Highway, all to be put in service by 1985. But by the year 2000, this road link may become a necessity in order to relieve pressures on the Al Raqqa-Aleppo and the Aleppo-Hama Highway. It is reported that the Hama Mohafaza has already started constructing this link with its own crews. A link connecting this road and the Tadmur-Deir Ez Zor road in the mid-point is also included in the alternatives. It would provide an almost straight line road connection between Damascus and Al Raqqa.

- Aleppo Bypass (16.25 kms): Bypass roads around Homs and Hama are already committed for construction. A bypass road around Aleppo will likely be a necessity by the year 2000.

- Tadmur-Albu Kamal Highway (258 kms): If transit traffic to Iraq from Tartous or Beirut through Albu Kamal is great enough, cost savings by shortening the distance from Tadmur-Dier Ez Zor-Albu Kamal would justify this project.

Construction cost estimates for these links are shown in Table 7.4.2.

Highway Betterment and Maintenance Program

The Consultants' highway betterment and maintenance program is discussed in Chapter 3 above. The program is based on the geometric standards shown in Table 3.2.4.

Financial and economic unit costs were developed for the highway betterment. They vary depending upon the type of road, the terrain, and the region. Table 7.4.3 summarizes the results.

Maintenance costs were estimated as a function of the road type and the traffic volume. The resulting equations for the per kilometer annual maintenance costs are shown below:

- Asphaltic Concrete: $C = \underset{(2585)}{2900} + \underset{(0.27)}{0.34} + \underset{(603)}{678} \text{ LN } \frac{T + 300}{100}$

- Hot Mix: $C = \underset{(2243)}{2520} + \underset{(0.41)}{0.45} + \underset{(603)}{678} \text{ LN } \frac{T + 300}{100}$

- Bituminous Surface Treatment: $C = \underset{(1671)}{1898} + \underset{(0.99)}{1.13} + \underset{(603)}{678} \text{ LN } \frac{T + 300}{100}$

Table 7.4.2

CONSTRUCTION COST ESTIMATES OF HIGHWAYS INCLUDED IN YEAR 2000 ALTERNATIVE NETWORK

(Costs in million SP at 1980 prices)

Highway	Kilometers	Financial Cost	Economic Cost
Hama - Al Salamieh - Al Raqqa	260	233	207
Aleppo Bypass	17	87	77
Tadmur - Albu Kamal	258	340	299

Source: Consultants' estimates.

Table 7.4.3

FINANCIAL AND ECONOMIC UNIT COSTS OF BETTERMENT

(SP per meter^2)

		X	A	B	C[1]	
Resurfacing	Financial	8.0	8.0	6.5	2.0	
	Economic	7.0	7.0	5.7	1.7	
Widening						
Flat Terrain	Financial	161	80	46	30	(38)
	Economic	140	66	38	24	
Rolling Terrain	Financial	173	93	60	41	(51)
	Economic	144	78	50	34	
Hilly Terrain	Financial	180	123	83	62	(74)
	Economic	148	103	70	52	
Mountainous Terrain	Financial	195	138	86	76	(79)
	Economic	162	115	71	63	

Source: Consultants' estimates.

[1] Widening costs for Class C roads in Al Suweida and Dera'a Mohafazat are shown in parenthesis.

(Where T is the ADT, LN is the logarithm, and C is the per kilometer maintenance cost in Syrian pounds. Figures in parenthesis indicate the factors used for economic costs.)

Pavement surfaces deteriorate with time and the repeated movement of traffic over them. If surface conditions are measured on a scale of 1 through 9, without maintenance, a newly surfaced road with condition code 9 will eventually deteriorate to condition code 1. For the alternative, with a proper maintenance program, the following deterioration rates per year were assumed:

- for asphalt concrete surface:

  $$R = 5/(15.5 - 0.001\ ADT)$$

- for low type hot mix surface:

  $$R = 5/(9.94 - 0.0011\ ADT),$$

- for bituminous surface treatment:

  $$R = 5/(7.56 - 0.0022\ ADT)$$

(where R is the deterioration rate in points per year and ADT is the average daily traffic).

For the alternatives without a proper maintenance program it was assumed that deterioration rates would be twice as high as those shown above, and the resurfacing would be applied when the surface condition becomes the lowest grade.

Comparison of Alternative Scenarios

No alternative infrastructure developments were examined for the period up to 1985. Because of the long preparation time for any major transport facility project, only fine tuning of the transport sector will be possible as the policy alternative. Moreover, alternative passenger pricing policies (the 2 percent annual increases in relative costs and marginal cost pricing by 2000) would not result in a significant difference by 1985. Therefore, no alternative scenarios were contemplated for the period up to 1985.

For the combined system of road and rail modes in the year 2000, 12 alternative systems were tested. They are summarized in Table 7.4.4. The cost comparisons of the alternatives are shown in Table 7.4.5

Table 7.4.4

SUMMARY OF SYSTEM ALTERNATIVES

Alternative Code		Description
Series	A	Passenger transport fares of rail, taxi, microbus, and bus fixed at present levels relative to each other but increased by 2 percent per annum relative to nontransport prices.
	A0	Low rail share for commodity transport. Rail network addition to the 1985 network is the new Hijaz line only. No new highway links added to the 1985 network.
	A1	Low rail share for commodity transport. Rail network additions are the new Hijaz line and the Lattakia-Tartous line. No new highway links added to the 1985 network.
	A2	Rail the same as in A1. Highway link additions are Tadmur-Albu Kamal, Hama-Al Salamieh-Al Raqqa, and the Aleppo bypass.
Series	B	Passenger transport fares of rail, taxi, microbus, and bus will be set at economic marginal costs of each mode by the year 2000, resulting in a 4 percent per annum price increase as a whole relative to nontransport costs, and changes will occur in relative prices among the modes.
	B1	Low rail share for commodities. Rail network additions are the same in A1 and A2. Highway link additions are the same as in A0 and A1.

Table 7.4.4 (Continued)

SUMMARY OF SYSTEM ALTERNATIVES

Alternative Code		Description
Series B (Contd.)		
	B2	High rail share for commodities. Rail network additions are the same as in A1 and A2. Highway link additions are the same as in A0 and A1 and B1.
	B3	High rail share for commodities. Rail network additions are the same as in A1, A2, and B2 plus the Tadmur-Albu Kamal line. Highway link additions are the same as in A0, A1, and B2.

Note: Each alternative shown above was further divided into two alternatives, with a second digit added. The second digit 1 indicates cases without the recommended highway betterment and maintenance program and the second digit 2 indicates cases with the recommended program.

Table 7.4.5

COMBINED RAIL AND ROAD SYSTEM COSTS

(in million SP)

System Alternatives	Present Value of Total System Costs[1]	Economic Comparison Costs[2]
Without Betterment and Maintenance Program		
A01	65,128	65,128
A11	65,208	65,208
A21	65,111	65,111
B11	62,898	63,008
B21	62,813	62,923
B31	62,836	62,996
With Betterment and Maintenance Program		
A02	62,145	62,145
A12	62,225	62,225
A22	62,140	62,140
B12	59,900	60,010
B22	59,822	59,932
B32	59,890	60,000

Source: Consultants' estimates.

[1] Sums of cost streams for the period 1981-2000 discounted to 1980 at 12 percent per annum discount rate.

[2] For the B series alternatives economic costs for lost or suppressed passenger trips are added to the actual system costs. (See Table 4.4.3).

Among the system alternatives tested, alternative B22 is the least cost solution. In other words, a combination of the following policies would result in achieving the least total system economic costs for the combined rail and road transport system in Syria:

- implementing the recommended highway betterment program,

- gradually changing passenger transport fares to achieve marginal cost pricing by the year 2000,

- upgrading the rail network so that the rail mode would capture higher shares than otherwise. This includes construction of the Lattakia-Tartous line and some double tracking.

The largest cost savings come from the proposed highway betterment and maintenance program. Regardless of the other alternatives of the system components the proposed betterment program would produce a difference of SP 3 billion in terms of present value, or roughly 5 percent of the total combined costs of the rail and the road modes. If one examines the breakdown of the total system costs, the effectiveness of the highway betterment and maintenance program is obvious.

In all cases more than 63 percent of the total costs are attributable to the road vehicle direct operating costs (VOC). Any means of reducing or preventing an increase in road vehicle operating costs is also effective in reducing the total. In particular, the preventive resurfacing is the most effective since the road VOCs are very sensitive to the highway surface conditions and the cost of resurfacing is relatively inexpensive. Moreover, total costs of resurfacing are not significantly lower without the program because highways deteriorate much faster without the program and they have to be resurfaced at the bottom conditions anyway. Thus the proposed highway betterment and maintenance program would reduce the total road vehicle direct operating costs by 7 percent with little increase in highway investment costs.

In 1978 the Government owned 12 percent of the total vehicle fleet, which was heavy in buses, 39 percent, and light in trucks, 9 percent. Assuming that per vehicle annual kilometers of Government vehicles are not different from any other, it is estimated that the Government bore 13 percent of the total road vehicle operating costs in 1978. If this Government share remains stable, cost savings to the Government alone by the highway betterment and maintenance program would be SP 390 million in present value, enough to cover the cost of betterment projects.

It should be noted that VOCs were calculated not only for interzonal traffic but also local traffic on the primary road network.

The policy of gradual passenger tariff charges to achieve marginal cost pricing for all surface passenger transport modes by the year 2000 would lead to a substantial total system cost reduction, more than compensating for the suppressed passenger trips. Two factors contribute to this cost reduction.

As a proxy to establishing the long-run marginal costs a comparison of passenger-kilometer and total discounted costs in the year 2000 was made for each mode. By shifting passenger-kilometers every year from road to rail equivalent to one passenger-kilometer in the year 2000, the total present value of the rail mode increases by SP 0.33, but the total present value of the road mode decreases by SP 0.49, resulting in the reduction of the total system present value of SP 0.16. A freight traffic analysis similar to the passenger traffic was also made. In Table 7.4.5 the results show that by shifting freight ton-kilometers equivalent of one ton-kilometer in the year 2000, the present value of the rail mode increases by SP 0.22, but the present value of the road mode decreases by SP 0.30, resulting in a reduction of the total system cost present value of SP 0.08. This occurs even though earlier double tracking investments are required.

Alternative B1 and B2 carry the same number of passengers and commodity tonnages, making the comparison actually that of modal split. The data indicate that in order for the alternative B1 to become the least-cost solution, rail costs should be more than 36 percent higher than the original estimates, or conversely, road costs should be more than 36 percent less than the original estimates. It is unlikely for road costs to become less expensive in that magnitude. Under the pressure of rising energy and labor costs, the costs of the labor and energy intensive road mode would not decrease relative to others.

Rail costs depend very much on the operating efficiency. A much improved level of efficiency over the present level was assumed for all alternatives, although the assumed level is still lower than those of European railways. If the rail mode is operated at 62 percent of the efficiency assumed, the rail mode would no longer be a favorable mode when earlier double tracking is involved.

In summary the following conclusions can be drawn from the above analysis:

- The proposed highway betterment program is expected to yield high economic benefits regardless of rail operations.

- The proposed marginal cost pricing for passenger transport would result in substantial total system cost savings, not only because it would suppress excessive passenger trips but also because it would lead to a more desirable split among modes. Its effect of relieving the Government from excessive subsidies to passenger transport is also substantial.

- The rail mode is more cost efficient than the road mode under normal circumstances even when the double tracking of the Damascus-Aleppo line is involved. Efforts should be made in all areas to ensure high rail mode shares of passengers and freight through the level of service, pricing, marketing, and governmental guidances. The cost advantage of the rail mode, however, depends on the operating efficiency, which could vary widely. Efforts also must be made to achieve an operating efficiency of at least 65 percent of the level assumed in this study.

- The Tartous-Lattakia railway line should be constructed after 1985; the Tadmur-Albu Kamal railway line should not be constructed before 2000. The Aleppo Bypass, opening in 1995, and the Hama-Al Raqqa and the Tadmur-Albu Kamal highways, opening in 2000, are all economically feasible.

Evaluation of Road Modal Investments

General

Economic evaluation of road transport alternatives has been carried out in three stages.

The first stage has been performed in the context of the total transport system cost. The Consultants analyzed aggregate levels of investment on road improvements and vehicle fleet expansion and of vehicle operating costs against alternative demand levels for road transport. Proper evaluation can only be done in the context of total transport system cost.

The second stage is the evaluation of road projects for the period 1981 through 1985. Committed projects are not the subject of the detailed economic evaluation in accordance with the TOR Section III.B.2.b. Such committed projects and existing roads constitute the Consultants' base 1985 road network. There are, however, two projects that are included in the base 1985 road network but are not technically committed by the definition. They are: the Lattakia-Ariha new road and the Hama-Saraqueb second carriageway.

Feasibility studies have previously been carried out for the first two projects. The Consultants reviewed the study reports

and found their conclusions acceptable. Projects subjected to the Consultants' own economic analysis in this stage are the Hama-Saraqueb second carriageway project and projects included in the highway betterment and maintenance program. Evaluation of these projects is presented below.

The third stage is the evaluation of projects for the period 1986 through 2000. Probable projects for this period have been identified and preliminary evaluation has been carried out in terms of likely traffic volumes and possible range of benefits.

Lattakia-Ariha New Road

The Lattakia-Ariha corridor is approximately 100 kilometers in length and lies in a difficult terrain. The existing road provides a very low level of serviceability. A feasibility study of a new road for this corridor was carried out by an international consultant, Lyons Associates, in 1977-1978. Lyons Associates concluded that the proposed four-lane highway was technically and economically feasible. The total project cost was estimated at U.S. $230.6 million, including the right-of-way acquisition and the escalation from 1978 to mid-project point. The economic rate of return was calculated at 19.2 percent and the benefit-cost ratio calculated with a discount rate of 15 percent was 1.5.

The above evaluation was performed for a four-lane highway design because projected traffic volumes on project links exceeded 4,000 vehicles per day, which was the Ministry of Communication's criterion for this type of road at that time. Lyons Associates performed a comparative analysis for a staged construction of an initial two lanes and an additional two lanes. The consultant concluded that within six years all sections would require four lanes.

Again, the Consultants found that projected traffic shown in this report did not significantly differ from their own projections and that the methods used and the conclusions reached were acceptable.

Hama-Saraqueb Second Carriageway

The north-south corridor between Damascus and Aleppo is the most heavily trafficked route in Syria. A good part of it is already served by a four-lane dual carriageway and construction is underway for the remaining part to extend the dual carriageway except for the section between Hama and Saraqueb. A plan does exist for this section to complete the dual carriageway over the entire length of the corridor, but the project had not officially been funded by the middle of October 1980.

The Consultants carried out a brief study to determine the economic feasibility of constructing a parallell second carriageway for this section.

Physical characteristics of the existing and the proposed carriagways are shown in Table 7.4.6. Project costs were estimated on the basis of unit costs shown in Table 7.4.7. The costs were allocated over the construction period of five years. Benefits were calculated as the difference in vehicle operating costs with the project and without the project. The Consultants' road vehicle operating cost model was applied. Projected traffic volumes were supplied by the traffic assignment model. Road surface deterioration and periodic maintenance were assumed for the two cases of with and without the project. Details of the models have been described previously. Resultant cost and benefit streams are presented in Table 7.4.8 along with economic evaluation indicators.

At the discount rate of 12 percent per annum the net present value is estimated at SP 897 million, the benefit cost ratio at 11.3, and the economic rate of return at 60 percent. The very high level of benefit is due to relieving congestion. The project is economically feasible.

Highway Betterment and Maintenance

Methodology

A direct consequence of poor road surface or inadequate width relative to traffic levels is the higher cost of operating vehicles over such roads. The direct benefit of highway betterment and maintenance is the cost differential of vehicle operation between the cases with and without such betterment or maintenance. If the discounted present value of such benefit exceeds the present value of such cost, the betterment or maintenance operation is economically worthwhile.

A computer model for the economic evaluation of the highway betterment and maintenance program has been developed by the Consultants. It performs the following for each road link of the network:

- determines year by year ADT after accepting results from the traffic assignment model,

- calculates annual betterment costs whenever economically justifiable under the projected ADT stream following the highway betterment and maintenance program,

- calculates annual resurfacing costs when applicable under the existing practice,

Table 7.4.6

HAMA-SARAQUEB DUAL CARRIAGEWAY CHARACTERISTICS

	Existing Carriageway	Second Carriageway
Length (Kilometers)	85.5	85.5
Pavement Width (Meters)	7.3	7.3
Surface Type	A.C.	A.C.
Average Grade (Percent)	3-5	3-5
Length at Grade (Kilometers)	9.9	5.0
Number of Curves	1	0
Number of Side Frictions	10	10

1979 Two-way ADT	9560
Estimated 1985 ADT	12950
Estimated 2000 ADT	29540

Table 7.4.7

HAMA-SARAQUEB SECOND CARRIAGEWAY UNIT CONSTRUCTION COSTS

(in thousand Syrian Pounds per Kilometer)

Cost Item	Financial Costs	Economic Costs
Construction	1,232	1,084
Right-of-Way	140	140
Engineering and Control	185	185
Contingency	185	157
TOTAL	1,742	1,566

Table 7.4.8

HAMA-SARAQUEB ADDITIONAL CARRIAGEWAY ECONOMIC EVALUATION

Discount Rate	.120
Present Value of Benefits	984
Present Value of Costs	87
Net Present Value	897
Benefit Cost Ratio	11.26
Internal Rate of Return	60%

Year	Benefits	Costs	Year	Benefits	Costs
1980	0	0	2001	341	0
1981	0	0	2002	302	0
1982	0	20	2003	335	0
1983	0	33	2004	341	0
1984	0	33	2005	302	0
1985	0	40	2006	335	0
1986	153	7	2007	341	0
1987	140	0	2008	302	0
1988	157	0	2009	335	0
1989	166	0	2010	341	0
1990	153	0	2011	302	0
1991	185	0	2012	335	0
1992	207	0	2013	341	0
1993	196	0	2014	302	0
1994	228	0	2015	335	0
1995	235	0	2016	341	0
1996	225	0	2017	302	0
1997	264	0	2018	335	0
1998	283	0	2019	341	0
1999	272	0	2020	302	0
2000	318	0			

Source: Consultants' estimates.

- calculates annual maintenance costs,

- calculates annual total vehicle operating costs (VOC) as a sum of VOCs of eight vehicle types over the link for the with and for the without case.

The economic evaluation of link betterment is carried out on the basis of the first year return for the widening and on the basis of the benefit cost ratio for the resurfacing with the benefit being the VOC differential between the cases with and without the work. (The benefit-cost ratio was used for resurfacing because of its shorter life.)

The model also accumulates total system costs over the entire network to be used in the system evaluation explained above, and total costs by Mohafaza for the purpose of developing the road betterment and maintenance budget.

Priority Ranking of Primary Road Betterment Projects

Table 7.4.9 indicates the priority ranking by year of the primary road network based on the above. Only economically justifiable projects were selected. This priority ranking evaluation by year was based on the first year return (FYR):

$$FYR = \frac{\text{First Year Benefits}}{\text{Betterment Costs}}$$

The projects are listed in Table 7.4.9 in priority order by year. Where the same link shows projects in successive years, e.g., Damascus-Zabadani, it will almost certainly be advisable to combine them into a single project. This will have to be determined on a link by link basis. There may also be instances where this will apply to projects two years apart, e.g., Ma'arrat-Ariha.

7.5 RECOMMENDED INVESTMENTS

5th Five Year Development Plan

The Consultants' recommended investments for the 5th Plan period are shown in Table 7.5.1. These are public sector investments and do not include investments in the motor vehicle fleet required over the 5th Plan period, which are largely private sector investments. The Consultants' estimates of motor vehicle fleet requirements, which are discussed in Chapter 4, total SP 8 billion in foreign exchange for the 1981-1985 period.

Table 7.4.9

PRIMARY ROAD BETTERMENT PROJECT RANKING BY FIRST YEAR RETURN 1981-1985

LINK		LOCATION	MOHAFAZA	LENGTH (KM)	OPERATION	RANKING 1981	1982	1983	1984	1985
1601	1604	DAMASCUS-ZABADANI	DAMASCUS	.80	RESUR. +WDNNG	1	48	0	0	0
3107	3109	IFRIN-IDLEB	ALOPPO	11.70	RESURFACING	2	0	0	0	0
2502	2505	MISSIAF-BANIAS	TARTOUS	27.10	RESUR. +WDNNG	3	25	0	0	0
115	2502	MISSIAF-BANIAS	TARTOUS	4.30	RESURFACING	4	0	0	0	0
2401	2402	MISSIAF-HAMA	HAMA	33.10	RESUR. +WDNNG	5	0	0	3	0
3909	3910	KAMISHLI-RAS AL AIN	AL HASSAKE	40	RESUR. +WDNNG	6	0	2	0	0
3109	3112	IFRIN-IDLEB	ALOPPO	26.50	RESUR. +WDNNG	7	23	0	0	0
518	519	SARAQUEB-AL MA'ARRAT	IDLEB	.50	RESURFACING	8	0	0	0	0
150	103	KASSAB-LATTAKIA	LATTAKIA	16.90	RESUR. +WDNNG	9	53	0	0	0
307	3608	RADDA-TAL ABIAD	AL RADDA	6.00	RESURFACING	10	0	0	0	0
3201	3202	IFRIN-TURKEY BORDER	ALOPPO	21.50	RESURFACING	11	0	0	0	0
3103	3104	ALEPPO-IZAZ	ALOPPO	1.00	RESUR. +WDNNG	12	10	0	0	0
2406	2101	HOMS-MISSIAF	HAMA	20.80	RESURFACING	13	0	0	0	0
3101	3103	ALEPPO-IZAZ	ALOPPO	25.10	RESURFACING	14	0	0	0	0
3112	504	IFRIN-IDLEB	ALOPPO	7.20	RESURFACING	15	0	0	0	0
129	130	LEB BORDER-TARTOUS	TARTOUS	11.20	RESURFACING	16	0	0	0	0
3410	3411	MANBJ JARABLUS	ALOPPO	34.70	RESURFACING	17	0	0	0	0
103	105	KASSAB-LATTAKIA	LATTAKIA	9.60	RESURFACING	18	0	0	0	0
2914	2915	IDLEB-HAREM	IDLEB	2.60	RESURFACING	19	0	0	0	0

Table 7.4.9 (Cont'd)

PRIMARY ROAD BETTERMENT PROJECT RANKING BY FIRST YEAR RETURN 1981-1985

LINK		LOCATION	MOHAFAZA	LENGTH (KM)	OPERATION	RANKING 1981	1982	1983	1984	1985
1609	1610	DAMASCUS-ZABADANI	DAMASCUS	.70	WDNNG. +RESUR	20	1	0	0	0
2601	2606	SUQAILBIEH-HAMA	HAMA	42.50	RESURFACING	21	0	0	0	0
505	506	BAB AL HAWA-ALEPPO	ALOPPO	1.90	RESURFACING	22	0	0	0	0
2204	2205	SALAMIA-HOMS	HOMS	2.40	RESUR +WDNNG	23	0	7	0	0
224	517	TAFTANAZ-MA'ARRAT	IDLEB	3.00	RESURFACING	24	0	0	0	0
3901	3905	KAMISHLI-RAS AL AIN	AL HASSAKE	26.20	RESURFACING	25	0	0	0	0
3104	3105	ALEPPO-IZAZ	ALOPPO	20.00	RESURFACING	26	0	0	0	0
2403	2404	MISSIAF-HAMA	HAMA	6.60	RESURFACING	27	0	0	0	0
3905	3906	KAMISHLI-RAS AL AIN	AL HASSAKE	.40	RESUR. +WDNNG	28	21	0	0	0
3906	3909	KAMISHLI-RAS AL AIN	AL HASSAKE	7.70	RESURFACING	29	0	0	0	0
224	2902	TAFTANAZ-IDLEB	IDLEB	14.30	RESURFACING	30	0	0	0	0
3202	3203	IFRIN-TURKEY BORDER	ALOPPO	8.90	RESUR. +WDNNG	31	29	0	0	0
2103	2204	SALAMIA-MISSIAF	HOMS	48.30	RESURFACING	32	0	0	0	0
751	708	DER EZ ZOR-AL HASSAKEH	DIER EZ ZOR	64.10	RESURFACING	33	0	0	0	0
316	325	AL RAQQA-DER EZ ZOR	DIER EZ ZOR	62.30	RESURFACING	34	0	0	0	0
2911	2914	IDLEB-HAREM	IDLEB	9.60	RESUR. +WDNNG	35	34	0	0	0
308	316	AL RAQQA-DER EZ ZOR	AL RAQQA	59.90	RESURFACING	36	0	0	0	0
812	816	DAMASCUS-TADMUR	DAMASCUS	83.40	RESURFACING	37	0	0	0	0
3910	3925	KAMISHLI-RAS AL AIN	AL HASSAKE	75.60	RESURFACING	38	0	0	0	0

Table 7.4.9 (Cont'd)

PRIMARY ROAD BETTERMENT PROJECT RANKING BY FIRST YEAR RETURN 1981-1985

LINK		LOCATION	MOHAFAZA	LENGTH (KM)	OPERATION	RANKING 1981	1982	1983	1984	1985
1424	1411	SUWEIDA-BOUSRA	AL SWEIDA	1.30	WDNNG +RESUR	39	13	0	0	0
1105	1107	IFRIN-IZAZ	ALOPPO	9.50	RESUR +WDNNG	40	22	0	0	0
1601	1604	RAQQA-TAL ABIAD	AL RAQQA	56.10	RESURFACING	41	0	0	0	0
709	717	DER EZ ZOR-AL HASSAKEH	AL HASSAKE	107.20	RESURFACING	42	0	0	0	0
740	719	ALMAYADIN-ABU KAMAL	DIER EZ ZOR	86.80	RESURFACING	43	0	0	0	0
1310	906	IZRA' - QUNEITRA	QUNEITRA	15.00	RESURFACING	44	0	0	0	0
508	2903	IDLEB-ALEPPO	IDLEB	33.70	RESURFACING	45	0	0	0	0
2606	2401	SUQAILBIEH-HAMA	HAMA	30.80	RESURFACING	46	0	0	0	0
2906	2911	IDLEB-HAREM	IDLEB	20.40	RESURFACING	47	0	0	0	0
2205	2206	SALAMIA-HOMS	HOMS	7.70	RESUR. +WDNNG	48	42	0	0	0
1102	1103	SALKHAD-BOUSRA	AL SWEIDA	13.00	RESURFACING	49	0	0	0	0
3503	3504	IZAZ-TURKEY BORDER	ALOPPO	4.40	RESURFACING	50	0	0	0	0
2206	2209	SALAMIA-HOMS	HAMA	16.50	RESURFACING	51	0	0	0	0
2802	2802	MA'ARRAT-AFIHA	IDLEB	2.30	WDNNG. +RESUR	52	0	1	0	0
2505	2405	MISSIAF-BANIAS	HAMA	15.10	RESURFACING	53	0	0	0	0
2905	2906	IDLEB-HAREM	IDLEB	4.50	RESUR. +WDNNG	54	51	0	0	0
1002	502	BAB AL HAWA-ALEPPO	IDLEB	8.60	RESURFACING	55	0	0	0	0
701	603	ABU ALSHAMAT-TADMUR	HOMS	41.10	RESURFACING	56	0	0	0	0
301	302	ALEPPO-EAST OF ALEPPO	ALOPPO	10.00	RESURFACING	57	0	0	0	0

Table 7.4.9 (Cont'd)

PRIMARY ROAD BETTERMENT PROJECT RANKING BY FIRST YEAR RETURN 1981-1985

LINK		LOCATION	MOHAFAZA	LENGTH (KM)	OPERATION	RANKING 1981	1982	1983	1984	1985
2407	121	MISSIAF-TARTOUS	TARTOUS	40.50	RESURFACING	58	0	0	0	0
1102	1110	AL SUWEIDA-QUNEITRA	DARAA	71.00	RESURFACING	59	0	0	0	0
2612	2613	JISR SHUGHOUR-HARM	IDLEB	.60	RESURFACING	60	0	0	0	0
2406	2407	MISSIAF-TARTOUS	HAMA	14.50	RESURFACING	61	0	0	0	0
106	107	LATTAKIA-KASSAB	LATTAKIA	13.20	RESURFACING	62	0	0	0	0
1301	1302	AL SUWEIDA-IZRA'	AL SWEIDA	5.50	RESUR. +WDNNG	63	41	0	0	0
105	106	KASSAB-LATTAKIA	LATTAKIA	13.40	RESUR. +WDNNG	64	55	0	0	0
2613	2614	JISR SHUGHOUR-HARM	IDLEB	19.20	WIDENING	65	0	0	0	0
2611	2612	JISR SHUGHOUR-HARM	IDLEB	24.20	RESURFACING	66	0	0	0	0
2805	2806	IDLEB-ARIHA	IDLEB	9.00	WIDENING	67	0	0	0	0
2619	2620	HARM-ALEPPO	IDLEB	25.00	WIDENING	68	0	0	0	0
333	340	DER EZ ZOR-AL MAYADIN	DIER EZ ZOR	4.00	WDNNG. +RESUR	69	17	0	0	0
1609	1610	DAMASCUS-ZABADANI	DAMASCUS	.70	WDNNG. +RESUR	20	1	0	0	0
803	1601	DAMASCUS-ZABADANI	DAMASCUS	5.90	WIDENING	0	2	0	0	0
517	518	SARAQUEB-AL MA'ARRAT	IDLEB	3.40	RESURFACING	0	3	0	0	0
521	522	MA'ARRAT-HAMA	HAMA	2.40	RESURFACING	0	4	0	0	0
511	512	BAB AL HAWA-ALEPPO	ALOPPO	2.40	RESUR. +WDNNG	0	5	15	0	0
1501	1504	DAMASCUS-AEROPORT	DAMASCUS	21.70	RESURFACING	0	6	0	0	0
802	1608	DAMASCUS-ZABADANI	DAMASCUS	2.00	RESUR. +WDNNG	0	7	6	0	0

Table 7.4.9 (Cont'd)

PRIMARY ROAD BETTERMENT PROJECT RANKING BY FIRST YEAR RETURN 1981-1985

LINK		LOCATION	MUHAFAZA	LENGTH (KM)	OPERATION	RANKING 1981	1982	1983	1984	1985
2011	2012	SAFITA-TARTOUS	TARTOUS	5.70	RESURFACING	0	8	0	0	0
2009	2010	SAFITA-TARTOUS	TARTOUS	6.50	RESURFACING	0	9	0	0	0
3101	3104	ALEPPO-IZAZ	ALOPPO	1.00	RESUR.+WDNNG	12	10	0	0	0
501	504	BAB AL HAWA-ALEPPO	IDLEB	2.00	RESURFACING	0	11	0	0	0
504	505	BAB AL HAWA-ALEPPO	ALOPPO	4.60	RESURFACING	0	12	0	0	0
1420	1421	SUWEIDA-BOUSRA	AL SWEIDA	1.30	WDNNG.+RESUR	39	13	0	0	0
1421	1101	SUWEIDA-BOUSRA	AL SWEIDA	15.70	RESURFACING	0	14	0	0	0
2620	503	HARM-ALEPPO	IDLEB	4.00	RESURFACING	0	15	0	0	0
905	911	DAMASCUS-QUNEITRA	QUNEITRA	27.00	RESURFACING	0	16	0	0	0
333	340	DER EZ ZOR-AL MAYADIN	DIER EZ ZOR	4.00	WDNNG.+RESUR	69	17	0	0	0
2007	2009	SAFITA-TARTOUS	TARTOUS	2.70	RESUR.+WDNNG	0	18	12	0	0
506	511	BAB AL HAWA-ALEPPO	ALOPPO	23.50	RESURFACING	0	19	0	0	0
902	905	DAMASCUS-QUNEITRA	DAMASCUS	23.40	RESURFACING	0	20	0	0	0
3905	3906	KAMISHLI-RAS AL AIN	AL HASSAKE	.40	RESUR.+WDNNG	28	21	0	0	0
3105	3107	IFRIN-IZAZ	ALOPPO	9.50	RESUR.+WDNNG	40	22	0	0	0
3109	3112	IFRIN-IDLEB	ALOPPO	26.50	RESUR.+WDNNG	7	23	0	0	0
719	721	HASSAKEH-KAMISHLI	AL HASSAKE	65.30	RESURFACING	0	24	0	0	0
2502	2505	MISSIAF-BANIAS	TARTOUS	27.10	RESUR.+WDNNG	3	25	0	0	0
1603	1604	DAMASCUS-ZABADANI	DAMASCUS	11.70	RESURFACING	0	26	0	0	0

Table 7.4.9 (Cont'd)

PRIMARY ROAD BETTERMENT PROJECT RANKNG BY FIRST YEAR RETURN 1981-1985

LINK		LOCATION	MOHAFAZA	LENGTH (KM)	OPERATION	RANKING 1981	1982	1983	1984	1985
3106	3501	IZAZ-IFRIN	ALOPPO	3.20	RESURFACING	0	27	0	0	0
1408	1420	DAMASCUS-AL SUWEIDA	AL SWEIDA	62.70	RESURFACING	0	28	0	0	0
3202	3203	IFRIN-TURKEY BORDER	ALOPPO	8.90	RESUR. +WDNNG	31	29	0	0	0
1407	1408	DAMASCUS-AL SUWEIDA	DARAA	7.50	RESURFACING	0	30	0	0	0.
1404	1407	DAMASCUS-AL SUWEIDA	DAMASCUS	23.30	RESURFACING	0	31	0	0	0
2202	2303	SALAMIA-HAMA	HAMA	29.10	RESURFACING	0	32	0	0	0
2608	2609	SUQAILBIEH-JISR SHUGH.	HAMA	20.50	RESURFACING	0	33	0	0	0
2911	2914	IDLEB-HAREM	IDLEB	9.60	RESUR. +WDNNG	35	34	0	0	0
325	333	DER EZ ZOR-AL MAYADIN	DIER EZ ZOR	40.60	RESURFACING	0	35	0	0	0
602	603	TADMUR	HOMS	1.10	RESURFACING	0	36	0	0	0
2609	2610	SUQAILBIEH-JISR SHUGHOUR	IDLEB	8.00	RESURFACING	0	37	0	0	0
2012	128	SAFITA-TARTOUS	TARTOUS	2.10	RESUR. +WDNNG	0	38	4	0	0
303	304	AL TABKAH-ALEPPO	ALOPPO	93.10	RESURFACING	0	39	0	0	0
304	308	TABKAH-AL RAQQA	AL RAQQA	78.10	RESURFACING	0	40	0	0	0
1301	1302	AL SUWEIDA-IZRA'	AL SWEIDA	5.50	RESUR. +WDNNG	63	41	0	0	0
2205	2206	SALAMIA-HOMS	HOMS	7.70	RESUR. +WDNNG	48	42	0	0	0
1104	1105	SALKHAD-BOUSRA	DARAA	4.50	RESURFACING	0	43	0	0	0
2606	2607	SUQAILBIEH-JISR SHUGH.	HAMA	5.20	RESURFACING	0	44	0	0	0
221	222	ARIHA-SARAQUEB	IDLEB	2.70	RESURFACING	0	45	0	0	0

Table 7.4.9 (Cont'd)

PRIMARY ROAD BETTERMENT PROJECT RANKING BY FIRST YEAR RETURN 1981-1985

LIN		L O C A T I O N	MOHAFAZA	LENGTH (KM)	OPERATION	P 1981	A 1982	N 1983	K 1984	I 1985	N G
2607	2608	SUQAILBIEH-JISR SHUGH	HAMA	21.70	RESUR +WDNNG	0	46	19	0	0	
1105	1106	SALKHAD-BOUSRA	DARAA	1.10	RESUR +WDNNG	0	47	8	0	0	
1603	1604	DAMASCUS-ZABADANI	DAMASCUS	.80	RESUR +WDNNG	1	48	0	0	0	
1106	1109	BOUSRA-DERA'A	DARAA	25.90	RESURFACING	0	49	0	0	0.	
584	1901	HOMS-ALOUSEIR	HOMS	25.90	RESURFACING	0	50	0	0	0	
2905	2906	IDLEB-HAREM	IDLEB	4.50	RESUR +WDNNG	54	51	0	0	0	
1103	1104	SALKHAD-BOUSRA	AL SWEIDA	3.40	RESURFACING	0	52	0	0	0	
150	102	KASSAB-LATTAKIA	LATTAKIA	16.90	RESUR +WDNNG	9	53	0	0	0	
1401	1402	DAMASCUS-AL SUWEIDA	DAMASCUS	5.80	RESURFACING	0	54	0	0	0	
105	106	KASSAB-LATTAKIA	LATTAKIA	13.40	RESUR +WDNNG	64	55	0	0	0	
2010	2011	SAFITA-TARTOUS	TARTOUS	4.30	RESUR +WDNNG	0	56	20	0	0	
1402	1404	DAMASCUS-AL SUWEIDA	DAMASCUS	.80	RESUR +WDNNG	0	57	21	0	0	
565	566	DAMASCUS-DERA'A	DAMASCUS	2.60	WIDENING	0	58	0	0	0	
2802	2803	MA'ARRAT-ARIHA	IDLEB	2.30	WDNNG +RESUR	52	0	1	0	0	
3909	3910	KAMISHLI-RAS AL AIN	AL HASSAKE	.40	RESUR +WDNNG	6	0	2	0	0	
816	819	ABU AL SHAMAT-TANF	HOMS	170.80	RESURFACING	0	0	3	0	0	
2012	123	SAFITA-TARTOUS	TARTOUS	2.10	RESUR +WDNNG	0	38	4	0	0	
2004	2005	HOMS-SAFITA	TARTOUS	.10	RESUR +WDNNG	0	0	5	10	0	
802	1603	DAMASCUS-ZABADANI	DAMASCUS	2.00	RESUR +WDNNG	0	7	6	0	0	

Table 7.4.9 (Cont'd)

PRIMARY ROAD BETTERMENT PROJECT RANKNG BY FIRST YEAR RETURN 1981-1985

LINK		LOCATION	MOHAFAZA	LENGTH (KM)	OPERATION	RANKING 1981	1982	1983	1984	1985
2204	2205	SALAMIA-HOMS	HOMS	2.40	RESUR. +WDNNG	23	0	7	0	0
1105	1106	SALKHAD-BOUSRA	DARAA	1.10	RESUR. +WDNNG	0	47	8	0	0
2616	2619	JISR SHUGHOUR-HARM	IDLEB	10.40	RESURFACING	0	0	9	0	0
502	503	BAB AL HAWA-ALEPPO	IDLEB	4.60	RESURFACING	0	0	10	0	0
406	407	HOMS-TAL KALAKH	HOMS	35.10	RESURFACING	0	0	11	0	0
2007	2008	SAFITA-TARTOUS	TARTOUS	2.70	RESUR. +WDNNG	0	18	12	0	0
2801	2802	MA'ARRAT-ARIHA	IDLEB	20.30	RESURFACING	0	0	13	0	0
409	411	HOMS-TAL KALAKH	HOMS	7.60	RESUR. +WDNNG	0	0	14	4	0
511	512	BAB AL HAWA-ALEPPO	ALOPPO	2.40	RESUR. +WDNNG	0	5	15	0	0
412	2001	HOMS-SAFITA	HOMS	11.20	RESUR. +WDNNG	0	0	16	0	14
559	812	DAMASCUS-ABU AL SHAMAT	DAMASCUS	6.80	RESURFACING	0	0	17	0	0
2001	2002	HOMS-SAFITA	HOMS	2.20	RESURFACING	0	0	18	0	0
2607	2608	SUQAILBIEH-JISR SHUGH.	HAMA	21.70	RESUR. +WDNNG	0	46	19	0	0
2010	2011	SAFITA-TARTOUS	TARTOUS	4.30	RESUR. +WDNNG	0	56	20	0	0
1403	1404	DAMASCUS-AL SUWEIDA	DAMASCUS	.80	RESUR. +WDNNG	0	57	21	0	0
2005	2007	HOMS-SAFITA	TARTOUS	19.90	RESURFACING	0	0	22	0	0
2002	2004	HOMS-SAFITA	HOMS	26.30	RESUR. +WDNNG	0	0	23	12	0
1605	1606	DAMASCUS-ZABADANI	DAMASCUS	1.00	RESURFACING	0	0	0	1	0
1601	1603	DAMASCUS-ZABADANI	DAMASCUS	1.20	RESURFACING	0	0	0	2	0

Table 7.4.9 (Cont'd)

PRIMARY ROAD BETTERMENT PROJECT RANKING BY FIRST YEAR RETURN 1981-1985

LIN		L O C A T I O N	MOHAFAZA	LENGTH (KM)	OPERATION	R A N K I N G 1981	1982	1983	1984	1985
2401	2403	MISSIAF-HAMA	HAMA	33.10	RESUR.+WDNNG	5	0	0	3	0
409	411	HOMS-TAL KALAKH	HOMS	7.60	RESUR.+WDNNG	0	0	14	4	0
567	1003	DAMASCUS-DERA'A	DAMASCUS	9.90	RESURFACING	0	0	0	5	0
818	701	ABU ALSHAMAT-TADMUR	HOMS	54.00	RESURFACING	0	0	0	6	0.
223	224	ARIHA-SARAQUEB	IDLEB	18.20	RESURFACING	0	0	0	7	0
109	213	LATTAKIA-JISR SHUGHOUR	LATTAKIA	60.70	RESURFACING	0	0	0	8	0
1607	1608	DAMASCUS-ZABADANI	DAMASCUS	6.60	RESURFACING	0	0	0	9	0
2004	2005	HOMS-SAFITA	TARTOUS	.10	RESUR.+WDNNG	0	0	5	10	0
213	214	LATTAKIA-JISR SHUGHOUR	IDLEB	10.40	RESURFACING	0	0	0	11	0
2002	2004	HOMS-SAFITA	HOMS	26.30	RESUR.+WDNNG	0	0	23	12	0
738	4001	YA'ROUBIA-MALKIAH	AL HASSAKE	34.00	RESURFACING	0	0	0	0	1
519	521	SARAQUEB-AL MA'ARRAT	IDLEB	81.60	RESURFACING	0	0	0	0	2
2604	2605	RAQQA-TAL ABIAD	AL RAQQA	11.60	RESURFACING	2	0	0	0	3
121	112	JABLEH-BANIAS	LATTAKIA	22.20	RESURFACING	0	0	0	0	4
731	737	HASSAKEH-YA'ROUBIA	AL HASSAKE	28.40	RESURFACING	0	0	0	0	5
801	802	DAMASCUS-LEB. BORDER	DAMASCUS	28.00	RESURFACING	0	0	0	0	6
123	124	TARTOUS-BANIAS	TARTOUS	2.20	RESURFACING	0	0	0	0	7
803	805	DAMASCUS-LEB. BORDER	DAMASCUS	4.60	RESURFACING	0	0	0	0	8
112	114	JABLEH-BANIAS	TARTOUS	4.40	RESURFACING	0	0	0	0	9

Table 7.4-9 (Cont'd)

PRIMARY ROAD BETTERMENT PROJECT RANKNG BY FIRST YEAR RETURN 1981-1985

LINK		LOCATION	MOHAFAZA	LENGTH (KM)	OPERATION	RANKING 1981	1982	1983	1984	1985
128	129	TARTOUS-LEB. BORDER	TARTOUS	14.30	RESURFACING	0	0	0	0	10
1002	578	DAMASCUS-DERA'A	DARAA	52.60	RESURFACING	0	0	0	0	11
216	219	JISR AL SHUGHOUR-ARIHA	IDLEB	40.70	RESURFACING	0	0	0	0	12
120	122	BANIAS-TARTOUS	TARTO'US	4.70	RESURFACING	0	0	0	0	13.
412	2001	HOMS-SAFITA	HOMS	11.20	RESUR.+WDNNG	0	0	16	0	14
402	407	HOMS-TAL KALAKH	HOMS	45.20	RESURFACING	0	0	0	0	15
224	516	ARIHA-SARAQUEB	IDLEB	2.20	RESURFACING	0	0	0	0	16
598	1020	NABEK-HOMS	HOMS	2.20	RESURFACING	0	0	0	0	17
593	1015	DAMASCUS-NABEK	DAMASCUS	4.75	RESURFACING	0	0	0	0	18
591	592	DAMASCUS-NABEK	DAMASCUS	.25	RESURFACING	0	0	0	0	19
594	595	NABEK-HOMS	HOMS	21.75	RESURFACING	0	0	0	0	20
596	597	NABEK-HOMS	HOMS	5.90	RESURFACING	0	0	0	0	21

Source: Consultants' estimates.

Table 7.5.1

PROPOSED ROAD DEVELOPMENT PLAN 1981-1985, BY PROJECTS

(1979 SP - Millions)

	1981	1982	1983	1984	1985	Total
Primary Network						
A. Projects Carried Forward						
1. Damascus-Aleppo Autostrad						
Ma'loula-Homs 2nd Road	21.0					21.0
Aleppo-Saraqueb	12.0					12.0
Homs-Hama	11.7					11.7
Damascus-Ma'loula Jct.	10.0					10.0
Hama-Saraqueb, 2nd Road	33.3	33.3	33.2	33.2		133.0
Homs Bypass	8.0					8.0
Hama Bypass	2.0					2.0
Ma'loula-Homs Resurface	15.0	11.8				26.8
Total	113.0	45.1	33.2	33.2		224.5
2. Second Group Autostrad						
Damascus-Jordan Border	30.0	70.0	70.0	90.0	40.0	300.0
Damascus-Lebanon Border	22.4					22.4
Tal-Kalakh Diversion	20.0	20.0	9.0			49.0
Akkari-Tartous	25.0	20.0	20.0	20.0	18.0	103.0
Tartous-Lattakia	10.0	35.0	60.0	60.0	82.0	247.0
Lattakia-Ariha	25.0	55.0	85.0	90.0	127.0	382.0
Total	132.4	200.0	244.0	260.0	267.0	1,103.4
3. Aleppo-Tal Kojak						
Aleppo-Kara Kojak	15.0	20.0	25.0	30.0	15.0	105.0
Kara Kojak-Ain Issa	10.0	14.0				24.0
Kantari-Tal Tamer	15.0	20.0	9.0			44.0
Tal Tamer-Tal Alo	15.0	30.0	30.0	35.0	47.3	157.3
Tal Alo-Tal Kojak	8.9					8.9
Total	63.9	84.0	64.0	65.0	62.3	339.2

Table 7.5.1 (Continued)

PROPOSED ROAD DEVELOPMENT PLAN, 1981-1985, BY PROJECTS

(1979 SP - Millions)

	1981	1982	1983	1984	1985	Total
4. Other						
Jableh-Ain Sharkieh	10.0	20.0	15.0			45.0
Nasrieh-Qariatain Phosphate	8.0	10.0	10.0	3.0		31.0
Damascus-Baghdad	6.6					6.6
Tadmur-Deir Ez Zor	15.0	15.0	10.0			40.0
Furglos-Phosphate	5.0	8.0				13.0
Damascus Bypass	80.0	130.0	110.0			320.0
Total	124.6	183.0	145.0	3.0		455.6
Total Projects carried Forward	433.9	512.1	486.2	361.2	329.3	2,122.7
B. New Projects						
5. Primary roads-betterment program	34.3	43.7	6.9	13.7	12.0	110.6
6. Secondary and tertiary roads-new roads	84.0	84.0	85.0	86.0	87.0	426.0
7. Secondary and tertiary roads-betterment program	32.7	23.6	45.8	52.7	49.0	203.8
8. Rural Roads	75.0	62.1	61.1	61.1	42.3	301.6
Total New Projects	226.0	213.4	198.8	213.5	190.3	1,042.0
Total Road	659.9	725.5	685.0	574.7	519.6	3,164.7

Source: Consultants' estimates.

Priorities

For the 5th Plan period, the Consultants recommend the following order of priorities, for the reasons given:

1. Committed projects. These are specified in the Terms of Reference.

2. Equipment needed to utilize existing and committed transport facilities. Port equipment shows a net present value of benefits over costs of SP 24 million over a 10-year period. The rail equipment and road vehicles are essential for utilization of the facilities, given forecast demand. The mix recommended is based on the least total system cost alternative, as discussed above.

3. Air navigation equipment. This equipment cannot be justified or ranked based on economic analysis. The equipment recommended is that required to bring the system up to agreed international standards.

4. Two new primary road links. These links are integral parts of otherwise committed projects and each of these shows a high economic rate of return. The rates are:

   - Lattakia-Ariha: 19.2
   - Hama-Saraqueb: 60.0

5. Road betterment program. Over a 40-year period, the road betterment program produces net present benefits that exceed net present costs by SP 3 billion. A nationwide priority ranking of individual primary road sections is shown in Table 7.4.9 above. The ranking is based on the first-year return of each project.

6. New secondary and tertiary roads. The Syrian paved road network has doubled in the last 10 years, and 31 percent of the network currently has average daily traffic volumes of less than 400 vehicles per day. These facts support the conclusion that secondary and tertiary road construction in the 5th Plan period should consist of upgrading existing earth roads to gravel standards and constructing 1,045 kilometers of new gravel and rural access roads. (The supporting analysis is presented in Section 3.5, Chapter 3 of Volume IV.) Analysis of the benefits of improved or additional rural access roads must be done on a link by link basis. The preferred methodology is an analysis of development potential in the area influenced by the road. Even if

the requisite data were available, the level of analysis would be beyond the scope of a national transport study. Studies elsewhere indicate that rural access roads can have a significant social and economic development impact. However, in the absence of specific benefit data, the Consultants consider that the rural access roads, as a group, should have a lower priority than the paved road betterment program with its high net present benefits over costs.

7. Domestic air service. If necessary, infrastructure improvements at domestic airports are included; the net present value of costs for a domestic air service substantially exceeds benefits. The system as a whole can only be justified on sociopolitical grounds.

Road Betterment and Maintenance

The 1981 through 1985 financial investment cost of the primary road betterment program and the estimated primary road maintenance costs by Mohafaza and for the whole country are in Table 7.5.2. Width and surface condition deficiencies in the primary network have been evaluated for the 1981 through 1985 period. Maintenance costs were derived from forecast pavement deterioration based on projected average daily traffic. The network evaluated is in the existing 1979 network plus projects to be constructed during the 5th Five-Year Plan period.

In summary, the total cost is SP 225 million (betterment SP 110 million, or 49 percent, and maintenance SP 115 million, or 51 percent).

Table 7.5.3 shows the 1981-1985 financial investments for the road betterment program and the estimated maintenance costs for secondary and tertiary roads by Mohafaza and for the country as a whole. The methodology is the same as that used for primary roads, applied to the existing network.

In summary, the total cost is SP 393 million (betterment, SP 204 million or 52 percent, and maintenance, SP 189 million or 48 percent).

Probable Transport Investments 1986-2000

The Consultants' forecast of probable investment requirements for roads for the period 1986-2000 is shown by plan period in Table 7.5.4.

Table 7.5.2

FINANCIAL COSTS OF PRIMARY ROAD BETTERMENT/MAINTENANCE PROGRAM 1981-1985

Mohafaza	Type of Operation	1981	1982	1983	1984	1985	Total
Damascus	Resurfacing	1,208	5,908	238	702	2,905	10,961
	Widening	81	771	140			992
	Betterment Total	1,289	6,679	377	702	2,905	11,953
	Maintenance	2,276	2,294	2,317	2,344	3,088	12,319
	Total	3,565	8,973	2,694	3,047	5,993	24,272
Aleppo	Resurfacing	6,326	5,729				12,056
	Widening		4,174	197			4,371
	Betterment Total	6,326	9,904	197			16,427
	Maintenance	2,528	2,517	2,510	2,519	3,070	13,144
	Total	8,855	12,421	2,707	2,519	3,070	29,571
Homs	Resurfacing	1,270	1,465	1,777	775		5,287
	Widening		195	86	1,745	401	2,426
	Betterment Total	1,270	1,659	1,863	2,520	401	7,713
	Maintenance	3,786	3,811	3,845	3,817	5,613	20,873
	Total	5,056	5,471	5,708	6,337	6,014	28,586
Hama	Resurfacing	3,671	3,117				6,787
	Widening			889	1,905		2,793
	Betterment Total	3,671	3,117	889	1,905		9,580
	Maintenance	1,545	1,533	1,541	1,553	1,921	8,093
	Total	5,216	4,649	2,429	3,457	1,921	17,673
Lattakia	Resurfacing	585			5,668		6,253
	Widening		1,855				1,855
	Betterment Total	585	1,855		5,668		8,108
	Maintenance	842	831	826	825	1,320	4,644
	Total	1,427	2,686	826	6,493	1,320	12,751

Table 7.5.2 (Continued)

FINANCIAL COSTS OF PRIMARY ROAD BETTERMENT/MAINTENANCE PROGRAM, 1981-1985

Mohafaza	Type of Operation	1981	1982	1983	1984	1985	Total
Dera'a	Resurfacing	1,046	2,027				3,073
	Widening			34			34
	Betterment Total	1,046	2,027	34			3,108
	Maintenance	1,084	1,073	1,057	1,045	1,771	6,030
	Total	2,130	3,100	1,091	1,045	1,771	9,137
Tartous	Resurfacing	980	754	1,134			2,868
	Widening		1,798	367	4		2,169
	Betterment Total	980	2,552	1,501	4		5,036
	Maintenance	1,095	1,102	1,114	1,128	1,675	6,114
	Total	2,074	3,654	2,615	1,132	1,675	11,150
Quneitra	Resurfacing	177	1,261				1,438
	Widening						
	Betterment Total	177	1,261				1,438
	Maintenance	487	491	496	502	508	2,484
	Total	664	1,752	496	502	508	3,921
All Country	Resurfacing	25,813	33,970	4,995	9,816	11,596	86,190
	Widening	8,500	9,710	1,882	3,874	401	24,368
	Betterment Total	34,314	43,680	6,877	13,690	11,997	110,558
	Maintenance	21,344	21,357	21,417	21,465	29,230	114,813
	Total	55,657	65,037	28,294	35,155	41,227	225,371

Source: Consultants' estimates.

Table 7.5.2 (Continued)

FINANCIAL COSTS OF PRIMARY ROAD BETTERMENT/MAINTENANCE PROGRAM, 1981-1985

Mohafaza	Type of Operation	1981	1982	1983	1984	1985	Total
Deir Ez Zor	Resurfacing	2,917	2,262				5,179
	Widening	124					124
	Betterment Total	3,041	2,262				5,303
	Maintenance	1,341	1,329	1,321	1,316	1,399	6,706
	Total	4,382	3,591	1,321	1,316	1,399	12,009
Idleb	Resurfacing	1,293	787	1,847	2,671	8,691	15,289
	Widening	8,241	682				8,924
	Betterment Total	9,535	1,470	1,847	2,671	8,691	24,213
	Maintenance	2,394	2,395	2,383	2,385	2,490	12,047
	Total	11,929	3,864	4,230	5,056	11,181	36,260
Al Hassakeh	Resurfacing	3,305	3,494				6,799
	Widening		10	10			20
	Betterment Total	3,305	3,504	10			6,820
	Maintenance	2,052	2,078	2,109	2,133	3,189	11,561
	Total	5,357	5,583	2,120	2,133	3,189	18,380
Al Raqqa	Resurfacing	1,427	3,623				5,050
	Widening						
	Betterment Total	1,427	3,623				5,050
	Maintenance	1,194	1,173	1,160	1,150	2,425	7,102
	Total	2,621	4,796	1,160	1,150	2,425	12,151
Al Suweida	Resurfacing	1,609	3,543				5,151
	Widening	53	225	160	221		659
	Betterment Total	1,662	3,768	160	221		5,810
	Maintenance	720	729	738	749	762	3,698
	Total	2,382	4,497	898	970	762	9,508

Table 7.5.3

FINANCIAL INVESTMENT PLAN - SECONDARY AND TERTIARY NETWORK

(in million SP)

Mohafaza and Type of Investment/Cost	1981	1982	1983	1984	1985	Total
Damascus						
Betterment	22.1	9.1	4.0	17.8	2.6	55.6
Maintenance	6.6	6.6	6.7	6.8	6.9	33.6
Aleppo						
Betterment	0.2	1.5	-	5.9	13.4	21.0
Maintenance	3.4	3.4	3.5	3.5	3.6	17.4
Homs						
Betterment	-	-	12.9	2.2	1.9	17.0
Maintenance	2.2	2.2	2.2	2.3	2.3	11.2
Hama						
Betterment	8.8	7.1	15.8	7.4	5.4	44.5
Maintenance	3.9	4.0	4.1	4.2	4.3	20.5
Lattakia						
Betterment	1.5	2.8	2.3	7.6	5.0	19.2
Maintenance	4.7	4.8	4.9	5.0	4.9	24.3
Deir Ez Zor						
Betterment	-	-	-	-	-	-
Maintenance	0.9	0.9	0.9	0.9	0.9	4.5
Idleb						
Betterment	-	0.2	-	6.3	15.1	21.6
Maintenance	2.4	2.4	2.5	2.5	2.6	12.4
Al Hassakeh						
Betterment	-	1.4	-	0.5	0.1	2.0
Maintenance	1.5	1.6	1.6	1.6	1.6	7.9
Al Raqqa						
Betterment	-	-	-	-	-	-
Maintenance	1.2	1.3	1.3	1.3	1.3	6.4
Al Suweida						
Betterment	-	-	0.4	2.1	5.6	8.1
Maintenance	2.5	2.6	2.6	2.7	2.7	13.1

Table 7.5.3 (Continued)

FINANCIAL INVESTMENT PLAN - SECONDARY AND TERTIARY NETWORK

(in million SP)

Mohafaza and Type of Investment/Cost	1981	1982	1983	1984	1985	Total
Dera'a						
Betterment	-	-	2.3	0.7	-	3.0
Maintenance	2.3	2.3	2.4	2.4	2.5	10.2
Tartous						
Betterment	-	1.5	8.1	2.1	-	11.7
Maintenance	5.0	5.1	5.2	5.4	5.2	25.9
Country Total						
Betterment	32.7	23.6	45.8	52.7	49.0	203.8
Maintenance	36.5	37.1	37.9	38.6	38.9	189.0
GRAND TOTAL	69.2	60.7	83.7	91.3	87.9	392.8

Source: Consultants' estimates.

Table 7.5.4

PROBABLE LONG-RUN ROAD TRANSPORT INVESTMENTS, 1986-2000

(1979 SP million)

	1986-1990	1991-1995	1996-2000	Total
A. Primary Network				
. New Roads				
Hama-Salamieh-Al Raqqa			233.0	233.0
Aleppo Bypass		87.0		87.0
Tadmur-Albu Kamal			340.0	340.0
. Betterment	153.0	274.0	383.0	810.0
B. Secondary and Tertiary Network				
. New Paved Roads	38.2	38.2	38.2	114.6
. Betterment	335.0	428.0	546.0	1,309.0
. Rural Roads	87.8	87.8	87.8	263.4
Total Roads	614.0	915.0	1,628.0	3,157.0

7.6 USER CHARGES AND ROAD FINANCE

Background

User charges consist of charges for the use of publicly provided transport facilities, particularly highways, airports, and seaports. These charges have important implications both for equity and for efficiency. Excessively high charges for one user class forces members of the class to subsidize those of other classes. This may seriously impair the ability of the class concerned to compete in transport markets, thereby encouraging inefficient traffic allocations. Excessively low charges give artificial enhancement to the competitive position of the user class concerned, and they also tend to encourage inefficiency.

There are various theories concerning the road costs to be considered in defining the appropriate levels of road user charges, two of which are the theory of total cost and the theory of the social marginal cost.

The total cost theory postulates that the overall cost for construction and maintenance of highways should be recouped through road user charges. Under the theory of social marginal cost, the road users should pay charges equivalent to at least the short-run marginal costs, which should include elements such as:

- marginal cost of road maintenance,
- marginal congestion cost (cost caused to other users of the road),
- marginal cost of pollution, noise, etc.
- marginal cost of accidents,
- marginal cost of traffic police.

The total of the above elements represents the social marginal costs on the basis of which road user charges would be established. One could suggest that the social marginal cost theory tends to ensure the optimum utilization of resources; however, there are difficulties in implementing rational road user charges based on these costs, and difficulties may arise on the part of the Government in making up the difference between total road costs and marginal costs.

Generally, the burden of taxation borne by private cars is disproportionately high compared to charges levied on commercial vehicles, which range between the marginal costs and the total costs available to them.

Road user charges normally include the following type of taxes:

- taxes on purchase of vehicles,
- taxes on fuel, tires, parts, etc.,
- vehicle license taxes.

Actually, all the above, and in particularly the first two, are rarely established as specific road user taxes, and efforts have to be made to identify each component.

Government Revenues

The Government of Syria derives highway user charges revenues from the following sources:

- taxes on vehicle acquisition,
- import duties on vehicles, parts, etc.,
- vehicle ownership,
- driving license fees,
- vehicle utilization,
- taxes on road passengers and freight,
- tolls (Damascus-Baghdad highway).

The Ministry of Transport (MOT) is responsible for collecting fees on vehicle ownership and registration and driving licenses and their renewals. Fees on vehicle ownership are paid annually and vary with the type of vehicle, fuel used, transit levies, horsepower, and utilization purpose.

The Ministry of Finance is responsible for supervising the collection of duties on imported vehicles and spare parts, and for highway tolls. Import duties are assessed on the basis of the vehicle type, weight, value, and utilization. There is only one toll highway in Syria - Abou El Shamat to the Iraqi border. Toll fees were discontinued in 1976 but reactivated in early 1979.

The vehicle utilization taxes consist of revenues collected for motor fuel, lubricants, tires, and spare parts. The Department of Customs collects the taxes imposed on spare parts. SADCOP collects taxes on motor fuel and lubricants through the pump dealers, and the sole Government company for import of vehicles (AFTOMACHINE) collects the tire taxes through the various dealers.

Highway Account

Revenues

Revenues from users come principally from gasoline taxes, registration fees, and import duties on vehicles and spare parts.

These revenues have grown in step with the expansion of the vehicle fleet, increasing four-fold between 1971 and 1978, as indicated in Table 7.6.1.

Expenditures

Table 7.6.1 also shows the Government expenditures for the period 1971 to 1978. From 1971 to 1978 expenditures for roads increased five-fold.

The following tabulation indicates the 1971 to 1978 revenue/expenditure ratios, which are derived from Table 7.6.1.

1971	1972	1973	1974	1975	1976	1977	1978
1.07	1.84	1.95	1.80	2.65	2.57	1.01	0.62

The IBRD data indicate that from 1971 through 1975, highway users charges exceeded road expenditures in every year. By 1978 this pattern was sharply reversed due primarily to the substantial increase in road construction and maintenance expenditures. Because the Ministry of Local Administration expenditures in the latter years probably overstate maintenance and understate construction, construction expenditures are in fact the primary cause.

Future Financial Requirements

Recommended future investments were presented in Section 7.5 of this chapter. This subsection compares these investments and estimated road maintenance costs with projected revenues from road user charges. The projected revenues are based on current tax policies.

Chapter 4 noted the fact that funds required for future vehicle fleet investments are highly susceptible to changes in imports of passenger cars. This applies to an even greater extent to user charges because the import duties and taxes on automobiles are relatively so much greater than those on other vehicles. In November 1979, customs duties on automobiles ranged from 163 to 282 percent of the CIF price, depending on the size of the vehicle. This compares to 13 percent for two- or three-axle trucks.

The number of automobiles included in the Consultants' vehicle fleet requirements is based on estimated demand without restrictions on imports. Because of the large foreign exchange requirements involved (the equivalent of SP 4 billion over the 5th Plan period), the Government may choose to continue to restrict the number of passenger cars imported. As noted, this

Table 7.6.1

ROAD USER CHARGES REVENUES AND EXPENDITURES 1971 to 1979

(in million Syrian pounds)

ITEM	1971	1972	1973	1974	1975
Revenues					
Vehicle License Fees	26.4	29.0	23.0	43.0	77.0
Excise Tax on fuel	20.6	40.0	45.0	41.0	37.0
Fuel	2.4	2.5	2.8	4.8	6.2
Lubricating Oil	0.6	0.6	0.6	1.1	5.4
Vehicles	11.6	29.0	33.1	68.9	243.5
Spare Parts	13.3	15.9	18.1	15.5	48.3
Tires and Tubes	3.2	2.8	2.9	4.3	4.4
Transit Levy	-	9.6	6.4	12.6	20.8
Tolls	-	6.5	2.8	4.3	6.8
Totals	78.4	135.9	132.7	195.5	449.4
Expenditures					
Administration	16.0	16.9	17.3	16.0	21.2
Construction	48.2	48.0	41.8	61.3	96.8
Maintenance	9.0	9.0	9.0	31.3	44.0
Equipment Purchases	-	-	-	-	7.4
Totals	73.2	73.9	68.1	108.6	169.4

Table 7.6.1 (Continued)

ROAD USER CHARGES REVENUES AND EXPENDITURES 1971 to 1979

(in million Syrian Pounds)

ITEM	1976	1977	1978	1979[1]
Revenues				
Vehicle License Fees	84.0	104.3	112.2	110.0
Excise Tax on Fuel	100.0	100.0	100.0	43.0
Fuel	0.4	11.5	9.6	5.2
Lubricating Oil	1.5	1.6	1.1	NA
Vehicles	279.3	147.6	58.1	160.0
Spare Parts	24.3	33.4	41.4	NA
Tires and Tubes	5.5	6.4	5.3	NA
Transit Levy	14.2	7.0	5.0	10.0
Tolls	-	3.0	-	3.0
Totals	509.2	414.8	330.7	NA
Expenditures				
Administration	23.7	27.2	37.3	NA
Construction	89.1	212.3	292.0	384.2
Maintenance	57.8	63.7	132.7	167.6
Equipment Purchases	27.4	108.4	69.6	NA
Totals	198.0	411.6	531.6	NA

Source: 1971 - 1975 IBRD calculation. 1976 - 1979 Consultants'. Data from Ministries of Communications, Transport and Local Administration, and Customs Statistics and Tariffs.

[1]Estimated

will markedly affect vehicle investments and user charges, but it will have a limited effect on road costs. Passenger car vehicle occupancy rates are low, so that the offsetting effect on bus traffic would be limited. Moreover road betterment and maintenance costs do not increase in direct proportion to increases in traffic. For these reasons, road betterment and maintenance costs are virtually insensitive to changes in passenger car traffic, within any reasonable range.

The Government can use the SYSTRANS model to make forecasts of the effect of specific policy decisions regarding the impact of passenger cars. In the interim, the Consultants have forecast user charges and resulting fund availabilities under three alternative assumptions. The alternatives chosen are arbitrary and are designed only to give an indication of the magnitude of the effect of restricting the import of passenger cars. The alternatives are:

- Alternative A is based on vehicle import vs. forecast by the Consultants.

- Alternative B assumes a 50 percent reduction from alternative A in the number of passenger cars imported.

- Alternative C assumes a 75 percent reduction from alternative A in the number of passenger cars imported.

The Consultants' forecasts of road investments, revenues, and the resulting surplus or deficit are shown in Tables 7.6.2 and 7.6.3. Table 7.6.2 presents the forecast, by year, for the 5th Plan period. Table 7.6.3 presents the forecast, by five year periods, from 1981 to 2000. As with the historic analysis in Table 7.6.1, the forecast user charges in Tables 7.6.2 and 7.6.3 have not been adjusted for the civilian Government vehicle fleet. User charges paid by a government are transfer payments rather than a revenue to the government, and thus user charge revenues are overstated by the amount of user charges paid by government agencies. In 1979 the Government owned 12 percent of the vehicle fleet, and user charges are thus overstated by approximately this amount. For the future, the Consultants have not recommended significant Government investments in road transport, but rather that it should be primarily the province of the private sector. Depending on what policy the Government adopts, real user charge revenues would need to be reduced to reflect the share of the total vehicle fleet that is Government owned.

A review of Tables 7.6.2 and 7.6.3 indicates that over the 20 year period from 1981 to 2000 the differences between the three alternatives are only in the extent to which user charge revenues exceed road construction, betterment, and maintenance

costs. Over the period the difference is significant; however, the unrestricted import of automobiles produce 3.6 times as much revenue as alternative C, where imports are restricted to 25 percent of expected demand. The impact over the 5th Plan period is quite different. Because of the high investments for construction of committed projects expenditure will exceed revenues during the period that the import of passenger cars continues to be restricted. With a 50 percent restriction - alternative B - expenditures exceed revenues by SP 61 million over the five-year period, with the deficits higher in the earlier years of the plan. If passenger car imports are restricted by 75 percent, the deficit for the five-year period is SP 1 billion. In sharp contrast, unrestricted imports of passenger cars produce a surplus of SP 1.7 billion over the 5th Plan period. The trade-off is clearly between internal Government revenues and the availability of foreign exchange.

Table 7.6.2

ROAD TRANSPORT FINANCIAL PLAN, 1981-1985
(SP Million)

	1981	1982	1983	1984	1985	Total
Construction	560	633	599	464	411	2,667
Betterment	67	67	53	67	61	315
Maintenance	91	92	92	93	101	469
Total	718	792	744	624	573	3,451
ALTERNATIVE A						
Funds Available	961	981	1,020	1,062	1,105	5,129
Annual Excess/Deficit	243	189	276	438	532	1,678
Cumulative Excess/Deficit	243	432	708	1,146	1,678	-
ALTERNATIVE B						
Funds Available	626	653	678	703	730	3,390
Annual Excess/Deficit	-92	-139	-66	79	157	-61
Cumulative Excess/Deficit	-92	-231	-297	-218	-61	-
ALTERNATIVE C						
Funds Available	472	436	504	519	538	2,469
Annual Excess/Deficit	-246	-356	-240	-105	-35	-982
Cumulative Excess/Deficit	-246	-602	-842	-947	-982	-

Source: Consultants' estimates.

Note: Investments do not include vehicle investments.

Table 7.6.3

ROAD TRANSPORT FINANCIAL PLAN, 1981-2000
(SP Million)

	81-85	86-90	91-95	96-2000	Total
Construction	2,667	126	213	699	3,705
Betterment	315	488	702	929	2,434
Maintenance	469	455	478	501	1,903
Total	3,451	1,069	1,393	2,129	8,042
ALTERNATIVE A					
Funds Available	5,129	6,956	10,005	14,310	36,400
Excess/Deficit	1,678	5,887	8,612	12,181	28,358
Cumulative Excess/Deficit	1,678	7,565	16,177	28,358	-
ALTERNATIVE B					
Funds Available	3,390	4,476	6,286	8,686	22,838
Excess/Deficit	-61	3,407	4,893	6,557	14,796
Cumulative Excess/Deficit	-61	3,346	8,239	14,796	-
ALTERNATIVE C					
Funds Available	2,469	3,236	4,427	5,874	16,006
Excess/Deficit	-982	2,167	3,034	3,745	7,964
Cumulative Excess/Deficit	-982	1,185	4,219	7,964	-

Source: Consultants' estimate.

Note: Investments do not include vehicle investments.