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PD-AAF-244-A1

CENTRAL & WEST AFRICA REGIONAL

LAKE CHAD BASIN

FY 78-80

PUBLIC SAFETY ADMINISTRATION PROJECTS (700 PURPOSE CODES)

NO ABSTRACT ENTERED IN THE DIS SYSTEM

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PD-AAF-244-B1

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DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D.C. 20523

Proposal and Recommendations
For Review and Approval of the
Assistant Administrator for Africa

AFRICA REGIONAL: LAKE CHAD BASIN TELECOMMUNICATIONS GRANT - File

625-11-995.501

AID-AFR/GP-2

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SUMMARY AND RECOMMENDATIONS

1. Applicant: The Lake Chad Basin Commission, an international organization established in 1964 by convention between the Governments of Nigeria, Chad, Niger and Cameroon.

2. Amount: $50,000.

3. Total Cost of Activity:

$550,000	A.I.D. Grant (Foreign Exchange Costs)
15,000	Local Currency Contribution, Government of Chad
30,000	Local Currency Contribution, Government of Cameroon
30,000	Local Currency Contribution, Government of Nigeria
Total $625,000	

4. Description of Activity: To establish a reliable telecommunications link providing telephone, telegraph, and telex service connecting Fort Lamy (Chad), Fort Foureau (Cameroon), and Maiduguri (Nigeria).

5. Purpose of Grant: To finance the foreign exchange costs of (a) U.S. engineering services to prepare the design and bid documents, (b) U.S. equipment and its installation in the three countries, and (c) engineering supervision of the installation by U.S. engineers.

6. Background of Activity: This project is in fulfillment of a request by the Lake Chad Basin Commission acting for three member governments to establish direct, reliable telecommunications circuits among the three cities and thereby provide a link among the internal telecommunications systems of the three countries.

7. Economic Feasibility: The project is economically feasible. On a conservative basis, an internal rate of return of 10% is projected for the project.

8. Country Team Views: The AID Area Development Office in Yaounde and the country teams in Chad, Cameroon and Nigeria have recommended approval of the grant.

9. Statutory Criteria: Satisfied. See Annex B.

10. Issues: None.

11. Recommendations: Authorization of a grant not to exceed $550,000 in two parts: (1) authorization of $50,000 in FY 1971 for engineering services and (2) authorization of the remaining $500,000 in early FY 1972.

CAPITAL ASSISTANCE COMMITTEE MEMBERS:

Capital Development Officer: Richard S. Greene
Counsel: Arthur Fell
Engineer: Samuel Lubin
Desk Officer: Dianne Metzger

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AFRICA REGIONAL - LAKE CHAD BASIN TELECOMMUNICATIONS PROJECT

SECTION I: BACKGROUND

A. General Project Definition

This project consists of the establishment of a reliable telecommunications link providing telephone, telegraph, and telex service connecting Fort Lamy (Chad), Fort Foureau (Cameroon), and Maiduguri (Nigeria) and thereby permitting access from numerous points of each country to points in the other countries through the existing and future telecommunications facilities in each country. The project will also provide access for Chad via the existing and future facilities in Nigeria and Cameroon to international and intercontinental circuits.

The link will be established by means of a multipair telephone cable connecting the main telephone exchange in Fort Lamy with the main exchange in Fort Foureau. The two cities are separated by the Chari River, and a portion of the connection will be by means of a submarine cable crossing. At Fort Foureau the cable will connect with a microwave link consisting of a terminal station at Fort Foureau, four repeater (relay) stations and a terminal station at Maiduguri. Although the exact locations of the repeater stations can only be determined during the detailed engineering design of the project, preliminary investigations place two of the repeaters in Cameroon and two in Nigeria.

Fort Foureau is the terminus of a Cameroon microwave system extending northward from Yaounde now being constructed under an Export-Import Bank loan by an American contractor. The connection of the present project at Fort Foureau will therefore provide access from Maiduguri and Fort Lamy to all points of the Cameroon telecommunications system and through it to points beyond in Africa and other continents. Maiduguri is the northeastern terminus of the Nigerian telecommunications trunk system being constructed under Step III of Nigeria's Telecommunications Improvement Plan. Financing for the construction is provided by the U.K. and Canada, and engineering design and surveillance of construction is funded by A.I.D. Loan 620-H-008. The present project's connection at Maiduguri thus provides both Cameroon and Chad access to the Nigerian telecommunications system and to the satellite earth station under construction by an American contractor near Lagos with funding by the Export-Import Bank.

B. Historical Development of the Project

In 1967 the then U.S. Ambassador to Chad reported on the inadequacy of Chad's telecommunication links with the outside world and particularly with its neighbors, Cameroon and Nigeria. He relayed an informal request from the Chad Government for U.S. assistance in the improvement of Chad's international circuits. In 1969 an official request was received from the Lake Chad Basin Commission for AID assistance. AID then contracted with the firm of Morcom, Inc. of Washington, D. C. to study the feasibility

of establishing a link from Fort Lamy (Chad) to Fort Foureau (Cameroon) and a second link from Fort Lamy to Maiduguri (Nigeria). These were envisioned as separate links providing direct communication between Fort Lamy and two points with which there was a community of interest because of the flow of trade between them.

By the time the study was set in motion the Government of Cameroon had contracted for the construction of a backbone microwave system extending from Yaounde to Fort Foureau, financed by Ex-Im funds and Nigeria had contracted for a microwave, ultra-high frequency (UHF) and very-high frequency (VHF) countrywide system, one of whose branches terminates at Maiduguri. The consultant, therefore, in his report of September, 1969, recommended that Fort Lamy be linked to the two terminals, Fort Foureau and Maiduguri, by a single link so that the entire Chad telecommunications system could, via Fort Lamy, reach any point in Cameroon and Nigeria and via the international facilities of those two countries, practically any point on the globe.

The above objective could be realized in a number of ways. The two most practical methods from engineering and economic considerations were found to be:

1. A cable river crossing from Fort Foureau to Fort Lamy where the circuit would tie into a transhorizon (troposcatter) radio link direct to Maiduguri. With this system, calls from Fort Foureau to Maiduguri would go via the cable to Fort Lamy and then via radio to Maiduguri. This system which is the lowest in first cost and in maintenance and operation expense has the disadvantage of not permitting direct connections to points along the way between Fort Foureau or Fort Lamy and Maiduguri if the need for such service develops in the future.

2. A cable river crossing from Fort Lamy to Fort Foureau where the circuit would tie into a microwave chain to Maiduguri. Four intermediate repeater (relay) stations would be required between Fort Foureau and Maiduguri which are about 140 miles apart. While this system would be somewhat more expensive to install and maintain than the single transhorizon radio link it has the advantage of being able to provide drop-off service at each of the four intermediate relay points if traffic developed in the future. The microwave system has the further advantage of being easily expandible in circuit capacity at lower cost than similar expansion for the transhorizon system.

The relative advantages and disadvantages of the two systems were weighed and considered by the Lake Chad Basin Commission and the microwave plus cable system was selected. AID reviewed the Commission's arguments and agreed in favor of its choice.

C. The Grantee

The Lake Chad Basin Commission (LCBC) is an international organization established in 1964 by convention between the Governments of Nigeria, Chad, Cameroon and Niger. Its purpose is to recommend plans for surveys, research and other economic development activities in the Lake Chad Basin

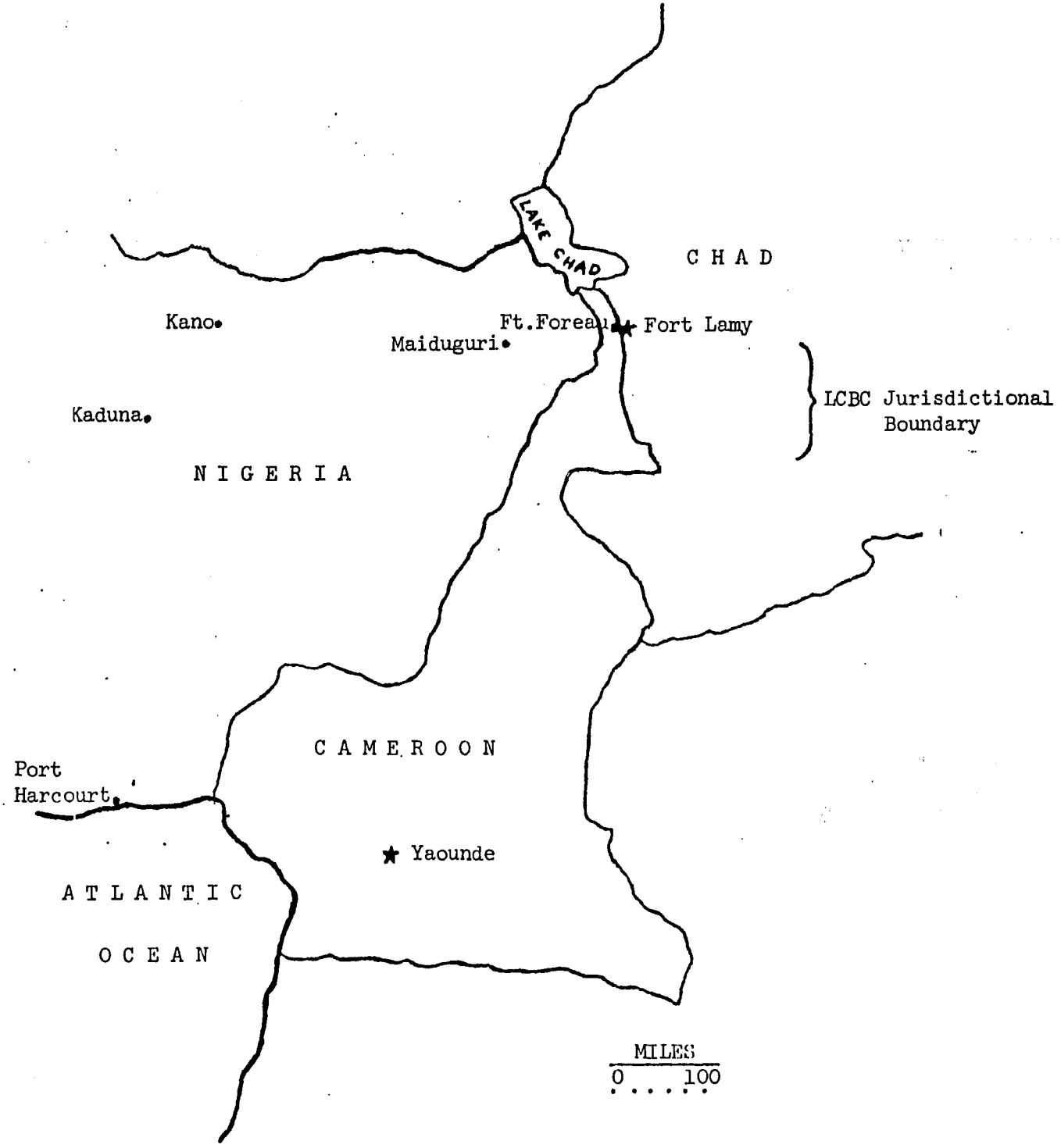
area. It has promoted Lake Chad fish production and has coordinated area studies for improved transport, telecommunications and agriculture.

Two Commissioners from each member state meet twice a year, together with the Executive Secretary, permanent secretariat and technical subcommittees, to plan and implement Commission projects.

AID has supported the LCBC as an active and useful regional organization. It has been agreed that the Commission will be the grantee and will sponsor the project in order to simplify project implementation and coordination. All grant dollar funds will be paid by AID directly to the U.S. engineer and equipment supplier to cover foreign exchange costs, while the LCBC will be responsible for obtaining small local currency contributions from the beneficiary countries to cover local costs of the project. Prior agreement by beneficiary states to provide such local currency and other project support will be a condition of the AID grant.

MAIDUGURI -- FT. FOREAU -- FT. LAMY TELECOM LINK

Sketch Showing Project Area and Area Subject to LCBC Jurisdiction



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SECTION II: ENGINEERING ANALYSIS

A. Existing Regional Telecommunications Facilities

There is no direct circuit in existence today to connect the three cities included in the present project. France Cable and Radio Company, a French entity partly owned by the French Government, operates a high frequency (HF) radio circuit between Fort Lamy and Douala (Cameroon). Another HF circuit between Fort Lamy and Lagos was planned by France Cable and Radio but was never implemented. All traffic between Fort Lamy and Lagos is now routed via Paris and London. An HF telegraph link also operates between Fort Lamy and Kano (Nigeria) with messages relayed from Kano to Maiduguri. No telephone circuit exists between Fort Lamy and Maiduguri. Although some 50,000 tons of freight are annually shipped by truck from the railhead at Maiduguri to Fort Lamy, the only present means of reliable communication by the shipping firms is by written message sent via the truck drivers. A single pair cable at one time provided service between Fort Lamy and Fort Foureau, but the circuit never functioned effectively, and when the submarine cable broke and was lost, it was never replaced so that, although these two cities are separated only by the Chari River, there is no direct telephone contact between them.

There is, at present, no direct telecommunications link between Cameroon and Nigeria, although a microwave link was planned between Douala (Cameroon) and Calabar (Nigeria) prior to the Nigerian war.

B. The Proposed Project

The project consists of establishing a reliable telecommunications link providing, initially, 12 voice channels and capable of future expansion as required, to interconnect the Chad, Cameroon, and Nigerian telecommunications systems through terminals located at Fort Lamy, Fort Foureau, and Maiduguri. At Fort Lamy connection will be made to the existing telephone exchange by means of a 240 pair underground and submarine cable across the Chari River to Fort Foureau. At this point the cable will be connected to the microwave terminal of the Yaounde-Fort Foureau microwave system now under construction. From Fort Foureau the link will continue by means of a microwave chain including four unattended repeater (relay) stations - two in Cameroon and two in Nigeria - to Maiduguri where it will terminate at the terminal of the Maiduguri-Bauchi section of the Nigerian Step III backbone radio network. The microwave system will have an initial capacity of 12 voice channels and will be expandable to an ultimate capacity of 72 voice channels.

Preliminary engineering studies made by the Consultant in 1969 indicate that a narrow-band 2000 MHz system utilizing solid state equipment would be suitable. The microwave chain will follow substantially the route of

the existing Maiduguri-Fort Lamy road and the preliminary study identified the most probably locations of the four repeater stations as:

1. Afade (Cameroon) about 3 miles from Fort Foureau.

2. Fotokol (Cameroon), located on the border with Nigeria and about 32 miles from Afade. Fotokol is also adjacent to the Nigerian town of Gamboru, across the El Beid River.

3. Dikwa (Nigeria), about 31 miles from Fotokol.

4. Mafa (Nigeria), about 24 miles from Dikwa and 31 miles to Maiduguri.

The repeater stations will all be of the baseband repeater type so that, although no multiplex equipment is contemplated for installation under the present project, such equipment can be easily added for local traffic at each station when the demand warrants it. A service channel (order wire) will, however, be provided at each repeater for the use of maintenance personnel or for emergency communications. Each terminal and repeater station will have dual transmitter/receiver equipment with the second equipment functioning either as a standby or in frequency diversity, depending on final engineering design considerations based on field tests of signal strength and fading.

Since the equipment is all solid state the power requirement at each station can be supplied by a storage battery kept on charge at the unattended stations by a small thermal generator. An automatic alarm will signal to both terminals any failure of equipment at the unattended repeaters.

Provision is made in the financing for spare parts for two years of normal operation and test equipment for routine maintenance and repair.

C. Technical Feasibility

The AID financed feasibility study made in 1969 by Morcom, Inc. and reported in "Chad Basin Telecommunication Study," September, 1969 and in a "Supplementary Report" of June, 1970 arrived at estimates for traffic requirements for the projected link over the period 1972 - 1980 for telephone, telegraph, and telex service. Annex A, Table I shows the breakdown of estimated traffic for each service between Chad-Cameroon, Chad-Nigeria, and Cameroon-Nigeria. The telephone traffic estimates were based on the following data:

1. 1968 data on calls over the existing HF circuit Fort Lamy/Douala.

2. Data on interurban traffic patterns in Chad and Nigeria obtained from earlier AID feasibility studies in these countries, and updated to 1968.

3. Estimated truck traffic and goods tonnage from an AID financed 1968 report on projected international road links in the area.

Similar methods were used for estimating telegraph and telex traffic, except that it was assumed that telegraph traffic would decline with the availability of more reliable telephone service and telex traffic would grow at about a 2.5 times faster rate than telephone traffic once the service became available and freight tonnage increased over the Maiduguri-Fort Lamy route.

To summarize the results of Table I, Annex A, telephone traffic over the link would rise from an initial 29,800 calls averaging 4.5 minutes each in 1972 to 63,500 in 1980; telex traffic would go from 1,900 messages of 4.5 minutes each to 10,900; telegraph messages of an average of 15 words each would decline from 50,500 to 36,900.

Channel requirements to handle the estimated traffic were calculated in accordance with recommendations of the Africa Plan (1967) of the International Radio Consultative Committee (CCIR) and the International Telephone and Telegraph Consultative Committee (CCITT) of the International Telecommunications Union (ITU). Among these recommendations is the use of a 3% "lost call" standard, meaning that during the maximum traffic or "busy hour" period not more than 3% of call attempts would result in a "busy circuit" signal. This is in contrast with the higher design standards used in Europe of 1% lost calls and 0.05% or better used in U.S. circuit design. Using these standards it was estimated that 10 voice channels plus two spare, making a total of 12 channels would be required for the through circuit Fort Lamy-Maiduguri. However, to take care of future local traffic demands between intermediate points the microwave equipment to be installed sill be capable of expansion to 72 channels by the simple addition of multiplex equipment at any of the intermediate stations, as required. The requirement for traffic between Fort Lamy and Fort Foureau, including onward traffic to other points in Cameroon requires no more than 4 channels so that the Fort Lamy-Fort Foureau cable could be limited to 20 pairs to carry the total system traffic. Since, however, this cable is partly a submarine cable under the Chari River, sufficient spares should be provided for replacement of faulty pairs and for unanticipated future growth. The incremental cost of larger cable compared to the initial cost of installation is so low that a 240 pair cable can be installed at very little more than the minimum of 50 pairs required to assure sufficient spares for the 20 channel requirement.

Before deciding on the cable plus microwave system for implementing the project, the Consultant, AID, and the Lake Chad Basin Commission's Engineering Subcommittee examined the only other technically feasible method of providing the needed facilities - a transhorizon (troposcatter) radio link direct from Fort Lamy to Maiduguri and a cable link from

Fort Lamy to Fort Foureau. This, in fact, was the system originally recommended by the Consultant on the basis of slightly lower initial cost (about $25,000 less than the proposed microwave system) and about $10,000 per year less in operating costs.

Although AID initially agreed with the Consultant's recommendation for the troposcatter system, objections were voiced and supported by good arguments by the Lake Chad Basin Commission's Engineering Subcommittee at a series of meetings held in Niamey, June 22-25, 1970. Representatives of AID and the Consultant were present at these meetings and reported on the LCBC objections. In essence, those objections which AID found valid can be summarized as follows:

1. Troposcatter is a relatively new system and not yet extensively tried in Africa.

2. Technical telecommunications maintenance personnel in Cameroon and Nigeria are unfamiliar with the system and would require extensive training in its maintenance and repair.

3. Since the internal systems under construction and terminating in Maiduguri and Fort Foureau are microwave, it would be easier for operating and maintenance personnel at these terminals to work with a microwave system connecting the two terminals.

In a more sophisticated technical environment the economic and technical advantages of the troposcatter system could outweight these arguments. A.I.D. agreed, however, that considering the technical level of maintenance and operating personnel and the unfamiliarity of the telecommunications authorities in the area with troposcatter systems, it would not be advisable to override, on strictly financial grounds, the objections presented by the LCBC. Since, also, the cost difference based on preliminary estimates was within the margin of error, there was no solid economic basis for insisting on the troposcatter solution.

SECTION III: ECONOMIC AND FINANCIAL ANALYSIS

A. The Project's Relationship to Overall Development

The project meets with AID objectives in this region of Africa in several ways. First, it answers the current emphasis on regional development - the project involves the construction of a telecommunications link into or across three countries. Moreover, the project gives support to an established regional organization, the Lake Chad Basin Commission, and will encourage future cooperation among the beneficiary countries under the aegis of the LCBC. Second, the largest part of the physical facilities required for the project will be erected in Nigeria, one of AID's major development emphasis countries. Thus, the project will serve to strengthen the Nigerian telecommunications system as well as to foster regional cooperation among the beneficiary countries. Finally, the project can be viewed as essentially one more step in a continuing multi-donor effort to construct a reliable telecommunications system across West Africa from the Ivory Coast to the Cameroon. In this sense, the project is one small part of a quickly-expanding modern telecommunications network reaching into at least nine countries in West Africa with the combined support of AID, French, U.K., Canadian and Ex-Im Bank assistance.

The three member states of the LCBC which are directly involved in this project - Nigeria, Chad and Cameroon - have, as yet, little in common in terms of trade. The mainstay of the Chadian economy, for example, is cotton, which accounts for as much as 80% of exports and goes chiefly to France. Nigeria's chief exports are petroleum, peanut products and cocoa, and its chief trading partners are Britain, The Netherlands, the U.S. and West Germany. The Cameroonians export coffee, bananas, cocoa and aluminum (produced from imported alumina). France takes almost half of the country's exports.

It is true that livestock (chiefly for food) and dried fish are sold by Chad to Nigeria, and that Nigeria is actually Chad's second biggest export customer taking about 11% of Chad's exports. However, the Chadian trade (much of which is smuggled to avoid taxation) is of negligible importance in the relatively large Nigerian foreign trade picture, while even in Chad, which has a much smaller trade volume, the role of cotton in export is so important as to reduce all other export commodities to truly minor significance.

Because the three countries converge geographically in the area of Lake Chad, there exists substantial potential for regional cooperation and increased trade between these countries in the future. The new telecommunications link to be constructed under the project will be a vital element in fostering future regional trade and communications. For the time being, however, the project is fully justifiable as a means of communications to facilitate the exchange of information concerning the outflow of export commodities from land-locked Chad and Northern

Cameroon through Nigeria to customers abroad and the inflow of imported goods from abroad to the remote areas of the Lake Chad Basin. As described elsewhere in this paper, the existing communications system is unreliable, costly and inadequate - although some 50,000 tons of goods flow annually from the railhead at Maiduguri in Nigeria to Fort Lamy in Chad, the only reliable means of communications at present between shipping firms, importers and transport companies is by written messages carried by the truck drivers.

B. The Economics of the Project

Table I, Annex A, is an estimate of projected traffic over the period beginning 1972, when the proposed project would go into operation, and ending 1980. Since the proposed link provides a new service where no direct service now exists, historical data on which to base long range trends are non-existent. It was felt that no reasonably accurate figures could be given for traffic growth beyond 1980. This is especially so because many planned regional telecommunications links in West and Central Africa will have unpredictable effects on the proposed project if and when they are constructed. Implementation of some of these links could reduce long haul traffic demands on the Fort Lamy Maiduguri route while at the same time encouraging the growth of shorter haul traffic over portions of the circuit. It was, therefore, considered to be more conservative to project traffic and revenue over only a nine year period during which other projects are being constructed and to assign a residual, or salvage, value to the equipment at the end of 1980. With an assigned salvage value of about 30% of investment cost the residual value of the property is about equal to the revenue projected for the year 1980. A conservative estimate of benefits is thus arrived at and with the project showing a feasible internal rate of return under these conditions it can be expected to do even better should traffic growth be maintained at the predicted rate beyond 1980.

In calculating benefits from projected traffic, incremental revenues were obtained from the following formula:

$$I = R_2 \ (T_1 = X) - R_1 T_1$$

where: I = incremental revenue

R_1 = present rate

R_2 = proposed rate

T_1 = present traffic volume

X = projected traffic increase

New rates had to be developed for traffic between points now served by indirect routings and original rates for points between which no

service now exists. For example, the existing rate between points in Cameroon and Nigeria is $8.82 per three minute telephone call via Paris and London. The new rate proposed over the Fort Foureau/Maiduguri link is $2.80. In general, the rates selected for use in calculating the benefits from the proposed system are based on mileage charges recommended by the ITU for Africa.

It should, of course, be noted that if the telecommunications authorities decide to keep the present high rates based on indirect routings via Europe, traffic may not develop to the extent predicted in the study.

Using the calculated benefits and 1980 salvage value and the estimated investment cost of $625,000 a conservative internal rate of return of 10% is arrived at. Table II of Annex A shows the projected benefits and Table III, Annex A illustrates the calculation of the internal rate of return. Table IV, Annex A is a breakdown of project costs and Table V, Annex A gives, for comparison, a cost breakdown of the rejected troposcatter alternative.

C. Financial Analysis

1. Financial Requirements

For AID/W funding purposes, the $550,000 of total foreign exchange requirements is divided into a $50,000 FY 1971 grant (Phase I) and a grant of $500,000 for FY 1972 (Phase II).

Phase I (FY 1971 Financing)	Foreign Exch. Costs	Local Costs (in $)
Engineering (surveys, design, preparation of specifications and bid documents, supervision of construction)	$45,000	-0-
Contingency	5,000	-0-
Total Phase I	$50,000	-0-
Phase II (FY 1972 Financing) - Contingencies Included		
Construction of Buildings (to house the relay stations)	-0-	$20,000
Supply of U.S. Equipment	$407,000	-0-
Installation and Testing of U.S. Equipment, Training of Personnel	93,000	55,000
Total Phase II	$500,000	$75,000

2. Financial Plan

The financing for the project is planned as follows:

	Foreign Exch. Costs	Local Costs (in $)
AID Grants:		
FY 1971	$50,000	-0-
FY 1972	500,000	-0-
Government of Nigeria Contribution	-0-	$30,000
Government of Cameroon Contribution	-0-	30,000
Government of Chad Contribution	-0-	15,000
Totals:	$550,000	$75,000

SECTION IV: MISCELLANEOUS CONSIDERATIONS

A. Implementation Plan

1. Engineering Design and Supervision of Construction. To assure the necessary uniformity in system design and equipment AID will contract directly with an engineering firm to conduct the field strength measurements, design the system, and prepare bid documents for the supply and installation of equipment in the three countries. The engineer will work in close coordination with the Cameroon, Chad, and Nigerian telecommunications technical staffs to ensure that the system will match existing equipment with which it must connect at each terminal. The engineer's contract will also cover bid evaluation and the supervision of installation and acceptance testing.

2. Equipment Supply, Installation, and Training. To assure standardization of equipment and installation workmanship AID will contract directly with a qualified U.S. equipment manufacturer for the supply and installation of the equipment in the three countries. The contract will be awarded on the basis of competitive bidding by prequalified contractors. The contractor will also be responsible for carrying out any construction work, to be financed by the Governments of Cameroon, Chad, and Nigeria, required for housing of the relay and terminal stations or for laying of the Fort Lamy-Fort Foureau cable. The contract will include the supply of all accessories, enough spare parts for an initial two years' operation, and for training in equipment maintenance.

3. Implementation Schedule:

	Months After Signature of Grant Agreement
Engineering Contract Executed	3
Field measurements completed	5
Bid documents draft completed	7
Bid documents approved by Cameroon, Chad, Nigeria, and AID/W	9
Bid awards	11
Installation completed	18
Final Acceptance	20

A.I.D. Disbursements are estimated as follows:

By December 31, 1971	$30,000
By June 30, 1972	450,000
By August 31, 1972	70,000
	$550,000

B. Impact on the U.S. Economy, Balance of Payments and Private Enterprise.

The AID grant will be used entirely to finance the foreign exchange costs of providing the services of a U.S. engineer, U.S. equipment and U.S. installation services. In the absence of AID assistance, it is probable that the LCBC would have sought other donor assistance and that the goods and services which are not available locally would be purchased from European or other sources. The AID grant will therefore have a favorable impact on the U.S. economy by financing U.S. goods and services for export which might not otherwise be procured. For the same reasons, the grant will aid U.S. private enterprise and have no adverse effect on the U.S. international balance of payments.

Traffic Projections, Revenues, Costs, and Internal Rate of Return

TABLE I

Estimated Traffic, 1972 - 1980 (No. of Messages *)

YEAR	TELEPHONE			TELEGRAPH			TELEX		
	Chad Cameroon	Chad Nigeria	Cameroon Nigeria	Chad Cameroon	Chad Nigeria	Cameroon Nigeria	Chad Cameroon	Chad Nigeria	Cameroon Nigeria
1972	3,000	25,500	1,300	1,000	48,300	1,200	450	1,250	200
1973	3,000	28,300	2,000	1,000	46,800	1,600	450	1,550	500
1974	3,000	31,200	2,700	1,000	45,200	1,900	450	1,950	800
1975	3,000	34,000	3,300	1,000	43,500	2,300	450	2,350	1,000
1976	3,000	36,700	5,100	1,000	40,600	2,400	450	3,050	1,400
1977	3,000	39,700	6,900	1,000	38,300	2,600	450	3,800	1,800
1978	3,000	42,500	8,700	1,000	36,000	2,800	450	4,750	2,200
1979	3,000	45,300	10,500	1,000	35,000	3,000	450	5,950	2,600
1980	3,000	48,200	12,300	1,000	32,800	3,100	450	7,450	3,000

* Telephone and Telex messages are at the average length of 4.5 minutes/message. Telegrams are average of 15 words/message.

TABLE II

PROJECTED INCREMENTAL BENEFITS *, 1970 - 1980

YEAR	TELEPHONE	TELEGRAPH	TELEX	TOTAL
1972	$ 43,406	$ 27,639	$ 3,105	$ 74,1[illegible]0
1973	64,525	36,076	5,003	105,604
1974	72,180	34,981	6,298	113,4[illegible]9
1975	80,110	33,796	7,843	121,749
1976	90,883	32,397	10,478	133,708
1977	101,140	30,654	13,465	145,259
1978	111,656	28,954	16,964	157,5[illegible]4
1979	122,172	27,428	21,[illegible]80	170,6[illegible]0
1980	132,684	25,335	28,[illegible]63	184,4[illegible]2
TOTALS	$818,756	$277,731	$113,199	$1,206,845
1980	RESIDUAL VALUE OF PROPERTY			$ 192,210
			TOTAL	$1,399.055

* Calculated for each circuit by the following equation (see Section III.B. for explanation of terms):

$$I = R_2 (T_1 + X) - R_1 T_1$$

TABLE III

DETERMINATION OF INTERNAL RATE OF RETURN

YEAR	GROSS BENEFIT	NET COST	NET BENEFIT	DISCOUNT FACTOR AT 10%	DISCOUNTED NET BENEFITS
1971 *	-0-	$625,000	-$625,000	1.0000	-$625,000
1972	$74,150	27,975	46,175	0.9091	41,978
1973	105,604	37,400	68,204	0.8264	56,364
1974	113,459	37,600	75,859	0.7513	56,993
1975	121,749	37,700	84,049	0.6830	57,651
1976	133,708	37,900	95,808	0.6209	59,487
1977	145,259	38,100	107,159	0.5645	60,491
1978	157,574	38,200	119,374	0.5132	61,263
1979	170,680	38,400	132,280	0.4665	61,709
1980	184,482	38,600	145,882	0.4241	61,869
1980 **	192,210	-0-	192,210	0.4241	105,025
				Total	-$ 1,170

* Investment Cost

** Residual Value of Property at 30% of Investment

TABLE IV

PROJECT COST BREAKDOWN - (CABLE FROM FT. LAMY TO FT. FOUREAU AND FIVE HOP MICROWAVE FROM FT. FOUREAU TO MAIDUGURI)

Item	FX Cost	Local Cost	Total
Radio Terminals (2)	$ 20,760	-0-	$ 20,760
Repeaters (4)	93,040	-0-	93,040
Voice Freq. Multiplex (2)	24,360	-0-	24,360
Order Wire	3,400	-0-	3,400
Fault Alarms	13,200	-0-	13,200
Antennas & Tower Mounts	9,000	-0-	9,000
Wave Guide	7,000	-0-	7,000
W/G Switches	15,000	-0-	15,000
Towers	48,000	-0-	48,000
Batteries & Chargers	36,000	-0-	36,000
Cable-250 pr. plus 2 Video Pairs (11,000 ft. unarmoured)	25,000	-0-	25,000
Cable-same, 2000 ft. Armoured (for river crossing)	15,000	-0-	15,000
Cable Pressurizing Equipment	600	-0-	600
Cable Terminating Equipment	1,200	-0-	1,200
Installation, Test, & Training	93,000	55,000	147,000
Power Supplies	40,000	-0-	40,000
Test Equipment & Spares	20,000	-0-	20,000
Buildings	-0-	20,000	30,000
Packing & Shipping	27,000	-0-	27,000
Engineering	45,000	-0-	45,000
	$536,560	$75,000	$611,560
Say	$550,000		$625,000

TABLE V

COST BREAKDOWN - (CABLE FROM FT. FOUREAU TO FT. LAMY AND TROPOSCATTER LINK FROM FT. LAMY TO MAIDUGURI)

Item	FX Cost	Local Cost	Total
Radio Terminal (2)	$ 91,400	-0-	$ 91,400
V-F Multiplex	24,360	-0-	24,360
Order Wire	1,100	-0-	1,100
Fault Alarm	2,260	-0-	2,260
Antennas & Tower Mounts	78,160	-0-	78,160
Wave Guide	5,500	-0-	5,500
W/G Switches	15,000	-0-	15,000
Cables (as per Microwave Project)	41,800	-0-	41,800
Installation, Test, & Training	87,000	50,000	137,000
Power Supplies	48,000	-0-	48,000
Test Equipment & Spare Parts	23,000	-0-	23,000
Buildings	-0-	20,000	20,000
Packing & Shipping	28,000	-0-	28,000
Engineering	40,000	-0-	40,000
	$485,580	$70,000	$555,580