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N'DJAMENA, CHAD

PHASE I FINAL REPORT

STRENGTHENING ROAD MAINTENANCE PROJECT CHAD

CONTRACT NO. 677-0050-C-00-6004-00

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Gannett Fleming
ENGINEERS AND PLANNERS

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EXECUTIVE SUMMARY

The Strengthening Road Maintenance Project (SRMP), Project 677-0050, was initiated by the United States Agency for International Development (AID) in 1985. The project objective was to assist the Government of Chad (GOC) in establishing regular maintenance of its road network.

Gannett Fleming, Inc., in association with Roy Jorgensen Associates, Inc. and Lee Wan & Associates, Inc. as subcontractors, was contracted by AID to provide technical assistance services for implementation of Phase I of the project.

The project goal was to develop the newly established "Office National des Routes" (OFNAR) into a technically competent and financially responsible organization for the maintenance of Chad's national network of roads.

OFNAR is a semi-autonomous government agency created on February 2, 1984, within the Ministry of Public Works, for the sole purpose of restoring Chadian roads. The OFNAR central services complex of administrative offices and workshops was created from facilities transferred from the Ministry of Public Works.

The GOC's commitment to provide regular maintenance of its road network is reflected in the extraordinary authority and operational flexibility of OFNAR, whereby OFNAR is exempt from the civil service administrative process and receives its operating revenues from tax receipts on petroleum product imports. The GOC agreed that OFNAR should finance at least 10 percent of its recurrent costs during the first year and not less than 50 percent of operating costs at the end of the project.

AID provided a grant of \$27.5 million over the five-year period of Phase I, 1985-1990, to establish a capability within the GOC to maintain its road network. The road network had been badly neglected during the previous decade because of civil war and economic difficulties.

An important aspect of the SRMP was the rehabilitation of the Djermaya-Dandi Road. However, the cost of rehabilitation exceeded the budgetary constraints of the AID grant monies. The proposed rehabilitation was reevaluated in 1988, and the decision was made to include the Djermaya-Dandi Road in a World Bank financed contract for the reconstruction of the Djermaya-N'Djamena Road, the N'Djamena Loop Road, and the N'Djamena-Guelendeng Road, at a cost of \$5.6 million to the SRMP.

The major element of assistance in the SRMP was the technical assistance of 11 expatriate professional and technical personnel to ensure institutional development within OFNAR. These specialists included a Senior Advisor to OFNAR's Director, provided under a host country personal services contract; a Planning Engineer, a Field Engineer/Chief of Party, an Accountant Advisor, a Brigade Foreman, an Equipment Foreman, a Shop Superintendent, a Parts Specialist, an Engine Foreman, a Machine Shop Foreman and a Service Foreman, provided by Gannett Fleming.

The Technical Assistance (TA) Team was responsible for advising certain levels of OFNAR management in long- and short-range planning, financial management, developing road maintenance operations, and organizing and supervising the activities of a Maintenance Training Brigade. The Team was also responsible for organizing and supervising a heavy equipment shop; a light vehicle shop; and a parts, materials and supply warehouse in the Central Workshops. The OFNAR administrative offices, central shops, central warehouse and a planning/training office complex had to be rehabilitated and furnished before they were operational. Road maintenance equipment, vehicles and shops tools had to be purchased. Rehabilitation of pre-war equipment scattered throughout the country was an immediate priority before road maintenance activities could begin.

Personnel training in all specialties was a high priority. At project inception, on the job training (OJT) was determined to be the most effective means of accomplishing the greatest results within the shortest time period. The OJT was supplemented by informal classroom instruction by each TA member.

In 1988, the World Bank began rehabilitating a group of buildings at the south end of the Ministry of Public Works complex that became the headquarters for the N'Djamena Road Maintenance Subdivision. The buildings included an office building, warehouse, heavy equipment shop, light vehicle shop, and a fuel storage and refueling station. The TA team became responsible for organizing and controlling the Subdivision road maintenance activities and training personnel.

Also in 1988, the World Bank contracted a consultant to develop a reorganization plan for OFNAR and the Ministry of Public Works. The reorganization plan called for a Chadian Director General and Chadian Director of Finance without advisors, an expatriate Director of Equipment, an expatriate Director of Works, an expatriate Warehouse and Procurement Specialist, and an expatriate Accountant Advisor. The reorganization was implemented in 1989. All expatriate positions created by the reorganization were staffed by contractor personnel of the Bureau Central pour l'Equipeement d'Outre-Mer (BCEOM) under contract to the World Bank.

According to the new OFNAR reorganization chart, the SRMP TA team was under the direction of the Chadian and Expatriate Directors. In actuality, the TA team was directed by the AID representative assigned to the project. The BCEOM Warehouse and Procurement Specialist assumed the responsibility for the warehouse and procurement activities of the OFNAR central services. The BCEOM Accountant Advisor diminished the role of the TA Accountant Advisor to controlling SRMP accounts and providing budgetary input to the overall OFNAR budget planning and budget preparation efforts. By this time, mid-1989, the TA team numbered only five expatriates.

The reorganization of OFNAR and the intervention of other donor agencies reduced the role of the TA team to advising and assisting road maintenance activities in the N'Djamena Subdivision, providing limited technical assistance to the Central Workshop and financial management of project accounts. Difficulties in implementing this change in direction diluted the effectiveness of the TA team and precluded attainment of some project goals.

Phase I of the SRMP was an extremely bold and ambitious undertaking considering the circumstances that existed at its inception - destruction

following the civil war, economic crisis, and political instability. OFNAR's administrative buildings and the central workshops were rehabilitated. Approximately 50 pieces of equipment were retrieved from the countryside and rehabilitated. The N'Djamena Subdivision became an organized, functioning road maintenance unit. The major part of the SRMP's planned off-shore procurement was completed, including the purchase of 13 Mercedes trucks with spare parts, six pieces of Caterpillar road building equipment with spare parts, compactors, an office trailer and \$400,000 worth of shop tools. The Maintenance Training Brigade was established, training 77 personnel and completing 1,763 km of road rehabilitation and maintenance in 2 1/2 years. Local procurement was a major facet of the project, but problems resulted from OFNAR's overly complex and slow procurement system and the lack of an adequate system for inventory control. Recent modifications to the system are remedying the situation. The reconstruction of the Djermaya-Dandi Road is about 80 percent completed. The actual final cost is not known at this time. The World Bank has decided to add the money needed to construct an asphalt paved roadway.

Through close cooperation between AID, OFNAR, the Ministry of Public Works and the TA Team, the SRMP goals and objectives were substantially achieved. The SRMP successfully assisted in the rehabilitation of previously unserviceable equipment, rehabilitated central administrative and workshop facilities and procured the necessary equipment and tools for their operation. It established and equipped a maintenance training brigade, and trained supervisors, administrative personnel, equipment operators and mechanics. It also initiated systems and procedures to develop OFNAR's institutional capability to plan and manage road and equipment maintenance operations. These achievements have increased OFNAR's physical capability to maintain roads and equipment. The framework is in place for OFNAR to be a technically competent and financially responsible road maintenance organization.

With the advent of other donor agencies, particularly the World Bank, future technical assistance in the Phase I Extension of the SRMP will concentrate on institution building within OFNAR, implementation of management information systems, establishment of structured training procedures, and development of the N'Djamena Subdivision into a technically competent, financially responsible road

maintenance unit capable of maintaining 750 km of road annually. Gannett Fleming is pleased that AID has chosen to continue the SRMP to benefit Chad, and is proud to have been a contributor during the difficult initial years of the project.

Gannett Fleming is especially appreciative of the support and guidance provided its personnel by the AID Mission. Without the encouragement and participation of individual AID employees there would have been more difficulties and fewer accomplishments. The assistance of the AID Mission Directors, Contracting Officers and Controllers in contract administration is gratefully acknowledged, as is the technical advice provided by the AID Project Managers.

RECOMMENDATIONS

To continue with the Phase I Extension of the SRMP, Gannett Fleming recommends the following actions be taken:

1. Provide an advisor to OFNAR senior management for planning, budgeting and coordinating SRMP activities.
2. Continue development of efficient workshop operations and establishment of the management systems that have been introduced in the Central Workshop.
3. Simplify the procurement and distribution procedures for spare parts and supplies, and organize a supply section to service the maintenance brigades.
4. Review and modernize personnel recruitment procedures and establish an employee benefit program.
5. Develop a structured training program tailored to benefit the different educational levels of OFNAR employees.
6. Organize a Safety Section and provide first aid facilities.
7. Organize a Security Section to safeguard property and supplies.
8. Increase assistance to the N'Djamena Subdivision in planning scheduling, budgeting, coordinating and supervising road maintenance.

9. Discontinue the use of an outside firm to assist with offshore procurement, and implement future offshore procurement through host country contracts.
10. Develop asphalt pavement maintenance capabilities within the N'Djamena Subdivision.
11. Develop clearly defined and realistic project goals and objectives within the capabilities of the TA team and project limitations.
12. Provide short term specialists, as required to supplement the TA team in meeting the needs of OFNAR.

Section I
Introduction

I. INTRODUCTION

The Strengthening Road Maintenance Project, Chad (SRMP) was authorized June 24, 1985, by the U.S. Agency for International Development (AID) to assist the Government of Chad (GOC) in establishing regular maintenance of its road network. Phase I of the 10-year project was initially funded by a \$27.5 million grant over a 5-year period, 1985-1990. This was increased by \$2 million to fund a Phase I Extension for a two year period.

The project's purpose was to develop a technically competent and financially responsible organization to maintain the road network throughout Chad. Major elements of the project were:

- Technical assistance in planning and administering a road maintenance program
- Training and equipping a road brigade and operational support
- Rehabilitation and equipping workshop facilities, and training in equipment maintenance
- Rehabilitation of a 63 km road through host country contracting.

To accomplish this, the SRMP financed approximately 34 person years of technical and managerial assistance to OFNAR, consisting of a Senior Advisor, a Planning Engineer, a Field Engineer, a Shop Superintendent, Accountant Advisor, a Parts Specialist, a Brigade Foreman, an Equipment Foreman, an Engine Foreman, a Machine Shop Foreman and a Service Foreman. Gannett Fleming provided 10 of the expatriate personnel. The Senior Advisor was contracted by AID under a host country personal services contract.

This Technical Assistance Team was responsible for institutional development, rehabilitating and equipping workshop facilities, training personnel in equipment maintenance, equipping and training a road maintenance brigade, providing operational support to the N'Djamena Subdivision, and rehabilitating

the Djermaya-Dandi Road through host country contracting. AID later eliminated the road rehabilitation from the SRMP because of budgetary constraints.

The Office National des Routes (OFNAR) was the implementing agent and the object of the project's institutional strengthening efforts. At the end of the contract in 1990, OFNAR would be capable of regularly maintaining, with its own personnel and equipment, 1,600 km of roads and financing 50 percent of its recurrent costs. There would be an effective Central Workshop maintaining OFNAR equipment and a trained work force of managers, supervisors, equipment operators, mechanics and shop technicians.

OFFICE NATIONAL DES ROUTES

The Government of Chad (GOC) established the Office National des Routes (OFNAR) within the Ministry of Public Works in February 1984, as a rapid response agency to restore regular road maintenance. OFNAR is a semi-autonomous government agency funded by operating revenues from tax receipts on petroleum products. It is exempt from civil service administrative processes and has special organizational status outside the usual bureaucratic constraints of governmental agencies. This was done to facilitate staffing, personnel management and operational activities. OFNAR was given extraordinary authority and flexibility to develop rapidly and operate effectively, but trained personnel and equipment were in short supply.

All of the OFNAR administrative offices and central shops are located at the OFNAR central services complex in N'Djamena. The complex is composed of several buildings and an equipment storage yard transferred from the Ministry of Public Works. The buildings, consisting of the main workshop; a heavy equipment shop; and three office buildings, were badly damaged and looted during the recent civil war (1979-1983). The SRMP rehabilitated the buildings and re-equipped the shops, financed the retrieval and rehabilitation of old equipment, and purchased new equipment.

The chief administrative officer of OFNAR is the Director - General, who is responsible for two functional areas: Central Services and Regional Services.

Central Services is located in N'Djamena and is comprised of five divisions: Administration, Finance, Inspection, Road Planning, and Equipment Maintenance. Regional Services consists of the N'Djamena and Sarh Arrondissements. The N'Djamena Arrondissement consists of the N'Djamena and the Abeche Subdivisions. The Sarh Arrondissement consists of the Sarh, Mongo and Moundou Subdivisions. Each subdivision is to have a road maintenance center providing road maintenance service through fully equipped operational units, and its own workshop for maintaining equipment. Phase I of the SRMP focused on the N'Djamena Subdivision.

PHYSICAL AND CULTURAL GEOGRAPHY

Chad is a landlocked, Central African country having an area of approximately 495,755 square miles. The country is divided into three climatic zones: a northern Saharan Zone (40%); a central Sahelian Zone (35%); and a southern Tropical Zone (25%). It has two principal rivers: the Chari originating in the south and flowing northward; and the Logone originating in the east and flowing westward. They are both limited navigable waterways. The nearest seaport, Douala, Cameroon, is about 1,400 miles south of Chad.

The population of Chad is estimated to be 5.3 million with an annual growth rate of 2.4%. Approximately 80% of the population lives in rural areas; however, the population of the urban areas is growing at three times the rate of the entire population. The northern Saharan Zone contains less than 3% of the population; the central Sahelian Zone, 57%; and the southern Tropical Zone, 40%. N'Djamena, the capital and largest population and commerce center in Chad, is in the Sahelian Zone.

The per capita annual income is about \$160 (U.S.), making Chad one of the poorest countries in the world. Agriculture in the south and livestock herding in the north are the main economic activities. Cotton, grown primarily in the southern Tropical Zone, is the chief export crop. Most manufactured goods are imported.

Economic development has been constrained by the lack of an adequate transportation system, long distances between population centers, the recent civil war, drought, and a drop in cotton prices. The three year civil war ended

in 1982, and the new government, assisted by the international community, has brought about national reconciliation and some economic stability.

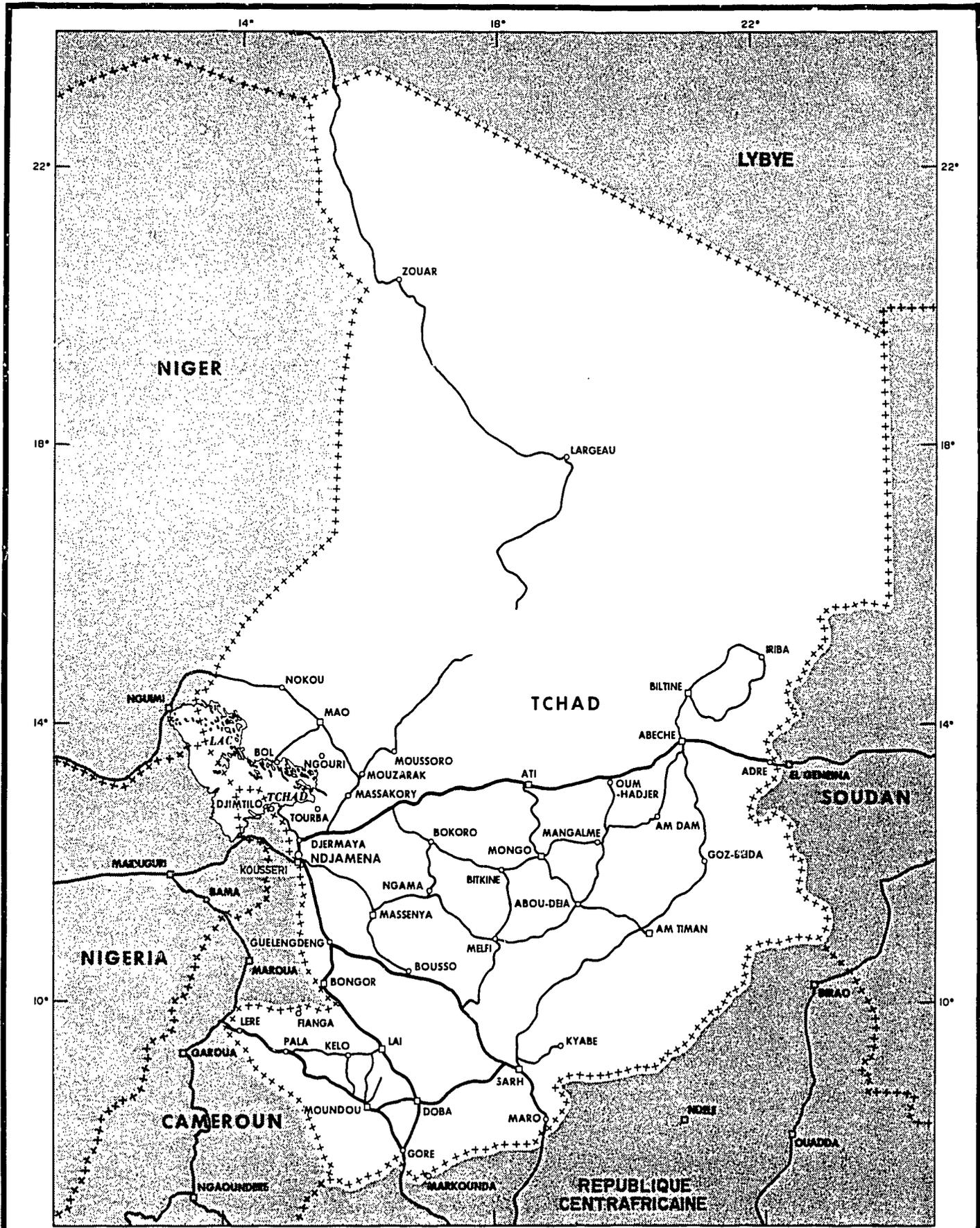
The GOC is committed to continue economic growth, to improve access to isolated regions, to increase the standard of living, to encourage growth of the private sector, and to improve the efficiency of the administration. The goals of the 1988-1993 development program are to complete the post-war reconstruction phase, alleviate the effects of recent droughts, continue the restructuring in the cotton sector, and establish the basis for sustainable growth.

ROAD TRANSPORT SECTOR

Road transport is the principal mode of transportation in Chad. The road network (Figure 1) comprises about 7,300 km of classified roads and 24,000 km of tracks. Originally, 1,500 km of roads were constructed to improved earth standards and 250 km were paved. Most of the roads are situated in the southern part of the country and link the principal cities of N'Djamena, Sarh, and Moundou. The road network has rapidly deteriorated and road transport is slow and costly. At the end of the civil war, only about 40 km of paved roads remained and most of the improved earth roads were in a state of disrepair.

Several road rehabilitation programs have been undertaken since 1983. Rehabilitation of some 2,000 km of roads has been completed or is underway, with financing from the European Development Fund, the United Nations Development Program, and French and Italian aid programs. Additional road sections, totalling 1,800 km, are scheduled to be rehabilitated by 1993, with financing from the World Bank, the African and European Development Funds, the Governments of France and Germany, and other donors.

The SRMP was the first road maintenance project in Chad sponsored by a donor agency after 1982, and was instrumental in encouraging other donor agencies to undertake road rehabilitation projects. The SRMP provided OFNAR and the N'Djamena subdivision with technical assistance, equipment, training, and operational support in planning and administering a road maintenance program. The International Development Association (IDA), during the period 1987-1988, provided technical assistance, equipment rehabilitation and procurement, and



LEGENDE

- Chef-lieu de Prefecture
- Chef-lieu
- Capitale d'Etat
- Route Principale
- Route Secondaire
- Frontiere Internationale

LE'GEND

- Chief Town of Prefecture
- Chief Town
- State Capital
- Primary Road
- Secondary Road
- + + + + + International Boundary



FIGURE 1
CHAD ROAD NETWORK

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facilities restoration for road maintenance in the Subdivisions of Sarh, Moundou, Mongo and N'Djamena. IDA also provided technical assistance to the Ministry of Public Works and for several studies, including a study for the reorganization of OFNAR. Other road maintenance is planned with financing from EDF, ADF and IDA.

GANNETT FLEMING CONTRACT

AID contracted with Gannett Fleming Inc. on November 7, 1985, to provide the technical assistance services of nine expatriate professional and technical personnel to the SRMP to assist the GOC in reinstating regular road maintenance and to develop a technically competent and financially responsible road maintenance organization in Chad. The budget was estimated at \$3,154,043 to provide 317 person months of direct employee, consultant, and/or subcontract labor for technical assistance and 11 person months of home office support.

The contract was amended in May 1987 to include the Planning Engineer for 36 person months. Subsequent contract amendments increased the contract budget to \$4,863,905 and increased the number of person months to be provided to 381. The contract termination date was July 31, 1990.

Roy Jorgensen Associates, Inc., a leading authority in road maintenance management; and Lee Wan and Associates, Inc., a certified Section 8a small minority business enterprise provided some personnel to the SRMP under subcontracts to Gannett Fleming. Roy Jorgensen provided experienced capability in workshop rehabilitation and management, and equipment repair and maintenance. Lee Wan's involvement provided important minority and small business participation in AID's Sahel and West Africa Program.

To meet the objectives of the GOC and AID, Gannett Fleming, Inc. undertook to:

- Develop a permanent capacity to plan, organize and implement a road maintenance program and secondarily a road rehabilitation program.

- Solicit and encourage private sector involvement in preliminary project activities and, if successful, develop construction packages for local contractors for road rehabilitation and maintenance work.
- Assist with the implementation of the road maintenance program for 1,600 km of road using GOC and private sector contractors.
- Provide engineering and management services for the supervision and inspection of 63 km of road rehabilitation by host country contracting.
- Assist in evaluating and improving the organization and management of OFNAR as required to effectively implement the road rehabilitation and maintenance programs.
- Provide on-the-job training (OJT) to Chadian personnel in road maintenance and equipment maintenance and operation.
- Evaluate existing OFNAR equipment and finalize an equipment recovery and rehabilitation program.
- Develop and implement an operational plan for the Central Workshop including an equipment repair schedule with procedures; preventive maintenance programs; spare parts, fuel and lubricants supply, procurement and delivery systems; warehousing system to store and dispense supplies.
- Assist with the establishment and preparation of an operational plan for future workshop facilities.

LOGISTICAL SUPPORT

All logistical support for the TA team was provided by Gannett Fleming. This included housing, household furnishings, utilities, and house maintenance. AID provided diplomatic pouch, check cashing and health room privileges through

the U.S. Embassy, and project vehicles for official in-country travel. OFNAR provided office space.

In 1985 when the SRMP began, Chad was just beginning to recover from the devastating civil war. The downtown commercial district on Avenue Charles de Gaulle was 80 percent destroyed. Only a few shops, offices and a grocery store were operating. Other businesses and merchants were just beginning to become established. All Western-style housing was destroyed and had to be rebuilt prior to occupancy. A hotel was open, but barely operating, having not received maintenance or repair for many years.

The initial mobilization effort in December 1985 concentrated on locating houses that could be rehabilitated in one to three months. Household furnishings, including appliances and air conditioners were purchased locally. The urgency to have the TA team operable quickly, precluded the importation of U.S. manufactured goods. Procurement in the U.S. could have taken as long as eight months for the goods to arrive in Chad and the cost would have been more expensive. Also, this outlay of capital at the start of the SRMP aided the local economy at an important time.

Electric power was a continuous and expensive problem. The supply was erratic, causing frequent blackouts, low voltage, and voltage spikes that instantly destroyed fluorescent light fixtures. Air conditioners suffered from low voltage operation and required repair or replacement every 3 to 4 months. In May 1988, when outages of 24 hours or more were common, electric generators were purchased for each house. The generators automatically supplied power whenever voltage dropped below a specific level.

Water supply was also erratic with shortages occurring at times of high community usage. Pressure pumps were installed to solve low pressure problems.

General household repair and maintenance was contracted to a Chadian electrician/plumber, whose services were used on an almost daily basis.

Section II
Technical Assistance

II. TECHNICAL ASSISTANCE

The initial goal of the SRMP was to develop a technically competent and financially responsible road maintenance organization. The Technical Assistance (TA) Team was to institutionalize road maintenance within OFNAR, and assist in planning and administering a road maintenance program.

The SRMP employed a concept previously untried in AID projects. That concept being expatriate operational control of specific activities within the legitimate governmental functions of the cooperating country. This concept required the integration of the TA team into Chadian governmental activities, namely OFNAR, where TA personnel directly supervised and trained Chadian governmental employees in road maintenance activities. The TA personnel were both supervisors of, and advisors to, Chadian personnel.

The uniqueness of the SRMP concept necessitated close coordination and cooperation among the participants, which included AID, OFNAR, the Senior Advisor and the TA team. The TA team was integrated within the OFNAR organization, advising and issuing directives, and was also responsible to AID for contract performance. There were misunderstandings and confusion over the TA team's operational and supervisory roles, and the SRMP requirements to develop and establish systems and procedures to institutionalize OFNAR.

The implementation plan for the SRMP in the Project Paper scheduled many activities to be largely completed prior to the arrival of the TA Team, including procurement of shop tools and equipment, project vehicles, surveying and soil testing equipment; rehabilitation of buildings; preparation of specifications and procurement of Training Brigade equipment; preparation of preliminary training plans, and preliminary road contract plans. The six to seven months time allowed to complete these tasks was too short and unrealistic. When the TA team arrived in Chad these tasks were not completed, and there was frustration on the part of the TA personnel, some waste of technical assistance time, and the use of TA personnel to do the uncompleted or unstarted activities of others.

TECHNICAL ASSISTANCE TEAM

The TA Team consisted of 11 expatriate professional and technical personnel, two of who, the Senior Advisor and the Planning Engineer, were to be provided under an agreement with the U.S. Department of Transportation, and the remaining nine by Gannett Fleming. The Senior Advisor and the Planning Engineer were to have advisory roles and the nine expatriates were to have mainly operational and supervisory roles within OFNAR's Central Workshop and the Road Maintenance Training Brigade. The project staffing did not provide for a Chief of Party position to manage and lead the TA team. It was assumed this function would be performed by the Field Engineer, but other duties limited his time to administrative and logistical affairs, and liaison with the AID Project Manager.

The Senior Advisor was appointed to the position in early 1986 under a host country personal services contract. The appointee was ineffective and the position was eliminated in July 1988.

The Planning Engineer position was assigned to Gannett Fleming in January 1987, and the Field Engineer was promoted to the position. Unfortunately, the new Planning Engineer had to leave the project for medical reasons in July 1987, and resigned three months later. A second Planning Engineer was appointed in January 1988, and also designated Chief of Party. He resigned five months later for personal reasons. Shortly thereafter, the Mission deleted the position from the Staffing Chart. The Project Manager made several extended visits to Chad to act as Chief of Party and to substitute for the Planning Engineer.

Table 1 shows the contract person months, as of January 1987 after the addition of the Planning Engineer, and the person months expended on the contract termination date of July 31, 1990. The dates the positions were staffed and terminated are shown for time reference. Person months were calculated as 176 work hours equals a calendar month.

TABLE 1
DISTRIBUTION OF CONTRACT PERSON MONTHS

<u>Staff Position</u>	<u>Contract P/M*</u>	<u>Start Date</u>	<u>Expended P/M</u>	<u>End Date</u>
1. Planning Engineer (2)	36	12/30/86	9.5	05/21/88
2. Field Engineer (3)	31	01/27/86	44.2	07/31/90
3. Shop Superintendent (4)	45	02/24/86	37.8	07/04/90
4. Accountant Advisor (2)	45	06/30/86	46.2	07/30/90
5. Parts Specialist (2)	36	01/22/86	34.3	04/18/89
6. Brigade Foreman (2)	26	10/26/86	34.3	03/21/90
7. Equipment Foreman	26	10/27/86	20.7	10/29/88
8. Machine Shop Foreman	36	02/16/86	34.7	06/27/89
9. Engine Foreman (2)	36	01/13/86	29.9	02/28/89
10. Service Foreman (2)	36	01/13/86	42.6	04/28/90
11. Logistician	-	12/07/85	2.0	02/15/86
12. Project Manager	11	12/01/85	34.5	07/31/90
13. Office Staff	-	12/01/85	<u>10.8</u>	07/31/90
	<u>364</u>		<u>381.5</u>	

*January 1987

() Numbers in parentheses show the number of employees staffing the position if there was more than one.

Personnel turnover was unexpectedly high for various reasons. There were three terminations for medical reasons, four terminations for cause, and three resignations for personal reasons. One employee completed his 3-year personal contract, and chose not to extend. Some positions were deleted as the persons left the project, and for the last contract year, the TA team comprised only five persons.

Turnover was also high within the AID and OFNAR organizations. There were two Mission Directors, two Project Managers, three Controllers and three Contracting Officers administering the project. The OFNAR Director, Assistant Director, Accountant and Field Engineer counterparts each changed once.

It was determined early in the project development stage that one of AID's responsibilities was to contract for short term consulting services to augment the TA team when the need was identified. The services of a training specialist, procurement specialist, and computer specialist were identified as needed by Gannett Fleming and the project evaluation studies, but no action was taken to

add these positions to the TA Contract. Around this time, the study to reorganize OFNAR was in progress, the World Bank was funding road construction and road maintenance, and AID was studying changes in project direction.

The World Bank Program in 1988 introduced personnel into positions overseeing several of the roles occupied by TA team members. Several months later the TA team's responsibilities were redefined to:

1. Develop the N'Djamena Road Maintenance Subdivision into a technically competent, financially responsible and well managed road maintenance unit;
2. Provide limited support to the Central Workshop;
3. Provide management support, and training to the N'Djamena Subdivision and the Central Workshop;
4. Involve private sector contractors in road construction.

Following is a brief description of the duties and responsibilities of each TA team member. Each team member worked in close cooperation with a Chadian counterpart.

Planning Engineer

The Planning Engineer served as an advisor to the Chadian Planning Engineer in the following activities:

1. The classification of the Chadian road network by function;
2. The development of a numbering and locating system for the road network;
3. The development of an inventory of road features to include culverts, bridges, intersections, village limits, and all other features that affect road usage.
4. The allocation of available maintenance equipment to arrondissements, subdivisions, and sectors in proportion to the road responsibility of each unit;

5. The development and implementation of traffic studies and truck weight control procedures.
6. The development of typical cross-sections and geometric standards for each classification of road;
7. The development of standard material and drainage specifications for general maintenance and rehabilitation activities;
8. The estimating of cost and development of priorities for the performance of spot improvements on existing roads;
9. The projection of future needs in personnel, equipment and materials.

Field Engineer/Chief of Party

The Field Engineer/Chief of Party was responsible for overall supervision of the contractor personnel and Maintenance Training Brigade. He was the principal OFNAR official in charge of field inspection and supervision of private sector contractors executing work for OFNAR under host country contracts executed by Public Works. He was responsible for developing and controlling OFNAR/private sector contracts. His duties also required him to perform as a technical advisor to the Chief of the N'Djamena Subdivision advising him on all engineering matters concerning road rehabilitation and maintenance activities. Other responsibilities were:

1. Organize and establish the Subdivision administrative personnel and the warehouse and shops operations;
2. Direct the contractor expatriate and local personnel;
3. Establish the location, and define the nature of work to be performed by the Maintenance Training Brigade,
4. Direct the Brigade Foreman in technical requirements for culvert sizes, structural requirements, materials specifications, workmanship and quality control; all to comply with approved standards and specifications;
5. Define the nature of work to be performed by private sector host country contractors and prepare technical specifications of bid documents for private sector host country contracts;

6. Manage engineering layout, inspection, and acceptance or rejection of private sector host country contractors' work;
7. Define the nature of maintenance and rehabilitation work to be performed by operational OFNAR units; i.e., subdivision and sector personnel and equipment;
8. Direct the Subdivision in matters related to project equipment and recurrent costs;
9. Prepare work plans for the Subdivision, consistent with budgetary, equipment, personnel, and geographic constraints,
10. Supervise Chadians assigned to the Subdivision parts warehouse, shops, parks, fuel storage and refueling facility operations.
11. Serve as Planning Engineer in his absence.

Shop Superintendent

The Shop Superintendent directed all activities of the OFNAR Central Workshop. His activities included:

1. Operational control of OFNAR's Central Workshop in N'Djamena. This encompassed supervision through intermediate expatriate foremen of all assigned personnel, tools, supplies, and equipment;
2. Determine work priorities, staffing, assignments, equipment requirements, and training needs;
3. Provide general supervision to foremen of an engine repair shop, a machine and body shop, and general service unit together with any other subunits established in the repair and rehabilitation of OFNAR equipment;
4. Schedule all work to be performed by the Central Workshops keeping accurate records;
5. Prepare budgets for the Central Workshop;
6. Maintain equipment records with regard to utilization, downtime, routine maintenance, and other factor relating to performance;

7. Submit monthly reports to the Director of OFNAR relative to Central Workshop activities;
8. Generate requisitions for project related spares and supplies for the Central Workshop.

Accountant Advisor

The Accountant was an advisor to the Chief of the OFNAR Finance Department on highway financial management systems. He was also responsible for accounting for local currency monies advanced by USAID for OFNAR operational costs. His activities included the following:

1. Advise the Chief of the OFNAR Finance Department in highway accounting systems;
2. Prepare payroll for all Chadian personnel engaged in the project;
3. Prepare general ledger for the project;
4. Prepare general disbursements for the project;
5. Maintain project inventory records;
6. Prepare project financial reports and documentation;
7. Procure supplies, tools, and materials for the project;
8. Prepare project budget analysis;
9. Supervise project accounting staff;
10. Recommend data processing system including hardware/software suitable for OFNAR and supervise the purchase, installation, and implementation of the system.

Parts Specialist

The Parts Specialist managed the spare parts warehouse in the Central Workshop. His duties included the following:

1. Provide general supervision of Chadians assigned to the parts warehouse, training them in each related activity;
2. Arrange the warehouse so as to receive and dispense parts efficiently;
3. Maintain an accurate inventory of, and order parts;
4. Establish and maintain appropriate stock level of routine maintenance parts;
5. Assist shop foreman in identification of parts;
6. Evaluate performance of Chadian counterpart and other Chadian subordinates;
7. Perform other tasks as directed by the Shop Superintendent;
8. Advise OFNAR on computer software suitable for parts inventory management.

Brigade Foreman

The Brigade Foreman supervised the Maintenance Training Brigade field operations. His duties were to:

1. Supervise all maintenance and rehabilitation activities assigned to him, assuring that technical requirements set forth by the Field Engineer were met;
2. Direct and train Chadian foremen in the performance of maintenance and rehabilitation activities and evaluate their performance.
3. Keep written records of progress of work, including utilization of equipment, labor, materials.

Brigade Equipment Foreman

The Equipment Foreman supervised and trained OFNAR personnel in the operation and routine care of all types of road maintenance equipment used by the Maintenance Training Brigade. His duties included the following:

1. Supervise and train Chadian equipment foremen and equipment operators in the operation and maintenance of road maintenance equipment, and evaluate their performance;
2. Maintain written records of equipment use, operators performance, and such other records as were required by the Brigade Foreman.

Machine Shop Foreman

The Machine Shop Foreman directed the activities of the OFNAR machine shop in the Central Workshops. His duties included the following:

1. Assign and oversee all machine work
2. Instruct machinists in proper use of machine tools;
3. Determine machine work required and inspect completed work.
4. Advise parts specialist of needs;
5. Maintain records as directed by Shop Superintendent.

Engine Foreman

The Engine Foreman directed the activities of the OFNAR engine shop in the Central Workshops. His duties included the following:

1. Determine need for repair or replacement of engine parts.
2. Assign and oversee all engine repair work;
3. Instruct mechanics in proper engine repair techniques;
4. Advise parts specialist of needs;
5. Maintain records as directed by Shop Superintendent.

Service Foreman

The Service Foreman managed all general services performed at the OFNAR Central Workshops. His duties included the following:

1. Determine the nature and priority of work to be performed, and assign the work to the appropriate shop.
2. Instruct counterpart and mechanics in proper service techniques, and inspect work performed;
3. Assure that complete routine maintenance is performed in addition to repair work;
4. Evaluate performance of Chadian counterpart and mechanics;
5. Maintain records as directed by Shop Superintendent.

WORK PLANS

The TA team routinely developed work plans and implementation schedules on a short- and long-term basis for administrative, shop and road maintenance activities located at or originating from the central services complex. Construction planning and upgrading of the physical facilities were an ongoing program. OFNAR began with only the bare essentials, and improvements were needed to accommodate the rapid expansion. The Central Complex employs approximately 200 persons, and the N'Djamena Subdivision about 300. This is half of the total number of OFNAR permanent employees.

The work plans included training of office personnel and section heads as well as shop craftsmen and road maintenance crews in the field. Regular information meetings were held on a weekly or monthly basis for information sharing and monitoring of work progress. Chadian office personnel were employed in the field with each work crew to provide accurate reporting of operating expenses and work accomplishments.

DJERMAYA-DANDI ROAD REHABILITATION

One of the major components of the SRMP was the rehabilitation of the existing 63-km road from Djermaya to Dandi using private sector contractors under host country contract. Improvement of the existing dry season track to all-weather standards would provide year round access to the AID supplied aggregate crushing plant at Dandi Quarry, and would foster rural agricultural and socio-economic development in the road's zone of influence. The development of a

private sector road construction industry would be promoted by dividing the work activities into small specialized contracts such as earthwork, drainage, and paving. The exposure to this type of road work would provide OFNAR employees with experience in engineering supervision and construction control of private sector contractors.

Two previously completed engineering studies provided the necessary alignment, profile and geometric design standards for rehabilitating the Djermaya-Dandi Road. In 1971, BCEOM completed the Djermaya-Djimtilo Feasibility Study, and in 1980, Gannett Fleming completed a similar Djermaya-Djimtilo Road Study, including an Economic Development Report and a Preliminary Engineering Design Report. The alignment and design standards were established, but construction cost estimates required updating.

In 1986, OFNAR and the TA team prepared contract documents and updated the construction cost estimates. When it was learned the updated cost estimates exceeded the SRMP construction budget by a factor of two, AID commissioned an independent U.S. engineering firm to review the existing road designs and cost estimates, develop acceptable minimum all-weather road design standards and modify the preliminary engineering design to contain the road construction costs within the funds available. The review, completed in June, 1987, estimated the road construction costs (excluding road surfacing) to rehabilitate the Djermaya-Dandi road to minimally acceptable all-weather road standards would exceed the SRMP budget by \$5 million or almost a factor of two. The report concluded that the only way to rehabilitate the road with the funds available would be to use the Maintenance Training Brigade to do the road construction and to utilize the equipment, central facilities and technical assistance support funded under other components of the SRMP. This procedure would also avoid delays associated with the bidding process.

Discussions were held with the World Bank to undertake the rehabilitation of the Djermaya-Dandi Road as part of a larger contract under its road reconstruction credit agreement with the GOC, if the SRMP budgeted funds were transferred to them. The reasoning was that if the Djermaya-Dandi road segment was added to the World Bank's much larger 250 km construction contract from Djermaya to Guelending, economies of scale would substantially reduce

mobilization and unit costs so the Djermaya-Dandi Road could be built for \$5 million. The Bank agreed to contract the work and AID awarded a subgrant to effect the transfer.

OFNAR EMPLOYMENT POLICIES

Personnel recruitment is the sole responsibility of OFNAR and follows the "Chadian Accords" or bilateral agreement reached following the civil war. According to the agreement, OFNAR must hire employees under either of two mandates:

1. All previous employees must be reemployed first, regardless of education, technical competency or previous performance;
2. Additional recruitment must be proportionate to the three regional cultural groups, Gourane, Zakawa, and Southern Chadian population.

Political favoritism or familial relationships often take precedence over qualifications when selecting applicants. As a result, there is a high percentage of illiterate and poorly trained personnel among lower echelon OFNAR employees. Many employees do not speak French. Lost time and unproductive or incorrect labor resulted from misunderstood verbal and written instructions.

Under the agreement, it is nearly impossible to discharge a permanent employee for any reason. Slacking and absenteeism are not considered serious offenses. Imprisonment is an excused absence for a given period of time. Incentive awards and disciplinary actions can be considered discriminatory and have political overtones according to current policies.

The TA team developed a recruitment program for technical positions based on qualifications and job descriptions oriented toward the local labor market. Job descriptions were also prepared for nontechnical/administrative personnel positions. OFNAR did not accept the program. Offers by the TA team to improve the quality of recruited personnel by assisting in the evaluation process were also rejected. To date, the OFNAR administration has recruited all personnel. The SRMP does not participate in the determination of pay scales for OFNAR employees nor does it pay OFNAR employee salaries.

Present personnel practice suggests the need for six months basic training in fundamental skills normally taught in the public school system. An outside educator would conduct the classes with the objectives of determining skill levels, trainability and willingness to accomplish job responsibilities. An evaluation following this six month training or probation period would determine the individual's continued employment with OFNAR, and the position where the applicant has the greatest aptitude.

ACCOUNTING/FINANCIAL MANAGEMENT

At the start of the SRMP, OFNAR had an administrative accounting system. They did not use double entry accounting nor did they have a balance sheet. A cash journal was kept to record movements in and out of the safe. For budget purposes, accounts for functional activities were used to classify encumbrances and liquidations. All checks and cash payments were approved by the OFNAR Director. Typically, a voucher included a requisition signed by a division manager, a purchase order signed by the Director, an invoice with a receiving report, and a payment order signed by the Director. When an invoice was presented for payment, an entry was made in the encumbrance and liquidation journals, and in the cash journal or check register.

A balanced budget was prepared annually, but investment was not separated from operations. The different functional sections of the budget, such as equipment operations, became the chart of accounts. Personnel was a separate account. The Director was totally responsible.

A record was kept by the Technical Services Division of the parts charged to each piece equipment each month, and files were kept by list of equipment. This information was not available in Accounting. Therefore, it was not possible to calculate cost of repair, cost of equipment, or cost per kilometer of road maintenance.

There was no control of inventory by Accounting or an inventory account. There were no fixed asset or depreciation accounts or an asset register to control fixed assets.

The Annual Report corresponded to a statement of Sources and Uses of Funds, showing Cash/Bank balance at the beginning of the year, movements during the year, and a Cash/Bank balance at the end of the year. This final balance was compared and reconciled with actual cash in the safe and in the Bank.

New Accounting System

Beginning January 1, 1988, OFNAR had an accrual based, double entry, general accounting system that followed OCAM procedures and was compatible with AID regulations. Cost accounting information was developed and budget responsibility was delegated to Division Managers. AID project funds and financed activities were integrated into the OFNAR accounts, and the SRMP maintained cash basis accounting in accordance with AID requirements. Monthly reconciliation was maintained within the two systems. This technique provided a reliable method of monitoring the assets and liabilities of the OFNAR and SRMP accounts.

The following steps were taken by the TA Accountant Advisor in establishing the OFNAR accounting system:

- Integrated project funds and activities into OFNAR accounts;
- Began bank reconciliations, bank journal, regular deposit of cash receipts and established petty cash system;
- Reduced cash on hand to a practical minimum;
- Moved from single entry administrative accounting to double entry general accounting;
- Moved from cash basis to an accrual basis in measuring accounting transactions;
- Developed cost centers and delegated budget responsibility to Division Managers for cost gathering purposes;

- Adopted OCAM accounting system to develop the OFNAR chart of accounts;
- Separated investments from operations in the annual budget;
- Advised OFNAR to enlarge the Finance Division from 3 to 22 persons, including 3 in Purchasing and 9 in the Warehouse;
- Created a budget section, cost centers, subdivision and general accounting sections;
- Installed a purchase order control system to enable purchasing to follow and report on current purchasing activity;
- Instituted an inventory accounting and control system in the warehouse;
- Installed data processing equipment,

The data processing system, when established, will serve as a monitoring mechanism for reconciliation of vendor accounts, financial statements, general ledger accounts and fixed asset records. The fixed asset records are presently incomplete, lacking a depreciation schedule for real properties and mobile/rolling stock for 1989 and 1990. Also, OFNAR has not established a separate bank account to replenish worn-out equipment and light vehicles. Until such time as the bank account and depreciation tables are established, the SRMP is not able to participate in the recurrent costs.

In the case of equipment maintenance, the fixed asset records monitor the life of the equipment and are used as a decision making mechanism to determine whether a particular unit of equipment should be rehabilitated or replaced with new equipment. As a general rule, if estimated rehabilitation costs exceed 35% of the equipment original value, the unit should be replaced.

Budgetary Counseling

Budget planning and management were high priorities with the TA effort as proper "front end" planning prevents overruns and lessens the possibility of unforeseen expenses. The TA Accountant provided budget counseling to OFNAR on project related matters.

The TA Accountant maintained a dialogue and interfaced with USAID, OFNAR and donor organizations on budget constraints and USAID accepted procedures as to how the benefits from project contributions could be maximized. Solutions and alternatives for all budget related problems, and multiple recommendations as to how the budget preparation could be improved were suggested and discussed.

In the spirit of institutionalizing OFNAR, pre-financing was provided to the OFNAR/Project Account in a similar fashion as an advance for certain periods up to perhaps three or four months. The "interest income earned" on the project bank funds balances represented sums in excess of the project authorized amount. They were eventually returned to the United States Treasury.

The TA Accountant recognized that it was advantageous to minimize project pre-financing as much as possible. U.S. Government interest rate may be as much as 12%, whereas, the OFNAR/Project bank account may earn only 5% interest. The TA Accountant developed and maintained a utilization plan for the project needs, and made every effort to maximize the benefits to the project, and at the same time minimize the real costs of the grant monies. Serious efforts were made to ensure that financial transfers coincided with project expenditures, wherever and as often as possible. The TA Accountant counseled OFNAR in budget preparation since the beginning of the project in areas of: financial management, capital improvement, equipment and spares purchases, operations, seminars, special training courses, workshops, salary projections, travel etc.

The TA Accountant advised OFNAR to either; 1) establish a separate bank account for proceeds received from project equipment rental or 2) to reimburse the USAID/Chad account. To date, OFNAR has accepted neither of the alternatives, however, in at least one case, the lessee reimbursed the project accounting directly for equipment rental.

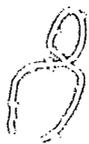
COMPUTERIZATION

The SRMP purchased four IBM PS2 computers with Iomega 20 Megabyte Cartridges and Iomega Bernouli box 20 Megabyte add-on units, LQ1050 Epson Printer, uninterruptured power supply packs and software for each unit. The software programs were Word Perfect, Lotus 123, dBase, Norton utilities, Norton Commander and Side Kick plus. The Word Perfect, Lotus and dBase programs are in French and English.

At the time the computers were received, OFNAR did not have standby generators. Electric power outages were daily occurrences, and often there was no power for days. The units remained in storage for almost a year until 1989, when OFNAR was able to obtain standby generators. Then it was necessary to wire or rewire electrical circuits in the buildings and install grounding systems in accordance with the electrical code for powerload centers.

PRIVATE SECTOR

In an effort to help develop the private sector, the TA team developed contracts with local contractors and vendors and provided guidance to Chadian personnel engaged in contract administration. Contracts were prepared for spare parts vendors agreements, fuel purchases, water well drilling, physical plant construction and facilities upgrading.



Section III
**Equipment Maintenance
Division**

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III. EQUIPMENT MAINTENANCE DIVISION

The TA Shop Superintendent and his Chadian counterpart directed the activities of the Central Workshop, developed work plans, provided budget planning information and warehouse stock requirements, approved spare parts acquisition and organized training programs. To improve supervision, training, and work performance they organized the Central Workshop into the following sections under the direction of section heads.

- Light Vehicle Section
- Machine Shop
- Body Shop
- Heavy Equipment Maintenance and Repair
- Engine Repair
- Automotive Electrical
- Fuel Service

Section heads were selected and trained by the TA team's Machine Shop Foreman, Engine Foreman and Service Foreman. Recommendations for upgrading shop facilities and purchasing new shop equipment, tools and accessories were developed and submitted to the TA Shop Superintendent for integration into a Shop Improvement Program.

The Workshop maintained records of equipment purchased by the project. These records included vendors' names and addresses, equipment serial numbers, license numbers, OFNAR equipment inventory number, dates of reception, and the equipment cost, including shipping and transit fees and the listing of spare parts purchased with the equipment. Operating records were compiled from daily use logs showing the cost of fuel, maintenance and repairs for each equipment unit.

REHABILITATION OF OFNAR FACILITIES

At SRMP start-up, there were three existing buildings that were to be rehabilitated to serve as repair facilities, classrooms, spare parts and storage facilities and administrative offices. The Central Workshop building was

operating but needed repairs and improvements. The principal administrative offices, which included the Director's office group and the procurement and finance office, required renovation. This work was planned to be completed by Chadian building contractors selected by AID/Chad bidding procedures prior to arrival of the TA Team, but work did not begin until July 1986, and continued into 1987. The offices were supplied with furniture, air conditioners and office supplies and equipment to make them fully functional. Machine shop equipment was repaired and additional equipment and shop tools were ordered by the TA team.

After completion of the building reconstruction in 1987 (Figure 2), upgrading of the Central Workshop became a high priority. The garage floor was mostly dirt. There were no water lines, air compressors or compressed air distribution system or electric lines in the building except for the Shop Superintendent's office. Electric and pneumatic power tools purchased by the project were of no use without electricity or compressed air.

In 1988, the physical layout of the parts storage area was changed and walls were constructed to the rooftop to restrict storage room access to authorized personnel. Work was programmed to install concrete floors throughout the workshop, and provide a concrete apron alongside the shop and at the rear shop entrance. An equipment washing station was constructed beside the engine and heavy equipment repair shop, complete with electric power for a high pressure washing machine, water piping and a drain system. The TA team redesigned the entire electric power distribution system for the Central Workshop as the existing system was inadequate for the new shop and garage equipment.

Installation of the power distribution system began in 1989, and was completed in 1990. This included installation of underground cables, the addition of three transformers and installation of a power load center. The light vehicle shop, machine shop, engine repair shop, heavy equipment shop, welding section and body shops are presently equipped with 380, 220 volt three phase power, and 220, 110 volt single phase power.

The fuel service office, lubricants storage rooms and new tool bins were constructed in late 1989, and finished in 1990.

FIGURE 2
REHABILITATED OFNAR COMPLEX



OFNAR Administrative Offices



Auxiliary Heavy Equipment Shop

In 1988, the World Bank obligated itself to finance the operations of the N'Djamena Subdivision, renamed the Agence des Routes de N'Djamena (ARN), and undertook construction of office and shop facilities for the ARN at the south end of the OFNAR/Ministry of Public Works complex. Eight offices, a shop area, a small warehouse and fuel depot were completed and finished. The shop was completed as an "open shop" with no security.

In April 1989, the SRMP undertook to secure the property with the addition of exterior walls and a chain link security fence on the riverside, enclosure of part of the shop area, a vehicle lock-up and some small modifications to the offices.

EQUIPMENT RECOVERY PROGRAM

The equipment recovery program was a critical aspect of initiating the road maintenance program. At the start of the SRMP, the existing equipment inventory of OFNAR was scattered throughout the country in varying states of disrepair. The equipment had to be located in the field; inspected; repaired on site, if possible, or transported back to the Central Workshop or to the appropriate local dealer for repair. The SRMP planned to procure a field repair truck complete with tools and equipment, a tow truck, a truck tractor with low boy and a fork lift to assist this effort prior to the arrival of the TA team. When this equipment was not forthcoming, the TA team rehabilitated an OFNAR truck tractor and low boy to carry the equipment, transported the equipment under its own power or towed it behind a dump truck.

As the equipment was field inspected, the TA Shop Superintendent prepared an equipment assessment report providing recommendations for using, repairing, or cannibalizing each piece of equipment. The report documented the parts that could be salvaged from equipment considered beyond repair, and estimated a time frame and cost for repairing equipment that could be made operational. Equipment having a repair cost in excess of 35 percent of the cost of a new unit was usually scrapped.

Major equipment repairs such as engine overhauls, transmission rebuilding and similar complex activities were to be done by local repair shops with OFNAR

performing general service, unit component replacement, adjustments and minor fabrication. This procedure was planned to encourage the development of the private sector, but the private sector was not prepared to participate. The local Caterpillar dealer provided some repair assistance, but the majority of all repair work was done by OFNAR under the direction of the TA Service Foreman. Initially, progress was slow because tools and equipment ordered for the shop in December 1985 had not arrived. This delay provided the opportunity to plan, organize and train mechanics.

The equipment recovery program began in February and continued through December 1987. Eighty-four pieces of equipment, as shown in Table 2, were retrieved and rehabilitated. This total includes equipment unexpectedly recovered and released by the Chad Army at Faya Largeau.

TABLE 2
EQUIPMENT RETRIEVED AND REHABILITATED

Bulldozers	- 9	Backhoes	- 3
Front End Loaders	- 12	Forklifts	- 1
Motor Graders	- 15	Heavy Trucks	- 22
Compactors	- 10	Light Vehicles	- 12

Rehabilitated equipment was quickly deployed in the field and a road maintenance program begun early in the project, Spring 1986. In October 1986, the TA Brigade Equipment Foreman and Brigade Foreman were mobilized on the project in advance of the formation of the Maintenance Training Brigade to assist in forming, equipping and training small maintenance brigades in the N'Djamena Subdivision. Actual road maintenance began at that time on the N'Djamena-Djermaya Road, and the N'Djamena-Guelendeng Road.

The initial fleet inventory of OFNAR equipment was prepared as part of the equipment recovery program. A reporting form was prepared identifying each piece of equipment by number and classification, along with technical and mechanical data of components. An equipment history file was begun to document equipment age, condition, maintenance and repair activities, usage and costs. Inventory control procedures were developed to track the addition, transfer, and disposal of equipment.

WORKSHOP OPERATIONAL PROGRAM

The TA Shop Superintendent implemented an operational program for the Central Workshop designed to develop mechanical and administrative procedures that would optimize the benefits of available resources and improve workshop management. The objectives were to minimize equipment down time, lower costs to repair and maintain equipment, extend the useful life of the road maintenance equipment and provide management with the information needed to make decisions. The responsibilities of the TA Service Foreman were increased to include the Heavy Truck Section and the Electrical Section. The TA Machine Shop Foreman also supervised the Body Shop and the Light Vehicle Section, and the TA Parts Specialist supervised the Parts Section and the Central Warehouse. The TA Engine Foreman organized the engine repair shop into three sections, (1) disassembly, parts cleaning and parts requisition, (2) assembly and trial performance, (3) engine overhaul.

A preventive maintenance program was established to identify routine servicing needs on a regular basis and to inspect for repair work before a problem developed. With the program, parts and supplies could be ordered prior to the scheduled service, and inspection work and downtime could be minimized. A routine maintenance schedule was established for each equipment class. Responsibility and authority for accomplishing the work were assigned to mechanics who were instructed in the procedures to follow and the proper tools to use. The mechanic was given a checklist for each type of equipment and instructed to document the manpower, equipment and materials expended for each maintenance or repair activity. The work was inspected by the assigned authority to assure quality control.

Equipment repair procedures employed shop manuals and trouble shooting guides to help diagnose mechanical problems. After diagnosis of the problem, replacement parts were requisitioned, a step by step procedure was outlined, and the required manpower was assigned to complete the work.

Time standards appropriate to the Chadian work force were developed for all equipment and repair activities. These standards measured the time required to perform certain maintenance and repair items such as component removal and

installation, disassembly and assembly, reconditioning, and cleaning, lubrication and adjustment. The time standards were used to plan and schedule maintenance and repair work, estimate the cost, and evaluate the performance of individual mechanics and work shop crews.

The preventive maintenance schedule, the equipment repair procedures, and the time standards were used to instruct the workshop administrative personnel in work scheduling. They were taught to prioritize equipment maintenance and repair activities and to project the work load on a weekly, monthly and annual basis. Manpower requirements, workshop equipment, spare parts and materials could then be ordered to meet the projected workload.

All work performed was reported on forms designed to effectively monitor work ordering procedures, actual work performed, resources expended and equipment down time. This helped to provide an efficient flow of work through the shop and to keep track of costs.

An equipment replacement program was developed to help determine when a piece of equipment became obsolete or nonrepairable. When major repairs were required, an assessment was made to determine if the equipment was still necessary and its expected service life. Repair and operational history was reviewed and compared with current repair costs. A decision was then made to repair or to cannibalize for spare parts and order new equipment. Generally, a repair cost in excess of 35 percent of replacement caused the equipment to be scrapped.

As experience was gained through implementation of the Workshop Operational Program, changes were made in staff size, equipment and tools used, preventive maintenance schedules, repair procedures, time standards and work schedules. Delays that occurred, such as in the procurement of parts, were addressed. Improvements in the floor layout of shop facilities were recommended and, in some cases, accomplished. There is a need for more sophisticated diagnostic equipment and training in electrical repair. Mechanics must all be taught responsibility and pride in their work.

CENTRAL WAREHOUSING

By 1988, most of the Central Workshop rehabilitation was completed, and the warehouse area was located inside the Workshop, separated from the main shop area by a high wall through which access was limited to a single door. The wall did not extend to the roof of the Workshop, and the storage area was without ceiling and open to the roof. Although the wall could be scaled and the storage area entered, the warehouse was considered secure as entry would have to be gained through the main workshop doors and passed outside security guards.

Following a large, after work hours, robbery in April 1988, the wall was extended to the roof and the warehouse completely enclosed. At the same time, the warehouse storage area was expanded to about three times its original size, and a general storage area in the Workshop was converted into a receiving room with a separate outside entrance. The outside entrance eliminated public access to the main warehouse area. The TA team designed a shelving plan and organized work parties of OFNAR employees to construct storage bins and shelf racks. Spare parts that had been stacked on the floor could now be stored on shelves and in storage bins. Each part was listed on the Kardex Inventory Control forms as it was categorized and stored.

The Kardex System designed by the TA Parts Specialist was a simple, practical inventory system that provided OFNAR with the information necessary to control the movement of spare parts and supplies. The system included:

- A numbering system to identify and classify all spare parts and supplies
- Cross referencing of interchangeable items
- Shelf and bin location labeling
- Inventory data recording part number, manufacturer's code number quantity on hand, source of supply, receipts, cost and minimum stock level.

Personnel were taught record keeping procedures to maintain inventory control. They were taught to log-in the information when an item was received, to assign each item to a specific storage bin or shelf, to document transfers of

parts to subdivision workshops, and to document on a work order when spare parts were issued.

The warehouse manager's office was renovated for installation of an IBM PC2 computer. Computerization of the entire warehouse stock is in progress by the World Bank funded TA Team. Computerization was not done by the SRMP because computers were not installed in the warehouse until after the TA Parts Specialist completed his tour.

The parts storage area was organized by manufacturers' sections, such as Caterpillar, Mercedes, Toyota, Peugeot and Berliet. All parts were identified, located and pertinent information recorded into the Kardex System. Dispensing is well ordered as dispensing tickets (Bon de Sorties) are issued for each item dispensed.

AID, with input from the TA Team, established a written procedure for the year-end inventory of the warehouse stock. The inventory was conducted in 1989, under the direction of the BCEOM Accountant Advisor and the Warehouse Specialist without notification to the TA Accountant Advisor. Because AID resources and spare parts were used for activities of OFNAR not supported by the SRMP, the SRMP no longer participates in stocking the warehouse.

PARTS PROCUREMENT

The TA Parts Specialist developed criteria and procedures for purchasing and ordering spare parts and supplies. The criteria considered historical demand, supply on hand, storage capacity, delivery times, bulk purchases and procurement costs. The reorder quantity was calculated to minimize inventory costs and usually conformed to the minimum stock level. The minimum stock level is that quantity required to satisfy demand during the time replenishment stocks were being ordered and received plus a safety factor.

The traditional procurement system entrenched in OFNAR required no less than a dozen internal signatures of approval for even the smallest purchase. Purchase of spare parts and supplies took four to six months to complete, and the Workshop was filled to capacity with partially dismantled equipment and vehicles

waiting repair parts. Despite strong objections, individual approval power was gradually relinquished, and by 1989, the internal procedure was reduced to four approval signatures. These signatures were the TA person who originated the requisition, the TA Accountant Advisor who encumbered the expenditure, the AID Representative, and the OFNAR Director or Assistant Director.

From OFNAR, the requisition proceeded to the "Controle d'Etat" (IGCE). The IGCE signs all requisitions, receipts and check payments for the purchase of approved commodities by order of the GOC. IGCE approval is frequently difficult to obtain, and the turn around time and taxing of documents can be time consuming.

After the requisition is approved by the IGCE, the OFNAR purchasing section advertises for bids, and awards the requisition to the lowest-cost qualified bidder. At delivery, the merchandise is witnessed on a receiving document and signed for by the IGCE agent and the OFNAR warehouse representative. Upon receipt of payment documents, the OFNAR accountant draws a check on the appropriate project account. The check passes from the TA Accountant Advisor, to the OFNAR representative, to the IGCE, for visa, and back to the TA Accountant Advisor for payment to the vendor.

Time is an important consideration when purchasing spare parts. There are no spare parts produced in Chad and few items are inventoried in the local market. Delivery time frequently exceeds scheduled dates and normal expectations. When spare parts are not delivered within four months, the requisition must be canceled and the procurement process repeated. The inhouse response time within the procurement section may extend into three to six weeks because of other donor priorities or work backlog.

The Team established a blanket order procurement system (B/O) to effect same date purchase authorization, provided the spare parts are available in the local market. Two TA members were authorized to use the system. The B/O was designed to provide immediate supply of spare parts, thereby minimizing equipment down time, strictly controlling spare parts purchased, and eliminating warehouse risk of loss. The vendor accounts were handled and paid by the project controller directly, thereby reducing the time in paying vendors. The success

of the system depends on the availability of goods in the local market or the ability to quickly import the requisitioned goods.

Chadian custom permits anyone to sell goods to OFNAR. An approved list of vendors is in use, but the list continues to grow as management deems necessary or as special cases occur. A strict system of prequalification of vendors must be established and procurement must adhere to the system if fraud, deception and incompetence are to be eliminated.

Counterfeit parts are occasionally supplied and normally go undetected until placed in use. Efforts to identify the vendors are usually unsuccessful because the parts become mixed with the warehouse inventory. If the vendor can be identified, he usually cannot be located.

Customs duties, sometimes as much as 85%, must be paid on imported commodities. Otherwise, a special duty free franchise document must be produced for each importation or by individual purchases. Franchise document approvals are frequently difficult or impossible to obtain from customs. The SRMP is not permitted to pay any identifiable taxes. Therefore, a franchise document must accompany the purchasing documents for payment. An example in circumventing the unobtainable franchise document is the fuel purchased for the project. All fuel is purchased through the OFNAR account, tax included, and reimbursed to OFNAR at the price excluding tax.

Following the recent reorganization of OFNAR, procurement is now under the direction of the BCEOM technical assistance effort.

TRAINING

The SRMP provided five TA team members within the Central Workshop, each of who worked in cooperation with a Chadian counterpart. Four of the TA members directly supervised at least five Chadian mechanics, service personnel, or machinists in servicing and repairing equipment. The fifth TA member, the Shop Superintendent, in cooperation with his Chadian counterpart, supervised the Workshop operations.

Training was primarily "on-the-job training" supplemented by more formal classroom instruction. The TA members instructed by demonstrating proper techniques and observing the trainee in performing actual service and repair activities. Personal attention was given to each trainee, as needed.

Many of the trainees were previous OFNAR employees who had acquired acceptable skill levels. In these cases, refresher or remedial training methods were employed to improve skill levels and efficiency, or to correct bad habits. These employees formed a "cadre" for training inexperienced personnel. Training programs were conducted in the following areas of technology and specialization:

1. Warehousing and dispensing
2. Heavy equipment maintenance and repair
3. Parts fabrication and machinery
4. Automotive maintenance and repair
5. Specialty training in electrical repairs, welding, engine rebuilding, and bodywork.
6. Workshop safety.

The SRMP mistakenly assumed a basic educational level for all trainees, when in fact many trainees had never been to school and had received no formal education except for instructions from the Faqui in their village. Competency in the French language was not universal among the trainees, and instructions frequently had to be translated from French into Arabic by other trainees.

Correcting improper techniques and acquired bad habits proved a formidable challenge, but perhaps the most frustrating trait was the reluctance of the trainee to admit he did not know or did not understand. Errors were made, and instructions were frequently repeated. In spite of these drawbacks, personal skill development progressed, and many trainees reached acceptable skill levels for their job duties and responsibilities.

Section IV
**Maintenance Training
Brigade**

IV. MAINTENANCE TRAINING BRIGADE

The Maintenance Training Brigade (MTB) was established to provide a newly equipped road maintenance unit capable of maintaining 800 kms of road annually. Selected personnel were trained as heavy equipment operators, mechanics and maintenance support personnel for later assignment to existing subdivision road maintenance units. Formal classroom training was proposed with practical training to be conducted in an assigned area near OFNAR, but it was decided the Brigade would be an operating unit emphasizing "hands on" operating training, and learning by doing. The operational area was the N'Djamena Subdivision. Operational control and training were the responsibility of the TA Brigade Foreman and the TA Equipment Foreman under the general direction of the TA Field Engineer.

EQUIPMENT PROCUREMENT

Equipment procurement (Table 3) for the MTB began in May, 1986, when the TA team wrote the equipment specifications. Caterpillar was selected as the manufacturer to supply road maintenance equipment, and Mercedes Benz was selected to supply heavy trucks. These manufacturers were selected because of their reputation for quality equipment, and because of the desire to standardize the type of equipment in OFNAR's inventory. Standardization of equipment would improve the quality and efficiency of equipment repair work, ease spare parts procurement and reduce the number of spare part categories in inventory. The Caterpillar equipment was purchased through the local authorized dealer (Figure 3). The Mercedes trucks were purchased direct from the factory in West Germany. Approximately 15% of the equipment cost was added to the purchase orders for spare parts.

Auxiliary equipment, such as compactors, office trailer, farm tractor, travel mixer, and tools were procured from U.S. manufacturers by an outside service organization under contract to AID (Figure 4). Two Porta-Kamp trailers were designed and purchased by Gannett Fleming to provide living accommodations for the TA Brigade Foreman and the TA Brigade Equipment Foreman. Pickup trucks were purchased locally.

TABLE 3
MAINTENANCE TRAINING BRIGADE EQUIPMENT

Caterpillar Equipment

<u>Item</u>	<u>Quantity</u>
Bulldozer D-7H	2
Front End Loader 955	2
Graders 120G	2

Mercedes Benz Truck

Dump Trucks 2628	8
Fuel Truck 2628	1
Water Truck 2628	2
Field Service Truck 911	1
Maintenance Truck 911	1

Other Equipment

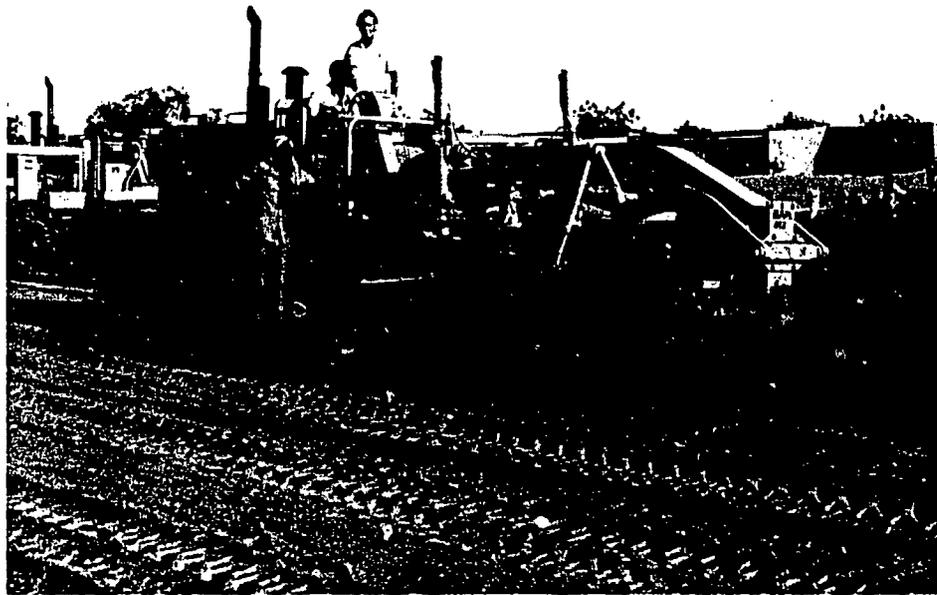
Vibratory Compactors, S.W.	2
Towed Sheepsfoot Rollers	2
Compactor, 7T	1
Pick-up Trucks	2
Office Trailer	1
Water Pump	1
Travel Mixer	1
Farm Tractor	1

The time span required to complete the procurement process, manufacture and shipment of the equipment delayed the arrival of the Caterpillar equipment until August, 1987. The Mercedes trucks arrived in November, and the remaining equipment by May, 1988. As work progressed, the need for a tow truck; truck tractor with flatbed and low-boy trailers; and a back hoe was identified, but funding was unavailable.

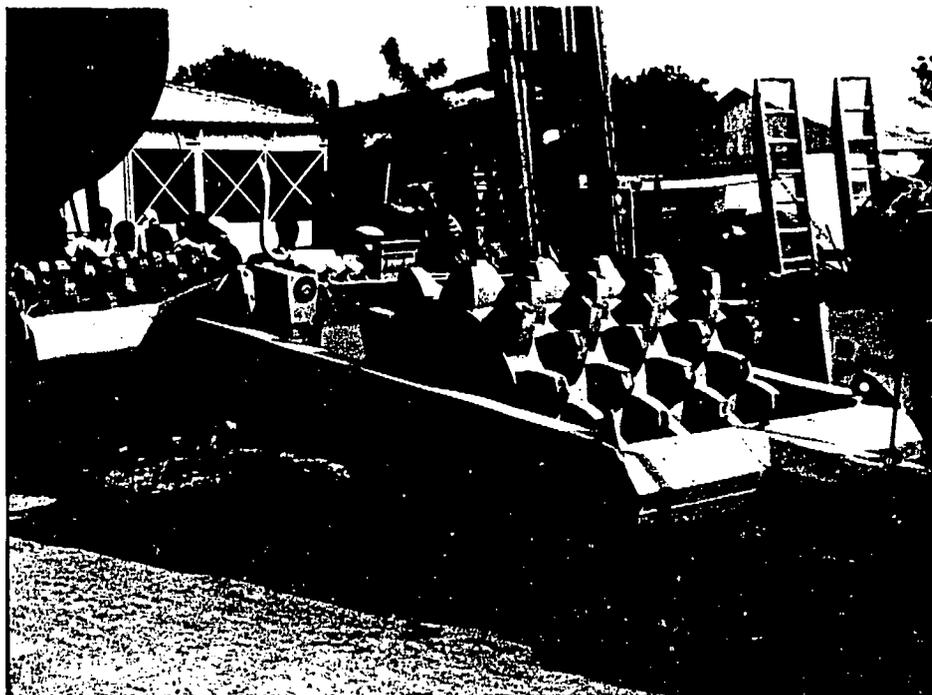
MAINTENANCE TRAINING BRIGADE ORGANIZATION

Originally scheduled to begin training in June, 1986, the MTB began organizing in August, 1987, when the Caterpillar equipment arrived. The MTB was staffed with personnel recruited by OFNAR. The staffing included a field engineer, a field office manager, clerks, work supervisor, operators, truck

FIGURE 3
MAINTENANCE TRAINING BRIGADE EQUIPMENT



Caterpillar Grader Working N'Djamena City Streets

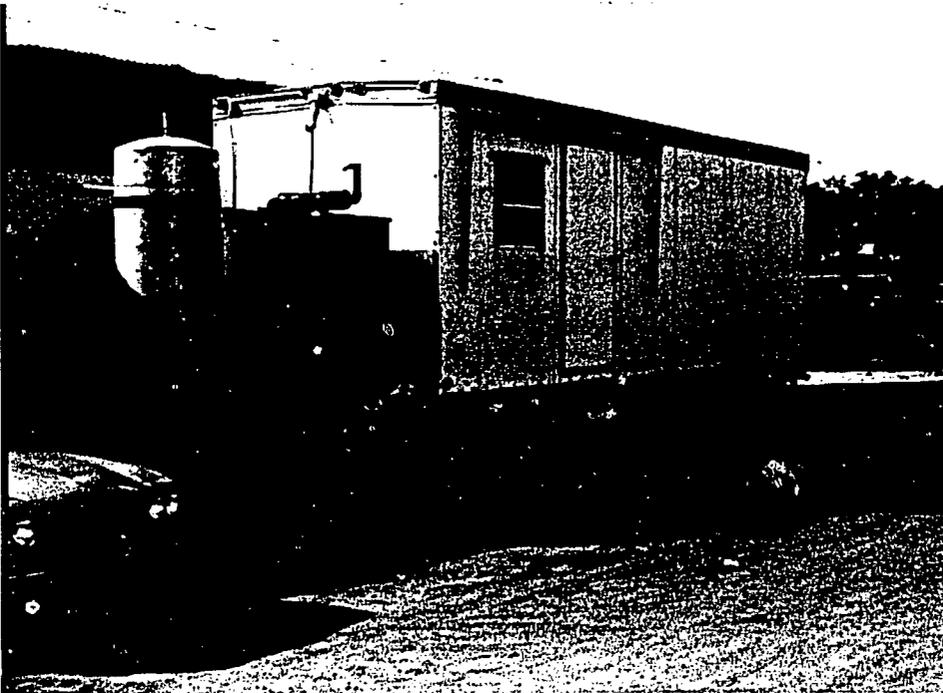


Bomag Vibratory Sheepfoot Roller

FIGURE 4
MAINTENANCE TRAINING BRIGADE EQUIPMENT



John Deere Farm Tractor for Towing and Backhoe Work



TA Brigade Foreman House Trailer

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drivers, fuel and water pumpers, greasers and laborers. The brigade numbered between 35 and 50 employees.

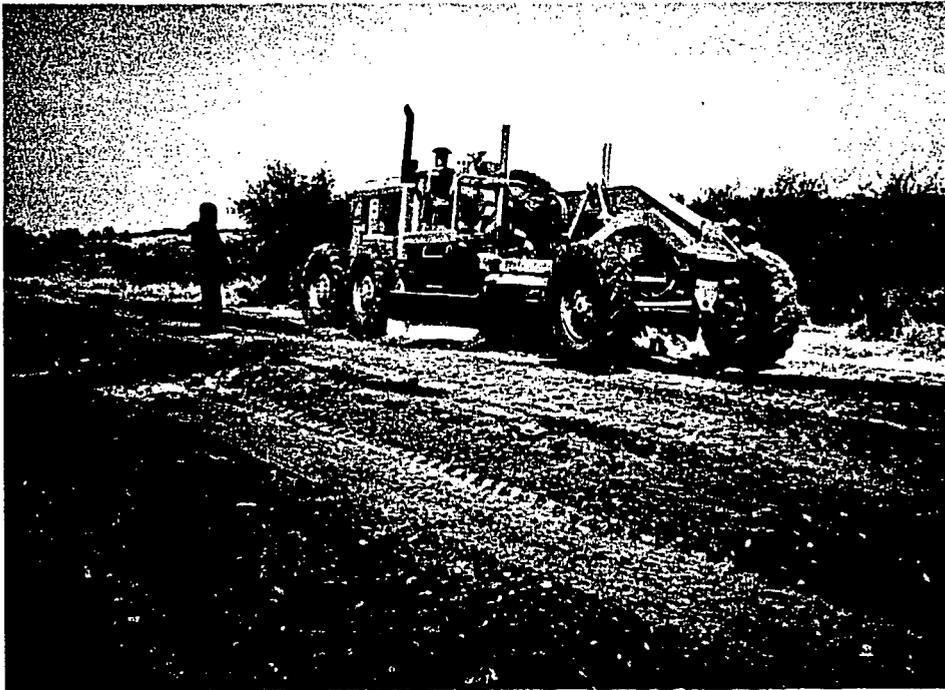
Training was planned to be accomplished by doing productive work, but with emphasis on the development of operating skills. The MTB was to operate in close proximity to N'Djamena where logistical, organizational and personnel problems could be identified and solved, and training progress could be monitored by AID, OFNAR, and the TA team. After a brief period of familiarization with the equipment by grading city streets, the MTB began work on the N'Djamena-Guelendeng Road. With the arrival of the Mercedes trucks, the MTB was stationed in Bongor to work on the Guelendeng-Bongor-Lai road rehabilitation program.

The inexperience of several of the drivers and errors in judgement caused several truck accidents. There were no serious injuries, but truck damage was severe. Communications with the MTB was by messenger until radios could be purchased and installed. Initially, supply of spare parts and operating materials was undependable, frequently causing excessive down time on some pieces of equipment. Thievery also occurred until a more controlled parts ordering and reception system was established, and security measures installed in the storeroom.

In spite of these start-up problems, the MTB filled pot holes the size of craters and reprofiled the roadway from N'Djamena to Bongor in its initial year of operation (Figure 5). Travel time between N'Djamena and Guelendeng was reduced from 8 to 2 hours, and between Guelendeng and Bongor, from 5 hours to 1.25 hours. The traveling public benefitted in speed, ease and safety of travel at lower operating cost.

At the training year's end in 1988, certificates of achievement were awarded to 13 equipment operators and 8 drivers. The equipment operators had reached competency levels in the operation of bulldozers, graders, front-end loaders and compactors. The drivers were trained in the operation of dump and tank trucks.

FIGURE 5
MTB ROAD MAINTENANCE ACTIVITIES



Filling and Grading Depressed Area



Borrow Pit Operation to Obtain Road Fill

It was planned to assign the graduate trainees to existing subdivision maintenance brigades and begin a new training cycle, but there were few position openings available, primarily because of a scarcity of equipment. All rehabilitated equipment was in use, and new equipment contributed by other donor agencies was on order. Consequently, training was discontinued until additional need for trainees materialized. The trainees remained with the MTB, and the MTB was divided into two smaller operating brigades, called the Brigade North and the Brigade South. Their assignment was to concentrate on productive road maintenance within the N'Djamena Subdivision. The addition of the two brigades made the subdivision an equipped, trained, and viable road maintenance organization. The Brigade South continued performing road maintenance from its base in Bongor and had the additional responsibility of providing training on demand. The Brigade North moved to a base at Massaguet.

On reorganizing the MTB, the TA Field Engineer was assigned the responsibilities of operating and controlling the N'Djamena Subdivision, renamed the Agence des Routes N'Djamena (ARN). This responsibility included organizing and operating the ARN warehouse and central shops in N'Djamena; supervising ARN administrative personnel; equipping the offices; controlling the main equipment park, satellite warehouse, encampment parks, and the ARN fuel depot and fuel dispensing operations. The TA Brigade Foreman was reassigned duties as work superintendent to advise the Brigade North and the Brigade South. The TA Brigade Equipment Foreman completed his contract in October, 1988, and the position was deleted from the project.

As additional road maintenance equipment arrived in country for assignment to the other road maintenance subdivisions, the Brigade South began again to train operators and drivers. A Chadian equipment operator/trainer was assigned to instruct and supervise the training effort under the general direction of the TA Brigade Foreman.

WORK ACCOMPLISHED

The MTB began road maintenance at the end of August, 1987, by grading the city streets in the Moursal section of N'Djamena. The work was done at the request of the city and supported by city equipment. The city provided trucks,

water tankers and compactors. Between the end of August and the end of October, approximately 45 kms of city streets were repaired. Then the two MTB graders teamed with two city graders and spent two weeks grading the road to Linia. This work provided the trainees with an opportunity to learn teamwork and develop grader manipulative skills.

At the end of October 1987, the MTB began work on the N'Djamena-Guelendeng Road. The 153-km long N'Djamena-Guelendeng Road is the principal truck transport route south. At one time it was asphalt paved, but the absence of maintenance caused the surface to deteriorate severely. Large holes developed that made long sections of the roadway impassable. Vehicles had to leave the roadway and travel parallel to the base of the embankment, or on cross country tracks, and then remount the roadway when the surface again became trafficable. Because this road section was programmed for reconstruction under a World Bank contract beginning in 1989, the MTB objective was to fill the holes in the degraded asphalt sections and provide a reasonable running surface instead of undertaking major earthwork and asphalt repair. The MTB completed the work before the end of February, placing, spreading, and compacting more than 200,000 m³ of earth.

At the completion of this assignment, the MTB established an operating base in Bongor and began work on the Guelendeng-Bongor Road. This earth road had not been graded in 15 years. Numerous depressions, holes and ruts had developed that filled with water during the rainy season and made the road impassable. The only trafficable section was for 15 km outside Bongor where the road was located on a dike. The maintenance effort was vastly improved on June 1, 1988, when two new compactors arrived and increased the compacting capability of the MTB. Prior to that time, compaction was done by loaded trucks and traffic. An estimated 130,000 m³ of earth was added to this 83 km road section. Ditches were constructed and the surface was regraded with a crown to improve surface water runoff. The road is currently programmed to be reconstructed within two years by another donor agency .

In early July, 1988, the MTB placed 3,000 m³ of earth materials on the access road to the ferry at Bongor. The principal streets in Bongor were regraded, and work began on constructing embankments for the Bongor-Lai Road. More than 86,000 m³ of earth were placed on this road section for a distance of

20 km south of Bongor when heavy rains caused flooding that halted the activities. More than 1,000 m³ of gravelly sand were taken from the Logone River at Naina for surfacing and mixing with common earth material to increase the embankment stability.

When the rain halted the maintenance operations in the south, four trucks and a loader were sent to the north to work with the subdivision on the 265 km N'Djamena-Bokoro Road. This formed the Brigade North.

Other work assignments of the MTB were:

1. Clear and regrade streets of Guelendeng and Bongor
2. Install culvert at Farcha
3. Build emergency flood dikes at Bongor, Chagoua and Ngueli
4. Rebuild ferry accesses at Kousseri, N'Djamena and Bousso
5. Repair guard rails on Chagoua Bridge
6. Repair abutments and railings of Linia Bridge
7. Repair abutments of Loumia Bridge and Ngueli bridge
8. Install 30 culverts on Bongor-Lai-Ere Road
9. Repair multiple culverts near Ngueli
10. Grade road between N'Djamena and Pont Belele.

A considerable amount of work was accomplished by the MTB in the 2 1/2 years between 1987 and 1990, a summary of which is shown in Table 4. Major accomplishments were road maintenance on the principal north-south road from Ere/Lai north to Bokoro. These roads were upgraded from rutted tracks to reasonably good, dry-weather roads. Major road sections were N'Djamena-Linia, N'Djamena-Guelendeng, Guelendeng-Bongor and Bongor-Lai. Other work was improving access to ferries at Bongor, Ere and Bousso, and aiding the municipalities of N'Djamena, Guelendeng and Bongor in maintaining their city streets.

OBSERVATIONS

A complete road maintenance brigade, consisting of two graders, four dump trucks, front end loader, bulldozer, water truck, two compactors and mechanical service and repair equipment can properly maintain 200 km of road annually on a

TABLE 4

**ROAD MAINTENANCE BY MAINTENANCE TRAINING BRIGADE
N'DJAMENA SUBDIVISION**

Route	Length (Km)	Brigade N or S	Equipment		1987	1988			1989			1990			Length of Roadway (Km)	Quantity of Earth Placed (m ³)					
			Alternative ①	Alternative ②		S	O	N	D	J	F	M	A	M			J	J	A	S	O
N'Djamena-Guelendeng	153	S	8 Trucks 2 Maint. Trk. 1 Fuel Trk. 2 Water Trk. 2 Bulldozers 2 Loaders 2 Graders			200,000 m ³								153	200,000						
Guelendeng Bongor	83	S	8 Trucks 2 Maint. Trk. 1 Fuel Trk. 2 Water Trk. 2 Bulldozers 2 Graders 2 Loaders 1 Compactor	4 Trucks 1 Maint. Trk. 1 Fuel Trk. 2 Water Trk. 1 Bulldozer 1 Grader 1 Loader 1 Compactor		① 130,000 m ³	① 8,000 m ³	② 30,000 m ³		② 21,000 m ³	② 10,000 m ³	② 54,000 m ³	425 (5 Passes)	251,400							
Bongor-Lal Ere	173	S	4 Trucks 1 Maint. Trk. 1 Fuel Trk. 1 Water Trk. 1 Bulldozer 2 Graders 1 Loader 1 Compactor	8 Trucks 2 Maint. Trk. 1 Fuel Trk. 1 Water Trk. 2 Bulldozers 2 Loaders 2 Compactor		② 88,000 m ³	2 Bulldozers ① 150,000 m ³		1 Truck under Repair ① 24,400 m ³		① 30,000 m ³	386 (2 Passes)	290,400								
Ferry Access Bongor	5	S	4 Trucks 1 Water Trk. 1 Bulldozer 2 Graders 1 Loader	2 Trucks 1 Loader 1 Grader		② 3,000 m ³	② 3,000 m ³	① No Bulldozer 8,000 m ³	② 3,000 m ³	① 8,000 m ³	① 1,000 m ³	36 (6 Passes)	26,000								
Ferry Access Ere	9	S	4 Trucks 1 Water Trk. 1 Bulldozer 2 Graders 1 Loader						20,000 m ³		2,000 m ³	2,000 m ³	18	24,000							
Ferry Access Bouso			1 Truck 2 Trucks 1 Bulldozer 1 Loader						5,000 m ³			3,000 m ³	2	8,000							
Djermaya-Bokoro	224	N	4 Trucks 2 Water Trk. 1 Field Trk. 3 Graders 1 Bulldozer 1 Loader 1 Compactor						160,000 m ³		No Bulldozer 100,000 m ³		672 (3 Passes)	260,000							
N'Djamena-Linia	30	N	4 Trucks 1 Water Trk. 2 Graders 1 Bulldozer 1 Loader 1 Compactor	2 Graders 2 Graders	②					① 30,000 m ³		1 Grader 1 Water Truck	70 (2 Passes)	30,000							
Customs Road N'Djamena	2	N	4 Trucks 1 Bulldozer 1 Grader 1 Loader 1 Compactor								5,000 m ³		1	5,000							
Rehabilitation of ARN		N	4 Trucks 1 Water Trk. 1 Bulldozer 2 Graders 1 Loader 1 Compactor							20,000 m ³			300 M	20,000							
Other													--	30,000							
TOTAL													1763.3	1,144,800							

Note: Maintenance Training Brigade was reorganized into two operating brigades after one training year.

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roadway that has not been recently maintained. With regular scheduled maintenance, it may be possible to achieve 800 kms annually. The reason for the difference in production is the unmaintained road requires substantial rebuilding. Large volumes of fill material must be placed and compacted to raise and reshape the roadway cross section. With scheduled maintenance, a single pass of the grader and minor filling would be all that would be necessary to provide an improved surface. Approximately 5 to 15 centimeters of surfacing material disappear annually through erosion and traffic movement. This must be replenished annually, or rebuilding becomes necessary.

The majority of the roads maintained by the MTB were merely tracks with no elevated cross sections or side drainage ditches. The tracks were usually below the natural surrounding ground level. This caused water to pond on the roadway during the rainy season. The result was mud which was churned deeper and deeper by passing traffic until large ruts developed and the road became impassable.

The road maintenance operations performed by the MTB followed specified procedures in the order listed below:

After the Rainy Season

1. Rapid grading of the road profile to fill large holes and make the roadway passable.

During the Dry Season

1. Slow grading to redefine roadway width and clear away brush.
2. Develop a roadway cross section from 50-75 centimeters above the natural ground surface and crowned in the middle to promote surface drainage.
3. Grade side drainage ditches and open run-off ditches.
4. Place culverts, drainage channels and elevate low sections where water ponding is evident.

Before the Rainy Season

1. Rapid grading to fill holes and compact loose surface material.

During the Rainy Season

1. Grade and compact when possible to take advantage of moisture in the soil to improve compaction and in-place density.
2. Excavate and replace mud areas.
3. Cease operations for approximately the last month of the rainy season to avoid damaging water saturated embankments and roadway sections.

Soils within the N'Djamena Subdivision are very fine sand, silt and/or clay. These are poor road building materials because they quickly lose stability during the rainy season, and turn to dust during the dry season. Sand can be obtained from the rivers during the dry season and improves the stability of fill material and road surfacing when mixed with suitable cohesive soils. Rock is available only from the quarry at Dandi and from Cameroon.

As a practical solution to obtaining road materials and expediting maintenance work, borrow pits were located along the roadway at approximately 20-25 km intervals. Subsurface soils were selected for use by performing simple field tests to determine hardness, grain size and plasticity. Some mixing of pure sand and silty clay took place in the borrow pit to improve the engineering characteristics of the material. The best soil type was a mixture of sand with 30-40% low plasticity clay. A soil exploration program involving extensive subsurface exploration, laboratory testing and establishment of semi-permanent borrow pits with soil mixing capabilities would assure that the best available, naturally occurring materials were used in maintenance work.

The OFNAR practice has been to stop maintaining roads during the rainy season from July through September, and use the time to repair equipment for operation in the dry season. The TA team encouraged working during the rainy season to take advantage of the water absorbed by the soil, and water that had collected in depressions. Water is essential to compacting soils to their maximum densities. During the dry season, water was obtained from rivers by tank

truck, or from municipalities with adequate water sources. This frequently required long distance hauling which delayed work progress or caused some road sections to be compacted without benefit of water. Preliminary plans have been made to drill wells and construct retention basins at intervals along heavily travelled roads as water supply points for the Brigades.

TRAINING

The goal of the MTB was to train equipment operators and field road maintenance personnel to be competent and responsible OFNAR employees. Many of the trainees lacked basic education and the ability to speak or understand French, but by judicious use of pictures, demonstrations, practical application and the help of more experienced trainees, a larger than expected number of employees were trained, evaluated, and located in suitable positions. Seventy-seven persons were trained of which 66 are still employed by OFNAR. Table 5 shows the number and classification of trained personnel.

TABLE 5
PERSONNEL TRAINED BY THE MAINTENANCE TRAINING BRIGADE

<u>Position</u>	<u>No. Proposed</u>	<u>No. Trained</u>
Field Supervisors	8	3
Equipment Operators	42	36
Field Mechanics	10	3
Mechanic's Aides	10	4
Truck Drivers	8	16
Light Vehicle Drivers	2	5
Warehouse Men	0	2
Welder	0	1
POL Technician	0	1
Clerks	2	4
Operator Instructor	0	1
Field Office/Radio	<u>0</u>	<u>1</u>
TOTAL	82	77

During the rainy season when field work was not possible, the trainees received classroom instructions. The equipment operators were issued books by Caterpillar on how to operate and maintain Caterpillar equipment. These books contained many pictures, and step by step instructions making them easy to understand and easy for the operators to apply the principles to the actual piece of equipment. The operators used these books as references for problem solving throughout the training period.

Equipment operators and supervisors received copies of Road Maintenance Manuals (Manuel d'Entretien des Routes) published by the United Nations specifically for use in Africa. These books provided simple instructions with illustrations in basic road maintenance. Drivers received copies of "Code de la Route," and individualized instruction in safe driving techniques, tire changing, tire repair, and preventive truck maintenance.

Superintendents and foremen received training to improve or refresh their technical skills. The training was aimed at upgrading their ability to plan and control road maintenance work, lead and motivate their staff, solve field technical problems and personnel problems and become conscious of productivity and manhours. They were also taught techniques to enable them to pass on their skills to other personnel. Instructions in work planning and control included setting work priorities, establishing and implementing schedules, performance measurements, quantity estimates, and quality and cost control. Supervisory techniques included human relations, communications, motivation techniques and personnel evaluation. Practical training included opening borrow pits, selecting materials, stockpiling materials, proper water application, repair of damaged embankments, eroded culverts and bridge abutments, and establishing field camps.

Equipment operators received instructions in equipment operation and maintenance, basic equipment mechanics, servicing and safety. They were taught to have pride in keeping the equipment assigned to them in good operating condition, and the need for performance and productivity. Field demonstrations of proper road maintenance techniques included placement and grading of fill material, profiling road surfaces and embankments, scarifying, ditch forming, cutting slopes, blading without segregation, identifying and removing unstable soils, excavating and compaction.

Mechanics and field servicemen received training in preventive maintenance, field servicing, inspection, and component replacement. Support personnel were instructed in the use of forms and methods for inventory control, record keeping, and filing.

Some of the trainees appointed to the MTB lacked the education, aptitude, physical attributes and character needed for their positions. These employees were reassigned to lower level positions to gain experience and advance to higher positions as they became more responsible and reliable. Selective evaluation of applicants according to position requirements prior to employment followed by a probationary employment period should be part of personnel policy so that irresponsible or untrainable persons can be dismissed or assigned elsewhere.

The MTB was too large as organized. There should have been no more than 20 trainees. This would have allowed the TA Brigade Foreman to devote more time to individual training instead of spending most of his time managing operations. The attained skill levels would be higher and the training cycle would be shorter. Probably the same number of graduates could be produced in the same time period with better overall results. The suggested equipment for a maintenance training brigade is shown in Table 6.

TABLE 6
EQUIPMENT FLEET FOR A MAINTENANCE TRAINING BRIGADE

<u>Equipment</u>	<u>Quantity</u>
Bulldozer	1
Grader	2
Loader	1
Dump Trucks	2
Water Truck	1
Maintenance Truck	1
Tractor and Low Boy	1

One of the problems encountered in the training program was the resistance of trainees to new ideas and techniques, and their reluctance to change. Trainees accepted only those parts of the training that blended with traditional methods, and as a result their training was incomplete. Follow-up instructions are recommended to assure that concepts taught were understood and accepted, and are practiced.

Section V
N'Djamena Subdivision

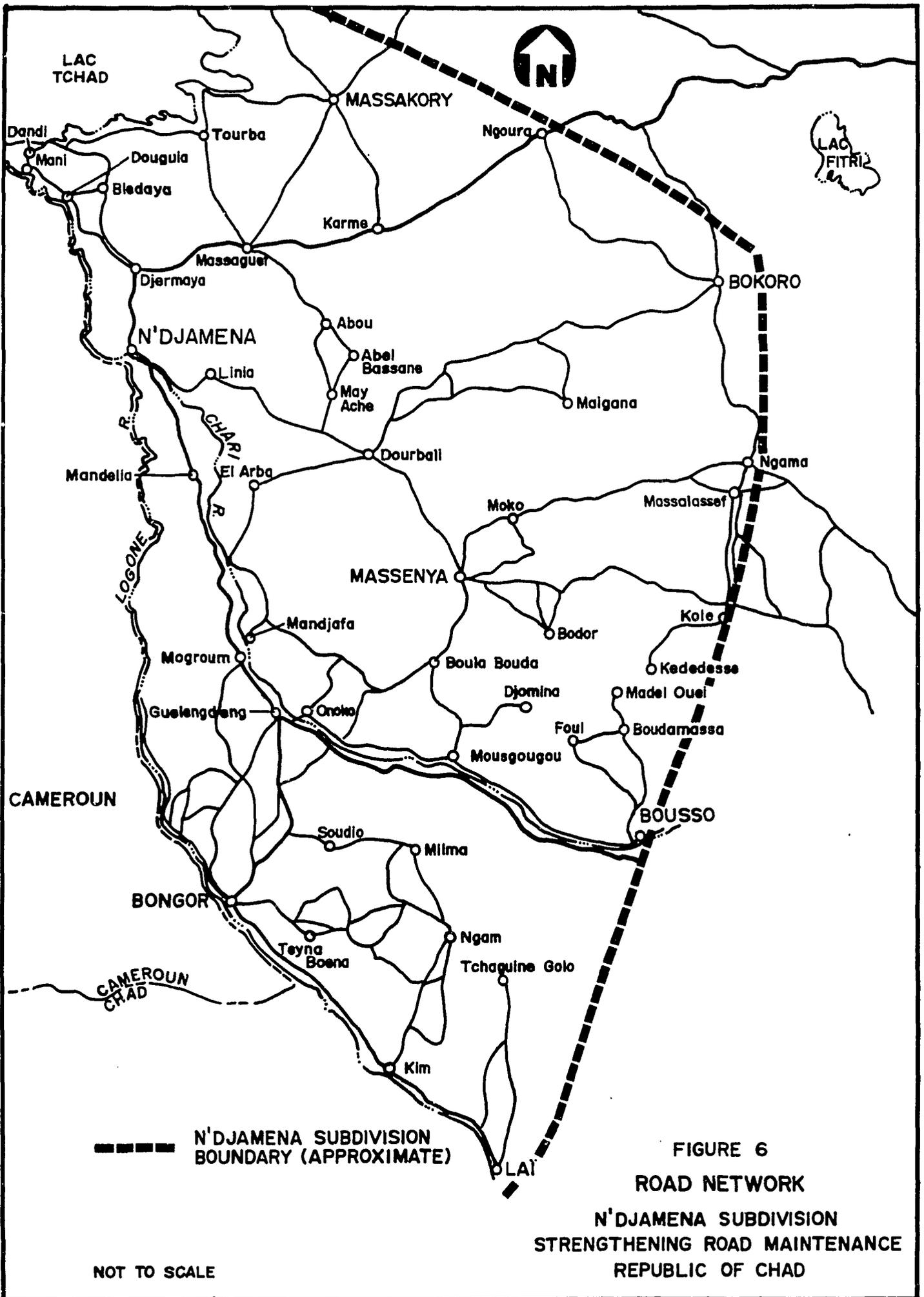
V. N'DJAMENA SUBDIVISION

The N'Djamena Road Maintenance Subdivision, renamed Agence des Routes N'Djamena (ARN) is responsible for maintaining all roads within the geographic limits of the N'Djamena Subdivision. The ARN is the largest of the OFNAR road maintenance subdivision both in terms of area of responsibility and numbers of personnel. A map of the subdivision is shown on Figure 6. Major roads are listed in Table 7. The ARN also controls rain barrier stations which are used to prohibit vehicle travel on selected road segments for four hours after a rain.

TABLE 7
MAJOR ROADS IN THE N'DJAMENA DIVISION

<u>Road Section</u>	<u>Length (km)</u>
Roads North of N'Djamena	
N'Djamena-Djermaya	30
Djermaya-Dandi	67
Djermaya-Massaguet	46
Massaguet-Ngoura	125
Ngoura-Bokoro	101
Massaguet-Massakory	68
Massakory-Bol-Bagasola	260
Bir-Garat-Faya Largeau	<u>781</u>
Subtotal	1,478
Roads South of N'Djamena	
N'Djamena-Guelendeng	146
Guelendeng-Mogo	149
Guelendeng-Bongor	83
Bongor-Lai	153
N'Djamena-Massenya	160
Massenya-Bouso	153
Massenya-Massalassef	125
Bokoro-Massalassef	<u>82</u>
Subtotal	1,051
Total	2,529

The objective of assistance to the ARN was to plan and prioritize its road maintenance program on rehabilitated roads within its operating area, with the primary objective of improving the circulation of light vehicles. The ARN was



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under the general direction of the TA Field Engineer, who advised the ARN Chief on engineering matters and maintenance planning. With the reorganization of the MTB, the TA Brigade Foreman changed from managing the MTB to supervising all ARN brigades in the field.

The ARN is currently responsible for 508 km of priority road maintenance. Approximately 740 km of roads are under rehabilitation contract, and the remaining road kilometers are not in the priority network. When the ARN becomes current with the maintenance of the priority network, it will begin assuming responsibility for maintaining other roads. As the rehabilitation contracts end, ARN will be assigned continuous maintenance of these roads, and will need to acquire asphalt pavement maintenance capability.

ARN MAINTENANCE BRIGADES

At the start of the SRMP, the ARN was organized into small units performing continuous maintenance on about 200 kms of established road. The work involved grading, reshaping and compacting the road surface; shoulder maintenance; and labor intensive repair of pot holes, culverts and bridge abutments (Figure 7). The proposed equipment fleet for each unit was to consist of a motor grader, two or three dumps, a front end loader, a rubber tired compactor and a water truck obtained from existing equipment, rehabilitated equipment and equipment from other donors, but insufficient equipment was available to meet the needs. The TA Brigade Foreman and Brigade Equipment Foreman were mobilized in October 1986 to assist these units until the MTB equipment arrived.

With the addition of the MTB, the ARN reorganized into six brigades, named Brigade North, Brigade South, Culvert Brigade, Asphalt Brigade, and two Reprofilng Brigades. Each brigade was headed by a field superintendent, who reported to the ARN Chief, and had a field office manager. The field office manager performed daily administrative duties and developed monthly operating expense and progress reports. A field warehouseman in each brigade controlled and dispensed spare parts and supplies. Only the Brigade North and Brigade South were fully equipped and organized. They were under the direction of the TA team.

FIGURE 7

N'DJAMENA-GUELENDENG ROAD MAINTENANCE - MAY 1987



ARN Reconstructing Roadway Cross Section



ARN Filling Potholes and Profiling Asphalt Sections

68

The ARN central complex was organized into offices, a warehouse, light and heavy equipment shop, and fuel and lubricants sections. Each section provided monthly reports on activities. The accountant prepared salary and per diem statements, and paid purchases from petty cash or by check. The paymaster dispensed salary and per diem payments.

Brigade South

The Brigade South (MTB) began work in September, 1988, on grading and compacting the Guelendeng-Bongor Road. Approximately 30,000 m³ of earth were placed to fill holes and ruts, smooth the travelled surface, and raise the profile where necessary.

The Bongor ferry access road was rebuilt, and work resumed on the Bongor-Lai Road. This 160 km long dirt track was completed in June 1989 as a smooth, slightly elevated roadway that could be driven safely in the dry season at reasonable speed. Approximately 150,000 m³ of fill materials were placed and compacted.

The ferry access road at Ere was rebuilt using approximately 24,000 m³ of fill material. Reprofiling of the Guelendeng-Bongor Road was accomplished in preparation for the rainy season to begin in July 1989.

In November and December, 1989, the Guelendeng-Bongor-Ere Road was graded and holes were filled. The ferry access roads at Bongor and Ere were repaired, placing a total of 44,400 m³ of fill materials. The Brigade returned to the Guelendeng-Bongor Road, working until the end of March, 1990, improving the embankment sections and ditches. The ferry access roads were extended, and work began on elevating the road section from Koyom to Lai.

The road maintenance equipment in use by the Brigade South consisted of the following:

<u>Equipment</u>	<u>Quantity</u>
Mercedes 2628 Dump Trucks	4
Mercedes 2628 Water Truck	1
Mercedes 2628 Fuel Truck	1
Mercedes 911 Grease Truck	1
Caterpillar Bulldozer D7-H	1
Caterpillar Loader 950 B	1
Caterpillar Grader 120 B	2
Bomag Compactor	2
Berliet Truck/Low Boy	1

Brigade North

The Brigade North was formed from the MTB and had four Mercedes 2628 dump trucks procured by AID, plus equipment rehabilitated by the Central Workshop. This was approximately the same equipment fleet as the Brigade South. After the June/October 1988 rainy season, work began on the N'Djamena-Bokoro Road. Approximately 160,000 m³ of surfacing materials were replaced on existing embankment sections and all sections were graded and compacted by April, 1989. An attempted coup d'etat forced the return of most of the Brigade equipment to N'Djamena for safety reasons. While in N'Djamena, the Brigade worked on expanding the ARN parking area by extending an embankment section along the river bank and relocating the OFNAR/ARN compound access road onto the embankment. Approximately 40,000 m³ of fill material were placed and the project was completed in two months. This expanded the storage yard and improved security at the ARN complex.

Between June and August, 1989, the Brigade regraded the N'Djamena-Linia Road, placing 30,000 m³ of fill material along 30 km of road. During the rainy season, the Brigade worked around N'Djamena, improving the approach at Pont Ngueli and the customs parking lot in N'Djamena. From September through the end of May, work was conducted on the N'Djamena-Bokoro Road, placing 100,000 m³ of fill material. The absence of a bulldozer during most of this period, because of repairs, limited the volume of work accomplished.

BASE CAMPS

Before the civil war, the Ministry of Public Works had numerous base camps throughout Chad to provide lodging, storage and parking for personnel, materials and equipment. Most of these camps are available to OFNAR but they need rehabilitation. Two camps at Massaguet and Karne were repaired for the Brigade North, including water well with pump. Camps at Guelendeng, Moukou and Bongor need rehabilitation for the Brigade South.

PROJECTED MAINTENANCE REQUIREMENTS

Currently the two principal Brigades (North and South) routinely perform maintenance on the Djermaya/Bokoro Road (275 km) and Guelendeng/Lai Road (244 km) including ferry approaches. Numerous roads/tracks remain without any maintenance. Table 8 lists important roads/tracks that should be maintained or improved by the ARN. Hundreds of kilometers of other tracks are not listed.

TABLE 8
ROADS/TRACKS REQUIRING MAINTENANCE

<u>Road Section</u>	<u>Length (km)</u>	<u>Classification</u>
Roads North of N'Djamena		
Mao - Niger Border	192	Secondary
Mao - Bol	114	Secondary
Mao - Moussoro	170	Secondary
Massakory - Moussoro	134	Secondary
Moussoro - Largeau	121	Secondary
Ngoura - Ati	242	Main
Subtotal	1,473	
Roads South of N'Djamena		
Gambaye - Bongor	81	Secondary
N'Djamena - Massenya	160	Main
Massenya - Bousso	148	Secondary
Massenya - Massalassef	125	Tertiary
Melfi - Bokoro	208	Tertiary
Guelendeng - Magao-Bongor	84	Tertiary
Subtotal	806	
Total	2,279	

The ARN is also responsible for maintaining three major bridges. The truss bridge at Loumia (Figure 8) requires immediate attention as the trusses on both ends are severely bent. The other two bridges require routine maintenance such as repair of approaches, resurfacing, and guardrail replacement.

The Massaguet/Bo1, Guelendeng/Bouso and Guelendeng/Ere roads are currently designated for rehabilitation by other donors and are not included in the list. If these roads are to be maintained, additional personnel and equipment are required. The TA Field Engineer recommended forming a Bridge/Culvert Brigade to maintain the bridges and correct drainage problems. A backhoe should be added to the equipment group to facilitate culvert placement and bridge abutment repairs.

BRIGADE EQUIPMENT

The ARN was to be supplied with rehabilitated equipment to carry out road maintenance and the MTB was to do only training. This was not the case as OFNAR chose to assign rehabilitated equipment elsewhere, and the ARN did not receive a full complement of equipment. Rehabilitated equipment assigned to the ARN at the end of 1989 consisted of:

- 4 Graders, Caterpillar 120 B
- 1 Compactor, Albaret M-6
- 1 Compactor (small), Hyster 530
- 1 Low boy, Berliet TML 12 (poor condition)
- 1 Low boy, Renault TGH 280
- 2 Water trucks
- 1 Loader-IH-530 A (poor condition)
- 6 Trucks, Mercedes 911 (arrived in 1990: poor condition)
- 2 Trucks, Berliet (poor condition).

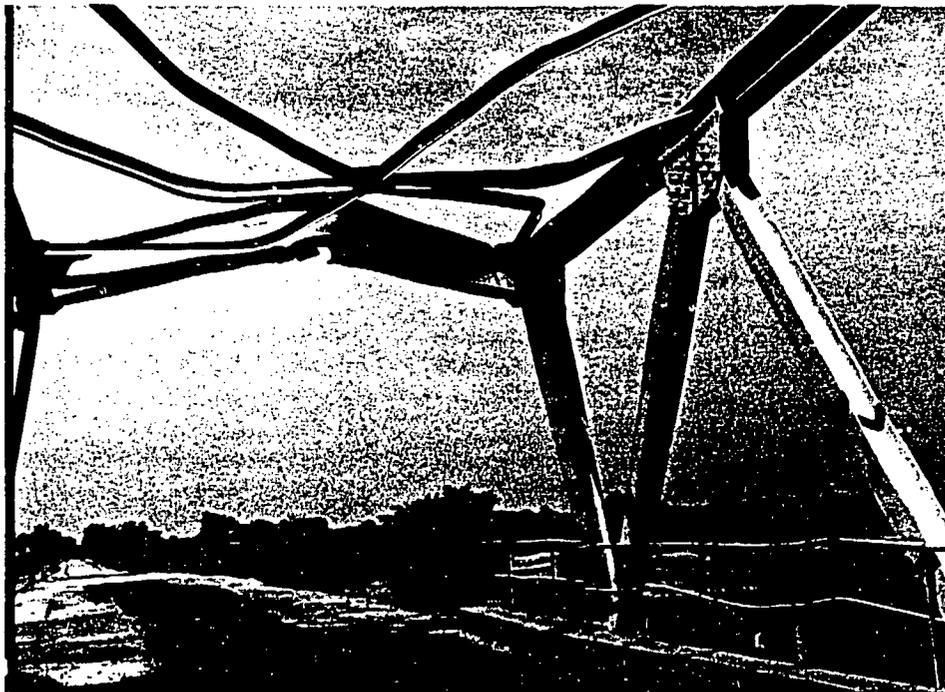
This equipment was generally unreliable, but ARN Brigade North could not have functioned successfully without it.

Table 9 shows is a comparison of equipment purchased by the SRMP and the equipment proposed in the project paper. The fact that two units of the heavy equipment were purchased instead of one was fortunate as they make up most of the ARN equipment. A low boy with truck tractor, a flatbed truck, tank trailers with

FIGURE 8
LOUMIA BRIDGE



Damaged Truss at North End of Bridge



Damaged Truss at South End of Bridge

73'

truck tractors, a pneumatic compactor and a backhoe are needed to complete current equipment needs. To make the existing Brigades fully effective, four large water trucks (>19,000 liters), a lowboy with truck tractor and four all terrain light vehicles should be purchased.

TABLE 9
SRMP PURCHASED ROAD MAINTENANCE EQUIPMENT

Qty	Proposed Brigade Equipment Project Paper	Qty	Actual Brigade Equipment Purchased
8	Dump Trucks	8	Dump Trucks
3	Water Tanks		
1	Fuel Tank		
1	Bulldozer D-7 H	2	Bulldozers D-7 H
1	Front End Loader	2	Front End Loaders
1	Grader 120 G	2	Graders 120 G
1	Compactor 815 B	2	Compactors
1	Towed Roller	2	Towed Rollers
1	Loader/Backhoe		
1	Fuel Trailer		
1	Water Trailer		
1	Tilt Trailer 20 Tons		
1	Field Service Truck	1	Field Service Truck
1	Supply & Maintenance Truck	1	Supply & Maintenance Truck
1	Flat Bed		
2	Pick-up Trucks	2	Pick-up Trucks
1	Towed Camper-Office	1	Towed Camper-Office
1	Compactor 7 Tons	1	Compactor 7 Tons
1	Water Pump	1	Water Pump
1	Travel Mixer	1	Travel Mixer
1	Farm Tractor	1	Farm Tractor
1	Low boy 50 Tons		
1	Truck Tractor 290 H.P.		
		1	Fuel Truck (19.000 1)
		2	Water Trucks (19.000 1)

TYPICAL MAINTENANCE BRIGADE

Most of the roads in the ARN are tracks, and the maintenance on the tracks should be referred to as track improvement. Track improvement requires first making impassable sections of sand or marsh passable and then, systematically raising the road profile above the natural ground level, so that rain runs off the road surface. Raising the profile over long distances requires earth moving equipment such as scrapers. Since scrapers are not part of the authorized equipment list, the typical equipment make-up of a Brigade should include the items listed in Table 10.

TABLE 10
EQUIPMENT FLEET FOR TYPICAL MAINTENANCE BRIGADE

Type of Equipment	Number	Characteristics
Bulldozer D-7	1	
Loader 950 B	1	
Grader 12-14 G	2	
Compactor	1	Pneumatic
Dump Trucks	4	Capacity 12 m ³
Field Service Trucks	1	
Fuel Truck	1	Capacity 19.000 l
Water Truck	4	Capacity 19.000 l
Light Field Vehicle	2	
Lowboy & Tractor	1	
Backhoe & Loader	1	

The two existing brigades need four water trucks, a low boy with truck tractor and four all-terrain light vehicles. One (1) scraper could replace one loader, one grader and four dump trucks. A soil stabilizer would also be helpful for blending clay with sand soils or when mixing water, cement, or other additives to the soils.

If the typical maintenance brigade is a training brigade, the number of dump trucks should be reduced to two and water trucks to one. Otherwise the brigade foreman will more time to spend on training. Expected production levels should also be reduced to account for the limited experience levels of the trainees.

WATER SUPPLY

The unavailability of water in easy proximity to road maintenance activities limited progress. Water wells are needed in areas where surface water is unavailable to limit water hauling to less than 30 km. Plans are currently in progress to drill as many as 11 water wells between Djermaya/Bokoro.

COST OF TRACK MAINTENANCE

The Ham/Ere/Lai Road (126 kilometers) in the Mayo-Kebbi province is typical of the roads on which maintenance was performed in the ARN. The track had not been maintained for years, and contained sections of deep holes, non-existent ditches, and poorly defined alignment. Filling, profiling and ditching were

required over the entire length. The maintenance work was accomplished during the 6-month period January-June, 1989. The cost to perform this work was estimated to be 1,932,611 Cfa/Km or \$6,234/km based on the equipment operation and maintenance costs shown in Table 11. Equipment amortization assumed an equipment value of 333,870,000 Cfa (\$1.1 million in 1985) and a vehicle life of seven years. Labor was 40,000 hours at an average 357 Cfa/hour = 14,280,000 Cfa or 447,695,714/yr for 6 months = 23,847,857 Cfa. The following equation calculates the cost per kilometer:

$$\frac{205,381,150 + 23,847,857 + 14,280,000}{126 \text{ km}} = 1,932,611 \text{ CFA/km or } \$6,234/\text{km}$$

TABLE 11

EQUIPMENT COST OF ROAD MAINTENANCE

HOURLY COST OF EQUIPMENT (OPERATION AND MAINTENANCE)

Equipment	Hourly operating cost Project Paper estimate 1985	Hourly cost increased by 20% for 1989 & converted to CFA:@310/\$
Bulldozer D7	\$52.81	\$52.81 x 1.2 x 310 CFA = 19,645
Grader 120G	23.36	\$23.36 x 1.2 x 310 CFA = 8,690
Loader 950B	31.09	\$31.09 x 1.2 x 310 CFA = 11,565
Compactor	38.42	\$38.42 x 1.2 x 310 CFA = 14,292
Field Service Truck	30.00	\$30.00 x 1.2 x 310 CFA = 11,160
Dump Trucks	20.73	\$20.73 x 1.2 x 310 CFA = 7,712
Fuel Tanker & Water Truck	18.00	\$18.00 x 1.2 x 310 CFA = 6,696
Toyota Pickup	9.75	\$ 9.75 x 1.2 x 310 CFA = 3,627

EQUIPMENT OPERATING AND MAINTENANCE COSTS, JANUARY-JUNE 1989

Equipment	Cost/HR CFA	Number	Total Hours Worked	Total Cost CFA
Bulldozer D7	19,645	1	893	17,542,985
Grader 120 G	8,690	2	1,395	24,245,100
Loader 950 B	11,565	1	741	8,569,665
Compactor	14,292	1	550	7,860,600
Dump Trucks	7,712	4	4,000	123,392,000
Field Service Truck	11,160	1	900	10,044,000
Fuel Tanker	6,696	1	500	3,348,000
Water Tanker	6,696	1	900	6,026,400
Toyota Pickup	3,627	1	1,200	4,352,400
Total				205,381,150

ASPHALT MAINTENANCE BRIGADE

OFNAR has an Asphalt Maintenance Brigade that has been on loan to the city of N'Djamena. Since the City has no other means of street maintenance, the probability exists that when the equipment is returned it will be beyond economical repair. equipment probably will not be returned until it is of no value. The equipment list is:

OFNAR should plan to purchase new asphalt road maintenance equipment to meet existing asphalt repair needs, and to form an asphalt maintenance brigade with the capability to repair and maintain approximately 550 kms of paved roads. This is the currently projected length of paved roads Chad will have by 1995. Existing paved roads and those currently under construction total approximately 228 kms. Equipment units recommended for purchase are an asphalt sprayer, a gravel spreader, an asphalt storage tank, a 7-ton compactor, a Sabron dumper and front end loader.

Section VI
Summary/Conclusions

VI. SUMMARY/CONCLUSIONS

The Strengthening Road Maintenance Project (SRMP) was authorized June 24, 1985 with funding of \$27.5 million. The Government of Chad (GOC) signed the Project Agreement on June 29, 1985. Gannett Fleming was contracted on November 7, 1985 to provide 317 person months of technical assistance over a period of five years at a cost of \$3,154,043. Subsequent contract amendments increased the person months to 381 and the contract budget to \$4,863,905. Contract termination date was July 31, 1990.

The stated goal of the SRMP was to maintain the road network throughout Chad. The stated purpose was to assist the GOC in developing a technically competent and financially responsible organization to maintain the road network in Chad. The Office of National Roads (OFNAR) was established by the GOC as a semi-autonomous government agency within the Ministry of Public Works to be the implementing agency and the object of the SRMP's institutional strengthening efforts. Major elements of the project were:

- Technical assistance in planning and administering a road maintenance program;
- Training and equipping a road brigade and operational support;
- Rehabilitating and equipping workshop facilities and training in equipment maintenance;
- Rehabilitation of a 63-km road under a host country contract.

Project outputs corresponding to these elements were: (1) 50 mechanics and shop technicians, 42 equipment operators, and 18 supervisors and managers trained; (2) road maintenance crews in the field maintaining 1600 kms of roads; (3) the Central Workshop maintaining OFNAR equipment and vehicles; (4) rehabilitation of the Djermaya-Dandi Road. The SRMP also financed the restoration of OFNAR's administrative building and central workshop; purchased road maintenance equipment, tools and shop equipment; and rehabilitated approximately 50 pieces of disabled road maintenance equipment scattered around the country.

TECHNICAL ASSISTANCE TEAM

The technical assistance team included a Senior Advisor to the OFNAR Director, provided under a personal services contract, and 10 professional and technical personnel provided by Gannett Fleming. These personnel included a Planning Engineer, Field Engineer, Accountant Advisor, Brigade Foreman, Brigade Equipment Foreman, Shop Superintendent, Parts Specialist, Engine Foreman, Machine Shop Foreman and Service Foreman. A Logistician was employed for the first three months of the project to help locate and rehabilitate houses for the team and to procure furnishings. A Home Office Project Manager provided support throughout the project, and substituted at times for the Planning Engineer and Field Engineer during their absences. The team lacked a Chief of Party responsible for project management and coordination of the TA team efforts. The Field Engineer was assigned this responsibility.

The Senior Advisor and Planning Engineer positions were deleted from the project in July 1988, and other positions changed in scope.

CENTRAL WORKSHOP

The Central Workshop was organized into seven sections, namely the Engine, Heavy Equipment, Light Vehicles, Electrical, Machine Shop, Body Shop and Fuel Service Sections. There is also a Central Warehouse whose personnel report to the Finance Division.

There are three workshops comprising the Central Workshop. The SRMP rehabilitated all three workshops and the OFNAR administration building. AID/Chad prepared the design plans and contract documents, incorporating comments of OFNAR and the TA team. A local contractor under contract to AID did the rehabilitation work, starting in August 1986. The administration building was completed in December 1986, and the workshops during the period April-August 1987. The Central Warehouse was later enlarged, made more secure, and provided with an outside door leading to a separate reception area.

More than 350 items of workshop equipment and tools, at a cost of more than \$440,000, were procured by AID for the Central Workshop. The delivery was mostly completed by mid-1988.

The Workshop was reorganized into more efficient operating areas, and simple procedures were established for tracking work progress. A work order is prepared for each piece of equipment to be repaired. A card is completed identifying the equipment and the work to be done and tracked on a wall board under the columns Repair/Rehabilitate, Diagnosed/Parts Ordered, Under Repair, and Work Completed. Following work completion, a description of the work performed is entered on the card, and the card is filed to create an historical record.

Approximately 50 units of previously unserviceable equipment was retrieved from the field and rehabilitated under the equipment recovery program. As a general rule, equipment was not rehabilitated if the cost of parts exceeded 30-35% of the price of a new unit. Scrapped units were cannibalized for usable parts.

A parts inventory control system was introduced using Kardex cards to record parts purchased and parts issued. Periodic inventories were conducted to check the quantities shown on the cards.

The existing local procurement system was long and difficult requiring no less than a dozen signatures and four-months to complete the purchase of even minor and urgently needed parts. The number of signatures were reduced to three, and a blanket order system was established to effect same date purchase authorization for parts available in the local market.

A plan to computerize workshop operations management, preventive maintenance schedules and inventory controls was developed. The plan was implemented in 1989 by the World Bank funded TA Team, following the installation of AID purchased computers.

Training of workshop personnel was practical on the job training supplemented by demonstrations and informal classroom instruction. Training subjects included supervision, mechanical repair, brakes, cooling systems, drive train, electrical systems, engines, welding, body straightening, painting, parts machining and safety. Seven shop supervisors and foremen, 16 mechanics, 11 mechanic aides, 14 technicians and 8 parts personnel, for a total of 56 persons, were trained. Some were assigned to OFNAR field units.

MAINTENANCE TRAINING BRIGADE (MTB)

The MTB began operations in August 1987 with the arrival of two graders, two front end loaders and two bulldozers from Caterpillar. Equipment familiarization and training were conducted on N'Djamena streets until eight dump trucks, two water trucks, a fuel truck and two service trucks arrived in November. At that time, the MTB began productive road maintenance on the N'Djamena-Guelendeng Road, and later established a base at Bongor to maintain roads in that area.

Equipment procurement was completed by May 1988 with the arrival of two vibratory rollers, two sheepsfoot rollers, one farm tractor, an office trailer and two house trailers. Four service trailers fabricated in local shops were delivered in December 1987, but were rejected because of deficiencies. They were not replaced.

The training program prepared by the TA Brigade Foreman covered supervisors and foremen, equipment operators, drivers, field mechanics and administrative personnel. Training methods included field demonstrations supplemented by classroom instructions. Equipment manuals and road maintenance procedure manuals were supplied for study. Equipment operators were evaluated monthly, and their performance graded. Truck drivers were tested prior to employment, and their performance was reviewed periodically. Seventy-seven persons in all classifications were trained.

Productive road maintenance work by MTB units totaled 1,763 km of roadway between October 1987 and April 1990, during which time 1,144,800 m³ of earth were placed, graded and compacted. Major routes maintained were N'Djamena-Guelendeng, Guelendeng-Bongor, Bongor-Lai, Djermaya-Bokoro, and N'Djamena-Linia.

PROCUREMENT OF COMMODITIES

Local procurement was slow and unresponsive to the needs of the OFNAR organization. The TA team made recommendations to streamline the system, some of which were implemented. A blanket order system was established for locally available commodities, and a petty cash fund was set up for emergency purchases. The Central Warehouse was established as the receiving point of purchases for record purposes only.

Offshore procurement of road maintenance equipment workshop tools and equipment was delayed, and the commodities received were not entirely satisfactory. The preparation of specifications and ordering of equipment and tools were to be done by other short-term specialists before the arrival of the TA team, but this was not done.

Preliminary specifications for the MTB Caterpillar equipment were prepared by the TA team in May 1986. Following discussions among OFNAR, the TA team, AID/Chad, AID/REDSO/WCA and the Caterpillar dealer in Chad (SHO-Tchad), the specifications were finalized, and a host country procurement contract was signed between OFNAR and SHO-Tchad in January 1987. The equipment arrived at OFNAR in August 1987.

Preliminary specifications for the MTB trucks were prepared by the TA team in May 1986. Following discussions between all concerned parties, the specifications were finalized by AID/Chad. There was a delay in placing the order because of high quotations. A procurement contract was finally signed with a Mercedes Benz supplier in West Germany in April 1987. The trucks arrived at OFNAR in November 1987.

Lists of workshop tools and equipment were prepared by the TA contractor in December 1985 and finalized by the TA team in May 1986. Preliminary specifications for compactors, rollers, office trailer, farm tractor and other MTB equipment were prepared by the TA team in June 1986. Following discussions with all concerned parties, a purchase order was placed with an IQC firm for AID procurement in October 1986. Following clarification of specifications, invitation and evaluation of bids, purchase orders for the bulk of the equipment and tools were placed by June 1987. All MTB equipment, workshop tools and shop equipment arrived at OFNAR by March 1988.

Some of the equipment specifications were incomplete or conflicting, which caused delays while the IQC firm sought clarification. Some of the equipment procured was not the equipment originally specified, and other delays went unexplained. The TA team should have been allowed contact with the manufacturer to discuss the intended use of the equipment, to refine details of components, and to expedite shipment. For example, house trailers specified directly by the

TA contractor in September 1987, arrived at OFNAR in March 1988, fully equipped with heavy duty frame, desert tires, generator and steel water tank for off-road use.

ADVISORY SERVICES TO OFNAR MANAGEMENT

The Senior Advisor, recruited by AID under a host country personal services contract, was responsible for advising and counseling OFNAR's senior management in operational control, organizational structure, daily management, road maintenance planning, budgeting and prioritization, private sector activities, and coordination of donor activities. Although he took action on some road maintenance projects and made observations and recommendations concerning road maintenance planning and budgeting, his efforts were not effective and the position was eliminated from the SRMP after 30 months service.

ROAD MAINTENANCE PLANNING

Routine road maintenance programs were prepared by the Districts and Subdivisions. The Planning Engineer was to advise the Chief of the Planning and Programming Division for planning, budgeting and allocation of equipment for road maintenance. When unsuccessful at filling the position through a personal services contract, AID added the position to the TA contract in January 1987. The TA Field Engineer was promoted to TA Planning Engineer, and a new field engineer was appointed to the TA team.

The TA Planning Engineer worked closely with the Chief of the Programming Division who occupied the same office. He classified and numbered approximately 12,000 km of roads, conducted traffic studies, and prepared a road maintenance planning and programming manual, a road maintenance cost accounting manual, and a report on modern techniques of road network management. He was forced to leave the project for medical reasons near the end of July 1987, and resigned shortly thereafter.

A second Planning Engineer was appointed in January 1988 and was also assigned Chief of Party duties. Most of his work involved Chief of Party functions because at that time the MTB was operating, the World Bank program was being introduced and the study for the reorganization of OFNAR was underway. Also, two evaluation studies of the SRMP were being performed by outside firms,

a more structured training program was being developed, local procurement was being studied, and new directions for the TA team were being explored. The Planning Engineer made investigations and assessments of current OFNAR long range planning activities. He initiated studies for the development of a fleet management system, identified problems and deficiencies within the Subdivision, and prepared cost data for an equipment depreciation schedule and for a road maintenance cost analysis. The Planning Engineer resigned his position the end of May 1988 for personal reasons, and the position was deleted from the SRMP.

Other agencies have entered the road maintenance planning area and there is some duplication of effort between the planning functions of OFNAR, the Ministry of Public Works, the Ministry of Planning and other agencies. For example, the Ministry of Planning published a report presenting the transport sector strategy and development program for 1988-1993, which included a needs analysis, project prioritization and technical guidelines for road system standards. This overlapped OFNAR planning responsibilities. In addition, other agencies were planning road rehabilitation projects.

FINANCIAL MANAGEMENT SYSTEMS

When the SRMP began, OFNAR had a cash based administrative accounting system. It did not use double entry accounting, nor did it have a balance sheet. It tracked cash receipts and disbursements, only, with no encumbrances or accrual records. The annual report corresponded to a statement of sources and uses of funds, and the final balance reconciled with actual cash in the safe and in the bank.

Beginning January 1988, OFNAR had an accrual based, general accounting system. A balance sheet was established and double entry accounting was used. The OCAM accounting system was adopted to develop the OFNAR chart of accounts, cash, bank, receipt, encumbrance, and liquidation journals were maintained for both OFNAR and the SRMP. Monthly financial reports were prepared presenting OFNAR operations on both cash and accrual bases.

The TA Accountant Advisor implemented a double entry cash basis accounting system for the SRMP local currency budget conforming to AID regulations and generally accepted accounting principles. This system was not the same as the accrual based commercial accounting system established for OFNAR by the

"Fiduciaire de la Tour" of France, under contract to the World Bank, but the systems are integrated and daily reconciliation was maintained between the two systems. The TA Accountant also maintained formal accounting records on all project related transactions and expenditures, monitored the assets and liabilities of the OFNAR and project accounts, and maintained fixed asset records from information provided by OFNAR.

The TA Accountant Advisor organized the Financial Division into six sections with clear delineations of responsibilities. He trained and enlarged the staff from three to nine persons. He established a new accounting system and devoted a majority of his time accounting for SRMP local currency expenditures. He performed all bookkeeping operations, making journal entries himself and prepared all project related financial reports. He also assumed the functions of financial advisor for OFNAR's overall financial management.

N'DJAMENA SUBDIVISION

The N'Djamena Subdivision (ARN) is the largest of five road maintenance subdivisions in OFNAR. It has the responsibility of maintaining 1248 km of main roads and more than 2500 km of earth tracks.

At the start of the SRMP, the ARN had little equipment and was filling potholes and eroded areas around culverts and bridge abutments. OFNAR assigned only enough equipment, rehabilitated by the Central Workshop, to form one ARN maintenance brigade. From January-June 1987, the brigade worked on the N'Djamena-Guelendeng Road. With the start-up of MTB operations at Bongor, the ARN began road maintenance north of N'Djamena, and set up a semi-permanent road camp at Massaguet. In the period September 1987-April 1988, the ARN performed maintenance on the N'Djamena-Linia Road and the N'Djamena-Ngoura-Bokoro Road, and repaired access roads to the ferries at Bongor and Bousso. With the reorganization of the MTB into two brigades and its integration into ARN, additional maintenance was performed on the Guelendeng-Bongar-Lai Road and the N'Djamena-Massenya Road. Two smaller brigades are being formed for culvert replacement and asphalt pavement maintenance.

The TA Field Engineer was the designated advisor to the N'Djamena Subdivision, and also had responsibility for rehabilitation of the Djermaya-Dandi Road, the Maintenance Training Brigade, and coordinating TA team activities. The

TA Field Engineer also approved local procurement requisitions. The TA Brigade Foreman supervised field operations of the MTB and ARN brigades.

DJERMAYA-DANDI ROAD REHABILITATION

AID budgeted \$5.6 million to rehabilitate the Djermaya-Dandi Road to all weather road standards under a host country construction contract. The cost estimate by the TA Field Engineer in 1986 was much higher than the budget, and an outside consulting firm was asked to modify the road design to lower the cost. The resulting cost estimate was still much higher than the budget. It was then suggested the road be constructed by the MTB using the newly purchased equipment and the additional funds provided for the Brigade's operation. This was not accepted.

Finally, it was agreed by AID, the GOC and the World Bank that in order to achieve economies of scale, the Djermaya-Dandi Road would be added to the contract for the rehabilitation of the Djermaya-N'Djamena-Guelendeng Roads being financed by the World Bank. AID transferred the funds to the World Bank and bids were received in March 1988.

OFNAR SUPPORT OF THE PROJECT

The conditions precedent to disbursement under the Project Grant Agreement were that the GOC would pay all OFNAR employees' salaries and would finance at least 10% of OFNAR's project recurrent costs during the first year of the SRMP, 20% the next, and 10% additional each year thereafter for the project duration. The system of fuel tax collection assured that revenues would be sufficient to pay at least 50% of OFNAR's recurrent costs at the end of five years. OFNAR met these conditions.

OFNAR management supported the SRMP and assigned counterpart personnel, workshop personnel, and MTB trainees, as requested. There were some vacant positions in the Central Workshop, but this did not affect progress.

Some of the technician and trainees lacked basic educational qualifications, and it would have been beneficial if TA members had been allowed to participate in the screening and selection process.

OFNAR employees were cooperative, friendly, helpful and receptive to advice, recommendations and guidance. Some reluctance to change was encountered when new procedures differed from traditional procedures. There were also a few instances of theft and disgruntled employees. These cases were quickly resolved.

AID SUPPORT OF THE PROJECT

AID provided substantial support to the SRMP in contracting, procurement, engineering and administrative support to the TA team. A project committee was established to monitor the project, press for progress, search for violations and non-performance of contract items, scrutinize OFNAR budget proposals and Gannett Fleming reimbursement claims, and oversee procurement and operating expenditures from SRMP funds. This project committee consisted of the Program Officer, the Project Development Officer, the Controller and the Project Manager. The committee, acting primarily through the Project Manager, was essential to decision making, and in modifying project direction as experience was gained and OFNAR expanded.

RECOMMENDATIONS

The SRMP with some delays successfully assisted in the rehabilitation of previously unserviceable equipment, rehabilitated central administrative and workshop facilities and procured the necessary equipment and tools for their operation. It established and equipped a maintenance training brigade, and trained supervisors, administrative personnel, equipment operators and mechanics. It also initiated systems and procedures to develop OFNAR's institutional capability to plan and manage road and equipment maintenance operations. These achievements have increased OFNAR's physical capability to maintain roads and equipment. The framework is in place for OFNAR to be a technically competent and financially responsible road maintenance organization.

With the advent of other donor agencies, particularly the World Bank, the role of the SRMP was changed to concentrate on providing assistance to the N'Djamena Subdivision, to provide limited assistance to the Central Workshop, and to target further assistance to areas of OFNAR where other donors are not providing support. Gannett Fleming is pleased that AID has chosen to continue the SRMP to benefit the Chadian people, and offers the following recommendations for continuance:

1. Provide an advisor to OFNAR senior management for planning, budgeting and coordinating SRMP activities.
2. Continue development of efficient workshop operations and establishment of the management systems that have been introduced in the Central Workshop.
3. Simplify the procurement and distribution procedures for spare parts and supplies, and organize a supply section to service the maintenance brigades.
4. Review and modernize personnel recruitment procedures and establish an employee benefit program.
5. Develop a structured training program tailored to benefit the different educational levels of OFNAR employees.
6. Organize a Safety Section and provide first aid facilities.
7. Organize a Security Section to safeguard property and supplies.
8. Increase assistance to the N'Djamena Subdivision in planning scheduling, budgeting, coordinating and supervising road maintenance.
9. Discontinue the use of an outside firm to assist with offshore procurement, and implement future offshore procurement through host country contracts.
10. Develop asphalt pavement maintenance capabilities within the N'Djamena Subdivision.
11. Develop clearly defined and realistic project goals and objectives within the capabilities of the TA team and project limitations.
12. Provide short term specialists as required to supplement the TA team in meeting the needs of OFNAR.