PROJECT PAPER

O.M.V.S. GROUNDWATER MONITORING PROJECT

625 - 0958

USAID/SENEGAL

BP 49

DAKAR, SENEGAL

AGENCY FOR INTERNATIONAL DEVELOPMENT

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: A (A = Add, C = Change, D = Delete) — Amendment Number: _____ — DOCUMENT CODE: 3

2. COUNTRY/ENTITY: Senegal River Basin (OMVS)

3. PROJECT NUMBER: 625-0958

4. BUREAU/OFFICE: AFR/SWA

5. PROJECT TITLE (maximum 40 characters): Groundwater Monitoring Project

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 09 DD 30 YY 87

7. ESTIMATED DATE OF OBLIGATION (Under "B." below, enter 1, 2, 3, or 4): A. Initial FY 83 B. Quarter 3 C. Final FY 86

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY 83			LIFE OF PROJECT		
	B. FX	C. L/C	D. Total	E. FX	F. L/C	G. Total
AID Appropriated Total	1,130	0	1,130	4,651		4,651
(Grant)	(1,130)	(-)	(1,130)	(4,651)	(-)	(4,651)
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country		175	175		551	
Other Donor(s)						
TOTALS	1,130	175	1,305	4,651	551	5,202

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	C. PRIMARY TECH. CODE 2. Loan	D. OBLIGATIONS TO DATE 1. Grant	D. OBLIGATIONS TO DATE 2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	E. AMOUNT APPROVED THIS ACTION 2. Loan	F. LIFE OF PROJECT 1. Grant	F. LIFE OF PROJECT 2. Loan
(1) SH	S 121	080				4,651		4,651	
(2)									
(3)									
(4)									
TOTALS						4,651		4,651	

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 080 960 970

11. SECONDARY PURPOSE CODE:

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)

A. Code	R/AG	BS	INTR	TECH	INC		
B. Amount							

13. PROJECT PURPOSE (maximum 480 characters)

To establish an effective monitoring and early warning system to identify current and potential problems and possibilities related to groundwater development and management and to distribute information to Member States.

14. SCHEDULED EVALUATIONS: Interim MM / YY — Final MM 05 YY 87 / MM 09 YY 87

15. SOURCE/ORIGIN OF GOODS AND SERVICES: [X] 000 [ ] 941 [X] Local [ ] Other (Specify) _____

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a _____ page PP Amendment.)

17. APPROVED BY — Signature: David Shear — Title: Mission Director — Date Signed: MM 04 DD 15 YY 83

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM DD YY

AID 1330-4 (8-79)

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I. INTRODUCTION

A. Summary and Recommendations

USAID/Senegal recommends approval of a grant of $ 4.6 million from the Sahel Development Appropriation to the "Organisation pour la Mise en Valeur du Fleuve Sénégal" (OMVS),* for a groundwater monitoring project (No. 625-0958).

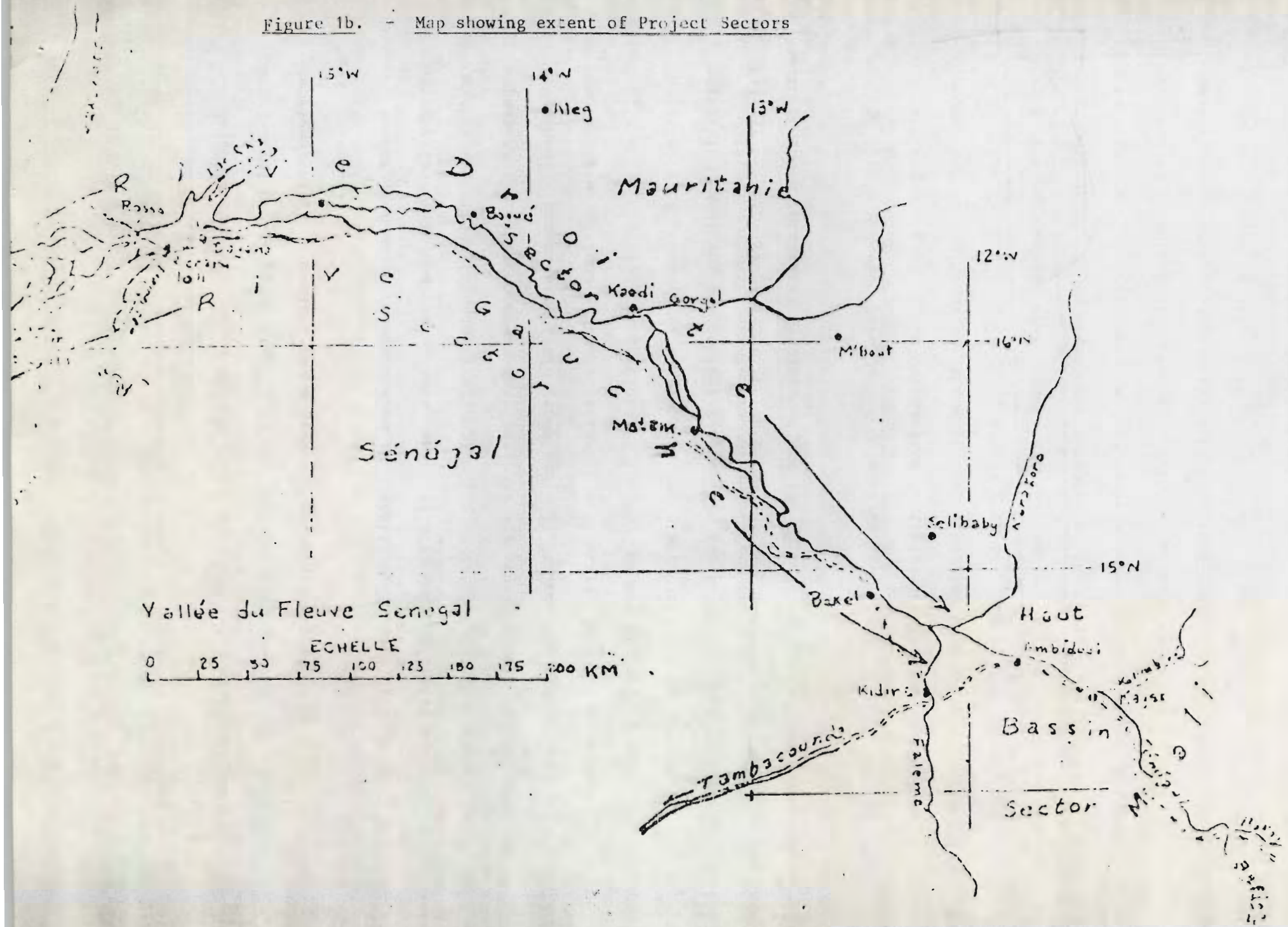
The project will concentrate on the establishment of a network of observation wells and piezometers, and will also include assistance for the OMVS organizational and institutional building capability. The project will emphasize the creation of an institutional structure capable of implementing a basin-wide groundwater field study and will include the training of OMVS Member States nationals. These nationals will staff the OMVS Groundwater Unit and the hydrological services of the OMVS Member States, to monitor the effects of groundwater development and other hydraulic management activities involving the aquifer systems. In addition, the data collected will be utilized by other agricultural development projects such as the AID-financed Integrated Development and the Agricultural Research II Projects.

B. Project Goals, Purpose and Objectives

The overall goal of the Groundwater Monitoring Project is to increase incomes and food production in the Senegal River Basin. A sub-goal is to support the execution of projects in the OMVS Basin development plan, namely, irrigation perimeters, dams, hydroelectric power generation, ports and river navigation. To this end, the purpose of the project will be to establish an effective monitoring and early warning system which identifies current and potential problems (i.e. water logging, salination, water quality) and identify opportunities related to groundwater development and management and to distribute information to Member States.

* River Basin Development Organization.

Figure 1b. - Map showing extent of Project Sectors



The Groundwater Monitoring Project encompasses the following elements:

1. Overall institutional development assistance to the OMVS and Member-States to develop their capabilities in groundwater monitoring and management planning;

2. Specific short-and medium-term assistance to help the hydrogeological services of the OMVS to establish a groundwater management system in the Senegal River Basin;

3. Establishment of a network of observation wells and piezometers to monitor the effects of dam construction and irrigation development on the recharge and water quality of aquifers and drainage systems; and,

4. Provision of human and material resources to the OMVS and Member States for a continuation and expansion of their capabilities for groundwater monitoring and management planning.

The project's objectives will be attained through the provision of quantitative data required for evaluation and exploitation of the groundwater systems. AID will finance materials, vehicles, expatriate technical assistance and a portion of operating costs, and construction of piezometers. Long-term training in the US , third country training as well as on-the-job training on the aspects of groundwater hydrology will be gained by the Member-States' personnel participating in the work.

II. PROGRAM FACTORS

Three related documents provide the general framework for the Groundwater Monitoring Project. They are the "OMVS Data and Institutional Development Project", the OMVS Indicative Program for Hydro-Agricultural Development of the Senegal River Basin (1981-1990) and the AID Regional Development Strategy Statement within the context of the CILSS and Club du Sahel.

Each of these statements is outlined below so that the relationship between the project, the OMVS and USAID planning can be seen.

A. OMVS Data and Institutional Development Project

The OMVS Data and Institutional Development Project (625-0620) was approved in 1977 with three subprojects : Institutional Development, Water Data Collection, and Basin Survey and Mapping. At that time only the Basin Survey and Mapping sub-project was submitted for funding. Groundwater resources were studied in a series of USAID-financed reports, but a sub-project was not then developed. Further study and recommendations of an October 1979 report by George C. Taylor, Jr.,of CH2M Hill International (attached as Annex G) reviewed the needs and requirements for this project.

The DID project structure highlights that existing data on the occurence and quality of groundwater are adequate for the purpose of siting wells for relatively small-scale developments for stock, domestic and public supplies. However, the data are inadequate for the purpose of evaluating water management practices or for planning large scale development for irrigation supply, especially with respect to the Maestrichtian artesian aquifer which probably is the only potential regional source of groundwater supply for irrigation in the Basin. Lacking are data on the hydrodynamic relationships between the Maestrichtian aquifer, and under aquifers in the Senegal River. These data are required to evaluate water management practices and to determine the development potential of the Maestrichtian aquifer under different modes of development of the land and water resources of the Senegal River Basin.

In theory, the Maestrichtian aquifer may be developed for irrigation supply throughout its area of occurrence in the Senegal Basin. But the area of immediate interest is the reach of the Senegal River Valley between Matam and Boghé. This reach probably is the principal source of natural recharge to the Maestrichtian aquifer; it also will contain several large irrigation developments which may produce marked changes in the groundwater regime; and regardless of other considerations it probably will be the scene of rather extensive groundwater development to supply the growing demands for public and industrial supplies which will arise as a result of the irrigation activities.

In sum, the DID project views the groundwater monitoring activities as complementary elements in the development of the basin. In addition, it identifies the need for sub-projects to be more responsive to existing data. This element is directly addressed by the project through the establishment of a central locale for groundwater-related data and institutional assistance to the OMVS.

B. OMVS Indicative Program for Hydroagricultural Development of the Senegal River Basin

The OMVS has four broad objectives which are :

1. to provide and improve income for a maximum number of inhabitants in the basin and in neighboring regions;

2. to establish a more stable balance between the human population and the environment;

3. to make the economies of the three States less vulnerable to climatic and external factors; and,

4. to accelerate the economic development of the three States through inter-State cooperation.

In the basin, these objectives are being reached through the aforementioned plan which includes the construction of :

a. Manantali Dam -- a multipurpose upstream reservoir of 11 billion cubic meters capacity, for irrigation of some 255,000 hectares plus hydroelectric power and riverine navigation, based on a regulated flow of 300m³/sec downstream from Kayes, Mali. Although Manantali will reduce flood peaks in most years, it cannot provide sufficient reduction of the highest probable flood peaks to eliminate unplanned flooding completely. The storage effect of Manantali on the Bafing River will be partly offset by constrictions of the floodplain due to road, levee and other construction. The flows of the Bakoye and Falémé will remain unchanged.

b. Diama Dam -- a low barrage to prevent salt water intrusion and permit irrigation of some 55,000 hectares. Until upstream storage is provided by Manantali, Diama Reservoir levels will fluctuate seasonally between 0 and 1.5 meters above sea level as its far more modest projected storage capacity of 250 million cubic meters is used to meet irrigation requirements in the Delta. After Manantali begins operation, Diama will be operated at a nearly constant water level of 1.5 meters to facilitate river navigation.

As a result of the dam construction, flood recession agriculture which provides a marginal existence for a population of about 400,000 living along the river banks will change. Changes in this type of cultivation are expected as a result of the water-flow control proposed by the OMVS. The OMVS plan for the operation of Manantali Dam provides for an artificial flood of 2,500 cubic meters/second to be provided during the August-September period for a transition period estimated at seven years (the duration in years is still under consideration and discussion). The purpose of this artificial flood period is to permit a steady transition from flood recession agriculture into intensive irrigated agriculture. During the transitional period recession agriculture should have a more predictable water supply, and yields should be more stable.

Recession agriculture will be reduced as irrigated areas are developed but will not be eliminated by Manantali operation. The Bakoye and Falémé Rivers would remain unregulated, and these provide about 50 percent of the flow volume. Only when other upstream storage sites are ultimately developed will recession agriculture disappear. When this happens, nearly 400,000 hectares could be irrigated in the basin.

Once the artificial flood release program has been terminated, overbank flooding in many areas will be reduced or eliminated, which raises the question of whether recharge of aquifers may be adversely affected. This problem as well as the problem of drainage, will be investigated by the project.

C. AID Regional Development Strategy Statement

The AID Regional Development Strategy Statement (RDSS) endorses the project approach, stating that AID will give high priority to the development of irrigated agriculture and to river basin planning and feasibility studies necessary for future projects. The RDSS further emphasizes a regional approach to river basin development and expresses AID's desire to assist international organizations like the OMVS in formulating optimum strategies for river basin development. The formulation of optimum and basin development requires that data be compiled and analyzed by the project on aquifer hydraulics, groundwater flow, recharge, water quality and changes in these resulting from development.

As an institution-building effort, the present project will strengthen the capacity of the OMVS and Member States to monitor and manage groundwater development. It will directly affect OMVS and Member States officials as beneficiaries. The ultimate beneficiaries of this increased institutional capability will be approximately 2.0 million residents of the Senegal River Basin. These benefits will derive from better development planning and management of groundwater resources by the OMVS and Member States.

D. Relation to Other Projects

a) USAID Funded Projects

In addition, AID is funding through OMVS the Agricultural Research Project (625-0957). This project will assist the OMVS in carrying out improved crop research and adaptive agriculture programs by trained agriculture and extension personnel and by upgrading research centers in

Senegal, Mali and Mauritania. Other U.S. assistance to the OMVS has included funding of the Environmental Assessment Project[1]/ (625-0617) which evaluated the environmental effects to the overall Senegal River Basin Development Plan, and funding for a UNDP-sponsored socio-economic study.

Future assistance to the OMVS is expected to include an Integrated Development Project (625-0621), now in the final stages of design. As of July 1981, there existed a total of 29,700 hectares of irrigated perimeters in the Senegal River Basin. By country, this aggregate consisted of 24,500 hectares in Senegal, 4,900 hectares in Mauritania and 280 hectares in Mali. The OMVS plan for irrigation perimeter development as presented in the " Indicative Programme for Hydro-Agricultural Development of the Senegal River Basin, 1981-1990" sets as a goal the development of an additional 41,000 hectares by 1990. The rate of development is estimated at 3,500 hectares/year in the beginning of the planning period; increasing to a 5,100 hectares/year later.

The IDP's contribution towards development of irrigated perimeters will consist of the upgrading of approximately 703 hectares of existing perimeters and the construction of 2,120 hectares of new small perimeters, 1, 663 hectares of medium-sized perimeters and 933 hectares of gravity-fed irrigated perimeters. In addition,the project will fund Feasibility Studies for an additional 15,000 hectares. Other new agricultural development activities include the development of 2,250 additional hectares of large perimeters in the Delta

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1/ This project addressed the problems of salination, changes in quantities of groundwater for recharge and use of pesticides and fertilizers.The "Plan of Action" recommended the establishment of a groundwater monitoring program along with piezometer construction as a means of mitigating detrimental groundwater impacts. Additional discussion is found on pages 15 and 19.

Region to be operational by 1984. This will include 750 hectares in Debi-Tiguet which will be financed by the Government of Kuwait; 250 hectares in Kassack North; and 720 hectares in Ndombothiago. Renovation of some large perimeters will be accomplished in Dagana, Nianga and Boundoum. In the upper basin, irrigated perimeters are being studied in Térékolé and Lake Magui Valleys, 30,000 hectares, and in the Karakaro and Faleme areas; as well as the Bafoulabe-Kita plains, 20,000 hectares.

The Groundwater Monitoring Project will complement the Integrated Development Project as well as other U.S -funded OMVS projects, such as the Agricultural Research II and the Basin Survey and Mapping Projects, by providing decision makers with vital information on existing and potential drainage and salinity problems affecting the design and location of irrigation projects and also, potentials for supplemental irrigation from groundwater.

In addition, this project will also use data collected by the AGHRYMET project which is being implemented by CILSS.

b) Mauritanian Projects

In Mauritania, both the national components of the Groundwater Monitoring Project and AGHRYMET will be under the auspices of the Division of Hydraulics. According to the Director of the Division of Hydraulics, he plans to closely coordinate the activities being carried out under the

Groundwater Monitoring Project with those of AGHRYMET. The AGHRYMET Project is assisting in developing an agrometeorological and hydrological forecasting capability in order to establish a water resource data collection and processing network. Given the similar nature and common objective of those two projects, the Director contemplates eventually linking the activities of the Groundwater Monitoring and AGHRYMET Projects into one operation to be called National Agro-Meteorological Services.

c) CILSS and the Club du Sahel

This project supports AID regional objectives within the context of CILSS and the CLub du Sahel. The CILSS/Club Strategy emphasizes the quick execution of feasibility and planning studies so that large multi-purpose projects can begin in the mid to late 1980's. By establishing a system of groundwater monitoring, analysis and management planning, this project will assist in the development of a hydrological information and institutional base necessary for proper development and utilization of the water resources in the Senegal River Basin. This information will identify actual and potential hazards in and near irrigated lands, making possible better drainage design, will identify any deterioration of water quality in existing domestic and livestock wells that may result from irrigation development, and will define relationships of river recharge to changes in aquifer storage in areas considered most critical by Member States and OMVS. (See figure 1 for the area to be covered by the project). The project is technically feasible and appropriate as presented.

III. PROJECT DESCRIPTION

A. Overview

The Senegal River, 1800 kms long, is one of the major rivers of West Africa, draining an area of approximately 300,000 km². Its major tributaries are the Bakoye , Bafing and Falémé Rivers. This area contains the principal land and water resources of the Sahel and has been an important concern of the Member States of the OMVS, namely Senegal, Mali and Mauritania.

B. Groundwater Occurence

The groundwater resources of various parts of the basin have been investigated by several parties. A bibliography of the most pertinent studies is attached as Annex 1. Most of these studies merely investigated the existence of groundwater and its availability for villages, livestock and public water supply. Most of these studies have had limited, short-term objectives, with little attention given to the training of groundwater specialists and technicians who are nationals of the three Member States.

Of all the studies reviewed, that of ILLy (1973),[1/] sponsored by OMVS/FAO, most pertinently described the hydrodynamic relationships among the river, its contiguous alluvial aquifer, and the underlying regional aquifers. The principal conclusions were that:

1. the river and its contiguous alluvial aquifer form a line source of recharge for deeper regional aquifers in the Continental Terminal, Eocene, and Maestrichtian formations underlying the western parts of the Senegal River Basin in Senegal and Mauritania;

1/ ILLy, P., Etude Hydrogéologique de la Vallée du Fleuve Sénégal. 3 parts, OMVS/FAO Etude hydroagricole, FAO, RAF/65/061, 1973.

2. the alluvial aquifer is alternatively recharged by the river during floods and depleted during the dry season thereby sustaining most of the base flows of the river below Bakel; and,

3. hydrogeologic conditions are favorable for the development of groundwater for irrigation in the Matam-Boghé sector of the valley, but additional investigations, including exploratory drilling and aquifer testing, are needed to determine the limits of such development.

The ILLy study recommended continuing monitoring of water level and water quality in the piezometers constructed for his investigation and the establishment of a pilot groundwater irrigation project in the Matam-Boghé sector. While water level and water quality observations were continued by the OMVS during 1973-74, they were subsequently discontinued due to the lack of operating funds, personnel and vehicles. The pilot project recommended by ILLy was not implemented, possibly because it was considered premature in view of OMVS emphasis at that time on surface-water development.

Another OMVS/FAO sponsored study by Audibert (1970)[1/] concentrated on the Senegal River Delta. This study concluded:

1. virtually all the aquifers beneath the delta and extending upstream as far as Podor contain saline or brackish groundwater;

2. the groundwater beneath most of the delta is highly saline and present at a depth less than 3 meters; and,

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1/ Audibert, M., Delta du Fleuve Sénégal, Etude hydrogéologique, 4 parts, OMVS/FAO Etude hydroagricole du Bassin du Fleuve Sénégal. Projet MAR/REG 61. 1970.

3. deep drainage systems would be required within irrigated perimeters in order to control water-logging and soil salination.

Audibert also advised that monitoring groundwater quantity and quality is needed as part of water management in irrigated perimeters as lack of this knowledge could threaten the entire investment.

The installation of an observation well network in the river valley downstream from Bakel was recommended by an April 1976 study prepared for USAID by the US Bureau of Reclamation [1/]. This network was recommended to monitor the response of the water table to changes in the river regime, irrigation activities and groundwater recharge and discharge. The number, location, and specification of observation wells were not detailed, nor were the aquifers to be monitored, nor the costs.

The lack of groundwater data and of knowledge of the recharge characteristics has deterred at least one potential project. This was the Bechtel proposal for the development of groundwater to irrigate 2,800 hectares of sandy "diéri" lands for vegetable production at Matam[2/].

1/ US Bureau of Reclamation, Senegal River Basin - Preliminary Basic Data and Examination and Suggested Study Program, 1976. - USAID Report.

2/ Bechtel Overseas Corp., Development of Irrigated Agriculture at Matam, Senegal. Feasibility study, USAID report, 1976.

Greenman presented a proposal for a basin-wide program of groundwater data collection and analysis that included training and institutional development components for OMVS. He proposed a first phase, one-year effort to identify requirements for data collection, program formulation, and institutional development, then a long-term second phase of technical assistance[1/].

Further study of groundwater was conducted during 1977-78 as part of a USAID-financed series of studies by Gannett Fleming Corddry and Carpenter. This effort concluded:

1. groundwater levels and saline water from the shallow aquifer will tend to rise around the impoundment created by the Diama Dam in the Senegal Delta;

2. water-logging and salinity are likely to develop in irrigated perimeters unless there is adequate water management;

3. the potability of the shallow groundwater tapped by village and livestock wells could be adversely affected by increasing use of fertilizers and pesticides; and,

4. regulation of river flows permitted by the Manantali Dam should somewhat reduce the periodic recharge to groundwater in the alluvial and regional aquifers.

In conclusion, the Gannett Fleming Corddry and Carpenter report strongly recommended a program to monitor groundwater levels and water quality. This conclusion was supported and further developed by the Taylor report.

1/ Greenman, D.W., "Proposal to assemble groundwater data in the Senegal River Basin," USAID/OMVS, Dakar, 1977.

C. Project Components

1. Goals

The project aims to establish within the OMVS a system for monitoring and investigating potential groundwater problems related to irrigation development and to the construction of the Diama and Manantali dams. The system will address:

a. recharge-discharge relationships of the Senegal River, its valley aquifer and contiguous regional aquifers;

b. changes in groundwater regime caused by the construction of the Diama and Manantali dams and the resulting alterations of the flow regimes of the river;

c. irrigation development potential from groundwater in the Matam-Boghé sector;

d. water quality in domestic and livestock wells resulting from changes in river flow, irrigation and use of fertilizers, pesticides and other materials; and,

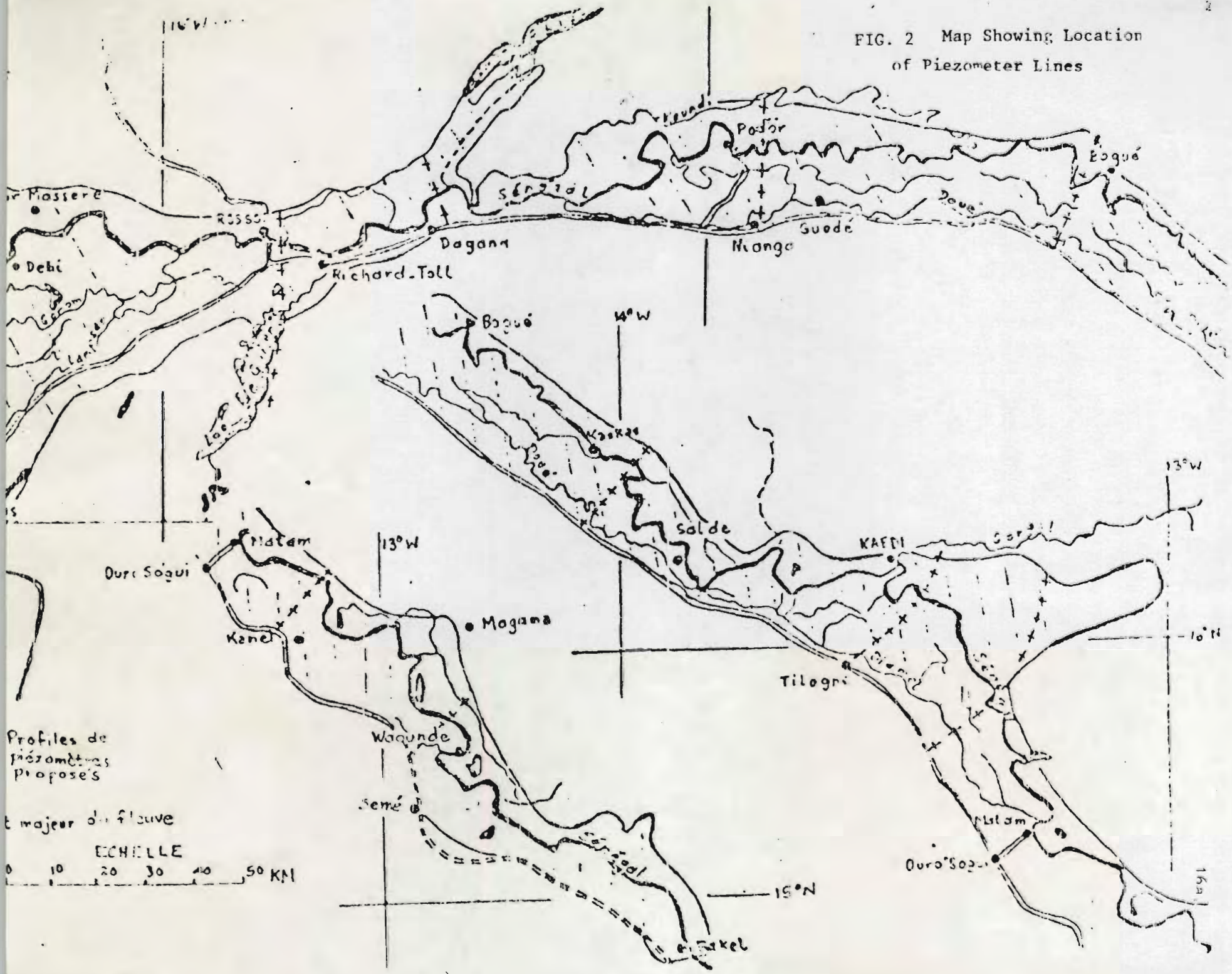
e. groundwater dynamics, including water-logging and salination, in and around irrigated perimeters.

2. Implementation

The project will be carried out over a four-year period to accumulate significant observational data for interpretative analysis, and to establish the OMVS institutional capabilities given personnel and funding constraints of the technical agencies of the Member States and of the OMVS. By the end of the project, there will be the following outputs:

a. a groundwater monitoring system, including a network of observation wells and piezometers:

FIG. 2 Map Showing Location of Piezometer Lines



b. trained OMVS and Member State staff for water data collection and management planning; and ,

c. a capability for groundwater data compilation and analysis.

D. Management and Operational Procedures

The project will be directed and managed by a central hydrologic/hydrogeologic office to be established in OMVS at Saint-Louis, Senegal. The central office staff will consist of:

1. the OMVS Chief of Project;
2. Deputy Project Chief;
3. an Administrative/Finance Officer;
4. an Hydrologist in charge of data compilation and analysis and training;
5. an Hydrologist or Engineer in charge of sector operations;
6. three Sector Chiefs (technicians);
7. two draftsmen;
8. three secretaries;
9. a translator;
10. an accountant; and,
11. three chauffeurs/mechanics.

The three Sector Chiefs, designated by their parent national agencies, will be trained and oriented in the central office and then, when field activities begin, move to sector headquarters in Saint-Louis, Kaedi, and Manantali.

The three Sector Chiefs will implement and supervise the field activities of the construction and/or surveying crews and will monitor the work of the well observer crews. These crews will be comprised of national agency employees of Senegal, Mali and Mauritania. (The administrative structure and project implementation are discussed in detail in Section IV C, "Institutional Analysis", and Section VI "Implementation Plan"). To achieve these results, the project includes financing for technical assistance, training, equipment, construction, and operating support. The OMVS will supervise the project and field operations with its central staff, but most of the data collection will be through national agencies of the Member States. The OMVS will, therefore, assume responsibility for filling the professional, administrative and support positions required for the central office and for overseeing project implementation.

More specifically, implementation of the project involves technical assistance, commodities, construction, and operating support. The proposed technical assistance is for a total of 94 person-months. This includes one long-term Deputy Project Chief with expertise in groundwater hydrology and monitoring technology who will be assigned to the project for 36 months. The Deputy Project Chief will work directly with the Project Chief in Saint-Louis, beginning late in the first year of the project to assist the Project Chief in developing field methodology, procurement of commodities, training of field personnel, and in setting up a central system for data collection, compilation and analysis.

In addition to this Deputy Project Chief, an additional 13 months of short-term technical assistance will be provided for water budget and

salt balance analysis, water quality analysis, and groundwater modeling. This technical assistance is to be provided by the US Geological Survey under a PASA[1]/.

Further, AID will finance the services of an Administrative/Finance Officer for a total of 45 months. (see Annex B-4 for a detailed description of his/her duties).

Commodities to be financed by this project include technical equipment, office equipment, materials and vehicles. The technical equipment includes electric water-level tapes, steel tapes, specific conductivity meters, surveyor levels, water-level recorders, hand augers, power augers, pipe cutters, and miscellaneous hand tools. The office materials includes desks, tables, chairs, typewriters and other items. The materials include the pipe, gravel, cement, etc., needed for constructing the piezometers and wells.

Construction of the piezometers along the proposed 10 lines in Senegal and Mauritania is to be done under local contract.

1/ In the event that the US Geological Survey is unable to field a qualified hydrologist, AID will seek the services of this professional via an institutional contract.

The construction of shallow (less than 5 meters deep) piezometers and intermediate (5 to 30 meters) piezometers in and around the irrigated perimeters will be done using hand and truck-mounted power augers, respectively, by teams working under the supervision of the Saint-Louis and Kaédi Project Sector Chiefs. In Mali where virtually all piezometers must be constructed in hard consolidated rocks to depths averaging 60m, the Malian Directorate of Hydraulics and Energy will provide special drilling equipment with trained drilling crews on a direct cost reimbursement basis. The sites for the piezometers will be chosen on the basis of antecedent photogeologic analyses and geophysical surveys by trained Malian personnel.

Operating costs to be funded by the project include administrative support for OMVS headquarters, salaries for short-term employees at Saint-Louis office, gasoline and maintenance for vehicles, and travel expenses for implementation supervision. The OMVS Member States will gradually assume the burden of recurrent costs. Recurrent costs, however, will be handled directly by the Member States.

The training proposed under this project will include:

1. long-term and on-the-job practical training for sectoral teams;

2. training of OMVS central staff personnel in hydrogeological compilation and analysis, both under the guidance of the OMVS training officer assisted by the Deputy Project Chief; and,

3.a. USAID/RBDO will issue PIO/Ps for long and short-term participants who will be placed at US institutions by the Office of International Training (S & T/IT).

b. candidates for training will be nominated by the OMVS for each Member State and jointly selected by the respective USAIDs, the OMVS and RBDO. A training program for each candidate will be proposed by the US Geological Survey and approved by USAID and will include on-site research for the degree program. Candidates will be selected among hydrology service personnel of the three participating countries;

c. an English language program will be coordinated by ICA/Senegal for training of US degree students; and ,

d. all candidates will be placed in an institution selected on the basis of criteria defined by AID for institutional degree training programs.

Training at the university level will provide OMVS with the necessary staff to take over project functions after AID's assistance is terminated. This will also insure continuation of project activities at improved level of competence. This training will address all aspects of project methodology and implementation necessary to institutionalize and continue the groundwater monitoring project, and therefore, cover a broad range of activities from hydrological data analysis to the care and maintenance of technical and field equipment.

The project is an institution-building activity which will have no direct impact on the social structure of the Senegal River population. Nevertheless, a social analysis has been included as well as an economic

analysis (See Sections IV.B and IV.D). The proposed research activities may affect the physical appearance of the locality; however, it will not have a significant effect on the environment as a result of its limited scope, carefully controlled nature and effective monitoring system. The Initial Environment Examination recommends a negative determination and details of that examination are attached as Annex F.

All procurement of drilling and monitoring equipment has been distributed between procurement from Code 000 (US only) and waivers for shelf-item procurement (Code 935). A waiver for vehicle procurement is listed under Annex E, "Procurement List". Local contracting will be utilized for construction of some 200 piezometers and 10 observation boreholes. In accordance with Handbook 11, Section 2.2.5.2.e, the use of a local firm is permitted since: 1) the estimated cost of construction services is less than $ 5 million, 2) no US firms with the required capabilities are operating in the host countries and 3) the locally based companies have been doing business in the host country on a continuing basis for more than three years prior to the issuance date of invitations for bids or requests for proposals.

As a Condition Precedent to the disbursement of project funds, the OMVS will establish the Hydrology and Groundwater Monitoring Unit at Saint-Louis. The establishment of this unit will require the appointment of a Project Chief and central office administrative personnel. The Project Chief and the technical supporting staff will be appointed prior to the disbursement of any project funds and the Sector Chiefs will be appointed prior to disbursement of the second tranche of project funding for training, field operations,

and construction. The terms of financing the costs of certain personnel by Member States' national services to work under the Sector Chiefs shall be governed by a written agreement between the OMVS and each participating Member State. The functions and coordination of these personnel are discussed in the "Institutional Analysis" and "Implementation Plan", Sections IV.C and VI. Total funding of $ 4.0 million is requested for this project over a four-year life of project. Project implementation over this period will follow the general schedule provided in the Implementation Plan. For the first year the amount of $ 1.0 million is requested with approval of this Project Paper.

IV. PROJECT ANALYSES

A. Technical Analysis

The technical feasibility of this project was analyzed by George C. Taylor,Jr., of CH2M-Hill International in an October 1979 report, "USAID Groundwater Management Planning", The technical design of the project is based on the soundness analysis completed by the consultant, and the design team considers that the project is feasible and will achieve the intended output.

To date, water monitoring in the Senegal River Basin has been virtually nil. Hence, water-logging and salination problems have surfaced in several areas in the valley. Proposed investments from the World Bank, FED and USAID amount to several millions of dollars for diked irrigated perimeters in the Senegal River Basin. These investments, if realized, may be jeopardized in the absence of an adequate water monitoring system. This project may serve as the needed linkage between the planned development of irrigated agriculture and an appropriate infrastructure to support and improve water management in the Basin.

1. Proposed Data Collection and Monitoring Program

Over a four-year term the project will establish a system of data collection to monitor and investigate existing and potential problems of groundwater development and management. This system will address several problems:

a. recharge-discharge relationships of the Senegal River and its aquifers;

b. groundwater changes caused by the construction of the Diama and Manantali dams and alterations in the flow regime of the river;

c. development potential of groundwater for supplemental irrigation in the Matam-Boghé sector;

d. water quality in domestic and livestock wells resulting from changes in river flow, irrigation and use of fertilizers, pesticides and other materials; and,

e. Groundwater dynamics in and around irrigated perimeters.

The four-year life of project will permit time for training and institution-building within OMVS and allow enough time to accumulate a volume of statistically significant hydrologic data. The project takes into account personnel and funding constraints of the technical services of the Member States and the OMVS, by allowing for long-term and on-the-job training and for their take-over of project support costs. The OMVS Directorate of Regional Infrastructure will be responsible for staffing most of the professional and administrative support positions called for in the project. For these positions, adequate skills are available in the technical agencies of the Member States and in the OMVS and advanced training is proposed for higher level technicians, to insure proper follow-up.

2. Technical Assistance

Contractual technical assistance for a total of 49 person-months will be provided to assist in on-the-job training in developing the final implementation and monitoring strategies, and in specialized studies of water quality, salt balance analyses, water budgets and groundwater modeling. One long-term Deputy Project Chief with expertise in general hydrology and groundwater monitoring will work a total of 36 months on the project. This technician will work with the Project Chief in Saint-Louis beginning late in the first year of the project. The Deputy will also assist in procurement, training and planning activities. An estimated 13 person-months of additional short-term technical assistance will be provided for special training in water budget studies, salt balance analyses, and groundwater modeling.

3. Work Plan

The "Technical Analysis" (Annex A) examines in detail the five principal work components of the project. These are planning, data compilation and analysis, training, field operations, and construction. The planning activities involve designing appropriate systems for project management, implementation supervision, data recording, and other project activities. The establishment of a large network of observation wells and piezometers will require careful planning. Data compilation and analysis involves updating earlier studies, compiling information from published reports, and using this and new data from the project to construct maps of groundwater and water quality fluctuations and hydraulic profiles as well as to study the water budget and the salt balance in irrigated perimeters. Project personnel will prepare technical reports interpreting these data for water resources planners and managers.

On-the-job and workshop training will involve the use and maintenance of electric tapes, water sampling equipment, leveling instruments, automatic water-level recorders and other equipment, the systematic recording of field measurements, and the training of surveyors, well observers, mechanics, and other personnel. Professional personnel will receive more advanced training in the construction of hydraulic profiles, water-table, water quality and other groundwater maps. At a later stage of the project, training will be provided in water budget, salt balance analyses, and groundwater modeling. In addition, candidates for both long-term US and third-country (Senegal or Niger) training in hydrogeology and related areas will be identified during implementation of the project. This training will be initiated early in the project so that trained personnel will be integrated into the project prior to completion.

The construction and field activities will be supervised by three sector field offices at Saint-Louis, Kaédi and Manantali respectively (Fig. 1). Sites will be selected and construction undertaken for new or replacement shallow piezometers in and around each major diked perimeter and in the vicinity of Diama reservoir and for 10 lines of combined batteries of shallow (less then 5 meters), intermediate (5 to 30 m), and deep piezometers (30 to 60 m) along the lines of the IIIy and Bechtel studies. In all, 450 piezometers of shallow and intermediate depth will be constructed in and near major diked irrigated perimeters, and some 200 shallow, intermediate and deep piezometers and observation wells in 10 lines (Fig. 2) across the valley. Also, 20 deep piezometers will be constructed around the periphery of the Manantali reservoir to observe the effects of the impoundment of the Bafing River on the local groundwater regime.

The measurements of water level and specific conductivity will be made about once a month in the beginning. After the teams gain experience, the frequency will be increased to weekly intervals, where needed, especially during the flood season. Water sampling will also be taken for detailed chemical analysis to be performed by the "Direction des Mines et de la Géologie" for about 150 samples during the life of the project. Testing for pesticides/herbicides will be done in the US., since the capability does not exist locally. The results of the measurements and analyses will be compiled and evaluated by the technical staff of the central office in Saint-Louis.

In addition to the records of groundwater levels and quality, logs will be made of the lithologic characteristics of subsurface formations encountered during the construction of piezometers and observation boreholes. An additional duty of the Deputy Project Chief will be to determine the scope of future hydrogeological investigations which should be carried out in the basin following the monitoring program and to advise OMVS on special equipment which will be required. To this end, the Deputy Project Chief will consult OMVS and Member States organizations having responsibilities for long-term hydrogeological investigations.

4. Technological Strategy

The technology selected for the project is the simplest possible, consonant with the requirements for technically sound groundwater monitoring and data collection. With the exception of ten automatic analog water-level recorders to be used on deep observation boreholes on each of the ten proposed piezometer lines and on five deep piezometers in the Manantali Reservoir area, all instruments for field observations will be hand-operated. The proposed investment in field equipment (excluding that for constructing piezometers) is approximately $ 45,000. In reviewing the draft Project Paper, it was suggested

by USAID/REDSO/Abidjan that consideration be given to automating the piezometer network using digital water-level recorders with radio transmittal of data to a central master receiving station for computer processing. This suggestion was made in the interest of reducing recurring personnel costs of observation well crews using hand-operated equipment.

It should be pointed out, however, that the capital cost of such an automated system would be of the order of $ 2,000,000 (See Economic Analysis, Section IV B). A radio transmitter at each observation well or piezometer line would cost about $ 10,000 in addition to the cost of an automatic water-level recorder (about $ 2,700 each). Add to these the cost of a central master receiving station for the observation well network which would be about $ 50,000 and a computer for processing the data which would cost about $100,000.

In addition to the high initial cost is the problem of operation and maintenance. All these instruments are mechanically sensitive and must be regularly serviced by highly specialized technicians if they are to function effectively. Also, realistically there is very limited need for real-time data in groundwater monitoring as most secular changes in groundwater levels and water quality occur rather slowly over time as compared to, say, the rapid passage of a flood crest down a river, for example. In view of the financial and personnel constraints described above and taking into account the prevailing weak infrastructure of the region, it has been decided that the simplest technology is also likely to be the most viable approach in the project. Also it is anticipated that recurring costs of observation well crews will be picked up in the regular operational budgets of the Member States on completion of the four-year term of the project.

5. Timing of Project Implementation

During preparation of the draft Project Paper, the question was raised as to optimum timing for initiation of the project vis-à-vis changes in the river regime that will be caused by the construction and operation of the Diama and Manantali dams. With respect to changes caused by these dams, actual observational activities in the monitoring project should optimally begin about 2 to 3 years before the actual operation of the dams begins and continue indefinitely thereafter. Such a schedule would provide sufficient time for acquisition of base-line data which subsequently can be compared with later data effected by the operation of the dams.

Construction of the Diama dam began in November 1981 and the dam is scheduled for completion seventy months after contractor mobilization.

Full-scale construction of the Manantali dam is scheduled to begin later in 1982 with the dam becoming operational in 1988-89, depending on levels of funding.

The data collection activities of the Groundwater Monitoring Project will, initially, have their greatest significance in the Senegal Delta and in the lower valley downstream of Podor and should be given first priority in these areas. In the delta, water-logging and salination problems are already manifested in the older diked perimeters, such as M'Pouré near Rosso, and are likely to develop rapidly in the newer perimeters of Savoigne-Lampsar and Grand Digue-Kassack, which will lie along the southern periphery of the Diama reservoir. In the lower valley water-logging and salination are already problems in parts of the Guédé Chantier, Nianga, and Dagana operating diked perimeters and will intensify in the absence of good water management.

Additional diked perimeters, not yet designated, are likely to be recommended for construction under the USAID/RBDO Integrated Development Project. Thus, in so far as the requirements of the delta and lower valley are concerned, data collection activities should begin as soon as possible. Taking into account the usual delays inherent in project design, approval, and implementation, it now seems unlikely that data collection activities under the project can reasonably be expected to begin before the middle of 1985. This is good timing with respect to the construction schedule for Diama dam.

Lower priority will be given to the initiation of data collection activities in the middle valley until such time as these are fully operational in the lower valley and the delta. In any case, full data collection activities under the project in this reach of the valley would not be likely to be ready to begin before the middle of 1986, thereby giving adequate time for acquisition of base-line data before the beginning of operation of the Manantali dam.

6. Protection of Piezometers and Observation Wells

In past groundwater studies, vandalism or willful destruction of piezometers or observation wells has been a chronic problem. Pipe caps are removed and the piezometer pipes are filled with sand or other debris, making them useless for water-level and water-quality observations.

Some effective means must be found to protect new installations. In some localities a counselling program undertaken through the district chief and the local village chiefs may be effective in abating the problems. Experience has proven that hiring a watchman or placing new installations under the preview of the village chief may be the best prevention against

vandalism. Also the concept of proper maintenance needs to be learned by project participants.

Piezometers located at sites subject to flooding, as in the cuvettes or flood basins, must be protected from direct entry of silt-laden water into the piezometer pipes. This means that the end of the piezometer pipe must be elevated 3 to 5 m above ground level, depending on the anticipated maximum flood heights. In past investigations (Illy 1973), this was done by adding 1 or 2 m joints of pipe to the piezometer during rising stages of the flood and then detaching them during falling stages. Also, during the three to four months of the flood season, such piezometers can only be reached by boat. It is estimated that some 20 to 25 percent of the piezometers located outside of the diked irrigated perimeters will be at sites subject to flooding. Such piezometers, of course, could not be protected by the method suggested in the previous paragraph.

7. Groundwater Monitoring in the Upper Valley Sector

Discussions with the Malian Directorate of Hydraulics and Energy (DNHE) pointed out that it gave higher priority to groundwater monitoring activities in the environ of the Manantali reservoir than to the reaches of the Bafing and Senegal Rivers downstream of the dam. The plan for groundwater monitoring in Mali consists of the development of a network of observation points at existing open wells and boreholes along the reach of the Bafing River between Manantali Dam and Bafoulabé and, also, along the Senegal River from the confluence with the Bafing River at Bafoulabé downstream to the Malian border. In addition, twenty piezometers would be constructed upstream of Manantali Dam in areas of hydrologic importance adjacent to the impoundment.

The network of observation points along the Bafing and Senegal Rivers downstream from Manantali Dam would be utilized to monitor changes in the groundwater regime resulting from the alteration of flow patterns caused by operation of the dam. The data acquired during the monitoring period will be utilized in the development of plans to mitigate any adverse results of river flow regulations i.e. possible reduction of recharge to the aquifers with a resulting lowering of the water table, and, also in the planning of other projects which contemplates the utilization of groundwater resources (irrigation, domestic water supply, etc).

The piezometers to be constructed in the areas adjacent to Manantali reservoir will provide hydrogeologic data on the effects of the creation of the impoundment and the seasonal variation in reservoir water levels on the existing groundwater regime in the peripheral areas with hydrologic connections to the impoundment. This network of piezometers will provide planning agencies, OMVS and Malian Government agencies with information required for the utilization of groundwater resources in the area around Manantali Reservoir. Of most immediate concern is the need for groundwater data for utilization in the planning for resettlement of the 12,000 people who will be displaced by the Manantali project. Concern has also been expressed over the possibility of leakage from the basin through fracture zones identified during preliminary geologic reconnaissance. The aerial photographic and geophysical studies proposed under this component along with the strategic siting of piezometers will attempt to identify areas of leakage and estimate its magnitude.

B. Economic Analysis

1. Economic Benefits

Since this project is a data-gathering, research, and institutional-building effort and not a revenue-producing project, economic benefits directly attributable to the project are difficult to measure. However, the act of gathering data on groundwater levels and quality over time will provide essential information for the best management of hydraulic resources in the Senegal River Basin for agricultural production. The most direct use of the data will be in irrigated agriculture, but the information will also be important in managing the area's water resources for household consumption and for livestock. Below is an analysis of these problems:(a) water-logging and salination of irrigated lands, (b) leakage from the Manantali dam, and (c) the improvement of the development planning, management and monitoring capability of the OMVS.

A. Nature of Risk

Water-logging on irrigated perimeters and build up of toxicity.

(1) Valuation of Affected Assets

This risk is associated with irrigated perimeters. Two valuation approaches are possible: (a) the present value of the installed infrastructure (land preparation, water control system, etc.); and (b) the net value of production. Assume that these are equal and represented by recent results on existing perimeter developments, i.e., Bakel.

Area:	500 hectares
Yield:	4 tons/hectare
Value:	$ 400 thousand

Per hectare:	$ 800
Deduct:	$ 300 cost of inputs (to be verified)
Net per hectare:	$ 500 per year, current prices.

(2) Potential Loss

Several types of loss are possible: (a) loss due to improper selection of perimeter site. Assume this is permanent, unavoidable (once investment decision has unwisely been made) and total (yield falls below operating cost, land is abandoned), this type of loss is not considered here; (b) loss due to improper application of inputs (excessive water, excessive pesticide). Assume this is correctable by altering inputs and by supplementary (drainage) infrastructure. Actual loss is equal to a drop in production for number of years before remedial action is undertaken. Calculate:

Period of analysis:	25 years
Net yield before loss:	$ 500 per hectare
Probability of loss over 25 yrs:	50%
Probability in any one year:	2%
Average affected yield:	$ 10
Pattern of loss:	20% per year until corrected.

Year	1	2	3	4	5 and later
Loss in year	$2	4	6	8	10
Cumulative	$2	6	12	20	30

(3) Remedial Action

This may involve (a) altering inputs (including water), or (b) supplementary infrastructure. For purposes of this analysis, it is assumed that these remedial actions would eventually be taken in any case. Neither their cost, nor their rate of ultimate success, therefore, affects the analysis. Comment: ability to recover (potential success of remedial action) in practice may be dependent on speed with which remedial action is initiated.

(4) Identification of Imminent Loss

Without the project, loss would not be identified until after it has occurred for one or more years. Assume average time to identification is two years.

With the project, imminent loss would be identified one year before actual occurence by measurement of marginal changes in water quality.

Comment: This is a best-case hypothesis.

Remedial action is assumed to require one year.

Therefore without the project, average loss would be $12 per hectare, while with the project it would be zero.

(5) Cost of Identification

At least two costing options are possible: (a) relative to the total cost of the project; or (b) relative to that subsystem which most directly addresses this specific risk. In the following analysis, option (b) is utilized.

Subsystem Description: a mix of 450 shallow and intermediate piezometers will, on the basis of 1 piezometer per 100 hectares, provide surveillance for approximately 45,000 hectares of irrigated land.

Cost Per Piezometer

Total Project Cost	$ 5,202,000
Less cost of Malian Component	- 618,000
	$ 4,584,000
Less cost of construction of the 200 piezometers and 10 boreholes by contract ("lines")	- 770,000
	$ 3,814,000
Less cost of materials for piezometers (pipe, $ 144,000[1]/ + local materials $ 12,000 = $ 156,000)	$ - 156,000
	3,658,000

This amount, $ 3,658,000, represents the various costs to implement the Senegal and Mauritania components i.e. technical assistance, vehicles, technical equipment, operating expenses, administrative and training costs; less the cost of materials for construction of the 450 piezometers. Assuming that this cost is divided equally between the activities involved in the monitoring system and the piezometers and boreholes on the lines, the portion attributable to the irrigated land is $ 1,829,000. Therefore, the cost of installing the 450 piezometers is $ 1,829,000 plus the cost of materials, 156,000 or 1,985,000.

1/ Pipe cost including transportation and inflation.

The cost/hectare is $ 1,985,000/45,000 ha or $ 44/ha.

Recurrent Costs

Saint-Louis OMVS Office	$ 141, 600
Senegal Sector	43, 100
Mauritania Sector	38, 400
Total	$ 223, 100

Assuming that recurrent costs associated with the piezometers in the irrigated perimeters are proportional to the ratio of the number of piezometers in the perimeters to the number on the 10 lines, 450 to 210, the recurrent cost attributable to the irrigated perimeter is about 2/3 x $223,100 or about $ 149,000/yr. On the basis of 45,000 hectares,the annual recurrent cost per hectare is $ 3.30.

Summary Cost Per Hectare

Investment	$ 44.00
Recurrent	$ 3.30

(6) Cost Benefit Analysis

The proposed subsystem of 450 piezometers in this case would be sufficient to protect 45,000 hectares. Costs and benefits would be:

Costs

Investment	$ 1,985,000
Recurrent per year	$ 149,000/year
Benefit	$ 540,000 per year (at $12 per hectare)

(loss averted).

It is assumed (very liberally) that piezometer installation investment costs are all incurred one year before production begins, and that the project is 25 years long.

Year	Investment	O & M	Total	At 10% D.F.	Present worth	Benefit	Benefit Present Worth
1	1,985,000	149,000	2,143,000	.909	1,939,800		
2 - 25	-	149,000	149,000	9.276	1,382,100	540,000	5,009,000
Total	603,000	2,362,500	3,060,000		3,321,900		5,009,000

$$\text{Benefit - cost ratio} = \frac{5,009,000}{3,321,900} = 1.51$$

(7) Conclusions

Under the fairly reasonable but nonetheless unverified assumptions presented in this analysis, the net benefit from the project in averting water-logging and toxicity build-up losses appears substantial. The cost-benefit ratio implies this project sub-component is well worth the investment.

B. Nature of Risk

Reduced hydropower capacity at Manantali dam. The Manantali dam is to be located in a geological zone characterized by faults through which water from the reservoir could force its way as the reservoir fills and water level and pressure increase, producing loss of water, lower sustainable water level in the reservoir and, potentially, danger to the dam infrastructure itself.

(1) Valuation of Affected Asset

It is assumed that the principal risk is lower sustainable water level behind the dam. Water lost is assumed to re-enter the river without net effect on downstream flow (valid provided that loss rate does not exceed planned minimum release rate from the dam so that downstream flow can be compensated by dam flow management to remain on target). Risk of damage to the structural integrity of the dam is considered not measurable by this project.

The principal asset affected will be power generating capacity, assuming that management strategy is to compensate loss by reducing turbine flowthrough, so that total downstream flow (release plus loss) remains on target.

- Power generation potential is 800 gigawat/hours/year
- Unit value at dam is assumed to be $0.1 per Kwh
- Value of annual production - $80 million

(2) Potential Loss

Without elaborate scientific and engineering data and models, the extent and probability of power capacity loss cannot be estimated. For the present purpose, it is assumed:

Maximum loss: 20% of capacity.

(Given the management strategy assumed above, this loss rate does not seem unrealistic).

Probability of occurrence: 50%

Under these assumptions, the maximum loss in any given year would be $ 16 million, and the probable loss would be $ 8 million.

It is further assumed that (a) any loss to occur will take place only in the first 10 years of dam operation; and (b) once identified and remedied, there is no future occurence.

(3) Remedial Action

It is assumed that the engineering capability exists to block major leakages to the extent necessary to recover full power capacity. Related studies make reference to such measures in TVA developments, but detail is not available. The risk of failure to fully recover capacity is not covered by this project. It is also assumed that the cost of remedial action would be incurred irrespective of whether this project was implemented or not, and therefore does not enter this analysis.

However, in the absence of precise information on the rate of loss and its location, the delay before remedial actions could be planned and implemented might be extensive. During this time, power output would deteriorate.

(4) Identification of Loss

The sub-purpose of this project related to Manantali dam monitoring is to provide earlier and more accurate identification of water loss endangering generation capacity, permitting more effective management decision-making as to (a) flow-through management and (b) remedial engineering interventions.

In the absence of a formal model of the probability of advanced detection and the delay to completion of remedial action, it is assumed that:

- without the project, time to full recovery would be 3 years, worth $24 million;
- with the project, time to full recovery would be 1 year, worth $8 million.

(5) Cost of Identification

The sub-system in the project addressing this risk is an array of 20 deep piezometers around the dam.

Comment : probability of timely and accurate detection obviously will be sensitive to the number of piezometers installed above or below this planning level.

Costs are calculated as:

Installation	
- Site identification	$ 60,000
- Construction, instrumentation, vehicles, equipment, etc[1/]	618,000
- Associated Project Costs[2/]	610,000 (pro-ration to construction costs)
	$ 1,288,000

1/ Based on Nov. 15, 1982 Memo to File outlining costs of Malian Component

2/ Proportion of Technical Assistance, Operation, Administrative, Training and Evaluation Costs; estimated at 20% of $ 3,054,000 or $ 610,000.

Recurrent

- Monitoring $ 4,200 ($ 210 per borehole per year)

(6) Cost - Benefit Analysis

It is assumed that investment costs are incurred in 1987 and measurements commence on that date.

It is assumed that the power generation begins at full capacity in 1993.

The net benefit is the difference between probable cumulative loss without the project (3 years at $8 million) and with the project (one year at 8 million) or $ 16 million. This benefit is considered possible only once and only during the first 10 years of the project. Thus the average annual benefit during the first 10 years is $ 1.6 million.

Groundwater Monitoring - Manantali

Cost Benefit Analysis

($ thousands)

	Costs					Benefits	
Year	Investment	O&M	Total	10% D.M.	Present Worth	Current Value	Present Worth
1	1,288	4.2	1,292.2	.909	1,175	-0-	-0-
2-5	-0-	4.2	4.2	2.881	12	-0-	-0-
6-15	-0-	4.2	4.2	3.815	16	1,600	6,104
16-25	-0-	4.2	4.2	1.483	6	-0-	-0-
	1,307	105	1,412	-	1,209	1,800	6,104

$$\text{Benefit cost ratio} = \frac{\$6,104}{\$1,209} = 5.04$$

(7) Conclusion

The essentially illustrative cost-benefit analysis presented above suggests that the Manantali dam piezometer sub-system could permit a substantial net benefit in terms of reducing the risk of power capacity loss.

(8) Sensitivity Analysis

The project would still have a net economic benefit if the risk averted was only 6% as high as assumed above. Such lower level of risk aversion might be associated with lesser severity or probability of loss, less effective predictive capability of the piezometer sub-system, or ineffectiveness of remedial actions.

All aspects of this analysis merit additional refinement. Given the apparently high risk of some (and perhaps substantial) water loss due to the geological structure of the Manantali dam site, it would appear likely that some advance-warning and monitoring program, such as that proposed in this sub-system, would still be shown to be a worthwhile investment.

C. Nature of Risk

Failure to improve the groundwater development planning, management and monitoring capability in the Basin.

One of the major objectives of this project is to improve the tools of planners in selecting areas for irrigated development and maximizing the potential for use of subsurface water in the broader basin fed by aquifers recharged from the Senegal River.

(1) Valuation of Affected Asset

The risk to be averted and the benefit to be realized are extremely difficult to quantify. Following is only a schematic outline of how those factors might be studied:

(a) Economic losses due to misplaced irrigation perimeters. Conversely, economic benefits from optimal placement of such perimeters.

(b) Economic losses due to failure of existing or planned use of subsoil water (for human, animal and pump-irrigated agricultural purposes).

Conversely, economic benefits from optimal exploitation of such resources (for example, current policy precludes intensive use of groundwater for irrigation due to uncertainty about recharge patterns).

(c) Subsoil transmission of urban, industrial and agricultural pollution, and linkage to changes in the quality of surface water.

(d) Economic benefits and losses of all three categories above associated with water management decisions at the two dam sites and offtakes for irrigation.

(2) Impact of the Project

The subsystem devised to address these broader planning concerns is a series of ten lines of piezometers at roughly equal distance between Diama and Bakel, and extending some 25 kilometers on each side of the river.

This subsystem should provide a means to obtain broad planning information related to the four types of risks and benefits outlined above, and thereby to avoid costly errors of commission and omission in developing the basin.

Finally (and perhaps most important) this project will develop the institutional capability of the OMVS to handle groundwater management issues in the future.

(3) Cost-Benefit Analysis

Given the wide range of unknowns, a standard cost-benefit calculation cannot be supported. However, it appears that positive benefits (to give a benefit-cost ratio of 1.0 or better) would be derived from the proposed project if the present worth of the subsystems is calculated and

compared over an appropriate (25-year) period.

2. Cost-effectiveness

In addition to the above economic benefits that will be reaped from this project, the following illustrates the cost effectiveness of the project:

- the project has a relatively minor cost compared to the larger investment in irrigation and agricultural development in the Senegal River Basin over the next 20 years and protects much larger investment;
- the organizational structure chosen is the least-cost combination of regional and national organizations; and,
- the technology chosen has the lowest overall cost.

a. Project Cost versus Total Investment Cost

The total cost of the Groundwater Management Project is estimated at $ 5.2 million, with AID contributing $ 4.6 million. Relative to the cost of this project which will play a key role in supporting most, if not all, developmental activities in the Senegal River Basin, the total investment portfolio in the Basin is estimated to be $ 1 billion. Of this total US investment will amount to approximately $ 100 million over a period of ten years.

This project's investment of $4.6 million, which underpins the substantial irrigation and other agricultural development activities in the Senegal River Basin, represents a minimal percentage of the total investment.

Thus, the significance and the cost-effectiveness of this project is quite self-evident. The importance of groundwater monitoring for the protection of irrigation investment, domestic water supplies for humans and livestock, and for greater overall efficiency in the use of the total hydraulic system (the river and associated aquifers) has already been discussed.

b. Recurrent Costs Implications

Upon completion of this project, the recurrent costs to the OMVS will be relatively low. In summary, the total annual recurring costs are estimated as follows:

I.	Saint-Louis OMVS Office		
	a) Rental and Office Supply	30,000	
	b) Personnel	102,000	
	c) 2 vehicles (oil and maintenance)	9,600	
	Subtotal		141,600
II.	Senegal Sector		
	a) 1 team (including vehicle)	24,000	
	b) Replacement of piezometers	7,100	
	c) Office rental and supplies	12,000	
	Subtotal		43,100

III. Mauritania Sector		
a) 1 team (including vehicle)	24,000	
b) Replacement Costs of piezometers	2,400	
c) Office rental and supplies	12,000	
Subtotal		38,400
IV. Mali Sector		
a) Personnel (supervision and monitoring of piezometers)	31,000	
b) Office supplies	4,000	
c) Vehicle operation and maintenance	4,000	
Subtotal	39,000	
Estimated Total Annual Recurrent Costs	262,100	

The estimated total annual recurrent costs represent only 5% of the total project cost of approximately 5.2 million. In terms of the total investment portfolio of approximately $ 1.0 million that is expected to be carried out in the Senegal River Basin region, which the Groundwater Monitoring Project will support in providing critical data regarding water quality and quantity, the recurrent costs for this project would be negligible.

Considering that these costs would be shared by three countries, the recurrent costs for this project will have little impact on the debt servicing capacity of the Member States.

Finally, AID will obtain a commitment, in writing, from OMVS assuring AID that the Member States will underwrite the cost of those employees

required by the Groundwater Monitoring Unit upon completion of this project.

d. Choice of Organizational Structure

The OMVS and AID considered several alternatives in organizing the project. At first, Senegal planned to establish a groundwater monitoring capability in the riverine areas it considered important.

The approach, if followed later by Mauritania and Mali, would have meant three separate organizations for groundwater monitoring. This would have created expensive duplications in analysis of data and in higher-level direction and administration -- 3 project managers, 3 officers of studies and analysis, 3 high-level directors of construction (of piezometers and observation wells), and so on.

The organizational option, chosen by both AID and the Member States, was implementation of the project by the national hydraulic entities of the Member States but with strong coordination by the OMVS through an office of Hydrology and Geohydrology at Saint-Louis. Several high-level technicians would be assigned to this OMVS office by the Member States with some supporting personnel. However, most of these employees would not be new employees. Only a few would remain at Saint-Louis after the project was fully implemented. The employees would return to their national entities bringing new technical skills to their own organizations.

In this organizational option, the sectors have been cut "horizontally". In other words, the sector office at Kaedi will direct all activities on the Mauritanian side of the river, the Saint Louis sector office, all activities on the Senegalese side; in the Kayes office, all activities

in the Malian Upper Valley. The personnel for these sector offices would be existing personnel, if available, of the national hydraulic entities except for some short-term personnel needed for the one-time construction of large numbers of shallow- and medium-depth piezometers. As mentioned earlier, private firms under contract would construct the limited number of deep observation wells needed in each sector.

Therefore, the chosen option provides for regional coordination by the OMVS and responsibility for analysis and training functions needed only at the higher OMVS level. This option uses existing national hydraulic entities for specific project activities in the national sectors. Since it prevents duplication of costly high-level analysis capabilities while it uses existing personnel and structures for sectoral activities, it is the least-cost organizational alternative.

d. Least-cost Technology

During the development of this project, certain parties suggested that an automated system of data recording and radio transmission to Saint-Louis would be preferable to a system requiring that people collect the groundwater data at the several hundred piezometers. Those suggesting the automated alternative argued that recurrent costs would be sufficiently lower to justify somewhat higher capital costs.

A comparative view of costs for the two systems follows. This is a partial picture because it represents only 10 lines of 20 piezometers crossing the valley at various points. This does not include the majority

of piezometers planned within irrigated perimeters, which are even more urgent than the other piezometers, because of the need to monitor closely salination, and water-logging of this land. However, no additional recurrent costs are associated with the piezometers within irrigated perimeters because SAED and SONADER personnel will be collecting the data as part of their normal activities.

Table 1.

Comparative Costs of Non-Automated versus an Automated Partial System

10 lines of 20 piezometers - Outside of Perimeters.

Non-Automated System	Advanced Automated System
Will have 10 piezometers lines with 20 piezometers per line plus 10 large diameter observation boreholes, one on each line.	Would require all piezometers to be large diameter boreholes.
75 shallow, small diameter piezometers distributed on 10 lines.	200 large diameter observation boreholes. Estimated cost is $ 1,140,000 2/
80 intermediate , small diameter piezometers distributed on 10 lines	Shelter for instruments at $500 each - $ 100,000
45 deep small diameter piezometers distributed on 10 lines.	
10 large diameter observation boreholes one on each line.	
Construction Costs $ 770,000 1/	Construction Costs $ 1,240,000
Instrumentation	Instrumentation
10 analog water-level recorders completely equipped at $1,800 each $ 18,000	200 digital water-level recorders completely equipped at $2,700 each $540,000.
Hand instruments $ 16,000	200 radio transmitters at $ 10,000 each - $ 2,000,000.
	1 central master receiving station $ 50,000.
	1 computer for processing data- $ 100,000.

1/ includes contingencies, see Technical Analysis. Appendix A

2/ based on a unit price of $220/m plus contingencies.

Table 1. cont.

Instrumentation Costs	Instrumentation Costs
$ 34,000	$ 2,690,000
Capital Costs	Capital Costs
Construction plus instrumentation 804,000	Construction plus instrumentation 3,930,000
Recurring Costs	Recurring Costs
Operation and Maintenance	Operation and Maintenance
2 observer crews at $ 21,000/yr. each or $ 42,000/yr.	10 watchmen full-time at $3,000/yr. each or $ 30,000/yr. 2 Instrument technicians at $ 12,000/yr. each or $ 24,000/yr. 2 driver/mechanics full-time at $ 4,000/yr. or $ 8,000/yr.
$ 42,000/yr. for 10 years or $ 420,000.	$ 62,000/yr. for 10 years or $ 620, 000.

Assuming a 10-year life for both piezometers and instruments:

(A)	(B)
Total Cost	Total Cost
$ 804,000	$ 3,930,000
420,000	620,000
$ 1,224,000	$ 4,550,000

(A) is 3.7 times less costly than (B).

Thus, this cost comparison shows that the non-automated system of 200 piezometers could have one fifth of the capital costs of the automated system. On the recurrent cost side, the unautomated system would require approximately two thirds of the recurrent costs that the automated system would require to keep it functioning. This results from the greater delicacy and sophistication of the instruments in the automated system which would require more expensive surveillance and protection on the one hand and more highly trained technicians for repair and adjustment on the other hand.

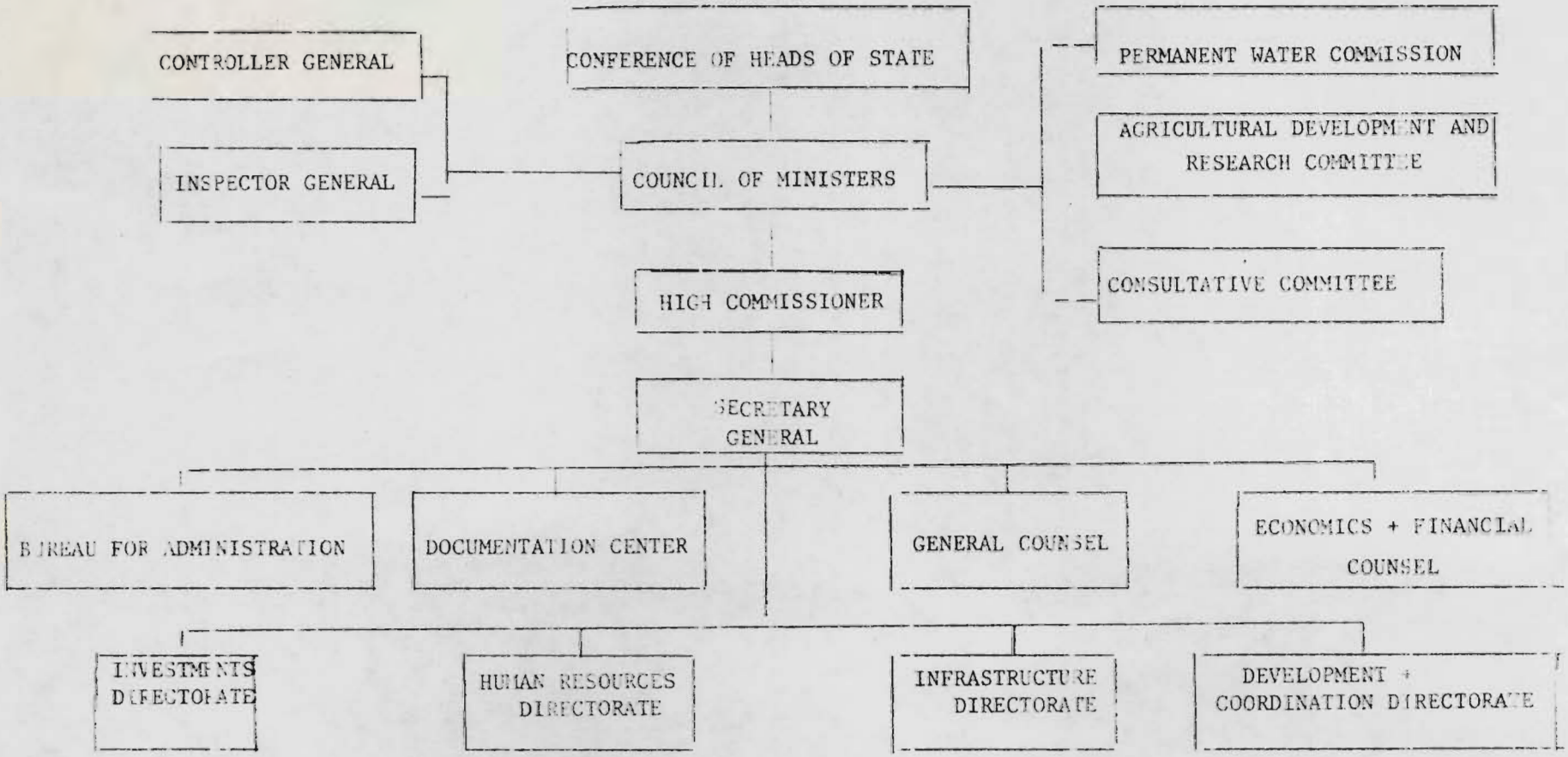
C. Institutional Analysis

1. OMVS

As shown by the OMVS Organizational Chart (Fig. 3) the OMVS is governed by the Conference of Chiefs of States. This Conference is the final decision-making body which rules on questions of general policy. Such decisions must be unanimous and are binding obligations of the respective States. The Chair of the Conference is rotated every two years among the Member States. The next level of organization is a three-person Council of Ministers.

The Council is comprised of one individual of ministerial rank appointed by each State, one of whom is designated as OMVS President. The Presidency is rotated every two years. The Council of Ministers directs the general operations of the OMVS by defining priorities for development projects, authorizing the acceptance of loans and grants, and apportioning payment obligations among the Member States.

Fig.3 - OMVS ORGANIZATIONAL CHART



The Groundwater Monitoring Project will be established as a new unit within this Directorate

In 1975, a High Commissioner's Office was created under the Council of Ministers and broad executive powers were delegated to it by the Council of Ministers. The High Commissioner is nominated by the Chiefs of State and serves for a four-year term. With the amendment of the OMVS Charter in December 1979, the High Commissioner was given broad responsibilities over the execution of all studies, the management of irrigation development, and control of OMVS personnel and administration. Within the office of the High Commissioner there are 4 main Directorates.

(a) Development and Cooperation (Planning and Coordination)

This Directorate is responsible for the long-range Master Plan for the integrated development of the entire Senegal River Basin, for the harmonization of individual national development plans with the Master Plan, and for the planning, and evaluation of specific basin development actions.

(b) Training and Human Resources

This Directorate plans and addresses all manpower needs of the OMVS program including training of personnel for the High Commission and of personnel required for the management and operation of all infrastructure within the OMVS development program. The Directorate also coordinates training required within the Member States for realization of irrigated agricultural development projects in the Basin.

(c) Program and Finance

This Directorate plans and executes the overall OMVS budget, including

the execution and monitoring of contracts and the management of all accounts. These activities are carried out according to the guidelines governing the relationships among the OMVS Member States and in close liaison with external sources of financing.

(d) Regional Infrastructure

This Directorate handles all tasks associated with the studies, construction, management and operations of the Diama and Manantali dams, hydroelectric power, navigation and river ports.

The Groundwater Monitoring Project will be established as a new Unit within the OMVS Directorate of Regional Infrastructure (See Fig. 3) as the concerns of this Directorate are related to the studies, construction, operation and management of the water resources of the valley. This Directorate is also charged with overseeing activities relating to the survey and implementation of joint construction works which involve the basic infrastructure of the Senegal River Basin such as: (a) the Diama dam, (b) the Manantali dam, (c) the Manantali hydroelectric dam and power transport networks, (d) navigable river systems and ports, and (e) basic survey (mapping, hydrology and hydrogeology).

The Operations Section will be directed by an engineer who will supervise three Sector Chiefs located at Saint-Louis (Sector 1), Kaédi (Sector 2), and Manantali (Sector 3). Sector 1 includes the valley to the left of the Senegal River (Rive Gauche) as far upstream as the mouth of the Faleme River (Rive Droite) as far upstream as the Markigot de Karakoro.

Sector 3 includes both banks of the Senegal and Bafing Rivers upstream from Sectors 1 and 2, to and including the Manantali Reservoir area.

The OMVS Operations Chief will coordinate construction and observational schedules through the three Sector Chiefs to assure that these are congruent. National agency employees assigned as observers will remain under national agency control. However, the Sector Chief will coordinate their activities and the OMVS will be responsible for their transportation.

The Rive Gauche (Senegal) and Rive Droite (Mauritania) Sector Chiefs will each be assigned two (2) brigades of five (5) persons each for construction of shallow piezometers (less than 5 m deep), for surveying assistance, and for piezometer observation and maintenance.

The two (2) drilling construction and observer brigades each in Sectors 1 and 2 will be composed of national agency employees funded by their respective governments through the OMVS. The employees will work under the supervision and direction of the Sector Chief. The Sector Chief will coordinate his activities with the national hydraulic entities to assure that they are consistent with the national plans and objectives of the Member States. Two brigades will work in Sector 1, and 2 in Sector 2. A power auger operator with two helpers will work directly under the Sector Chief for construction of intermediate depth (5 to 30 m) piezometers. Also, a surveyor will work directly under the Sector Chief. The Surveyor will be responsible for installing a bench mark or altitude reference point at or near each piezometer or observation well. He will also be responsible for determining the elevation

of the measuring point (MP) of each piezometer or observation well relative to the common IGN mean sea level datum.

The location of each piezometer and observation well will also be described relative to easily found landmarks. These descriptions will be maintained at sector headquarters in an appropriate file with a duplicate set at the OMVS Project Headquarters in Saint-Louis. As the deep piezometers in the Upper Basin (Mali) would all be constructed with a DNHE drilling rig and trained DNHE drilling personnel, only a limited staff would be required for surveying assistance and for piezometer observation and maintenance. A surveyor will work under the Upper Basin Sector Chief with duties and responsibilities comparable to those of the Senegal and Mauritania Sectors described below. On-the-job training will be provided in the project for Sector Chiefs, shallow piezometer construction crews, surveyors, and observers.

The Administrative Services Section will provide a full range of administrative and financial management responsibilities in order to assure the financial accountability of the project. An AID-financed Administrative/Finance Officer will direct the Section; he will report to the Deputy Project Chief. This Section will be responsible for meeting all of the non-technical administrative requirements of the project, including the secretarial, translation, transport and vehicle maintenance, procurement (including contracting), storage and general financial management functions. As the Administrative/Finance Officer will assist in the establishment and start-up operations of the decentralized Sector Offices, this position should be filled as soon as possible after the project is executed.

2. Senegal

In Senegal the national entity responsible for the Groundwater Monitoring Project is the Directorate of Hydraulic Studies which is one of the four Directorates comprising the Ministry of Hydraulics. The Directorate of Hydraulic Studies is responsible for the following:

1. Exploration, documentation and study of all surface and groundwater resources in Senegal;

2. Baseline studies necessary for hydraulic and rural development studies in topography, agroclimatology, hydrometeorology and geophysics, geomorphology, agricultural hydraulics, river basin hydraulics, etc;

3. Data analysis and its relationship to water resources legislation, specifically water conservation; and,

4. In collaboration with private laboratories it is responsible for the calibration of hydrologic and geophysical instruments, economic and statistical analysis and responsible for all general programming and technical monitoring bearing on water resources in Senegal.

(a) Organizational Structure

As shown in the organizational chart (Fig.4), the Directorate of Hydraulic Studies is comprised of:

1. The Office of the Director

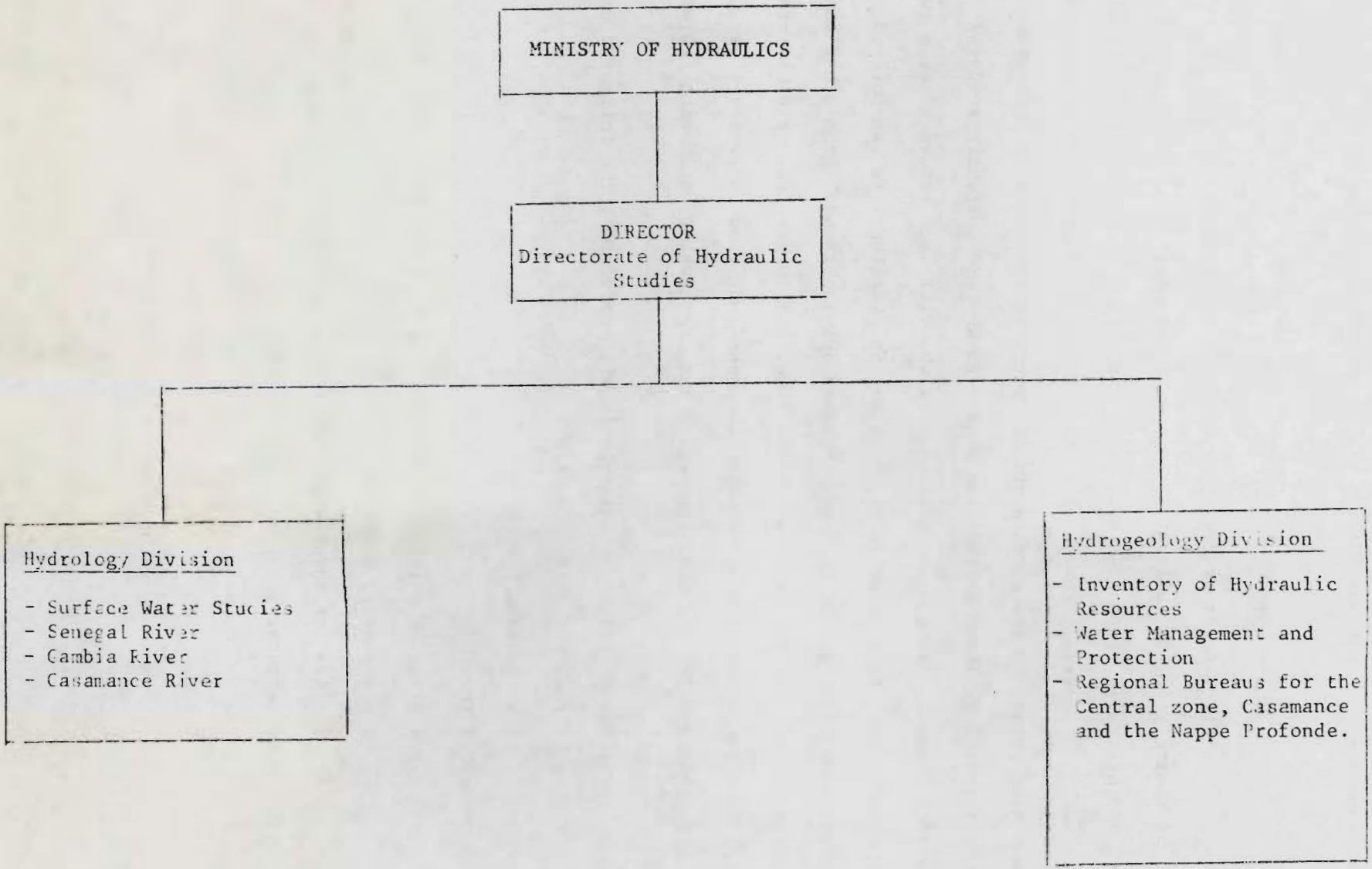
The Office of the Director is responsible for planning all research activities to determine the quantity, quality and location of surface and groundwater resources in Senegal. The Office of the Director is also responsible for the coordination of activities with the Directorate of Urban and Rural Hydrology which is charged with drilling operations. The latter has several well drilling crews (for a total of approximately 50 men) available for the construction of shallow wells or piezometers. The drilling of the deep piezometers, however, is done by private drilling companies based in Senegal.

The Directorate of Hydraulic Studies is divided into two principal subdivisions, as follows:

1. The Division of Hydrology is charged with the development of a network of hydrological observation wells; the study of the development of river basin systems in Senegal; the forecasting of floods; the study of the regulation and control of surface waters; and surface water data collection.

Fig.4 Organizational Chart of the Directorate of Hydraulic Studies

(S E N E G A L)



2. The Division of Hydrogeology is responsible for the research and documentation of groundwater and its development potential.

(b) Staff

The Directorate of Hydraulic Studies currently has a staff of approximately 40, as follows: 10 engineers, 20 trained technicians and 10 administrative support staff. There are also five (5) expatriate staff members. In addition, there are several upper level personnel in training who will return to the Directorate of Hydraulic Studies upon completion of their training. These include two engineers who are currently studying hydrogeology in France, and six students who will soon return after a two-year AGHRYMET training program for technicians in hydrology. It was pointed out that the Directorate of Hydraulic Studies draws personnel from other local African training schools from time to time. For this reason, the Director felt confident that there are sufficient and qualified upper-level personnel in Senegal available for assignment to the Groundwater Monitoring Project.

The Sector Office at Saint-Louis will consist of the following personnel:

a) 1 Technician (Sector Chief)

b) 2 Drivers/Mechanics

c) 1 Surveyor

d) 2 Brigades which will be comprised of 2 foremen and 8 laborers

e) 1 power auger operator

f) 2 aides for power auger operator

g) A Secretary.

AID will finance the costs of the employees at the Sector Office. It is anticipated that these employees will begin their service around the second year of the project.

(c) Current Project Activity

The Directorate of Hydraulic Studies is currently engaged in a variety of projects, some of which have significant contributions from other donors. For example, there is a Water Supply for Chemical Industries of Senegal Project funded by FED to explore the possibilities of increasing chemical production in Senegal by greater inputs of water resources. Specifically, the project will study the feasibility of providing 12,000 m^3 per day to the Senegalese Phosphates Company of Taïba. Under this project the FED is funding 1 engineer (Hydrogeologist) and 1 technician. In addition, there is an on-site engineer/hydrologist with responsibilities for monitoring and supervising project activities. A private drilling company, SASIF, is responsible for the drilling and related field operations. The Directorate of Hydraulic Studies is also responsible for another study entitled Survey Program of Resources and Needs in the North of Senegal which is funded by the FAC and the Caisse Centrale (the French soft-loan window). This study will examine the water resources, principally in the Senegal River Basin, Louga and Diourbel regions.

In the Saloum region the Caisse Centrale and the World Bank are funding, through the Directorate of Hydraulic Studies, a feasibility study to determine water resource needs of the local population.

(d) Conclusions

The Directorate of Hydraulic Studies is confident that there is adequate qualified staff with the necessary experience to discharge its responsibilities under the Groundwater Monitoring Project. As already noted above, the Director did indicate, however, that lower-level personnel for the project, e.g. construction crews, surveyors, power auger operators, etc. are not presently available and will have to be locally recruited.

3. Mauritania

In Mauritania, the national entity responsible for the Groundwater Monitoring Project is the Division of Hydraulics which is within the Ministry of Hydraulics and Housing. The Division of Hydraulics is charged with the following:

a) exploration and development of water as well as its conservation;

b) survey and study of groundwater resources;

c) planning, implementation and supervision of water resource development through the construction of wells, boreholes, etc., as well as their maintenance;

d) carrying out of hydrological studies;

e) carrying out studies for the control and installation of agrometeorological networks.

f) formulation of legislation as well as the regulation of surface and groundwater usage;

g) production and distribution of water and the development of a water treatment system;

h) study, construction and maintenance of a water canal network as well as the sewage system;

i) study, execution and control of electrical systems for urban areas and special projects; and,

j) technical supervision of SONELEC (the Mauritanian national electrical company).

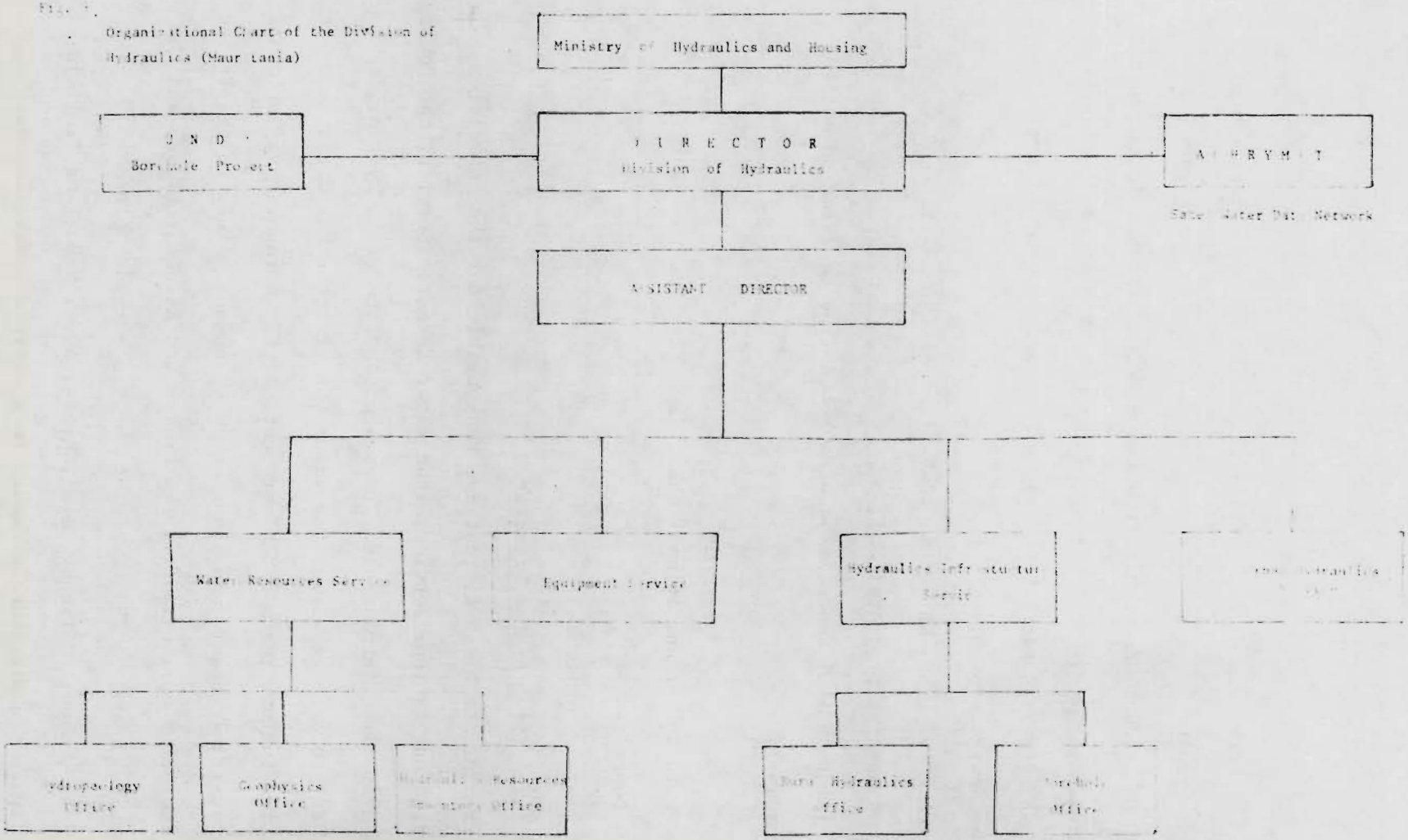
As shown in the organizational chart (see Fig. 5), the Division of Hydraulics is comprised of:

(a) Office of the Director

The director and his assistant are responsible for the activities that are carried out by four services (the Water Resource Service, the Equipment Service, the Hydraulics Infrastructure Service, and the Urban Hydraulics Service). Other project activities for which the Director has direct responsibilities include the AGHRYMET project, a UNDP borehole project consisting of 36 boreholes for vegetable and livestock development mainly in the Trarza region but also being carried out in the Brakna and Assaba regions, and the well construction brigades. The Chiefs of the ten brigades (located in Atar, Nouakchott, Rosso, Kaedi, Sélibaby, Aleg, Kiffa, Aiou, Nema, and Tidjikja) report directly to the Director, although they operate under the auspices of the Rural Hydraulics Office, one of two offices of the Hydraulics Infrastructure Service.

Fig. 1.

Organizational Chart of the Division of Hydraulics (Mauritania)



(b) Water Resource Service

The Water Resource Service is comprised of three Offices which are:

1) Hydrogeology Office: the activities being carried out by this office include hydrogeological synthesis of the Mauritanian South-East Basin, and hydrogeological evaluation for Kiffa, Aiou and Tidjikja.

2) Geophysics Office: among the activities being carried out by this office are exploration between Kiffa and Nema along the Kiffa-Nema road, exploration of Zouerate region for survey of Taoundeni Basin. water searching in Batha de Tidjikja, and geophysical research in the Aftout region.

3) Hydraulics Resources Inventory Office:This office is responsible for design and documentation of hydraulics surveys and studies.

(c) Equipment Service

The activities of this service include contracting for equipment supply for the office, wells and boreholes; inventory and control of equipment as well as its repair and maintenance.

(d) Hydraulics Infrastructure Service

This service is comprised of two offices, the Borehole Office and the Office of Rural Hydraulics:

1) Borehole Office: this office is constructing large boreholes at Kiffa and is planning to construct medium and small size boreholes at Atar and Tidjikja.

2) Rural Hydraulics Office: construction of wells is being carried out by brigades in ten locations (for locations refer to above Office of the Director).

(e) Urban Hydraulic Service

This service is responsible for, inter alia, the extension of the water network in Nouakchott, installation of water pipes at Rosso, extension and improvement of water system in Moudjeria, and the reinforcement of urban water works system as well as the strengthening of SONELEC's supervision.

In 1981, the budget for the Division of Hydraulics was approximately $14.5 million, and in 1982 it was reduced to around $ 14.0 million. The amount allocated for personnel totaled about $ 7.7 million.

The Division of Hydraulics confronts several institutional constraints. They include:

- the lack of qualified and skilled personnel;
- the lack of structure in training and improving mid-level managers in hydraulics;
- difficulties in training senior staff and reintegrating them into the national services;
- lack of adequate structure for contractors in water works;
- the exodus of senior and mid-level qualified staff due to the existing financial conditions of the GIRM and the lack of competent technicians;
- difficulties for the regional authorities in the timely mobilization of personnel and material, thus limiting the productivity and efficiency of the staff;
- lack of liaison and coordination systems;
- lack of facilities and offices in out-lying regions; and
- lack of financial resources for maintenance and repair of equipment.

Notwithstanding the above constraints, the Director of the Division of Hydraulics expressed confidence in being able to mobilize the personnel necessary for the Groundwater Monitoring Project, with the possible exception of the Surveyor to be located at the Kaédi Sector Office. Consideration was given to the integration of the well-drilling brigade presently working in Kaédi and the OMVS Sector Office to be established there to execute this project. A capable technician, the brigade chief, is assigned to Kaédi and is believed to be competent to handle the Groundwater Monitoring Project Sector Chief position. However, the consideration of integrating the OMVS Sector Office and national service well drilling brigade was dropped as lines of authorities and responsibilities of the two distinct activities could well be confused. Thus, it was determined by the Director that a discrete Sector Office would be established to implement the Mauritanian component of the Groundwater Monitoring Project.

The Sector Office at Kaédi will consist of the following personnel:

a) 1 technician (Sector Chief)

b) 2 Drivers/Mechanics

c) 1 Surveyor

d) 2 Brigades which will be comprised of 2 foremen and 8 laborers

e) 1 power auger operator

f) 2 aides for power auger operator

g) 1 secretary

AID will finance the cost of the above employees who will, for the most part, begin their services around the second year of the project.

With regard to lines of responsibilities and authorities, the Sector Office in Kaédi would be under the supervision, for technical matters, of the OMVS Chief of the Operations Division (Saint-Louis) but for administrative matters (e.g. recruitment and funding of certain national personnel) it would report to the Mauritanian Division of Hydraulics. A written agreement between the OMVS and the Division of Hydraulics or the responsible CIRM representative should be executed outlining the responsibilities and relationship of the Division of Hydraulics vis-à-vis the OMVS Sector Office in Kaédi and the role of OMVS, Saint-Louis-based office, prior to the disbursement of any funds under the project.

4. Mali

The Ministry of Industrial Development, notably the technical division called DNHE with its "Groundwater Division", is responsible for groundwater exploration and monitoring. Regional subdivision, assigned to each of the 7 regions of the Malian territory, coordinate water-related activities of of the regions and the management of DNHE. The organizational chart (see Fig.6) shows the responsibility and position of the Groundwater Service regarding all hydrogeological issues in Mali.

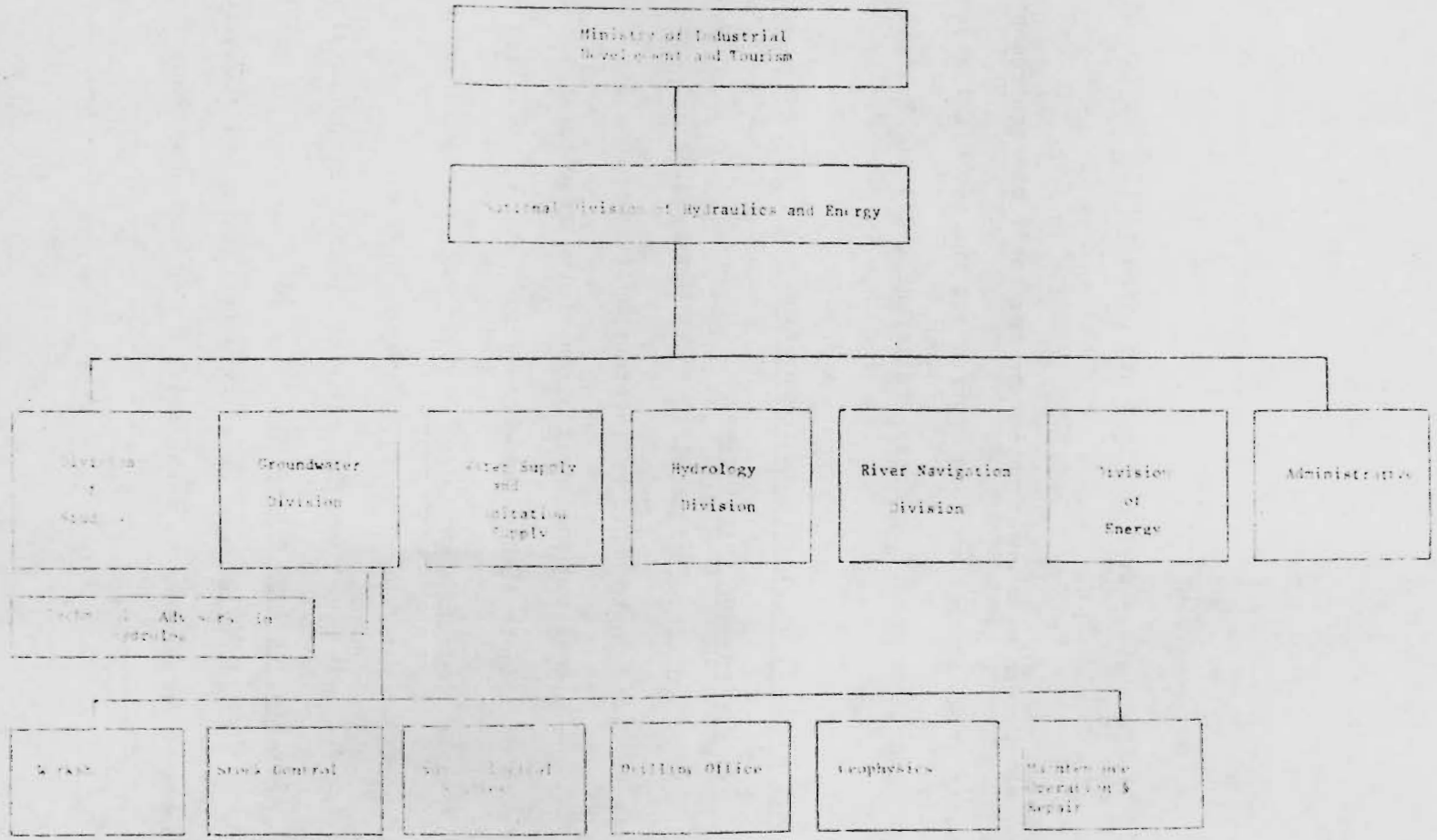
The Groundwater Division has the following tasks:

a. At the Management Level

1) To conduct an inventory of all hydrogeological data collected during the implementation of drilling and well construction projects.

2) To draw a map showing tubewells and update results and to index existing documents.

ORGANIZATIONAL CHART OF THE DNHE (MALI) - Fig. 6



3) Plan and organize hydrogeological studies in collaboration with the financing agencies and those in charge of the studies.

4) Supervise the implementation projects, the construction of wells e.g. projects at the level of:

- the DNHE
- other departments within the Ministry of Rural Development of Public Works concerning the "Hydraulics components".

5) To survey water requirements and establish water holes programs.

6) Determine a water policy on the basis of requirements, the groundwater works which have been carried out and technical aspects of related issues (socio-economic, geographical,ethnic, livestock, agriculture, etc.)

b. At the Level of Project Implementation

1) Hydrogeological Studies

- Monitoring of studies of all hydrogeological activities which are financed and implemented by international agencies.
- Discussion and application of the results at the level of the Ministry of Industrial Development and the National Division of Hydraulics. To make the rural population and the regional services which are working in close collaboration with the other departments, e.g. Public Health and sanitation, Public Works, Agriculture and Livestock aware of the hydrogeologic studies.

2) Project Implementation

- Supervision of on-going drilling and well construction projects financed and managed by international and non-governmental agencies.

- Analysis of project data. If required, transmit and distribute documents to interested services and organizations in order to assure satisfactory groundwater management.

- Put an emphasis on the maintenance service of water works.

(i) Geology and Hydrogeology Training

In Bamako, two public institutions are responsible for training technicians. They are:

- National School of Engineers
- Central School for Industry, Commerce and Administration.

(ii) International Aid and Cooperation in Groundwater Research and Monitoring.

Several water drilling projects are currently being implemented in various regions of the Republic of Mali. These projects are under the supervision of the Groundwater Service of the DNHE. None of the projects is financially autonomous; they are financed by external donors and their management is also in the hands of expatriate experts. Given the variety of financing sources, and the nature of the projects to be implemented, there are several categories of water drilling projects.

1. Hydraulic Projects

Hydraulic projects are submitted directly to the DHNE, specifically to the Groundwater Service. The latter is responsible for supervision

and implementation in accordance with regional requirements for water and the urgency of cases. These projects serve as a basis for regional development in order to improve water supply in villages and rural areas. It should be underscored that these well-drilling projects are part of a Mali-wide strategy whose objective is to supply water to the rural populations.

2. Non-Governmental Organizations Hydraulics Projects

These projects are financed by various groups, particularly non-profit and private organizations. They in turn receive grants from international agencies and foreign governments. The projects are managed by a project director, who in principle is the representative of a religious organization working in Mali.

3. Water Supply Components of Other Projects

Some regional development projects include "hydraulics" components in their implementation plan in order to supply water to the population of the region. They are usually hydrogeological and geophysical studies followed by one or several boreholes or well construction.It is of course evident that water drilling is necessary prior to public health, hygiene, livestock and agricultural activities.

Eight on-going projects are being implemented by the Division of Groundwater. They are:

(1) UNDP/UNICEF - This is a 5-year project (1977-82) for $ 11.0 million (UNICEF, $ 2.5 million and UNDP, $8.5 million) to increase rural water supply of small settlements and for

the improvement of sanitary conditions.

This project is being carried out in Central West Mali.

(2) Mali-Sud Helvetas - The aim of this project is the provision of water supply to Mali-Sud (Bougouni, Yanfolila, Koloudieba). The project began in 1978 and will be completed in 1983. The cost is $4.0 million.

(3) Mali Aqua Viva - This rural village water supply project for approximately $ 6.0 million began in 1975 and is being executed in Central Mali (Djenné, San, Tominian, Koutiala, Yorosso, Bla and Ségou).

(4) OMBEVI - This is a 25-year project which began in 1978 with the first phase continuing through 1983. The project assists in the development of water and pasture resources in the Kayes-North and Nara-East region. The total cost of the project is $14.9 million, of which $3.0 million is for water resource development.

(5) ODIK - This is an integrated land development project including construction of 50 dug wells and 100 drilled wells for the improvement of rural water supply for the northwestern region of Mali (Nioro). The cost of the project is $1.9 million. It began in 1973 and is scheduled to be completed in 1983.

(6) ODEM - This project is a component of regional improvement of cattle raising and animal husbandry for $12.8 million, of which $3.0 million is for water supply. Approximately 70 wells and 50 water holes are to be constructed and improved, respectively, under this project. The project duration is 1973-1983 and is being carried out in the Senomango and Dioura region of Mali.

(7) Japanese Project - This project which is being implemented in Eastern Mali (Kidal, Gao, Ansonga) involves the construction of 70 wells, the carrying out of hydrological studies, exploratory drilling and training of drillers, hydrogeologists, and mechanics. The cost of the project is $4.0 million.

(8) Plateau Bandiagara - The aim of this project is to increase rural water supply through the construction of drilled wells, exploratory boreholes and the training of personnel for well construction.

c. Staffing

The organizational chart (Fig. 6) shows that all water projects are assigned to the Groundwater Division and hydrogeological Studies DIvision which is responsible for starting and executing water works to implement its activities. The staff of these divisions is comprised of 20 engineers (e.g.geologists,

hydrologists, geophysicists, etc.), 10 technicians and 10 mechanics. Accelerated training of technicians is necessary for Mali to participate in the various groundwater monitoring projects, organized and financed by international agencies. It is projected that the personnel which are trained in the two technical schools in Bamako will eventually take over the organizing and mangement of the on-going projects. The technical school graduates will, for the most part, be hired by the Government, notably, by the Ministry of Industrial Development and the DNHE.

Personnel for the Sector Office at Manantali will either be drawn from existing personnel or recruited, if not available at DNHE, to staff the office.

The Sector Office at Manantali will be comprised of the following personnel:

a) 1 technician (Sector Chief)

b) 1 Driver/Mechanic

c) 1 Surveyor

d) Laborer, 1 guard and eventually 3 piezometer observers

e) 1 Clerk/Typist

AID will finance the cost of the employees at the Sector Office.

D. Social Soundness Analysis

1. Beneficiaries

The most immediate beneficiaries of this project will be the technical and administrative personnel of the OMVS and its affiliated agencies who will receive technical assistance and training in the improved performance

of their groundwater monitoring functions. The activities that will support the work of other AID projects involve primarily the study of the effects of the dams on the water regime and drainage of the area. Therefore the project will be providing information that will increase the chances for the success of current programs and projects which more directly involve and benefit the local populations described herein.

Current estimates of the Senegal River Basin population are approximately 2.0 million people, or about 14 percent of the total population of the three Member States. Among the six ethnic groups in the basin, subsistence food production is the primary economic activity, with 85 percent of the rural basin residents and many urban residents participating in subsistence agriculture. Much of the Senegalese and Malian River Basin has long been sedentarized. Mauritania, however, has only recently experienced a dramatic shift from transhumance herding to sedentarization due to recent drought conditions. These have played a critical role in destabilizing much of the region's economic activity creating increased uncertainty in the production habits of the residents.

2. Productive Activity

Although subsistence food production is the primary activity in the delta, commercial agriculture now exists, following 150 years of experimentation with irrigated agriculture. The two crop seasons in the Middle Valley consist of rainfed dieri away from the river followed by the productive oualo flood recession farming of the rich river floodplains after the flood waters have receded. Dieri farming predominated in the Upper Valley.

The major crop is millet, followed by rice, maize, and assorted vegetables.

Herding is the secondary activity for the region. Sheep and goats combine to generate 20 percent of the wealth in the river basin. Herding is not normally regarded in terms of production, but as an investment -- a savings system. Animals often have a higher social value than the equivalent amount of cash invested elsewhere. The drought and the consequent degradation of rangelands have either displaced many nomadic herders or forced them to integrate into agriculture intensification schemes.

Water is basic to conduct all these activities and remains the primary need of peasants. In this context, the project will serve to collect useful data on the local perceptions on water requirements.

3. Feasibility

Since the socio-economic feasibility of a project relates the proposed technology to the people who are expected to support it and benefit from it, the dams will have diverse impacts in the basin's population.

Groundwater monitoring, as a technology, will identify and seek solutions to remedy water-related adverse effects. The ressettlement of 12,000 people will certainly result in an alteration of agriculture activity. Irrigation water or the source of it in turn will affect the production pattern. Although the OMVS predicts a decrease in flood recession agriculture, the regulation of groundwater resources may serve to stem this decline. Because of the maintenance of good quality water, the availability of

water sites, livestock activities and irrigated forage could be increased in return.

4. Social Impact of the Project

One of the effects of this project will be to create a better general understanding on the part of local inhabitants concerning the relationship between groundwater resources and agricultural activities in which the vast numbers of the people of the basin are engaged. This outcome will be largely the result of the community education activities contemplated under this project and the participation of some of the local villagers in monitoring and data gathering activities in their locales. Specifically, the achievement of this project's objectives will allow villagers to identify any deterioration of water quality in existing domestic and livestock wells that may result from irrigation development. Above all, the achievement of project objectives will demonstrate the importance of groundwater monitoring data in preventing loss of land to agricultural production.

Project data will be made available to the local Regional Development Agencies (RDAs) as a tool in planning the development of groundwater resources of the Senegal River Basin.

It is, however, necessary to discuss one of the principal problems oftentimes encountered by this type of project, namely, vandalism. In the past, vandalism of piezometers by local inhabitants has been a chronic problem. Pipe caps are often removed and the piezometer tubewells are filled with debris, thus making them useless for water level and water quality

observations. Although this sort of destruction is oftentimes the work of idle school-children, adults are occasionally involved.

This project will address these problems by: (a) a community education program; and,(b) through the physical protection of the piezometers and other instrumentation.

5. Education/Local Involvement

Past experience has demonstrated that the best method of addressing this problem is by a community education program aimed at educating the local population in the principal objectives of the project and/or directly involving them in some of the project activities. In this manner, local involvement not only protects investment in the piezometers but also allows participation by the poor in the development process itself.

In its early phase, the Groundwater Monitoring Unit in Saint-Louis will be responsible for planning local education programs, including the extent of local participation in the project. This strategy will include specific plans which take account of the socio-cultural diversity of the Senegal River Basin. Subsquently, Sector Chiefs will be trained in field methodology before they go to the villages to work with local chiefs and "significant others" in explaining the program, specifically how the piezometers and data compilation relate to the long-term welfare of the local inhabitants.

The Sector Chiefs will also be responsible for choosing, where feasibible, selected members of local communities to assist as paid monitors.

An attempt will also be made to select local women to assist in the monitoring process.

6. Environmental Concerns

The basic components of this project consist of data compilation, analysis and institution building. Groundwater data thus obtained and analyzed by the project will improve the quality of decisions which relate to the development impacts upon groundwater, agricultural lands, and upon the environment because the construction of the majority of piezometers will be located in and near irrigation fields which have already been altered in the course of developing irrigated perimeters. Furthermore, the project will be carefully monitored throughout its entire life and will be limited to data gathering activities.

An IEE has been prepared by the USAID's Environmental Affairs Officer and a Negative Determination has been recommended (See Annex G).

V. FINANCIAL PLAN

A. Summary

Project costs over the four-year life of project will be $ 5.2 million. AID's contribution will be $ 4.6 million as a grant.

The OMVS and its Member States will contribute $ 551,000 of this amount in project costs.

Table II. summarizes major categories of expenditures.

BUDGET - Table II- of Expenditures by Proje..

	YEAR 1		YEAR 2		YEAR 3		YEAR 4		TOTAL		GRAND TOTAL
1. Technical Assistance	AID	OMVS	AID	OMVS	AID	OMVS	AID	OMVS	AID	OMVS	
a) Hydrologist, Deputy Chief (36 months at $ 135,000 per year)	67,500		67,500		135,000		135,000		405,000		405,000
b) Administrative/Finance Assistant (45 months at $ 90,000 per year)	45,000		90,000		90,000		112,500		337,500		337,500
c) Short Term TA (13 Months at $15,000 per month	45,000		30,000		75,000		45,000		195,000		195,000
Sub Total	157,500		187,500		300,000		292,500		937,500		937,500
2. Commodities											
A. Off-Shore Procurement											
1. Technical Equipment + pipes (168,000 + 96,000)	264,000								264,000		264,000
2. Office Equipment	10,000								10,000		10,000
3. Vehicles											
a. Rehabilitation (5 at $5,000 each from AID and at $ 10,000 each from OMVS)	25,000	50,000							25,000	50,000	75,000
b. All terrain vehicles (vehicles ;2 foreign made for Mauritania, $25,000 each;and,2 for Mali and 2 for Senegal at $ 15,000each)	50,000		60,000						110,000		110,000
c. 1 1/2 ton trucks (4 at $ 35,000 each; 2trucks for Senegal and Mauritania	105,000		35,000						140,000		140,000
d. Passenger cars (3 at $9,000 each)	18,000		9,000						27,000		27,000
e. Motorbikes (30 at $850)	13,000		13,000						26,000		26,000
f. Spare Parts (15% of vehicles costs, which adds up to $300,000)	45,000								45,000		45,000
Sub Total	530,000		117,000						647,000	50,000	697,000
4. Transportation and Insurance (40% of commodity cost, which is 640,000)	209,000		47,000				64,000		320,000		320,000
5.1/ Inflation (10% of commodity cost which is 640,000							64,000		64,000		64,000
6. PSA Services (7%)	45,000								45,000		45,000
Subtotal	784,000	50,000	164,000				128,000		1,076,000	50,000	1,126,000
B. Locally Procured Commodities											
1. Office Materials											
St-Louis Headquarters ($ 6,000/yr x 3 1/3 yrs = $20,000; photocopy and duplicating machines at $6,500)	24,500		6,000		6,000		2,000		38,500		26,500
Sector Office ($5,400/yr x 3 years)	11,400		5,400		5,400				22,200		16,200
2. Cement + Local construction materials			6,000		6,000				12,000		12,000
3. Inflation (10% of Local Commodity Costs, or $48,200							5,500		72,700 5,500		72,700 5,500
Sub Total	35,900		17,400		17,400		7,500		78,200		78,200

1/ Totals for inflation are added up only in the 4th year rather than being spread over the life of the project, in order to simplify the calculation of the budget.

BASIS OF ESTIMATE: All piezometers to be constructed on lines by "Contract".
All piezometers in/around irrigated perimeters to be constructed by "Sector Forces".

	YEAR 1		YEAR 2		YEAR 3		YEAR 4		TOTAL		GRAND TOTAL
	AID	OMVS	AID	OMVS	AID	OMVS	AID	OMVS	AID	OMVS	
3. Construction (piezometers + boreholes)											
Senegal and Mauritania	-	-	200,000	-	400,000	-	100,000	-	700,000	-	700,000
Mali (includes Sector Office)	25,000	-	70,000	-	85,000	-			180,000	-	180,000
Sub-total	25,000		270,000		485,000		100,000		880,000		880,000
Inflation [1] (10%)	-	-	-	-	-	-	88,000	-	88,000	-	88,000
Sub-Total	25,000		270,000		485,000		188,000		968,000		968,000
4. Operating Costs											
a) Geophysical Studies (Mali)	-	-	30,000	-	30,000	-	-		60,000	-	60,000
b) Water Analyses (150)	-	-	3,000	-	15,000	-	15,000	-	33,000	-	33,000
c) Vehicle operation and maintenance ($60,000 per year x 3 years)	-	-	60,000	-	60,000	-	60,000	-	180,000	-	180,000
d) Office and Warehouse rental											
-St-Louis office ($30,000 per yr x 4 yrs, rental plus operational costs)	-	30,000	-	30,000	-	30,000	-	30,000	-	120,000	120,000
-St-Louis Warehouse ($12,000 per year x 3 years)	6,000		6,000	-	12,000	-	12,000	-	36,000	-	36,000
-3 Sector Offices ($36,000 per year x 3 years)	18,000		18,000		36,000	-	36,000	-	108,000	-	108,000
e) Personnel											
(1) St-Louis headquarters	26,000	95,250	30,000	95,250	22,000	95,250	10,000	95,250	88,000	381,000	469,000
(2) Senegal Sector Office	26,000	-	35,000	-	100,000	-	79,500	-	240,500	-	240,500
(3) Mauritania Sector Office	26,000	-	35,000		100,000	-	79,500	-	240,500	-	240,500
(4) Mali	26,000	-	35,000	-	43,000	-	27,000	-	131,000	-	131,000
Sub-Total	128,000	125,250	254,000	125,250	418,000	125,250	379,000	125,250	1,179,000	501,000	1,620,000
5. USAID's Administrative Support Costs											
3 Project Assistants for USAID/Dakar, Nouakchott and Bamako ($8,000 per year for 3 years each)	-	-	24,000		24,000	-	24,000	-	72,000	-	72,000
6. Training											
a) 3 Long-term US Participants ($20,000 per year x 4 1/2 yrs ea, or $90,000 per participant)	-	-	45,000	-	75,000	-	150,000	-	270,000	-	270,000
b) 6 Long-term third country (in Senegal or Niger for Malians and Mauritanians; $3,000/yr for 2 yrs)			15,000	-	21,000	-	-	-	36,000	-	36,000
c) In-Country Training	-	-	-		7,000	-	7,000	-	14,000	-	14,000
Sub-Total			60,000		103,000		157,000		320,000		320,000
7. Evaluation/Monitoring (3 pm)	-	-	-				45,000		45,000		45,000
8. Contingency					30,300		15,000		35,300		35,300
GRAND TOTAL	1,130,400	175,250	976,900	125,250	1,367,700	125,250	1,176,000	125,250	4,651,000	551,000	5,202,000

B. AID Expenditures

1. Technical Assistance

Technical assistance (See Technical Analysis Section for details concerning the types of technical assistance to be provided) will be provided by the U.S. Geological Survey through a PASA. The cost for long-term technical assistance for a hydrologist (Deputy Project Chief) and an Administrative/Finance Assistant are $135,000 and $90,000, respectively, inclusive of travel, in-country support, per diem, etc. It is anticipated that the Hydrologist will begin his duties at the beginning of the second year of the project (13th month) for a duration of 36 months, and the administrative assistanat around the third to sixth month of the project for the contractual period of not more than 3-3/4 years. In addition, the cost for 13 months of short-term consultant services at approximately $15,000 per month is budgeted for: (1) 3 of the 13 months short-term consultancy will be utilized in assisting, in establishing, and in the start-up operations of the decentralized sector offices in Saint-Louis, Kaedi and Manantali; (2) setting up a monitoring information system early in the project; and (3) carrying out an evaluation of the project toward the end of the project's life.

2. Commodities

A variety of technical equipment, office equipment, materials and vehicles will be procured under the project. The technical equipment, office equipment/material and pipe will all be purchased from the United States (Code 000), except as noted in waiver requests submitted with this PP or waivers subsequently prepared.

The OMVS Deputy Project Chief will coordinate procurement of most commodities to be purchased for this project. USAID Mission will assist OMVS in procuring an initial list of basic commodities that will be required upon arrival of the AID-financed Hydrologist (Deputy Project Chief).

Vehicles to be purchased under the project include 13 in the first two years. New vehicles will include 6 four-wheel all-terrain vehicles for field transportation, 4 one-and-a-half-ton trucks, and 3 passenger cars for the control office at Saint-Louis. The vehicles will be used by the three sectors in Saint-Louis, Kaedi, and Manantali. As adequate maintenance is not available for American vehicles in Mauritania and Mali, all-terrain vehicles for Kaedi and Manantali will be purchased from the Free World. A waiver is being requested for the vehicles which is attached to Annex E. Further, the establishment of a central maintenance center is not feasible. Some maintenance training will be provided to each sector, but non-routine services and repairs will be done through private garages.

Shelf item procurement will include cement, gravel and other miscellaneous construction materials and office supplies. A waiver will be requested to raise permissible shelf item purchases from 10% of the total project local cost financing to 25%.

The USAID Mission in Dakar will provide procurement guidance and assistance as necessary. Ocean shipping and marine insurance source rules will apply. The commodities to be purchased and their estimated cost are found in Annex E, "Procurement Plan."

3. Shelf Items

Estimates of local procurement are the following:

Office materials

Saint-Louis central office	38,500
3 Sector offices	22,200
Cement, gravel and other local construction materials	12,000
Inflation (10%)	5,500
Total	$78,200

4. Construction

Construction of the 450 shallow (less than 5 meters) and intermediate (5 to 30 meters) piezometers in and around the irrigated perimeters will be carried out by the OMVS Sector Offices. Construction of the 210 piezometers and 10 observation boreholes to comprise the ten "lines" transversing the alluvial valley (Senegal and Mauritania) will be accomplished by local well drilling firms under contract with OMVS . In Mali, the 20 proposed piezometers will be constructed by DNHE utilizing the agency's equipment and work forces.

(a) Construction of Observation Boreholes (Contract)

One observation borehole will be constructed at each of ten proposed lines transversing the alluvial aquifer in Senegal and Mauritania. These boreholes will be equiped with a water-level recorder to provide a continous record of groundwater level fluctuations.

The observation boreholes will be 8 inches in diameter and 30 to 60m deep(averaging 45 m deep) for a total of 450 m of plastic casing and hole. The casing will be set in a 12 inch hole. The casing of each borehole will be slotted in the lower 3 to 5 m; gravel packed, packers placed above the gravel; backfilled with clay in the annulus between the casing and the hole wall; cemented for 5 m below the land surface; and developed by compressed air. The contractor will also construct a concrete recorder shelter with dimensions of approximately 1.5 m x 1.5 m with a lockable steel door over each borehole. The shelter will be provided with a wooden platform about 80 cm above the base for positioning the water-level recorder (See Fig. 3, Annex A).

The estimated cost of the 20 boreholes is a shown below. The $ 220/meter unit price includes drilling, casing and development by the contractor .

Cost Estimate - Observation Boreholes

10 boreholes at 45 m = 450m x $220/m	=	$ 99,000
10 recorder housing at $ 500 each	=	5,000
		$ 104,000
Contingencies (10%)		10,000
Total		$ 114,000

(b) Piezometer Construction along the 10 lines (Contract)

Construction of the proposed 75 shallow,80 intermediate and 45 deep piezometers to be located along the 10 lines will also, be accomplished by contract.

The design of these piezometers is as shown in Figure 2., Annex A and consists of a 5-6 inch bored hole, a 2 "diameter PVC piezometer pipe with the lower section slotted and gravel packed and a short section of galvanized pipe set in a concrete block and extending above ground surface to provide protection.

Cost Estimate - Piezometers along the Lines

Shallow - 75 at 8 m = 375 m x $ 125/m	=$ 46,875
Intermediate - 80 at 26 m = 2080 m x $ 125/m	=$ 260,000
Deep - 45 at 40 m = 1800 m x $125/m	=$ 225,000
Subtotal	$ 531,875
Contingencies (10%)	53,125
Total	$ 585,000

Summary of Contract Costs

Observation Boreholes	$ 114,000
Piezometers	585,000
TOTAL ESTIMATED CONTRACT COSTS	699,000
Rounded to	$ 700,000

(c) Malian Component - Construction by"DNHE"

Twenty observation boreholes, 5 to 7 inches in diameter and ranging in depth between 60 and 80 meters, will be drilled by the Malian DNHE around the perimeter of Manantali Reservoir using departmental drilling equipment and trained drilling crews. The design of these boreholes is shown on Figure 4, Annex A and further discussion of the details of the Malian Component is contained in Section 6, Annex A. Costs are based on the Direction de l'Hydraulique et de l'Energie's"Proposal for the Execution of Hydrologic Studies". The following estimate also includes the cost of the small office complex to be constructed in the vicinity of Manantali Reservoir.

Cost Estimate- Malian Component

Borehole construction

Mobilization	$ 8,000	
Boreholes, 20 at 70 m = 1400mx $90/m	126,000	
Demobilization	7,000	
		$141,000

Office Complex

Office 60m² x $300/m²	18,000	
Storage 12m² x $ 300/m²	3,600	
Latrine	400	
		$ 22,000

Subtotal	$ 163,000
Contingencies (10%)	17,000
TOTAL	$ 180,000

(d) Construction of Shallow and Intermediate Piezometers by Sector Forces

The proposed construction of the 450 piezometers in and around the irrigated perimeters will be accomplished by sector work forces with equipment and materials furnished by the project. The technique to be employed is discussed in detail in Annex A and the cost of this work is included in the project budgets for equipment, materials and operational support.

5. Operating costs

a. Costs of geophysical and photogeological studies by the Malian DNHE for selection of sites for 20 deep observation boreholes in Manantali reservoir area at $ 3,000 per site : 60,000

b. Chemical analyses

Laboratory analyses in Dakar 150 tests, $ 60 each;	$	9,000
Pesticide/Herbicide in US 40 tests $ 500 each		20,000
Supplies		3,000
		32,000
Contingencies (10%)		3,000
TOTAL	$	35,000

c. Vehicle operation and maintenance at
$ 60,000/yr. (excludes replacement vehicles)
for 3 years: 180,000

d. Office and warehouse rental

Saint-Louis warehouse at $24,000/yr.
for 3 years: 72,000

3 Sector Offices at $36,000/yr. for
3 years: 108,000

e. Personnel

Budgeting for personnel costs to be paid by AID has been done under the following principles:

(1) The OMVS and Member States would pay the cost of all permanent employees working at the project headquarters at Saint-Louis;

(2) AID would pay for the salaries of the temporary employees at Saint-Louis Headquarters as well as for the per diem of all permanent employees requiring it; and,

(3) In addition, AID would pay salaries and per diem for all employees working at the sector offices during the life of the project.

TABLE 3 - TOTAL ALDEVS PERSONNEL COSTS

Permanent/ Temporary (P or T)	Number/Position	Total AID Costs		Total OMVS Costs	
		Salaries	Per Diem	Salaries	Indemnities
I. ST-LOUIS	(Groundwater Monitoring Unit Headquarters)	$	$	$	$
P	1 Project chief at $16,000/yr. for 4 years	-	10,000	64,000	18,200
P	1 hydrogeologist at $12,000/yr for studies + analysis for 4 years	-	10,000	48,000	17,000
P	1 engineer/hydrologist at $12,000/yr for 4 years (training + operations)	-	10,000	48,000	17,000
P	1 accountant/storekeeper at $8,000/yr for 3.1/4 years	-	3,000	26,000	13,130
P	1 draftsman/technician at $10,000/yr for 3.1/4 years	-	-	32,500	13,130
T	1 draftsman/technician at $10,000/yr for 2.1/2 years	25,000	-	-	13,130
P	2 clerk/typists at $5,000/yr for 4 years	-	-	40,000	-
P	2 driver/mechanics at $5,000/yr for 3.years	-	6,000	30,000	-
T	1 translator/secretary at $8,000/yr for 3 years	24,000	-	-	-
	T O T A L	49,000	39,000	288,500	92,190

GRAND TOTAL AID = $88,000
GRAND TOTAL OMVS = $381,000

* Permanent employee -- AID will finance the costs of the temporary employees (1 draftsman and a translator/secretary) throughout the life of the project. In addition, AID will finance per diem for all employees working on the project.

Permanent/ Temporary (P or T)	Number/Position	Total AID Costs $	
		Salaries	Per Diem
I. SENEGAL SECTOR OFFICE			
P	1 technician (sector chief) at $10,000/yr for 3. years	30,000	10,000
P	1 mechanic/driver at $5,000/yr for 3. years	15,000	5,000
T	1 mechanic/driver at $ 5,000/yr for 2 1/2 years	12,500	3,000
T	1 surveyor at $8,000/yr for 2 years	16,000	4,000
P*	2 foremen at $4,000/yr for 3 years	24,000	9,000
T*	8 crew laborers at $3,000/yr for 3 years	72,000	
T	1 power auger operator at $5,000/yr for 2 years	10,000	3,000
T	2 aides for power auger operator at $3,000/yr for 2 years	12,000	
P	1 clerk/typist at $5,000/yr for 3 years	15,000	-
	TOTAL	$ 206,500	$ 34,000
	GRAND TOTAL		$ 240,500

* 1 team and foreman will remain after the project for monitoring.

Permanent/ Temporary (P or T)	Number/Position	Total Life Costs $	
		Salaries	Per Diem
1. MAURITANIA SECTOR OFFICE			
P	1 technician (sector chief) at $10,000/yr for 3 years	30,000	10,000
P	1 mechanic/driver at $5,000/yr for 3. years	15,000	5,000
T	1 mechanic/driver at $,000/yr for 2. 1/2 years	12,500	3,000
T	1 surveyor at $8,000/yr for 2 years	16,000	4,000
P*	2 foremen at $4,000/yr for 3 years	24,000	9,000
T*	8 crew laborers at $3,000/yr for 3 years	72,000	-
T	1 power auger operator at $5,000/yr for 2 years	10,000	3,000
T	2 aides for power auger operator at $3,000/yr for 2 years	12,000	-
P	1 clerk/typist at $5,000/yr for 3 years	15,000	-
	TOTAL	$ 206,500	$ [illegible]
	GRAND TOTAL		$ 240,500

* 1 team and foreman will remain after the completion of the project for monitoring and data collection.

Permanent/ Temporary (P or T)	Number/Position	Total AID Costs $ Salaries	Total AID Costs $ Per Diem
IV.	MALI SECTOR OFFICE (MANANTALI)		
P	1 technician (sector chief) at $ 8,000/yr for 3 years	24,000	10,000
P	1 driver/mechanic at $ 4,000/yr for 3 years	12,000	5,000
T	1 surveyor at $ 6,000/yr for 2 years	6,000	2,000
P	1 laborer at $4,000 for 3 years	12,000	3,000
P	1 guard at $3,000/yr for 3 years	9,000	
P	3 well monitors at $4,000/yr for 3 years	36,000	
P	1 clerk/typist at $4,000/yr for 3 years	12,000	-
	TOTAL $	111,000	20,000
	GRAND TOTAL $	131,000	

VI. IMPLEMENTATION PLAN

A. Management

Project implementation will be the responsibility of the OMVS Groundwater Monitoring Unit which will plan and coordinate the activities as well as act in a technical advisory capacity to the Member States. In addition, they will be responsible for training of personnel so as to strengthen the institutional capability of the national hydraulics agencies. However, implementation of project activities in each country will be the responsibility of the respective national hydraulics agency.

The Groundwater Monitoring Unit will regroup the management of all activities and will serve as a support service component for the three sectors described in Section C, "Institutional Analysis".

For this project to succeed the USAIDs involved as well as the OMVS and the three Member States, must provide strong and continous capabilities in project management, logistical support and technical expertise. To this end, the following administrative structure will be established, based on the staffing requirements of the Unit. A Project Chief will be appointed by OMVS to direct and manage the Unit, as well as to coordinate project implementation activities that will be carried out by the national hydraulic entities of the Member States. Likewise, the Project Chief will collaborate and work closely with USAID/RBDO to assure that project implementation is carried out as planned. The Project Chief will be assisted by a Deputy , hired under a PASA with the concurrence of the OMVS.

This person, preferably an Hydrologist, will supervise the training of the personnel of the Unit and the three Sectors. In addition, he will design, supervise and assist in implementing an on-the-job training program, including seminars.

B. Sector Offices

Sector offices in the Groundwater Monitoring Unit will be set up and financed by AID throughout the life of the project. Operating under the supervision of the Chief of the Operations Division, these offices will organize, coordinate and supervise construction and survey personnel under its direct control and will monitor and coordinate observer personnel* composed of employees from the national hydraulic agencies. The Sector Chief will coordinate with the appropriate national hydraulic agencies in planning the work of the observer personnel to ensure that the needs and priorities of the national hydraulic agencies are adhered to.

Successful implementation of this project depends on good field-level cooperation with, and coordination of, national employees by OMVS supervisors. Written commitments from each Member State concerning its contribution of personnel and their qualifications to be assigned to the project by each of the national hydraulic agencies will be required. These agreements should also include the employees' reporting responsibilities for administrative and technical matters to OMVS and to the national hydraulic services. Further, the agreements will include a commitment by the national hydraulic services to undertake groundwater monitoring activities in the Senegal River Basin

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* SAED and SONADER personnel already working in the irrigated perimeters where 450 of the piezometers will be installed.

after the completion of the project.

C. Role and Responsibilities of USAID/RBDO

The USAID/RBDO will have overall responsibility for planning, coordination and monitoring of project activities and will be ultimately responsible to AID/Washington for the implementation of the project. An AID direct-hire employee of the USAID/RBDO will be the Project Manager. He will be responsible for maintaining close communication with counterpart OMVS project staff as well as with USAID/OMVS project officers located in Nouakchott, Bamako and Dakar. The Project Manager will be responsible for preparing 6-month project implementation reports which will be reviewed jointly by the OMVS and the USAIDs. The RBDO Engineer will provide assistance in preparation of IFBs and monitoring implementation of the project.

D. Role and Responsibilities of the USAIDs

The USAID Missions in Mali, Mauritania and Senegal will be responsible for overseeing the implementation of country-specific activities. In each USAID Mission, OMVS Project Officers will be assigned, possibly consisting of the following:

1. USAID Project Officer - This person will be an AID direct hire employee or a contract/PASA technician to be designated by the Mission.

2. Country Project Officer - This person will be funded under the Integrated Development Project (615-0621).

3. Deputy Project Officer - This person will be funded under the Agricultural Research II Project (625 0957).

4. Secretary - This person will be funded under the Groundwater Monitoring Project.

In the event that authorizations of the proposed Integrated Development Project (625-0621) and the Agricultural Research II Project (625-0957) are delayed, the existing staff of the USAID Mission will cover the implementing and monitoring activities of this project.

The OMVS Project Officers will be under the general supervision of, and accountable to, the respective Mission Directors. Further, the OMVS Project Officers will coordinate project implementation activities with each national hydraulic entity and also with the OMVS Sector Chief in their country. However, the OMVS Project Officers will provide reports periodically on the status of project implementation to the USAID/RBDO and will receive reports from the Saint-Louis Groundwater Monitoring Unit.

5. Staffing Schedule

Provided that Conditions Precedent to disbursement have been fulfilled, RBDO will attempt to execute project implementation documents simultaneously with the signing of grant agreement.

Short-Term Advisory Services will be provided by USGS for approximately 3 months to assist in the establishment of the overall organizational structure i.e. the Headquarters Office at Saint-Louis as well as the Sector Offices.

An Administrative/Finance Officer will be recruited to work with the short term advisor in the creation of the Sector Offices. This officer will be required for procurement of essential supplies for the various offices, payroll and financial management.

The Deputy Project Chief will be provided for under the USGS PASA. whose PIO/T will be prepared in a timely fashion to facilitate his arrival by the 13th month of the project life.

The Hydrologists for the Technical and Operations Divisions will be nominated by their respective governments and submitted to AID's approval.

The Sector Chiefs will also be selected among the national hydraulic services and assigned to the Sector Offices. They in turn will participate in the selection of staff for the Sector Offices (as described in Section IV C, Institutional Analysis).

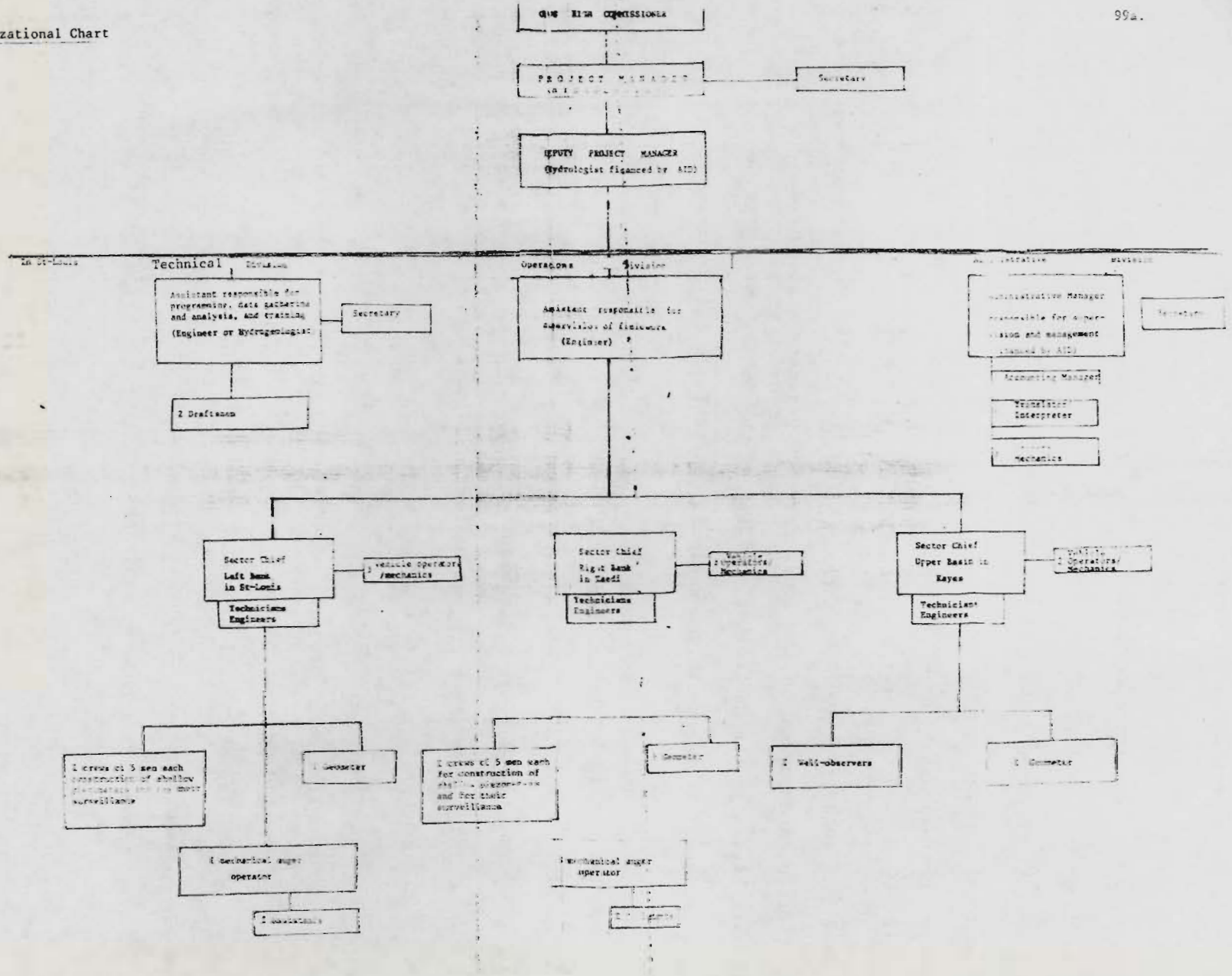
The organizational chart (Fig. 7) follows on the next page.

E. Programming and Fiscal Procedures

After the project is authorized by AID/Washington, a Project Agreement will be executed between the Director of USAID/Dakar, or his designee, and the OMVS. Only one Project Agreement, covering the authority and responsibilities of the OMVS, USAID/RBDO, USAID/Nouakchott, USAID/Bamako, USAID/Dakar, as well as those of the respective national hydraulic entities, will be required for the project. However, the Project Agreement subimplementing documents and related Project Implementation Letters (PILs) concerning country-specific matters will be cleared with USAID/Nouakchott, USAID/Bamako and USAID/Dakar prior to their execution and/or issuances.

All allotments for the Groundwater Monitoring Project will be made to the Regional Controller's Office which will be responsible for coordinating,

Project Organizational Chart



compiling, and reporting on the financial status of the project. The AID-financed Administrative/Finance Officer of the Saint-Louis based OMVS office will assist in carrying out the functions. As local currency expenditures (e.g. salaries, construction costs, shelf-items, per diem, etc.) will be incurred in both Mali and Mauritania, advances will be made by the Regional Controller's Office to USAID/Bamako and USAID/Nouakchott to cover such expenses. The OMVS Administrative/Finance Officer will assist the sector offices entities and the USAIDs in preparing the requests for advances and salaries to be paid by AID, vouchers for shelf-item commodities, etc. Certification and payment of the local currency expenses will be the responsibilities of the Controller's Office of the USAIDs which provide periodic financial reports to the Regional Controller's Office in Dakar.

F. Project Implementation Schedule

Month 1 - Signing of Project Agreement
- OMVS establishes Project Office in Saint-Louis
- OMVS Project Chief appointed
- Negotiation of leases for temporary (6-8 months) office space
- Preparation of project implementation documents (i.e. PIO/Ts and PIO/Cs.

Month 2 - Meeting of Conditions Precedent.

Month 3 - Administrative Officer (expatriate) reports for duty
- Short-term technical assistance arrives for start-up operations

Month 6 - Planning begins for establishment of Sector Offices at Saint-Louis, Kaedi and Manantali.

- First 6-month project implementation report and review with OMVS

Month 9 - OMVS Engineer (Operations) reports for duty

- OMVS Hydrogeologist (Data Compilation and Analysis and Training) reports for duty
- Filing and recordkeeping system developed for Saint-Louis Project Office
- Sector Chiefs appointed and report to their respective sectors to arrange for office space, local construction and operational personnel
- Work Plan established for first year

Month 10- Commodities arrive

- Leases negotiated for permanent office space in Saint-Louis
- Plans finalized for field activities.
- Leases negotiated for Sector Offices in Kaédi and Manantali.

Month 11- Sector Offices opened

Month 12- Long-term hydrology technician (Deputy Project Chief) arrives.

- Begin training of OMVS Senior Staff as well as Sector Chiefs. Complete training of Sector Chiefs
- Short-term consultant arrives to organize monitoring system.
- Commodities delivered to Sector Offices

- Continue training of OMVS Senior Staff
- Construction brigades organized in Sector Offices
- IFBs prepared for local well-drilling companies for deep piezometer construction
- 2nd 6-month project implementation report and review

Month 13-23 - Continuing operational field tasks: (1) construction of shallow and intermediate depth piezometers; (2) identification and selection of observation wells; (3) establishing measuring points; and (4) collection of water samples for analysis.

- 6-month project implementation reports and reviews

Month 14 - Contract construction of deep piezometers by well drilling company begins (July 83)
- Continuing data compilation and planning
- Continuing technical assistance for on-the-job training of surveyors, well-observers , mechanics, etc.

Month 15 - Sector Chiefs report to Saint-Louis for initial orientation

Month 25-41 - Six-month project implementation reviews continue
- Operational field tasks continue: (1) construction completed; (2) piezometer and observation well network established; and (3) data collection and analysis underway.

Month 44 - Major project evaluation, with contract assistance (3 person-months)

Month 36-48 - 6-month project implementation reviews continue
- Operational field tasks continue : (1) piezometer maintenance; (2) observer teams collect data; etc.
- Data compilation and analysis continue
- Continue short-term technical assistance consultancies for water balance and quality studies, hydraulic profiles, mathematical modeling, etc.
- Groundwater Monitoring Office and system functioning effectively

Month 48 - Long-term technician (Deputy Project Chief) departs

VII. MONITORING AND EVALUATION PLAN

Project activities will consist of : a) on-going monitoring and b) evaluation. Short- term technical assistance will help in establishing a monitoring information systems, assist project staff and USAID/RBDO in carrying out a project assessment in the third year of the project; and, assist in a broader evaluation of the project in its fourth year.

A. Monitoring

During the second year of the project, AID will provide one month of technical assistance to assist project staff to establish a monitoring information system. This system will provide project staff, the OMVS and USAID/RBDO with basic information on progress in meeting training, data collection and piezometer construction targets. Information from the monitoring system will provide the major source of data for the 6-month implementation reports which the USAID/RBDO Project Manager will prepare and which will form the basis for semi-annual joint reviews. The OMVS and USAID/RBDO, as well as USAID/Senegal, Mali and Mauritania, will participate in these bi-annual joint reviews of project progress.

Using the information collected through the monitoring system and half-year reviews, a short-term consultant will participate in a project assessment to investigate a number of issues, including the following:

- the adjustments needed to enable the project to reach its original objectives;
- the quality of training, piezometer construction, and data collection efforts, and improvement needed;
- the actions necessary by the OMVS and its Member States to cover recurrent costs of the project when AID funding ends;

- the appropriate timing and nature of the 6 months of short-term technical assistance planned for the fourth and fifth years of the project; and,
- given the data so far collected, the problems (on salinity, water Logging, etc) that are likely to arise and will require OMVS action and the systems needed to insure that the OMVS and Member States act on the recommendations for corrective action.

This assessment will indicate the necessary changes in project strategy for meeting the project's objectives.

B. Evaluation

The above monitoring activities will serve as a basis for the in-depth project evaluation to occur during year 4 of the project. The periodic reviews will provide information which will be used for measuring the institutionalization of project activities in the OMVS and Member States. Three person-months of external technical assistance will assist project staff and USAID/RBDO to assess project progress, performance and impact.

C. Execution of the Monitoring and Evaluation Plan

The project budget incorporates three months of technical assistance for monitoring and evaluation. Many of the project outputs involve data compilation and analysis as well as hydrological planning studies for which proper assessment requires specialized expertise.

Hydrogeological expertise will be needed for monitoring and evaluation assistance, (1) creation of the monitoring information system. The USAID/RBDO Project Officer will coordinate the broader project evaluations. All project

records and reports will be available for review as will other USAID and OMVS documents and financial records.

VIII. NEGOTIATIONS STATUS AND CONDITIONS PRECEDENT

A. Negotiating Status

As this project is primarily an institution-building project directed toward improving the capabilities of the OMVS and of Member States national services, the full and active commitment of the OMVS and the Member States to this project is necessary. AID will finance most of the OMVS administrative costs during the first three years of implementation with OMVS gradually taking over these costs in the fourth year of the project. Senegal, Mauritania and Mali will provide field-level personnel for the construction, survey and observations crews who will be assigned to work out of the Sector Offices at Saint-Louis, Kaédi and Manantali.

B. Conditions Precedent

In order to assure OMVS commitment to the project, the OMVS official creation of the Groundwater Monitoring Office and the appointment of the Project Director shall be Conditions Precedent to the disbursement of any project funds. In addition, a written agreement will be entered into between OMVS and each participating country which will delineate each party's responsibilities to the project, especially its contribution of field-level personnel to be assigned to the Groundwater Monitoring Unit by each of the national services. Another Condition Precedent to the disbursement of second-year funding will be that the Sector Chiefs are appointed and the Sector Offices at Saint-Louis, Kaédi and Manantali are formally established.

TABLE 4. SCHEDULE OF TECHNICAL ASSISTANCE (Person-months)

	YEARS				
	0 - 1	2	3	4	Total
Long-term T.A.	9	24	24	24	81
Short-term T.A.	3	2	5	3	13
T O T A L	12	26	29	27	94

The OMVS shall covenant that it will provide administrative support to this project as specified in the Project Paper. OMVS administrative support will include salaries,office space, secretarial and other administrative support. This contribution is estimated to be approximately $551,000 over the life of the project.

As indicated on Table 3, "AID/OMVS Personnel Costs" (Page 91), the total contribution required of the OMVS Member States to cover the costs of those personnel assigned to the Saint-Louis headquarters amounts to $381,000. However, since the Project Chief is already on-board, only $298,000 ($381,000 less $ 64,000 and $18,000) will be needed by OMVS to cover its share of the personnel costs. This would average approximately $ 100,000 per country. Thus the yearly contribution per country would be $ 25,000 over the four-year period of the project.

To assure adequate and timely support for these personnel, as an initial condition to the disbursement of funds under this project, each Member State is required, within 90 days of the signing of the Project Agreement, to contribute an initial advance to cover the first year of the personnel costs. This amounts to $ 25,000 for each Member State. At the end of the first, second and third years after the execution of the Project Agreement, each Member State is required to contribute another $25,000,which would fully cover its share of $ 100,000. Should more than 90 days elapse after the expiration of the dates for the first, second and third years before the Member State makes its required contribution, no additional AID funds will be provided to that country's component of the Groundwater Monitoring Project until the arrears are paid in full.

ANNEX A

TECHNICAL ANALYSIS

ANNEX A

Technical Analysis

The technical feasibility of this project was analyzed by George C. Taylor, Jr. of CH2M Hill in an October 1979 report entitled "USAID Groundwater Management Planning". This annex includes the project justification and detailed work plan adapted from Taylor's report.

Project Justification

Several diked irrigated perimeters are under construction or have recently been completed in the Senegal Valley with the financial aid of various donors, including the IBRD, FED, and USAID. Multimillion dollar investments have already been made in these perimeters and investments for perimeters under construction and planned for construction are expected to be more than $1 billion in the next decade. Despite these investments, little attention, with the exception of the sugar plantations operated by the Compagnie Sucrière Sénégalaise (CSS) at Richard-Toll, has been given to water-management in the Senegal Valley. As a result, water-logging and salination problems are already in evidence in the M'Pourié rice perimeter near Rosso, in the Dagana perimeter, and in the Nianga and Guédé chantier perimeters, and they are impending elsewhere.

Good water management of irrigated perimeters requires accurate measurement of gross pumpage, water use by crops, evapotranspiration, losses by leakage from canals and by deep percolation from irrigated fields, and monitoring of changes in groundwater levels and salinity.

Large investments could be vitiated in a few years by water logging and/or salination, if good water management practices are not developed and implemented. Water management is likely to be most critical in the immediate future in the diked irrigated perimeters of the Senegal River Delta and in the valley downstream from Podor, but is important also in the middle and upper valley.

The role of the Senegal River and its alluvial aquifer in recharging regional aquifers which sustain the water supplies of hundreds of domestic and livestock wells has been shown by earlier groundwater studies. The alluvial aquifer is alternatively discharged during the dry season and replenished by floods during the rainy season. Since aquifer charge-discharge relationships are imperfectly understood, one of the project objectives would be to compile and analyse groundwater data bearing on these relationships. The need for groundwater analysis is intensified by construction of the Diama [1/] and Manantali [2/] dams which will change the regime of the river and of groundwater in adjacent areas.

1/ Construction on the Diama dam began in November 1981 and is expected to be completed in 1986.

2/ Full construction on the Manantali dam is scheduled to begin in middle to late 1982. The dam is expected to become operational in 1988-89, depending on levels of funding.

The Diama dam, located near the mouth of the river, will prevent upstream flow of sea water, and will create a fresh-water impoundment. The loading effects of this reservoir could cause lateral migration of saline groundwater or aggravate irrigation-related problems. For this reason, groundwater monitoring is of particular importance in the vicinity of the reservoir. Similarly, the Manantali dam will change the river regime by regulating and altering the flow of river. Overbank flooding will be reduced. This could affect the alluvial aquifer recharge, and indirectly, the contiguous regional aquifers.

Groundwater monitoring established prior to the initiation of flow regulation by the Manantali dam will provide important base line data for quantifying the magnitude of the changes. The area of investigation included in this project will include the reaches of the Bafing and Senegal Rivers affected by river regulation. Also the Malian DNHE gives high priority to the emplacement of observation boreholes (large diameter piezometers) in the Manantali area. Geological surveys made during feasibility studies of the dam site and reservoir area disclosed the presence of an extensive system of faults some of which may offer avenues of leakage during and following impoundment of the Bafing. Piezometers will be required to observe the effects of build-up in hydraulic head or groundwater in the fault system caused by the impoundment.

The possible contamination of shallow groundwater by fertilizers and pesticides, being increasingly used in irrigation perimeters, is another potential problem, as this groundwater also sustains many existing domestic and livestock wells. Therefore, another project objective would be to monitor groundwater quality as it relates to these hazards.

Finally, as shown in the Illy (1973), Bechtel (1976), and other studies, an important potential exists for development of groundwater for irrigation, especially in the Matam-Boghé sector. This project would provide groundwater monitoring and analysis of aquifer data to further quantify this potential and its limits.

Work Plan

The area to be covered is the Senegal River Delta and valley from Bafoulabé downstream to St-Louis, including a strip 10 to 12 km wide on either side of the valley. Also included is the Manantali reservoir area and the Bafing downstream from Manantali dam. The work components of the project are divided into planning, data compilation and analysis, training, field operations, construction and evaluation.

A. Planning:

Planning activities that will be initiated early in the project include:

1. Design of an appropriate system for filing hydrogeologic data, construction details, location, and equipment inventories for each existing open well, tubewell, piezometer and observation well in the project area.

2. Design of an appropriate format for recording the hydrogeologic data, construction details, location, and equipment for each existing open well, tubewell, piezometer, and observation wells.

3. Establishment of an appropriate system for filing periodic water-level and specific conductivity measurement data at project headquarters in St. Louis.

4. Design of an appropriate format for recording water-level and specific conductivity measurements for each observation well and piezometer.

5. Design of plans and blueprints for a network of observation wells with an average density of about one for each 100 km2 along the valley downstream of Bafoulabe and the strip about 10 to 12 km wide on either side of the valley. Carefully selected open wells (puits) now existing can be used for observation together with proposed piezometers.

6. Planning for a network of shallow piezometers for each existing diked irrigation perimeter in the alluvial valley in an area exceeding 100 hectares. If feasible, one piezometer will be installed in each 100-hectare block. Piezometers will also be installed immediately outside perimeters for purposes of comparison.

7. Planning for a network of shallow piezometers adjacent to the proposed Diama reservoir to monitor the effects of impoundment on groundwater levels and water quality in the delta.

8. Planning a network of shallow and deep piezometers in the Matam-Boghé sector to study in greater detail the observations of Illy (1973) on the recharge-discharge relationships of the Senegal River, its valley aquifer, and contiguous regional aquifers. This sector holds the greatest promise for groundwater development for irrigation, both in the valley as well as in the adjacent "dieri".

B. Data Compilation and Analysis

Data compilation activities to be initiated early will continue throughout the project life. Analysis will begin around the middle and later stages of the project after a data base has been established.

The first data compilation task will be to update the well inventories and related groundwater data initiated during the OMVS/FAO Hydroagricultural Study referred to in the project.

The second task will be the search and identification of all published reports and data pertaining to identified objectives in the Documentation Center in St. Louis and the review of the documents listed in Annex I of the Project Paper.

The third task will be a search and identification of unpublished data in the files of the Malian Direction de l'Hydraulique et de l'Energie and the OVSTM, at Bamako; the Mauritanian Direction de l'Hydraulique and the SONADER, at Nouakchott; the Senegalese Direction de l'Hydraulique, at Dakar; and the SAED at St. Louis.

When sufficient water-level and water-quality data have been accumulated, data analysis and interpretation activities can begin. These activities will include:

1. Construction of maps for groundwater salinity, depth-to-water (below land-surface datum) of the larger diked irrigation perimeters.

2. Construction and analysis of hydraulic profiles along lines of piezometers showing the pressure and water-quality relationships of the river, the valley fill aquifer and deeper regional aquifers, particularly the Matam-Boghé sector.

3. Study of water-quality fluctuations in domestic and livestock wells and seasonal and/or long-term trends in groundwater levels.

4. Study of the water budgets and salt balances of selected irrigation perimeters.

These studies should be based on water table and water quality fluctuations compared with irrigation applications, infiltration and evapotranspiration estimates.

C. Training

Training activities will begin early in the project and continue at regular intervals throughout the life of the project. Training elements will include:

1. Instruction in the use and maintenance of electric tapes, water sampling equipment, specific conductivity meters, levelling instruments, water-level recorders, and other field equipment.

2. Instruction in the systematic recording of field measurements on standard schedules. These would include the dates and times of measurements and any local observations of conditions that might affect measurements.

3. Early in the project training of the assigned CMVS management staff at St. Louis in the scope and objectives of the project. This training will be combined with that of the Sector Chiefs.

4. Training surveyors and assistance to operate in teams of three.

5. Training well observers to operate alone or in pairs.

6. Training will be achieved and intensive workshops coupled with on-site instruction in the use of field instruments.

7. Training and indoctrination of well observers and villagers in the function and importance of the piezometers and the need for their protection against vandalism. The USAID/REDSO anthropologist/sociologist will be requested to provide consultation on this problem.

8. Periodic inspections by supervisory personnel of the activities of well observers and surveying teams will be required of the data collection activities to insure quality control.

9. At a later stage in the project, training of professional personnel attached to the OMVS office at St-Louis in the basics of water balance and salt balance analysis, water-quality, groundwater hydraulics, and mathematical modelling and in the preparation of technical reports for use in reclamation and/or water development planning.

D. Field Operations:

Operational activities at the field level, which will be carried out with close supervision by the St-Louis professional staff, will include:

1. Identify and select observations wells from among existing village and livestock open wells (puits) and boreholes (forages). It is estimated that some 450 observations wells will be required in the network.

2. Establish measuring points at observation wells. Identify by painting appropriate, easily read markings on well curbings (margelles).

3. Refer measuring points to land-surface datum and to sea-level datum by instrumental levels.

4. Make a field check of lines of piezometers constructed for the Illy (1973) study at Kanel (left bank); Matam (right and left banks); Guédé (left bank); Nianga (left bank); Boghé (right bank); and Podor (left bank). Do the same for the Audibert (1970) study in the delta and the Betchel (1976) study at Matam.

5. Rehabilitate or replace these piezometers as needed and as desirable.

6. Select sites for in-house construction of new shallow piezometers with hand augers or power auger drilling equipment. Approximately 10 to 15 shallow piezometers will be installed in or near each major diked irrigation perimeter and about 25 to 30 in the vicinity of Diama reservoir. A total of about 450 shallow piezometers 3 m to 15 m deep will be required in and near the larger irrigated perimeters of the project area. About half of these can be installed by hand auger and the remainder by power auger.

7. Select sites for lines of combined shallow (less than 5 m), intermediate (5 m to 30 m) and deep (30 to 60) piezometers along the lines of the Illy and Betchel studies. Some piezometers will be set up as "three-hole batteries" with shallow, intermediate, and deep piezometers to measure pressure heads and water quality at different depths in aquifers at the same site. It is estimated that an average of about 20 piezometers will be required on each of 10 piezometer lines for a total of about 200. In addition 10 larger diameter observation boreholes, are equipped with water level recorders will be constructed under contract with a local well drilling firm.

8. Between Bakel and the Manantali dam site the Senegal and Bafing flow largely on hard consolidated rocks. In these reaches of the valley existing open wells and boreholes near the rivers will

be included in the observation well network to observe the fluctuations in river flows on the water table.

9. Around and in the vicinity of the Manantali dam and reservoir there will be need for monitoring the effects of the impoundment of the Bafing River on the local groundwater regime, particularly potential leakage through fault systems which transect the reservoir area. For this purpose some 20 piezometers averaging 60 m deep will be drilled around the periphery of the reservoir for periodic water level observations. Also existing open wells (puits) in the environs will be measured periodically for additional data control.

10. Once observation wells are selected and identified in the field, periodic measurements can begin. An average frequency of about once a month is suggested in the beginning for all observation wells (puits), piezometers, and observation tube wells (forages). As the teams gain experience increasing effort should be made to take weekly measurements of water level and specific conductivity, especially during the flood season.

11. Copies of all measurements by well observers will be sent to OMVS St-Louis headquarters for compilation and analysis as soon as they are made. Check measurements will be made from time to time during field inspections by the OMVS technical staff to ensure that well observers are fulfilling their responsibilities.

E. Construction

1. Traditional Construction Method

Numerous shallow piezometers have been installed in the Senegal River Basin using hand augers and relatively simple bailing techniques. The hole is started with a hand auger and proceeds until either caving material is encountered or the limits of the hand augering equipment is reached. When caving materials are encountered the piezometer pipe is inserted into the hole and the pipe is forced downward by bailing the hole and applying force to the pipe. If the caving material is dry, water is added to facilitate bailing. The depth of piezometers constructed by this method is limited to about 6 to 8 meters. Two, two and a half and three inch galvanized pipes have been used in piezometer construction.

However, 2 inch pipes have a tendency to fail during driving and 2 1/2 inch pipes (64 mm) are recommended as the minimum size for this type of operation. Slotting of the lower section of pipe is accomplished by hacksaw cuts. The equipment required for this operation is inexpensive and uncomplicated. These include hand auger and extension sections, a locally fabricated bailer, a tripod, rope and a pulley.

2. Construction Details

Construction activities for installation of shallow and intermediate piezometers can begin at any time after the selection of sites for

piezometers and the arrival of the required commodities. Most of the piezometers will be 64 mm (2 1/2 inch) in diameter. Such a piezometer can readily accomodate an electric tape or other water-level measuring device and also a 2.5 cm tubular "bucket" for water sampling. The piezometers will generally be set in grout with a concrete block to prevent removal of the pipe. They will be fitted with a threaded cap that can be removed only with a pipe wrench. Where vandalism appears to present a serious problem the piezometers can be equipped with a lockable steel cap or cut off flush with the top of the concrete block and protected by a lockable steel plate.

Vandalism or willful destruction of piezometers by local inhabitants has been a chronic problem in past groundwater studies. Some means must be found to protect new installations against vandals, perhaps a counselling program undertaken with assistance from village chiefs or local police would be effective (see Social Soundness Analysis).

3. Shallow Piezometers

Piezometers less than 5 m deep (Fig. 1) will be constructed by in-house crews directly supervised by the sectorial technical staff. The method of construction will be the traditional method as described in 1. above. Four crews of three to four men each, two in the Rive Gauche sector and two in the Rive Droite sector can be kept intermittently occupied during most of the life of the project installing shallow piezometers and replacing damaged ones. Shallow piezometers need not to

be more than simple pipe with the lower 50 cm or so slotted and wrappped with a nylon to serve as a filter; they would be installed about 2 m below the water table in a permeable, saturated sand.

4. Intermediate Piezometers

Piezometers ranging from 5 to 30 m deep (Fig. 1) will be installed by a truck-mounted power auger under the control of the St-Louis and Kaedi sectorial operators and helpers. Two (2) power augers will be provided for the project. Sectorial headquarters at St-Louis and Kaedi will provide technical supervision.

The construction technique will be similar to the traditional method with the exception that the provision of the power auger will provide the Sector Offices with the capability to bore the deeper holes.

5. Deep Piezometers and Observation Boreholes

(Senegal and Mauritania)

The deep piezometers and observation boreholes in the Rive Droite and Rive Gauche Sectors will be constructed under contract by a locally based drilling firm. There are two experienced drilling companies based in Dakar.

The work to be accomplished under contract consists of the construction of approximately 45 deep piezometers and 10 larger diameter observation

boreholes to be located along the 10 piezometric lines proposed. Each observation borehole will be equipped with a continuous water-level recorder housed in a locked concrete shelter (see Figure 3). One well observer would be assigned to maintain each recorder and assure its protection against vandalism.

Bid documents will be developed by OMVS Groundwater Monitoring Unit staff with the Deputy Project Chief (USGS groundwater hydrologist) providing technical assistance in the siting of deep piezometers/boreholes and in the development of the technical specifications. The RBDO, which will have a contract engineer on its staff, will assure that the bid documents are in conformance with AID's requirements for host country contracting. The contractor will be responsible for the entire construction package; including construction of the boreholes, geologic logging, furnishing and installing casing and screen, temporary casing if required, development and pump testing of the observation boreholes if this option is recommended by the technical staff of the OMVS Groundwater Monitoring Unit. With the exception of the water-level recorder, the contractor will be responsible for providing all materials required including construction of the recorder housing.

6. The Malian Component

(1) Observation Network - Bafing and Senegal Rivers Downstream from Manantali Dam.

The work planned for the area extending from Manantali Dam downstream to the Malian Border consists of:

(a) the identification and selection of existing open wells and boreholes to comprise the observation network;

(b) surveying to establish location and the elevation of measuring points;

(c) implementation of the groundwater monitoring program; i.e. measurement of water levels and water parameters(conductivity, PH and temperature) at regular intervals.

This operation will be conducted out of Kayes where DNHE has an established office with technical personnel. The reach of river to be studied is about 300 km in length and has been divided into two sectors for operational purposes. The Groundwater Monitoring Project will provide an all purpose vehicle and motorbikes along with radios for transmitting data and for general communication purposes. Radio communication is essential for coordination between the sub-sector office at Kayes and the sector office which will be established at Manantali. The project will also provide water level indicators and other instruments necessary for data collection.

(2) Observation Network - Manantali Reservoir Area

The work planned for this area consists of :

(a) geologic reconnaissance

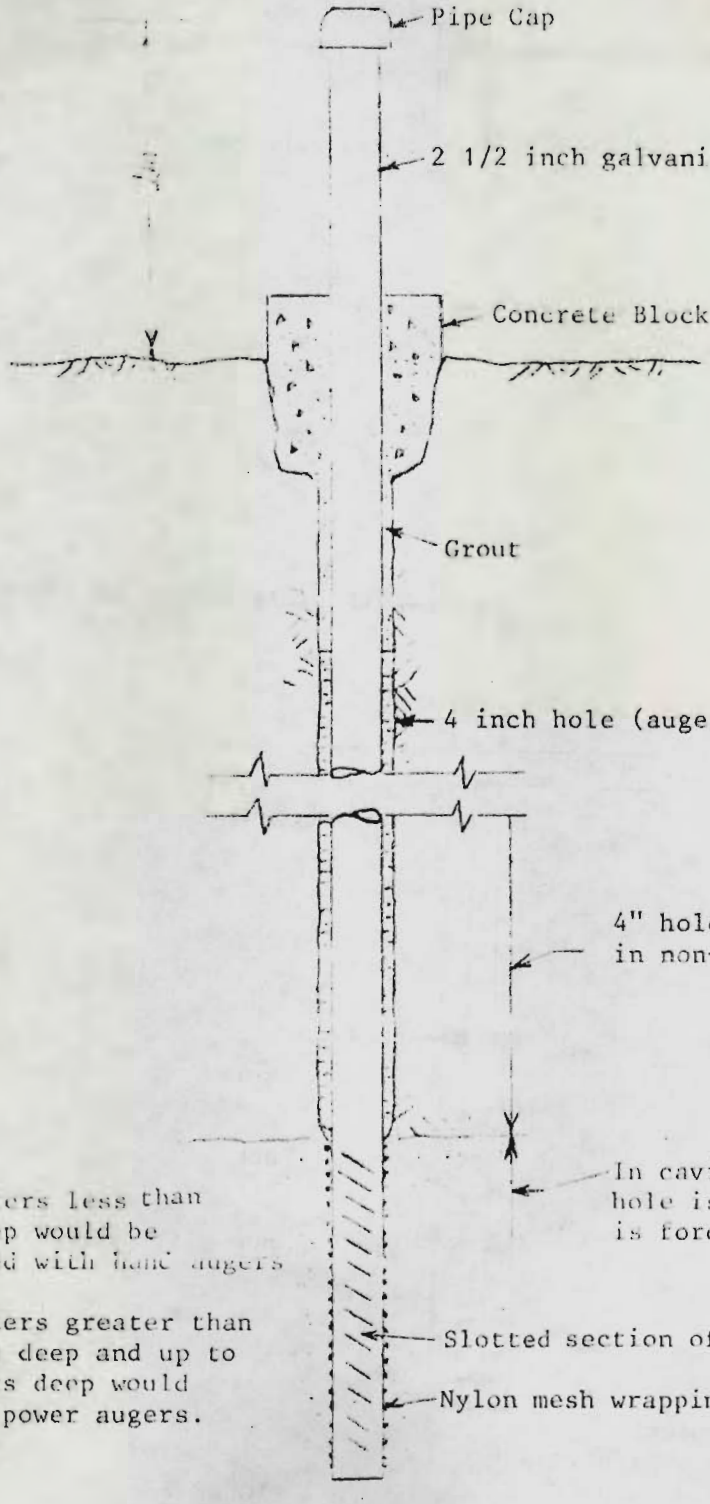
(b) Piezometer site selection utilizing aerial photography and geophysical methods

(c) Piezometer construction

(d) Construction of a small office complex in the vicinity of the Reservoir.

The aerial photographic and geophysical studies will be accomplished by DNHE personnel under the supervision of the Sector Chief and the OMVS personnel. Geophysical methods will consist of electrical resistivity, seismic and gravimetric methods. The DNHE has the required equipment available.

Construction of the 20 piezometers will be accomplished by DNHE personnel utilizing DNHE drilling equipment. The design of the piezometers is also shown on Figure 4 and consists basically of a 6-8" diameter borehole equipped with 4-6"PVC well casing. Slotted PVC well screen will be utilized and the well will be gravel packed. The average depth of the piezometers is estimated at 60 to 80 meters. It should be noted that the well diameter and casing are larger than required for piezometric observations; however,DNHE justifies this on the basis of the eventual utilization of the piezometers for water supply. Also,

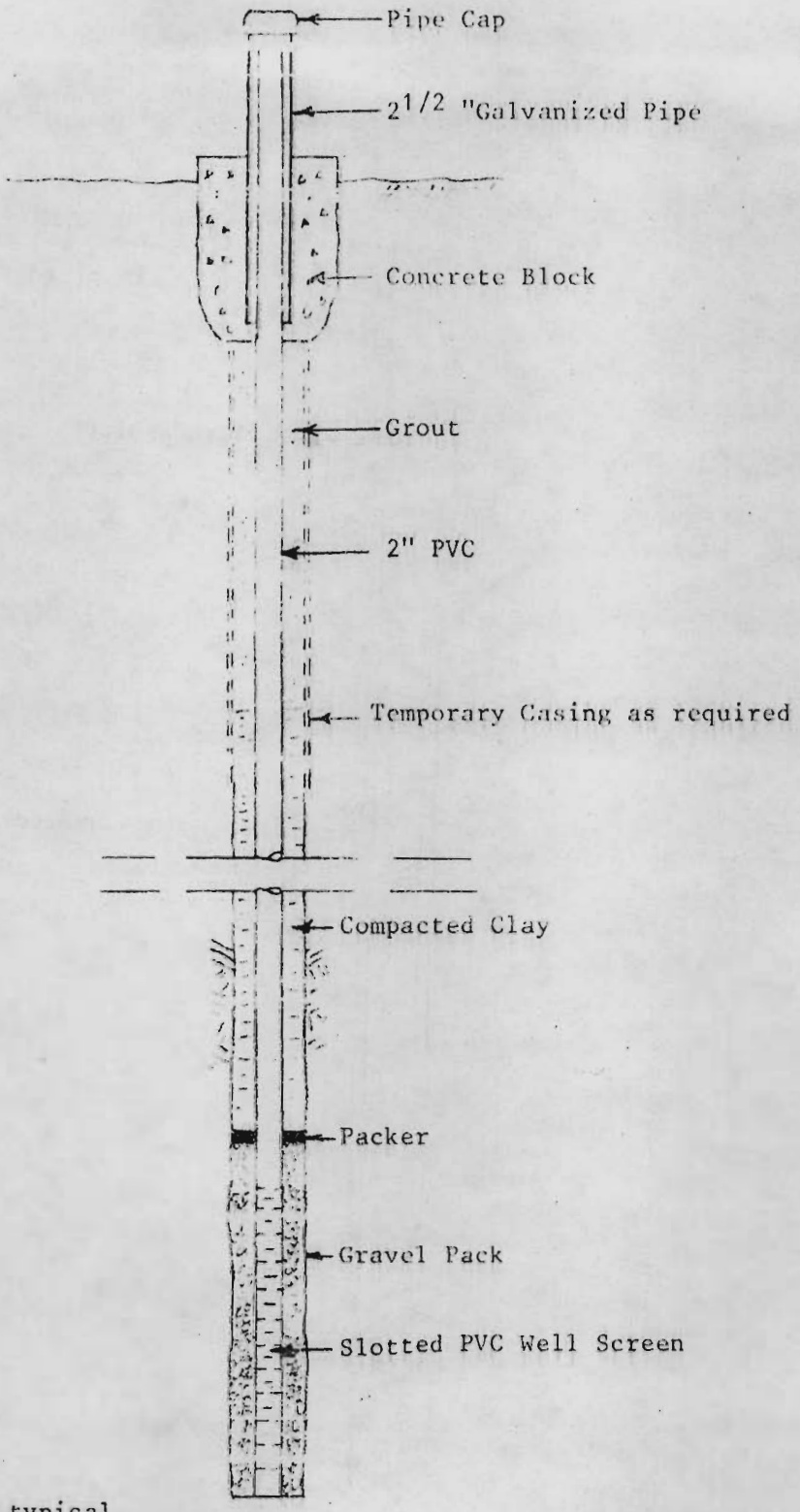


Note : (1) Piezometers less than 5m deep would be installed with hand augers

(2) Piezometers greater than 5 meters deep and up to 30 meters deep would utilize power augers.

FIGURE 1.

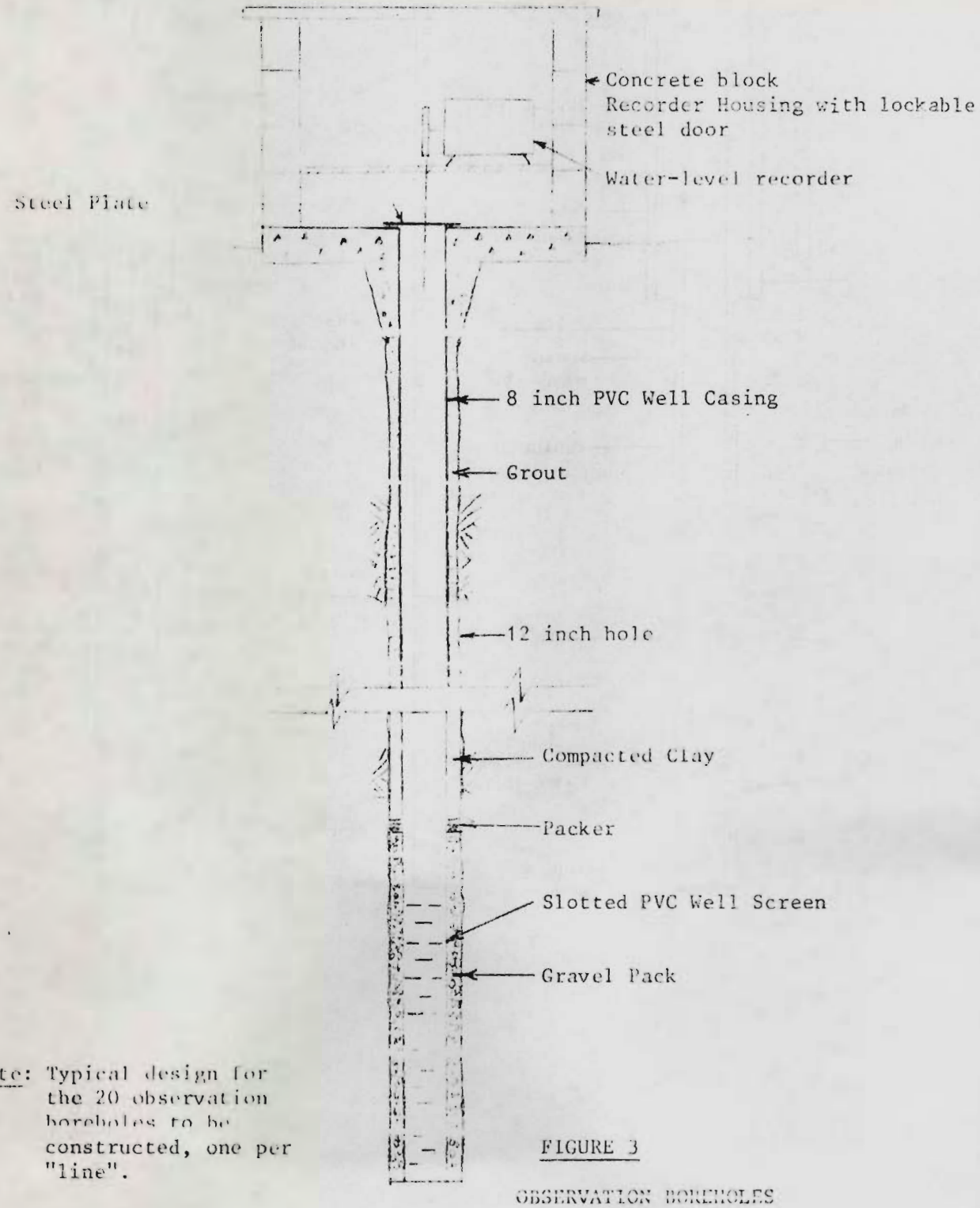
SHALLOW AND INTERMEDIATE DEPTH PIEZOMETERS TO BE CONSTRUCTED IN AND AROUND IRRIGATED PERIMETERS BY SECTOR FORCES.



Note: This is the typical design for the shallow, intermediate and deep piezometers to be constructed along the 10 lines.

FIGURE 2

PIEZOMETERS CONSTRUCTION BY LOCAL DRILLING CONTRACTOR.



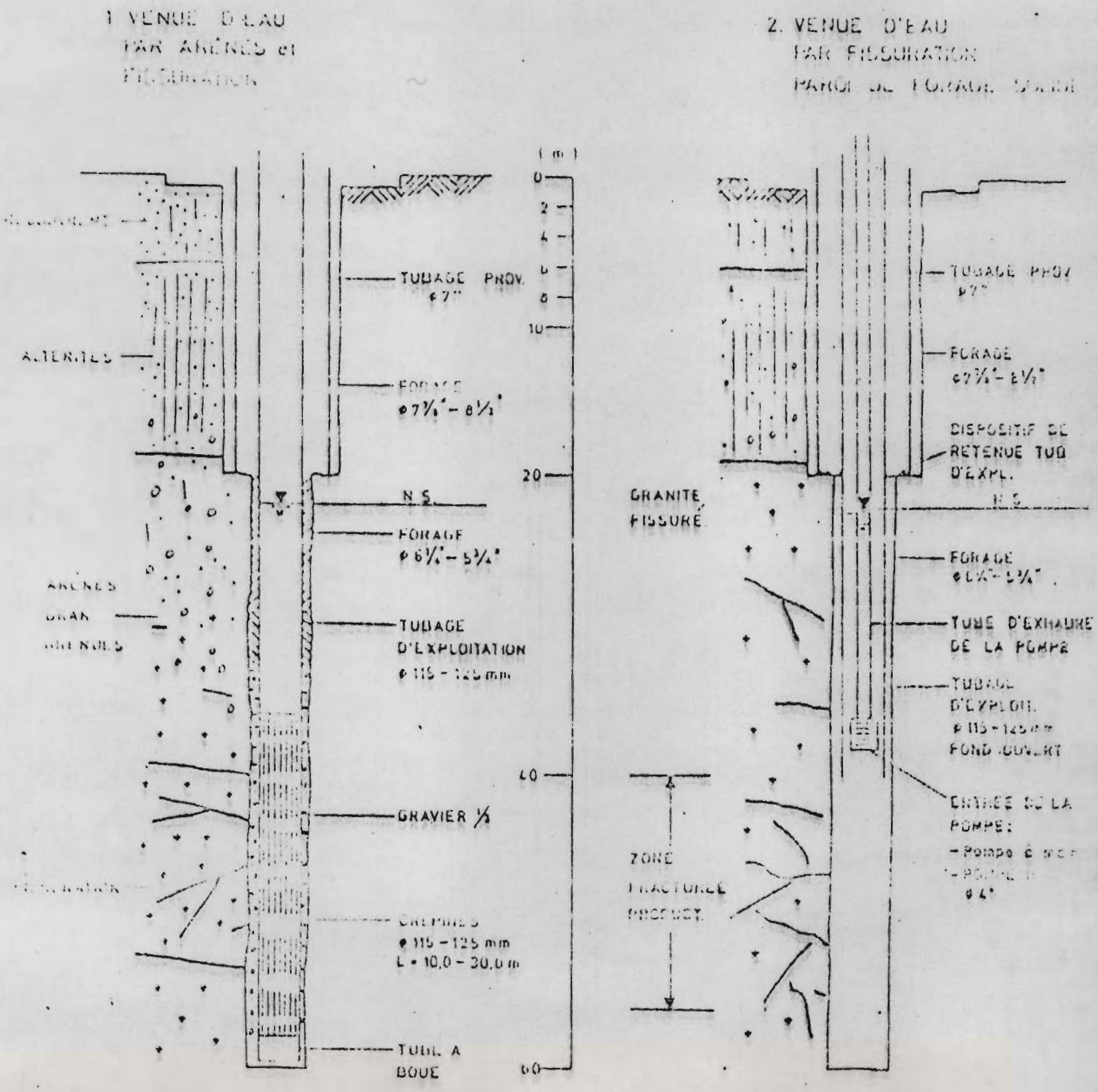
Note: Typical design for the 20 observation boreholes to be constructed, one per "line".

FIGURE 3

OBSERVATION BOREHOLES CONSTRUCTION BY LOCAL DRILLING CONTRACTOR.

FORAGE TYPE "SOCLE"

fig. 4



to ensure the accuracy of iron and manganese determinations when laboratory analysis is requested. Procedures will be established for bailing of the piezometers for a long enough period to remove standing water and ensure that groundwater has entered and the sample is representative of the water in the aquifer.

The initial chemical analysis of groundwater from the deep piezometers and observation boreholes, those which will be constructed by contract, will be accomplished by the drilling firm as a contract requirement. Subsequently, water quality along the 10 lines, will be monitored by the sector staff using field methods, in addition to collecting samples for laboratory analyses. Considering the time required to complete the deep piezometers and observation boreholes the monitoring period during the life of the project would be about two years. The CNVS estimates that about 40 samples for laboratory analyses, would be collected during that period (2 samples/line/year for 2 years).

In and around the irrigated perimeters laboratory analyses of water from the shallow and intermediate piezometers will be accomplished on a selective basis. Factors such as previous water quality analyses in the area, electrical conductivity measurements and the use of pesticides, herbicides and fertilizers in the area will be used to determine the location and scheduling of sample collections for laboratory analyses. A preliminary estimate of the number of laboratory analyses required

is 110 with most being conducted during the 3rd and 4th years of the project.

Laboratory analyses will be accomplished by "Groupe Laboratoires de la Direction des Mines et de la Geologie" located in Dakar. This laboratory serves the water testing needs of Senegal by providing service to other government agencies and private drilling companies. It has the capability to perform the specific constituent analysis required for general tests under this project ; i.e. specific and total anions and cations, boron, SAR, etc. The laboratory, however, does not have the equipment required for pesticide/herbicide analyses. These analyses will be accomplished by the U.S.G.S. National Water Quality Laboratory in the United States.

The estimated cost of testing and materials required for the water quality monitoring component is as follows:

Laboratory analysis in Dakar	
150 tests at $60/test	$9,000
Pesticide/Herbicide analysis at USGS Lab	
40 tests at $500/test	$20,000
Supplies (bottles, reagents)	3,000
Total	$32,000
Contingencies (10%)	3,000
	$35,000

This total does not include the cost of the additional initial water quality analyses to furnished by the well drilling contractor.

ANNEX B

TERMS OF REFERENCE FOR

TECHNICAL ASSISTANCE

AND

PERSONAL SERVICES CONTRACTS

ANNEX B

Technical Assistance and Personal Services Contracts

A. Scope of Work for Technical Assistance Contract

The U.S. Geological Survey under a PASA will provide basic technical support and quality control for the five components of the project which include planning, data compilation and analysis, training, field operations, and construction. Planning activities include designing appropriate systems for, implementation, supervision, data recording, and other activities.

Training will be provided in the use and care of all types of technical field equipment; in data recording and compilation; in measurement/observation of water-level, water-quality, and other groundwater maps; and in the preparation of interpretative technical reports. Field operations and construction include inventories of existing wells, construction of piezometers, systematic water-level and water-quality observations in piezometers and observation wells. All these components are described in detail in Annex I.

The USGS will provide up to 49 person-months of technical assistance during the four year life of the project divided as follows:

(a) One hydrologist or groundwater engineer (long term) on a continuing assignment beginning about the end of the twelf month of the project, until its completion.....36 person-months

(b) One water budget expert to evaluate data collected during the project and to recommend needs for additional data needed for developing groundwater models of the Diama reservoir area, selected diked irrigated perimeters between Richard Toll and Boghé, and the groundwater development potential of the Matam-Boghé sector, beginning about the 24th month.....3 person-months

(c) One hydrologist (short term) to assist with start up operations of the project, including the establishment of the Sector Offices. This also involves formulating the initial work program and identifying commodities for early procurement. The assignment is scheduled to begin upon finalization of the PASA, or about the 6th month .....3 person-months

(d) One water-quality expert to evaluate water-quality data collected during the project and to recommend needs for additional data for appraisal of groundwater contamination by fertilizers and pesticides and for water-quality modelling, beginning about the 34th month .....2 person-months

(e) One groundwater modelling expert to carry out the following duties:

(1) develop conceptual and mathematical models of flow and/or solute transport in the Diama Reservoir area of the Senegal delta,

(2) develop conceptual and mathematical models of flow and/or solute transport of selected diked irrigation perimeters between Richard Toll and Boghé, particularly directed toward water management for irrigation and salinity control.

(3) develop conceptual and mathematical models of flow and/or solute transport of recharge-discharge relations between the Senegal Valley alluvial aquifer and contiguous regional aquifers of the Matam-Boghé sector,

(4) calibrate and verify the models developed in (d) and (2). This technician will begin work about the 30th month of the project .....5 person-months.

B. Duties to be Performed by the Long-Term Technician

(Hydrologist or Groundwater Engineer)

1. Assist the OMVS in developing standards and operating modes for monitoring and investigating existing and potential problems of groundwater development and management related to :

(a) Water-logging and salination in existing and proposed diked irrigation perimeters.

(b) Deterioration of water quality in domestic and livestock wells.

(c) Recharge-discharge relationships of the Senegal River, its valley aquifer and contiguous regional aquifers.

(d) Changes in the groundwater regime caused by construction of the Diama and Manantali Dams and resulting alterations of the flow regimen of the river.

(e) Potential leakage along fracture systems in the Manantali Reservoir area.

(f) Irrigation development potential of groundwater for either supplemental irrigation or with surface water in the Matam-Boghe sector.

2. Assist in the training at workshops in St. Louis of the OMVS' senior staff and the three Sector Chiefs.

3. Assist in on-the-job training of piezometer construction crews, power auger operators, surveyors, and well observers in the use and care of technical equipment and in recording water-level and water-quality measurements.

4. Assist in developing effective means of protecting piezometers against vandalism including sensitizing local villagers. This work would be done with the USAID/REDSO Abidjan anthropologist/ sociologist.

5. Assist the OMVS' senior staff in compiling and illustrating hydrogeologic data including general water-table, depth-to-water and water quality maps, hydraulic and water-quality profiles and

similar more detailed maps and profiles of selected irrigated perimeters.

6. Assist in developing standards and data requirements for detailed water-budget studies of selected diked irrigated perimeters.
7. Assist in setting up the terms of reference for short-term specialists.
8. Train Senior staff member of the OMVS to analyze and interpret groundwater data and prepare technical report and maps for the guidance of water resources planners, developers and managers.

Qualifications of the Long-Term Technician

(Hydrogeologist or Groundwater Engineer)

1. Equivalent or FSI R-3, S-3 competence in the French language.
2. Good managerial, communication and teaching skills.
3. Strong background in general groundwater hydrology, including quantitative aquifer theory, particularly with applications to:
   (a) River-alluvial aquifer relationships,
   (b) Fresh-water salt-water relationships in deltaic environments,
   (c) Water-logging and salinity control in irrigated areas.
4. Minimum of 8 years experience in groundwater investigations and/or development, some of which preferably should have been in the developing countries of Francophone Africa.

C. Duties to be performed by the Administrative /Finance Officer (U.S. expatriate local hire) based at St-Louis

1. Provide continuing administrative support for the project.

2. Work closely with USAID/RBDO and with OMVS/Dakar as well as with the USAID's in Mauritania and Mali in order to coordinate administrative needs in all countries.
3. Work in close collaboration with the Deputy Project Chief in carrying out basic administrative duties as well as monitoring of national activities for procurement, logistics, tax exoneration, field-level liaison with project principals, contractors, and national services.
4. Manage day-to-day activities in logistics and vehicles, procurement and property, cash disbursement for local expenditures, and recruitment and supervision of local administrative personnel.
5. Assist in preparation of budgets, verification of monthly accounts, preparation of progress reports.
6. Assist in the leasing, furnishing and maintenance of office space as well as living quarters for expatriate technical assistance personnel.

Qualifications of Administrative Officer/ Finance Officer (U.S. expatriate local hire) in charge of Administrative and Fiscal management

1. Fluent in French to FSI R-3, S-3 level or better.
2. Good managerial, communication and teaching skills.
3. Strong background in fiscal management, office management, procurement and inventory, personnel management.
4. Minimum of 6 years experience in administrative support of technical assistance and development projects, some of which should preferably have been in the developing countries of francophone Africa.

ANNEX C

QUALIFICATIONS OF NATIONAL AGENCY PERSONNEL ATTACHED TO PROJECT

ANNEX C

Qualifications of National Agency Personnel attached to Project:

A. Hydrogeologist or Engineer in charge of data compilation and analysis:

1. Educational qualifications: Equivalent to 2 years at the Senegal Institut Universitaire de Technologie (IUT) plus 2 to 3 years of university technical education outside his home country.

2. Experience: Preferably 3 or 4 years experience in the collection, compilation, analysis and interpretation of hydrologic, hydrogeologic, and hydrochemical data.

B. Hydrogeologist or Engineer. Will share some of duties of "A" above.

1. Educational qualifications: Similar to "A" above.

2. Experience: Similar to "A" above but with additional capability in training and teaching.

C. Engineer in charge of operations:

1. Educational qualifications: Similar to "A" above but with the option practical field experience in ground-water exploration and/or development in substitution for education.

2. Experience: Preferably 3 to 4 years experience in directing ground-water exploration and development activities including well drilling and/or well construction operations. Good managerial skills important.

D. Draftsman

1. Educational qualifications: Graduate of 7 year secondary school with preferably some more advanced education at the level of the Senegal IUT or its equivalent.

2. Experience: Preferably 3 or 4 years experience in drafting maps, plans, diagrams, and/or other live drawings. Skills in using drafting instruments and in the design of maps and drawings essential.

E. Accountant-bookkeeper to work under the Administrative Officer (expatriate) and serve as his assistant.

1. Educational qualifications: Graduate of 7 year secondary school with preferably some more special training in accounting and bookkeeping.

2. Experience: Preferably 3 or 4 years' experience in accounting and bookkeeping.

F. Sector Chiefs

1. Educational qualifications: Equivalent to 2 years at the Senegal Institut Universitaire de Technologie (IUT) with a "Technicien Superieur" rating.

2. Experience: Preferably 3 to 4 years experience in ground-water inventories, data collection, and well construction operations. Good managerial skills important.

G. Surveyors

1. Educational qualifications: Graduate of 7 years secondary school with preferably some more special training in use of surveying instruments, particularly the engineer's level.

2. Experience: Preferably 3 to 4 years experience in field engineering surveying, particularly use of engineering leveling equipment.

H. Power Auger Operators

1. Educational qualifications: Graduate of 7 year secondary school with preferably some more special training in the use of light drilling equipment.

2. Experience: Preferably 3 to 4 years experience around drilling equipment, particularly light rotary drilling rigs.

I. Foremen and Well Observers:

1. Educational qualifications: Preferably at least a primary school education and ability to read and write.

2. Experience: Preferably experience in using and maintaining small mechanical equipment. Reliable character.

J. Translator/interpreter:

1. Educational qualifications: Graduate of 7 year secondary school with preferably some more special training in English-French translation.

2. Experience: Preferably 3 to 4 years experience in English-French translation-interpretation. Good communication skills important.

ANNEX D

PROJECT DESIGN SUMMARY

LOGICAL FRAMEWORK

Life of Project :
From FY 83 to FY 86
Total US Funding : $4.6 million
Date Prepared June 1982

Project Title & Number Groundwater Monitoring Project 625-0958

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal : The broader objective to which this project contributes :	Measures of Goal Achievement	Goal:	Assumptions for Achieving goals targets :
Goal: Increased incomes and food production in the Senegal River Basin.	Goal: a. Income and production level targets based on OMVS projections (data collection will be facilitated by AID-financed IDP project).	a. Check of statistics compiled by OMVS and Member-States (data collection will be facilitated by AID-financed IDP project). b. At the beginning and end of project, socio-economic survey to be undertaken in project zone.	1. OMVS will continue to command political and financial support from Member-States. 2. That USAID/RBDO and OMVS Member-States recognize constraints inherent to institutional-building and USAID financed advisor arrives as planned.
Sub-goal: Execution of projects in the OMVS Basin Development Plan, involving irrigation perimeters, dams, hydroelectric power generation, ports and river navigation.	Sub-goal: a. number of project implemented b. 65% of projects in accordance with basin development plans. c. 65% of projects achieving stated objectives by 1990.	Sub-goal: a. Copies of six-month Joint Review Program. b. Review of related Basin projects to insure application of data collected	3. That competent nationals are recruited to fill all posts.

PROJECT DESIN FRAMEWORK

LOGICAL FRAMEWORK

Life of Project :
From FY 83 to FY 86
Total US Funding $4.6 million
Date Prepared June 1982

Project Title & Number : Groundwater Monitoring Project (625-0958

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Purpose:	Conditions that will indicate purpose has been achieved : End of project status :		Assumptions for achieving purpose :
To establish an effective monitoring and early warning system to identify current and potential problems and possibilities related groundwater development and management and to distribute information to Member-States.	a. Data compiled and analysed concerning water-logging, salination, water-quality, recharge-discharge, changes and irrigation potential and brought to attention of appropriate parties by completion of project (1987). b. Problems (e.g. pesticides and fertilizers) in groundwater identified and brought to attention of appropriate parties by 1987. c. Solutions to problems developed and tested as they are discovered.	a. Site visits b. Copies of reports; recordings and water analysis data collected. c. Site visits reports OMVS and hydrogeological evaluations.	a. Continued support for OMVS from Member-States and international donors. b. Systematic implementation of all planned monitoring and evaluations conducted as necessary. c. Planned monitoring and evaluations conducted as necessary. d. Criteria and personnel review for all project maintained. e. USAIDs and OMVS recognize realistic constraints and make necessary adjustment as work progress.

PROJECT DESIGN SUMMARY

LOGICAL FRAMEWORK

Life of Project :
From FY 83 to FY 86
Total US Funding $4.6mil.

Project Title & Number : Groundwater Monitoring Project 625-0958

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Outputs: 1. Comprehensive Master Plan for monitoring and solving problems created by hydro-agricultural developments in the SRB. 2. Management Information System for OMVS. 3. Data compilation and analysis system. 4. Trained staff for implementation of Comprehensive Master Plan. 5. Network of piezometers and observation wells established in the Senegal River Basin.	Magnitude of Outputs : Outputs Indicators (by end of Project) Magnitude of outputs: 1. Plans established for the eight work components. 2. Data compilation for three work components and analysis for four work components. 3. Central staff of about 10 and field staff of about 30 technicians trained in US in-country. 4. 450 piezometers constructed by OMVS, 10 wells and 45 piezometers by contractor, and 20 piezometers constructed by the Malian DHNE.	a. Grants Agreement contracts between OMVS Member-States-site visits b. OMVS Saint-Louis Documentation Center Workshop Reports, records, correspondence and institutional visits; c. Deputy Director's reports, development plans, social and technical specifications.	Assumptions for achieving Outputs. a. TA and training programs effectively establish OMVS staff capabilities for project. b. Effective management of all activities of project c. All inputs supplied in a timely manner.

PROJECT DESIGN SUMMARY

LOGICAL FRAMEWORK

Life of Project :
From FY 83 to FY 88
Total US Funding $4.8 million
Date Prepared June 1982

Project Title and Number Groundwater Monitoring Project (625-0958

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Inputs: 1. Technical Assistance 2. OMVS Personnel 3. Member-States Personnel 4. Construction Materials 5. Participant Training 6. Commodities 7. Operating Expenses 8. Evaluation personnel	Implementation Target (Type and Quantity) : See Chapter V "Financial Plan"	OMVS Member-States and AID Records	Assumptions providing inputs AID Funds made available OMVS Budget receives continued support No change in other donors' support.

ANNEXE

PROCUREMENT PLAN

ANNEX E

PROCUREMENT PLAN

A. Procurement Responsibility - Procurement of technical equipment will be the responsibility of the AID-financed Deputy Project Chief and will be included in the scope of work under the PASA.

Procurement of the balance of commodities will be carried out in collaboration with USAID/RBDO, in conformity with AID's procurement policy. Procurement assistance will be requested, as needed, from the USAID/Dakar, Supply Management Office (SMO).

B. Procurement Services Agent (PSA) - Procurement of commodities in the USA will be delegated to a professional procurement services agent.

C. Equipment/Commodity List - The items listed under this heading represent the general needs of the project over its life span. Details pertaining to the specifications of the commodities will be furnished in the Project Implementation Orders/Commodities (PIO/C's) which will be issued to initiate procurement.

Quantity	Commodity	
	Technical Equipment	
10	Electric water level tapes, of 100m long Fi long Fisher-M-scone type WLM-100 graduated in centimeters and meters with extra probes at $164 per set.	$1,640
40	Cloth tapes graduated in centimeters with sampling bucket, combined with sounder for water-level measurement (local manufacture in Senegal) at $60	2,400
10	Steel tapes, 30 m long, graduated in centimeters and meters, Lufkin-black-face type with reel at $93.45	935
10	Steel tapes, 50 m long, graduated in centimeters and meters, Lufkin black-face type with reel at $164 each	1,640
10	Specific conductivity meters, portable, battery-operated for field water-quality measurements at $495 each.	4,950
10	Thermometers graduated in degrees Centigrade (C) up to 100 C for water temperatures measurement at $4.75	48
5	Engineer's levels, dumpy-type with accessories, tripod and stadia rods for instrumental leveling at $505 each	2,525
5	Rods, level, 7.5m extended at $129 each	645
10	Compass, Brunton-type w/case at $127 each	1,270
15	Float-type water-level recorders with floats, pens, cable, gears, and counterweights. Leupold-Stevens type A-71 at $1,800 per set	27,000
10	Hand earth post-hole Augers, 4 inch diameter with 10 1 meter extensions for each auger at $175 per set	1,750

Quantity	Commodity	
2	Power augers with helical continuous spiral flights, in lengths of 1 meter and good to depths of up to 30 m, truck mounted on a tandem axes at $36,000 each	$ 72,000
3	Pipe cutting and threading sets for 3-inch pipe at $600 per set	1,800
2	Miscellaneous hand tools, pipe wrenches, chain wrenches, etc.	1,800
2	Stool, drafstman at $142 each.	284
2	Light tables for drafstmen at $681 each.	1,362
	Drafting equipment	850
12	Pipe snakes with basked and valve attachments for removing sand with 30 m length for 7.5 cm (3 inch) pipes at $1,500.	18,000
	Sub-Total	$140,899
	Contingencies (20%)	27,101
		$168,000
	Office Equipment (Off-Shore Procurement)	
6	Desk with armchairs at $500	3,000
12	Office chairs at $200	2,400
6	Secretary desks with chairs at $400	2,400
1	Map and plan file	913
5	File cabinets at $150	750
5	Bookcases at $150	750
	Sub-Total	$10,213
	Rounded to	$10,000

Office Equipment/Materials (Local Procurement)

1	Photocopy machine	$ 6,000
1	Duplicating machine (manually operated)	500
10	Electric fans at $150 (220V 50 cycles)	1,500
2	Electric typewriters at $1,000 (220V 50 cycles)	2,000
3	Manual typewriters at $400	1,200
5	Calculators at $150 (220 V, 50 cycles)	750
20	Work tables (1.2 x 0.8 m) at $270	5,400
4	Conference tables (6 x 2.4 m x 1.2 m) at $600	2,000
80	Wooden chairs at $50	4,000
10	Wooden Benches (2 meters long) at $50	500
	Sub-Total	$23,850
	Rounded to	$24,000

Construction Materials

The pipe is a standard 2 1/2 inch (64 mm) galvanized pipe for piezometers to be installed by the sector forces.

A cost of $18.50 per meter including requisite couplings and caps has been used for the budget calculation.

Irrigated Perimeters	Average Length of Casing	Total (m)
225 (shallow)	6	1,350
225 (intermediate)	15	3,375
	Total	4,725 m
Pipe Cost	4,725 m c $18.50/m*	87,400
	Contingencies (10%)	8,600
	Total	$96,000

Vehicles

**5	Land Rover or equivalent, all terrain vehicles for field transport of leveling crews, piezometer construction crews, and supervisory personnel for rehabilitation at $5,000 each	$25,000
6	All terrain vehicles, (2 at $25,000 and 4 at $15,000)	110,000
4	Trucks of 1 1/2 tons for transport of pipe and supplies at $35,000 each	140,000
3	Passenger cars for St-Louis at $9,000	27,000
30	Motorbikes for transport of well observers at $850 each	26,000
	Spare parts at 15 percent of costs (15 x 303,000)	45,000

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* Cost of 2 1/2 "G" pipe: $5,10/Ft = $16.80/m + 10% for couplings = $18.50/m.

** These are rehabilitated vehicles salvaged from those furned over to OMVS on completion of Basin Survey and Mapping Project (Teledyne).

D. Waivers

The following waiver authorization from Geographic Code 000 (United States) to Code 935 (Special Free World) is being requested and is contained herein.

(1) A Source/Origin Procurement Waiver for vehicles. The approximate value of the waiver is $400,000.

In addition, a Source/Origin waiver for the procurement of construction materials and office equipment costing approximately $20,000 will be approved by the Director, USAID/Senegal, after the authorization of this Project Paper.

ACTION MEMORANDUM FOR THE ASSISTANT ADMINISTRATOR FOR AFRICA

From: David Shear, Director, USAID/Senegal

Subject: OMVS - Source/Origin Procurement Waiver for Vehicles

Problem: The Groundwater Monitoring Project will require the procurement of non-U.S. manufactured vehicles and spare parts for which your authorization is required. You are hereby requested to authorize such procurement by granting the following:

(1) A source/origin waiver from Geographic Code 000 (United States) to Geographic Code 935 (Special Free World).

(2) A waiver of the provision of Section 636(i) of the FAA.

Facts:

(A)	Cooperating Country	:	OMVS Member-States of Senegal, Mali and Mauritania
(B)	Project	:	Groundwater Monitoring (625-0958)
(C)	Nature of Funding	:	Grant
(D)	Source of Funding	:	SH
(E)	Description of Goods	:	6 all-terrain vehicles (2 at $25,000 and 4 at $15,000) - 4 ½ ton trucks ($35,000 each) - 3 passenger vehicles ($9,000 each) - 30 motorbikes ($850 each) - Spare-parts (15%)
(F)	Approximate Value	:	$400,000
(G)	Probable Sources	:	Senegal, Mali
(H)	Probable Origin	:	Germany, France, Japan, United Kingdom, etc.

Discussion:

A. Source/Origin Waiver

The Groundwater Monitoring personnel will be required to frequently visit the project sites which are located in rural areas of the Senegal River Basin to supervise construction of the piezometers. For the most part, the road network in the Basin is poor. Most paved roads are poorly maintained and potholes are rampant. Unpaved, washboard-type roads are extensive throughout the region. During the rainy season the road further deteriorates, many are impassable, and others require sturdy four-wheel vehicles. In Mali and Mauritania non-U.S. manufactured vehicles are utilized because of their proven durability, longer life, and resultant lower replacement costs. Further, adequate spare parts, maintenance and repair facilities are available in Mauritania, Mali and Senegal. On the other hand, while there are distributors of U.S. manufactured vehicles in Senegal, although none in the other countries mentioned above, the density of such vehicles throughout Senegal has not reached the point to justify investment of substantial spare parts inventories with the result that spare parts support is still very poor in Senegal as well as in the other countries. In Senegal, the distributors confine their support activity to the main city which results in lack of service in the country. Throughout all of the countries, the local mechanic with some degree of know-how is unable to cope with the English measure system of nuts and bolts, even if he could sufficiently understand the unfamiliar American vehicle.

In addition, this waiver request is to cover 30 motorbikes which are needed for monitoring and data collection. This small size (49 c.c.) is not manufactured in the United States.

In accordance with Handbook I, Supplement B, procurement of commodities from Code 935 under a grant financed project requires a waiver. Under Handbook I, Supplement B, Chapter 5B4a (2) and (7) a waiver may be granted if "the commodity is not available from countries included in the authorized geographic code" and for "such other circumstances as are determined to be critical to the success of project objectives."

B. Waiver of Section 636(i)

In addition to the general source/origin limitations on the procurement of commodities, Section 636(i) of the FAA prohibits the procurement of non-U.S. manufactured vehicles. However, the provisions of Section 636(i) may be waived when special circumstances permit it. Under Handbook I B, Chapter 4C2d(1)(a), special circumstances are deemed to exist if there is an "inability of U.S. manufacturers to provide a particular type of needed vehicle." The authority to find such circumstances and grant a waiver has also been delegated to you by AID Delegation of Authority No. 40.

Since, as discussed in the source/origin context, U.S. manufacturers are unable to provide for adequate spare parts support and service of their vehicles, the special circumstances criterion set forth above is satisfied.

Conclusion: The waivers authorizing the procurement of the non-U.S. manufactured vehicles (e.g. Mercedes-Benz, Land Rover, Peugeot or their equivalent) are justified because:

1. Such vehicles are not available from countries in the authorized geographic code; and

2. The non-availability of spare parts, inadequate knowledge of servicing the vehicles and lack of adequate repair facilities.

Recommendations: For the above reasons, it is recommended that you:

(1) Approve a vehicle procurement source/origin waiver from AID Geographic Code 000 to Code 935;

(2) Conclude that special circumstances exist which merit a waiver of the provisions of Section 636(i) of the Foreign Assistance Act of 1961, as amended; and

(3) Certify that the exclusion of procurement from Free World countries other than the cooperating countries and countries in Code 941 would seriously impede the attainment of U.S. foreign policy objectives and the objectives of the foreign assistance program.

APPROVED: _____

DISAPPROVED: _____

DATE: _____

ANNEX F

INITIAL ENVIRONMENTAL EXAMINATION

INITIAL ENVIRONMEN[illegible]

Project Location : Senegal River Valley

Project Title : Groundwater Monitoring (625-0620B)

Funding : FY 82 [illegible]

IEE Prepared by : Peter Freeman Date : 3/26/82
Environmental Advisor
USAID/Senegal

Environmental Action Recommended : Negative Determination. No further environmental analysis needed.

Concurrence : John S. Balis Date : 7/6/82
Environmental Affairs Officer
David Shear
Director 7/12/82

Assistant Administrator's Decision :

Approve : Date :

Disapprove : Date :

Attachments:

Examination of nature, scope, and magnitude of environmental impacts. Impact identification and evaluation form.

Examination of Nature, Scope, and Magnitude of Environmental Impacts

A. Description of the Project

The purpose of this project is to establish within the OMVS a capacity for monitoring and investigating problems of groundwater development and management. This will be accomplished by (1) establishing a methodology and plan for a groundwater management system in the Senegal River Basin Valley, (2) establishing a system of approximately 650 observation wells and piezometers, (3) compiling and analyzing groundwater data, and (4) strengthening an OMVS and Member State capability for groundwater monitoring and management planning.

The total cost of the project over a 4-year period is estimated to be $4.6 million. This cost includes $551,000 of in-kind local cost support by the OMVS and Member States for personnel, office space. The proposed technical assistance is for a total of 94 man-months. This includes one long-term technical advisor in groundwater hydrology who would be assigned to the project for 36 months, and an Administrative/Finance Officer for 45 months. Thirteen (13) months of short-term technical assistance will also be provided.

The project will be implemented by a central hydrologic and hydrogeologic office to be established in OMVS at St. Louis, Senegal. The central office staff will consist of the OMVS Chief of Project, a Hydrogeologist Deputy Project Chief in charge of data compilation/analysis

and training, an Administrative Officer, an Engineer in charge of sector operations, 2 draftsmen, 3 Secretaries, a Translator, a Storekeeper, and 2 Drivers and 1 Mechanic. The three sector chiefs, designated by their parent national agencies, will be trained and oriented in the central office and then, when field activities begin, will move to sector headquaters. The three Sector Chiefs will implement and supervise the field activities of the construction and/or surveying crews and will monitor the work of the well observer crews.

B. Examination of Nature, Scope and Magnitude of Environmental Impacts

Because this project responds to an important resource monitoring need, it makes a clearly positive contribution to the future needs of resource management in the basin. The project will go a long way to satisfy two recommendations made in the Action Plan which embodies the recommendations of the Assessment of Environmental Effects of Proposed Development in the Senegal River Basin (Gannet et al). Specifically, the Action Plan recommended the monitoring of groundwater quality, among other parameters. This project carries out that recommendation. Secondly the Action Plan recommended integrated water use planning. Data from this project will be essential to this planning. Outside of the hydrographic basin, the project's data will also be essential in the planning and further development of deeper aquifers that underlie the Groundnut Basin, and which are believed to be charged in the past from water of alluvium in the Senegal River Valley.

The physical impact on the environment from augering approximately 650 piezometers will be small. Of this number, 450 of the piezometers are to be located in and near irrigated fields where the environment is already altered more than the piezometer installation could possibly cause. The remaining 200 piezometer stations are to be located on 10 transects, each of which also will have one observation well. Existing rural roads will provide access to 10 wells and 250 stations.

Impact identification and Evaluation 2/

Impact Areas and Factors 1/

A. LAND USE

1. Changing the character of the land through :

a. Increasing the population	N
b. Extracting natural resources	N
c. Land clearing	L
d. Changing soil character	N
2. Altering natural defenses	N
3. Foreclosing important uses	N
4. Jeopardizing man or his works	N
5. Other factors	

B. WATER QUALITY

1. Physical state of water	N
2. Chemical and biological states	N
3. Ecological balance	N
4. Other factors	

1/ See Explanatory Notes for this form.

2/ Use the following symbols : N - No environmental impact
L - Little environmental impact
M - Moderate environmental impact
H - High environmental impact

E. ... IDENTIFICATION AND EVALUATION FORM

C. ... LOGICAL

1. Air additives ---------- N

2. Air pollution ---------- N

3. Noise pollution ---------- N

4. Other factors

---------- ----------

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D. NATURAL RESOURCES

1. Diversion, altered use of water ---------- N

2. Irreversible, inefficient commitments ---------- N

3. Other factors

---------- ----------

---------- ----------

E. CULTURAL

1. Altering physical symbols ---------- N

2. Dilution of cultural traditions ---------- N

3. Other factors

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---------- ----------

F. SOCIOECONOMIC

1. Changes in economic/employment patterns ---------- N

2. Changes in population ---------- N

3. Changes in cultural patterns ---------- N

4. Other factors

---------- ----------

---------- ----------

G. HEALTH

1. Changing a natural environment _____ N
2. Eliminating an ecosystem element _____ N
3. Other factors

_____ _____

_____ _____

H. GENERAL

1. International impacts _____ N
2. Controversial impacts _____ N
3. Larger program impacts _____ N
4. Other factors

_____ _____

_____ _____

I. OTHER POSSIBLE IMPACTS (not listed above)

Protective enclosures for the 10 observation tubewells would create a visual impact, but there is no basis for assigning a negative or positive value in terms of local people's perceptions.

See attached discussion of impacts.

ANNEX G

TAYLOR MEMORANDUM ON DHNE (MALI) PROPOSAL

ANNEX C

C - 1

MEMORANDUM

March 12, 1982

Subject: Review and recommendations on "Proposition pour l'Exécution d'Etudes Hydrogéologiques Complémentaires en vue de suivre l'Evaluation des Données Hydrauliques Souterraines lors du Fonctionnement du Barrage de Manantali".

From: George C. Taylor, Jr., Hydrogeologist

During a visit to Bamako, Mali on February 25-26, 1982 to discuss the terms of reference of the Malian Directorate of Hydraulics and Energy (DNHE) participation in the groundwater monitoring project, the project design team was presented for review and comment on the subject document entitled "Proposal for Complementary Hydrogeologic Studies for Evaluating Groundwater Data during the Operation of Manantali Dam". This document dated May 1981 together with a summary entitled "Complementary Hydrogeologic Studies for Evaluating Groundwater Data during the Operation of Manantali Dam" were submitted by the Malian DNHE to RBDO/OMVS/DAKAR but apparently had not been previously transmitted to USAID or OMVS/DAKAR for review and comment. As the studies proposed in the attached documents express the Malian government's technical priorities and are related to those to be undertaken in the present project, the writer was requested to review the document and make recommendations.

Phase A described in the document includes:

(1) an inventory of existing open wells and boreholes in the reservoir area and selection of some of these for periodic water-level and water-quality measurements, and (2) photogeologic and geophysical studies for the selection of some 60 sites for 120 boreholes over a period for about 8 months.

The cost of this phase of the proposed project is estimated by DNHE at $266, 667 (See attachment) . All this work would be carried out by presently available trained DNHE technical personnel.

Phase B includes drilling of the sites selected above with an average "success" rate of 75 %, so that some 90 boreholes with an average depth of 60 m would be completed as piezometers.
The cost of this phase of the proposed project is estimated by the DNHE at $ 626,400. This work would be carried out by presently available DNHE drilling equipment and trained drilling crews.

Finally phase C includes a 5-year program of water-level and water-quality observations in previously selected observation wells as well as recently constructed piezometers in the Manantali reservoir area.

Additionally water-level and water-quality observations would be carried out at selected existing open wells and boreholes (forages) in two subsectors between:

1. Manantali dam and the junction of the Bakoye and

2. Along the Senegal between Bafoulabe as part of phace C.

The cost of phase C over a 5-year term is estimated by DNHE at $ 142,916 (see attachment).

The writer has reviewed the documents and considers the technical approach generally well conceived. However, he has reservations about the desirability of setting up a "successful" piezometer as one capable of producing 1m3/h, which happens to be the minimum yield considered necessary in Mali for a borehole (forage) destined for a village water-supply point (the implication is that the boreholes are really not being constructed for piezometric observations but rather for village water-supply). Actually, a borehole (forage) yielding considerably less than 1 m3/h can be used very well for piezometric observations.

Taking into account the overall project objectives and related budget constraints for the Groundwater Monitoring Project, the writer makes the following recommendations:

1. That as part of the project, financing be provided for actual costs of DNHE's construction of twenty (20) piezometers averaging 60 meters deep around the periphery of the Manantali reservoir at an average cost of $ 7,000 per piezometer for a total of $ 140,000.

2. That the Malian counterpart contribution to the project includes costs for locating the sites for the twenty (20) piezometers using photogeologic and geophysical techniques and trained DNHE personnel at an average cost of $ 3,000 per piezometer for a total of $ 60,000.

3. That as part of the project, financing be provided for phase C with the exception of salaries and indemnities for Malian personnel.

ANNEX H

LEGISLATIVE CHECKLIST

ANNEX H - Legislative Checklists

5(72) - PROJECT CHECKLIST

Listed below are statutory criteria applicable generally to projects with FAA funds and project criteria applicable to individual fund sources: Development Assistance (with a subcategory for criteria applicable only to loans), and Economic Support Fund.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP TO DATE?
HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PROJECT?

A. GENERAL CRITERIA FOR PROJECT

1. FY 79 App. Act Unnumbered; FAA Sec. 653 (b). Sec. 634A. (a) Describe how Committees on Appropriations of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that figure)?

2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial, and other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?

3. FAA Sec. 611(a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?

No legislative action required.

4. FAA Sec. 611(b); FY 79 App. Act Sec. 101. If for water or water-related land resource construction, has project met the standards and criteria as per the Principles and Standards for Planning Water and Related Land Resources dated October 25, 1973?

Yes.

5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?

6. FAA Sec. 209. Is project susceptible of execution as part of regional or multilateral project? If so why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.

Yes. OMVS is a regional organization.

A.

7. FAA Sec. 601(a) Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.	N/A
8. FAA Sec. 601(b). Information and conclusion on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise)	N/A
9. FAA Sec. 612(b); Sec. 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized to meet the cost of contractual and other services.	The OMVS and its Member States are contributing an estimated $551,000 to the project.
10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?	U.S. does not own any excess foreign currencty
11. FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?	Yes competitive selection procedures will be used.
12. FY 79 App. Act Sec. 608. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar, or competing commodity?	No such commodities are involved.

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

a. FAA Sec. 102(b); 111; 113; 281a. Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained	Participation in data gathering and use of results in irrigated agriculture in the Senegal River Basin.

B.1.a.

basis, using the appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries?

b. FAA Sec. 103, 103A, 104, 105, 106, 107. Is assistance being made available: (include only applicable paragraph which corresponds to source of funds used. If more than one fund source is used for project, include relevant paragraph for each fund source.) N/A

(1) [103] for agriculture, rural development or nutrition; if so, extent to which activity is specifically designed to increase productivity and income of rural poor; [103A] if for agricultural research, is full account taken of needs of small farmers;

(2) [104] for population planning under sec. 104(b) or health under sec. 104(c), if so, extent to which activity emphasizes low-cost, integrated delivery systems for health, nutrition and family planning for the poorest people, with particular attention to the needs of mothers and young children, using paramedical and auxiliary medical personnel, clinics and health posts, commercial distribution systems and other modes of community research.

(3) [105] for education, public administration, or human resources development; if so, extent to which activity strengthens nonformal education, makes formal education more relevant, especially for rural families and urban poor, or strengthens management capability of institutions enabling the poor to participate in development;

(4) [106] for technical assistance, energy, research, reconstruction, and selected development problems; if so, extent activity is:

(i) technical cooperation and development, especially with U.S. private and voluntary, or regional and international development, organizations;

(ii) to help alleviate energy problems;

(iii) research into, and evaluation of, economic development processes and techniques,

(iv) reconstruction after natural or manmade disaster;

B.1.b.(4).

(v) for special development problems, and to enable proper utilization of earlier U.S. infrastructure, etc., assistance;

(vi) for programs of urban development, especially small labor-intensive enterprises, marketing systems, and financial or other institutions to help urban poor participate in economic and social development.

c. [107] Is appropriate effort placed on use of appropriate technology?

Yes, project will utilize appropriate technology.

d. FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or has the latter cost-sharing requirement been waived for a "relatively least-developed" country)?

This project will assist a regional organization under section 121 and thus the 25% requirement is not applicable.

e. FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to the Congress been made, and efforts for other financing, or is the recipient country "relatively least developed"?

N/A

f. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participation in governmental and political processes essential to self-government.

This project will provide groundwater monitoring data which will assist the OMVS Member States in irrigated agriculture projects.

g. FAA Sec. 122(b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase or productive capacities and self-sustaining economic growth?

OMVS will provide local manpower to complement the U.S. technical assistants.

2. Development Assistance Project Criteria (Loans Only)

a. FAA Sec. 122(b). Information and conclusion on capacity of the country to repay the loan, including reasonableness of repayment prospects.

N/A.

b. FAA Sec. 620(d). If assistance is for any productive enterprise which will compete in the U.S. with U.S. enterprise, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?

N/A

B.

3. Project Criteria Solely for Economic Support Fund

a. FAA Sec. 531(a). Will this assistance support promote economic or political stability? To the extent possible, does it reflect the policy directions of section 102?

N/A.

b. FAA Sec. 533. Will assistance under this chapter be used for military, or paramilitary activities?

STANDARD ITEM CHECKLIST

Listed below are statutory items which normally will be covered routinely in those provisions of an assistance agreement dealing with its implementation, or covered in the agreement by imposing limits on certain uses of funds.

These items are arranged under the general headings of (A) Procurement, (B) Construction, and (C) Other Restrictions.

A. Procurement

1. FAA Sec. 602. Are there arrangements to permit U.S. small business to participate equitably in the furnishing of goods and services financed?

2. FAA Sec. 604(a). Will all commodity procurement financed be from the U.S. except as otherwise determined by the President or under delegation from him? — Yes.

3. FAA Sec. 604(d). If the cooperating country discriminates against U.S. marine insurance companies, will agreement require that marine insurance be placed in the United States on commodities financed? — Yes.

4. FAA Sec. 604(e). If offshore procurement of agricultural commodity or product is to be financed, is there provision against such procurement when the domestic price of such commodity is less than parity? — N/A.

5. FAA Sec. 608(a). Will U.S. Government excess personal property be utilized wherever practicable in lieu of the procurement of new items? — Yes.

6. FAA Sec. 603. (a) Compliance with requirement in section 901(b) of the Merchant Marine Act of 1936, as amended, that at least 50 per centum of the gross tonnage of commodities (computed separately for dry bulk carriers, dry cargo liners, and tankers) financed shall be transported on privately owned U.S.-flag commercial vessels to the extent that such vessels are available at fair and reasonable rates. — Yes.

7. FAA Sec. 621. If technical assistance is financed, will such assistance be furnished to the fullest extent practicable as goods and professional and other services from private enterprise on a contract basis? If the — Yes, Sources for technical assistance will be selected on a competitive basis

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H - 7

A.7.

facilities of other Federal agencies will be utilized, are they particularly suitable, not competitive with private enterprise, and made available without undue interference with domestic programs?

8. International Air Transport. Fair Competitive Practices Act, 1974. If air transportation of persons or property is financed on grant basis, will provision be made that U.S.-flag carriers will be utilized to the extent such service is available? — Yes

9. FY 79 App. Act Sec. 105. Does the contract for procurement contain a provision authorizing the termination of such contract for the convenience of the United States? — Yes

B. Construction

1. FAA Sec. 601(d). If a capital (e.g., construction) project, are engineering and professional services of U.S. firms and their affiliates to be used to the maximum extent consistent with the national interest? — Yes

2. FAA Sec. 611(c). If contracts for construction are to be financed, will they be let on a competitive basis to maximum extent practicable? — Yes

3. FAA Sec. 620(k). If for construction of productive enterprise, will aggregate value of assistance to be furnished by the United States not exceed $100 million? — N/A

C. Other Restrictions

1. FAA Sec. 122(e). If development loan, is interest rate at least 2% per annum during grace period and at least 3% per annum thereafter? — N/A

2. FAA Sec. 301(d). If fund is established solely by U.S. contributions and administered by an international organization, does Comptroller General have audit rights? — N/A

3. FAA Sec. 620(h). Do arrangements preclude promoting or assisting the foreign aid projects or activities of Communist-Bloc countries, contrary to the best interests of the United States? — Yes

4. FAA Sec. 636(i). Is financing not permitted to be used, without waiver, for purchase, long-term lease, or exchange of motor vehicle manufactured outside the United States, or guaranty of such transaction? — Yes. AID procurement regulations will be applied. A waiver for purchase of some Non-US source and origin vehicles will be requested.

C.

5. Will arrangements preclude use of finances to:

a. FAA Sec. 104(f). To perform abortions or to motivate or coerce persons to practice abortions, to pay for performance of involuntary sterilization, or to coerce or provide financial incentive to any person to undergo sterilization? YES.

b. FAA Sec. 620(g). To compensate owners for expropriated nationalized property? YES.

c. FAA Sec. 660. To finance police training or other law enforcement assistance, except for narcotics programs? YES.

d. FAA Sec. 662. For CIA activities? YES.

e. FY 79 App. Act Sec. 104. To pay pensions, etc., for military personnel? YES.

f. FY 79 App. Act Sec. 106. To pay U.N. assessments? YES.

g. FY 79 App. Act Sec. 107. To carry out provisions of FAA sections 209(d) and 251(h)? (Transfer of FAA funds to multilateral organizations for lending.) YES.

h. FY 79 App. Act Sec. 112. To finance the export of nuclear equipment, fuel, or technology or to train foreign nations in nuclear fields? YES.

i. FY 79 App. Act Sec. 601. To be used for publicity or propaganda purposes within United States not authorized by the Congress? YES.

ANNEX I

SENEGAL RIVER BASIN

HYDROGEOLOGY BIBLIOGRAPHY

ANNEX 1

HYDROGEOLOGY

BIBLIOGRAPHY

SENEGAL RIVER - GENERAL

ILLY,P. (1973) - Etude Hydrogéologique de la Vallée du Fleuve Sénégal. RAF 65/061.

JUTON, M. (1972) - Le Régime du Fleuve Sénégal dans la Vallée de 1965-1972.

JUTON,M. (1972) - Etude Statistiques des Faibles Débits du Fleuve Sénégal

JUTON, M. (1972) - Rapport Technique de Fin de Mission.

KARPOFF, R. (1970) - Rapport de Mission Hydrogéologique dans la Vallée du Fleuve Sénégal entre le Delta et la Falémé.

MICHEL,P. (1969) - Notice de la Carte Géomorphologique de la Vallée du Sénégal au 1/50,000.

MICHEL, P. (1969) - Les Bassins des Fleuves Sénégal et Gambie - Etude Géomorphologique.

ROCHETTE, C. (1974) - Le Bassin du Fleuve Sénégal, monographies Hydrologiques, ORSTOM, N° 1, Office de la Recherches Scientifique et Technique d'Outre-Mer, Paris.

SASIF, (1967) - Barrage de Dagana, Sondages de Reconnaissance

SEDAGRI (1972) - Etude Pédologique de la Vallée du Fleuve Sénégal au 1/50,000.

SOGETIM, (1956) - Barrage de Dagana, Choix de l'Emplacement.

SOGREAH, (1972) - Etude Hydroagricole du Bassin du Fleuve Sénégal : Etude du Barrage du Delta.

SENEGAL

AUDIBERT, M. (1962) - Hydrogéologie de la nappe maestrichtienne du Sénégal. Rapp. BRGM DAK 62 A 14, Arch.Minist. T.P. Habitat et Urbanisme, Dakar.

AUDIBERT, M. (1963) - Etude de la nappe maestrichtienne. Essaid de débit à Tivaouane du 28/1 au 2/2/1963. Rapp. BRGM DAK 63 A 7, Arch.Dir. T.P. Dakar.

AUDIBERT M. (1963) - Etude hydrogéologique de la nappe profonde du Sénégal "Nappe maestrichtienne". Thèse 3ème cycle Univ. Montpellier, Mém. BRGM N° 41 (1966).

AUDIBERT, M.(1964) - Hydrogéologie de la nappe maestrichtienne. Campagne 1962-1963. Rapp. BRGM DAK 64 A 22 Arch.Serv. Hydraul. Dakar.

AUDIBERT, M.(1966) - Etude hydrogéologique de la nappe profonde du Sénégal, la"nappe maestrichtienne".

AUDIBERT, M.(1970) - Delta du Fleuve Sénégal. Etude Hydrogéologique.

AUDIBERT, M. POUL,X.VUILLAUME,Y. (1971) - Nappe profonde du Sénégal (nappe maestrichtienne). Interprétation des analyses isotopiques. Fonctionnement hydraulique du système. Rapp. BRGM 71 RME 035, Arch.Dir.Energie et Hydraul. Dakar.

AUDIBERT, M. Moussu, H. et al, (1972) - Nappe profonde du Sénégal (nappe maestrichtienne) Interprétation des observations périodiques de 1967 à 1970, interprétation des analyses isotopiques, fonctionnement hydraulique du système.

BCEOM, (1968) - Périmètre de Nianga. Documents de base pour l'aménagement.

BECHTEL OVERSEAS CORPORATION (1976) - Developpement de l'Agriculture Irriguée à Matam, Senegal. Etude de factibilité pour U.S. Agency for International Development.

BRGM, (1965) - Interprétation des fluctuations des nappes du haut Delta du fleuve Sénégal. DK A 24.

BRGM (1967) - Etudes géologiques des eaux souterraines de l'Afrique de l'Ouest, nappe des "sables maestriciens" du Sénégal.

BRGM (1967) - Document accompanying the hydrological map at 1/500,000 and the hydrochemical map of Senegal at 1/1,000,000.

BRGM (1968) - Etudes hydrogéologiques en vue du développement pastoral dans la région du Ferlo et la région du lac de Guiers, DAK 6.

BRGM (1969) - Etude de la réalimentation et de la salinité de la nappe des sables maestriciens du Sénégal. Interprétation des mesures périodiques de niveau et des données nouvelles.

BRGM (1969) - Interprétation des variations naturelles du niveau des nappes aquifères en Mauritanie et au Sénégal, DAK 7.

BRGM (1970) - Compte rendu de surveillance des travaux de recherche et d'exploitation d'eaux souterraines 1966-1968. Programme de 9 forages d'exploitation et 15 forages puits.

C.G.G. (1951-52) - Etude hydrologique par prospection électrique au Sénégal et en Mauritanie dans les régions de Dara, Mousti, Louga, Linguère, Matam, Saint Louis, Rosso, Podor, Aleg.

DEBUISSON, J. (1963) Aperçu sur l'hydrologie de la région nord Louga. Rapp. BRGM DAK 63 A 9, Arch.Dir. T.P. Sect. Hydraul. Dakar.

DEBUISSON, J. (1967) - Etude hydrogéologique de la nappe phréatique de l'ile de Sor(St.Louis). Rapp. BRGM DAK 67 A 13, Arch.Dir.Energie et Hydraul. Dakar.

DEBUISSON, J (1969) - Troisième plan quinquennal de Développement, 69-73. Etablissement d'un programme d'hydraulique villageoise au Sénégal, BRGM DAK 10,

DEFOSSES (1969) - Les nappes phréatiques du Sénégal

DEGALLIER R. (1954) - Hydrogéologie de la nappe maestrichtienne du Sénégal. Rapp.Dir.Féd.Mines et Géol. AOF, Dakar

DEGALLIER R. (1954) - Hydrogéologie du Ferlo septentrional. Rapp. Dir. Féd. Mines et Géol. AOF, Dakar

DEGALLIER R. (1956) - Géologie de la région de Richard-Toll (Sénégal) Rapp.Dir.Féd. Mines et Géol. AOF, Dakar.

DEGALLIER R. (1962) - Hydrogéologie du Ferlo septentrional. Mém. BGRM, N° 19.

DEGALLIER R.(1962 - Possibilités de la nappe maestrichtienne du Sénégal. Rapp. BRGM DAK 62 A 11, Arch. Min. T.P. Habitat et Urbanisme, Dakar.

GOUZES R (1969) - Etude de la réalimentation et de la salinité de la nappe des sables maestrichtiens du Sénégal. Interprétation des mesures périodiques de niveau et des données nouvelles, 1968. Rapp. BGRM 69, DAK 12, Arch. Dir. Energie et Hydraul. Dakar.

GOUZES R, LOUVRIER M. MARTIN A (1973) - Etude hydrochimique d'orientation agricole des nappes du bassin sédimentaire sénégalais. Nappe profonde "maestrichtienne". Nappes phréatiques. Rapp. BRGM 73 RME 018 AF. Arch. Min. Dev. Rural, Dakar.

GRANDAROVSKI G. (1962) - Dépression du niveau piézométrique des puits alignés et mis en service progressivement l'un après l'autre. Calcul théorique en vue d'application éventuelle à la nappe maestrichtienne du Sénégal. Rapp. BGRM DS 62 A 47.

LALEYE, A. (1964) - Etude hydrogéologique de la nappe phréatique du haut delta du fleuve Sénégal. DKA 18, BRGM.

MARTIN A. (1963) - Etude hydrogéologique de la région de Kédougou - Bakel (Sénégal Oriental) Campagne 1962. Rapp. BRGM DAK 63 A 12, Arch. Dir. T.P. Serv. Hydraul. Dakar.

MERMILLOD J. (1967) - Mémoire sur les perspectives d'aménagement hydropastoral. Région du Ferlo - Région ouest du lac de Guiers. Rapp. BRGM, Dakar.

MINISTERE DU DEVELOPPEMENT INDUSTRIEL DU SENEGAL (1971) - Rapport sur les éléments pour une politique de l'eau au Sénégal après 10 ans d'Indépendance, Dakar.

MONCIARDINI, G. (1965) - La Sédimentation éocène au Sénégal.

MOUSSU H. VUILLAUME Y. (1972) - Etude par la méthode isotopique de la nappe des sables maestriciens et du continental terminal du Sénégal, BRGM.

PLAUD M. (1966) - Pose de piézomètres et étude de la nappe phréatique autour du lac de Guiers (Sénégal). Rapp. BRGM.DAK 66 A 4. Arch. Dir. Energie et Hydraulique, Dakar

SAINTON C. (1957) - Etude géologique de la région du lac de Guiers (Sénégal). Rapp. Serv. Géol. et Prosp.min. AOF, Dakar.

SOGREAH (1972) - Etude hydroagricole du bassin du fleuve Sénégal "Casiers pilotes de Matam, Boghé et Mariga", schéma de principe détaillé.

MAURITANIA

ABADIE J. DEPAGNE J. GOUZES R. MARTIN A. PUTALLAZ J. (1969) - Interprétation des variations naturelles du niveau des nappes aquifères en Mauritanie et au Sénégal. Note de synthèse. Rapp. BGRM 69 DAK 7, Arch. CIEH.

ARCHAMBAULT J. (1950) - Eléments pour un équipement hydraulique de la Basse Mauritanie. BURGEAP R 123.

AUDIBERT M (1964) - Hydrogéologie de la nappe maestrichtienne du Sénégal (campagne 1962-1963). Rapp. BRGM Dakar 64 A 22 et Mém. BRGM N° 41.

BAUD L (1942) - Notes hydrogéologiques sur le Sénégal et la Mauritanie. Rapp.Serv. Mines AOF, Dakar.

BENSE C. (1959) - La série stratigraphique de la région de Kiffa. SPGM. Dakar.

BLANCHOT A, DEGALLIER R, DELPY J. ELOUARD P. RENAUD L. ROCCI C. & SOUGY J. - L'eau dans l'Ouest mauritanien et le Bas Sénégal

BOURGUET L (1957) - Etude géochimique des eaux souterraines de l'Afrique de l'Ouest : nappes du Sud-Ouest mauritanien. Dakar 67 A 12.

BURGEAP (1958) - Hydrologie du cercle de Guicinaka (Mauritanie) Etude des aménagements hydrauliques.

BURGEAP (1966 - Synthèse hydrogéologique et aménagement hydraulique du Sud-Est mauritanien. BURGEAP R 4

CHIRON J.C. (1967) - Mission série d'Akjoujt : Etude géologique et prospection de l'arc des mauritanides (secteur Moudjéria). Rapport BRGM. Dakar 67 A 1.

COMPAGNIE GENERALE DE GEOPHYSIQUE (1973) - Reconnaissance géophysique par méthodes électriques et sysmiques en Mauritanie (7 juin 1972-12 janvier 1973), 125 p.66 fig., 18 croquis.

C.G. G. (1965) - Etude par méthode électrique en Mauritanie, Aftout. Akerda, Khalwa, Dimja.

COMPAGNIE GENERALE DE GEOPHYSIQUE (1965) - Hydrogéologie des zones à substratum schisteux: étude par méthodes électriques en Mauritanie Aftout, Akrerai-khalwa-Dimja.

COMPAGNIE GENERALE DE GEOPHYSIQUE (1964) - Etud par sondages électriques dans la région d'Idini (23 février 20 mars et 8 - 14 mai 1964) BRGM.

COMPAGNIE GENERALE DE GEOPHYSIQUE (1958) - Reconnaissances hydrogéologiques et structurales par sondages électriques au Sénégal, en Mauritanie et en Casamance. Rapport C.G.G. Paris

DARS R. et SOUCY J. (1957) - La stratigraphie du cambro-ordovicien de l'Ouest africain et ses relations avec le précambrien. CNRS. Paris.

DEPAGNE J. (1963) - Exploitation et interprétation des mesures piézométriques effectuées de juillet 1961 à mai 1963 dans le Sud-Ouest mauritanien. BRGM Dakar 63 A 14.

DEPAGNE J. (1963) - Exploitation et interprétation des mesures piézométriques effectuées de juillet 1961 à mai 1963 dans le Sud Ouest mauritanien (vallée du fleuve Sénégal, lad R'Kiz, lac d'Aleg). Rapp. BRGM DAK 63 A 14, Arch. Serv. G.R. Nouakchott.

DEPAGNE J. COUZES R. (1967) - Rapport de synthèse exploitant et interprétant les mesures périodiques des niveaux piézométriques effectués entre mai 1960 et juin 1964 dans le Sud Ouest mauritanien (vallée du fleuve Sénégal, lac R'Kiz, lac d'Aleg). Rapp. BRGM DAK 67 A 5, Arch.Serv. G.R. Nouakchott.

DURANT J.H. (1965) - Etude pédologique de la plaine de Boghé.

ELOUARD P. (1959-1962) - Etude géologique et hydrogéologique des formations sédimentaires du Guebla mauritanien et de la vallée du Sénégal. Thèse Fac. Sci.Univ. Paris 1959. Mém. BRGM N° 7,1962

ELOUARD P.(1951) - Rapport géologique des sondages de recherches du triangle Aleg-Podor-Kaédi (Mauritanie) Rapp.Dir.Mines AOF, Dakar.

ELOUARD P. (1951) - Rapport de fin de campagne 1951 sur le Tertiaire et le Quaternaire de la région Aleg-Podor-Maghama (Mauritanie). Rapp. Dir. Mines AOF, Dakar.

ELOUARD, P. et RENAUD, L. (1953 - L'eau dans le Sud-Ouest mauritanien.

ELOUARD P. (1957) - Sondages de recherches d'eau dans la région d'Hassi el Bagra. SGPM.

ELOUARD, P. (1962) - Etude géologique et hydrogéologique des formations sédimentaires du Guebla mauritanien et de la vallée du Sénégal. Mémoire BRGM, Paris N° 7.

ELOUARD, P. (1973) - Problèmes d'eau et sous-sol de Mauritanie. In : Colloque sur les désertifications, Nouakchott.

GOUZES, R. (1962) - Etudes hydrogéologiques de l'arrière-pays de Kaédi (Mauritanie). Rapp. BRGM DAK 52 A 3 Arch.Serv. G.R. Nouakchott.

GOUZES, R. (1952) - Etudes hydrogéologiques des sources du Tagant et de l'Assaba. Rapport BRGM 62 A 34.

GOUZES, R. (1966) - Etude hydrogéologique de zones à substratum schisteux en Mauritanie. Rapport BRGM Dakar 66 A 11.

ILLY, P. (1973) - Etude hydrogéologique de la vallée du fleuve Sénégal FAO.

JACCOR, G. (1965)- Etude de la baisse moyenne des nappes libérées en Mauritanie (1960-64).

LALEYE, J. (1964) - Etude hydrogéologique de la nappe phréatique du haut delta du fleuve Sénégal (Sénégal-Mauritanie). Rapp. BRGM DAK 64 A 18, Arch Mission d'Aménagement du fleuve Sénégal (M.A.S. St.Louis.

LALEYE, J. (1965) - Interprétation des fluctuations des nappes du haut delta du fleuve Sénégal (Sénégal-Mauritanie). Rapp. BRGM DAK 65 A 24. Arch Mission d'Aménagement du fleuve Sénégal (M.A.S.) St.Louis.

MANGAN, M. (1958) - Rapport concernant le nivellement de la nappe des calcaires éocènes située à l'est de Boutilimit (Mauritanie).

MANGAN, M. (1959) - Nivellement barométrique des nappes aquifères du Trarza. ERS. Dakar.

N'GOM, CH.T (1958) - Inventaire des ressources hydrauliques du Trarza central et méridional (Mauritanie). SGPM. Dakar.

PALOC, H. (1960) - Campagne d'implantation de piézomètres sur la rive droite du Sénégal (avril-juillet 1960). Rapp. BRGM Dakar, Arch. Serv. G.R. Nouakchott.

(1960)
PALOC, H. - Eléments pour l'établissement d'un bilan des nappes du sud-ouest mauritanien. BRGM. Dakar.

PALOC, H.(1962) - Carte hydrogéologique du bassin sédimentaire du sud-ouest mauritanien au 1:500 00 et notice explicative. BRGM. Dakar.

RENAUD, L.(1961)- Hydrogéologie du précambien du Sud-Ouest de la Mauritnaie et de la bordure des plateaux primaires. DFMG. Dakar.

ROUSSEL, Ph. (1966)- Guide des eaux souterraines en Mauritanie. Bureau hydrogéologique, Direction de l'Hydraulique (RIM).

ROUSSEL p. (1968) - Notice explicative de la carte de reconnaissance hydrogéologique de la Mauritnaie au 1/1 000 000. Serv. Eaux souterraines Nouakchott.

SIMONOT, M. (1972) - Proposition pour le renforcement du Service des eaux souterraines de la R.I.M. 12p. 1 diagramme, 6 tableaux.

SIMONOT, M. (1972) - Zone de l'Aftout. Reconnaissance hydrogéologique. Implantation et réalisation des travaux de géophysique. Propositions de travaux complémentaires de géophysique et de forages de reconnaissance. 49 p. 14 fig. 2 tableaux, 2 cartes.

SIMONOT, M. (1972) - Zone de R'Kiz. Note sur la reconnaissance préliminaire de la zone du lac R'Kiz. 6 p. 2 tableaux, 1 carte.

SIMONOT, M. (1972) - Zone du lac R'Kiz. Aperçu et conclusions sur la campagne de géophysique. Définition du programme de reconnaissance par forage. 5 p.

SIMONOT M. (1972) - Zone de R'Kiz. Forage de reconnaissance observations et conclusions provisoires. 5p. 2 tableaux.

SIMONOT, M. (1972) - Zone de R'Kiz. Forage RK2 - MAI. Résultats des tests du 28 au 31 août 1972 et du 4 au 7 octobre 1972. Pompage d'essai du 4 au 6 avril 1973. 8p. 10 fig. 5 tableaux.

SIMONOT, M. (1973) - Zone du R'Kiz. Pompage d'essai du forage RK6 du 27 mars au 2 avril 1973. 3p.5 fig. 2 tableaux.

SIMONOT, M (1973) - Zone de R'Kiz. Pompage d'essai du sondage RK2 du 4 au 6 avril 197_. 3p. 6 fig. 2 table

SIMONOT, M.(1975) - Zone de R'Kiz. Pompage d'essai du sondage RK 10 avec piézomètre RK9 du 23 au 24 novembre 1973. 4 p. 3 fig. 2 tableaux.

SIMONOT, M.(1972) - Note sur la reconnaissance préliminaire de la zone de Kiffa-Kankossa. 7 p. 1 fig. 1 car

SIMONOT, M. (1972) - Zone de Kiffa. Reconnaissance géologique et implantation des travaux de géophysique. 4 p. 2 fig.

SIMONOT, M. (1973) - Note sur l'alimentation en eau de Kiffa. 10 3 fig.

TRENOUS, J.Y. et MICHEL, P (1971) - Etude de la structure du dôme Guier (Sénégal nord-occidental). Bull. Soc. géol. de France (7) XIII N° 1-2 p.113-139.

UNITED NATIONS, (1975) Renforcement de service des eaux souterraines, conclusions et recommendations du projet. New York.

MALI

PLOTE, H et MARTIN G. (1974) - Hydrogéologie de détail géophisiq campagne de forages. Recherches hydrogéologiques dans les cercles de Kayes et Yelimane. BRGM 74 DAK 002.

PLOTE H. et MARTIN, G.(1975) - Recherches hydrogéologiques dans les cercles de Bafoulabé et Kenieba. BRGM 75 DAK 002.

MAPS

DEPAGNE, J. MOUSSU H. (1965) - Carte hydrogéologique de la République du Sénégal (1/500,000) BRGM.

DEPAGNE J. MARTIN H.(1966) - Carte hydrochimique des nappes phréatiques de la République du Sénégal (1/100.000) BRGM.

MARTIN G. MOUSSU H. (1975) - Etat des connaissance hydrogéologiques du Sénégal. BRGM.

PALOC H. (1962) - Carte hydrogéologique du Sud-Ouest Mauritanien (1/500.000) et notice, BRGM.

ANNEX J

611 (e) Certification of Capacity to Maintain and Utilize the Goods and Services Provided by the Groundwater Monitoring Project (625-0958).

I. Project Data:

A.	Country:	OMVS - Senegal, Mauritania and Mali
B.	Project:	Groundwater Monitoring
C.	Funding:	$4.6 million
D.	Life of Project:	4 years

II. Description:

The purpose of the Groundwater Monitoring Project is to establish within the OMVS and Member-States institutions a system to monitor and analyse the Senegal River underground water regime.

The project will address problems of: (1) water-logging and salination in existing and proposed irrigated perimeters; (2) deterioration of water-quality in domestic and livestock wells; (3) discharge-recharge relationships of the Senegal River Valley aquifers and contiguous aquifers; (4) changes in the groundwater regime caused by the construction of the two dams and the resulting alterations of the flow regimes of the river and; (5) irrigation development potential of groundwater in the Middle and Upper Valley (Matam-Boghé and Kayes) sectors.

In sum, the project will include the following elements:

1. Overall long-term institutional development assistance to the OMVS and Member-States to develop their capabilities in groundwater monitoring and management planning;

2. Specific short and medium term assistance to helm the hydrogeological services of the OMVS member states to establish a groundwater management system in the Senegal River Basin;

3. Establishment of a network of observation wells and piezometers to monitor the effects of dam construction on the recharge of aquifers and drainage systems;

The project's objectives will be attained through the provision of quantitative data required for evaluation and exploitation of the dynamics of the groundwater systems. AID will finance materials, vehicles and expatriate technical assistance. Long-term training in the U.S., third country training as well as on-the-job training on the aspects of groundwater hydrology will be gained by the Member-States' personnel participating in the work.

As indicated in Section II of the PP, Program Factors (page 3), the OMVS has had previous experience in maintaining and utilizing goods and services under an earlier AID-funded project- The OMVS and Institutional Development Project (625-0620). Further, the OMVS has established, within the Directorate of Regional Infrastructure, a Groundwater Monitoring Unit which will be charged with the implementation of this project. In order to strengthen the institutional capability of the newly established Unit and to assure that the project is efficiently and effectively implemented, AID will provide adequate technical assistance (e.g. and Hydrologist and an Administrative/Finance Assistance) to the OMVS and also to the national hydraulic agencies. In addition, long-term, short-term and on-the-job training will be supported through AID's assistance to further improve the managerial and administrative capacity of the OMVS and its Member States.

III. Certification

As the principal officer of the Agency for International Development in Senegal and for the OMVS, I affirm that, in my judgement, the OMVS has both the financial capability and the human resources to effectively maintain and utilize the goods and services being provided by the Groundwater Monitoring Project (625-0958).

David Shear
Director,
USAID/Senegal

Signature David Shear

Date April 15, 1983

Clearance: DFranklin DSF
RegCon.

UNITED STATES GOVERNMENT

memorandum

DATE: April 13, 1983

REPLY TO ATTN OF: Barnabas Mosi[illegible], P.E. PDO/ENG

SUBJECT: OMVS Groundwater Monitoring Project - No. 625-0958 (611 A requirement)

TO: David Shear, Director

I have examined the relevant background material, technical material and preliminary cost estimates for subject project to make this determination.

The construction proposed for this project consists of 450 shallow piezometers done by hand or power augers with depths ranging from 3 to 15 meters. 20[illegible] piezometers will be constructed along ten piezometer lines. Of these approximately 75 will be constructed with hand augers; 80 by power augers, and 45 will be installed with percussion or rotary drilling equipment. Eight inch observation wells will also be put down on each piezometer line at depths ranging from 30 - 60 meters deep. These wells will be constructed by a private drilling contractor. It is also planned to have the Malian DHNE drill 20 observation boreholes in the Manantali reservoir area.

The proposed methods of construction appear sound and well planned. Accordingly I have determined that the plans and specifications for the boreholes and wells are adequate and that a reasonable estimate of cost for U.S. assistance has been made.

ANNEX K

From the High Commissioner of the OMVS

Request for Financing

To the Director of USAID/Dakar

SUBJECT: Groundwater Monitoring Projet

(625-0958)

On behalf of the Member States of the OMVS, (Mali, Mauritania, Senegal), I have the honor of presenting a request for financing by USAID of the aforementioned study.

The following decisions listed below were taken as the result of meetings:

-on one hand, of experts from April 15 to April 18

-on the other, of Council of Ministers on May 5th and 6th.

1) The national services will be the main implementing agencies under the supervision of the OMVS which will designate a Project Manager.

2) The Sector Chiefs whose job description will be described will be nominated within the project deadline.

3) The Member States commit themselves to guarantee participation in project follow up as of the 5th year.

4) the horizontal transection of sectors within the national boundaries is requested by the Member States.

5) The OMVS High Commissioner agrees to establish within the assigned deadline, a hydrology and hydrogeology unit in St-Louis and has nominated Mr. Abdallahi Ould HAMDINOU as a supervisor of this unit.

The Council of Ministers at its session of May 5th to May 6th 1981, has expressed the wish that this project becomes immediately operational. It would have wished however to adopt for this project a more appropriate title such as: Hydrogeological Studies Project for the Valley and the Delta of Senegal.

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(625-0958)

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OMVS DAKAR, II

JUL 09 PM

Le Haut Commissaire

OBJET : Projet d'Aménagement des Eaux Souterraines
(625 0620 - 3). ?

Monsieur le Directeur,

Au nom des Etats-membres de l'OMVS (Mali, Mauritanie, Sén... j'ai l'honneur de vous présenter une requête pour le financement pa... l'USAID de l'étude visée ci-dessus en référence.

A l'issue des réunions

. d'une part des experts du 15 au 18 Avril 1981
. et du Conseil des Ministres les 5 et 6 Mai, les décisio... suivantes ont été prises :

1) Les services nationaux seront les Agences principales ... cution sous la coordination de l'OMVS qui désignera un Chef de Proj...

2) Les Chefs de Secteurs dont le profil sera précisé aux ... seront désignés dans les délais prévus par le Projet.

3) Les Etats s'engagent à garantir leur participation à l... poursuite du projet à partir de la 5e année.

4) Le découpage horizontal des secteurs dans les limites ... toriales est demandé par les Etats-Membres.

5) Le Haut-Commissariat de l'OMVS est d'accord pour l'ins... à Saint-Louis dans les délais prescrits une cellule d'hydrologie ... d'hydrogéologie et désigne Mr Abdallahi Ould HAMZINOU comme responsa... de la cellule.

Le Conseil des Ministres au cours de sa session du 5 au ... 1981 a souhaité que ce projet soit immédiatement opérationnel. Il ... cependant d'adopter pour ce projet un titre plus conforme à ses ob... l'Projet d'études hydrogéologiques pour la Vallée et le Delta du Sén...

./.

ACTION
OMVS
INFO
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ITP
AMO
Ex Sec
Disp
IRV
PDO
PSU
Chron

Monsieur le Directeur
de l'U S A I D au Sénégal

- D A K A R -

Action Taken . Date
Tel TOAID A
NAN Other
Cmts. Re WID/CMO Attachments

Annex L

PROJECT AUTHORIZATION

Name of Country/Entity:
Sahel Regional

Name of Project: Groundwater Monitoring Project

Number of Project: 625-0958

1. Pursuant to Section 121 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Groundwater Monitoring Project for the Organisation pour la Mise en Valeur du Fleuve Sénégal (OMVS) involving planned obligations not to exceed $4,651,000 in grant funds over a four-year period from date of authorization, subject to the availability of funds in accordance with the AID OYB/Allowance Process, to help in financing foreign exchange and local currency costs for the project.

2. The project consists of assisting the OMVS in establishing an effective early warning system to identify current and potential problems related to groundwater development and management in the Senegal River Basin. To accomplish this purpose, the project will carry out the following: (a) long-term institutional development assistance to the OMVS and Member States to develop their capabilities in groundwater monitoring and management planning; (b) short and medium-term assistance to help hydrogeological services of the OMVS to establish a groundwater management system in the Basin; (c) establishment of a network of observations wells and piezometers to monitor the effects of dam construction on the recharge of aquifers and drainage systems; and (d) provision of human and material resources to the OMVS and Member States for a continuation and expansion of their capabilities for groundwater monitoring and management planning.

3. The Project Agreement, which may be negotiated and executed by the Officer to whom such authority is delegated in accordance with AID regulations and Delegations of Authority, shall be subject to the following essential terms, covenants and major conditions, together with such other terms and conditions as AID may deem appropriate.

a. Source and Origin of Goods and Services

Goods and services, except for ocean shipping, financed by AID under the project shall have their source and origin in Senegal, Mali, and Mauritania or in the United States except as AID may otherwise agree in writing. Ocean shipping financed by AID under the project shall, except as AID may otherwise agree in writing, be financed only on flag vessels of the United States.

b. Conditions Precedent

Prior to any disbursement of funds, or the issuance of any commitment documents under the Project Agreement, the OMVS shall furnish in form and substance satisfactory to AID evidence that: (1) the Groundwater Monitoring Unit of the OMVS has been officially created and that the Project Director of the said Unit is appointed; (2) a written agreement between the OMVS and the national hydraulic service of each participating country, delineating the roles and responsibilities of each party; the secondment or assignment of personnel to the Unit by each of the national hydraulic services, etc; and, (3) the contribution of an initial advance of $25,000 by each Member State to cover the first year's costs for permanent personnel employed at the St. Louis headquarters. Subsequent advances are also required at the end of the first, second and third years after the execution of the Project Agreement.

c. The OMVS shall Covenant as Follows:

To provide administrative support which include salaries, office space, secretarial and other administrative support amounting to approximately $551,000 over the life of the project.

Francis S. Ruddy
Assistant Administrator

Date

Clearances:

GC: _____

SUGGESTED MODEL AGREEMENT BETWEEN THE

ORGANIZATION FOR THE DEVELOPMENT OF THE SENEGAL RIVER BASIN

AND:

1) The Division of Hydraulics of the Ministry of Hydraulics and Housing of the Government of the Islamic Republic of Mauritania (GIRM);

2) The National Directorate for Hydraulics and Energy of the Ministry of Industrial Development of Mali (DNHE);

3) The Directorate of Hydraulic Studies of the Ministry of Hydraulics of Senegal (DHS).

FOR THE IMPLEMENTATION OF GROUNDWATER MONITORING ACTIVITIES IN THE SENEGAL RIVER BASIN - USAID FINANCED PROJECT No. 625-0958.

Between the Organization for the Development of the Senegal River Basin hereafter referred to as "OMVS";

and:

The Division of Hydraulics of the Ministry of Hydraulics and Housing of the Government of the Islamic Republic of Mauritania hereafter referred to as "DH/GIRM";

It has been agreed that:

Article 1: Objectives

This agreement is to establish the guidelines for collaboration between the OMVS and the DH/GIRM, to implement the Groundwater Monitoring Project financed by USAID - No. 625-0958 in accordance with the Grant Agreement between the OMVS and the Agency for International Development signed on _____.

This project will be implemented in the Sector of Kaédi in the Mauritanian side of the River Basin and will be effective from _____ 1982 to _____ 1986.

Article 2. Definition of work to be undertaken

The work to be undertaken under this agreement are defined in the Project Paper dated July 1982, pages 97 to 101, entitled "Implementation Plan" and specifically in Annex A, pages A-9 to 17, "Field Operations"; Annex C, pages 1-3, "Qualifications of National Agency Personnel Attached to Project".

This agreement is particularly concerned with the "Work Plan" described on pages 26 to 33 of the Project Paper.

Article 3. Establishment of an Action Plan for the Project Operations

During Month 9 of the Project, the Project Team, Project Personnel from the DNH/GIRM will meet with USAID/Mauritania Project Manager and Deputy Project Manager to establish workplans for the following year. During subsequent years, these meetings will take place 3 months before the end of Project Year for the following year.

These planning meetings will resolve issues such as:

- Achieving project targets;
- Review of tasks assignments between the OMVS Operations Office in St. Louis and the Kaedi Sector Office as well as field level brigade operations.

Article 5. Data Gathering and Construction of Piezometers

Data gathering and piezometer construction activities will be undertaken by the Kaedi Sector Personnel in accordance with the "Workplan" Annex A, pages 4-18 of the Project Paper. More specifically:

- Filing of hydrogeologic data, construction details - location and equipment inventory;
- Planning a network of piezometers;
- Implementation of the training program;
- Execution of field level operations outlined in Section D "Field Operations", Annex A, pages 8-12.

Article 6. Data Analysis and Dissemination

The DNH/GIRM will be responsible for the diffusion of groundwater data collected in the Mauritanian Sector. Each subject area (salination, water logging, seepage, etc.) will be analyzed in a technical report to be disseminated among the project participants, the OMVS Operations Office, USAID/Mauritania, USAID/RBDO.

All data analyzed will be placed at the OMVS designated central location for groundwater monitoring data bank.

Article 7. Tasks Assignments

The OMVS and DNH/GIRM will designate the services and persons responsible for effectiveness of this agreement. The OMVS, USAID/RBDO will be promptly advised of any personnel changes. These will be discussed at the Six Month Joint Review Meetings with USAID/Mauritania.

DNH/GIRM will designate the Sector Chief as well as the staff participating in Project Activities as listed on page 94 of the Project Paper, specifically:

1 Technician (Sector Chief)	for 3 years
1 Mechanic/Driver	for 3 years
1 Surveyor	for 2½ years
2 Foreman	for 3 years
8 Crew Laborers	for 3 years
1 Power Auger Operator	for 2 years
2 Aides Auger Operator	for 2 years
1 Clerk Typist	for 3½ years

The personnel will be selected in accordance with the criteria described on pages C-1 to C-3 of Annex C, "Qualifications of National Agency Personnel Attached to Project".

Article 8. Distribution of Financing Costs

All salaries of the personnel assigned to the sector offices as well as the temporary personnel assigned to the St. Louis headquarters will be paid by the Project. The OMVS will finance non-salary personnel costs and some operational expenses whereas the DNH/GIRM will pay for ____percent of these costs as described in the Financial Table, Table 5-Project Budget, page 98 of the Project Paper. It is agreed that the Member States will assume the recurrent costs of groundwater monitoring activites after USAID financing is terminated.

Article 9. Litigations

In case of litigations between the OMVS, DNH/GIRM and USAID/Mauritania, which could not be settled between the Project Manager and his Mauritanian Counterparts, the Secretary General of the OMVS and the Director General of the DNH/GIRM will try to come to a friendly solution.

Article 10. Modifications

The OMVS or the DNH/GIRM may request reviews and/or modifications for this agreement. However, these reviews and/or modifications should in no way affect normal implementation of the program.

Article 11. Approval

In accordance with the Regional Agreement between USAID/RBDO and the OMVS, this agreement will be submitted to USAID/RBDO approval.

Nouakchott, _____

_____ _____

Secretary General of the OMVS Director of the DNH/GIRM

_____

USAID

Clearances:

GC: _____

AA/PPC: _____