Sierra Leone

AGENCY FOR INTERNATIONAL DEVELOPMENT
DEPARTMENT OF STATE
WASHINGTON, D.C.

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# EVALUATION OF CARE FEEDER ROAD PROJECT SIERRA LEONE

## FINAL REPORT

Contract No. AID/otr-C-1298
Work Order No. 16

DECEMBER 1977

HARRIS
FREDERIC R. HARRIS, INC., Consulting Engineers,
New York, N.Y.

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# INTRODUCTION

This final report was prepared in accordance with the terms of an agreement signed between the Department of State-Agency for International Development, Washington, D.C., United States of America, and Planning Research Corporation of Los Angeles, California, a multidisciplinary professional service company.

The aforementioned agreement is identified as Contract No. AID/otc-C-1298, Work Order No. 16, and responsibility for tis execution was borne by Frederic R. Harris, Inc. of New York, New York, an international engineering firm wholly owned by and a subsidiary company of Planning Research Corporation.

## BACKGROUND OF PROJECT

In 1973 a multi-faceted program to substantially increase agricultural productivity in the Eastern Area of Sierra Leone was started. The program, still underway, is known as the Integrated Agricultural Development Project (IADP) and is financed in part by the International Development Association of the IBRD. The IADP activities include provision of modern agricultural inputs, credit facilities, farmer training facilities, pilot programs for estate cultivation, almost saturation coverage by extension workers, and institutional development. Excluded from IADP activities, however, is construction of new rural roads or rehabilitation of existing ones. As many of these IADP activities were road dependent - i.e., the farmers' response to development aids is a function of the pricing and reliability of road transport - the condition and coverage of the existing rural road network in the Eastern Area was critical to the success of the program.

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Unfortunately the density of rural roads that could be used by motor vehicles on a year-round, all weather basis in the Eastern Area was much too low to permit proper support of the IADP activities. This meant that the effectiveness of the IADP investments would be substantially diluted without an adequate rural road network in the area. To overcome this problem AID made a grant to CARE - a private voluntary organization - for the construction and rehabilitation of rural roads in the IADP program area. This program is known as the CARE/Sierra Leone Rural Roads Penetration Project.

The salient feature of this program is that CARE itself is the construction contractor. During the three-year construction period beginning in January 1975 and ending with the start of the rainy season in the fall of 1977 over 200 miles of rural roads were constructed or rehabilitated by CARE with AID support. These roads were built to standards, which with proper maintenance, would allow year-round operation by trucks and vans.

In February 1977 an evaluation of this work was made jointly by AID and CARE. The main conclusions of this evaluation was that further assistance from AID under a second OPG be given to CARE for the construction and rehabilitation of an additional 400 miles of rural road in Sierra Leone and the maintenance of the roads completed under the first OPG and to be constructed under the second OPG. Additional financinging will be supplied by CARE itself, the GOSL, and the IBRD for this work.

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# MAJOR FINDINGS AND RECOMMENDATIONS

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# MAJOR FINDINGS AND RECOMMENDATIONS

## 1.1 CARE

The use of a Private Voluntary Organization, CARE, to build low cost, low traffic volume, low design standard roads in rural areas of Sierra Leone has been successful. The support given by AID for the previous project (the first OPG) should be continued and expanded for the proposed project (the second OPG).

The Consultant has estimated the average cost per mile, in 1977 dollars, of the 400 miles of roads to be built under the second OPG as of roads to be built under the second OPG as:

- $12.3 thousand per mile for out-of-pocket expenditures exclusive of equipment purchases, this is the cash-flow needed by CARE,

- $16.5 thousand per mile in financial terms i.e., analagous costs if CARE were a private but not-for-profit contractor,

- $20.7 thousand per mile in economic terms.

The low costs are the result of a combination of efforts of:

- educated, highly motivated by minimally paid Peace Corps and V S O workers,

- competent and dedicated administration by CARE,

- well paid Sierra Leonian professionals and skilled labor,

- donated unskilled labor.

## 1.2 REPLICABILITY TO OTHER AFRICAN COUNTRIES

The success attained by CARE in Sierra Leone is due, partially to the fact that the local U.S. staff to date, have had some background in engineering. Another factor is their motivation and the ability to transmit this to others, particularly members of the GOSL.

This operation could be duplicated in other African countries if the same conditions that exist in Sierra Leone could be met.

That is, first the directors of an international organization be it CARE, Peace Corps, V S O or other, are road oriented and development motivated, motivation being the paramount ingredient in the undertaking. Secondly, the roads must be in an area of sufficient population to supply the communal or hired labor, eliminating such costs as camps, transportation or bush pay. And, thirdly, they must be in an area where the local chiefs have the authority or persuasive force to assure an adequate supply of labor. The Sierra Leone projects, while considered labor intensive, in reality, barely qualify for that designation because of the fact that the bulk of the actual work is performed by machinery operated by paid professionals.

Labor intensive production such as is carried out in the Far East on the construction of dikes, railroads dams and so forth by thousands of laborers head loading materials, simply isn't feasible in most parts of Africa. One, due to lack of heavily populated rural centers, and two, because Africans do not seem inclined to submit to such harsh regimentation.

Finally, the ongoing road program of the particular government must be evaluated. The case could be, as in Liberia for example, where the Ministry of Public Work forces are already over-stretched on force-account rural road projects and their financing. In this situation, it would be anticipated that the government's participation would be very slight.

## 1.3 PEACE CORPS AND VSO PERSONNEL

Construction costs per mile for the 1978/1980 period should not appreciably vary from estimated costs (exclusive of inflation) if Peace Corps and VSO support continues.

These volunteers, for the most part graduate engineers, came to Sierra Leone in the expectation of assisting the rural poor in local self improvement projects, while living in the African version of a pastoral setting.

Instead, they find themselves working twelve hours a day doing the same kind of thing that they would have been doing had they remained at home. And all for considerably less pay. As they are working alongside of a paid staff, they do get depressed and bitter.

This could be overcome by a thorough home country orientation of those destined for the project, emphasizing the fact that they are gaining valuable professional experience and responsibilities that they would not normally receive were they working back home as junior engineers.

If the work were being done by a private contractor, it might be considered that the project is overstaffed, with engineers, but in this instance, where the engineers are

mostly young and inexperienced, it is justified. Then too, most volunteers serve only two years, and having an extra on hand lends continuity to the operation.

## 1.4 UTILIZATION OF WELL WORN EQUIPMENT

This has not proven successful. The work is machine-intensive and all grading operations are carried out by equipment. This means that a mix of equipment be used. In turn this means that if one piece breaks down, say a front-end loader the dump trucks assigned to the particular unit are out of production in effect. With well-worn equipment, machines such as front-end loaders break down frequently. One solution of course, is duplication of equipment but this is almost as expensive as purchasing new equipment.

## 1.5 DESIGN STANDARDS

Geometric and construction standards are satisfactory except that no formation width should exceed 16 feet. Other comments pertaining to cost-reductions in certain work items and are given in Section 2.5.

## 1.6 EQUIPMENT

Detailed recommendations for size and mix of equipment units are given in Section 3.2.2.

## 1.7 SUB-PROJECT SELECTION

Suggested procedures for sub-project evaluation with particular attention to rural roads are presented in Section 6.0. Described below are some findings for immediate implementation:

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- No construction of short spurs - e.g., a two mile length of rural road - should be permitted without detailed justification.

- The most road dependent IADP activity is extension worker coverage. This is road dependent in that the extension workers will not service any village they cannot enter by motor vehicle. Even a 10 to 15 minute walk appears unacceptable to them. All sub-projects should be re-evaluated with regard to extension worker coverage.

- Field studies to identify the incremental productivity increases attributable to road construction should be carried out in the project area.

- The distance farmers are willing to headload their surplus crops as a function of both the weight and value of the surplus. Further study is needed to determine acceptable headloading distances for various types of crops in different terrains. This will in turn help define the service area of a rural road.

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# DESIGN STANDARDS AND ENGINEERING

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# DESIGN STANDARDS AND ENGINEERING

## 2.1 CURRENT DESIGN STANDARDS

Geometric design standards for the roads constructed by CARE (See Table 2.1) under the first OPG were established by the Ministry of Works. These correspond to Ministry geometric standards for Class IV roads - the lowest design classification of Sierra Leone's road system - an ADT of 150 vehicles per day or less.

Construction standards specified by the MOW are limited to surface type and compaction depth and to bridge loading. All other construction and geometric standards were established by CARE (See Table 2.1).

During the course of the first OPG repeated requests were made by CARE to the MOW for permission to build many roads to lower geometric and construction standards - in effect establishing a Class V road category. These requests were rejected by the MOW. CARE was told that the GOSL would not contribute to the project unless the roads were built to the established standards. Consequently, the design standards used to prepare the construction plans for the roads to be uilt under the second OPG were the same as the first OPG.

The MOW however requested CARE to increase for formation width - to a 20 foot minimum for some roads which would upon completion also carry through traffic. CARE complied with this request. In these instances traffic was expected

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TABLE 2.1

DESIGN STANDARDS USED UNDER FIRST OPG

GEOMETRICS

| | |
|---|---|
| Minimum Radius of Curvature | 300 feet |
| Maximum Gradient | 15 percent |
| Formation Width | 16 feet to 20 feet |
| Roadway X-Slope | 5 percent |
| Passing Sight Distance | 200 feet to 300 feet |
| Bridge Width Between Curbs | 12 feet |

CONSTRUCTION

| | |
|---|---|
| Bridge Loading | British Standard (BS) 153 Part 3a |
| Side Slopes | 1V:1.75H |
| Back Slopes - Cut | 5V:1H |
| Ditches | 1V:1.75H |
| Roadway Surface | 6 inches (min.) Compacted Laterite |

SOURCE: CARE

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to divert to the roads constructed by CARE because of the poor riding conditions on the existing trunk roads or because the new roads appreciably shorten travel distances

CARE termed the roads with a 20 foot formation width Class IVA and with a 16 foot width Class IVB.

In July 1977 CARE issued a construction manual entitled "CARE Feeder Road".

The principal aim of the manual is to provide guidance for design and construction of laterite roads in Sierra Leone. This manual also outlines in detail, the construction practices of the MOW.

## 2.2 FIELD INSPECTION OF COMPLETED CONSTRUCTION

Nine roads - eight completed, one underway - that formed part of the work under the first OPG were inspected by the Consultant. The inspection took place at the end of the rainy season. Table 2.2 lists the physical, topographic, and roadway characteristics of these roads. Comments on observed design and construction practices are given below.

1. After a full rainy season, the roads showed light or no damage due to water run-off. However, on long grades small erosion ruts on the roadway were noticed, which to a degree hampered the smooth-running of vehicles

2. The drainage structures and bridges had sufficient cross-sectional area for water passage significant erosion damage was observed. Drainage design appeared adequate.

TABLE 2.2
PHYSICAL, TOPOGRAPHIC AND ROADWAY CHARACTERISTICS OF INSPECTED ROADS

| SUB-PROJECT NUMBER (Length In Miles) | DENSITY OF VEGETATION | ORIGINAL TRACK WIDTH (PRIOR TO CONSTRUCTION | EXISTING STRUCTURES (PRIOR TO CONSTRUCTION) | FINAL FORMATION WIDTH | % OF LENGTH BY TYPE OF TERRAIN | | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | | FLAT | ROLLING | |
| R-121 (4.0) | Medium | 6' to 8' | Palm log bridges in swamps and short span conc. bridges in larger crossings. | 24'-26' | 10% | 90% | Cuts and fill up to 8'. Used few existing structures. Select material available at roadside. |
| R-30 (12.5) | Medium | 8' to 9' | Palm log bridges in swamps and short span concrete bridges in larger crossings. | 22'-24' | 30% | 70% | Gentle rolling terrain. Cuts up to 6'. Built on existing secondary road. Used ± 50% of existing structures. Amply available suitable material at roadside. |
| R-43 (7.0) | Light | 16' to 18' (old R/R bed) | Two bridges with timber decking and good conc. pipe and box culvert | Entire length under const. | 70% | 30% Gentle | On abandoned R/R embankment. Propose to utilize and modify existing structures. Clearing not required. Material appear amply available. |
| R-90 (9.0) | Thick | 6' to 8' | Palm logs in small crossings and conc. bridges in few larger crossings. | 6'-22' | 10% | 90% Hilly | Steep grades approaching Sakiema (up to 10%). Some erosion problems with these grades, stone masonry being used to pave ditches. Built on existing roads. |
| R-84 (11.1) | Medium | 8' to 9' | 12" Conc. culverts, palm logs and conc. bridges in larger crossings. | 16'-17' | 40% | 60% Gentle | Used numerous existing structures. Road not being adequately maintained for vegetation growth control. Built on existing road. |
| R-115 (5.0) | Medium | 8' to 9' | Palm log bridges in small crossings. | 16' | 95% | 5% | Very few structures required. No bridges shoulders are overgrown, and vegetation growth control is now required. |
| R-116 (3.5) | Medium | 6' to 8' | Palm log bridges. No large crossings. | 20' | 80% | 20% Gentle | Structures are all new construction. No bridges. This short spur is of recent construction. |
| R-75 (10.0) | Medium | 6' to 8' | Palm log bridges in swamps and short span conc. bridges in larger crossings. | 24'-26' | 90% | 10% | Used all existing bridges with little or no modification. Few crossings found. Some existing narrow bridges need curbing for protection of user. Built on existing road. |
| R-70 (6.0) | Light | 6' to 8' | Palm log bridges in swamps and conc. bridges in larger crossings. | 20' | 95% | 5% Gentle | All existing structures used with little or no modification. |

Construction was limited to regrading and light surfacing with no compaction. Road has severely deteriorated under heavy traffic. Care will reconstruct.

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3. Road elevations are high enough to protect against high water and flood water intrusion into the upper embankment. (An exception is R-70.)

4. The horizontal and vertical geometry generally permits running speeds of 35-40 MPH.

5. Some of the existing bridge structures left in place are too narrow and without barrier curbing. However, this could be considered a trade-off between safety and cost wherever the traffic volumes are low.

6. The culvert endwalls show excellent construction, but are over-sized. They are located at each edge of the formation platform instead of the bottom of the slope. This increases headwall height.

7. The embankment base and surfacing materials appear to be suitable. With very few exceptions, suitable material is available at roadside. Long hauls are rare. Generally, the soil conditions are favorable.

8. Formation widths generally exceeded design standards.

9. No roads were built through areas requiring rock cuts as the GOSL does not permit CARE to use explosives.

10. Some of the ditches on steep grades (e.g. R-9) are being paved with stone masonry. The consultant has recommended experimenting with use of shallow concrete dams at close intervals.

11. No faults were found with the geometric design of the roads.

In Summary:

- Design was adeuqate and any faults were towards over-sizing.

## 2.3 ENGINEERING DESIGN

At the start of the first OPG the technical staff doubled as designers and construction supervisors. Surveys were sketchy and design was carried out in the field concurrent with grading operations. Fortunately deficiencies in design were compensated for by over-sizing. As the work progressed surveys were made along proposed alignments and construction plans prepared. A design manual was also developed by CARE for use of field personnel. Design engineers were also made available through the Peace Corps and VSO.

Work under the second OPG will be done from plans and profiles which are in turn based on detailed field surveys.

Design of the roads in the first OPG - without making any allowance for deficiencies in survey and design personnel - was adequate. In the second OPG, with a larger and more experienced staff, design will also be adequate.

## 2.4 EVALUATION OF DESIGN STANDARDS

The underlying consideration in the choice of design standards is whether the road should be designed to provide either -

- All weather, year-round operation by trucks or buses or

- All weather operation by four-wheel drive vehicles only or

- Operation by trucks and buses only during the dry season and four-wheel drive vehicles only otherwise

It is the Consultant's opinion that design standards for roads to be built under the second OPG should provide dependable and reliable year-round transportation. There is no incentive to a farmer to use modern inputs - such as fertilizer or insecticide - if they cannot be delivered at the proper times. Similarily there is no incentive to increase production if the surplus crop cannot be marketed. The farmer must feel confident that transport is available. He will have no confidence that a road closed during the rainy season and that will only be open in dry season after maintenance will actually be put back in operation. This is ignoring the social-welfare benefits that accrue from year round dependable transportation. Accordingly, design standards should be selected that provide for year-round all-weather operation.

A review of major design elements of the roads of the first OPG, in the light of these considerations is as follows:

### 2.4.1 Riding Surface

This is now six inches of compacted laterite. An adequate depth for anticipated traffic volumes. Elimination of the surfacing is not warranted if year round service is to

be provided.

### 2.4.2 Formation Width

The minimum formation width that permits reasonably safe and efficient operation on low traffic roads (ADT of 10 or less) is 12 feet. This however requires almost daily maintenance to avoid erosion and wearing of the formation edges. Considering the particular conditions in Sierra Leone a formation width of 16 feet, as established by the MOW, is the most feasible. This will provide a 10 to 12 foot roadway at a minimum.

### 2.4.3 Slopes

Most, if not all, of the roads are built through areas of laterite soils. This type of soil permits steep back-slopes and side-slopes. In fact the steeper the slope in lateric soil, the less damage from rain and run-off.

### 2.4.4 Embankment Height

For year-round all weather operation the top of formation should be at least one foot but preferably two above normal high or flood water elevations.

## 2.5 PROPOSED DESIGN STANDARDS

The design standards established by the MOW are satisfactory except no formation width should exceed 16 feet.

CARE construction standards should be modified to show head-wall location near bottom of slope instead of at edge of

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formation. No change appears required to the other standards.

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# EQUIPMENT AND LABOR

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# 3.0
# EQUIPMENT AND LABOR

## 3.1 ORGANIZATION OF OPERATIONS

### 3.1.1 GENERAL

The orientation of the road construction techniques under the first OPG was towards maximum use of available mechanized road-building equipment. Experience during the course of the work, particularly with regard to voluntary labor, reinforced the necessity of using mechanized equipment. Consequently, the orientation of the second OPG is even more capital intensive than the first OPG.

### 3.1.2 MANAGEMENT AND SUPERVISION

Overall project management is furnished by U.S. nationals employed by CARE and working out of their Freetown office.

Onsite project supervision is by local nationals. Construction supervision is under the direction of Peace Corps and USO personnel.

### 3.1.3 DESIGN AND CONSTRUCTION OPERATIONS

Construction operations are carried out by construction units, or "spreads" to use American terminology. The "spreads" are divided into two sections, the road construction group, which does the grading, surfacing, etc., and the culvert and bridges group. Each section is headed by an engineer from the Peace Corps or VSO. In addition to the "spreads", there is another bridge and culvert group working independently on advance or catchup work, headed by a volunteer. Design work is also carried out by the same volunteer engineers.

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### 3.1.4 EQUIPMENT MAINTENANCE

Equipment maintenance is under the direction of a paid shop foreman or master mechanic, assisted by several volunteers from the Peace Corps and VSO.

Work is concentrated in a shop and yard in Bo.

## 3.2 EQUIPMENT

### 3.2.1 EVALUATION OF EQUIPMENT IN FIRST OPG

Most of the equipment used on the work of the first OPG was between 6 and 15 years old. As there was no heavy grading or rock excavation, the equipment was usable. Average down-time for FY 76/77 was about 45 percent.

The equipment was assigned to the four construction units (spreads) setup from the first OPG as shown on Table 3.1. Comments on the equipment mix are as follows:

- Unit No. 1 - This came closest to having a proper mix but still lacked a scraper.

- Unit No. 2 - Has a scraper but no loader. This means that surfacing material was placed with the scraper which is difficult and unwieldy.

- Unit No. 3 - Had fair hauling capacity, but needed compaction equipment. There was no possibility that adequate compaction could be assured by the passage of the six dump trucks and one dozer. The unit also lacked a grader to spread material.

- Unit No. 4 - Lacked compaction equipment and hauling capacity.

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TABLE 3.1

EQUIPMENT DESCRIPTION AND ASSIGNMENT TO CONSTRUCTION UNITS

FIRST OPG

| | CONSTRUCTION UNIT ('SPREAD') | | | |
|---|---|---|---|---|
| | #1 | #2 | #3 | #4 |
| DESCRIPTION | | ASSIGNMENT | | |
| Dozers | 2 | 1 | 1 | 1 |
| Graders | 2 | 2 | 0 | 1 |
| Scrapers | 0 | 1 | 0 | 0 |
| Rollers | 1 | 1 | 0 | 0 |
| Frontend Loaders | 1[a] | 0 | 1[a] | 1[b] |
| Dump Trucks | 6 | 1 | 6 | 2 |
| Tractor/Trailer | 1 | 1 | 1 | 1 |
| Water Truck | 1 | 0 | 0 | 0 |

Notes: a - Type: 920

b - Type: JCB

SOURCE: CARE

- All Units - Only Unit No. 1 had a water truck which was supposed to service the other units as required. During the dry season, this arrangement was inadequate as water requirements for compaction were considerable. Each unit should have water available at all times.

  The 920 frontend loaders were used as excavating equipment, for which they are not well adapted. The 920s are a bit light for digging and work much better if the material is ripped or dozed out first. The JCB is a good excavator but a slow loader.

  There is no backup equipment in any of the units to help out while any one piece is out of service. For example, in Unit No. 1, if the frontend loader is down, then the six dump trucks are idle also. The same can be said of Unit Nos. 3 and 4, if their loader is down, the entire unit is inoperative.

### 3.2.2 RECOMMENDATIONS FOR SECOND OPG

CARE proposes to reduce the number of construction units to three in the second OPG and broaden the equipment mix through purchase. The proposed assignment to road construction activities, including new purchases is shown on Table 3.2.

This gives a much more rational mix than the assignment for the previous construction season.

It still leaves units #1R and #3R a loader, but the work can be laid out so that there could be exchanges. For example, when surfacing operations are going on in Unit #2R, the scraper could be borrowed from another unit in return for a frontend loader and dump trucks.

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TABLE 3.2

PROPOSED EQUIPMENT ASSIGNMENTS

SECOND OPG

| DESCRIPTION | #1R | #2R | #3R |
|---|---|---|---|
| | | ASSIGNMENT | |
| Dozers[a] | 2-1/2 | 1-1/2 | 3 |
| Graders | 2 | 2 | 2 |
| Scrapers[a] | 1 | 0 | 1 |
| Rollers[a] | 2-1/3 | 2-1/3 | 2 |
| Frontend Loaders[a] | 0 | 2[b] | 0 |
| Dump Trucks[a] | 2 | 8 | 2 |
| Tractor/Trailer | 1 | 2 | 1 |
| Water Truck[a] | 1 | 1 | 1 |

Notes: a - Includes new purchases

b - Type: 920

SOURCE: CARE

If the new equipment purchases do not become available for use in the coming construction season, it will be impractical to try to operate four units as in the past. It would then be advantageous to concentrate all equipment in two units. This would increase the probability that at least two working fronts remain in continuous production, rather than have as many as three or four units inoperative at the same time.

If the new equipment does become available during FY 77/78 construction season, it would then be advisable to equip one unit with as much new equipment as possible. This would allow almost continuous operation on one working front at least leaving the mechanical problems in the other two units.

If the older equipment continues to be unreliable, it should be retired even if it is necessary to discontinue one working front. Keeping the equipment serviced and operating is particularly difficult due to the great variety of models on hand. Some were manufactured in the United Kingdom, some in the United States and many of them are as much as fifteen years old. This required an extensive search for spare parts. Parts from some of the older models can be obtained only by cannabilizing similar machines as may be found abandoned in MOW yards or at old mine workings.

## 3.3 LABOR

At the close of the 1976/1977 construction season, CARE carried on its payroll about 200 workers in job titles ranging from drivers through to lathe operators to foremen. Only 14 men were classified as unskilled laborers and paid by CARE. The other unskilled labor, some 200 per working day, are volunteers, coming from the communal labor pools of the surrounding chiefdoms.

CARE uses labor with equipment the same way that excavating contractors do. That is, operators and mechanics with the equipment and laborers on the ground. Usually two or three laborers are assigned to each earthmoving machine, guiding the operators, throwing out roots and stones and doing whatever else is needed to assist operations.

All unskilled laborers are volunteers except for a small number on CARE's payroll who generally work in the yards or shops. Each construction unit receives about forty volunteer laborers a day and even through they are not the same people each day, the services rendered are useful. Their contribution is most effective and valuable in bridge and culvert construction. They perform such work as excavating and washing sand from the river for fine aggregate; loading, unloading and placing culvert pipe and ditch and footing excavation. All supervisors reported they found this type of labor to be productive and generally in good supply.

CARE has made no attempt to replace earthmoving equipment with labor-intensive methods. While volunteer labor is generally available in sufficient numbers to assist the construction units, it would not be available on an unpaid basis, in the numbers needed to excavate and move earth manually. Even if the work were to be done for pay, it is doubtful if sufficient labor could be obtained. In any event, compaction would have to be done by mechanical means.

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# CONSTRUCTION COSTS

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# CONSTRUCTION COSTS

## 4.1 AVAILABLE RECORDS

A detailed review was made of all CARE's records directly pertaining or that could possibly pertain to the cost aspects of the work under the first and second OPG's (CARE stated that all pertinent records in their possession were made available to the Consultant). The depth of review varied with the comprehensiveness of the material. For example, random inspections were made of daily fueling records for each vehicle while thorough reviews were made of available monthly progress reports. The major findings resulted from this review are:

- The coverage and comprehensiveness of CARE's existing records preclude the possibility of developing unit costs for construction work items. At the close of the 76/77 construction season, an attempt was made by CARE to estimate unit costs for roads R75, R84, R90 and R120, a total length of thirty-five miles. This was done by allocating salaries, fuel consumption and materials to various work items, but the resulting unit costs varied so much, so as to be unusable. The wide variation in unit costs was apparently caused by improper allocation of fueld and material costs, and inaccurate measurement of quantities in the field.

- Good records were kept, however, for equipment maintenance logs. Records were sketchy at the beginning of the first OPG but as the work got underway, the quality of the records substantially improved. Current records for example, show for each machine, POL usage, spare part expenditures and down time.

- Record keeping was very sporadic with regard to in-place quantity measurements, personnel allocations or particular work and mechanized equipment used for certain operations. The records appear complete enough however, to develop, after time-consuming analysis, total out-of-pocket expenditures on certain roads only. Even if this work were done, it would be difficult to relate per-mile costs so obtained for isolated road sections to the entire project.

- Cost records for the first OPG can only be considered a guide for estimating the future costs of the second OPG. Records of available expenditures are valid only in the aggregate (e.g., total cement used) not by specific construction items. In many cases, there is no disaggregation even between cement and reinforcing bars for example.

- No fault should be imputed to CARE for the quality of its cost records. There seemed to be no need at the time for detailed records and quantity measurements, nor were funds and personnel available for this work. However, broader and more comprehensive record keeping will be instituted for work under the second OPG.

## 4.2 BASIS OF ESTIMATE

Many of the conditions of work under the first OPG will fortunately not be replicated under the second OPG. Engineering both with regard to design and construction will be more available and more thorough, equipment will be newer and will be assigned more efficiently, and managers and supervisors will be more experienced. On the other hand, the orientation of the OPG will become even more capital intensive

with all that it entails in the way of more skilled operators and increased maintenance and construction targets will be more ambitious. The Consultant , after due consideration of the changing work conditions, the coverage and comprehensiveness of existing records, and review of CARE's field operations were of the opinion that preparation of detailed cost estimates for roads completed under the first OPG would not be an accurate description of what had transpired. Too many items that comprised the work under the first OPG were not measured by invoice, payroll charge, etc., but by estimate. Accordingly the Consultant believed that best use of existing data and proposed expenditures could be made by preparing independent estimates of annual costs for the three year construction period of the second OPG.

## 4.3 COSTS PER MILE

Estimated construction costs per mile were developed for each construction season and the entire project for three cost categories, out-of-pocket expenditures, financial, and economic (see Table 4.1). Average costs per mile corresponding to each of these three categories were 12.3, 16.6 and 20.7 thousand dollars per mile respectively in constant 1977 dollars.

The estimated costs were based upon the Consultant's revisions to estimates prepared by CARE and the Consultants allocations of may aggregated costs to standard construction classifications.

Construction Targets: In the first OPG 224 miles of road were constructed in two construction seasons - an average of 112 miles per year. The second OPG raises the target to a target average of 133 miles per year. A feasible and realistic goal.

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TABLE 4.1

ESTIMATED CONSTRUCTION COSTS PER MILE
(In Constant 1977 Values)

(All costs in thousands of U.S. dollars)

| | Construction Season | | | Entire |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | Project |
| Scheduled Construction - Miles | 100 | 150 | 150 | 400 |
| Out-of-Pocket Expenditures (excluding equipment purchase) | 13.7 | 12.5 | 11.1 | 12.3 |
| Financial Cost | 20.8 | 16.3 | 14.0 | 16.6 |
| Economic Cost | 26.6 | 20.0 | 17.6 | 20.7 |

NOTE: Per mile costs computed from Table 4.12

Out-of-Pocket Expenditures: This figure represents the average cost-per-mile cash inflow requirements of CARE. Depreciation is not an actual cash cost but a book-keeping charge so it does not need to enter in the cash-flow picture.

Financial Costs: Financial costs shown reflect CARE's status as a non-profit organization. Financial costs represent the minimum amount an organization must receive from its work to continue to stay in business. Inclusion of depreciation is an appropriate cost, since the equipment must eventually be replaced for the organization to continue. Financial costs of CARE are lower than they would be for a private, for profit, contractor since, the original equipment is donated, either in kind or in purchase money; no profit is made, and no taxes are paid.

Economic Costs: These were prepared by assuming the social prices of all inputs to equal the market prices. Another adjustment was made for the opportunity cost of the undepreciated value of the equipment. The net result is that the economic costs are conservative. For example, with the underemployment that exists in Sierra Leone, shadow wages are lower than market wages.

## 4.4 CASH FLOW

Table 4.2 is a comparison of the estimated cash outflow based on the consultant's estimates for road construction and the proposed cash inflows for construction from all sources. Total estimated cash outflow required, including ten percent for contingencies but ignoring inflation is 7.425 million U.S. dollars. Anticipated cash inflow is 7.438 million U.S. dollars.

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TABLE 4.2

CASH FLOW
RURAL ROAD CONSTRUCTION

Total Cash Flow for Three Construction Seasons[1]

| Estimated Cash Outflow[2] - (In U.S. Dollars) | |
|---|---|
| Equipment Purchase | $1,833 |
| Out-of-Pocket Expenditures | 4,917 |
| | 6,750 |
| Contingencies @ 10% | 675 |
| TOTAL OUTFLOW | $7,425 |

| Anticipated Cash Inflow[3] - (In U.S. Dollars) | |
|---|---|
| AID | $3,758 |
| GOSL | 1,414 |
| CARE | 1,201 |
| IBRD | 1,065 |
| TOTAL INFLOW | $7,438 |

(1) Maintenance costs (personnel, equipment, etc.) excluded

(2) From Tables 4.10 and 4.12

(3) From second OPG Proposal - allocated to construction

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## 4.5 COST ESTIMATE BREAKDOWN

### 4.5.1 LOCAL PERSONNEL

This category covers all local personnel on CARE's payroll - both those employed on the project site and those employed in Freetown Table 4.3, 4.4 and 4.5 show the personnel requirements and annual payroll for construction labor, equipment maintenance labor, and management, design, etc. respectively.

Average annual payroll costs are set constant over the three year construction period at the manpower requirement levels of the second and third construction seasons. This will allow for training on the use of the new equipment and familiarization with more efficient design and construction practices during the first season.

A detailed review was made of the manpower schedules, for all job classifications at the project site to ensure that personnel requirements are consistent with equipment availability and construction targets. The schedules shown on Tables 4.3, 4.4 and 4.5 incorporate the Consultants revisions. Wage rates were furnished by CARE.

### 4.5.2 FOREIGN PERSONNEL

This category covers all costs to CARE of maintaining all foreign personnel working on the project. These costs are shown in detail on Table 4.6. For Peace Corps and V.S.O. personnel, CARE provides a staff house and transportation. In addition, CARE pays a subsistence allowance to V.S.O. personnel.

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CONSTRUCTION LABOR
ESTIMATED AVERAGE ANNUAL PAYROLL COSTS TO CARE
(In Constant 1977 Prices)

Employed Year Round (312 working days)

| Position Title | No. | Daily Rate (In Leones) | Annual Rate (In Leones) |
|---|---|---|---|
| LL Drivers | 2 | 3.08 | 1,920 |
| Crusher Operator | 1 | 1.65 | 515 |
| Driver | 16 | 3.45 | 17,220 |
| Operators | 10 | 3.30 | 10,330 |
| Paymaster | 1 | 7.62 | 2,380 |
| Surveyors | 3 | 4.20 | 3,930 |
| Chainmen | 6 | 1.30 | 2,435 |
| Foremen | 23 | 4.50 | 32,290 |
| | | Wages | 70,990 |
| | | Fringe Benefits @ 15% | 10,650 |
| | | Payroll | 81,640 |

Seasonally Employed (192 working days)

| | | | |
|---|---|---|---|
| Banksmen | 4 | 1.15 | 885 |
| Carpenters | 56 | 1.55 | 16,670 |
| Masons | 56 | 1.55 | 16,670 |
| Crusher Operator | 1 | 1.65 | 315 |
| Concrete Mixer Oper. | 2 | 1.65 | 635 |
| Lather | 22 | 1.76 | 7,435 |
| Drivers | 23 | 3.45 | 15,235 |
| Armco Pipe Installers | 4 | 1.41 | 1,085 |
| Operators | 24 | 3.30 | 15,210 |
| Pump Operators | 1 | 1.50 | 290 |
| Tractor Operators | 4 | 1.65 | 1,270 |
| Laborers | 64 | 1.22 | 14,990 |
| Chainmen | 6 | 1.30 | 1,500 |
| Communal Labor Foremen | 12 | 1.25 | 2,880 |
| | | Wages | 95,070 |
| | | Fringe Benefits @ 5% | 4,750 |
| | | Payroll | 99,820 |
| | | GRAND TOTAL PAYROLL | Le. 181,460 |
| | | | $ 157,790 |

Source: Consultants evaluation of data furnished by CARE

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EQUIPMENT MAINTENANCE LABOR
ESTIMATED AVERAGE ANNUAL PAYROLL COSTS TO CARE
(In Constant 1977 Prices)

| Position | No. | Daily Rate (in Leones) | Annual Wage (in Leones) |
|---|---|---|---|
| Bo Shop Foreman | 1 | 54.50 | 17,000 |
| Asst. Shop Foreman | 1 | 5.77 | 1,800 |
| Head Fitter | 1 | 4.66 | 1,455 |
| Mechanical Engr. | 1 | 5.77 | 1,800 |
| Fitters | 16 | 3.50 | 17,470 |
| Apprentice Fitters | 6 | 1.60 | 2,995 |
| Welders | 3 | 3.10 | 2,900 |
| Auto Electricians | 2 | 3.20 | 1,995 |
| Apprentice Welders | 1 | 1.50 | 470 |
| Lathe Turners | 2 | 2.10 | 1,310 |
| Panel Beater | 1 | 2.50 | 780 |
| Tiremen | 2 | 1.80 | 1,123 |
| Greasers | 4 | 1.30 | 1,162 |
| Fuel Clerks | 2 | 2.50 | 1,560 |
| Storekeeper | 1 | 1.50 | 470 |
| Laborers | 2 | 1.22 | 760 |

| | |
|---|---|
| Wages | 55,550 Le |
| + Fringe Benefits @ 15% | 8,330 |
| Payroll | 63,880 Le |
| | $55,550 |

Source: Consultants evaluation of data furnished by CARE

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TABLE 4.5

MANAGEMENT, DESIGN, CONSTRUCTION SUPERVISION
AND ADMINISTRATION - LOCAL PERSONNEL

Estimated Average Annual Payroll Costs to CARE[1]
(In Constant 1977 Prices)

| Position Title | No. | Daily Rate[2] (In Leones) | Annual Wages (In Leones) |
|---|---|---|---|
| Project Manager | 1 | 40.20 | 12,340 |
| Asst. Project Mgr. | 1 | 33.07 | 10,320 |
| Struct. Engineer | 1 | 20.58 | 6,420 |
| Site Engineers | 5 | 12.82 | 20,000 |
| Surveyors | 2 | 4.20 | 2,620 |
| Asst. Surveyor | 1 | 3.10 | 965 |
| Draftsman | 1 | 6.35 | 1,980 |
| Chainmen | 4 | 1.30 | 1,620 |
| Program Assistant | 1 | 5.77 | 1,800 |
| Accountant | 1 | 7.62 | 2,375 |
| Secretary | 1 | 3.50 | 1,090 |
| Typist | 1 | 2.75 | 860 |
| Paymaster | 1 | 7.62 | 2,375 |
| Cost Clerk | 1 | 3.85 | 1,200 |
| Junior Clerk | 1 | 1.45 | 450 |
| Delivery Clerk | 1 | 1.65 | 515 |
| Timekeeper | 1 | 2.20 | 685 |
| Storekeepers | 3 | 3.10 | 2,900 |
| Storehand | 1 | 1.26 | 385 |
| Office Messenger | 1 | 1.30 | 405 |
| Watchman | 1 | 1.20 | 375 |
| Drivers | 6 | 1.90 | 3,555 |
| | Design & Management | | 75,435 |
| | Freetown Office Back-up[3] | | 13,200 |
| | | Wages | 88,635 |
| | | Fringe Benefits @ 15% | 13,295 |
| | | Total Payroll | 101,930 Le |
| | | | $88,635 |

(1) Except as noted, all personnel are located at Project Site

(2) Bush allowances included in daily rate

(3) Bookkeeping allocation by CARE to Project of entire local payroll costs of Freetown office

TABLE 4.6

U.S. AND 3rd COUNTRY NATIONALS IN SIERRA LEONE
ESTIMATED AVERAGE ANNUAL COSTS TO CARE
(In Constant 1977 Prices)

(In U.S. Dollars)

| | U.S. Nationals | | 3rd Country | All |
|---|---|---|---|---|
| | CARE[1] Staff | Peace Corps | V.S.O. (United Kingdom) | Foreign Nationals |
| Payroll | $104,690 | - | - | 104,690 |
| Int'l Travel[2] | 19,000 | - | - | 19,000 |
| Location Allowance[3] | 16,510 | - | | 16,510 |
| Staff House Rental | - | 2,500 | 2,500 | 5,000 |
| On Job Transportation | 3,000 | 4,000 | 4,000 | 11,000 |
| Site Subsistence | 12,900 | - | 12,000 | 24,900 |
| GRAND TOTAL | $156,100 | $6,500 | $18,500 | $181,100 |
| (LEONES) | 179,400 Le | 2,475 Le | 21,275 Le | 208,265 Le |

(1) Portion of all CARE staff costs in Sierra Leone allocated to Project

(2) Includes movement of personal effects, R and R allowance, allocated portion of mobilization/demobilization travel

(3) Includes special allowances for education and housing

Source: Consultants evaluation of data furnished by CARE

Costs were estimated from internal book-keeping records of CARE. The costs are considered constant over the three year construction period.

### 4.5.3 ALLOCATED OVERHEAD

The breakdown between main office (New York) and Sierra Leone overhead costs is shown on Table 4.7. New York overhead is established by audit and includes payroll. The values shown on the table are the Consultant's estimates. Consistent with the personnel costs, the overhead costs are considered constant over the three year construction period.

### 4.5.4 ANNUAL OPERATING EXPENDITURES

These are expenditures by CARE, exclusive of personnel and equipment for: fuel and oil, maintenance shop equipment, construction materials, and spare parts. Estimates were prepared on the basis of a detailed analysis of available records of past costs and adjusted to reflect anticipated conditions. An inspection was also made of invoices selected at random. Available information was not adequate to allow disaggregation into construction units (e.g., pipes, headwalls, excavation, etc.) or fuel consumption by equipment type.

Annual operating expenditures for each of the three construction seasons are shown on Table 4.8. Expenditures reflect equipment use and construction targets.

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TABLE 4.7

ALLOCATED OVERHEAD COSTS
SIERRA LEONE AND U.S.A.
(In Constant 1977 Values)

(In U.S. Dollars)

| | |
|---|---|
| CARE OFFICE NEW YORK - | |
| Backup & Overhead - | 75,000 |
| FREETOWN OFFICE, SIERRA LEONE | |
| Supplies | 8,000 |
| Postage & Cable | 2,500 |
| Electricity | 13,500 |
| Transportation | 3,000 |
| Audit, Legal, Insurance | 17,500 |
| Miscellaneous | 8,500 |
| TOTAL SIERRA LEONE | 53,000 |
| TOTAL ALLOCATED OVERHEAD | $128,000 |
| (In Leones) | 147,200 Le |

Source: Consultants evaluation of data furnished by CARE

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TABLE 4.8

ANNUAL OPERATING EXPENDITURES BY CARE
EXCLUSIVE OF PERSONNEL AND EQUIPMENT
(In Constant 1977 Values)

| | (In U.S. Dollars) | | |
|---|---|---|---|
| | Construction Season | | |
| | 1st | 2nd | 3rd |
| Fuel and Oil | 290,000 | 390,000 | 390,000 |
| Maintenance Shop Equipment | 15,000 | 25,000 | 15,000 |
| Construction Materials | 270,000 | 405,000 | 405,000 |
| Spare Parts | 184,000 | 445,000 | 249,000 |
| ANNUAL TOTAL | $759,000 | $1,265,000 | $1,059,000 |
| (In Leones) | 872,850 Le | 1,454,750 Le | 1,217,850 Le |

Source: Consultants evaluation of data furnished by CARE

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### 4.5.5 EQUIPMENT

Table 4.9 shows the book value, depreciation schedule and capitalized cost of equipment on hand from the work under the first OPG. Table 4.10 shows similar data for the equipment to be purchased under the second OPG. Estimated equipment life is also shown.

Value of the equipment at time of acquisition was furnished by CARE. Equipment life is based on the Consultant's projections and varies to reflect condition at time of acquisition.

Tables 4.9 and 4.10 also show equipment costs in financial and economic terms. Only the original cost to CARE of equipment acquisition is a cash out-flow - financial costs are not. Depreciation on equipment donated to CARE is shown as a financial cost because this is considered part of CARE's contribution to the project.

### 4.5.6 DONATIONS OF LABOR AND MATERIAL

The monetary value of these donations forms part of the economic costs of the project. These costs, shown on Table 4.11 are considered constant over the life of the project.

### 4.5.7 SUMMARY BY CONSTRUCTION SEASON

Table 4.12 is a summation of the estimate breakdowns of Tables 4.3 through 4.11. Also shown are the adjustments to convert financial costs to economic costs.

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TABLE 4.9

BOOK VALUE AND DEPRECIATION SCHEDULE
OF EQUIPMENT ON HAND FROM FIRST OPG

I. BOOK VALUE OF EQUIPMENT (In U.S. Dollars)

| | | |
|---|---|---|
| A. | Estimated value of used equipment on hand prior to start of work under first OPG | $420,000* |
| B. | Estimated value of equipment donated during course of first OPG | $400,000* |
| C. | Equipment purchased during course of first OPG | $346,000* |
| D. | Depreciation (straight line)<br>3 year life equipment on hand<br>4 year life donated equipment<br>5 year life purchased equipment | $430,000 |
| E. | Book value of equipment on hand prior to start of second OPG | $736,000 |

*Cost data furnished by CARE

II. DEPRECIATION SCHEDULE (In U.S. Dollars)

| | Construction Season | | |
|---|---|---|---|
| | 1st | 2nd | 3rd |
| Book Value at Start | 736,000 | 394,000 | 192,000 |
| Straight Line Depreciation | 342,000 | 202,000 | 69,000 |
| Book Value at End | 394,000 | 192,000 | 123,000** |

**Salvage value

III. CAPITALIZED COST (In U.S. Dollars)

| | Construction Season | | |
|---|---|---|---|
| | 1st | 2nd | 3rd |
| Depreciation | 342,000 | 202,000 | 69,000 |
| Interest @ 10% | 74,000 | 39,000 | 19,000 |
| | 416,000 | 241,000 | 85,000 |

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TABLE 4.10

BOOK VALUE AND DEPRECIATION SCHEDULE
EQUIPMENT TO BE PURCHASED UNDER SECOND OPG

I. Estimated Purchase Price $1,833,000
(Cost data furnished by CARE)

II. Depreciation (Straight Line) 367,000 annually
5 year life

III. Depreciation Schedule

| | Construction Season | | |
|---|---|---|---|
| | 1st | 2nd | 3rd |
| | (in thousands of dollars) | | |
| Book Value at Start | 1,833 | 1,466 | 1,099 |
| Straight Line Depreciation | 367 | 367 | 367 |
| Book Value at End | 1,466 | 1,099 | 732* |

*Salvage Value

IV. Capitalized Cost (In U.S. Dollars)

| | Construction Season | | |
|---|---|---|---|
| | 1st | 2nd | 3rd |
| | (in thousands of dollars) | | |
| Depreciation | 367 | 367 | 367 |
| Interest @ 10% | 183 | 147 | 110 |
| | 550 | 514 | 477 |

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TABLE 4.11

DONATIONS OF LABOR AND MATERIAL
AVERAGE ANNUAL VALUE

Kind and Value of Donations
(In U.S. Dollars)

| | | | |
|---|---|---|---|
| **U.S.A. and 3rd Country Personnel** | | | |
| Peace Corps (USA) | 7 people @ $10,000 per annum | = | $ 70,000 |
| V.S.O. (United Kingdom) | 6 people @ 2,500 per annum | = | 15,000 |
| Total Volunteer Personnel | | | $ 85,000 |
| **Communal Labor - Voluntary & Non-Paid** | | | |
| 200 tribesmen per day corresponding to payroll rate of 1.28 Leones per day for 192 days per year | | | $ 42,700 |
| **Construction Materials Furnished by GOSL** | | | |
| Aggregate from abandoned railway | | | $ 15,700 |
| | | | $143,400 |

Source: Consultants evaluation of data furnished by CARE

TABLE 4.12
OUT-OF-POCKET, FINANCIAL AND ECONOMIC COSTS
SUMMARY BY CONSTRUCTION SEASON
(In Constant 1977 U.S. Dollars)

| | Construction Season 1st | 2nd | 3rd | Total |
|---|---|---|---|---|
| Local Personnel | | | | |
| Construction Labor | 157,790 | 157,790 | 157,790 | 473,370 |
| Equipment Maintenance Labor | 55,550 | 55,550 | 55,550 | 166,650 |
| Mgmt., Des., Const. Supv., Admin. | 88,640 | 88,640 | 88,640 | 265,920 |
| Subtotal | 301,980 | 301,980 | 301,980 | 905,940 |
| Foreign Personnel | 181,100 | 181,100 | 181,100 | 543,300 |
| Allocated Overhead | 128,000 | 128,000 | 128,000 | 384,000 |
| Operating Expenditures | 759,000 | 1,265,000 | 1,059,000 | 3,083,000 |
| Subtotal | 1,068,100 | 1,574,100 | 1,368,000 | 4,010,300 |
| Total Out-of-Pocket to CARE Exclusive of Equipment Purchase | 1,370,080 | 1,876,080 | 1,670,080 | 4,916,240 |
| Equipment Depreciation | | | | |
| On Hand from First OPG | 342,000 | 202,000 | 69,000 | 613,000 |
| Purchased in Second OPG | 367,000 | 367,000 | 367,000 | 1,101,000 |
| Subtotal | 709,000 | 569,000 | 436,000 | 1,714,000 |
| Financial Cost of Construction | 2,079,080 | 2,445,080 | 2,106,080 | 6,630,240 |
| Adjustment for Economic Cost | | | | |
| Interest | 441,000 | 406,000 | 386,000 | 1,233,000 |
| Donations | 143,400 | 143,400 | 143,400 | 430,200 |
| Subtotal | 584,400 | 549,400 | 529,400 | 1,663,200 |
| ECONOMIC COST OF CONSTRUCTION | 2,663,480 | 2,994,480 | 2,635,480 | 8,293,440 |

Source: Tables 4.3 through 4.11

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# 5.0
# MAINTENANCE

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# 5.0

# MAINTENANCE

## 5.1 PROPOSED MAINTENANCE PROCEDURES AND ORGANIZATION

A very comprehensive document on the maintenance requirements for the rural feeder roads constructed by CARE has been prepared and presented as annex G to the OPG proposal submitted to A.I.D. on July 29, 1977. This paper follows norms outlined in standard works on the subject of rural highway maintenance but is augmented by the authors, to reflect special conditions of Sierra Leone. The paper is a complete guide for supervisory and field operating personnel. It gives detailed step by step instructions for maintenance procedures for slopes, roadway surfaces, drainage structures, bridges and right of way. Particular attention is given to distinguishing between work required on newly constructed roads and roads that have been in operation for some time.

The guiding principle of the plan, is for the primary, or manual part of the work to be performed by people living in the vicinity of the sector to be maintained . The laborers will be supported by equipment such as graders, dump trucks and loaders. To this end, CARE is undertaking to train personnel in maintenance procedures. The personnel, after training will supervise the work of laborers hired, or hopefully, volunteering to work along their assigned sector of the right of way.

If volunteer labor can be provided in a viable, and ongoing manner - then of course, operating costs will be reduced

considerably. However until the system has been tried and proven, no budget should be predicated upon the availability of such labor.

It is planned that the trained maintenance personnel will make continuous inspections and supervise labor in the day to day upkeep of the right of way in surfacing, slopes, ditches and culverts, and all aspects of maintenance that can be done with hand tools. It is also planned that there will be at least semi-annual inspections of structures by engineers or qualified technicians. The plan includes a complete checklist of all items to be inspected.

## 5.2 GOSL MAINTENANCE ABILITY

On roads constructed prior to June 30, 1977 there has been only haphazard maintenance by the MOW regular forces. For that matter, some roads are showing signs of failure due to neglect. All of the roads constructed and operative that were inspected by the Consultants showed signs of neglect, mostly in work that could have been done manually, such as opening ditches and culverts and preventing the encroachment of vegetation on the roadbed. This work could have been performed by communal labor, or MOW employees at very low cost.

Since the GOSL will not be prepared by the end of FY 1978 to undertake a maintenance program, CARE has set up a program and budget for maintenance for the FY 78/79. The general plan for maintenance input by both CARE and the MOW for the two year period is outlined on pages 11 thru 13 in Annex G of the O P G proposal. This plan is complete, and in the opinion of the consultants, rational

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and practical. The only area of uncertainity being in the manner of implementation - all government departments as well as CARE must cooperate or the plan will fail - and the roads will fail shortly thereafter.

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# 6.0
# SUB-PROJECT SELECTION

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# 6.0

# SUB-PROJECT SELECTION

## 6.1 BACKGROUND

The roads that were built under this project in the first OPG and proposed for the second OPG, were chosen by a Selection Committee composed of officials of the Government of Sierra Leone and representatives of CARE. The GOSL representatives were almost equally divided between officials serving with various ministries of Freetown and those resident in the project area.

One of the major accomplishments of the Selection Committee was their insistence that all rural roads constructed by CARE were to have a visible relation to completed on-going or planned IADP activities.

Considering the almost complete absence of a functioning rural road system in the IADP area and the dependence of many IADP activities upon reliable transport any rational system of road selection based on accepted development criteria would result in economically efficient projects. This was the case for the roads constructed by CARE to date.

As road density increases and/or more road sub-projects compete for limited funds, it becomes vital that quantative methods be used to select rural roads for construction or rehabilitation. This, in turn, means that some form of an economic appraisal of possible construction or rehabilitation rural road sub-projects be made an integral part of the selection process.

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Following portions of this section contain recommendations for sub-project selection together with the theoretical basis of selection procedures.

## 6.2 CONCEPTUAL APPROACH TO RURAL ROAD SELECTION

Proposed investments in additions to the existing rural road network are intended to serve, support and stimulate both agricultural and social development. Stated in more formal terms the proposed rural road investments are intended to maximize total welfare. In the context of this project this specifically means that in the process of sub-project selection potential distributive and merit effects (social-equity considerations) of a proposed rural road are to be considered together with the potential economic efficiency (productivity and income increases) of the necessary investment.

### 6.2.1 Selection Process

The selection process of a rural road for construction or rehabilitation may be realistically viewed as a four-step process

Step 1--Nomination of roads for inclusion in program

Step 2--Screening to insure conformance with service and functional criteria

Step 3--Economic appraisal of alternate sub-projects

Step 4--Select sub-project and construct

The remainder of this will be devoted to a discussion of Steps 2 and 3. Step 1 is obviously and rightfully dependent upon local political institutions and practices and is thus almost completely independent of AID and CARE.

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### 6.2.2 Screening

To qualify for inclusion a proposed construction or rehabilitation sub-project must meet either or both of the following functional criteria:

> Link one or more villages directly to either an existing road under the maintenance responsibility of the MOW or to a market town.
>
> Connect an all-weather road, useable year-round by trucks and vans, and now serving one or more villages or a market town to another all-weather road.

In addition the proposed sub-project must meet the following service criteria for inclusion:

- Be at least five miles away from the closest parallel road.
- Be at least five miles in length
- Serve a completed, on-going or planned IADP activity.

In the event that roads less than five miles are to be considered for inclusion, they must meet one or more of the following additional criteria:

> Connect a market town or collection center to an all-weather road, useable year-round by trucks or vans.

- Link two otherwise disjointed rural road segments.

- Connect an area isolated by topographical features to an all-weather road.

- Be the first stage of an on-going - i.e., two or three construction season - program.

## 6.3 ECONOMIC APPRAISAL

Cost-benefit analysis is the generic name applied to a broad and continually evolving set of techniques for appraising choices among possible public investments. Though the kinds of investment choices, and to a lesser extent public investment projects, can be readily categorized (e.g., is the particular project or group of projects worthwhile - is the project concerned with fertilizer production or rural education), the cost-benefit appraisal techniques do not usually fit into distinct and easily definable classifications.

The appraisal techniques all proceed on the explicit basis that:

- Costs and benefits are regarded as synonyms for disadvantages and advantages, respectively.

- A project is deemed worthwhile if its benefits to society as a whole exceed the costs it generates.

- All costs and benefits are identified in a social rather than private context, and are evaluated at prices that reflect social rather than private

valuations of welfare.

- There is a distinct time profile of benefits and costs corresponding to each of the projects under study.

- Costs and benefits in future years are discounted to make them commensurate with present costs and benefits, and

- The social discount rate may differ from the private discount rate.

In theory cost-benefit analysis attempts to enumerate all costs and benefits resulting from a particular project whether they are incurred by or accrue to the investing agency or not; the intent is to determine the effect on society as a whole. In practice, enumeration is usually limited to those costs and benefits which can be readily quantified and the benefits (and quite often costs) relating to distributive and merit effects, employment opportunities, availability of medical services, etc. are ignored.

Reconciliation between theory and practice has been of little importance in the appraisal of most road investment projects in the past. These investments were almost all concentrated on improving existing roads or constructing roads to satisfy transport demands not on roads to encourage the development of rural areas. Social equity effects were minor as development had already occurred and the road investments were intended to reduce the operating costs of the traffic generated by this development. The savings in running and time costs accounted for almost all of the

possible benefits and extensive methodologies were designed for their quantification.

Other methods have been developed which estimate benefits by measuring differences in income before and after road investments. Unfortunately most of these methods ignore the complementary investments required to attain these productivity increases and/or ignore the mechanisms by which these complementary investments lead to an increase in production. However, these methods provide a basis for development of a technique - the value added approach - which can estimate the economic efficiency of a proposed rural road investment.

Unfortunately severe procedural difficulties are still attached to the enumeration and valuation of distributive and merit effects precluding the development of an appraisal technique comparable in accuracy to the value added approach.

## 6.4 VALUE ADDED APPROACH

The underlying concept of the value added approach is that the benefits of rural road construction can be measured as the difference between the net incomes of the "with rural road" and "without rural road" conditions. Income measurements on this basis will reflect benefits if the following holds true:

- The same level and mix of investments to increase agricultural productivity will be available for both the "with" and "without" project conditions; the differences between the two conditions will be

the rate at which these investments are applied.

- No additional investments outside of those planned or in progress will be needed to support the productivity programs.

- There will be no income or cash-flow restrictions preventing farmers from purchasing modern inputs.

- Transport cost savings between the "with" and "without" conditions will be negligible in comparison with productivity benefits.

- Exogeneous influences outside of those related to rural road construction will be the same for both conditions.

- Neither the "with" or "without" conditions will cause external diseconomies.

Computations of net income are to be made for each year of the analysis period for both the "with" and "without" rural road construction conditions. Net income will be the total of the gross revenues received from the sale of all crops with a marketable surplus less the production costs (labor, inputs, transport, etc.) of these crops. Marketable surplus for each crop will be the total yield less local and auto-consumption. Computations can be further simplified by only estimating incremental productivity increases and production costs between the "with" and "without" conditions.

The procedures for determining the benefits is essentially that of computing the incremental increases in net income attributable to the rural road. This can be done by:

1. Estimating for each year of the analysis period for both the "with" and "without" conditions:

   - Population
   - Acres sown and yield of each crop
   - Local and auto-consumption of each crop
   - Production costs of each crop
   - Ex-farm prices of each crop

2. Determining the marketable surplus of each crop for each year of the analysis period; the marketable surplus will be the total yield less local and auto-consumption.

## 6.5 DISTRIBUTIVE AND MERIT EFFECTS

In the case of investments intended to maximize both economic and social welfare strong arguments have been presented in recent literature to demonstrate that distributive and merit effects are at least as important as economic efficiency in project appraisal. The rationa for the detailed consideration of distribution and merit effects is based on the following propositions:

> The marginal utility of a monetary gain or less differs for each specified income group. As a consequence, the lower the income group the higher the marginal utility of a monetary gain or loss.
>
> The effect of any one project on the distribution of income among its beneficiaries is consequential

and cannot be disregarded.

- The benefit of such merit goods as better health, improved education, expanded communication, etc., should be measured.

In practice this means that two sub-projects may have vastly different distributive and merit effects because the composition of the rural population groups to which the benefits accrue, and the needs of these groups may be quite different in each case. A project with less economic efficiency may actually be the most desirable because of its contribution toward an equitable distribution of income or opportunities. Therefore the appraisal techniques should select the sub-projects that are both economically efficient and advance social-equity. Ideally, techniques should be developed that integrate efficiency and sodial-equity considerations - that is, both should be valued in commensurable terms so that sacrifices in one could be compared with improvements in the other.

## 6.6 SERVICE AREA

In order to determine the benefits and costs associated with a proposal rural road project either in terms of relative rank-ordering procedures or in absolute values a determination of the boundaries of the area affected by the road must be made. This presupposes that beyond some invisible line the proposed project has no impact or conversely another road has no impact in the area affected. While this might not be valid reasoning for a major transport route it is reasonable and logical for a rural road in a farming area.

The opening of a new road or the upgrading of an existing road affects established patterns of land use, economic activity and population distribution in the geographic areas surrounding the road. The spatial extent of the area influenced by the road will radically vary from one road to another, depending mainly on the roads new or altered function in the transport system network and changes in trip frequency, type and length. The geographic boundaries in the area influenced also can, for a particular road, show a marked expansion or contraction over time.

The term Service Area as used is thus defined as a bounded geographical area, of predominatly agricultural activity, influenced impacted and/or affected by a proposed rural road project. Similarly this definition can be applied to an existing rural road which is near a proposed project to determine its Service Areas with and without the proposed rural road.

The determination of the boundaries of the Service Area can be made from either the view point of out-of-pocket transport costs or from the viewpoint of perceived or subjective transport costs. These boundaries will vary for each crop produced. Transport costs which include loading and unloading from farm to market can have as many as five components for each crop. These would be the same for both out-of-pocket or perceived costs.

- Loading costs at the farm
- Transport costs from the farm to the road
- Transfer costs (unloading and loading) from off-road

transport to road transport.

- Transport costs from the road to the market

- Unloading costs at the market

If the total of these costs plus the production costs to the farmer for a particular crop is greater by some amount 'P' than the revenue from sales at farm-gate prices and the farmer finds some limiting value of the loss 'P' acceptable to him then the farmer will continue to raise this crop for sale. 'P' can be expressed either in terms of money or in terms of time, labor and discomfort expenditures. It is assumed that the farmer will continue to produce and sell the particular crop if the total of production and transport costs is less than or equal to the revenues he received. ("P" is negative or zero).

The only transport cost components that will vary with his distance from the road are the transport costs (including subjective costs) from the farm to the road. Of course if the farmer is near the road his off-road costs will be limited to loading. If the off-road transport component is the major transport cost variable then the decision to produce or not is a function of distance from the road. In turn the maximum limit of the Service Area for this particular crop would be the distance which leaves the value "P" at an acceptable level to the farmer. The Service Area limits would vary with each crop because production costs and farmgate prices would change depending upon the crop.

The length of the off-road trip is also effected by the perceived or subjective cost of the trip - the discomfort labor and time expenditures of the farmer. Field surveys, investigations and discussions with GOSL officials have brought out that a three-hour walk in each direction is acceptable for a special errands such as health center or government office visits. This allows the farmer to leave home, perform his business and return home before nightfall. The setting of the three hour limit presupposes that once the farmer reaches the proposed road with his marketable surplus he will transfer the load to a truck. Furthermore, it presupposes that the time the truck takes to go to market, with or without the farmer, has no influence upon the farmer's cost evaluations.

Accordingly the maximum boundaries of the Service Area will be located three hours walking distance away from the road. This will be the same for any crop. If the proposed road is parallel to an existing road then the Service Area boundary will be midway, in terms of time between the two roads. If the proposed project forms a 'T' or skew connections with an existing road than that portion of the Service Area of the existing road that is closer, in terms of time, to the proposed road will be in the new Service Area.

This means the length of new road construction can vary by cropping pattern. Except however for special cases (Sec. 6.2.2) minimum length of new construction should be five miles.