# EVALUATION REPORT

# OF

# RURAL ACCESS ROADS AND BRIDGES PROJECT, PHASE II

Prepared for USAID/Belize

by ATMA International, Inc.

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# I. EXECUTIVE SUMMARY

## A. Purpose of Activity Evaluated[1]

The activity being evaluated is Phase II of the Rural Access Roads and Bridges (RR&B) Project. Phase II began January 1, 1988. Its Project Assistance Completion Date (PACD) is April 30, 1991.

The goal of Phase II is to increase agricultural production in Belize by improving farm-to-market access. The purpose of Phase II is to further strengthen and institutionalize the capability of the Ministry of Works (MOW) to maintain and protect RR&B. This purpose includes the target of institutionalizing a national road maintenance program.

## B. Purpose of Evaluation[2]

The purpose of this evaluation is to determine to what extent, over the last six years, the project has managed to achieve its purpose. Further, this evaluation will provide some indication of the impact, if any, of the project or agricultural production in rural Belize.

## C. Methodology Used

Comparisons of planned vs. actual results of the Phase II interventions were assessed for each of the five components of the RR&B Project. The three-person evaluation team (civil/road engineer, economist/management consultant, and environmental

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[1] The goal, purpose and duration of the project are from p. 1 of Amendment No. 4 to the Project Paper.

[2] The purpose of the evaluation is based on Article II, Section C, p. 1, in the Scope of Work for this evaluation.

specialist) spent a combined total of 33 working days in Belize meeting with relevant personnel and carrying out inspections of field work, facilities, and project-related documents.

Time constraints prohibited the collection of primary data, except for interviews of relevant officials and observations during visits to project sites. But considerable analysis of data being generated by the project was done by each team member. Description of these analyses of secondary data are presented in Section IV of this report and in several Appendices.

## D. Findings and Conclusions

### 1. Institutional Aspects

The existing rural road organization has been established as an entity within the Ministry of Works. The organization is working but needs to be centralized and improved to be able to perform more effectively particularly with respect to the following major constraints:

** Diversion of resources to non-rural road purposes;
** Monitoring of work performed in the field;
** Accountability for results obtained;
** Timely reporting of results;
** Better utilization of the information developed for planning, control, and budgeting purposes;
** Incorporation of private sector contractors and consultants into the rural roads program;
** Reduction of physical plant.

### 2. Road Rehabilitation Units (RRUs)

The two mobile RRU units which do rural road rehabilitation and improvements have generally been able to obtain satisfactory

production rates despite resource limitations and equipment diversion. The quality of the rehabilitation and improvement program should be increased particularly with respect to drainage, type of surfacing, and roadside development in order to reduce maintenance workloads.

### 3. Road Maintenance Units (RMUs)

The six RMUs (one in each district) are not working effectively. Roads rehabilitated and improved by the RRU are not being adequately maintained so that much of the investment in the rehabilitation component is being lost. Furthermore, the RMUs are really not maintaining the rural road network to an optimal service level through a regular, scheduled program of routine maintenance. The work done by the RMUs appears to be limited to localized repairs of short sections of road which have deteriorated rather than a general upgrading of the road level by grading, blading, cleaning of the entire rural road network. Reporting procedures seem to overstate the amount of physical maintenance actually done.

### 4. Ministry of Works Personnel

The quality of the personnel currently employed by the MOW and associated with the rural roads program was found to be quite good. The Officers-In-Charge of the field districts were found to be experienced, practical engineers. Personnel in the Belmopan Office were well qualified. Equipment operators in some instances needed more experience and training to improve techniques. Shop personnel were generally considered to be quite good.

### 5. Maintenance Management System (MMS)

A maintenance management system had been introduced as part of the rural road program. The system appeared to be quite adequate without becoming unduly sophisticated so as to preclude effective

implementation. Both field and central office personnel understood the system and it seemed to be generally effectively implemented. The major criticism is that the information generated was seldom put to practical use to assist in planning, monitoring, and budgeting functions of the program.

6. Financing

Lack of adequate financing for rural road maintenance is endemic throughout the developing world and Belize is no exception. One of the objectives of the RR&B Project was to have a self-sustaining operation by the PACD of April 30, 1991. The project is currently far from self sustaining and there is not much evidence to indicate that this very critical aspect of the program has been adequately addressed or considered. The general impression is little or nothing has been done, since GOB allocations for road maintenance have averaged since 1984 only 62% of the estimates of funding needed for an adequate program of road maintenance.

7. Technical Assistance

The technical assistance provided to the MOW as part of the program has been marginal at best. Consultants utilized for this purpose have not always performed to the standards expected. This is considered to be a major restraint to the program as the project could easily be brought back on schedule if the right type of assistance were provided.

8. Training

The training component of the program also appears to be marginal. District officers questioned said that in many cases, training of equipment operators and mechanics, for example, was done at the entry level while the MOW personnel were already experienced and in need of higher level training to improve their

abilities. In other cases trainers reportedly did the work themselves rather than training MOW personnel.

9. Bridges

The bridge component of the program is considerably in arrears (only 12 of the 54 crossings scheduled in Phase II have been completed) and should be expedited through procurement of additional local funding if necessary.

10. Environmental

Potential direct and indirect environmental affects associated with rural road systems were identified. These included such issues as deforestation, erosion/loss of soils, siltation of water ways, loss of prime agricultural lands and shortening the milpa[3] fallow period. Additional concerns included avoidance of archeological sites and critical ecological habitats, dust generation and wildlife habitat destruction.

Rural roads in 5 of 6 Belizean districts were analyzed. Erosion and siltation potential existed in the Cayo and Toledo Districts beyond the road influence areas, and was confined to roadway segments in the other districts. Deforestation was greatest in the Corozal and Orange Walk Districts due to intensive sugar cane agriculture. Future demands for agricultural lands could shorten milpa fallow periods in the Toledo and Cayo Districts where large numbers of milpa farmers operate. Ecologically sensitive areas do not appear to have been impacted by the rural

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[3] Milpa cropping is defined to include basic "slash and burn" preparation and planting of corn, rice, beans, plantain, and root crops, primarily for home consumption. Average milpa corn farmers will have 4 to 10 acres cultivated annually out of an area of 30 to 50 acres. See Reference 3, p. 16, in Appendix G to this report for additional details on milpa agriculture.

road program. Wildlife habitat along roadways is enhanced if vegetation is allowed to grow to form "hedgerows". Abundant wildlife habitat still exists in all district rural roads but less so in Corozal and Orange Walk Districts. Some archaeological sites, however, have been harmed by MOW construction crews, according to the Commissioner of Archaeology. Corozal, Orange Walk, and Toledo Districts have apparently received the most damage to Mayan ruins, some of which has occurred during Phase II. However, at this stage of rural road development and maintenance, environmental impacts are considered negligible or minor.

## E. Recommendations

### 1. Institutional Aspects

Major changes are recommended in the structure and function of rural roads administration in MOW:

a) The rehabilitation and improvement of rural roads, as well as major resurfacing programs which normally are done as periodic maintenance, should be done by the private sector based on competitive bid prices or by the "lottery" system where prices are fixed by the Ministry and awards made to prequalified, interested local contractors on the basis of pulling names out of a hat or other chance systems. Under this program the RRUs would be phased out and the workload of the RMUs reduced as major resurfacing would be done by contract.

b) Routine maintenance of rural roads would continue to be done by the Roads Division of the MOW; however, operations would be centralized in Belmopan and mobile crews utilized instead of fixed at the district level. Many of the districts simply do not have enough workload in the form of road miles to utilize effectively a

permanent RMU. Large quantities of equipment in the district level provide a temptation for diversion to non-rural road uses. Although exact calculations could not be made, as the network of rural roads to be maintained on a regular basis had not been explicit defined, perhaps four mobile crews working out of and controlled by Belmopan could do the work of the six permanent RMUs in the districts. This would have to be confirmed by further study. The district repair shops, however, would continue to repair and serve the mobile units as required.

c) A control unit would be established as part of the Belmopan office with the explicit task of monitoring maintenance work performed by the mobile RMUs and the work done under contract to the private sector. This monitoring would take the form of both quantity and quality. Reported progress would be carefully checked to insure the scheduled work was performed in the field. Problems would be identified and solutions proposed.

d) The rural road maintenance program would be put under a full time director who would be responsible for all phases of the program and have the necessary authority to act without being unduly restrained, controlled or supervised by higher authorities. This in particular applies to the utilization or diversion of equipment to non-rural road maintenance. The Director should be in control except in the case of emergencies.

e) Physical plant would be reduced as more of the rural road work was assumed by private sector contractors and consultants.

## 2. Quality Standards

The general quality standards to which rural roads are being rehabilitated and improved should be upgraded to reduce maintenance workloads. Currently no such standards are being applied to work done by the RRUs. These technical packages would be developed as function of traffic volumes, terrain type, flooding conditions, availability of materials, climatic conditions and land use. Particular emphasis should be given to drainage, the quality and gradability of surfacing materials, and design features which will permit mechanized operations.

## 3. Maintenance Management System (MMS)

The MMS should be amplified to include quality standards for rural road maintenance that could be used as a bench mark by field crews. Quality levels should be defined in the form of variation in frequencies of maintenance operations as a function of traffic volumes. More effective utilization is required of the MMS information now being collected. The portion of the rural road network which will receive regular, programmed maintenance should be more explicitly defined in terms of location, length, and frequency of maintenance operations.

An Office of Planning and Budgeting with a full time Director should be established as soon as finances permit. Ideally, this should be done prior to the PACD.

## 4. Financing and Self-Sustainment

Once the rural road network to be maintained has been defined, then studies can proceed to determine just how much it will cost to maintain this network at a suitable service or quality level. This cost can be compared with revenue available and shortfalls determined. Additional sources of revenue can then be identified

and even earmarked specifically for rural road maintenance. In some countries, for example, road costs are first determined and then fuel taxes varied annually to meet these costs. In no case should the RR&B project be allowed to continue unless there is a guarantee by the Government that rural road maintenance can be made self sustaining through adequate appropriations to cover both recurring and capital costs.

5. Technical Assistance

The quality of the technical assistance provided to the RR&B Project needs to be improved. The general feeling is that the project could easily be turned around and brought reasonably back on schedule in six months or less if the right type of technical assistance were provided. The emphasis should be on working directly with the MOW organization in implementing the program and not on simple advisory services. The person should be carefully selected to insure that he can work effectively with local personnel. Counterpart personnel should be provided so there is continuity.

6. Training Program

Training programs should be more carefully reviewed and focused on those programs which are designed to train beginners with no previous experience and those which are designed to improve the skills of already qualified personnel. The general impression is more training at the improvement level is required while actual training inputs to date have been at the entry level.

The MOW does not have a serious turnover problem. Employees who work for the Ministry generally stay probably for lack of employment opportunities in the private sector. The problem, therefore, of training new people to replace those who have left appears to be minimal.

7. Bridge Program

In the opinion of the evaluation team, adequate local financing must be found to complete the bridge program. Budget allocations during Phase II have been insufficient to permit work on bridges to proceed as scheduled. If such financing is not forthcoming from the GOB, USAID/Belize should assume a greater proportion of the local costs in order to insure completion.

8. Equipment Management System

A key factor in the success of a rural road maintenance program based on capital intensive methods is to insure that equipment required to perform the work is available. The two major considerations are (a) that fast-moving spare parts, tires, and batteries are in inventory with controlled minimum and maximum levels so that repairs can be made expeditiously, and (b) that procedures exist whereby funds can be made available from capital budgets for timely replacement of units when their useful life has ended. The main issue here is self-sustaining operations. For MOW, a mechanism--either a sinking fund or other similar arrangement--must be introduced to insure funding for these purposes, preferably without reliance on external loans or grants.

9. Environmental

Although environmental impacts associated with this rural road program are negligible so far, future demand for agricultural lands will create more pressure on environmental resources. To mitigate potential adverse environmental impacts, the following recommendations are made:

a) Evaluate dust control measures.

b) Require archaeological clearance for road alignments and construction material sites.

c) Improve and maintain roadside drainage to prevent flooding of roadways. Coordinate this with "hedgerow" development. Evaluate need for mosquito control.

d) Evaluate production/productivity along new road segments:

e) Promote institutional requirements for land use in the future by means of:

** Land use classification and capabilities
** Water resources development and protection
** Milpa farmer re-education
** Sustainable resource evaluation
** Protection forests
** Parks, reserves, protected areas
** Studies of threatened and endangered species and their protection.

# II. ECONOMIC, POLITICAL, AND SOCIAL ENVIRONMENT OF THE PROJECT

## A. ECONOMIC[4]

### 1. Overview

The Gross Domestic Product (GDP) of Belize grew at an average annual rate of 7% during 1985-89. Increased economic activity in the transportation sector reflects this strong overall economic performance. The growth was largely export driven with citrus, sugar, bananas, tourism, and garment manufacturing the main export oriented activities. All these sectors are expected to show continuing high growth rates over the next four years, with the citrus industry in particular poised for rapid expansion in output following large increases in acreage planted in recent years.

Gross Domestic Investment increased as a percentage of GDP during 1985-89. The share of private sector investment increased relative to public sector investment. Also, domestic savings increased at a faster rate than GDP in this period.

Based on this encouraging recent performance, it is anticipated that private investment in bananas, citrus, sugar, tourism, and light manufacturing will generate most growth. Other prospects are forestry and wood products, fisheries, tourism, and foodstuffs for domestic consumption. The latter is important for import substitution, since imports of foods represent about 25% of total imports.

There are three main elements that comprise the economic strategy being pursued by the Government of Belize (GOB):

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[4] This entire section draws heavily from the October 1990 draft "Report on Transportation Sector Planning Study" prepared by the U.K. firm Tech Econ and financed by British O.D.A.

a) encouragement of self-sustained growth for exports;
b) development of efficient import substitution industries;
c) promotion of intersectoral linkages.

The transportation sector has an essentially supportive or permissive role to play in attaining these objectives.

2. Transportation Sector

The October 1990 transportation sector planning study recommends two priorities for the transportation sector to fulfill its supportive role and be compatible with the economic strategy of GOB:

** The main priority is to ensure that the primary road system is brought up to an acceptable standard. This will require reconstruction of parts of Hummingbird Highway and Stann Creek Valley roads that are in poor condition and improvement of parts of the Southern, Northern and Western Highways.

** The second major objective is to improve maintenance of transportation infrastructure to protect investments already made.

Regarding transportation patterns for major export crops, goods generally do not move between many different locations within Belize. Most transport demand can be clearly defined as being in a particular locality. Production of food for domestic consumption also has a fairly simple demand for transportation, although points of production are more diverse than for export-oriented products. Manufacturing requires a more balanced flow of input and outputs to and from a limited number of locations. That is, inputs move from ports to factories, with subsequent return movements of finished goods. Tourism's transportation needs primarily involve movement

of people rather than goods and are more spatially diverse than other sectors. Details about all these different elements of transportation demand are presented below:

**Sugar:**

Transport of cane is from growers to processing plants at Tower Hill near Orange Walk and Libertad near Corozal. Most (65%) transportation is within 15 miles radius of Tower Hill processing plant (Belize Sugar Industries). BSI transports bulk raw sugar by barges to Belize City. White sugar is transported in bags by truck to Belize City.

**Citrus:**

Most growers now are in or near Stann Creek Valley, which is where the two processing plants are located. After picking, fruit is transported by road to processing plants. After processing, concentrated juice is moved by road to Commerce Bight jetty near Belize City for export. Volumes are expected to increase rapidly over the next few years due to newly planted acreage, especially in South Stann Creek and Cayo. The main transport problem perceived by the citrus industry at present is the condition of some of the roads over which fruit and inputs have to be transported. However, although this condition affects vehicle operating costs, it is not perceived to be a major problem by growers. Also the processors do not experience any loss in value in transporting concentrated juice via steel drums.

**Bananas:**

Most growers who have licenses from the Banana Control Board (BCB) are located within a 25 mile radius of the port at Big Creek. Only about 80 miles of road are used by the industry. Output is expected to increase steadily in the next few years as new

plantings come into production. It is generally felt with the industry that the present condition of roads over which bananas are transported is causing damage of fruit. The BCB has estimated that as much as 10 to 15% of the production is damaged due to poor roads.

Domestic Agriculture:

Most farm-to-market movements are over small distances to serve local markets. Longer movements characterize some commodities such as rice. The major transportation problem for domestic agriculture is perceived by producers to be lack of agricultural feeder roads, which makes it difficult for farmers to transport their produce to market particularly in the rainy season.

Manufacturing:

Most activity is located in or near Belize City. Thus, the transportation demands of this sector are confined to a small fraction of the road network.

Tourism:

Although there is some degree of concentration in key locations such as Ambergris Caye, generally tourism transportation is spatially diverse. Most tourists arrive by air and use domestic air services to get to resorts. A small proportion arrive by air (and road), and use roads to reach inland locations. However, the increasing frequency of tourists visiting Maya ruins usually involve rural access roads.

Thus, the roads network is an essential aspect of economic activity in all these key sectors of growth.

## B. Political

Belize has a parliamentary system of Government modelled after those used in many British Commonwealth Countries. The House of Representatives is elected by popular vote every five years. The government is headed by the Prime Minister, who appoints the Cabinet as the principal instrument of policy to direct and control government.

The two main political parties are the People's United Party (PUP), headed by Prime Minister George Price, and the United Democratic Party (UDP) headed by former Prime Minister Manuel Esquivel. The UDP was in power during 1984-89, or almost the entire duration of Phase I of the Rural Access Roads and Bridges (RR&B) Project and the initial two years of Phase II. The PUP was voted back into power in 1989, and MOW was headed at that time by Minister Leopoldo Briceno. He resigned in October 1990 and was replaced by the current Minister, the Honorable Samuel Waight.

There are sixteen Ministries that make up the bulk of the executive agencies in GOB. During the first calendar quarter each year, the Ministry of Finance reviews budget requests from the other Ministries. In March, the allocations of recurrent and capital budgets for each Ministry are finalized. The GOB fiscal year begins April 1.

For fiscal year 1990/91, the Ministry of Works (MOW) received an allocation B$9.7 million, equivalent to 6.3% of the government's total recurrent budget. The MOW's budget is the fifth highest after Ministry of Finance (B$45.0 million or 29.2%, which includes B$30.0 million in debt service); Ministry of Education, Sports and Culture (B$35.5 million or 23.1%); Ministry of Health and Urban

Development (B$14.6 million or 9.5%); and Ministry of Home Affairs (B$10.1 million or 6.6%).[5]

An understandable but inefficient aspect of Belize's active democratic system is that Ministers are particularly sensitive to the needs (especially complaints) of constituents. As a result, some Ministers have contacted MOW from time to time with requests to repair city streets, rural roads, highways, and buildings on an emergency basis. Acquiescing to these requests frequently plays havoc with normal programming of road maintenance and construction.

## C. Social

The Social Soundness analysis in the 1983 Project Paper covers thoroughly the social environment in Belize and the interactions between it and the RR&B Project. This conclusion was also stated on page 40 of Amendment No. 4 to the Project Paper.

An important point noted on page 31 in the 1983 Project Paper is worthy of emphasis here. After noting that economic benefits of improved roads will probably be more important than social benefits in the northern districts (Corozal, Orange Walk, and Belize), the judgement is offered that

> "Elsewhere, road construction will have immediate social benefits (especially in health and education), short-term economic benefits and long-term land use benefits. In all cases, road improvement will help attract and hold additional rural population (retarding rural-urban immigration) through provision of better services, and will make possible a number of other rural and agricultural development projects."

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[5] These budget data are obtained from Estimates of Revenue and Expenditure, Fiscal Year 1990/91.

The quoted section is an important consideration in evaluating the case for continuing the RR&B Project in some form after the end of Phase II.

## III. COMPOSITION OF THE EVALUATION TEAM AND ITS STUDY METHODS

### A. Composition of the Team

Consistent with page 9, Article II, in the Scope of Work for this evaluation, the evaluation team consisted of three specialists:

** Environmental specialist (Jose-Maria Merino)
** Civil/road engineer (Allan Lubina);
** Economist/manager consultant (Edward Vickery);

Edward Vickery served as the Team Leader. He and Allan Lubina arrived in Belize on October 10 and left on October 27. Joe Merino arrived on October 14 and left on October 21. These durations of assignment are consistent with Article III, page 9, in the Scope of Work.

### B. Study Methods

Throughout the team's stay in Belize, all team members worked under the general guidance of the Chief Agricultural Development Officer in USAID/Belize and the day-to-day supervision of the USAID/Belize Project Manager, Joseph McGann.

Mr. McGann and Ms. Mosina Jordan, the AID Representative, met with Lubina and Vickery early on October 11. After renting a vehicle, Lubina and Vickery (accompanied by McGann drove to Belmopan to arrange accommodations and meet with the Permanent Secretary of MOW, Pedro Carrillo. They reviewed the scope of work for the evaluation with Mr. Carrillo and obtained his viewpoints regarding the key issues confronting the project. Mr. McGann also introduced Lubina and Vickery to Albert Sprinkle, the Management Engineer Advisor from Globetrotters Engineering Corporation (the technical assistance contractor for the project).

Also on October 11, the Team Leader drafted a detailed outline of the evaluation report. He and Allan Lubina agreed on the allocation of tasks for drafting different sections of the report. Copies of the outline were given to Joseph McGann (and to Joe Merino when he arrived on October 14). Also on October 11, Allan Lubina compiled a list of information needed by the team.

Early on October 12, Lubina and Vickery (accompanied by Albert Sprinkle) met with Edgar Puga, Chief Engineer of MOW. The meeting was arranged by Mr. McGann. They reviewed with Mr. Puga the scope of work for the evaluation and the information needed from MOW. Mr. Puga said he and his staff would cooperate fully. He gave us his viewpoints about key issues confronting the project.

During October 12-24, the team obtained and reviewed numerous documents, files, and reports concerning the RR&B Project. Each team member met with key MOW personnel in Belmopan and District Offices, with relevant GOB officials in other Ministries, and with representatives of the private sector. Visits were made by Lubina to five District Offices, by Merino to four, and by Vickery to one. Only the Toledo District was not visited by at least one team member (due to time constraints). Additional details about study methods used by each team member are described below in sub-sections 1-3.

1. Environmental Specialist

The environmental evaluation methodology for the evaluation of the Rural Access Roads & Bridges Project consisted of 3 parts:

a) Review of project literature, literature on other rural road projects, and available literature dealing with subtropical vegetation systems, ecology and agriculture.

b) Interviews with Ministry of Works, USAID personnel and others knowledgeable on the Rural Roads & Bridges Project, and on potentially affected agricultural and forested lands;

c) A site reconnaissance of selected feeder road segments in each district (except Toledo) to note road condition, and agricultural and ecological features necessary to evaluate environmental impacts, both positive and negative.

The initial environmental examination (IEE) for this project noted specific direct and indirect impacts associated with rural roads projects in general. These included the following:

**Direct Effects (Construction/Rehabilitation)**

** Erosion of hillsides where roads are built
** Siltation of rivers
** Dust production
** Flooding and erosion near outlets of drainage structures
** Loss of prime agricultural lands with changes in road alignments

**Indirect Effects (Post Construction: Rehabilitation/Maintenance)**

** Increase in Deforestation
** Increase in erosion
** Shortened milpa fallow periods with loss in soil fertility

Since the goal of the project is to stimulate agricultural development by improving existing rural roads for better market access, an environmental evaluation form was used to summarize the extent to which environmental concerns are addressed and met in the

program. A rating scale was generated to identify and evaluate environmental effects associated with the Rural Roads and Bridges Project for each district, and to evaluate the use of environmental protection in lessening impacts. The following is an example of the content of the form presented in Appendix E.

Rating
( N = No impact )
( L = Low/little impact )
( M = Moderate impact )
( H = High impact )
( U = Unknown impact )

DISTRICT:_____ Rating

- Erosion of hillsides
- Siltation of streams & rivers
- Dust production
- Flooding/erosion of feeder roads
- Loss of prime agricultural land
- Increase in deforestation
- Shortened milpa fallow periods
- Loss of native ecosystem lands
- Wildlife impacts
- Other negative impacts
  - Dumping
  - Poor drainage/water ponding
  - Degradation of watersheds
  - Pest control (mosquitos)
  - Visual/aesthetics degradation

A general discussion of these topics is presented in Section IV.B.2

## 2. Civil/Roads Engineer

The methodology followed by the Civil Roads Engineer for purpose of this study was first to determine the major items under consideration.

** Institutional Aspects
** Road Rehabilitation
** Road Maintenance
** Equipment and spare Parts
** Training
** Maintenance Management System

The major issues as specified for each of these items were than listed based on the scope of service for the project. The available background information was collected, reviewed and analyzed as pertinent to each of the items. A list of questions was then prepared in order to obtain the additional information required to respond to the major issues indicated in the scope of services. The required information was solicited at the Belmopan central offices and in the districts. Personnel were questioned not only to procure information but also to ascertain if they had been adequately trained and were competently filling their positions. Trips to the field were made to determine the quantity and quality of maintenance and rehabilitation work being performed and to confirm that work progress as reported was actually done in the field. One of the problems anticipated was that the number of field observations was limited. To base general conclusions on limited observations which may not have been representative could have led to erroneous conclusions and improper recommendations. General observations were therefore confirmed with MOW personnel and other interested parties prior to formulating general conclusions. General recommendations were then formulated and tested to insure they were practical and could be implemented.

3. Economist/Management Consultant

Over half of this team member's time was allocated to analyzing the reports being generated by the Maintenance Management System (MMS), determining whether the reports were being used as a management information system, and preparing recommendations on how to improve the effectiveness of MMS. During this process, the consultant generated the first estimate of road miles maintained on the rural access roads included in the RR&B Project.

The consultant visited Cayo District to understand better the MMS reporting procedures from the perspective of District Staff. He also obtained the view of the Officer-in-Charge and the clerk regarding the time demands of the reporting system.

Contacts with two officials in the Ministry of Agriculture were made to obtain data on agricultural production statistics and to try to locate studies about the economics of Milpa farming techniques. A meeting also held with Mr. Harold Arzu in the Ministry of Economic Development to review the draft transportation sector planning study. And a meeting was held with Mr. Johnny Morris, Commissioner of Archaeology, to discuss the extent that MOW involves his office in selecting rural roads for rehabilitation or reconstruction.

Throughout the period in Belize, this team member also served as team leader. This involved renting the vehicle, arranging for secretarial assistance and supervising them, coordinating travel by the other two team members, and continuously exploring tentative conclusions and recommendations with the other two team members and (selectively) with MOW staff.

# IV. KEY ISSUES AND QUESTIONS POSED BY THE EVALUATION

## A. EFFECTIVENESS OF THE PROJECT IN MEETING ITS GOALS

### 1. Analysis of Actual vs. Planned Outputs

#### a) Road Maintenance Units (RMU)

##### i. Background Information

The project contemplated that maintenance of the rural road network in each of the six districts will be done by a Road Maintenance Unit (RMU) comprised of the following equipment units.

| | | |
|---|---|---|
| 2 | - | Graders, Caterpillar 120 G or equipment |
| 4 | - | Dump Trucks, Ford 8000 |
| 1 | - | Loader, Caterpillar 930 or equivalent |
| 1 | - | Loader/backhoe, Caterpillar Model 416 |
| 1 | - | Pickup Truck, Ford 150 |
| 1 | - | Flatbed Stake Truck, Ford 350 |
| 1 | - | Bulldozer, Caterpillar D-7-G or equivalent |
| 1 | - | Water tanker |
| 1 | - | Fuel Tanker |
| 1 | - | Roller |

Low beds and ancillary support equipment is to be provided by the Ministry of Works as required.

The combined capacity of the six RMU has been estimated by the MOW to be 1,000 miles of gravel road annually or about 170 miles per RMU in each of the districts. The evaluating team's own estimate is that the RMU has a capacity far in excess of 170 miles per year. For example, in Costa Rica the highway department estimates that a crew composed of one grader and one roller performing ditch cleaning, shaping of the surfacing material to

restore original crown and occasional spreading of additional surfacing material to fill low spots can perform between 2.5 and 3.5 miles (4 to 6 kms) per day. A grader on road maintenance work should normally work about 1250 hours per year or about 150 days. Assuming a typical rural road to be graded twice a year just before and after the rainy period, one grader alone should normally be able to maintain 180 to 250 miles of feeder road per year. Possible explanations for low RMU estimated rates are:

** The rate has been purposely conservatively estimated.
** Efficiency of maintenance work crews in Belize are below average.
** Availability of equipment utilized for rural road maintenance is considerably less than 1250 hours per year.
** The quality standards of the feeder roads constructed are so low, that an excessive amount of maintenance input is required.
** The RMU assigned to the maintenance districts are not fully operational in the sense that some units are lacking equipment as indicated in Figure 1.

The evaluating team assumes that the purpose of the 4 dump trucks, loader and dozer on the RMU was to extract and transport surfacing material from the borrow pits to the road. Considering normal annual aggregate loss on a rural road to be 1 to 2 inches of thickness per year, only 150 to 300 cubic yards of material are required per road mile per year or 25,000 to 50,000 cubic yards per year for the estimated 170 miles of road that a RMU can maintain. Normally one truck should be able to transport at least 100 cubic yards per day or 25,000 cubic yards in a 250 day work year. Again, the production rate seems to be very low.

The maintenance workload as measured in terms of road miles of gravel road is summarized below:

FIGURE 1

ROAD MAINTENANCE UNIT
EQUIPMENT DISTRIBUTION STATUS DATE: 19 - 06 - 1990

| EQUIPMENT | | BELIZE | | | CAYO | | | COROZAL | | | O. WALK | | | S. CREEK | | | TOLEDO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | A | W | D | A | W | D | A | W | D | A | W | D | A | W | D | A | W | D |
| GRADER | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 0 | 1 | 1 | 1 | 1 | 0 | 2 |
| LOADER | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| BULLDOZER | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| TIPPERS | 4 | 4 | 4 | 0 | 4 | 4 | 0 | 4 | 4 | 0 | 4 | 4 | 0 | 4 | 4 | 0 | 4 | 4 | 0 |
| ROLLERS | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| WATER TANKER | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| FUEL TANKER | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 350 TRUCKS | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 150 PICKUP | 1 | 2 | 1 | 1 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |

LEGEND: R: REQUIRED A: AVAILABLE W: WORKING D: DEFICIT

| DISTRICT | GOOD CONDITION | POOR CONDITION | SUBTOTAL |
|---|---|---|---|
| Corozal | 12.5 | 116.0 | 128.5 |
| Orange Walk | 15.5 | 71.0 | 86.5 |
| Belize | 16.0 | 72.0 | 88.0 |
| Cayo | 24.5 | 68.0 | 92.5 |
| Stann Creek | 17.0 | 63.0 | 80.0 |
| Toledo | 7.0 | 44.0 | 51.0 |
| TOTAL | 92.5 | 434.0 | 526.5 |

Source: USAID/MOW report of June 27, 1990, page 8.

The maintenance workload as indicated by these figures for the feeder road network is extremely low. Normally one maintenance district alone would have between 300 and 600 miles of road. In Belize the whole country has 532 miles of gravel road and is divided into six districts. Actually, in most districts there is not enough workload to justify a maintenance crew and they should be combined to form larger road districts so as to maintain a RMU fully occupied. To place a RMU in the Toledo district to maintain 51 miles of feeder road annually, for example is just a waste of resources and an invitation to divert equipment to other non-project, political uses.

The curious fact is that despite what appears to be excess maintenance capacity the feeder road system is currently not being maintained based on observations made on field inspection trips. In fact, many of the feeder roads improved with project funds are receiving only minimal or no maintenance since completion of improvements and are gradually reverting from a good to fair condition. The official rationale given is that almost all of the maintenance resources are continuously being employed to perform emergency repairs on damaged roads rather than for routine scheduled maintenance. Other non-official sources have indicated that maintenance equipment, particularly in the Cayo and Belize districts, are being diverted to non-project related work. In any

event, if maintenance equipment is being utilized for emergency repair work, then the solution is to define where these problems exist and make the necessary repairs with funding other than from the RR&B program on private sector contracts so as to release maintenance resources for the purpose they were intended. Obviously to continue to finance a rural program only to have to these roads deteriorate because of lack of maintenance makes no economic sense.

Not only is the road maintenance work not being done but the quality of the work performed is deficient. Observations in the field indicated the primary emphasis in maintenance work was being placed on localized repairs whereby surfacing material was dumped on short (300 to 500) feet sections of deteriorated road, bladed and compacted. No evidence was observed whereby entire road lengths were being bladed and shaped in accordance with any regular scheduled program or frequency. In fact, one RMU foreman when questioned responded negatively indicating that equipment available was satisfactory only for emergency repair work and not for scheduled maintenance.

Inquiries at Belmopan, however, indicated that regular, scheduled maintenance on entire road sections was done. The evaluation team could not find any consistent evidence of this nor did the quality of the roads supposedly being maintained reflect the high service level which could be attributed to a well implemented, programmed routine maintenance program. In fact, many of the roads recently rehabilitated by the RRU had deteriorated from a good to fair condition for lack of maintenance. Major defects include lack of adequate crown on the gravel roads surface which were in many cases almost flat and pounding water; lack of adequate side and diversion ditches; and surface irregularities. The evaluating team could not find evidence that quality standards had been established for maintenance which could be used as a guide by field crews to insure adequate service levels.

When questioned, the district chief indicated that they considered the quality of the personnel both operators and mechanics to be adequate. Field observations did not always substantiate this. When one field foreman was questioned why a grader operator did not seem to be working very effectively the reasons given was that the regular operator was not available and he was just substituting. The evaluating team felt there was a continued need for upgrading operator performance not at the entry level but rather improving the capacities of existing experienced personnel.

Even though the capacity of the RMUs is considered to be in excess of that required to maintain the rural road network at an adequate service level, current productivity seems to be curtailed due to lack of spare parts and tires resulting in part from the recent suspension of AID funding. Furthermore, many of the RMUs have completed over 10,000 hours of service which is generally considered to be the limit beyond which the cost of equipment repairs and overhauls exceed the annualized cost of replacement.

A case in point was observed in the Corozal district where an old MOW loader was down for repairs due to lack of spare parts. As a result, the four trucks used to haul materials for replenishing of surfacing materials could not be loaded. The breakdown of a single, outdated loader caused a chain reaction whereby an entire replenishing work group of trucks, grader, compactor and water truck was made inoperative and had to be temporarily dispersed and reassigned to tasks of lesser priority.

ii. Targets vs. Achievements

The objectives of the Road Maintenance Unit component are specified in Amendment No. 4 to the RR&B Project Paper. The Logical Framework in Annex I of Amendment No. 4 states that each

District will have one fully operational RMU, and that these six RMU's will be capable of maintaining up to 1,000 miles of rural access gravel roads to all weather status annually. Additional objectives from Phase I of the RR&B Project are to train 100 staff for maintenance activities, reduce cost/mile for road maintenance by 33%, and increase the GOB allocations to MOW for the annual maintenance budget. All these objectives are summarized in Enclosure II of the letter dated April 17, 1990 from the A.I.D. Representative to the Minister of Works.

The extent that these objectives have been achieved is summarized in Table 1. The following observations refer to data in Table 1:

(1) Create an RMU in Each District

Each of the six Districts had received most of the equipment listed on p.20 of Amendment No. 4 by December 1988. The loader/backhoe for each District was not delivered until October 1990 due to the suspension of A.I.D. financing of the project during April 17 - September 28, 1990. The delay of loader/backhoe delivery did not affect each RMU's capability to perform basic maintenance work. However, it did restrict their capability to improve drainage along rural roads.

(2) Achieve Target for Miles Maintained

Until now, no reports have been forwarded from MOW to USAID/Belize to indicate the extent that rural roads are being maintained by the RMU's. As shown in line 2.b of Table 1, a significant number of rural road miles have been maintained. An average of about two-thirds of the target has been achieved during fiscal years 1988/89 and 1989/90. But that achievement is far short of expectations at the start of Phase II.

TABLE 1 - ROAD MAINTENANCE UNITS, TARGETS vs. ACHIEVEMENTS BY MOW FISCAL YEARS

| PRIMARY TASKS | PHASE I ( 10/83 - 12/87 ) | | | | PHASE II (1/88 - 4/91) | | |
|---|---|---|---|---|---|---|---|
| | 84/85 | 85/86 | 86/87 | 87/88 | 88/89 | 89/90 | 90/91 |
| 1. Create an RMU in each District | * | * | * | * | * | * | Done |
| 2. Attain Target for Miles Maintained: | | | | | | | |
| a) Target Mileage | | | | | 1000 | 1000 | 500 ** |
| b) Actual Mileage | 987 | 785 | 898 | 841 | 667 | 649 | |
| c) % Target | | | | | 66.7 | 64.9 | |
| 3. Train 100 Staff | | | | | | | |
| a) Number Trained | | | | | | | |
| b) % Target | | | | | | | |
| 4. Reduce Cost/Mile by 33% (BZ$): | | | | | | | |
| a) Actual Cost/Mile | n.a. | 3162 | 2187 | 2258 | 2133 | 2334 | 2168 |
| b) 1983 Cost/Mile | 3842 | 4075 | 4086 | 4301 | 4293 | 4436 | 4451 |
| c) % Incr./(Decr.) | n.a. | (22.4) | (46.5) | (47.5) | (50.3) | (47.4) | (51.3) |
| 5. Increase Maintenance Budget (Millions B$) | | | | | | | |
| a) MMS Estimates | 5.50 | 5.67 | 4.46 | 6.35 | 6.36 | 4.51 | 5.14 |
| b) MOW Requests | 5.50 | 3.51 | 3.26 | 4.20 | 2.76 | 3.29 | 3.18 |
| c) MOF Allocations | 2.96 | 3.32 | 3.54 | 3.32 | 3.04 | 3.84 | 3.17 |
| d) Alloc. as % 5.a) | 53.8 | 58.6 | 79.0 | 52.3 | 47.8 | 80.7 | 61.7 |

* Denotes partial completion in each District.
** Represents the target for six months' maintenance, April-September 1990.

Sources:

1. Most equipment for each of the six RMUs (one for each District) was delivered before the end of 1988. The project suspension in April 1990 delayed delivery of each District's loader/backhoe until October 1990.

2a. Target mileage is derived from Amendment No. 4 to RR&B Project Paper, p.14.

2b. Actual mileage is from MMS Monthly District Accomplishment and Expenditure Reports by Activity. See Table 2 on p. 34 for details.

3a. No data were available on number of MOW staff trained.

4a. Actual cost/mile is from the bottom line of Table 4, p. 38.

4b. The RR&B Project Paper, pp. 19-20, estimates average annual direct cost of Bt3756/mile (exclusive of administrative costs and other overhead items) in 1983 dollars. The conversion to current dollars in subsequent years is based on the "All Items Index" for August during 1983-90 from the Central Statistical Office.

5. MMS estimates of the required maintenance budget, MOW budget requests, and MOF budget allocations are from the 6/29/90 MOW reportto USAID/Belize, Appendix 5, Figure 6.

Detailed estimates for miles of rural roads that have received grading or resurfacing in each District are given by Table 1. The total for each year is recorded on line 2.b) in Table 1. The data for road miles actually graded are recorded in each District's monthly Accomplishment and Expenditure Report by Maintenance Activity. Roads are identified by number and name in that report. Grading miles for non-rural roads are excluded from Table 2. Resurfacing is reported in cubic yards in the monthly report. Conversion to an equivalent number of road miles assumes average road width of 18 feet and gravel depth of 6 inches.

One finding from Table 2 is that the great majority of activity is grading only. This is to be expected in normal maintenance operations, since resurfacing is typically carried out every few years while grading occurs annually. However, the proportion of resurfacing activity is unusually low. Resurfacing averages just 6.9% of total rural road miles graded or resurfaced. Although the range is 3.6% for Toledo to 13.9% for Corozal, the mode is 5.1%. These findings suggest that the overall quality of maintenance work on rural roads is low. This implication is supported by field visits to five Districts (Toledo was not visited due to time constraints).

A closely related issue is that the amount of road maintenance being recorded in MOW monthly reports may give a false indication of what is actually being done. Observations in five of the Districts indicate no formal, systematic road grading or blading program. In one or two instances side ditches had been untouched. Thus, some Districts may claim that blading was done for the entire mileage reported while a smaller part was actually accomplished (mainly where the road has failed on short sections).

Another point of concern is derived from Table 3, which shows the number and miles of rural roads that were not graded or resurfaced during fiscal year 1988/89. Out of 412 total rural

TABLE 2

MILES OF RURAL ROADS MAINTENANCE BY DISTRICT

| MAINTENANCE ACTIVITY BY DISTRICT | | MILES MAINTAINED BY MOW FISCAL YEARS | | | | | | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| | | 84/85 | 85/86 | 86/87 | 87/88 | 88/89 | 89/90 | |
| BELIZE: | GRADED | 197.1 | 124.8 | 119.3 | 146.7 | 109.5 | 40.1 | 122.9 |
| | RESURFACED | 16.0 | 11.0 | 3.1 | 1.4 | 2.2 | 6.9 | 6.8 |
| | SUBTOTAL | 213.1 | 135.8 | 122.4 | 148.1 | 111.7 | 47.0 | 129.7 |
| | % RESURFACED | | | | | | | 5.2 |
| CAYO: | GRADED | 12.0 | 92.9 | 130.5 | 72.0 | 30.5 | 50.5 | 64.7 |
| | RESURFACED | 1.0 | 5.0 | 1.8 | 0.9 | 8.2 | 5.8 | 3.5 |
| | SUBTOTAL | 13.0 | 97.9 | 132.3 | 72.9 | 38.7 | 56.3 | 68.2 |
| | % RESURFACED | | | | | | | 5.1 |
| COROZAL: | GRADED | 208.0 | 92.0 | 220.1 | 165.2 | 144.0 | 104.8 | 155.7 |
| | RESURFACED | 44.0 | 30.0 | 18.9 | 11.7 | 1.9 | 44.7 | 25.2 |
| | SUBTOTAL | 252.0 | 122.0 | 239.0 | 176.9 | 145.9 | 149.5 | 180.9 |
| | % RESURFACED | | | | | | | 13.9 |
| ORANGE WALK: | GRADED | 334.0 | 245.0 | 203.8 | 226.9 | 203.4 | 173.5 | 231.1 |
| | RESURFACED | 18.0 | 12.0 | 4.4 | 0.8 | - | 39.4 | 12.4 |
| | SUBTOTAL | 352.0 | 257.0 | 208.2 | 227.7 | 203.4 | 212.9 | 243.5 |
| | % RESURFACED | | | | | | | 5.1 |
| STANN CREEK: | GRADED | 49.0 | 47.8 | 33.3 | 145.5 | 81.4 | 78.8 | 72.6 |
| | RESURFACED | 7.0 | 13.0 | 0.8 | 0.9 | 0.2 | 1.9 | 4.0 |
| | SUBTOTAL | 56.0 | 60.8 | 34.1 | 146.4 | 81.6 | 80.7 | 76.6 |
| | % RESURFACED | | | | | | | 5.2 |
| TOLEDO: | GRADED | 94.5 | 107.5 | 157.8 | 68.0 | 84.2 | 99.0 | 101.8 |
| | RESURFACED | 8.0 | 4.0 | 4.8 | 0.8 | 3.9 | 3.2 | 3.8 |
| | SUBTOTAL | 100.5 | 111.5 | 162.4 | 88.8 | 88.1 | 102.2 | 105.8 |
| | % RESURFACED | | | | | | | 3.6 |
| COUNTRY: | GRADED | 894.6 | 710.0 | 864.8 | 824.3 | 653.0 | 548.7 | 746.9 |
| | RESURFACED | 92.0 | 75.0 | 33.6 | 16.5 | 14.4 | 101.9 | 55.8 |
| | SUBTOTAL | 986.6 | 785.0 | 898.4 | 840.8 | 667.4 | 648.6 | 804.5 |
| | % RESURFACED | | | | | | | 8.9 |

SOURCE: DATA FOR 84/85 - 88/89 ARE FROM M.O.W MONTHLY DISTRICT ACCOMPLISHMENT AND EXPENDITURE REPORT BY ACTIVITY. FOR 89/90, DATA FOR CAYO, COROZAL, AND ORANGE WALK ARE COMPLETE FOR ALL MONTHS; FOR BELIZE ONLY 10/89 - 3/90; FOR STANN CREEK AND TOLEDO ONLY 1/90 - 3/90. THE AVERAGE OF DATA FOR CORRESPONDING MONTHS IN 87/88 AND 88/89 WERE USED AS ESTIMATES FOR THE MONTHS WHICH HAD NO DIRECT DATA. THIS PROCEDURE PROBABLY OVERSTATES SLIGHTLY THE TRUE AMOUNT OF MILES MAINTAINED IN 89/90, SINCE THE AVERAGES OF 87/88 AND 88/89 FOR CAYO, COROZAL, AND ORANGE WALK EXCEED 89/90 ACTUALS.

## TABLE 3

## NUMBER AND MILES OF RURAL ROADS NOT GRADED OR RESURFACED, BY DISTRICTS: FY 88/89

| | Total Rural Roads | | Rural Roads Not Graded or Resurfaced | | | |
|---|---|---|---|---|---|---|
| | Number | Miles | Number | % Total | Miles | % Total |
| Belize | 39 | 91.7 | 28 | 71.8 | 48.1 | 52.4 |
| Cayo | 67 | 222.4 | 43 | 64.2 | 110.6 | 49.7 |
| Corozal | 126 | 196.4 | 92 | 73.0 | 76.5 | 38.9 |
| Orange Walk | 87 | 231.9 | 47 | 54.0 | 78.2 | 33.7 |
| Stann Creek | 56 | 165.7 | 44 | 78.6 | 79.3 | 47.9 |
| Toledo | 37 | 131.8 | 20 | 54.1 | 52.3 | 39.7 |
| TOTAL | 412 | 1039.9 | 274 | 66.5 | 445.0 | 43.0 |

Source: Number and miles of rural roads were obtained from the MOW's Belize Rural Roads Inventory. Rural roads not graded or resurfaced were obtained from the MHS Monthly District Accomplishment and Expenditure Reports by Activity for the months April 1988 through March 1989.

Note that the miles reported above for "Total Rural Roads" in each District differs slightly from those reported on p. 28 and those reported in Table 4. The sections of roads included differ slightly in the three sources referenced, which causes the differences in mileage. However, the differences are not large enough to affect the conclusions reached in this evaluation.

roads included in the MOW Rural Roads Inventory, 274 or 66.5% were neither graded nor resurfaced. When the analysis is switched to road miles represented by these rural roads, performance improves significantly. Out of the total 1039.9 miles of rural roads, 445 miles or 43.0% were neither graded nor resurfaced. That is still a high percentage of rural roads that were not properly maintained. The range across Districts is 33.7% to 52.4%, so this finding is pervasive. Furthermore, similar results apply to other Fiscal years.

Finally, the pattern of actual miles of rural roads being graded or resurfaced displays a steady downward trend. This observation is based on line 2.b) in Table 1. The expectation is for maintenance performance to improve with the start of Phase II. New equipment for establishing the RMU's, additional A.I.D. funding for spare parts, and more technical assistance are all associated with fiscal years 1988/89 and 1989/90. But total miles of rural roads maintained decreased markedly compared to Phase I. That is not a sound foundation for designing a follow-on project in 1991.

(3) **Train 100 staff for Maintenance Activities**

No data are available to report number of staff trained during Phase I. No training has been undertaken from RR&B funds during Phase II.

(4) **Reduce Maintenance Cost/Mile by 33%**

At first glance some progress seems to have been made toward this cost-reduction objective. Line 4.a) in Table 1 shows actual average maintenance cost/mile for fiscal years 1984/85 through 1989/90. Compared to the estimated average cost/mile in 1983 (adjusted each year for the effects of price inflation), actual costs show a clear trend of cost reduction.

Of course one obvious problem in this type of analysis is holding constant the quality of road maintenance. The downward movement of maintenance cost/mile may reflect little more than spreading even smaller budget allocations over approximately the same miles of rural roads. Another problem is the consistency of cost estimates over time. But this is likely to be a minor annoyance compared to the problem a varying quality in actual maintenance practices.

At minimum, average maintenance cost/mile seems to be falling rather than rising. Based on interviews of MOW staff, technical assistance advisors, and field observations, the quality of maintenance has almost certainly improved since 1984/85. If so, then the averages reported in line 4.a) of Table 1 suggest these are real cost reductions that are probably associated with the RR&B project.

Nevertheless, the large variance in average annual maintenance cost/mile across the six Districts raise questions about cost control practice in MOW. The range in the most recent complete year, 1989/90, is from B$1260 in Orange Walk to B$4245 in Belize, as can be seen in Table 4. No explanation was offered by MOW staff for this large variation in annual average cost/mile.

### (5) Increase Maintenance Budget Allocations

As indicated in Table 1, line 5.d), actual allocations to MOW for road maintenance have fallen far short of estimates indicated by the MOW's Maintenance Management System (MMS). Each year MOW staff in the Districts and the Central Office collaborate in preparing an Optimum Annual Work Plan. Central Office Staff then estimate the total cost of labor, materials, and equipment required to implement the plan. That estimate (derived from the MMS cost estimating procedures introduced in Phase I) is termed the MMS Estimate. MOW top administrators reduce the MMS Estimate, based on

TABLE 4

ROAD MAINTENANCE COST/MILE BY DISTRICT
FOR MOW FISCAL YEARS 1985/86 - 1990/91



| TOTAL MAINTENANCE BUDGET, ROAD MILES, AND COST/MILE BY DISTRICT | | MOW FISCAL YEARS | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1985/86 | 1986/87 | 1987/88 | 1988/89 | 1989/90 | 1990/91 |
| BELIZE: | | | | | | | |
| MAINT. EXPEND.'S ('000 B$) | | 1474 | 1001 | 1010.4 | 915.8 | 929.6 | 871.9 |
| ROAD MILES IN DISTRICT | | 195 | 222 | 222 | 222 | 219 | 219 |
| COST/MILE (CURRENT B $) | | 7559 | 4509 | 4551 | 4125 | 4245 | 3981 |
| CAYO: | | | | | | | |
| MAINT. EXPEND.'S ('000 B$) | | 748.1 | 623.5 | 601.7 | 707.7 | 769.9 | 585.3 |
| ROAD MILES IN DISTRICT | | 282 | 282 | 282 | 282 | 282 | 282 |
| COST/MILE (CURRENT B $) | | 2653 | 2211 | 2134 | 2510 | 2730 | 2076 |
| COROZAL: | | | | | | | |
| MAINT. EXPEND.'S ('000 B $) | | 502.5 | 333.5 | 357.4 | 245.1 | 314.7 | 367.3 |
| ROAD MILES IN DISTRICT | | 227 | 227 | 227 | 227 | 227 | 227 |
| COST/MILE (CURRENT B $) | | 2214 | 1469 | 1574 | 1080 | 1386 | 1618 |
| ORANGE WALK: | | | | | | | |
| MAINT. EXPEND.'S ('000 B$) | | 552.5 | 338 | 347.4 | 295.6 | 328.9 | 377.7 |
| ROAD MILES IN DISTRICT | | 261 | 261 | 261 | 261 | 261 | 261 |
| COST/MILE (CURRENT B $) | | 2117 | 1295 | 1331 | 1133 | 1260 | 1447 |
| STANN CREEK: | | | | | | | |
| MAINT. EXPEND.'S ('000 B $) | | 500.6 | 399 | 402 | 352.3 | 424.1 | 390.3 |
| ROAD MILES IN DISTRICT | | 236 | 236 | 236 | 236 | 236 | 236 |
| COST/MILE (CURRENT B $) | | 2121 | 1691 | 1703 | 1493 | 1797 | 1654 |
| TOLEDO: | | | | | | | |
| MAINT. EXPEND.'S ('000 B $) | 649.5 | 649.5 | 382 | 458.5 | 484.7 | 510.2 | 453.4 |
| ROAD MILES IN DISTRICT | | 179 | 179 | 179 | 179 | 179 | 179 |
| COST/MILE (CURRENT B $) | | 3628 | 2134 | 2561 | 2708 | 2850 | 2533 |
| ALL DISTRICTS: | | | | | | | |
| MAINT. EXPEND.'S ('000 B $) | | 4427.2 | 3077 | 3177.4 | 3001.2 | 3277.4 | 3045.9 |
| ROAD MILES, TOTAL | | 1400 | 1407 | 1407 | 1407 | 1404 | 1404 |
| COST/MILE (CURRENT B $) | | 3162 | 2187 | 2258 | 2133 | 2334 | 2169 |

SOURCES:

Estimates of Revenue and Expenditure for GOB Fiscal Years 1984/85 - 1990/91.

"Revised Estimates" of the total budget for each District were used for 1989/90 and "Estimates" for 1990/91. Expenditure were used for all other years.

Road miles in each District are the sum of mileage listed for road sections.

guidelines provided by the Ministry of Finance (MOF), before sending it to MOF as the official MOW request. After examining such requests from all Ministries, MOF notifies MOW of its allocation.

These actual allocations have ranged from 47.8% to 80.7% of MMS Estimates. Both of these extreme values are included in Phase II of the RR&B Project. The last two fiscal years in Phase II show increased allocation percentages compared to the average for Phase I. Even so, the MOF Allocations have been equivalent to an average 61.7% in phase I and 63.4% in Phase II.

The case for allocations that even exceed MMS Estimates is argued in the October 1990 "Report on Transportation Sector Planning Study" (by the U.K. firm Tecn Econ through a contract with British O.D.A.):

"On the basis of the MOW estimates, the minimum that should be allocated to road maintenance is $6 million annually. It would be preferable if more than this sum could be allocated to road maintenance. The first reason for this is that recent and planned capital expenditures on the road system will have the effect of increasing the value of the capital asset that requires to be protected by maintenance. The second reason is that the MOW estimates are based on a maintenance regime which is responsive to problems rather than one which is primarily programmed to prevent problems before they arise. A program based on a preventative approach would probably require more resources initially than a purely reactive one but in the long run would result in a saving in the resources needed for road maintenance and construction." (p.10)

Based on discussions with the Officers-in-Charge in five Districts, as well as the fact that optimum work plans are revised to fit budget allocation constructions, it is clear that current GOB allocations are depreciating the capital invested in Belize's

network of rural roads. Unless this chronic shortfall of MOF Allocations vs. MMS Estimates can be ended soon, projects such as RR&B will be destined to achieve small fractions of their objectives.

b. Road Rehabilitation Units (RRU)

i. Background Information

As part of the RR&B program, two mobile road rehabilitation units were created for the purpose of reconstructing 100 miles of road annually, i.e., 50 miles for each unit. The RRU is comprised of the following equipment.

| | | |
|---|---|---|
| 2 | - | Grader, Caterpillar 130 G |
| 1 | - | Bulldozer, Caterpillar, D7G |
| 1 | - | Front end loader, Cat. 930 |
| 4 | - | Dump trucks, Ford 8000 with Cat. 3208 engine |
| 1 | - | Pickup Truck |
| 1 | - | Fuel tanker (2,000 gal) |
| 1 | - | Water tanker (2,000 gal) |
| 1 | - | Roller, 13 wheel rubber tired |
| 4 | - | Water and fuel trailer |

The MOW supplies accessory units such as a low boy, prime movers on an as required basis.

For example, the production standard used in Costa Rica is that an equipment unit comprised of one loader, one tractor, one grader, one compactor, five dump trucks and a water tanker should be able to scarify the original and place, compact, and shape about 350 cubic yards of material a day. Assuming an average roadway width of 18 feet and a surfacing thickness of 6 inches, the crew would be able to rehabilitate about 0.18 miles of road a day. Assuming 150 working days in a year, one crew should be able to do

about 25 miles of road per year. It would seem therefore that the production standard of 50 miles per year per RRU in Belize is somewhat optimistic and should be reduce by half or 25 miles per year. This production rate is very close to that being achieved by the rehabilitation crews. The RRU seem to be working at a much higher efficiency than the RMU.

One of the major constraints on production of the RRU is the number of haul units. Generally for 10-12 cubic yard trucks the number of units required can be estimated by the formula $N=1.1+0.5d$ where d is the one way haul distance in miles. The four units would be adequate for hauls of about six miles. For a balanced operation, the number of units should be increased for haul distances exceeding this figure. Crew production rates could be increased if the number of haul units used were varied in accordance with haul distance instead of being fixed at four.

The other major production restraint on the RRU is the age of the equipment which was purchased during Phase I of the project and has probably exceed the normal useful life of 10,000 hours. A summary of equipment condition is indicated in Figure 2.

The evaluating team had only one opportunity to observe a RRU unit working in the field. Of the four haul units assigned to the RRU, only one was working. The loader was also down for mechanical repairs. The RRU foreman confirmed that no formal design standards were available for guidelines in the rehabilitation program. He rehabilitated roads based on his own personal judgement and experience. Requests for culvert pipe to improve drainage had not been granted so that such pipe could not be installed in eight locations on the six mile long road where he considered such to be desirable. Under normal conditions with all equipment working, he estimated that he could rehabilitate from two to four miles of road per month depending on terrain conditions and climate.

FIGURE 2

ROAD REHABILITATION UNIT
EQUIPMENT STATUS

| EQUIPMENT | | UNIT " A " CAYO DISTRICT | | | | UNIT " B " TOLEDO DISTRICT | | | |
|---|---|---|---|---|---|---|---|---|---|
| | R | A | W | D | S | A | W | D | S |
| GRADER | 2 | 2 | 2 | 0 | 0 | 2 | 2 | 0 | 0 |
| LOADER | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| BULLDOZER | 1 | 2 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |
| TIPPERS | 4 | 4 | 4 | 0 | 0 | 4 | 2 | 2 | 0 |
| ROLLERS | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| WATER TANKER | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| FUEL TANKER | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 350 TRUCKS | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| SUPERVISOR/T | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |

LEGEND: R: REQUIRED A: AVAILABLE W: WORKING D: DEFICIT S: SCRAP

ii. Targets vs. Achievements

One of the Phase I outputs was the establishment of two RRU's. During Phase II, the combined efforts of these units were expected (see Amendment No. 4, p. 21, to the RR&B Project Paper) to rehabilitate a total of 250 miles of gravel roads during the three-year Project Amendment period and 100 miles annually thereafter. Additional Phase I objectives are to train 150 staff for rehabilitation works, reduce cost/mile for road rehabilitation by 50%, and establish a national rural road inventory.

The extent that these objectives have been achieved is summarized in Table 5 and discussed below:

(1) Achieve Target for Miles Constructed

Phase I shows an average of 62.1% of the target mileage actually being constructed by December 1987. The performance ranges from 23.2% during 1984 to 99.7% in 1987. Phase II shows sharply reduced achievement: an average of just 46.3% of target mileage through September 1990. However, the annual target of 83.3 miles during Phase II is 11% higher than the 75.0 miles/year target in Phase I.

The Chief Engineer in MOW believes the correct target should be 50 to 60 miles annually. As previously indicated, some support for his viewpoint is offered by experience in Costa Rica.

(2) Train 150 Staff for Rehabilitation Activities

During Phase I, 143 staff were trained in various rehabilitation activities by December 1987. That achievement represents 95.3% of the target, seemingly an excellent result.

TABLE 5
ROAD REHABILITATION UNITS-TARGETS VS. ACHIEVEMENTS

| PRIMARY TASKS | PHASE 1 (10/83 - 12/87) | | | | | PHASE 11 (1/88 - 4/91) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1987 | TOTAL | 1988 | 1989 | 1990 | TOTAL |
| 1. ATTAIN TARGET FOR MILES CONSTRUCTED: | | | | | | | | | |
| a) Target Mileage | 75 | 75 | 75 | 75 | 300 | 83.3 | 83.3 | 41.7 | 208.3 |
| b) Actual Mileage | 17.4 | 66.9 | 27.1 | 74.8 | 186.2 | 27 | 40.8 | 28.7 | 96.5 |
| c) % Target | 23.2 | 89.2 | 36.1 | 99.7 | 62.1 | 32.4 | 49 | 68.8 | 46.3 |
| 2. TRAIN 150 STAFF | | | | | | | | | |
| a) Number Trained | | | | 80 | 143 | | | | |
| b) % Target | | | | 53.3 | 95.3 | | | | |
| 3. REDUCE COST/MILE BY AT LEAST 50%: | | | | | | | | | |
| a) Actual Cost/Mile (in '000 B$) | | | | | | | | | |
| Belize | | | | | | | | n.a. | |
| Cayo | | | | | | | | 28 | |
| Corozal | | | | | | | | 32.6 | |
| Orange Walk | | | | | | | | 24 | |
| Stann Creek | | | | | | | | 22.3 | |
| Toledo | | | | | | | | 19.8 | |
| b) % REDUCTION vs. 1983 Avg. Costs | | | | | | | | | |
| Belize | | | | | | | | n.a. | |
| Cayo | | | | | | | | 15.3 | |
| Corozal | | | | | | | | 1.7 | |
| Orange Walk | | | | | | | | 27.7 | |
| Stann Creek | | | | | | | | 32.8 | |
| Toledo | | | | | | | | 40.3 | |

Sources:

1. a) Target mileage for 1984-89 is taken from Enclosure I in 4/17/90 letter from AID Representative Ms. Mosina Jordan to Minister Leoplodo Briceno. For 1990 the estimate 41.7 equals 50% x 83.34 for months April - September 1990.

1. b) Actual mileage for 1984-89 is from the same source given in note 1.a). For 1990 actual mileage is from MOW reports summarizing miles reconstructed in January-March, April-June, and July-September.

2. a) Number trained by 1990 is from Enclosure II of same s Number for 1987 is from Amendment No. 4 to RR&B Project Paper, Table 1, p. 5.

3. a) Cost/mile is from MOW report of 6/29/90 Appendix 5, Figure 2.

3. b) Based on the "All Items Index" being 134.6 in July 1983 and 159.5 in August 1990, the estimated average cost of B $28,000 (in 1983 prices) from the RR&B Project Paper is equal to B$33,180 in 1990 prices.

The problem is that Officers in Charge (OIC) perceive that this training was ineffective. Several of them said the trainers did most of the work during the training sessions. Few MOW staff received hands on or practical instruction in how to improve their road construction techniques, according to OIC's.

(3) Reduce Cost/Mile by 50%

The same two RRU's perform road construction work in all six Districts. Consequently, variation in rehabilitation cost/mile should reflect variation in terrain, weather, and other natural factors as opposed to labor or management productivity in Districts.

All but two of the cost/mile estimates in panel 3.a) of Table 5 are below the 1983 "without project" estimate of B$28,000/mile (see 1983 Project Paper, p. 19, Table 1.). However, a more appropriate comparison would be to convert the 1983 cost/mile to 1990 B$. That yields a "without project" estimate of B$ 33,180. Using this benchmark, actual 1990 rehabilitation cost/mile ranges from 1.7% to 40.3% below the cost/mile at the start of the RR&B Project.

Although the 50% reduction target has not been achieved in any District, it is apparent that progress is being made.

c) Maintenance Planning and Budgeting

An important objective in Phase I was to develop and implement the Maintenance Management System (MMS) installed by means of World Bank financing in 1984. The three person-years of management advisory technical assistance in Phase I effectively institutionalized MMS as the manual reporting system used in all six Districts and the Belmopan Office.

The key planning and budgeting targets of MMS, and the extent that they have been achieved during Phases I and II, are summarized in Table 6. Although the system appears to work well, there are several major problems.

** The performance budget (termed the "MMS Estimate") based on the Optimum Annual Work Plan does not appear to be taken seriously in the process whereby MOW obtains its annual budget allocation for road maintenance from the Ministry of Finance (MOF). Top administrators (Chief Engineer, Permanent Secretary, and the Minister) determine the level of budget request sent to MOF by March each year. Except for 1984, the MOW request has ranged from 43% to 73% of the MMS Estimate, the average being 62%. At the present, therefore, MMS Estimates do not appear to influence the budget allocation processes in GOB.

** In three Districts the required forms were not completed for long periods: 4/89 - 12/89 in Stann Creek and Toledo; 4/89 - 9/89 in Belize. In all three of these cases, District Officers-in-Charge (OIC's) failed to prepare the required Weekly Crew Cards during several months. In Stann Creek and Toledo, personnel problems with clerks resulted in no action to transmit data from Weekly Crew Cards to the required monthly reports. No actions were taken by the Belmopan Office to cope with these District reporting problems.

** The Monthly Executive Summary (MES) has not been prepared since March 1989. During Phase I, the Management Advisor (Mr. Carl Lawrence) regularly sent memos to OIC's and the Chief Engineer noting problems revealed by the MMS reports. But the current Management Advisor (Mr. Albert Sprinkle) has not done this. When the MES was being

# TABLE 6

## MAINTENANCE PLANNING AND BUDGETING, TARGETS vs ACHIEVEMENTS

| Planning/Budgeting Targets | Achievements as of October 1990 |
|---|---|
| 1. Establish in MOW a National Road Maintenance System: | |
| a) Install Jorgensen Maintenance Management System (MMS) | Originally installed in 1984 from World Bank project. Used continuously by all Districts in Phases I and II of RR&B Project. |
| b) Train staff in District and Belmopan to Operate MMS | Officers in Charge (OIC) and clerk in each District trained to implement MMS; also 2 analyses and 1 secretary trained in Belmopan office. Detailed manual from Jorgensen Associates provides guidelines. All training completed by 1985. |
| c) Obtain Regular Reporting with MMS Forms/Procedures: | |
| (1) Optimum Annual Work Plan (OAWP) for Districts and the Nation. | OIC's prepare in November and December each year the programming and budgeting worksheets and send them to Belmopan Office where staff consolidate worksheet into OAWP. Worksheets are returned to District O.I.C. Road inventory for each District is updated by Belmopan Office. OAWP's have been prepared throughout Phases I and II. |
| (2) Performance Budget for MMS Estimates | Belmopan Office staff prepares performance budget for MMS Estimate. Cost rates for labour, materials, and equipment are updated from previous year. Updated rates are applied to physical units in OAWP to produce MMS Estimates. This procedure has been followed throughout Phase I and II. |
| (3) MOW Budget Request to Ministry of Finance (MOF) | Permanent Secretary and Chief Engineer review MMS Estimates and reduce them to level they expect MOF to approve. Resultant budget is sent to MOF by March as official MOW budget request. Except for 1984 (when MMS Estimate was sent to MOF), this downward revision of MMS Estimate has occurred throughout Phases I and II. |
| (4) Feasible Annual Work Plan (FAWP) for Districts and the Nation | MOF notify MOW in March about actual budget allocation for road maintenance. O.I.C's revise OAWP to FAWP based on funds allocated by Belmopan office to each District. O.I.C.'s choose which maintenance activities to retain. FAWP's have been prepared throughout Phases I and II. |
| (5) Quarterly Work Plans (QWP) for Each District | O.I.C's prepare at end of each quarter in fiscal year a reviewed QWP for next 3 months that takes account of actual accomplishment in road maintenance during previous quarters. QWP's have been prepared throughout Phases I and II. |
| (6) Weekly Crew Card (CC) | O.I.C. prepare cc's at end of week for next week's work, Crew Supervisors enter on cc's actual work done and labour, materials and equipment used each day. Except for Toledo and Stann Creek Districts during 4/89-12/89 and Belize District during 4/89 -9/89, CC's have usually been prepared throughout Phases I and II. |

TABLE 6

MAINTENANCE PLANNING AND BUDGETING, TARGETS vs ACHIEVEMENTS

(continued)

| Planning/Budgeting Targets | | Achievements as of October 1990 |
|---|---|---|
| (7) | Monthly Activity Summary (AS) | Clerk in each District summarizes data from CC's on AS forms. Except for interruptions noted in (6) above, these AS's have been prepared throughout Phases I and II. |
| (8) | Monthly Maintenance Activity Cost Ledger (MACL) | Clerk in each District prepares a separate MACL for each type of maintenance activity. It yields total labour, materials and equipment costs for that month and year to date. Except for interruptions noted in (6) above, MACL's have been prepared throughout Phases I and II. |
| (9) | Monthly Accomp. and Expend. Report (AER) by Road Section for Surface Type | Clerk in each District prepares AER's allocating expenditure to specific road sections by type of maintenance activity. Separate AER's are prepared for paved roads and unpaved roads. Except for interruptions noted in (6) above, these AER's were prepared throughout Phases I and II. |
| (10) | Monthly Accomp. and Expend. Report (AER) by Maint. Category | Clerk in each District prepare an AER allocating total expenditures by activity type between 5 maintenance categories (routine, periodic, upgrading, emergencies, other), city/town streets, and new construction. Except for interruptions noted in (6) above, Districts have usually prepared AES's throughout Phases I and II. |
| (11) | Accomplishment and Expend. Report (AER) by Maint. Activity | Clerk in each District prepares an AER showing actual v.s. programmed results for total expenditures, physical units, unit costs, and productivity for each type of maintenance activity. In addition to interruptions noted in (6) above, several Districts have not prepared this AER consistently during Phase II. |
| (12) | Monthly Executive Summary (MES) | Belmopan Office staff prepare MES summarizing for each Maint. category actual expenditures and actual work accomplished during the current month, the previous 2 to 4 months (varies), and year-to-date. MES's were prepared throughout Phase I and up to 4/89 when the interruption noted in (6) above began. No MES's have been prepared since 3/89. |
| 2. Monthly Report to USAID/Belize | | The technical assistance team (Mgt. Eng. and Equip. Spec.) are responsible for working with Belmopan Office staff to satisfy the 12 reporting requirements listed on p. 31 of Amendment No. 4 to the RR& B Project Paper. On May 8, 1990, MOW submitted a report that partially satisfied items (1), (3), and (9) but did not address the other 9 items. On June 29, 1990, MOW submitted a report that partially satisfied items (1),(3),(4),(6), (11) and (12). These are the only two instances that represent an attempt to comply with the required monthly reports. |
| 3. Establish a National Rural Access Roads Inventory | | Some such inventory was established in Phase I. Currently, a detailed list of roads exists for each District. Information for each road includes its number, name, surface type, class (main, secondary, feeder) length, width, current condition, and annual average daily traffic (by ranges, e.g. 0-50, etc.). This inventory is updated annually to incorporate new roads and changes in surface, condition, and traffic level. |

produced up through March 1989, Mr. Aleman forwarded it to the Chief Engineer, usually without any accompany letter. Thus, the MES is not being used as a management information tool.

** Rarely during Phase II have the District OIC's received any feedback from the Belmopan Office regarding analysis of the data they prepare. If there appear to be errors in a District's reports, one of the two Belmopan Office managers of MMS will visit that District to discuss the problem. But that is the extent of feedback. The Management Engineer Advisor has not become active in providing any feedback to OIC's with respect to the MMS.

To summarize the current status of MMS, the Districts are performing acceptably well (except for the interruptions noted in 1989) in collecting required data and sending monthly summaries to the Belmopan Office. But the Belmopan office is neither transmitting these reports to top administrators in MOW nor analyzing the data to yield recommendations on how performance might be improved.

Another problem noted in Table 6 is that none of the monthly reports MOW is required to submit to USAID/Belize have been prepared. Only in May and June 1990 were reports submitted in response to letters from the A.I.D. Representative asking for corrective actions to be taken. These two reports only partially fulfilled the requirements listed in Amendment No. 4 (p.31) to the RR&B Project Paper.

Regarding the capability of the Office of Planning and Budgeting to provide timely support to the RR&B Project and MOW, eleven comments are offered:

(1) At this time there is no organizational entity that can be labeled the Office of Planning and Budgeting. There are two individuals who receive and process data from District Offices. Mr. Theodoro Aleman (Works Overseer-Roads) is part of MOW's permanent or "established" Staff. He is responsible for Belize, Corozal, and Orange Walk Districts. Mr. Francisco Cuellar (Maintenance Management Officer) is an "unestablished staff" person. He is responsible for Cayo, Stann Creek, and Toledo Districts. They and the Management Engineer Advisor are supported by one secretary (Ms. Martha Galvez, assigned 100% to the RR&B Project) with additional assistance from another secretary (Ms. Aura Guy, assigned usually to work for the World Bank Funded Highway Improvement Project). All these individuals report directly to the Senior Executive Engineer (Mr. Wilfredo Guerrero). He is equivalent to the Deputy Chief Engineer. Mr. Guerrero is head of the Roads Division; he also supervises all Executive Engineers and a total of 14 staff in Belmopan.

(2) Mr. Aleman serves informally as the manager of MMS. Since he is also assigned duties involving highways and other components of MOW activities, he is not able to give MMS his full attention. If problems arise in reporting by Districts, he must clear with Mr. Guerrero any requests for corrective action. Of course, Mr. Guerrero must also supervise all work on roads as well as the work of the Executive Engineers, which leaves little time for his involvement in MMS.

(3) The Project Paper is somewhat ambiguous regarding the extent that the Management Engineer Advisor should become involved in the day-to-day administration of MMS. It does state that this Advisor "will work directly with the Head of the Roads Division, and the six District Inspectors of

Works in order to upgrade general management techniques. ...His role will be neither wholly advisory nor operational, but a combination of each. He should have the capacity to advise by doing, both in the central office and in the field." The spirit of the quoted section implies that this Advisor should be actively involved in MMS, since it is the major tool of management information available to MOW. Mr. Sprinkle has chosen not to become involved with MMS. The result has been minimal top-level management of MMS throughout Phase II, such that the quality of MMS inputs and outputs have deteriorated to an unacceptably low level.

(4) The capabilities, skill levels, and professional commitment represented in the three individuals (Aleman, Cuellar and Galvez) that now manage MMS are excellent. Aleman and Cuellar have been with the RR&B Project throughout Phases I and II, so turnover of key technical staff is nil. They appear to be capable of operating MMS, but they would benefit from having a full-time manager of an Office of Planning and Budgeting. This person should be computer-literate, capable of analyzing the data being collected to identify road maintenance management problems, and capable of training the staff to prepare analyses of data generated.

The three individuals are proficient in varying degrees in all of the software now available in MOW: dBase III, Lotus 1-2-3, SuperCalc 2, Superwriter 1.1, and Word Perfect 5.0). However, they have no operating manuals for dBase III and Word Perfect 5.0, and only photocopies of manuals for the other three programs. Clearly, the provision of proper manuals would be a useful contribution before the end of Phase II. The collection of software that is available seems adequate to support

current MMS tasks. But MOW should also consider computer assisted design (CAD) software systems (which could speed-up engineering design work on bridges and road reconstruction), placing road inventories on a computerized database, and designing special software packages to facilitate other design and management information needs.

(5) The computer hardware also seems adequate with three exceptions. One involves the IBM PC (installed approximately December 1983). It has no hard disk. For less than $1,000 a hard disk or hard card could probably be installed to greatly increase memory. Currently, Lotus 1-2-3 can only be used on the other computer, an IBM PS2 installed August 1988 which has a 40 megabyte hard disk.

The second hardware problem involves printers. The Epson FX 100 has a wide carriage (necessary for printing spreadsheets) but is very slow (vintage 1983). If funds are available (less than $2,000 probably will be sufficient) to purchase a new dot-matrix printer with a wide carriage (e.g., Epson 2500), it would improve greatly MOW's capability of production reports in a timely manner.

The third problem involves the use of these computers for other MOW work besides MMS. This demand for Ministry-wide services restricts greatly the access to computers by MMS staff.

(6) Facilities utilization is characterized as very tight. As already indicated, computers are barely adequate for the MMS work that should be performed plus assorted work processing needs of other MOW units. Although the hard

disk recommended above will allow Lotus 1-2-3 and dBase III to be used on both machines, an additional computer may be required if changes such as that in (7) below are adopted. Office space and file capacity seems particularly cramped. At present six staff members, including the Senior Executive Engineer and the Management Engineer Advisor, occupy an office of less than 550 square feet. The computers, printer, a photocopy machine, and an extra desk also share that space.

(7) The procedures now being used to store hardcopy files could benefit from a more orderly approach. The office seems to use the "stacks" system to excess, i.e., stacks of materials here and there. Although the staff were able to locate almost all information requested in support of this evaluation, the present procedure will be almost certain to misplace files, maps, and other information.

(8) Simplification of the original Jorgensen MMS approach should be considered. The system now calls for District Clerks to prepare five monthly summary reports. Although this only takes about three days (full-time equivalent) for each clerk, the reports are often submitted late. Considering that the Weekly Crew Card contains the only new data collected at the District level, a program could be written for dBase III that would easily produce the monthly summaries from the Weekly Crew Cards. This approach should save clerical labor at the District level. Instead of preparing five monthly reports, the clerk would simply make a duplicate copy of each Weekly Crew Card and send them to Belmopan. A secretary could enter data from the Weekly Crew Cards into a dBase III file. The special program could select the data elements

required for each report and print out the reports in Belmopan. It should yield greater accuracy and more timely production of reports as well as savings in clerical time.

(9) Despite the failure of MOW to submit the monthly reports called for by Amendment No.4, data from MMS reports and other sources in MOW can be used to produce most of the information requested. The sources for each of the twelve reporting requirements listed on p. 31 of Amendment No. 4 are described below:

(a) Mileage, level of maintenance, and cost of road segments maintained and rehabilitated by each District Road Maintenance and Rehabilitation Unit.

Mileage and cost estimates can be obtained directly from the monthly Accomplishment and Expenditure (A&E) report. If "level of maintenance" is defined as number of times various maintenance tasks are performed on a given road section, the A&E report can be used to measure that. If a measure of maintenance quality is intended, no existing data will provide it. Some sort of quality index would have to be submitted by District OIC's or by Belmopan staff making inspections.

(b) Degree of compliance with scheduled road maintenance operations for the preceding month

Comparison of A&E reports by road section with the Quarterly Work Plans for each District will yield information about types of maintenance programmed and carried out on each road section.

(c) Scheduled road maintenance operations for the coming month

The Quarterly Work Plan can provide this information.

(d) Equipment fleet status for each unit

Mr. Francis Burns (Mechanical Administrator) maintains records on the operational status of each piece of equipment assigned to each RRU and each RMU.

(e) Spare part and tire inventories and usage, including end user verification

Mr. Francis Burns (Mechanical Administrator) maintains a separate cardex inventory system in Belmopan for the RR&B spare parts and tires. Similar cardex files are maintained by each District office. A "USAID Parts Status Report" (one for Caterpillar equipment, one for Ford equipment) and a "USAID Tires and Tubes Status Report" are prepared each month in the Belmopan office. Each District prepares a "Purchase Requisition" and "Monthly Return" showing which equipment received spare parts or tires/tubes.

(f) Training conducted

No training records have been kept for Phase II. The Management Engineer Advisor might be assigned the task of compiling retrospectively a record of training activities, individuals involved, and whether they are still in MOW. Such a record can then be updated monthly.

(g) Amount and cost of central and district workshop operations

The annual MOW allocation indicates the funds budgeted for the central workshop. But at the District level, there is no separate budget for workshop operations. It could be estimated based on requisitions for spare parts and tires/tubes and on labor costs for mechanics and the stores clerk.

(h) Equipment diversion

No data are recorded for equipment diversion. By analysis of Weekly Crew Cards, an inference can be made about equipment diversion when graders and tippers (dump trucks) are indicated in the Crew's work record. All graders and four of the five or six tippers in each District were obtained through AID funding. Further, the "Daily Work Progress Report" indicates which tipper was used on each job and road section. Equipment diversion can be determined directly from these records.

(i) Status of bridge abutment construction by bridge

Mr. Rodrick Crawford (Executive Engineer and Head of the Bridges Division) can update each month the information now summarized in Appendix C of this evaluation report.

(j) Status of workshop improvements by shop

No workshop improvements have been undertaken in Phase II, as noted on p.26 of the MOW report submitted to the AID Representative on June 27, 1990.

(k) Receiving Reports for all commodities procured with project funds

The Receiving Reports are retained by the heads of each unit that is responsible for commodities procured. Messrs Burns (Mechanical Administrator), Crawford (Executive Engineer for Bridges), and Williams (Head of Soils Section) can provide copies of these reports.

(l) Report on host country project expenditure including in-kind expenditures

Mr. Perriot (Chief Finance Officer) can provide data on capital budget expenditure associated with the RR&B project. Recurrent expenditure is not allocated to specific projects. However, the A&E reports by road segment could be used to estimate recurrent expenditures associated with rural roads.

(10) Even though data can be generated to comply with the monthly reporting requirements, a quarterly instead of a monthly frequency would seem more appropriate. Quarterly periods for reports are more usual on AID projects. The administrative burden of compiling the twelve types of information each month will be large. For the remainder of Phase II, a more reasonable objective seems to be (a) report as soon as feasible on each of the twelve items of information for the entire period January 1988 through September 1990, (b) submit a quarterly report in January covering the period October - December 1990, and (c) submit a quarterly report in April covering the period January - March 1991. The Management Engineer Advisor should be responsible for working with MOW Staff to prepare these reports, as indicated on p. 31 of Amendment No. 4.

(11) The equipment unit cost rates now being used for the A&E reports need more precision. They are not now being estimated based on actual utilization rates and current cost. They are little better than rough guesses prepared by Mr. Francis Burns (Mechanical Administrator). Standard estimating procedures for equipment unit costs are available from Caterpillar. The Management Engineer Advisor could work with Mr. Burns to develop new unit costs for equipment, as well as general procedures that can be continued after the end of Phase II.

**d) Bridge Component**

The original RR&B Project Paper was amended in 1984 to include the construction of 54 new all-weather river crossings utilizing 103 bridge sets obtained from U.S. surplus property in Germany. Acquisition costs and freight for the 103 sets were paid for by AID at a cost of $1,219,727. The $3,000,000 cost for the erection of the steel trusses, construction of 108 abutments, 42 center piers and placement concrete bridge decks was to be paid directly by the Government whereby 90% of the annual budget appropriation for bridge maintenance was committed to the project. The work was to be done by local contractors through competitive bid contracts. The Ministry of Works agreed to perform the necessary foundation boring, design the bridges and elaborate the construction bid documents. It was estimated that 75% of the 54 crossings would be completed during the three years remaining in Phase II.

A complete inventory of all primary and secondary bridge crossings has been included in Appendix C of this report. The status of each crossings has been codified as follows:

| | | |
|---|---|---|
| (0) | Work not yet initiated ... | 26 Crossings |
| (1) | Design Completed ..... | 15 Crossings |
| (2) | Construction in Progress.. | 1 Crossings |
| (3) | Structure Completed..... | 12 Crossings |
| | | -- |
| | | 54 Crossings |

Of the total of 54 crossings, only 12 crossings or 22% of the total have been completed since May, 1984 when Amendment 1 to the Project authorizing the construction of the bridges went into effect. Progress on the bridge program falls far below the anticipated 75% of 54 structures or 40 structures expected to have been completed in the three year program. There obviously is no possibility to complete the program in the six months remaining by the PACD of April, 1991. The Bridge program for the 1990/1991 fiscal year indicated in the Appendix contemplated the construction of only 7 structures leaving 35 structures still to be done. Currently the sections needed to complete the structure are in open storage areas at the MOW Belmopan culvert yard. With minor exceptions, the units are complete and sufficient to terminate the 54 crossings. An inventory of the sections is indicated as part of the Appendix C. The MOW will sand-blast steel sections which have oxidized excessively. All sections will be painted prior to installation on the site.

The only major constraint which has delayed the bridge program is the inability of the Government of Belize to finance the $3,000,000 local component of the program for erection, substructure construction and placement of the concrete slab. The AID-Mission in Belize has recognized this and has diverted from the Economic Stabilization Fund (ESF) to the bridge program. For example, for the fiscal year 1990/91 the ESF contribution to the program was B $2,200,000 while the Government of Belize committed B $950,000 as a central budget allocation. Obviously, the bridge program has to be carried to completion as the sunk costs are

probably on the order of 75% of total project costs. Unfortunately, inquiries with Permanent Secretary and Chief Finance Officer at the MOW did not identify possible additional sources of local financing. The most direct procedure, of course, would simply be to request the line item in the annual central budget be increased for this purpose.

The designs and elaboration of the contract documents for the bridges are being done by the Highway Bridge Engineer at Belmopan. The Ministry currently has no formal highway or bridge design office. The contracts were reviewed and considered to be satisfactory, although time constraints precluded the evaluation of the designs produced. Inspection and supervision of construction is done by the Ministry Soils Laboratory who also perform the necessary foundation boring at each of the sites. Work is done in four ways:

| | | |
|---|---|---|
| (1) | Direct Administration Using MOW Resources..... | 6 Crossings |
| (2) | Competitive Bid Awards to Private Sector Contractors..... | 4 Crossings |
| (3) | As Part of a Training Program with the U.S. Corps of Engineer..... | 1 Crossing |
| (4) | Direct Negotiated Contract with Mennonite Groups in Belize..... | 1 Crossing |

The MOW's physical capacity to do all the work by direct administration is limited which precludes completion of the program by direct administration and lower financial costs as compared to private sector awards. On the other hand, the private sector is quite capable of managing the program on their own particularly if awards are limited to the bridge structure itself and do not, include the construction of approach roads. The amount of heavy equipment required for the bridge erection program is only a crane which is used for lifting purposes and driving piles. Roadworks,

however, require additional units of heavy equipment including trucks, loaders, graders, etc which are not possessed by the smaller local contractors. A common award procedure is to limit contractors strictly to bridge construction with approach roads constructed by the RRUs or RMUs working in the area. The procedure permits more local contractors with limited equipment to participate in the program. A listing of bridge contracts currently prequalified with the MOW based on capacity is included in Appendix C.

Minor constraints to the program are that the entire program is being done by the MOW Bridge Engineer who also serves as the City Engineer for Belize City and assists occasionally the Ministry of Housing. However, reportedly contract documents for 10 bridge sites have been completed and are on file waiting only for financing to be let. The Bridge Engineer felt that he alone could continue to manage the program without major outside assistance. The Soils Laboratory reportedly needs additional drilling tools in the form of drill bits, samples, etc. to efficiently complete the program. This equipment should be acquired.

### e) Central And District Repair Shop Improvements

Due to time restraints, the evaluating team was able to visit only five of the six districts and the Central Workshop in Belmopan. The Central Workshop in Belmopan has been previously analyzed by others (see Reference 2, pp. 26-30). The Central Workshop Building was found by that analysis to be adequate but some improvements and upgrading were required at an estimated cost of US $102,500. These included a relocated storeroom, shop extension, a new electrical shop, relocation of the machine shop and security fencing (Reference 2, page 26). This list was subsequently modified and consideration has been given to eliminating the storeroom relocation, office extension, new

electrician shop and machine shop relocation at a cost savings of US $67,500. Other improvements have been suggested in the form of a new tool room, an injector repair room, and general yard cleanup and improvement of access to shop facilities (Reference 2, pages 29 and 30). These improvements should be facilitated.

A Warehouse Management Procedure had been installed for spare part control. Actually two separate spare part inventories are maintained: one for AID financed equipment, and the other for MOW equipment. Stock record cards were maintained for both and personnel appeared to be trained in the use of inventory control systems. A Manual had been produced under a World Bank consultancy control and appeared to be extensively utilized.

The Ministry was attempting to reduce spare part inventories by limiting purchases of new U.S. equipment to Ford trucks and Caterpillar equipment. Stock levels, however, were low due to the recent suspension of AID funding for the project and required replenishing. A tour of the Central Workshop revealed a proliferation of obsolete, unusable parts which could not be disposed of due to administrative requirements. The same was true of obsolete scrap equipment which cluttered the work area. The quality of the shop mechanics was reported to be good.

Mr. Guerrero (the Senior Executive Engineer) indicated that, although the quality of staff in the workshops is good, there is considerable need for upgrading their skills. He believes that the RR&B Project urgently requires an equipment specialist who can provide technical assistance and on-the-job training for workshop staff. This type of technical assistance, according to Mr. Guerrero, will do most for increasing the productivity of the Roads Division through increasing the capability of the workshops to cope with demands for repair services. The evaluation team did not have enough time to explore this hypothesis. It should be examined

carefully in the process of designing any follow-on effort after Phase II.

At the time of the evaluation none of the workshops including central facilities in Belmopan appeared to be very busy. Probably lack of spare parts due to the suspension of funding precluded work on units which were down for repairs. With the anticipated reduction in equipment dedicated to rural road maintenance due to elimination of the RRUs and reduction of RMUs, the capacity of the workshops should be sufficient to meet requirements for rural road maintenance provided improvements are made as planned and funding becomes available for spare parts, fuels, tires, batteries, etc.

Guidelines for improvements and upgrading of the district workshops are also contained in Reference 2, along with a proposed implementation program in Appendix A4 of that document. The program has not yet been actualized due to the recent suspension of funding. The cost of upgrading district facilities has been estimated at US $300,000.

In visits to the district offices, their available shop equipment was reviewed. Most of the AID shop equipment originally purchased was still operative. Needs for additional shop equipment in the form of battery chargers, repair tools, pressure cleaners, and grinders were mentioned. A formal inventory of shop equipment should be made and any additional or replacement units acquired as part of the shop improvement program.

An inventory of heavy equipment purchased in Phase I along with its condition has been made and is included as part of Appendix D to this report. The inventory should form the basis any equipment management program which is subsequently implemented as part of the RR&B Project.

## 2. Compatibility of the Project with GOB's Policies and Priorities for Development

The discussion in Section II.A.2 described the key role of the road network in permitting the GOB's economic strategy to be fulfilled. The transportation sector planning study identified improved road maintenance as the second highest priority for ensuring that the road network can provide effective support to exports, import substitutes, and improving inter-sectoral linkages in the Belizean economy. Therefore, it is clear that the RR&B Project is compatible with GOB's policies and priorities for development, since its objectives are to improve maintenance of rural access roads throughout the country.

## 3. Availability of Resources Consistent with Priority Accorded the Project

Without doubt the GOB has not made resources available to perform road maintenance work in a manner consistent with the implicit priority of the RR&B Project. As summarized in Table 1, line 5.d), GOB's allocations for recurrent costs to maintain roads have averaged since fiscal year 1984/85 only 62% of the funding required to implement the "Optimum Annual Work Plan" prepared each December by MOW.

The transportation sector study recommends a straightforward approach for raising funds to increase budget allocations for road maintenance:

### a) Increase Motor Vehicle Registration Fees

Annual vehicle licensing fees yielded about B$1.8 million in fiscal year 1989/90. The greatest potential from this source is adjusting the relationship between license fees and the sizes and types of vehicles. The present scale of annual

license fees has a B$250 charge for goods vehicles with tare weights exceeding 4,000 lbs. The transportation sector planning study suggests both subdividing the 4,000 to 10,000 lbs. range to have increasing license fees by weight, and a minimum fee of $500 for vehicles with tare weights in excess of 10,000 lbs.

b) Increase by 10% the import duty levied on gasoline and on diesel fuels used in transportation

At the present import duties on gasoline and diesel fuel are about 45% and 33%, respectively, of the retail price. The transportation sector planning study estimates tax revenue of approximately B$14.0 million in 1989 from gasoline and perhaps B$3.4 million from diesel fuel used in transportation. Thus, a 10% increase in these duties would probably yield an additional B$1.5 million in tax revenue. (That amount is over half of the current gap between the "MMS Estimate" of optimum road maintenance costs and the actual allocations given by GOB). This estimate assumes the demand for gasoline and diesel in transportation would not decrease significantly due to the 10% increase in taxes (or less than 4.5% average increase in retail price).

c) Reserve or "earmark" these increases in tax revenue for road maintenance allocations

There is currently a precedent for such an "earmarking" approach. The Tourist Authority, according to the transportation sector planning study, now collects taxes levied on hotel rooms and is allowed to retain half of these

receipts to cover costs of promoting tourism in Belize. A similar approach could be used for financing road maintenance. This approach is consistent with sound public finance practices, since it compels the vehicles that are doing greater damage to roads to pay a greater share of road maintenance costs. And the 10% increase in import duties is unlikely to have a dampening effect on export. The main reason is that road transportation costs usually represent less than 25% of the total production costs of agricultural commodities. Thus, a 10% increase in duties (which are now 45% of the retail price) will probably represent less than 1% of total production costs.

## 4. Appropriateness of MOW as Implementing Agency

In order to determine the optimal organizational structure for a rural road rehabilitation and maintenance project, objectives must first be determined and then the organizational structure developed which will best serve this purpose. Finally, the organization must be furnished with sufficient resources to be able to effectively obtain the objectives established.

The organizational structuring of the RR&B Project could be done in many ways:

- ** as part of a regular Ministry such as the Ministry of Works or Ministry of Agriculture;
- ** joint administration by one or more governmental ministries or agencies;
- ** as a autonomous agency;
- ** as part of the private sector with only minimal governmental administrative and monitoring activities.

It is the judgment of the evaluation team that the only practical option currently is to continue with an RR&B organization

that is part of MOW. To switch responsibility to any other Ministry would require them to expand their labor establishment to add different types of personnel to supervise roads and bridge work. There is no evidence, even for the Ministry of Agriculture which maintains some agricultural feeder roads in the Toledo District, that they would be any more effective than MOW has been. Joint administration by several Ministries would promise to complicate administrative problems even further. Also, there does not appear to be in Belize sufficient experience with autonomous agencies to justify serious exploration of this option. Finally, the current limitations of private sector contractors in Belize (see the discussion in item b. "Contract Maintenance" below) argue against turning over RR&B activities totally to them.

The major considerations in developing an appropriate organization within MOW are discussed below:

a) Centralized or Decentralized Organization

Until recently the general tendency in the developing world has been to decentralize rural road improvement and maintenance projects based on the assumption that these operations could better be performed at the District level where activities could be better controlled particularly in geographically dispersed areas. On the other hand excessive decentralization has resulted in inability to control work programs with the result that funds, equipment and staff were diverted to more popular, politically oriented projects rather than performance of assigned activities. Furthermore, decentralization has often resulted in the employment of excessive numbers of local casual labor on political grounds rather than actual need. On balance, the evaluating team felt that considering the relative small area of Belize (8,600 square miles) and the acute problems which have been encountered in diversion of equipment, spare parts and personnel, a centralized operation is to

be recommended to help reduce the diversion caused in part by pressures from local politicians in the districts.

b) Contract Maintenance

Contracting of rural road improvement and maintenance activities to the private sector rather than performing these activities by direct administration has been recommended and proven successful in several countries. Whether contract maintenance can be considered as a viable alternative in Belize would depend on such factors as:

(1) Can adequate funding be earmarked from the general budget to insure that contractors are paid on time?

(2) Are sufficient numbers of qualified local contractors available to perform the work required?

(3) Would contract maintenance create a Pandora's Box whereby local politician's would form contracting firms to gain contracts through favoritism rather than capacity and competitive pricing?

(4) Is the use of private sector contractors cost-effective compared to having MOW perform the work directly?

Unfortunately, answers to these questions are not available. Current funding in Belize goes into a central budget and is distributed to governmental agencies based on annual allocations which do not cover projected needs. Highway revenues are not earmarked for road projects but go into the central budget for distribution to all sectors of which rural road maintenance probably has lowest priority. Unless some sort of earmarking could be performed, it is doubtful based on current experience that funding would be made available to pay private contractors on a

timely, sustaining basis for rural road maintenance. Without payment contractors would stop working, go out of business or simply stop bidding on road maintenance projects. That outcome would only exacerbate the rural road maintenance problem and create political, social and economic negative impacts as well.

Furthermore, contractor bid prices would include both allowances for equipment ownership costs (currently budgeted by the Government as a capital expense probably paid for mainly by foreign loans and grants) and operational costs (budgeted by the Government out of annual recurrent cost budgets). Under the contract procedure, annual budgetary allocations for rural road maintenance would have to be increased to cover contractor bid prices. In addition, opportunities for obtaining foreign credits and grants for purchase of equipment would be reduced as equipment units would be provided by the local contractor. A higher percentage of rural road maintenance costs would have to be assumed by the Belizean Government, with less dependence on foreign assistance.

Finally, preliminary investigations made by the evaluating team indicated that the local contracting industry which could be made available for a contract maintenance program is not well developed. Response to recent World Bank bid openings for contract maintenance on the paved highway network have met with no or only limited response. Local firms that have undertaken contract maintenance programs are:

** CISCO Construction
** Valley Ranch Enterprises
** Modern Civil Engineers

Other local firms which have the capability but have not yet participated in a maintenance contract include:

** David Dyck
** Mennonites at Spanish Lookout
** Phoenix Ltd.

The evidence is that there is probably enough local capacity to perform contract maintenance work. The problem is lack of interest on the part of local contractors who are not yet familiar with contract maintenance and are not bidding.

For rural road maintenance, as opposed to maintenance on the primary paved network, a great deal of heavy equipment is not required. The local contracting industry could be given incentives toward contract maintenance by placing Ministry of Works maintenance equipment into a central pool and renting out the equipment to small private contractors who were interested and successful in obtaining road maintenance contracts. For example, in Guatemala equipment is rented by the government on a time-available basis at nominal rates (covering operating costs and depreciation) to private sector contractors.

Regarding whether use of outside contractors for maintenance work could be cost-effective, Mr. Guerrero (Senior Executive Engineer) stated that MOW's experience with private sector participation is that their cost is about three times higher than MOW's. Even if his observation is accurate, the annual cost (including equipment cost) of having a full-time establishment at MOW should be compared to private sector prices for performing the same maintenance tasks on demand. It is not obvious without further analysis that the sum of payments to private contractors would exceed the annual cost of the MOW staff and equipment.

In summary, contract maintenance could be considered as a long term alternative. However, prior to implementation, the problem of adequate local financing for the program and stimulation of a local contracting industry would have to be addressed. A contract

maintenance program was tried in Costa Rica as a pilot program under a AID Grant. The problem worked quite well, however, once the project was completed and AID financing withdrawn, the road quickly reverted to a poor to fair condition because the contract maintenance program could not be made self sustaining with local funding only.

c) Labor Intensive Operations

Labor intensive feeder road improvements and maintenance have been institutionalized in many countries as an effective way to reduce costs and preclude the utilization of expensive, heavy equipment units which require foreign exchange outlays. Unfortunately, these methods are applicable only where relatively inexpensive and abundant employable labor exists and communal organizations exist through which to channel these resources. Labor in Belize is relatively expensive, with a minimum wage of about US $5.00 per day full-time equivalent. Furthermore, the cooperative tradition necessary to mobilize communal labor and existing communal structures does not exist. Attempts to introduce such systems in Belize have usually resulted in failure. The situation is particularly difficult on road projects where such inputs are required over an indefinite time span unlike, for example, the construction of a school and health clinic which may require only several months of communal work to consummate. The utilization of labor intensive programs and organizations, therefore, appear to be impractical for implementation on rural road projects in Belize.

d) Diversion of Equipment

A major problem in the project has been the diversion of project equipment to non-project activities. Usually this takes the form of utilizing project trucks and graders for other roads in the area which are not part of the project. Although this occurs

in most countries, the problem appears to be particularly acute in Belize where equipment diversion is almost institutionalized. Political projects take priority over scheduled work and high governmental officials consider it as a prerogative of public office to be able to walk onto a worksite and order the foreman to move his equipment to another political worksite sometimes without even advising the controlling Ministry. The evaluation team's impression was that a great part of the diversion can be attributed to the Ministerial level where political consideration to satisfy the constituency take precedence over meeting established work programs.

For example, the evaluating team was categorically informed on October 12th by a high ranking MOW official that all diversion of AID equipment had been stopped and that all such equipment had been ordered to remain in the district equipment yard during holidays and weekends. Nevertheless, during field visits on Saturday, October 13th, AID project equipment including at least four dump trucks and a grader were observed working on the "Tea Kettle" culvert located on the main Western Highway. Material was being hauled for placement on non-project roads in the Belmopan city streets. Unfortunately, these diversions can only be controlled by the politicians themselves. Although temporary restraints can be imposed by USAID, the World Bank, and other international agencies, the measures are soon forgotten once the project is completed and the diversion continues as normal.

Generally the international agencies themselves are not so intransigent as to be unaware of the need for equipment diversion on an emergency basis. They will usually approve such diversion if officially informed. Part of the problem appears to be lack of communication so that most diversion takes place unilaterally within the Ministry of Works. Little attempt is made to inform AID or officially request authorization to divert rural road maintenance equipment to other purposes.

e) Mobile Maintenance crews

As indicated earlier, Calculations made by the evaluating team indicate that the capacity of the Rural Road Maintenance Units (RMUs) assigned to each of the six districts would be in excess of that required to maintain the rural road network if no major restraints or diversions were encountered. More effective utilization of maintenance equipment could be obtained if workloads could be increased. One such alternative would be to utilize mobile maintenance crews which would travel through the country as currently done by the Road Rehabilitation Units (RRUs). The current higher production levels achieved by the RRUs as compared with the RMUs could be attributed in part to the fact that opportunities for diversion are less under a mobile system rather than having crews with excess capacity assigned permanently to a given district. For example, approximate calculations assuming normal production rates would indicate that four mobile maintenance crews scheduled to work throughout the country could perform the currently assigned rural road maintenance workload as compared to the six permanent units currently utilized.

f) Separate Rural Road Maintenance Facilities

One approach utilized in some countries, the Dominican Republic for example, has been to create a separate rural roads maintenance division within the Ministry with independent facilities from road construction and paved road maintenance. The rural roads maintenance entity would have separate repair shop facilities, separate equipment, separate administrative facilities in the districts with no diversion permitted except under emergency situations. The system is undoubtedly inefficient as considerable duplication is involved; however, it is considered by many as the only way to insure that rural roads will receive the necessary priority to realize adequate maintenance. Considering the small

size of Belize and current budgetary restraints, the implementation of such system is not considered advisable.

g) Internal Accountability

One of the major defects in the current organization is that there appears to be no one person who is responsible for the program on a full time basis at MOW central office in Belmopan. Many people are involved in the program on a part time basis but no one seems to be in charge of the daily operations who has the authority to coordinate, monitor, control and expedite the program. The evaluating team understands that such inputs were built into the program; nevertheless, local funding for two key positions was not available and the positions were never filled. Unless a qualified, aggressive local manager can be found for the program who has the authority to manage it and the responsibility for the results obtained, the chances of a successful program will be minimal.

h) Monitoring of Work

Another weakness in the current organization appears to be that work done in the field is inadequately monitored, not only regarding quantity but also quality of the work performed.

Obviously, a more stringent monitoring system must be implemented at the Belmopan Central Offices to insure that projected goals are met and to investigate areas where production or quality is not up to expected standards. The current reporting system alone is not sufficient to insure this. A control entity within the rural roads office will be required to perform field visits and compare reported work with that actually done in the field.

As part of the monitoring system, the evaluating team considered the possibility of introducing an incentive system whereby maintenance crews who performed well would be rewarded or paid extra for quality work exceeding established production standards. Unfortunately, such incentive system are difficult to implement fairly and often result in internal problems as one crew may attain high production due to better available equipment or easier terrain conditions rather than more efficient operation. The utilization of incentive systems was therefore discarded.

i) Guidelines for Rural Roads Maintenance Organization

In developing the long-term rural roads maintenance organization the evaluating term considered that the following guidelines should be used:

(1) The rural road maintenance organization should continue to form part of the Ministry of Works; however, the function of the organization should be limited strictly to routine rural road maintenance. No periodic maintenance in the form of rural road improvements involving major resurfacing or rehabilitation should be performed by the organization.

(2) Major rural road resurfacing, improvements, and construction should be let to private sector contractors with particular emphasis on improving the quality of roads constructed through adequate standards and supervision designed to reduce maintenance workloads and facilities maintenance operations.

(3) Generally design work should be given to local consultants; however, a small design office should be maintained in the MOW for emergency work and small

projects which do not warrant the effort or time constraints in going to public competition.

(4) District workshops should continue to be utilized for repair and servicing of all MOW equipment. Separate shops just for rural road maintenance equipment are not warranted.

(5) Administratively, the rural roads maintenance organization should be a separate entity within the MOW in Belmopan with a full-time Director with full authority and responsibility for rural road maintenance only.

(6) Further study should be given to restructuring the RRUs and RMUs currently working in the field. The RRUs could theoretically be phased out as the entire rural road network is gradually rehabilitated and improved to a maintainable condition. Any improvements or new construction would be done under contract to the private sector. The amount of equipment in the RMUs could be reduced as major resurfacing of gravel roads would also be done under contract to the private sector. Consideration could be given to adopting a smaller number of mobile RMUs, dispatched out of central offices in Belmopan instead of permanent units in each of the districts. If properly administered by Belmopan, the mobile RMUs could reduce the diversion problem at the district level. These procedures would gradually reduce the heavy equipment pools carried by the rural road maintenance division with a corresponding reduction in support facilities, spare part inventories, and lower operating costs.

(7) As part of the administrative structure in Belmopan a Field Control Unit should be established with the

specific function of monitoring the quality and quantity of work performed by the maintenance units. This unit should be authorized to take the necessary actions required to insure that production and quality standards are met.

The proposed organizational system is indicated in Figure 3.

## B. Short and Medium Term Effects of the Project

### 1. Agricultural Production and Productivity

As rural roads are rehabilitated and maintained, the thesis is that these activities will stimulate agricultural production and productivity. Agricultural production is defined as the utilization of land to produce food stuffs for subsistence or market (plant or animal products). A partial measure of agricultural productivity is the yield (lbs/acre; No./acre, etc.) and is a quantitative indicator of agricultural exploitation (Success).

The Rural Roads and Bridges Project should result in:

** An increase in the number or quality of usable all-weather feeder roads for transport of foodstuffs to market locations; and
** An increase in acreage put into production.

Table 7 shows the production of principal agricultural commodities for Belize without regard to district during 1978-1986. Table 8 lists agricultural production statistics from the Ministry of Agriculture for the six Belizean districts. Data from these tables are a compilation of all production methods (i.e.,

FIGURE 3

ORGANIZATIONAL CHART FOR PROPOSED MOBILE RURAL REHABILITATION UNITS

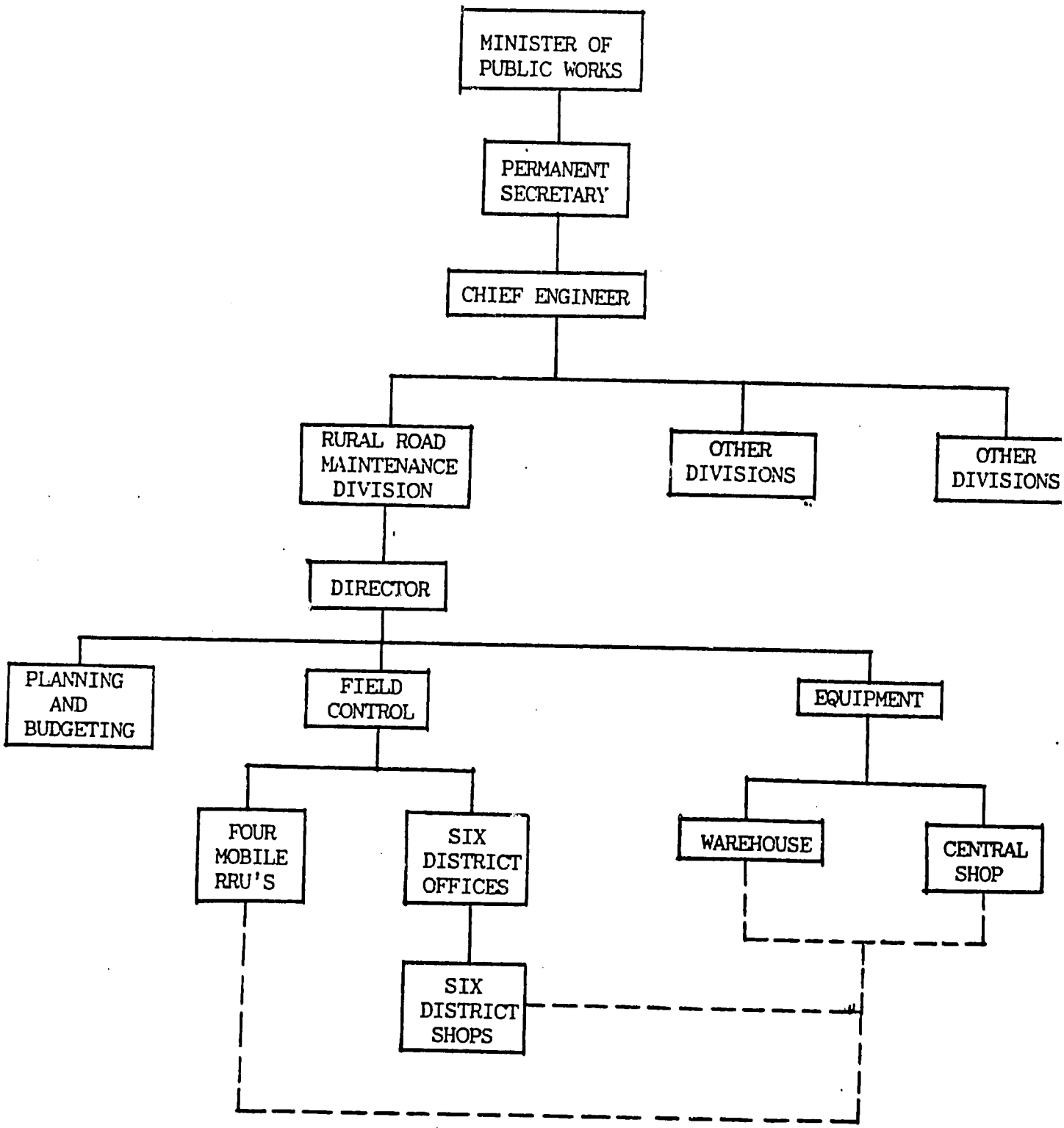

TABLE 7
PRODUCTION OF PRINCIPAL AGRICULTURAL COMMODITIES, 1978-86

| PRODUCT | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| SUGAR INDUSTRY: | | | | | | | | | |
| Cane (2) | 1123 | 989 | 1014 | 970 | 1096 | 1132 | 1022 | 962 | 854 |
| Sugar (2) | na | na | 103 | 98 | 106 | 114 | 102 | 102 | 93 |
| Est. Acres ('000) | na | na | 60 | 60 | 60 | 59 | 59 | 58 | 55 |
| CROPS: | | | | | | | | | |
| Oranges (1) | 656 | 568 | 1109 | 1063 | 1063 | 750 | 1124 | 1043 | 1265 |
| Grapefruit (1) | 303 | 188 | 408 | 586 | 703 | 178 | 312 | 476 | 650 |
| Bananas (1) | na | na | 785 | 549 | 524 | 531 | 555 | 507 | 672 |
| Corn (2) | 19.2 | 15.2 | 18.5 | 21 | 21 | 15.1 | 15.4 | 19.3 | 18.2 |
| Rice (2) | 6.3 | 6.6 | 8.4 | 10.6 | 7.8 | 6 | 5.6 | 5.5 | 4.3 |
| Beans (2) | .9 | 1 | 1.4 | 1.7 | 1.7 | 1.8 | 1.3 | 1 | 1.8 |
| Honey (2) | .2 | .2 | .2 | .2 | .2 | na | na | na | na |
| LIVESTOCK: (Dressed Weight, Reported Through Official Slaughterhouses.) | | | | | | | | | |
| Beef (3) | 2577 | 2562 | 2310 | 2216 | 1933 | 2127 | 2238 | 2300 | 2441 |
| Pork (3) | 764 | 659 | 487 | 365 | 332 | 506 | 595 | 635 | 660 |
| Poultry (3) | 3800 | 4500 | 4300 | 5216 | 6060 | 6477 | 6672 | 6757 | 5626 |
| Fresh Milk (3) | na | na | 535 | 616 | 649 | 701 | 975 | 1169 | 1244 |

na = not available
(1) '000 boxes: oranges, 90 lbs; grapefruit, 80 lbs; bananas, 42 lbs.
(2) '000 long tons at 2,240 lbs. each
(3) '000 lbs.

SOURCE: M/NATURAL RESOURCES, 1982; M/FINANCE AND ECONOMIC PLANNING, 1982;CENTRAL STATISTICAL OFFICE, 1987

TABLE 8
AGRICULTURAL PRODUCTION STATISTICS BY DISTRICT
FOR 1987, 1988, AND 1989

| CROP, ACRES AND YIELD (1987) | COROZAL | O. WALK | BELIZE | CAYO | ST. CREEK | TOLEDO | TOTALS |
|---|---|---|---|---|---|---|---|
| CORN (LB) | 6,180,000 | 10,415,000 | 1,424,000 | 26,160,000 | 524,000 | 6,500,000 | 51,203,000 |
| CORN (ACRES) | 3,425 | 7,000 | 902 | 16,000 | 665 | 4,500 | 32,492 |
| YIELD (LB/ACRE) | 1,804 | 1,488 | 1,579 | 1,635 | 788 | 1,444 | 1,576 |
| R.K. BEANS (LB) | 1,460,800 | 660,000 | 440,000 | 2,500,000 | 24,000 | 240,000 | 5,324,800 |
| R.K. BEANS (ACRES) | 1,626 | 1,500 | 600 | 5,000 | 40 | 400 | 9,366 |
| YIELD (LB/ACRE) | 300 | 440 | 733 | 500 | 600 | 600 | 569 |
| RICE PADDY (LB) | 59,200 | 2,400,000 | 751,200 | 199,320 | 1,252,000 | 5,464,689 | 10,126,409 |
| RICE (ACRES) | 75 | 1,200 | 650 | 60 | 460 | 2,750 | 5,195 |
| YIELD (LB/ACRE) | 789 | 2,000 | 1,156 | 3,322 | 2,722 | 1,987 | 1,949 |
| SUGAR (ACRES) | 30,000 | 25,000 | 0 | 0 | 0 | 0 | 55,000 |
| CATTLE (HEAD) | 2,160 | 16,279 | 10,448 | 20,027 | 1,290 | 1,608 | 51,806 |
| PIGS (HEAD) | 3,600 | 6,100 | 1,741 | 3,729 | 900 | 4,500 | 20,570 |
| POULTRY (NO) | 51,000 | 984,000 | 368,900 | 1,034,833 | 7,870 | 9,500 | 2,456,103 |
| BANANA (ACRES) | 0 | 0 | 88 | 0 | 3,242 | 0 | 3,330 |
| CITRUS (ACRES, ORANGES & GRAPEFRUITS) | 0 | 0 | 0 | 3,252 | 8,693 | 0 | 11,945 |
| CORN, ACRES - 1985 | 4,740 | 8,450 | 510 | 13,315 | 1,060 | 5,840 | 31,875 |
| -1984 | 0 | 0 | 0 | 0 | 0 | 0 | 29,000 |
| RK BEANS, ACRES - 1985 | 1,100 | 400 | 135 | 2,300 | 50 | 530 | 4,515 |
| -1984 | 0 | 0 | 0 | 0 | 0 | 0 | 4,500 |
| RICE, ACRES - 1985 | 111 | 525 | 260 | 250 | 615 | 3,055 | 4,816 |
| -1984 | 0 | 0 | 0 | 0 | 0 | 0 | 4,700 |
| SUGAR, ACRES - 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 58,000 |
| -1985 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BANANA, ACRES - 1985 | 0 | 0 | 0 | 0 | 0 | 0 | 1,645 |
| -1984 | 0 | 0 | 0 | 0 | 0 | 0 | 1,558 |

Source: Ministry of Agriculture

TABLE 8 (continued)
AGRICULTURAL PRODUCTION STATISTICS BY DISTRICT
FOR 1987, 1988 AND 1989

| CROPS, ACRES AND YIELDS (1988) | COROZAL | ORANGE WALK | BELIZE | CAYO | STANN CREEK | TOLEDO | TOTALS |
|---|---|---|---|---|---|---|---|
| CORN (LB) | 7,060,000 | 10,740,000 | 180,000 | 27,986,000 | 249,300 | 4,757,800 | 50,972,900 |
| CORN (ACRE,MILPA) | 1,400 | 2,100 | 200 | 4,164 | 312 | 5,947 | 14,123 |
| YIELD (LB/ACRE,MILPA) | 800 | 1,000 | 900 | 3,400 | 800 | 800 | 967 |
| CORN (ACRES, MECH) | 3,300 | 4,500 | 100 | 16,570 | 0 | 0 | 18,770 |
| YIELD (LB/ACRE, MECH) | 1,800 | 2,000 | 0 | 2,000 | 0 | 0 | 1,933 |
| TOTAL ACREAGE | 4,700 | 6,600 | 850 | 15,034 | 312 | 5,947 | 33,243 |
| RK BEANS (LBS) | 1,127,500 | 770,000 | 0 | 2,978,437 | 16,500 | 35,000 | 4,927,437 |
| RK BEANS(ACRES, MILPA) | 0 | 0 | 0 | 0 | 33 | 58 | 91 |
| YIELD (LB/ACRE, MILPA) | 0 | 0 | 0 | 0 | 500 | 600 | 550 |
| RK BEANS (ACRES, MECH) | 2,255 | 1,400 | 0 | 5,796 | 0 | 0 | 9,451 |
| YIELD (LB/ACRE, MECH) | 500 | 550 | 0 | 514 | 0 | 0 | 516 |
| TOTAL ACREAGE | 2,255 | 1,400 | 0 | 5,796 | 33 | 58 | 9,542 |
| RICE PADDY (LB) | 72,000 | 3,020,000 | 255,000 | 256,400 | 1,606,500 | 7,027,551 | 12,237,451 |
| RICE (ACRES, MILPA) | 30 | 350 | 170 | 83 | 121 | 4,173 | 4,927 |
| YIELD (LB/ACRE, MILPA) | 1,000 | 1,200 | 1,500 | 800 | 1,500 | 1,684 | 1,281 |
| RICE (ACRES, MECH) | 60 | 1,300 | 0 | 110 | 475 | 100 | 2,045 |
| YIELD (LB, MECH) | 700 | 2,000 | 0 | 1,727 | 3,000 | 3,500 | 2,185 |
| TOTAL ACREAGE | 90 | 1,650 | 0 | 193 | 596 | 4,273 | 6,802 |
| SUGAR, ACRES | 29,157 | 29,250 | 0 | 0 | 0 | 0 | 58,407 |
| CATTLE, HEAD | 1,582 | 21,000 | 6,278 | 20,234 | 778 | 1,706 | 51,578 |
| PIGS, HEAD | 3,800 | 7,000 | 1,992 | 4,288 | 475 | 4,000 | 21,555 |
| POULTRY, NO. | 20,800 | 1,242,000 | 21,500 | 1,510,288 | 30,000 | 6,416 | 2,831,004 |
| BANANA, ACRES | 0 | 0 | 0 | 0 | 2,613 | 0 | 2,613 |
| CITRUS, ACRES (ORANGE & GRAPEFRUIT | 0 | 0 | 550 | 3,702 | 13,849 | 0 | 18,101 |

Source: Ministry of Agriculture

TABLE 8 (CONTINUED)
AGRICULTURAL PRODUCTION STATISTICS BY DISTRICT
FOR 1987, 1988, 1989

| CROP, ACRES AND YIELD (1989) | COROZAL | O. WALK | BELIZE | CAYO | ST. CREEK | TOLEDO | TOTALS |
|---|---|---|---|---|---|---|---|
| CORN (LB) | 10,310,000 | 11,075,000 | 323,104 | 24,858,755 | 200,000 | 4,340,000 | 51,104,859 |
| CORN (ACRE,MILPA) | 1,300 | 2,475 | 220 | 2,778 | 250 | 3,600 | 10,623 |
| YIELD (LB/ACRE,MILPA) | 1,200 | 1,000 | 1,472 | 700 | 800 | 1,200 | 1,019 |
| CORN (ACRE,MECH) | 3,500 | 3,440 | 0 | 10,983 | 0 | 10 | 17,933 |
| YILED (LB/ACRE,MECH) | 2,500 | 2,500 | 0 | 4,115 | 0 | 2,000 | 3,485 |
| TOTAL ACREAGE | 4,800 | 5,915 | 220 | 13,761 | 250 | 3,810 | 28,556 |
| R.K. BEANS (LB) | 2,790,000 | 1,777,500 | 6,600 | 4,594,625 | 20,000 | 91,200 | 9,279,925 |
| R.K. BEANS (ACRE,MILPA) | 400 | 225 | 23 | 10 | 40 | 152 | 850 |
| YIELD (LB/ACRE,MILPA) | 600 | 500 | 287 | 400 | 500 | 600 | 558 |
| R.K. BEANS (ACRE,MECH) | 3,000 | 1,850 | 0 | 5,650 | 0 | 0 | 10,500 |
| YIELD (LB/ACRE,MECH) | 850 | 900 | 0 | 812 | 0 | 0 | 839 |
| TOTAL ACREAGE | 3,400 | 2,075 | 23 | 5,660 | 40 | 152 | 11,350 |
| RICE PADDY (LB) | 120,000 | 3,427,500 | 127,000 | 634,501 | 1,620,000 | 5,186,000 | 11,115,001 |
| RICE (ACRE,MILPA) | 20 | 225 | 107 | 269 | 150 | 3,228 | 3,999 |
| YIELD (LB/ACRE,MILPA) | 1,000 | 1,000 | 1,184 | 519 | 1,800 | 1,300 | 1,406 |
| RICE (ACRE,MECH) | 50 | 1,281 | 0 | 330 | 450 | 172 | 2,283 |
| YIELD (LB/ACRE,MECH) | 2,000 | 2,500 | 0 | 1,500 | 3,000 | 2,000 | 2,405 |
| TOTAL ACREAGE | 70 | 1,506 | 107 | 599 | 600 | 3,400 | 6,282 |
| SUGAR (ACRES) | 26,000 | 30,500 | 0 | 0 | 0 | 0 | 58,500 |
| CATTLE (HEAD) | 1,600 | 23,000 | 8,839 | 18,136 | 750 | 1,700 | 54,025 |
| PIGS (HEAD) | 2,700 | 8,000 | 3,215 | 2,002 | 500 | 0 | 16,417 |
| POULTRY (NO) | 7,000 | 800,000 | 62,400 | 1,608,309 | 0 | 2,500 | 2,460,209 |
| BANANA (ACRES) | 0 | 50 | 40 | 0 | 3,384 | 847 | 4,321 |
| CITRUS (ACRES,Orange & GRAPEFRUITS) | 0 | 90 | 0 | 6,917 | 25,000 | 340 | 32,347 |

Source: Ministry of Agriculture

mechanized, milpa, etc.) and show trends in agricultural production over a 12 year period.

If the thesis is correct, Tables 7 and 8 should indicate an increase in production and acreage if the RR&B project is producing and maintaining more all-weather feeder roads.

Data from 1982-1986 show no significant or steady increase in acreage put into sugar cane production (Table 7). Table 8 data for 1987-89 show that sugar cane acreage was 3,000 to 6,000 acres below the 1982 high of 61,000 acres put into sugar cane production. Data for corns, beans, rice are also presented. Data for 1988-89 show that although beans recorded an increase in total acreage planted by milpa farmers, corn and rice acreage planted by milpa farmers declined. Since the reduction in acreage planted to corn and rice is larger than the increased acreage planted to beans, the conclusion is that milpa farming did not expand during this period.

The data on production to date are variable, and increases or decreases in productivity may not be clearly attributable to the rehabilitation and maintenance of rural roads. One statistic, the increase in numbers of acres in production, should suggest whether the rehabilitation and maintenance of rural roads is a factor in agricultural production. Acreage data are shown in Table 8. The Table 8 data by district are variable with the exception of the following trends between 1987 and 1989:

a) Bean production and acreage increased by 74.3% and 21.2% respectively most of which was due to mechanized output;

b) Citrus acreage increased by 78.7%;

c) Cattle numbers increased by 4.8%; and

d) Banana acreage increased by 65.9%.

It seems safe to assume that larger agro-businesses account for most of these increases as opposed to milpa farmers. The extent to which increased production is a reflection of the rural road program is not clear from the data. One would need to use an econometric model to estimate statistically the impact of the RR&B Project's miles of rural road improvements on bringing additional acres into production or increasing productivity to arrive at a meaningful appraisal.

## 2. Environmental Impacts

The districts of Cayo, Belize, Stann Creek, Orange Walk and Corozal were analyzed for environmental impacts, both positive and negative. The Toledo District was not visited. It is estimated that 10% of the rural roads under this project were examined in each of the districts visited. Data from the Environmental Evaluation form were completed for each district visited. These forms are presented in Appendix E. They provide data for the discussion of environmental impacts of the Rural Roads and Bridges Project on environmental resources:

a) **Reduction in flooding/erosion near drainage structures through application of proper engineering design principles and standards.**

### BELIZE DISTRICT

Along the rural roads visited, flooding and erosion near drainage structures was minimal. Due to the flat terrain water tends to pond in low areas and erosion of road surfaces is to roadsides. These roadsides tend to fill with sediment thus encouraging natural revegetation of grasses and forbs, which in turn holds more water and sediments. There was little evidence that roadside drainage is maintained through regular maintenance: clearing and maintaining a ditch slope, draining water off

roadsides to catchment basins, water courses, etc. No engineered structures were in evidence.

CAYO DISTRICT

Rural roads in the Cayo District are subject to greater erosion because roads are built on hilly country, the terrain is stony, outcropping makes road maintenance difficult, and the lack of properly engineered drainage ditches designed to carry run-off and dissipate energy of run-off waters is evident.

Of all roads visited, these rural roads in Cayo District showed the greatest erosion effects and siltation of water courses near rural roads. Roads on level to slightly sloping surfaces showed erosion to side ditches and filling of ditches, with sediments and natural revegetation encroaching into the right-of-way. There was no evidence of engineered drainage structures designed to reduce flooding or erosion potential.

If roadside ditches were engineered to carry water and to dissipate its energy, less erosion of ditches and siltation of waterways would occur near rural roads.

COROZAL DISTRICT

No drainage structures were observed near rural roads. Flooding and erosion was confined to road segments in low spots. Typically the high spots on the road lose material which is carried in run-off to low spots in the road. These areas flood, deposit silt and then water evaporates off. Sediments in the ditch way, which are not removed through regular maintenance, promote vegetation growth of grasses and forbs. Thus native vegetation species and sugar cane begin to invade the road right-of-way. Without regular maintenance of roadside ditches, road flooding will continue to occur at low spots.

In this flat area, water has nowhere to go without the construction and maintenance of drainage ditches, drainage structures near water courses, and regular crowning of the road surface.

ORANGE WALK DISTRICT

The condition of roads and ditches, and the absence of drainage structures at Orange Walk, was similar to the conditions at Corozal District. Maintenance crews in Orange Walk were observed providing drainage for a rural road which had been flooded because it had no outlet for the water. A grader was cutting a drainage trench into the edge of the sugar cane field in an effort to move water off the road. In this district flooding and erosion is confined to low spots on roads. No engineered drainage structures were seen that effectively drain water off roadways.

STANN CREEK DISTRICT

Minor flooding and erosion of some road surfaces was observed. No engineered drainage structures were in evidence, but roadside ditches had been cleared. One road to Hopkins crossed a marshy area. Standing water occurred in low spots and no drainage ways had been made through either engineered structures or maintenance activities. Because the area is flat to gently rolling, flooding and erosion are confined to small road areas with little noticeable impacts beyond the road right-of-way.

TOLEDO DISTRICT - Not visited.

**b) Mitigation of undesirable indirect effects (e.g., erosion hazards, shortened milpa fallow period) though application of appropriate criteria for selection of candidate roads.**

## BELIZE DISTRICT

The erosion hazard along the road influence area is low due to relatively flat terrain and well developed vegetation communities. In road influence areas which go through Pine Ridge with a more open canopy and with shallow soils, the erosion hazard is greater. These soils could become problem areas if utilized for milpa farming because of their inherent low fertility, hard clay pan and sparse vegetation. The slash and burn activities in marginal lands could create greater erosion hazards.

The greatest evidence of milpa-mixed farming was observed along stretches of broad-leaf forest where the soils were deeper (near Burrell Boom). There was little evidence of agriculture in the poorer Pine Ridge soils. To the extent the poor soils are not presently required for agriculture, a shortening of the milpa fallow period will not occur. In this district the selection of rural roads has mitigated erosion hazards, low fertility soils and shortened fallow periods.

## CAYO DISTRICT

The erosion along the road influence area is high due to the presence of steeper slopes and a higher density of milpa agriculture. Coupled with lower natural soil fertility, slash and burn agriculture, and rainfall from 60"-80" per year, areas devoid of vegetation can contribute significantly to erosion hazard.

It was not possible to evaluate the milpa fallow period in this report for this district. However, the density of milpa farmers has probably not increased to the point of either increased exploitation of marginal lands or Shortening fallow period to bring land back into production. The reason is that acreage committed to milpa farming in Cayo District decreased significantly from 1988 to 1989, as indicated earlier.

For this area the potential impact is an increased erosion hazard from slash and burn agriculture. However, road selected has favored forested land rather than land devoid of vegetation or land in fallow.

## COROZAL DISTRICT

Along the road influence area there is no erosion hazard due to the flat, heavy vegetated land surface. Similarly, because the majority of the land along the road influence area is in sugar cane, little or no milpa farming takes place. The soils in Corozal are fertile and suited to a variety of crops, thus marginal lands are not in production at this time, and milpa fallow period is not a land use issue. The lands that are now forested will have a high probability of being converted to sugar cane in the near future.

## ORANGE WALK DISTRICT

There is no erosion hazard or shortening of the milpa fallow period in Orange Walk rural road influence areas for the same reasons discussed for the Corozal District.

## STANN CREEK DISTRICT

The flat to rolling hill terrain of the Stann Creek District poses little to no erosion hazard along the road influence area. Most erosion is confined to alternating high and low spots on the rural roads. Much of the road lengths pass through Pine Ridge and mixed deciduous forest where milpa agriculture could pose an erosion potential. Much of the Stann Creek Area is in citrus production, however, and milpa agriculture is not extensive. The demand for additional citrus lands will probably preclude milpa agriculture along road areas in the rural system, and milpa fallow period will not be an issue.

TOLEDO DISTRICT - (Not Visited)

If the road influence areas extend into hilly/steep terrain, erosion hazard could be increased with an expansion of milpa farming. The soils in the Toledo District are generally fertile under long-fallow milpa agriculture. Increased pressure by milpa farmers to increase production because of improved rural roads could increase erosion hazard through slash and burn of marginal lands, and decrease fallow periods by bringing fallow lands into production sooner.

**c) No construction of roads in ecologically sensitive areas.**

From the brief survey of 5 of the 6 districts it did not appear that rural roads extended into ecologically sensitive areas. Belize has large populations of birds, mammals, plants and other species that are considered threatened or endangered in other Central American Countries. Nevertheless, 15 mammal, 33 bird and 7 reptile species are considered threatened or endangered in Belize.

The 1981 National Parks System Act provides the statutory framework for establishing national parks, national monuments and wildlife reserves. To date several parks, monuments and reserves have been established, or are under study. Some have been lost/destroyed by hunters, fishermen and farmers. Ecologically sensitive areas need to be identified, protected and studied to preserve the rich natural resource heritage which still exists in Belize.

**d) No use of archaeological sites as sources of construction material to implement this project.**

## BELIZE DISTRICT

There are 41 recorded archaeological sites in the Belize District. These range from Altun Ha to minor settlement areas. At present it is assumed that no roads pass through archaeological sites. Borrow pits for construction material appear to be away from archaeological sites, although the Commissioner of Archaeology said the Western Highway construction destroyed several Mayan ruins, some of which are visible from the highway.

## CAYO DISTRICT

There are 120 recorded archaeological sites in the Cayo District which range from Caracol and Xunantunich to caves with ancient Mayan artifacts. At present it appears that both roads and borrow pits have avoided archaeological sites.

## COROZAL DISTRICT

There are 25 recorded archaeological sites in the Corozal District which include the Mayan centers of Cerros, Santa Rita and minor ceremonial centers like Sarteneja. At present it appears that both rural roads and borrow pits have avoided archaeological sites. However, the Commissioner of Archaeology said that MOW construction crews have often used bulldozers to level Mayan ruins and use the material for road construction and maintenance.

## ORANGE WALK DISTRICT

There are 53 recorded archaeological sites in the Orange Walk District which include the Mayan centers of Lamanai, Cuello and minor settlement areas. At present it appears that both rural roads and borrow pits have avoided archaeological sites. However, the Commissioner of Archaeology made the same comments about Orange Walk as about Corozal.

STANN CREEK DISTRICT

There are 33 recorded archaeological sites in the Stann Creek District. These sites are not as imposing as those mentioned above, but they include minor Mayan ceremonial centers, colonial battle grounds and settlement areas. At present it appears that rural roads and borrow pits have avoided archaeological sites.

TOLEDO DISTRICT

There are 54 archaeological sites in the Toledo District. Lubaantun and Nim Li Punit are examples of major Mayan ceremonial centers. Minor ceremonial centers, caves with Mayan artifacts and early settlement areas are examples of additional sites. To date it appears that rural roads and borrow pits have avoided archaeological sites. The Commissioner of Archaeology said this is one of the most heavily impacted areas in terms of MOW construction crews harming Mayan ruins.

e) **Involvement of Commissioner of Archaeology in assisting Ministry of Works to identify appropriate sites for borrow pits, gravel pits or other sources of construction material.**

The Commissioner of Archaeology (COA) said that he has not yet been contacted by any staff member of MOW to help identify appropriate sites, to assist in determining priorities for rural roads rehabilitation, or to suggest extensions of rural roads to help tourists reach Mayan ruins. If the five recommendations below are followed, there will be little to no future negative impact on archaeological sites:

(1) An accurate and detailed map of all rural roads and borrow pits, etc., should be prepared and provided to the COA.

(2) Future road needs and construction material needs should be mapped and provided to the COA.

(3) The COA should check MOW maps and advise MOW on archaeological site proximity and potential impact from RR&B Project.

(4) For new road alignment and construction materials, the MOW should request a clearance survey from the COA before finalizing construction plans.

(5) Any road alignment or construction material sites which have a potential to impact archaeological sites should be changed and receive COA clearance for use.

In addition the COA volunteered the information that MOW staff from time-to-time notify his office when construction work encounters a Mayan ruin. This report is consistent with the statement by Mr. Guerrero (Senior Executive Engineer) that the archaeology staff do not know where every ruin is located, and that MOW staff have been their chief informants with respect to new ruins and know that the COA should be informed whenever a borrow pit or road right-of-way shows signs of encountering ruins. Nevertheless, the COA believes that, on balance, there have been significant abuses to Mayan ruins caused by MOW work.

A concluding comment is addressed to another statement of Mr. Guerrero, that MOW feels the environmental assessment has been heavily biased in favor of the archaeology viewpoint. First, the assessment forms presented in Appendix E make no mention of archaeological aspects of construction planning. Second, the scope of work for this evaluation explicitly requires a report on the extent to which MOW has consulted the COA and harmed archaeological sites. This report presents the response of the COA as well as that of MOW.

## C. Probability for Sustained Impact of the Project

### 1. Population Growth and Economic Expansion

The discussion of Section II on the economic and social environment pointed out the two important impacts the RR&B Project will have on population growth and economic expansion:

a) the supportive role of all-weather rural roads in moving exports of agricultural commodities to ports for shipment abroad, and in stimulating domestic production of foodstuffs that are substitutes for imported foods;

b) the increased attraction of rural areas relative to urban areas (due to improved access to education, health, and other social services), thereby retarding rural-urban immigration and possibly even reducing the net out-migration of Belizeans to other countries.

One potentially adverse impact of the RR&B Project might be to encourage expansion of milpa farming using the economically inefficient slash and burn techniques. This negative impact is mentioned in Section IV.B.1 in the context of the project's potential impact on agricultural production and productivity, However, since the agricultural production statistics imply little increase in milpa farming, this potential cost is unlikely to be large.

### 2. Potential for Self-Sustaining Institutional Development in the MOW

One of the major uncertainties that has to be considered is to what extent rural road maintenance in Belize can be made self sustaining.

Two aspects must be considered:

a) Recurrent costs primarily in local currency to meet annual budgets for labor, materials and equipment operating and repair costs.

b) Periodic capital costs, mainly foreign exchange, needed to renovate maintenance equipment upon reaching the end of their useful economic life.

This requires a realistic projection of costs required to maintain the rural road network at an acceptable service level and an estimate of the extent to which current funding mechanisms can provide these funds. If the analysis indicates that shortfalls exist, then either alternative sources of funding must be obtained or cost savings measures introduced by reducing workloads or quality standards.

The fiscal situation in Belize appears to be that traditional road-based taxes in the form of fuel taxes, duties on imported vehicles and parts, and matriculation fees are more than adequate to cover recurrent road maintenance charges. Insufficient financing develops only when major new construction is programmed requiring a heavy capital investment during a relatively short construction period for which case foreign assistance must be solicited. Shortfalls for maintenance financing are currently due to the diversion of road tax revenues to other more politically visible sectors of the economy such as education, health and housing. For example, recent implementation of free health care programs in Belize has strained the budget with the result that health programs are partly being paid for by road revenues.

Increasing road maintenance revenues through higher or additional road taxes will not solve the problem unless a fiscal

decentralization policy is instigated which will allow road user revenues to be earmarked (at least partially) for rural road maintenance. Rural road maintenance projects, even at low traffic levels, often result in very high economic returns with internal rates of return generally in the 20 to 70 percent range.[6] Targeted taxation for rural roads maintenance can therefore be amply justified based on results of economic evaluations based on relative priorities as established from multi-sector studies. Although targeted taxation for specific purposes usually must be justified based on paying for activity-specific costs, it can be justified in the case of rural road maintenance as it appears to be the only way to resolve the funding allocation problem in Belize to insure adequate rural road maintenance.

One earmarked road maintenance program which has proven to be relatively successful is reported by the World Bank in the Central African Republic (Ref. 8, page 28):

> "A third road fund, instituted in 1981 in connection with the fourth highway project, is still functioning. As a public establishment with financial autonomy, the fund has the sole function of financing road maintenance. Revenues come from a fuel tax, which the government adjusts yearly to ensure the fund's capacity to do its work. The fund is under the control of a ministerial management committee, on which road users are represented through the Chamber of Commerce."

> "This third road fund has also had problems, but none fatal. At one time it had difficulty collecting the revenues. At another the government forced the fund to

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[6] The economic analysis in the 1983 Project Paper for the RR&B Project supports this assertion.

pay for a project outside its mandate. Despite these and other problems the fund has improved road maintenance by raising the level, and increasing the regularity, of the funding."

The problem of capital budgeting for renovation of maintenance equipment which has reached the end of its economic life requires that foreign exchange be made available on a timely basis. If this foreign exchange cannot be made available from internal sources, then continued reliance on foreign assistance is the only solution. These loan requests should be well planned in advance considering that the normal processing time on loan applications is on the order of three years. Highway maintenance equipment has an economic life on the order of 5 to 8 years so that loan applications for funding of renewal equipment must be made 2 to 5 years after the initial order.

A study should be undertaken by the Mission to determine policies to be adopted and alternate strategies for financing both recurrent and capital costs for rural road maintenance. The RR&B project should be suspended temporarily upon reaching the PACD of April 30, 1991 and renewed only after the Mission feels that the necessary measures to insure a self-sustaining program have been effectively implemented and that there is a firm commitment on the part of the GOB to maintain the rural road network at a satisfactory quality standard.

## D. Major Strengths and Weaknesses in Achievement of Project Goals

### 1. Factors Contributing to Attainment of Success

Rural Road Maintenance Programs are difficult to implement. As the World Bank states:

"The World Bank advanced more than $1.2 billion between 1971 and 1985 for training, technical assistance and management consultancies to improve the organization and management of road administration in developing countries. Despite these efforts to improve operations and administrative performance, it has been difficult to establish self-sustaining institutions that can manage road maintenance efficiently or use external resources effectively."[7]

Considering the difficulties involved, project expectations should not be overstated with a distinction between what is desired and what can be obtained practicably. The Mission should keep this objective in mind while evaluating the project and perhaps settle for something less than 100% compliance with the objectives of the project as stated in the Project Paper. The positive aspects of the project to-date are:

a) The basic institutional structure for a rural road maintenance program as part of the MOW is already in place. The system needs to be modified, improved and fine tuned; however, the basic framework exists and is working within certain limitations.

b) A Maintenance Management System (MMS) has been designed and implemented. The system appears to be well designed, not overly sophisticated, and understood at both the Belmopan and District levels.

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[7] Clell Harral and Asif Faiz, "Road Deterioration in Developing Countries - Causes and Remedies," A World Bank Policy Paper, 1988, page 17.

c) The Road Rehabilitation Units (RRUs) working in the field have been able to demonstrate reasonable productivity considering restraints imposed by equipment availability.

d) The general capacity and quality of MOW personnel at both the Belmopan and District levels appears to be quite good. Considering that rural road maintenance is not high technology, the general impression was that Ministry personnel were experienced, practical and generally well qualified for the positions held.

e) A heavy equipment administration program with inventory controls, shop repair facilities, cost and administrative controls has been established and is working fairly well.

f) Proper road selection to mitigate direct and indirect environmental effects of the RR&B Project appears to have been achieved. However, with light demand on agricultural lands at present this may be misleading. Erosion on hillsides is a potential problem in the Cayo and Toledo Districts as is siltation of waterways. As demand for agricultural lands increase, erosion and siltation will become a bigger issue. Flooding and erosion near outlets of drainage structures was not observed since these structures may not exist in any of the districts. The reverse was seen on flat terrain -- flooding and siltation of roadways. The primary environmental success factor is the present low demand for new agricultural lands. However, demand for prime agricultural lands increases, marginal lands susceptible to erosion will be farmed.

## 2. Weak Points in Each Component

The principal negative aspects of the program observed are:

a) From the institutional point, more centralization of control is required in the Belmopan Office. Job progress and quality in the field has to be more closely monitored and corrective action taken when required. More of the work, particularly road rehabilitation and periodic maintenance in the form of resurfacing should be done by the private sector. MOW equipment pools should be reduced by phasing out the RMUs and limiting MOW work to routine maintenance only. Rural Road Maintenance in Belize excessively politicized as equipment and other resources are diverted to more attractive road construction and primary, paved road maintenance.

b) The quality standards to which rural roads are currently being rehabilitated are too low. The general quality of roads should be improved particularly with respect to drainage, quality of surfacing, and roadside design.

c) The Maintenance Management System (MMS) is not utilized to the full extent designed. A large volume of paper and information is being generated which is not utilized as intended for planning, control, costing or budgeting of maintenance activities.

d) The Road Maintenance Units (RMUs) are not working effectively. There really is no routine maintenance being done on a programmed, scheduled basis. Maintenance appears to be limited to repairing short deteriorated sections of road rather than on general upgrading of road quality through periodic blading and shaping of entire lengths of roads. Road maintenance as being reported

overstates the amount of real maintenance being done in the field.

e) Insufficient attention appears to have been given to the financing aspects of rural road maintenance so as to have a self-sustaining program by the PACD of April, 1991. Considering that the project has been on line since 1983, the all too critical financing problem should have been addressed and resolved long ago. USAID/Belize should have taken more active part in implementing a viable financial plan to insure that adequate funding was available to sustain the program through the PACD.

f) The technical assistance and training component of the project seems to have been in many cases deficient and not effectively implemented. The technical assistance personnel were not sufficiently effective in serving as advisors and productive professionals in the context of Belize. Training programs were not always correctly focused, e.g., one of the principal complaints in the field was that training of equipment operators and shop mechanics was done at the entry level assuming no previous experience. What was required was perfection of existing skills of trained operators and mechanics which the Ministry employs. Nothing new was learned and in some cases instructors performed the work themselves instead of improving skill of MOW employees. Another case in point is the current Management Engineer Advisor who is providing technical assistance to the MOW in the implementation of the project. This advisor does not appear to be contributing appreciably to the project. The reason given - whether correct or not - is that his personal contract for the project limits his functions to that of an advisor. He does not implement, take the initiative, or make managerial decisions. The position

is of considerable importance and a way should be found to make his services more effective or to find a replacement. The fact that the evaluation team considered the general level of capacity of the staff to be good does not argue against the need for additional training. There is always a need for improvement of skills. The need for training of operators was indicated on page 4, item 8, and page 9, item 6. Certainly if specific areas can be identified where additional training or upgrading of personnel capability is required, then these inputs should be considered.

g) The bridge program whereby 54 permanent crossings are to be built is far behind schedule with no hope of completion by the PACD. The only major restraint is the non-availability of local financing to support the program. The bridge component is considered to be extremely desirable. Considering that a major investment has already been sunk into the project, the Mission should consider the possibility of additional AID-generated counterpart funding for the project in the event that GOB is not able to meet its commitments in this respect.

h) The lack of regular maintenance on rural roads has resulted in sedimentation and filling of road ditches along many lengths in all districts, and natural revegetation by species of grasses, forbs and trees. Although this is not an intended outcome, it has had a positive impact by:

(1) creating an edge effect and providing habitat to wildlife, particularly birds; and

(2) trapping much of the dust generated on the roads by vehicular traffic thus reducing dust impacts to humans (breathing dust) and crops (reduction in photosynthetic surfaces resulting in decreased crop yields).

## E. Assessment of Potential for Bringing Phase II to a Successful Conclusion

Obviously the project cannot be brought completely back on schedule by the current PACD of April 30, 1991. An extension will be required which again will be tied to inputs required from the Government of Belize particularly those with reference to local financing requirements so as to make the program self-sustainable. In general, it is felt that the program can be turned around in about six months provided that the proper inputs are provided and reasonable outputs are stipulated. If they cannot be provided, an extension would not be justifiable.

Suggestions to ensure efficient use of resources under existing conditions are present below. The following inputs are considered essential to the successful completion of the program:

a) Develop technical package and design criteria for rural roads as a function of traffic, terrain type, climatic conditions, flooding conditions with the intent of improving the quality of the rural roads built or improved so as to reduce maintenance workloads. Relevant quality control standards and terminology are contained in Appendix F.

b) Define the rural road network which is to receive regular, programmed maintenance and establish the level of service in the form of annual frequency of maintenance operations as a function of traffic volumes. For

example, recent research by the World Bank has indicated the optimum blading cycle of unpaved roads to be on the order of one blading for every 4,000 to 8,000 vehicle passes. In accordance with the criteria, the following schedule could be developed for unpaved roads in Belize.

**Unpaved Roads**

| Class | ADT | Blading/Year |
|---|---|---|
| 1 | 0-20 | 2 |
| 2 | 21-90 | 4 |
| 3 | 91-150 | 6 |
| 4 | Over 150 | 8 |

c) Estimate the annual cost of maintaining this road network at the intended service level. Evaluate current revenue sources and if a shortfall exists, determine where the additional funding should come from.

d) Work intensively with the MOW to introduce a road rehabilitation program and resurfacing program which would be awarded to the private sector and gradually phase out the use of the two RRUs.

e) Work intensively with the MOW to provide effective routine road maintenance based on the use of mobile units controlled from Belmopan rather than fixed units at the district level controlled by the Officer-In-Charge.

f) Work intensively with the MOW to implement the recommended control group whose function would be to monitor more closely the work perfcrmed by the MOW maintenance crews and private contractors working on MOW rural road rehabilitation, improvement and resurfacing programs.

g) Study in detail the current Maintenance Management System and make the changes and improvements necessary to insure that the data and information produced is effectively utilized as intended to plan, program, schedule, cost, budget, evaluate and control maintenance operations.

h) Expedite the completion of the bridge construction program.

i) Provide technical assistance as required to local personnel.

j) Review training programs to insure that they are properly focused and in accordance with MOW needs.

Section F discusses the time frame, personnel requirements, and other factors required to effect a smooth transition from the ending of Phase II to design of a new RR&B Project.

## F. Determination of Potential and Plans for Continued Project Activity

### 1. Potential

The current RR&B project is considered to be highly desirable and essential to the agricultural development of Belize. The fact that progress on the program has been less than hoped for is not surprising considering the financial, technical and institutional problems involved in implementing rural road maintenance programs. Few countries can claim success with similar programs. However, with a relatively small geographical area and minimal road network, Belize has excellent potential for attaining a high degree of success because problems are reduced by the small scale of inputs required. Furthermore, there are many positive aspects of the existing program, as indicated above: the basic institutional

structure has been implanted, equipment acquired, crews put to work, management systems introduced, and qualified personnel available. What is required is minor reorientation and fine tuning to make the system more responsive, efficient, and fiscally self-sustaining.

2. Time Frame

Continued project activity ought to be conditional on making RR&B activities financially self-sustaining with respect to both recurrent and capital expenditures. The evaluation team recommends that the mechanisms for assuring adequate funding[7] must be in place prior to considering any extension of the RR&B project. It may be difficult to implement these measures by the PACD of April 30, 1991. If this is the case, then the project should be suspended temporarily until the Mission feels satisfied that financial self-sustainment will be forthcoming.

3. Implementation Approach

When such assurance has been given by GOB, a one year program extension should be considered to implement the approach indicated below, to complete the design of the new project, and to test whether the assurances become reality.

a) Financial Sustainability:

The design of the new project needs to define more specifically just what sustainability means within the context of the project and just what steps will be taken to assure

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[7] See Sections IV.A.3, pp. 63-65, for several recommendations on increasing tax rates and "earmarking" the resultant tax revenues for RR&B activities.

such based on the concepts indicated in this evaluation report. Guarantees will be required from the GOB that:

(1) a permanent system has been instituted to generate revenues sufficient to meet recurrent and capital costs of rural road maintenance;

(2) these funds will be targeted specifically for rural road maintenance and will not be diverted to other uses such as maintenance of the primary paved road network, city streets improvements, or road construction programs.

As indicated previously these guarantees must be approved by the Mission as satisfactory prior to approval of the one-year extension recommended.

b) Private Sector Participation:

During the one-year extension, the Road Rehabilitation Units (RRUs) would gradually be phased out. After the phase out is completed, any rural road rehabilitation or improvement project would be let under contract to the private sector. Rehabilitation would also be defined to include major periodic resurfacing as required to replenish surfacing materials lost through traffic whipoff, dusting, or surface runoff. The value of these contracts will probably be small, so the participation of new, smaller contractors should be encouraged. Contractors would be pre-qualified, prices fixed by the MOW at reasonable levels, and awards made to those prequalified firms expressing interest by drawing lots or using other random selection methods. Firms that have completed a contract successfully would be guaranteed to be included in subsequent drawings. Firms not performing well would be removed from the prequalification listing.

c) Routine Road Maintenance:

Routine road maintenance will continue to be done by direct MOW administration using MOW equipment. However, mobile crews controlled by the central office in Belmopan would be utilized instead of permanent crews located in the districts. The exact number of mobile crews can only be determined after the network of classified rural roads receiving regular programmed maintenance is defined, maintenance quality standards developed, and frequency of maintenance operations established. The composition of the mobile crews should be varied depending on the type of work to be performed and haul distances involved.

d) Equipment Administration:

The only equipment to be operated by the Rural Roads Division would be that required for routine maintenance. This equipment will be targeted specifically for rural road maintenance with diversion to other purposes allowed only under emergency conditions. Equipment inventories of the RMUs and RRUs should be examined to determine the number of units in satisfactory working condition which could be used for rural road maintenance. Replacement and additional units as required would be purchased during the one-year extension with AID funding. All equipment would be allocated to a central pool in Belmopan established for rural road maintenance only. Mobile crews would be formed as required from this central pool. Equipment servicing and repair would continue to be done as a combined effort of the central repair shops in Belmopan and the six district shops. A program for scrapping obsolete units and replacing them with new units must be established with funding guaranteed as indicated above.

e) Workshops:

Improvements currently contemplated for the central and district workshops should be programmed for completion during the one-year extension. Inventories of existing shop tools should be reviewed and replacement or additional items purchased as required.

f) Bridge Program:

Completion of the bridge program should also be programmed during the one-year extension. If necessary a combined effort of the MOW and private contracts should be used to accelerate the rate of completing the scheduled work. If funding to cover local component costs is not forthcoming from the GOB, then AID should provide whatever additional funding is required.

g) Training:

Training programs should be reevaluated and additional training provided as required. Emphasis should be placed on improvement of existing skills rather than training at the entry level.

h) Technical Assistance:

The technical assistance program for the one-year extension is considered critical as the success of the program will depend to a great extent on these inputs. Special consideration should be given to screening of expatriate personnel to insure technical competence and social compatibility with local counterpart personnel.

i) Level of Funding:

These changes will require that the level of funding for recurrent budgets to be increased in order to pay for private sector road rehabilitation and improvement contracts. On the other hand, capital budgets for the purchase of equipment will be reduced due to the elimination of the RRUs and reduction in the number of RMUs. Inventories of spare parts, fuel, tires, etc., will be reduced correspondingly. The availability of these funds should be guaranteed by the GOB prior to approval of the contract extension.

j) Institutional Changes:

The institutional changes recommended in Section IV.A.4 of this evaluation report should be implemented as soon as is practicable so that adjustments can be made as required to perfect the organization during the one-year extension period.

k) Quality Standards:

Quality standards (see Appendix F) should be developed for maintenance operations. Also standards currently being utilized for feeder road construction and improvements should be analyzed with the intent to develop viable "technical packages" depending on traffic, terrain conditions, weather conditions, flooding potential, availability of materials, and social and economic conditions within the zone of influence of each road. Consideration should be given to utilization of one-land roads with widening of sections to permit passing. Drainage, as always, is a major consideration. Pit run materials which contain considerable rocky, oversize material should be crushed as part of the resurfacing program awarded to the private sector. Also, the contract should provide for reserve stockpiles of the crushed material for use by MOW

mobile maintenance crews as required for local replenishing and filling of potholes.[8]

4. Information Base

There are three major categories of management decisions that are required for operating the RR&B Project: determining priorities for rural road and bridge maintenance; estimating recurrent and capital budgets for each fiscal year; and monitoring and evaluating the efficiency of RR&B maintenance activities. The information bases required to help MOW's top managers make these decisions are described below.

a) Determining priorities for rural road and bridge maintenance:

Ideally, resources for maintenance of rural roads and bridges should be allocated so that net social and economic benefits are maximized in the geographic areas influenced by road improvements. It is well known that efforts required to collect the data to derive estimates of net social and economic benefits are very time consuming and costly. An acceptable short-cut is to collect data on traffic volumes by type of vehicle. Average daily traffic volumes can be used to generate rough estimates of savings in vehicle operating costs and passenger time (if data are also collected on the approximate number of occupants in each vehicle).

MOW now collects data annually on traffic counts at 48 census points (including 3 temporary ones) on the main roads and highways throughout Belize. Figure 4 shows the locations of the census points. These traffic counts are stored in the

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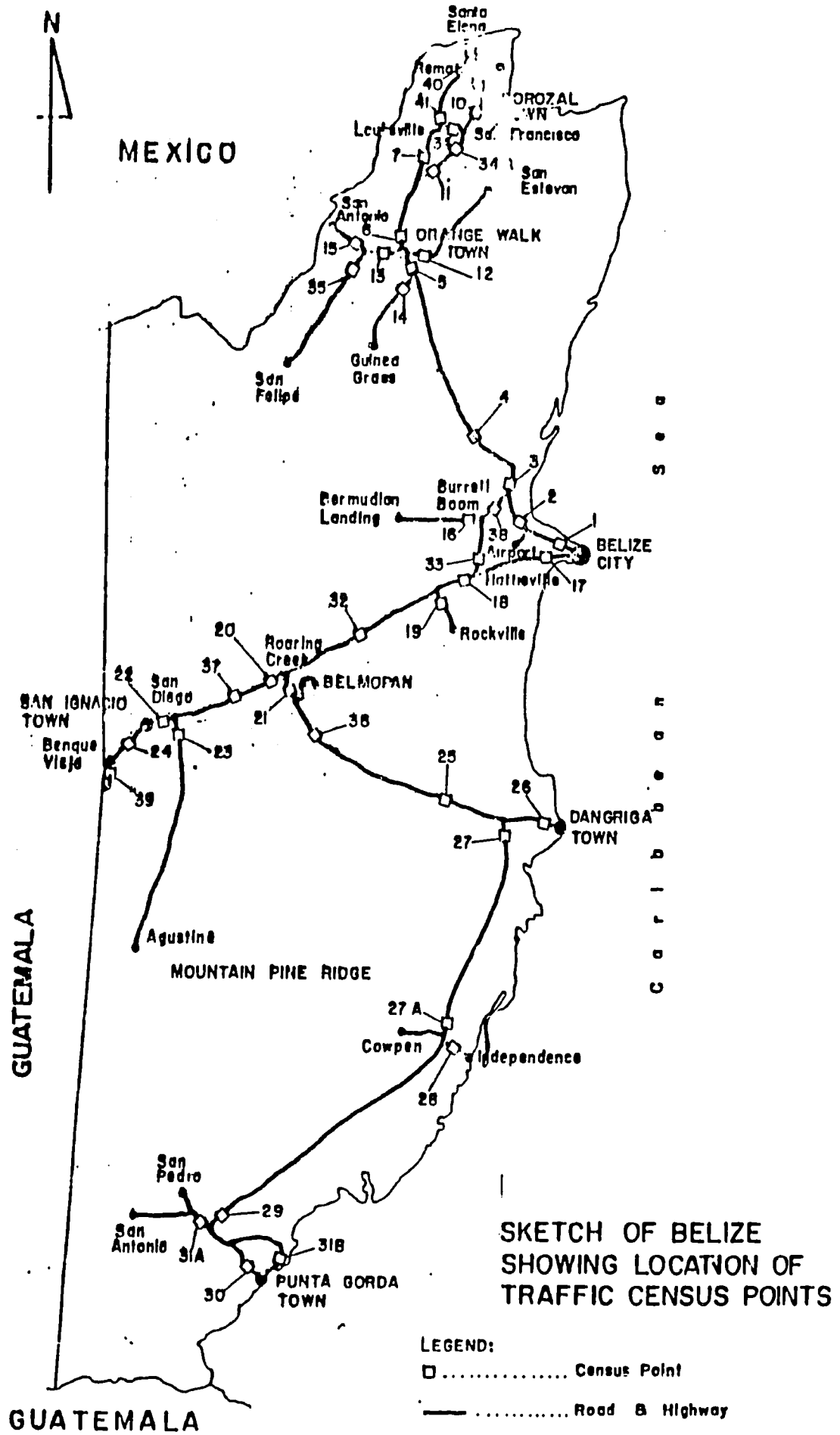
[8] If the private sector takes over resurfacing activities, those contractors can supply requirements for crushed material.

Figure 4




N
MEXICO
Santa Elena
Remat
40
41
10
OROZAL TOWN
Louisville
St. Francisco
7
34
San Estevan
11
San Antonio
6
ORANGE WALK TOWN
15
15
12
5
35
14
Guinea Grass
San Felipe
4
3
Bermudian Landing
Burrell Boom
2
16
38
1
Airport
BELIZE CITY
33
Hattieville
17
18
32
19
Rockville
20
Roaring Creek
37
22
San Diego
BELMOPAN
SAN IGNACIO TOWN
21
36
Benque Viejo
24
23
25
26
39
DANGRIGA TOWN
27
Agustine
MOUNTAIN PINE RIDGE
27 A
Cowpen
Independence
28
San Pedro
29
San Antonio
31A
31B
PUNTA GORDA TOWN
30
GUATEMALA
GUATEMALA
Caribbean Sea
SKETCH OF BELIZE SHOWING LOCATION OF TRAFFIC CENSUS POINTS
LEGEND:
Census Point
Road & Highway
City, Town & Village

MMS computer database and are available for years 1971-79 and 1984-90. They provide counts for light vehicles, heavy vehicles, and total vehicles. There are three limitations, however, in using these data:

(1) few census points are located on rural roads;

(2) no data are collected on number of passengers;

(3) the data are collected currently over a continuous period of seven days only once annually (from 1971-77, it was collected twice, once in January and again in July, to obtain information on seasonal variation).

The procedure now being used for traffic counts should be re-designed to include a large sample of rural roads. It should be conducted at least twice annually (once during the peak harvest season in each District and once during off-peaks), and estimates should be made of the number of passengers. These modifications can provide the basis of establishing maintenance priorities, since net social and economic benefits from road improvements are a positive function of traffic volume. Data are also required on the frequency of flooding and other hazards that render rural roads and bridges impassable. Currently, no data are systematically collected and stored by MOW regarding the frequency and duration that each road section is impassable each year.

The final task of data collection required for determining priorities is data on the condition of each rural road and bridge being maintained. Currently, the MOW's National Rural Access Roads Inventory includes a detailed list of roads for each District. Information on each road includes

its current condition of surface (good, fair, poor) and the range (e.g., 0-50) of its annual average daily traffic. This inventory is updated annually. If these data on condition of surface can be made more precise (e.g., by means of actually measuring the roughness of surface, as has been done for several highway loan projects in Belize), then combined with the data on traffic volume an index of potential net benefits for road improvements could be prepared for each rural road. This management tool would help MOW officials allocate limited maintenance resources to the highest priority road segments.

b) Estimating recurrent and capital budgets for each fiscal year:

Currently the Officer-in-Charge in each District prepares his worksheets of labor, materials, and equipment use for that District's Optimum Annual Work Plan (see Table 6). The Belmopan Office staff consolidates these programming and budgeting worksheets into the performance budget for the "MMS Estimates" (see Table 6), using their latest cost rates for labor, materials, and equipment. The cost estimates for labor and materials are straightforward enough, being based on current salaries and market prices. But the rates for equipment are rough estimates (see the discussion in Section IV, A.1.c) that are not verified by either careful calculation or comparison with rates used in the private sector. Further, they do not include so-called "ownership costs," or depreciation and interest charges.

In order to generate more appropriate recurrent costs budgets, accurate information needs to be collected on hours of use and cost of repairs for each major item of equipment. Procedures recommended by Caterpillar should be followed, as recommended earlier, to generate reliable estimates of equipment costs. These estimates will become an important

element in comparing the relative costs of work done by MOW crews versus contracts to private sector firms.

Regarding the capital budget, the MOW should begin producing an annual report on major items of maintenance equipment. It would present data on hours of use (or mileage), estimated year of replacement, and year of initiating actions either to purchase the replacement from GOB funds or to process an application for loans from international donors. This approach would be consistent with recommendations made in Section IV.C.2 of this report.

c) Monitoring and evaluating the efficiency of RR&B maintenance activities:

As indicated in Section IV.A.1.a), the current productivity of road maintenance units (RRUs) seems very low, based on comparisons with Costa Rica. Data are being generated through the MMS monthly reports that permit roughly accurate estimates of miles of rural road being maintained in each District. See Table 2 for details. A monthly report should be submitted to MOW's top administrators that indicates miles of rural roads graded or resurfaced in each District and the average cost per mile of road actually maintained.

5. Personnel Requirements

Prior to and during the one-year extension period, two expatriate advisors will be required:

a) Roads Maintenance Engineer (12 person-months):

The roads engineer should have a bachelor's degree in civil or highway engineering with a minimum of five years experience in the design, improvement and maintenance of rural

feeder roads in the developing countries. He/she should be registered as a professional engineer in at least one state in the U.S. The roads engineer must be thoroughly conversant with all phases of roads engineering and roads maintenance operations. He/she should be computer literate, have good knowledge of planning, organization, and operation of rural road maintenance systems, cost evaluations, contract procedures, and roads maintenance management systems. The roads engineer should have a basic knowledge of transportation planning, economic evaluations, and traffic surveys. He/she must be able to work in harmony with local counterpart personnel.

b) Economist (3 person-months initially, plus other short assignments as needed for training and problem-solving):

The economist must hold at least a masters degree with in-depth knowledge of transportation economics applied to less developed countries. He/she must have a minimum of one year's experience in developing countries with applied empirical research concerning the economic analysis of transportation projects. The economist must be familiar with management information systems and be able to train MOW staff in using MMS data to prepare management reports for senior officials in MOW. He/she must be computer literate, and must be able to work in harmony with local counterpart personnel.

If the services of these two professional are not available from expatriate staff currently assigned to or available under the contract, separate contracts should be authorized. The economist should start as soon as possible in order to develop reporting procedures, train MOW staff to generate management reports from the MMS data, assist in producing estimates of the budgets required for recurrent and capital costs during fiscal year 1991/92, and design

procedures for collecting, storing, and retrieving the data specified in item F.4 above. The roads engineer should start at the beginning of the extension period and follow the project through the one year extension period. Both professionals will work directly with MOW counterpart personnel and be responsible for successful implementation of the major issues indicated previously.

6. Estimated Costs

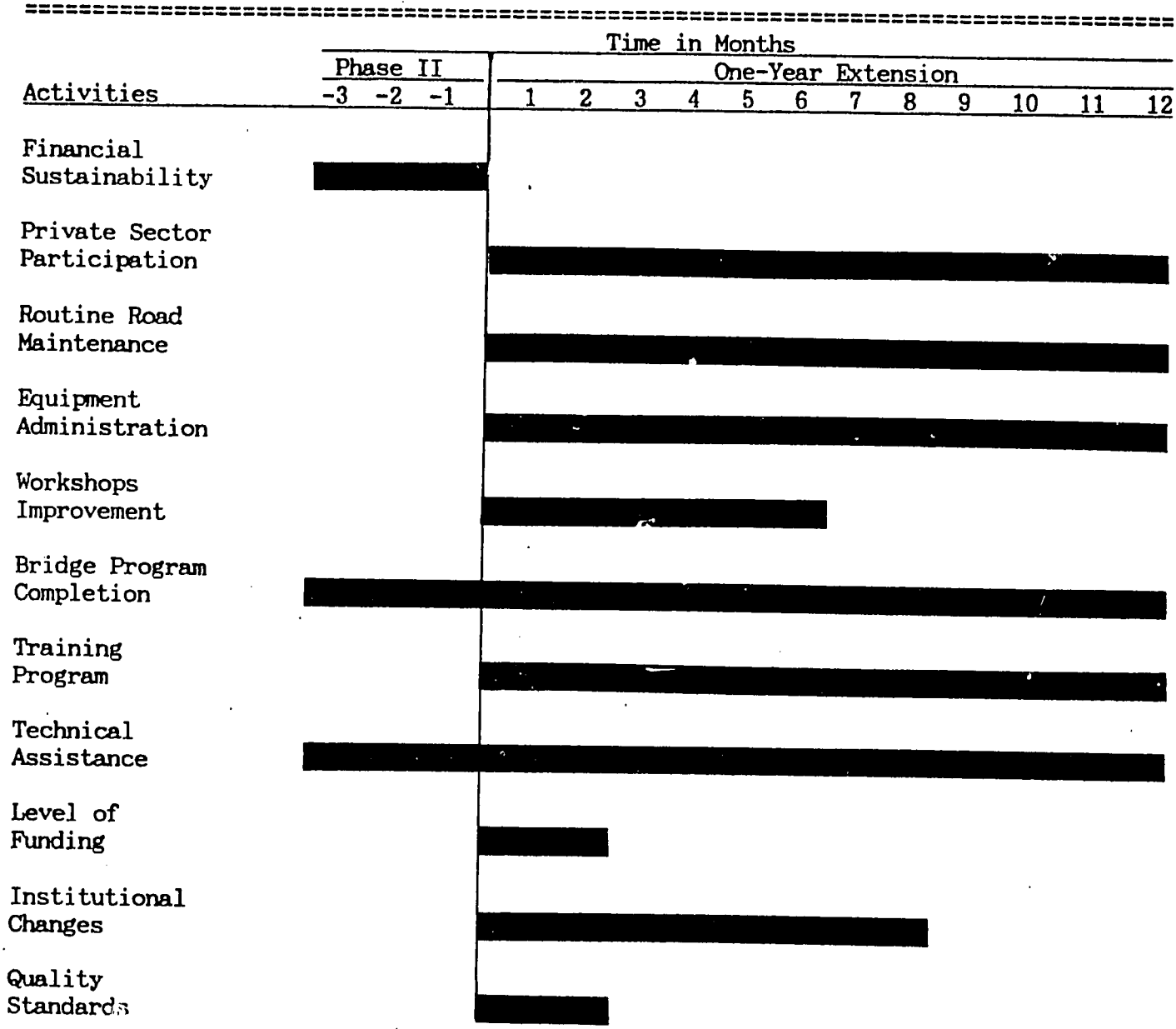
Costs cannot be estimated in this report due to time constraints.

7. Implementation Schedule

A tentative implementation schedule is attached as Figure 5.

FIGURE 5

SUGGESTED IMPLEMENTATION SCHEDULE FOR ONE-YEAR EXTENSION




Note: This schedule assumes the financial sustainability issue can be resolved by the PACD of April 31, 1990. If not, then the entire extension should be delayed until the financing can be arranged.

# APPENDIX A

## A. Evaluation of the Scope of Work

The scope of work (SOW) for this evaluation was thorough and encompassed all important aspects of the Rural Access Roads and Bridges (RR&B) project. However, there was insufficient time for team members to satisfy fully the instructions in the SOW for evaluating several items:

1. Article II, Section C.1.a on p. 1, states "this evaluation will determine the impact, if any, of the project on agricultural production in rural Belize." We assume that means the separate impact of the project, i.e., the assessment "with" versus "without" the RR&B project. To control statistically for all other variables that might affect agricultural output (weather, soil fertility, farming practices, quality and quantity of labor and other inputs, etc.) would mean a major effort in data collection and analysis. Sample survey data would be required on those variables for farming units inside and outside the road impact areas, ideally both before and during project implementation. That sort of time series data might be avoided if cross-section data were available on "experimental" and "control" farming units inside and outside the road impact area for one recent year that could be defined as "representative" of the typical situation with respect to weather and other exogenous variables. With such data and a carefully specified econometric model, one could estimate the responsiveness of agricultural production to the effects brought about by improved all-weather roads (decreased vehicle operating costs, reduced damage to crops being transported, and reduced risks from flooding at river and stream crossings).

Clearly, this type of analysis would be impossible to carry out in 14 days. Thus, the SOW should have been more realistic with respect to its objectives for determining the impact of the RR&B project on agricultural production in rural Belize. In Section IV.B.1 of this evaluation report, we did as well as could be expected within the constraints of the time, manpower, and data that were available.

2. Similarly, in Section C.1.c.(2) on p. 3, the last sentence asks "What are the environmental impacts of the project to date?" And Section C.2.c.(2) on p. 8, asks the evaluation team to "determine the direct and indirect effects this project has had on the environmental/natural resources in Belize... ." The same conceptual problem arises here as in comment (1) above. We attempted to provide such an assessment within the constraint of the environmental specialist having only five days to inspect project impact areas and relating his observations to the available literature.

3. In Section C.1.c(6) on p. 4, the evaluation team is asked to "develop an information base which can be utilized as the focus around which subsequent/possible extension of the project can be developed." Some satisfaction of this request appears in Tables 1-8, particularly with respect to estimates of road miles graded or resurfaced. Appendix E also represents a summary of primary data collected on environmental impacts. Nevertheless, the quoted statement from the SOW is quite broad and could be interpreted as requiring the evaluation team to product all data needed to design a new project. That was not feasible in the constraint of a 14-day assignment.

Also in that same Section the SOW requires that costs be estimated for the project extension recommended. In order to obtain even an approximate estimate of costs, the number of

mobile RMU's would have to be determined, equipment needs determined, an estimate made on completing the bridge program, technical assistance evaluated, and training programs developed. This was clearly not feasible under the time frame of 14 work days assigned to the evaluation.

4. Section C.1.d.(1) on p. 4 of the SOW asks the evaluation team to determine whether the Road Maintenance Units are adequately trained and equipped "in all six districts". Toledo District was not visited since two days travel time would have been required. The USAID/Belize Project Manager approved our recommendation not to visit Toledo due to time constraints.

5. In satisfying Section C.1.d.(4) on p. 5, the team obviously could not "look" at all the bridge crossings completed to inventory and assess the condition of the spans in the 14 days available.

6. Regarding Section C.2.c.(1)(a) on p. 7, since the evaluation team could not visit Toledo district due to time constraints, the flooding and erosion problem could not be addressed in this district, which suffers heavily from flood and erosion damage. Furthermore, no evidence of MOW engineering design principles or standards could be found on which to base such an evaluation.

B. **Concluding Comments**

Nevertheless, the evaluation team believes there was sufficient time to assess reasonably accurately the extent to which the RR&B project had achieved its objectives. Additional time would only bring more precision to the findings.

# APPENDIX B

## Individuals and Agencies Consulted

The evaluation team met with the individuals listed below to seek their impressions about the effectiveness of the RR&B project and to obtain information relevant to the evaluation. Mr. Joseph McGann arranged most of these meetings.

USAID/Belize

Ms. Mosina Jordan ..... A.I.D. Representative
Mr. Paul Bisek ..... Program Officer
Mr. Joseph McGann ..... Project Officer

Ministry of Works, Belmopan Office

Honorable Samuel Waight ..... Minister
Mr. Pedro Carrillo ..... Permanent Secretary
Mr. Edgar Puga ..... Chief Engineer
Mr. Wilfredo Guerrero ..... Senior Executive Engineer and Head of Roads Division
Mr. Roderick Crawford ..... Executive Engineer and Head of Bridges Division
Mr. Francis Burns ..... Mechanical Administrator
Mr. Teodore Aleman ..... Works Overseer (Roads)
Mr. Francisco Cuellar ..... Maintenance Management Officer
Mr. Carlos Manzanilla . Superintendent, Road Rehabilitation Units

Ministry of Works, District Offices

Mr. Charles Young ..... O.I.C., Belize District
Mr. Carmen Fabro ..... O.I.C., Cayo District
Mr. Eric Flowers ..... O.I.C., Corozal District
Mr. Edmund Parham ..... O.I.C., Orange Walk District
Mr. Errol Brooks ..... O.I.C., Stann Creek District

Expatriate Advisors to Ministry of Works

Mr. Rusty Campbell ..... Highway Rehabilitation Project
Mr. Albert Sprinkle ..... Rural Access Roads and Bridges Project

Ministry of Agriculture

Mr. Liborio Gonzalez ..... Chief Agricultural Officer
Mr. Eulalio Garcia ..... Principal Extension Officer
Mr. Roberto Harrison ..... Policy and Economic Analysis Division

Ministry of Economic Development

Mr. Harold Arzu ..... Senior Economist

Ministry of Finance

Mr. Roberts ..... Central Statistical Office

Ministry of Trade and Industry

Mr. John Morris ..... Commissioner of Archaeology

Private Sector

Mr. John Woods ..... President, Cisco Construction Company
Staff in Belize City ..... Robert Nicolait & Associates

# APPENDIX C

RECOMMENDED PRIMARY PROJECT BRIDGE SITES



| DISTRICT | ROAD SEGMENT | DESCRIPTION | BRIDGES SETS & TYPE | STATUS | REMARKS |
|---|---|---|---|---|---|
| COROZAL | Progress Road - Little Belize | 25' Span, roadwork needed first | 1 - 70' R.R. Deck | 0 | Existing wooden structure measures 20'. One 17' R.R. I-Beam should be sufficient. |
| ORANGE WALK | Trinidad - August Pine Ridge | 20' in village of August Pine Ridge | 1 - 17' R.R. I-Beam | 1 | Existing structure measures 20' annual flood stage is 3' above bridge if route were changed 1-17' R.R. I-Beam would be sufficient. |
| ORANGE WALK | San Lazaro - Trinidad | 17' span on road north of Trinidad | 1 - 17' R.R. I-Beam | 1 | Existing structure measures 17' with an annual flood stage 2' above bridge. One 17' R.R. I-Beam should be sufficient. Bridge is south of village. |
| ORANGE WALK | Northern Highway - San Roman | 90' Rio Hondo at San Roman | 1 - 70' R.R. Deck | 1 | Existing pontoon bridge measures 88' with a western approach 79' and an eastern approach 12'. Flood stage is at bridge level. One 70' R.R. Deck with extended approaches recommended. |
| ORANGE WALK | Yo Creek - San Antonio | 100' at San Antonio replace pontoon | 1 - 70' R.R. Deck | 1 | Existing pontoon bridge measures 85' with western and eastern approaches of 141' & 15'. Flood stage is at bridge level. One 70' R.R Deck with extended approaches recommended. |
| ORANGE WALK | August Pine Ridge - San Felipe | 3-17' All on Highway (includes 3 crossings) | 3 - 70' R.R. Deck | 1 | Existing structures, all multiple culverts, are located 3.6, 1.65, & 2.2 km south of August Pine Ridge and measure 13', 16' & 17'. Flood-stage is 3' above bridge level for all and one 17' R.R. I-Beam for each is recommended. |
| ORANGE WALK | Orange Walk - San Estevan | At Orange Walk - 70' replace ferry | 1 - 70' R.R. Deck | 2 | Acutal crossing is 117' with abutments of 15' & 12'. Bridge would need to be elevated a minimum of 4' to allow barge clearance. Two 70' through bridges required but not recommended. |

STATUS CODES

0 = NOTHING DONE
1= DESIGN COMPLETED
2 = CONSTRUCTION IN PROGRESS
3 = BRIDGE COMPLETED

RECOMMENDED PRIMARY PROJECT BRIDGE SITES



| DISTRICT | ROAD SEGMENT | DESCRIPTION | BRIDGES SETS & TYPE | STATUS | REMARKS |
|---|---|---|---|---|---|
| ORANGE WALK | Orange Walk - San Estevan | At Narrows - 100' replace ferry | 1 - 70' R.R. Deck | 0 | Actual crossing is 180'. Bridge would need to be elevated a minimum of 4' to allow barge clearance Three 70' through R.R bridges required but not recommended. |
| BELIZE | Bermudian Landing - Lemonal | New Bridge 100' | 2 - 70' R.R. Deck | 3 | Approximate crossing, after seven days of dry weather, is 210' and is much higher during rainy season. Three 70' R.R. through bridges required but not recommended. |
| BELIZE | Bermudian Landing - Rancho Dolores | Ferry 100' | 4 - 90' Highway Pony | 3 | Bridge location and length of crossing required is still under consederation by the MOW and USAID |
| BELIZE | Bermudian Landing - Rancho Dolores | Bridge (Spanish Creek) 100' | 4 - 70' R.R. Truss | 3 | Existing wooden structure measure 132' with flood stage 2 - 3' above Four 70' R.R. through bridges to make a double lane of 140' along with 21' extensions to each approach recommended. |
| BELIZE | Western Highway - Gracy Rock Bank | Sibun River - Gracy Rock - New Bridge, 70' | 1 - 70' R.R. Deck | 0 | Approximate crossing, after seven days of dry weather, is 280' and river floods annually. Four 70' R.R. through bridges required but not recommended. |
| BELIZE | Western Highway - La Democracia | Sibun River (not included) in original sites list) | 6 - 70' R.R. Deck | 3 | |
| BELIZE | Burrell Boom - Bermudian Landing | None | 4 - 70' R.R. Truss Sebastian Bridge | 3 | Existing wooden structure measure 232'. SpanishCreek is slow moving at this point so four 70" R.R. through bridges to make a double lane 240' along with 46" extension to each approach is recommended. |
| BELIZE | Bermudian Landing - Flowers Bank | Creek at village entrance 35' | 1 - 30' Fixed Span | 0 | There are three wooden bridges on this road. The one nearest Villa measures 13' 6". One 17' R.R. I-Beam bridge is recommended. |
| BELIZE | Northern Highway - Grace and Davis Bank | 40' Span | 1 - 30' Highway Fixed Span | 0 | Existing wooden structure measure 68' with flood stage at bridge level. Since the bridge is elevated 12' one 70' R.R. through bridge is recommended. |

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2 = CONSTRUCTION IN PROGRESS
3 = BRIDGE COMPLETED

RECOMMENDED PRIMARY PROJECT BRIDGE SITES



| DISTRICT | ROAD SEGMENT | DESCRIPTION | BRIDGES SETS & TYPE | STATUS | REMARKS |
|---|---|---|---|---|---|
| CAYO | Bullet Tree Falls - Callar Creek | 5 - 17' All new creeks (includes 5 crossings) | 5 - 17' R.R. I-Beam | 0 | Creeks are located 5 km, 2.6 km, 2.7 km, 2.9 km, & 3.2 km from Bullet Tree Falls road. Five 17' R.R. I-Beams recommended but road requires rehabilitation first. |
| CAYO | San Ignacio - Bullet Tree Falls | Bullet Tree Falls 100' replace | 1 - 70' R.R. Deck | 3 | Existing wooden structure measures 162' with annual flood stage 10' above bridge. Three 70" R.R. through bridges recommended. |
| CAYO | Cristo Rey - Macaw Bank Rancho Dolores | 50' Creek near village | 1 - 60' Hwy. fixed span | 0 | Area is midway between Macaw Bank and road to Cristo Rey. Presently served by culverts and road section has annual flooding 7-8' above road. Recommend causeway construction. |
| STANN CREEK | Stann Creek Valley Road - Mullins River | Big Creek on Mullins River Road 60' | 1 - 70' R.R. Deck | 3 | One 70' R.R deck bridge currently being erected. Cost overruns associated with abutment design and construction could probably have been reduced had a 70' R.R. through bridge been employed. |
| STANN CREEK | Stann Creek Valley Road - Mullins River | Mullins River on Mullins River Road 40' | 1 - 70' R.R. Deck | 3 | Existing concrete bridge measures 111' with flood stage 3' above bridge level. Two 70' R.R. through bridges are recommended to span this fast moving stream. |
| STANN CREEK | Southern Highway - Georgetown | 34' span replace wood bridge | 1 - 70' R.R. Deck | 1 | Existing wooden structure measures 41'. Recomend One 27' R.R. I-Beam bridge with extended approaches. |
| STANN CREEK | Mullins River - Gales Point | Mangrove Creek 26' Span | 1 - 70' R.R. Deck (Mangrove) | 1 | Existing structure measures 23' with 4' wing walls for a total of 31'. One 27' R.R. I-Beam bridge recommended. |
| STANN CREEK | Mullins River - Gales Point | Quamina Creek 36' Span | 1 - 27' R.R. I-Beam (Quamina) (Listed as a secondary source) | 1 | Existing structure measures 37'. Recommend one 27' R.R. I-Beam bridge with extension of both approaches by 5' each. |

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2 = CONSTRUCTION IN PROGRESS
3 = BRIDGE COMPLETED

RECOMMENDED PRIMARY PROJECT BRIDGE SITES



| DISTRICT | ROAD SEGMENT | DESCRIPTION | BRIDGES SETS & TYPE | STATUS | REMARKS |
|---|---|---|---|---|---|
| STANN CREEK | Mullins River - Gales Point | None | 1 - 30' Highway Fixed Span (Wagner) | 1 | Existing structure measures 25' and creek is not fast moving. One 21' R.R. I-Beam with extended approaches recommended. |
| TOLEDO | Blue Creek - Aguacate | Aguacate Creek at Aguacate, 40' | 1 - 70' R.R. Deck | 0 | Existing concrete bridge measures 80' with an eastern abutment of 15' & a western abutment of 10'. This crossing rarely floods but when it does the water recedes rapidly. No new bridge required. |
| TOLEDO | San Antonio Road - San Jose via Crique Jute | Juan Chun Bridge 30' | 1 - 70' R.R. Deck | 3 | Existing wooden bridge measures 28' and present abutments could be used for new structure. Recommend one 27' I-Beam. |
| TOLEDO | San Antonio Road - San Jose via Crique Jute | Creek 3.41 km East of San Jose Road | 1 - 70' R.R. Deck | 3 | Existing wooden bridge crosses Crique Jute and measures 54' in two 26' spans. Present abutments and center pier could be used for new bridge. Recommend two 27' I-Beams. |
| TOLEDO | San Antonio - Santa Cruz | Mile 21 Bridge 30' | 1 - 70' R.R. Deck | 0 | Existing wooden structure measures 27'. Recommend replacement with one 27' R.R. I-Beam. |
| TOLEDO | Blue Creek - Jordan | Blue Creek at Blue Creek | 1 - 70' R.R. Deck | 0 | Existing concrete structure measures 72' with eastern and western abutments of 15' & 30'. When this crossing floods water subsides rapidly. No new bridge required. |
| TOLEDO | Santa Elena - Pueblo Viejo | Pueblo Creek at Pueblo viejo, new road, 80' | 1 - 70' R.R. Deck | 1 | Crossing measures 80" but approaches could be used to allow for one 70' R.R. deck bridge. |
| TOLEDO | Santa Cruz - Santa Elena | Rio Blanco, now a low concrete ford 60' | 1 - 70' R.R. Deck | 3 | Existing concrete structure measures 110' and crossing floods regularly. If an upstream location could be used, one 70' R.R. deck should be sufficient |

STATUS CODES

0 = NOTHING DONE
1= DESIGN COMPLETED
2 = CONSTRUCTION IN PROGRESS
3 = BRIDGE COMPLETED

RECOMMENDED SECONDARY AND ALTERNATE BRIDGE SITES





| DISTRICT | ROAD SEGMENT (MOW CROSSING NAME) | STATUS | REMARKS |
|---|---|---|---|
| COROZAL | Fresh Water Creek Rond. Approximately three miles. | 0 | District officer identified area that now has a culvert but floods annually and makes access to Chunox and Sarteneja impossible. He recommends installation of one 17' R.R. I-Beam. |
| BELIZE | Old Northern Highway - Bomba (Bomba Causeway) | 0 | Causewny was visited after seven days of dry weather. Water was over causeway 2-6" everywhere and to a depth of 3-4' in two distinct locations. Recommend adding 2' to causeway elevation and installing two 17' R.R. I-Beams to allow water flow. |
| BELIZE | Northern Highwny - Crooked Tree (Crooked Tree Causeway) | 1 | District officer recommends installing one 17' R.R. I-Beam in Crooked Tree causeway to allow water to flow freely between lagoons. |
| TOLEDO | San Antonio Rond (San Antonio) | 0 | Existing wooden structure measures 62'. Recommend replacement with one 70' R.R. deck bridge. |
| TOLEDO | San Antonio Rond (Mile 20 1/2) | 0 | Existing wooden deck and stringer bridge measures 30'. Crossing could be upgraded with one 27' R.R. I-Beam and installation would require construction of one new abutment. |
| TOLEDO | San Antonio Road (Santa Cruz) | 1 | Existing concrete structure measures 40'. If elevation were were changed one 30' highway bridge could be utilized. |
| TOLEDO | San Antonio Rond (Santa Elena) | 1 | Existing wooden deck and stringer bridge measures 35'. Recommend replacement with one 27' R.R. I-Beam bridge. |
| TOLEDO | San Antonio Rond (Crique Trosa) | 0 | Existing wooden bridge measures 95' in four sections. Bridge could be shortened to one 70' R.R. through bridge and would require the construction of one new abutment. |
| TOLEDO | San Antonio Rond (Run Away Branch) | 0 | Existing wooden deck and stringer bridge measures 30'. Crossing could be upgraded with one 27' R.R. I-Beam. Erection of new bridge would require construction of two new abutments. |
| TOLEDO | San Antonio Rond (Run Away Bridge) | 0 | Existing wooden deck and stringer bridge measures 32'. Recommend replacement with one 27' R.R. I-Beam. Installation would require construction of one abutment. |

STATUS CODES

0 = NOTHING DONE
1= DESIGN COMPLETED
2 = CONSTRUCTION IN PROGRESS
3 = BRIDGE COMPLETED

| DISTRICT | ROAD SEGMENT (MOW CROSSING NAME) | STATUS | REMARKS |
|---|---|---|---|
| TOLEDO | San Antonio Road (Cuevas) | 0 | Present structure is a 42' wooden deck and stringer bridge with two concrete approaches measuring 92' total. Recommend replacement with one 70' R.R. through bridge with two new abutments. Installation would also require drainage work. |
| TOLEDO | San Antonio Road (Jacinto) | 0 | Existing structure measures 70' and could be replaced with one 70' R.R. through bridge. |
| TOLEDO | San Marcos Road (San Marcos) | 0 | According to district bridge officer existing 28' wooden bridge could be upgraded with one 27' R.R. I-Beam. |
| TOLEDO | Big Falls By-Pass Road (Crique Chano) | 0 | Existing wooden structure measures 36'. Crossing could be upgraded with the installation of two 17' R.R. I-Beam bridges. |
| TOLEDO | Big Falls By-Pass Road (Columbia) | 1 | This crossing is critical as a Big Falls by-pass when flooding occurs. Existing concrete structure is 80' and 6-8' too low. Recommend two 70' R.R. deck bridges. Could be erected utilizing present bridge as a center pier. |
| TOLEDO | Big Falls By-Pass Road (Crique Queso) | 1 | Existing wooden structure measures 38'. Recommend replacement with one 21' and one 17' R.R. I-Beam. |
| TOLEDO | Southern Highway (Indian Creek Bridge) | 0 | Existing wooden deck and stringer bridge measures 20'. Recommend replacement with one 21' R.R. I-Beam. |
| TOLEDO | Southern Highway (Hickatee Creek No. 1) | 0 | Existing wooden structure measures 21' and could be replaced with one 21' R.R. I-Beam. |
| TOLEDO | Southern Highway (Hickatee Creek No. 2) | 0 | Existing wooden structure measures 21' and could be replaced with one 21' R.R. I-Beam. |

STATUS CODES

0 = NOTHING DONE
1= DESIGN COMPLETED
2 = CONSTRUCTION IN PROGRESS
3 = BRIDGE COMPLETED

## LIST OF BRIDGE CONTRACTORS

Category A - Large Engineering Firms with all necessary resources.

Category B - Firms/Individual with less capacities than Category A.

### Category A Firms

1. Cunningham & Associates Ltd.
   # 7 Prince Street
   Belize City

2. H.L.C.
   # 2 1/2 Miles Northern Highway
   Belize City

3. Merton Commercial & Construction Co. Ltd.
   P.O. box 106
   Belmopan

4. Becho Belize Ltd.

5. Seramak Belize Ltd.
   1 1/2 Miles
   Western Highway

Category B

1. Indeco Enterprises Ltd.
   # 2 Freetown Road
   Belize City

2. A.T. Banman
   Shipyard
   Orange Walk District

3. David Dyck
   Shipyard
   Orange Walk District

4. Wilhem Lopez
   # 1 Pine Street
   Belize City

5. Cisco Construction Ltd.
   2 1/2 Miles
   Western Highway

6. Charles Garbutt & Associates
   Roaring Creek Village
   Cayo District

7. B & C Construction
   c/o Isiah Banner
   Camalote Village
   Cayo District

INVENTORY OF U.S. AID BRIDGES - CULVERT YARD

| Item | Description | Mark | Quantity | Remarks |
|---|---|---|---|---|
| 1. | End Post | S-5A | 68 | T & D |
| 2. | Floor Beam | S-42D | 94 | D |
| 3. | Stringers | S-16 | 102 | D |
| 4. | Chord 15 ft. long | S-1A | 129 | T & D |
| 5. | Chord 20 ft. long | S-2A | 477 | T & D |
| 6. | Diagonal Web | S-4 | 511 | T & D |
| 7. | Vertical Web | S-3 | 486 | T & D |
| 8. | Diaphragm Chord Splice | S-9 | 162 | T & D |
| 9. | Bearing Block | S-6 | 22 | T & D |
| 10. | Bed Plate | S-23 | 32 | T & D |
| 11. | Angle, Bracing, Gusset | S-13A | 799 | T |
| 12. | Angle, Bracing, Lateral | S-48 | 81 | T |
| 13. | Filler, Diagonal | S-11 | 59 | T & D |
| 14. | Filler Plate | S-47 | 224 | T |
| 15. | Filler Plate | S-45 | 107 | T |
| 16. | Filler Plate | S-44 | 58 | T |
| 17. | Filler Plate | S-46 | 44 | T |
| 18. | Splice Plate Diagonal | 3-10 | 38 | T & D |
| 19. | Splice Plate Flange, Chord | S-49 | 130 | T & D |
| 20. | Splice Plate, Flange, Chord | S-37 | 294 | T & D |
| 21. | Splice Plate, Web, Chord | S-7 | 580 | T & D |
| 22. | Gusset Tee | S-22 | 101 | D |
| 23. | Angle, Bracing, Cross | S-20 | 33 | D |
| 24. | Angle, Bracing, Lateral | S-19 | 122 | D |
| 25. | Angle, Strut | S-21 | 119 | D |
| 26. | Bolt, Hold Down | S-26 | 214 | T & D |

I - BEAM BRIDGES

| | | | |
|---|---|---|---|
| 1. | I-BEAM 27 FT. LONG | N-27 | 64 |
| 2. | I-BEAM 21 FT. LONG | N-28 | 66 |
| 3. | I-BEAM 17 FT. LONG | N-29 | 72 |
| 4. | ANGLE, BRACING, TRESTLE UNIT | L-6 | 26 |

HIGHWAY SEMIPERMANENT

| | | | |
|---|---|---|---|
| 1. | I-BEAM 30 FT. LONG | G-1 | 12 |

HIGHWAY SEMIPERMANENT

| | | | |
|---|---|---|---|
| 1. | GIRDER, INNER, CENTRE SECTION | G-5 | 2 |
| 2. | GIRDER, INNER, END, SECTION | G-4 | 4 |
| 3. | GIRDER, OUTER, CENTER SECTION | G-3 | 2 |
| 4. | GIRDER, OUTER, END SECTION | G-26 | 2 |
| 5. | GIRDER, OUTER, END SECTION | G-2R | 2 |
| 6. | DIAPHRAGM, INTERMEDIATE | D-3 | 18 |
| 7. | DIAPHRAGM, END | D-4 | 2 SHORT 4 |
| 8. | CLIP, TRACTION | C-2 | 7 SHORT 1 |
| 9. | BEARING PLATE | BP-1 | 24 |

# APPENDIX D

BELOW IS A LIST OF THE ROAD REHABILITATION EQUIPMENT SUPPLIED BY U.S.A.I.D. UNDER PHASE 1

| REG. NO. | MAKE | TYPE | DATE ACQUIRED | LOCATION | CONDITION |
|---|---|---|---|---|---|
| 84C01 | Cat | D7G Bulldozer | 1984 | Toledo | Fair |
| 84L02 | Cat | 930 Loader | 1984 | Toledo | Fair |
| 84G07 | Cat | 130G Grader | 1984 | Toledo | Fair |
| 84G08 | Cat | 130G Grader | 1984 | Toledo | Fair |
| BZ-B 270 | Ford | Tipper | 1984 | Toledo | Fair |
| BZ-B 271 | Ford | Tipper | 1984 | Bel/Tol Workshop | Not Working |
| BZ-B 272 | Ford | Tipper | 1984 | Toledo | Fair |
| BZ-B 273 | Ford | Tipper | 1984 | Toledo | Not Working |
| BZ-B 292 | ARMY U.S. | Water Truck | 1984 | Bel/Tol Workshop | Poor Scrap |
| BZ-B 293 | Army U.S. | Fuel Truck | 1984 Used | Bel/Tol Workshop | Not Working |
| 84R04 | Army U.S. | Roller | 1984 Used | Corozal | Not Working |
| 84C02 | Cat | D7GBulldozer | 1984 | Bel/Cayo Workshop | Not Working |
| 84L01 | Cat | D7G Bulldozer | 1984 | Cayo | Fair |
| 84G09 | Cat | 130G Grader | 1984 | Cayo | Fair |
| 84G10 | Cat | 130G Grader | 1984 | Cayo | Fair |
| CY-B 146 | Ford | Tipper | 1984 | Cayo | Fair |
| CY-B 147 | Ford | Tipper | 1984 | Cayo | Fair |
| CY-B 148 | Ford | Tipper | 1984 | Cayo | Fair |

BELOW IS A LIST OF ROAD MAINTENANCE EQUIPMENT

SUPPLIED BY U.S.A.I.D. UNDER PHASE 1 and 11



| REG. NO. | MAKE | TYPE | DATE Acquired | LOCATION | CONDITION |
|---|---|---|---|---|---|
| 89C01 | Caterpillar | D7H Bulldozer | 1989 | Corozal | Good |
| 84G04 | Caterpillar | 120G Grader | 1984 | Corozal | Fair |
| CZL B50 | Ford | Tipper | 1984 | Corozal | Fair |
| CZL B69 | Ford | Tipper | 1989 | Corozal | Good |
| CZL B70 | Ford | Tipper | 1989 | Corozal | Good |
| CZL B71 | Ford | Tipper | 1989 | Corozal | Good |
| 85T01 | Ford | Bush Cutter | 1985 | Corozal | Fair |
| BZ B252 | Ford | Pickup,Supercab | 1984 | Corozal | Fair |
| CZL B52 | Ford | Pickup,Supercab | 1984 | Belmopan Workshop | Scrap |
| 89C02 | Caterpillar | D7H Bulldozer | 1989 | Orange Walk | Good |
| 84G01 | Caterpillar | 120G Grader | 1984 | Orange Walk | Fair |
| OW B163 | Ford | Tipper | 1984 | Orange Walk | Fair |
| OW B166 | Ford | Tipper | 1989 | Orange Walk | Good |
| OW B167 | Ford | Tipper | 1989 | Orange Walk | Good |
| OW B168 | Ford | Tipper | 1989 | Orange Walk | Good |
| 89L01 | Caterpillar | 930 Loader | 1989 | Orange Walk | Good |
| 85T02 | Ford | Bushcutter | 1985 | Orange Walk | Fair |
| BZ B255 | Ford | Pickup,Supercab | 1984 | Orange Walk | Fair |
| 84G06 | Caterpillar | 120G Grader | 1984 | Belize City | Fair |
| 89C03 | Caterpillar | D7H BUlldozer | 1989 | Belize City | Good |
| BZ B626 | Ford | Tipper | 1989 | Belize City | Fair |
| BZ B654 | Ford | Tipper | 1989 | Belize City | Good |
| BZ B655 | Ford | Tipper | 1989 | Belize City | Good |
| BZ B656 | Ford | Tipper | 1989 | Belize City | Good |
| BZ B504 | Ford | F350 Truck | 1989 | Belize city | Good |

| REG. NO. | MAKE | TYPE | DATE ACQUIRED | LOCATION | CONDITION |
|---|---|---|---|---|---|
| SC-B 122 | Ford | Tipper | 1989 | Stann Creek | Good |
| SC-B 123 | Ford | Tipper | 1989 | " | Good |
| SC-B 124 | Ford | Tipper | 1989 | " | Good |
| SC-B 125 | Ford | F-350 Truck | 1989 | " | Good |
| SC-B90 | Ford | Pickup Super Cab | 1984 | " | Fair |
| 85T05 | Ford | Bush Cutter | 1885 | " | Fair |
| 84LP02 | White | Light Plant | 1984 used | " | Not Working |
| 84G05 | Cat | 120G Grader | 1984 | Bel/PG Workshop | Not working |
| 89L03 | Cat | 930 Loader | 1989 | Toledo | Good |
| BZ-B 275 | Ford | Tipper | 1984 | Toledo | Not Working |
| TOL-B 77 | Ford | Tipper | 1989 | Toledo | Good |
| TOL-B 78 | Ford | Tipper | 1989 | Toledo | Good |
| TOL-B 79 | Ford | Tipper | 1989 | Toledo | Good |
| TOL-B 81 | Ford | F-350 Truck | 1989 | Toledo | Good |
| 85T04 | Ford | Bush Cutter | 1985 | Toledo | Fair |
| 84LP 01 | White | Light Plant | 1984 | Toledo | Fair |
| BZ-B 246 | Ford | Pickup Super Cab | 1984 | Toledo | Fair |
| BZ-B 254 | Ford | Pickup | 1984 | Belmopan/ Workshop | Fair |
| BZ-B 384 | Ford | Bronco | 1984 | Belmopan Workshop | Fair |
| BZ-B 441 | Ford | Pickup Super Cab | 1984 | Belmopan Workshop | Fair |
| BZ-B 304 | Ford | Pickup Super Cab | 1984 | Buildings Belmopan | Fair |

| REG. NO. | MAKE | TYPE | DATE ACQUIRED | LOCATION | CONDITION |
|---|---|---|---|---|---|
| BZ-B 245 | Ford | Bronco | 1984 | Bel/ Workshop | Not Working |
| CY-B 559 | Ford | Pickup | 1989 | Belmopan | Good |
| CY-B 560 | Ford | Pickup Super Cab | 1989 | Bel Workshop | Good |
| CY-B 552 | Ford | Lowboy | 1989 | Belmopan | Good |
| CY-B 129 | Army U.S. | Lowboy | 1984 | " | Fair |

# APPENDIX E

## APPENDIX E - TABLE 1

## Environmental Evaluation Form

Rating
( N = No impact )
( L = Low/little impact )
( M = Moderate impact )
( H = High impact )
( U = Unknown impact )

DISTRICT: BELIZE

| | Rating |
|---|---|
| • Erosion of hillsides | N/L |
| • Siltation of streams & rivers | L |
| • Dust production | H |
| • Flooding/erosion of feeder roads | L |
| • Loss of prime agricultural land | N/L |
| • Increase in deforestation | N/L |
| • Shortened milpa fallow periods | U |
| • Loss of native ecosystem lands | L |
| • Wildlife impacts | L |
| • Other negative impacts | |
| - Dumping | L |
| - Poor drainage/water ponding | H |
| - Degradation of watersheds | N/L |
| - Pest control (mosquitos) | U |
| - Visual/aesthetics degradation | L |

*** NOTES: (41 RECORDED ARCHAEOLOGICAL SITES)**

Roads seen: (1) Hattieville to Burrell Boom to Burmudian Landing; (2) Burmudian Landing to Rancho Dolores; (3) Northern Highway to Burrell Boom. Areas with shallow sandy soil. Palm and pine bush. Forested areas along river. After rain water stands along roadsides - poor drainage. High dust production. Evidence of milpa along river; not much along pine and palm ridges, lots of water ponding off roadways. Ditches fill in with sediment from erosion of road. Evidence of siltation in creeks. Standing water may present breeding areas for mosquitos. Wildlife habitat is present.

## APPENDIX E - TABLE 2

## Environmental Evaluation Form

Rating

( N = No impact )
( L = Low/little impact )
( M = Moderate impact )
( H = High impact )
( U = Unknown impact )

DISTRICT: CAYO

| | Rating |
|---|---|
| • Erosion of hillsides | L/M |
| • Siltation of streams & rivers | L |
| • Dust production | H |
| • Flooding/erosion of feeder road | H |
| • Loss of prime agricultural land | N/L |
| • Increase in deforestation | M |
| • Shortened milpa fallow periods | U |
| • Loss of native ecosystem lands | M |
| • Wildlife impacts | M |
| • Other negative impacts | |
| - Dumping | L |
| - Poor drainage/water ponding | L |
| - Degradation of watersheds | L/M |
| - Pest control (mosquitos) | U |
| - Visual/aesthetics degradation | L |

*** NOTES: (120 RECORDED ARCHAEOLOGICAL SITES)**

Roads seen: (1) Main Highway to Spanish Lookout; (2) Main Highway to Cool Shade, San Antonio, Cristo Rey to Georgeville; (3) Main Highway to Chaa Creek. Abundance of milpa. Roads rocky, hilly and very dusty. Ditches moderately to heavily eroded on hills; filled in on some level spots. Borrow pits turn to trash pits and ponds. Good natural revegetation. Streams/creeks with minor siltation. Deforestation and fallow sites obvious. Roadside vegetation suitable habitat for small wildlife, particularly birds. Potential for watershed and water quality degradation.

## APPENDIX E - TABLE 3

## Environmental Evaluation Form

Rating

( N = No impact )
( L = Low/little impact )
( M = Moderate impact )
( H = High impact )
( U = Unknown impact )

DISTRICT: COROZAL

| | Rating |
|---|---|
| • Erosion of hillsides | N |
| • Siltation of streams & rivers | N |
| • Dust production | M |
| • Flooding/erosion of feeder roads | M |
| • Loss of prime agricultural land | N |
| • Increase in deforestation | N/L |
| • Shortened milpa fallow periods | U |
| • Loss of native ecosystem lands | H |
| • Wildlife impacts | M |
| • Other negative impacts | |
| - Dumping | L/M |
| - Poor drainage/water ponding | H |
| - Degradation of watersheds | L |
| - Pest control (mosquitos) | U |
| - Visual/aesthetics degradation | L |

*** NOTES: (25 RECORDED ARCHAEOLOGICAL SITES)**

Roads seen: (1) Corozal to Consejo; (2) Corozal, Xaibe, Patchachan; (3) San Roman - San Victor; (4) Buena Vista towards Libertad, Santa Cruz & Caledonia. Flat land. Mostly sugar cane - farmed to road ditch. Good revegetation of grasses, forbs and trees. Some ponding/erosion. Borrow pit an eye sore with lots of dumping. Variety of birds along roadside vegetation. No evidence of stream siltation. Wildlife habitat about 70-90% removed from road influence area, and turned into sugar cane production. Road maintenance and rehabilitation material produces dust when dry.

## APPENDIX E - TABLE 4

## Environmental Evaluation Form

Rating

( N = No impact )
( L = Low/little impact )
( M = Moderate impact )
( H = High impact )
( U = Unknown impact )

DISTRICT: ORANGE WALK

| | Rating |
|---|---|
| • Erosion of hillsides | N |
| • Siltation of streams & rivers | N |
| • Dust production | M |
| • Flooding/erosion of feeder roads | M |
| • Loss of prime agricultural land | N |
| • Increase in deforestation | L |
| • Shortened milpa fallow periods | L |
| • Loss of native ecosystem lands | H |
| • Wildlife impacts | M |
| • Other negative impacts | |
| - Dumping | L |
| - Poor drainage/water ponding | H |
| - Degradation of watersheds | L |
| - Pest control (mosquitos) | U |
| - Visual/aesthetics degradation | L |

*** NOTES: (53 RECORDED ARCHAEOLOGICAL SITES)**

Roads seen: (1) Orange Walk to Yo Creek to Santa Cruz; (2) Yo Creek to August Pine Ridge; (3) Guinea Grass to Orange Walk. Very like roads in Corozal - mostly along sugar cane fields. Ponding along roadside - inadequate drainage ways. Erosion of roads fills in roadside ditches. More of the bush has been converted to agricultural lands. Therefore, native ecosystems and wildlife habitat are greatly reduced. No evidence of siltation in streams. Flat land. Moderate dust. Very little native vegetation. Grassy natural revegetation along roads.

## APPENDIX E - TABLE 5

## Environmental Evaluation Form

Rating
( N = No impact )
( L = Low/little impact )
( M = Moderate impact )
( H = High impact )
( U = Unknown impact )

DISTRICT: STANN CREEK

| | Rating |
|---|---|
| • Erosion of hillsides | N |
| • Siltation of streams & rivers | L/M |
| • Dust production | M |
| • Flooding/erosion of feeder roads | M |
| • Loss of prime agricultural land | N |
| • Increase in deforestation | L |
| • Shortened milpa fallow periods | U |
| • Loss of native ecosystem lands | L |
| • Wildlife impacts | L |
| • Other negative impacts | |
| - Dumping | L |
| - Poor drainage/water ponding | L/M |
| - Degradation of watersheds | L |
| - Pest control (mosquitos) | U |
| - Visual/aesthetics degradation | L |

*** NOTES: (33 RECORDED ARCHAEOLOGICAL SITES)**

Roads seen: (1) Hummingbird Highway to Mullins River; (2) Hummingbird Highway to Hopkins. At bridge construction at Mullins River siltation in evidence from construction project. Flat to rolling terrain. Erosion of roads to roadside; ponding due to poor drainage ways. Dust production. Pine forests mixed with broadleaf deciduous. Native lands still available. Native wildlife species impacts probably low. Sandy soils. Milpa would not do well in these areas. Land more suited for permanent tree crops.

# APPENDIX F

## A. Quality Control Standards

One of the questions which must be resolved is whether a viable set of design standards exist for the rehabilitation of rural access roads and bridges under the Project. Such questions must be asked as:

1. Do present standards optimize total transport cost, i.e. construction, maintenance and road user costs?

2. In view of the difficulties of adequately maintaining rural roads in Belize, should the MOW be upgrading deteriorated feeder roads to a higher standards with the intent to reduce the amount of maintenance effort required after construction? Are current standards so low that only "disposable roads" are being constructed which must be reconstructed every eight to nine years because the maintenance effort which Belize can afford is so minimal that adequate maintenance is impossible.

3. Are two lane feeder roads required or justified considering actual and anticipated traffic volumes or could both construction and maintenance costs be reduce by single lane roads for low volume roads with ADT values less than, say, 50.

4. Are variations in the technical standards appropriate to accommodate changes in topography, traffic volumes, weather and flooding patterns and the economic characteristics of the roads?

5. Are technical standards as set for the project actually being followed during the rehabilitation or improvement process?

6. Is the drainage problem, which is all too critical to rural roads, being properly addressed?

7. Do road construction standards reflect the type of maintenance to be provided? Mechanized maintenance such as that contemplated for the project would dictate the use of triangular shaped side ditches which can be maintained by a motor grader rather than the trapezoidal sections which are more easily maintained by labour intensive pick-and-shovel procedures. Shoulders and right-of-way should have sufficient width and be cleared so that mechanized methods can be used rather than hand cutting of brush with machetes. Surfacing materials placed should have the proper size distribution and plasticity requirements so as to be easily bladed, dragged and shaped without need for scarification. Transverse culverts should have a minimum diameter of 24 inches to facilitate cleaning. The right-of-way through forested areas should be cleared of trees so as to permit the sun to dry out the road surface as soon as possible after rains. Checks on lining or placement of ditches should be contemplated where ditch erosion is a problem.

8. Are standards for bridge construction appropriate and economically justifiable?

Unfortunately, these considerations do not seem to have been taken into account during the project design period. At least no evidence to this effect could be encountered in the MOW. Although a single, typical cross section was available (supposedly for all rural roads being rehabilitated and improved), this standard did not seem to be adhered to on field work performed. Geometric criteria or specifications standards to which the roads were being built were not available. Currently roads are being rehabilitated without any formal quality control, i.e. soil testing, compaction tests, or drainage calculations.

The evaluating team concluded that the quality standards to which the roads were being built were not always consistent in the following respects:

a) The width of a road as being rehabilitated on a given project often varied significantly in a short distance. In order to reduce construction and maintenance costs, the minimum width established for the project should be adhered to.

b) The surfacing material utilized was in some cases pit run material with no screening or processing attempted. Some of these materials, particularly those utilized in the Belize, Cayo and Stann Creek Districts, had considerable oversize material including boulders and cobbles which make surface maintenance difficult and in some cases impossible. The general impression was that shaping of the gravel surface to remove corrugations and restore cross shapes by simply placing new material over the existing surface was not possible. Scarification of the surface and reblading (both expensive and time consuming maintenance operations) would be required first. The possibility of introducing some sort of minimum screening or crushing operation where required to remove oversize particles should be considered, since the initial cost could be compensated by lower maintenance inputs.

c) The evaluating team is not sure two lane roads can be justified on the project considering the rather low volumes of traffic observed on these facilities during field trips. Usually, on rural road rehabilitation projects with existing access, economic justification for two-lane construction does not reach the threshold value until Average Daily Traffic Values (ADT) are on the order of 50 to 300 vehicles per day. This volume is far in

excess of existing and projected traffic volumes on project roads (Reference 1, pages 8, 50, 76). ADT values are classified into four categories for upgrade roads.

| Category | ADT Value |
|---|---|
| 1 | 0- 20 |
| 2 | 21- 90 |
| 3 | 91-150 |
| 4 | 151-250 or more |

Over 90% of the existing feeder roads in Belize are category 1,2 or 3 roads which could be considered as candidates for one lane construction, having a width of 10 to 13 feet with widening every 2000 feet or so to permit passing.

d) There is a need for impermeabilization of surfacing materials on steep longitudinal grades where runoff occurs along the axis of the road rather than transversely into side ditches. In order to avoid the longitudinal erosion channels on these steep grades, a soil-cement mixture or bituminous seal coat should be utilized.

e) On low, flat areas, particularly in costal areas, feeder roads should be considered on one to two meter high fills to facilitate drainage and raise the road surface above the phreatic surface.

f) Inadequate crossfall was found on many of the roads. The road surface was almost flat, pounding water, rather than sloped to carry water to the side ditches.

g) The evaluation team was told that cross drainage in the form of concrete and corrugated metal pipes was not placed in all locations required due to funding limitations.

h) Observations during field trips also indicated insufficient ditch capacity, absence of diversion channels and sections where ditch lining was required to preclude excessive erosion and reduce maintenance workloads.

i) The permanent, high-level bridges being constructed to preclude temporary flooding and washouts of the existing low level structures seem to be designed to structural and hydraulic standards which far exceed those normally applied to rural feeder roads.

In summary the evaluation team recommends that technical standards being utilized for feeder road construction in Belize be reviewed to insure that optimal standards are adopted considering in particular that road maintenance will undoubtedly remain a continuing problem. Higher standards could possibly be considered for surfacing and drainage. Costs could be partially compensated by reducing widths to a minimum or even going to one-lane construction in some cases. The emphasis here should be to formulate alternative features of the design based on economic evaluation of the standards utilized and not base such standards on personal experience or preferences. This economic formulation of design features would have to be based strictly on road user benefits as non-road user savings would be common to all alternatives and cancel out of comparative design feature evaluations. Computer programs such as the World Bank Cost Model or Corps of Engineer Paver Program have been developed for this purpose.

One of the problems the evaluating team has encountered on most AID-financed road projects is that these projects are "fast tracked" in the sense the project goes directly from the Project Paper into project implementation. Although some preliminary designs are done at the Project Paper level, there is really no design phase prior to project implementation. Designs are produced

as the project progresses which invariably requires changes and adjustments or project extensions as the project develops. The evaluating team feels that project implementation in many cases should be attempted only after a formal project design phase has occurred and all the elements are available on which to base project implementation so as to reduce program adjustment and changes required. If fast tracking is required then more formal and intensive design work be done during the preparation of the Project Paper.

## B. Terminology

Considerable confusion often results in discussing rural road construction and maintenance projects because of differences in the interpretation of the terminology applied. For the purpose of this evaluation the following definitions have been utilized which correspond to those given in the ASHTO Manual of Uniform Highway Accounting and Financial Management Procedures.

### 1. Construction Terminology

a) New Construction--The construction of a road on a new alignment which has no relationship with the reconstruction or improvement of an existing facility.

b) Betterment, Improvement or Upgrading--The improvements, adjustments or additions to a road which more than restore it to its former good condition and which result in better traffic serviceability without major changes in its original construction. Betterment includes the construction of short sections of new alignment of an existing road intended to improve horizontal or vertical geometry.

c) Rehabilitation--The restoration of an existing road (which has deteriorated due to lack of maintenance, inadequate design or poor construction procedures) to its originally intended service level without exceeding this level. After rehabilitation the road will require only routine and periodic maintenance to keep it at a satisfactory service level.

d) Reconstruction--The rebuilding of an existing road or component section to a degree that a new, supplementary or substantially improved facility is provided with significant geometric or structural improvements.

2. Maintenance Terminology

a) Physical Maintenance--The preservation and upkeep of a road including all of its elements at its intended service level through the life of the facility. Physical maintenance or sometimes just the term maintenance alone is a global term applied to the combined effort of routine, periodic and emergency maintenance and minor improvements.

b) Routine Maintenance--Maintenance activities performed at frequent intervals, usually several times per year such as blading, filling of potholes, cleaning and reshaping ditches, mowing of shoulders, and cleaning of culvert pipe.

c) Periodic Maintenance--Maintenance performed at intervals which exceed a one year period such as regravelling of road sections which have become depleted due to traffic whipoff and surface runoff.

d) Emergency Maintenance--Maintenance performed on a non-programmed critical basis to rehabilitate or restore roadworks which have been damaged or destroyed by acts of God including floods, storms, earthquakes, landslides or civil disturbances with the purpose of restoring normal passage of vehicles.

e) Minor Improvements--Activities which result in minimal improvements which can normally be done and included as part of routine and periodic maintenance.

It should be mentioned that based on the above definitions most of the rural roads being considered are being improved or upgraded rather than rehabilitated in that the service level of the road is being improved through drainage, placement of all-weather surfacing, and construction of high level bridge crossings. Furthermore, once these roads have been improved there should be no need for rehabilitation provided adequate maintenance is provided. Any regravelling required due to traffic or runoff/removal of existing gravel surfacing becomes a periodic maintenance function and not a rehabilitation program. Theoretically, once the rural road network is rehabilitated or improved to the required service level, there is no need for road rehabilitation crews as the road is kept at the desired service level by routine and periodic maintenance only.

## APPENDIX G

## References


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## APPENDIX H

## Definitions of Acronyms

| | |
|---|---|
| A&E: | Accomplishment and Expenditure |
| BCB: | Banana Control Board |
| B$: | Belizean Dollars |
| CAD: | Computer Assisted Design |
| COA: | Commissioner of Archaeology |
| ESF: | Economic Stabilization Fund |
| GDP: | Gross Domestic Product |
| GOB: | Government of Belize |
| IEE: | Initial Environmental Examination |
| MES: | Monthly Executive Summary |
| MMS: | Maintenance Management System |
| MOF: | Ministry of Finance |
| MOW: | Ministry of Works |
| ODA: | Overseas Development Administration of the United Kingdom |
| OIC: | Officers-in-Charge |
| PACD: | Project Assistance Completion Date |
| PUP: | People's United Party |
| RMU: | Road Maintenance Unit |
| RR&B: | Rural Access Roads and Bridges |
| RRU: | Road Rehabilitation Unit |
| UDP: | United Democratic Party |
| USAID: | United States Agency for International Development |