TARRAFAL WATER RESOURCES

(IRRIGATION INVESTIGATIONS AND TRAINING)

(655-0003)

JOINT EVALUATION

November 1 - 20, 1981

Ministry of Rural Development
(Cape Verde)

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U.S.A.I.D.

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CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations are presented in parallel. They cover, first of all, the three main project components, and the management of three categories of inputs. Finally, there is an effort to outline future projections for the project, considering it in relation to the full Cape Verde program of soil conservation, water resources, and irrigated agriculture.

I. PROJECT COMPONENTS

A. Soil Conservation (Watershed Protection)

1. Progress in carrying out upstream watershed protection in Tarrafal using resources of the Food Aid Program has been good. This activity has been carried out mainly on GOCV land. The GOCV has unit cost information available.	1a. The techniques of watershed protection should also be applied to watersheds mainly in private ownership, although issues of equity might arise. 1b. Smaller works higher up in the watershed should be pursued, in accordance with GOCV plans and priorities.
2a. There is testimony regarding downstream effects in terms of more agricultural activity. 2b. There is no plan for generating hard information on the effects of watershed protection, but there are indications of interest in developing such a plan.	2. A program for generating hard data on the contribution of watershed protection to water conservation should be produced and implemented.

B. Water Resources

1. Progress in developing underground water resources is seriously behind schedule. Problem areas have included: a. Drilling supervision b. Testing results c. Effectiveness of AID assistance.	1a. Ministry of Rural Development (MRD) should address supervision problems on drilling by issuing appropriate regulations, and guaranteeing coordinated implementation of the drilling program. 1b. MRD should implement its program for generating pertinent data on water resources explored in drilling programs. 1c. AID should increase efforts to make its assistance responsive to perceived Government of Cape Verde (GOCV) needs.
2. Wells have been proven feasible for providing water. With current information, nothing can be determined about the feasibility of galleries or dams.	2. Future work should respect the following order of priorities: a. Well drilling should be speeded up and exploitation introduced where feasible. b. Dams should be built on a small-scale, and results observed and measured on water retention and/or water recharge, based on a principle of learning by doing. c. Further exploratory work on establishing the feasibility of galleries

3. There is no comprehensive baseline data on the water resources available for irrigation, their present utilization and technologies employed.

should be pursued as resources permit.

3. The remaining resources under the Consortium for International Development (CID) contract should be partially devoted to assisting the GOCV to conduct a comprehensive baseline study, outlined in an annex to this report, and concentrating on Santiago Island.

C. Irrigation

1. Each of several of the drilled wells are believed to provide approximately 20 - 40 cubic meters per hour adjacent to areas appropriate for farming in Colonato (Chao Bom). It is hoped that experience with exploiting these sources will determine reliable levels for sustained pumping.

1a. The GOCV should pursue exploitation of wells for irrigation with the objective of establishing a sustainable yield without aquifer deterioration.

1b. The water should be allocated to three principal uses:

i. Domestic consumption

ii. Experimental farm

iii. Small farm plots under close to real-life farming conditions.

2. The GOCV has a general location in Chao Bom appropriate for irrigated agriculture on a pilot basis, and can select farmers for the exploitation of plots in this area. A part of this area has been set aside and is being developed as an experimental farm. The GOCV will need technical assistance on irrigation layout.

2. The experimental farm run by the Agrarian Research Center (CEA) should be physically close to the farm plots to assure maximum interaction between the spheres of theory and practice.

3. Farmers using irrigation for the first time will require technical advice as well as assistance in obtaining agricultural inputs.

3a. MRD should develop detailed plans for the selection of farmers and management of the irrigated area, including attention to land tenure issues.

3b. Arrangements should be made for support of the small farmers efforts under normal government programs.

II. MANAGEMENT OF PROJECT INPUTS

A. General Management (No conclusions or recommendations.)

B. Commodities

1. The drilling equipment choice has raised controversy, but now appears to have been accepted by the GOCV.	1. The GOCV should continue to use the Koehring Speedstar (rotary) drilling equipment.
2. Commodity procurement has frequently suffered from delays, while selection of appropriate spare parts has also been a problem.	2a. Respective responsibilities of MRD and USAID in procurement require definition.
	2b. A line of credit with Koehring Co. should be established to expedite procurement.
	2c. MRD should review the manufacturer's recommended spare parts lists. Spare parts catalogs from suppliers should be obtained. It should be determined if an arrangement for Koehring to accept return of excess or inappropriate spare parts is possible.
	2d. High quality detergents for drilling would speed up the drilling process and be more economical in the long run. Arrangements for purchase in bulk should be set up.

C. Participant Training

1. Training has mainly consisted of long-term degree type that has little relationship to project requirements. Corrective action on training emphasis appears to be underway.	1a. More non-degree training, for shorter periods, using third countries to overcome serious language deficiencies would be desirable improvements. 1b. Individual programs designed to specific needs of each participant, providing greater technical depth, and geared to project management requirements should be implemented. 1c. Plans for employment of returned participants should be a selection criterion for training candidates.

D. Technical Assistance

1a. The individuals provided to perform technical services have generally been considered satisfactory by their GOCV counterparts. Nevertheless, problems have arisen.

1b. Roles and responsibilities of technical advisors have often lacked clarity.

1c. Problems have sometimes tended to go unresolved for long periods, and this has interfered with implementation progress.

2a. The MRD is anxious to take more, if not full, responsibility in the well drilling area. In other areas it wants to receive more technical assistance.

2b. Responsibility for success or failure of joint undertakings is appropriately assigned to the GOCV, while responsibility for the quality of assistance is clearly in AID's bailiwick.

1a. The project managers on the U.S. and Cape Verdean sides respectively (Byrne and Soares currently) should be advised immediately by subordinate personnel of any implementation problems, especially in the realm of personality conflict.

1b. The co-managers should investigate thoroughly and find appropriate solutions, including clarification of roles and responsibilities, and even removal of personnel if there is no other way.

2. AID should try to respond to MRD needs and aspirations during the remainder of Phase I, and this policy should be a connerstone for a Phase II.

III. FUTURE PROJECTIONS

A. Present Status of Phase I

1. Phase I is due to terminate on Dec. 31, 1981. However, certain activities including the CID contract have potential for carrying at least into mid-1982.	1. Action should be taken immediately to extend Phase I until Dec. 31, 1982, and to extend the CID contract to the same termination date.
2. The GOCV has presented a proposal for the continuation of the implementation of Phase I activities, which will require continuing technical assistance in irrigation engineering, hydrogeology, agronomy, dam construction, etc.	2. The GOCV proposal should be carefully explored, details flushed out, priorities established, and cost estimates determined.
3. To implement the final aspect of Phase I (irrigated agriculture) even on a small scale will require at least one year, and probably a small amount of added funding.	3. A separate amendment adding funding in an amount to be negotiated should be undertaken as soon as an appropriate figure can be arrived at, probably in the second quarter of the fiscal year. At that time, funding as appropriate should be added to the CID contract, and necessary modifications made in the scope of work.

B. Possible Phase II

1a. There has been mention of continuing the project into a second phase.

1b. The GOCV proposal received while the evaluation was in process does not really go beyond an extension of Phase I.

1a. Consideration of a second phase should depend in part on the GOCV's ability to complete Phase I along the lines of its own proposal.

1b. It is possible that enough progress will have been made by the later part of FY82, in which case a design of Phase II could be undertaken. Basically, this should be a joint undertaking of Mission, including on-board contract and GOCV personnel, with outside assistance to be identified.

PROJECT BACKGROUND

In 1976, the Government of Cape Verde requested AID's assistance in developing water resources in the Tarrafal region. GOCV's plans in this area were based on a report by a UNDP hydrogeology advisor. A Project Identification Document (PID) for this project was submitted to AID/W in July 1976; the project goal at this point was "the improvement of the agricultural potential of 350 hectares of arable land in Tarrafal and to provide an assured source of potable water for the town of Tarrafal." During the PID review, several issues were identified for further analysis at the Project Review Paper (PRP) stage. However, a PRP was never written for this project. A Project Paper (PP) team was fielded in September-October 1976 and later the Tarrafal Water Resources project (Irrigation Investigations and Training) was authorized January 21, 1977 for initial Life of Project (LOP) funding of $1,900,000 and a Project Assistance Completion Date (PACD) of March 22, 1980. Two subsequent amendments increased LOP funding by $1,100,000 for a new total of $3,000,000 and extended the PACD to December 31, 1981.

The focus was to assist the Government of Cape Verde to test the availability of and methods for utilizing ground and surface water resources. This was preliminary to preparations for the expansion of 600 ha. of irrigated land in the Tarrafal region. To accomplish this, the project proposed to finance (1) the drilling of 50 test wells; (2) exploration of ten gallery sites; (3) testing and design work requisite to construction of two medium-size dams and related tunnels and canals; (4) technical assistance; and (5) 13 man-years of technical training in areas of hydrology, agronomy and agriculture economics.

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Of the three essential ingredients required for continuing effort - time, money, and personnel - time is most urgent to give the MRD, and the Mission, a chance to sort things out and get implementation onto a firm footing. Certainly, agreement in depth between both parties as to the future project course is indispensable before resources can be utilized to full effect. Time will hopefully make possible the attainment of a full understanding between all those involved in the search for and exploitation of water resources in Tarrafal, including other donors, so that future project undertakings, whatever their nature, will have a better chance to succeed.

EVALUATION METHODOLOGY

The evaluation methodology is the following:

1. Develop a scope of work (see below);
2. Assemble a joint evaluation team;
3. Visit project sites, and interview key persons involved with the project;
4. Assign tasks to team members to investigate and write about individual topics listed in the scope of work;
5. Assemble written sections and organize material;
6. Develop conclusions and recommendations;
7. Discuss them with those involved in project management;
8. Produce final report.

The scope of work is the following:

The evaluation team will prepare a report consisting of

1. Summary of project history;
2. Over-all evaluation of how well project achieved goals, purposes and outputs stated in the Project Paper, and assessment of changes in targets made during implementation;
3. Evaluation of data collected, studies performed and technical observations made;
4. Evaluation of administrative and decision-making mechanisms during project implementation involving AID direct-hire, AID contractors, MRD/Praia, MRD/Tarrafal, and UNDP.
5. Evaluation of contractor performance (CID and Personal Services Contract well driller);
6. Evaluation of equipment problems;
7. Evaluation of training component;

8. Evaluation of project expenditures;

9. Conclusions and recommendations including (but not limited to) discussions on the following issues: (a) Until what date should Phase I PACD be extended to satisfactorily complete project activities? (Current PACD is 12/31/81); (b) Is Phase II feasible, and if so, when should PID design be scheduled? (c) What form (in general terms) should Phase II take? (d) How much priority does GOCV place on development of Tarrafal region? (e) What has been the involvement of intended beneficiaries with the project? How can their participation be increased in the future?

In order to get the most use out of the evaluation exercise, when the draft report is completed the team will present its findings to a general meeting of Cape Verdeans and Americans who have been involved with the project. Report will then be put into formal form and distributed.

I. ANALYSIS OF PROJECT COMPONENTS

A. SOIL CONSERVATION (Watershed Management)

This project component was to develop the capability in the preparation of terraces and dikes for control of soil erosion and rapid water runoff. This was to be accomplished largely through fieldwork by GOCV technicians with heavy equipment (a Cat D-6, a MF245 Farm Tractor, and a 10-ton Ford Dump Truck) and advice provided by technical assistance in soil conservation engineering, soils science and hydraulic engineering (3 person-months).

The local MRD, under the supervision of Francisco Barbosa, engaged and directed work crews (numbering up to 600 laborers) in dike and terrace construction, contour furrowing and tree planting. A detailed list of these soil conservation works is in Annex IV. Technical advice was provided by Kern Stutler, the CID soil conservation specialist and, since July 1980, project coordinator.

Stutler has made five site visits. On his recommendation and following his design, the MRD laid out a 25-ha. pilot watershed on Achada Carreira to establish and evaluate trial practices of Acacia plantings, terraces, contour furrows and diamond ditches. He also assisted the on-site training programs in June, 1979 and September 1981. The thrust of Stutler's recommendations has been the need to shift emphasis from larger rockwork dikes in streambeds to on-slope upstream soil conservation practices such as reforestation, terracing, furrowing, etc.

Soil conservation public works are becoming widespread throughout Cape Verde. The evaluation team was impressed by both quantity and quality of the soil conservation works. Since 1979, the project has completed

approximately 22,000 cubic meters of rockwork dikes, 10,000 meters of terracing and planted 27,000 trees, mostly on state lands. Almost all works have held up through at least one rainy season. Maintenance and repairs of these works have been expeditious. The benefits have been direct in the form of workers' salaries and rebuilt flood-ravaged agricultural lands (Ribeira da Prata); and indirect in increased infiltration, hence aquifer recharge, topsoil retension and future firewood supplies, although no quantifiable results have been reported.

The MRD's budget figures for 1979 indicate that the costs of these works were reasonable: approximately $4.50 per cubic meter of rockwork and $0.40 per tree. These costs do not include the "sunken" capital cost of $125,000 of AID-supplied heavy equipment. The farm tractor is currently undergoing major repairs. The dump truck lacks tires. The bulldozers has been used extensively and is in operating condition.

The works in the pilot watershed were effective. Despite this year's early and faltering rains (only 135 mm at Chao Bom between July and September), the corn grown in the small, $\pm$ 100 square meter plots formed behind the check dams, or "arretos" in the ravines was the only healthy rainfed crop seen in the project zone. FAO experts have also found measurable increases in soil moisture around such structures. Stutler has not yet reported the data and observations from the pilot watershed, and the evaluation team assumes that these findings will be a part of CID's final report. Even without his final conclusions, the effectiveness of Stutler's work is obvious.

Based on the positive and substantial effects of the soil conservation program in the project, and in light of the obvious magnitude of soil erosion and rainfall runoff in the project zone, the evaluation team believes that such work should be a primary focus of future activities. Furthermore, the team makes the following specific recommendations:

1. Following Stutler's advice, emphasis should be placed on more small works upstream in the watersheds on the "achadas" rather than on only larger works in the "ribeiras". Certainly larger-scale works are more impressive and often necessary to curtail destructive flooding, yet the "roots" of soil erosion will be found upstream and reforestation, terracing, furrowing and diking work should be concentrated there.

2. The soil conservation program should be increasingly directed at the private farmers in the watershed (most works have so far been on state lands). Their land tenure and the cropping systems should be studied. They should be made aware of the gravity and pervasiveness of the soil erosion problem, and of the soil conservation program extended to them. To do this, the project must first establish longer-term soil conservation techniques adapted to present farming systems (e.g. abandon cropping slopes over fifty percent, encourage tree farming, furrows, crop residue mulching, terrace cropping, and water harvesting), then create a system with incentives - most likely through the MRD's proposed cooperative network to extend these practices to the dryland farmers. The Watershed Management project has just begun to develop an extension program and close coordination will be profitable.

3. Also in close coordination with the Watershed Management project, the Tarrafal project should begin a program to monitor watershed changes due to soil conservation works. Precipitation, runoff, soil moisture, infiltration, sediment loads and soil chemistry are parameters which should be frequently gauged and recorded, especially during the rainy season, to provide a quantitative data base to evaluate program effectiveness. There are separate departments within MRD in charge of measuring water and soil resources. Actions on CID recommendations in this area should be based on mutual understandings with corresponding department heads.

To implement this program, the MRD will have to assign appropriate staff to the Tarrafal project to complement works design and management (i.e. engineering) with an extension administration. USAID should assist with sponsorship of an on-site training program in soil conservation techniques and extension. The USDA soil conservation service might be a source for this programming. Stutler would also be a key resource in the design of this program. A survey of present farming systems in the project zone will be necessary to craft appropriate extension approaches and this may require several months of specific assistance. And finally, several small appropriate vehicles and selected truck parts will be necessary for continued mobilization.

B. WATER RESOURCES

1. Well Drilling

The project planned on drilling 50 test wells for the purpose of defining the groundwater resources of the Tarrafal region. Unless this information is obtained, it will be impossible to exploit this resource for maximum

benefit. Following this investigative phase, it would then be possible to convert some of the test wells to production wells. Production wells were not envisioned under the current project and no funds were accordingly provided.

The project funds provided a rotary percussion drilling rig, utility truck, tanker truck, pickup, drilling equipment, test pumps, water level recorders and other miscellaneous material to carry out the drilling program. The total cost for drilling equipment is approximately $1,500,000. In addition, approximately five months of technical assistance from a factory representative was approved on-site to instruct the Cape Verdean drilling crew in the operation of the equipment. Later in the project it was concluded that a full-time well drilling advisor was needed and an additional ten months of assistance was provided through a personal services contract with Lynn Brumbaugh, commencing in February 1981.

The basic implementation assumption contained in the project paper was that after providing the equipment and the limited technical assistance from the factory representative, that "Existing Cape Verdean experience in water exploration is considered adequate to carry out the bulk of this task without further technical assistance." The technical assistance/ training contractor, CID, was initially not explicitly requested to be directly involved in this effort. However, during the project, they did provide a consulting hydrogeologist, John Logan, to assist the GOCV in program management and data interpretation.

The progress to date for the groundwater exploration activity is not satisfactory. Twenty-three bore holes have been realized, however, at

least three of these are not usable due to stuck tools or collapsed walls. Further, only four of the boreholes have been pump tested to determine capacity, drawdown and aquifer characteristics. To quote John Logan from his report of July 1981, "The information returned by this program is much less than desirable."

The lack of progress in number of boreholes appears to be primarily the result of difficult drilling conditions and equipment problems. The latter problem has been largely overcome since the arrival of the well drilling advisor.

Logan's recommendation concerning placement of boreholes have been generally adhered to, however, the data which he has requested, with few exceptions, has not been obtained. Four drawdown tests have been made, but with inconclusive results due to insufficient drawdown. The water level recorders have not been installed and very little conductivity/ chemical analysis data has been obtained.

The evaluation team has reviewed the recommendations contained in Logan's reports (August 1979 and July 1981) and supports them. They are attached in Annex V. If satisfactory hydrogeological information is to be developed for the Tarrafal region, it is crucial that a well-conceived plan be developed and adhered to. Until the present, substantial resources in time, capital and labor have been invested. Unless appropriate data are gathered, very little benefit will be realized.

2. Dams

The project plan was to perform appropriate testing and data gathering to determine the feasibility of constructing two medium size dams (100 foot

high) in two river valleys. The purpose is to store water for irrigation. Preliminary design was to be provided.

The GOCV was responsible for performing the geotechnical boring with the Longyear machine and developing the rainfall/runoff information. CID was to analyse the information and provide preliminary designs.

The boring work was carried out at five sites (two in Ribeira Cincho, two in Ribeira Garca, and one in Ribeira Funtao). Analysis of these results and observations at the sites indicate that infiltration losses would be large.

CID provided the technical assistance in geotechnical studies, sedimentation and surface hydrology. The GOCV was to collect the necessary sediment and hydrological information. This information would be necessary to determine dam design and feasibility, but has not been gathered. The reason appears to be lack of capable manpower rather than any decision to not collect the data.

The level of effort by CID is lower than initially planned (2 man-months versus 5 man-months), however, CID was not able to interpret hydrological or sediment data, nor was it requested that they provide a geologist for 3 months. Therefore, the CID technical assistance was satisfactory in view of the present conclusion that storage dams are not feasible.

Data collection by the GOCV, especially of hydrological data, would be useful. Groundwater recharge can be estimated if this information is coupled with precipitation data. This is needed if efforts continue to exploit the groundwater resources.

3. Galleries

The gallery testing was performed by the GOCV with AID input of equipment to perform the test boring. If galleries are to be constructed,

there are provisions in the budget to purchase materials for that purpose.

The results from boring tests with the Longyear machine have not demonstrated the feasibility of groundwater exploitation by galleries. At present, the machine is inoperative with the tools stuck in the hole at a site in Ribeira Cincho. Prior to October 1980, this equipment was used for damsite investigations and not available for gallery exploration. It is apparent that further investigation is needed prior to gallery construction. If funds become limited, this activity has a lower priority than the well drilling activity.

4. Priorities among Wells, Galleries and Dams

In contemplating priorities among the three categories of works proposed for increasing water supplies, it is necessary to consider the conditions required for their success as well as the uses to which water so derived could be put. Wells and galleries both are based on the principle of extracting underground water, while dams, under optimal conditions, would retain surface runoff and contribute to recharging groundwater. There is little point in storing water from underground sources that is produced at a fairly steady and reliable rate.

The other activity being undertaken on a large scale is watershed protection, with a number of methods in use varying in detail. However, the principle of watershed protection is the same everywhere. It is to hold most or all of the water on the uphill slopes and reduce runoff to a minimum. Another very important function of soil conservation in Cape Verde is the necessity for soil capture or the reduction of erosion of the soil on slopes to the sea. The two main hopes in this regard are surface vegetation and physical catch basins, and these are generally being combined.

The upstream water protection, such as rock terraces, contour ditches, etc., is not vital for use of either wells or galleries, since these underground sources are not subject to the more violent effects of flood and erosion. Special care need only be taken with locating well-heads and gallery-mouths where they would not be inundated by water and debris. The water from wells or galleries would be expected to be pure and reliable for steady use. Such sources would be ideal for domestic use and for irrigation on a year-round basis.

The conditions for dams as well as the potential use of water conserved may be quite different in Cape Verde, no matter what may apply elsewhere. The difference between a dike, of which many have been built, and a dam is partly a question of size. Most dikes have filled entirely with erosion debris. A "dam" that filled with debris in short order would no longer be a dam. It would become a dike with a terrace behind it. Its utility for water storage could become zero.

Therefore, dams should be contemplated only in areas which have been given close to 100 percent of the possible upstream protection. Such dams would fill rather slowly with minimal sedimentation, not in a few hours during a heavy storm. Their function would be to hold water for a few weeks or months so as to afford a more reliable water supply for irrigation purposes over the space of a few months. The water so supplied would be designed to assure a single good crop, or possibly two, during a growing season from the onset of rains in July until possibly December. The water would not be of potable quality, nor would it be available year-round.

Another point on dams is that there is said to be few, if any, good dam sites. Valleys are narrow with steep gradients. Therefore, dams

should be thought of as having small capacity. Larger capacity dams, to be most useful, should be built in highland areas, if there are appropriate locations available. In valley floors, erosion is potentially a much more serious problem; good agricultural land will be flooded, and the versatility in use of the water is lost. Certainly upstream damsites should be sought, especially at very high elevations, and those relatively small watersheds fully protected as a first step toward eventual dam construction on a modest scale.

Priorities came out as follows:

a. Wells get highest priority because more is known about them, sources are available for exploitation, and upstream protection is not indispensable.

b. Dams are next in priority, because they are technically within present local building capacity, particularly if kept small. However, the upstream protection is an absolute prerequisite.

c. Galleries are an alternative to wells, but less is known about them. It is doubtless better to concentrate on wells for water exploitation until more can be learned about galleries through exploration and testing.

C. IRRIGATION

The project paper called for studies of the existing irrigated farming system and plans for an expanded system by specialists in agronomy, agricultural engineering, hydrology, and economics. Short- and long-term participant training in irrigation was also proposed (see Training, Section II.C.). The CID contract reflected this mix of study, planning and training, although later contract amendments included considerable sprinkler and trickle irrigation equipment, and the addition of a soils scientist and an on-site irrigation engineer/resident project coordinator.

The technical specialists provided by CID were Howard Peterson, agronomist (two visits); Alvin Southard, soil scientist (1 visit); and Phil Coolidge, irrigation engineer (resident coordinator). Southard has completed a soil survey and map, and collaborated with Peterson on an interim guide to soils utilization and cropping alternatives. Coolidge has studied the existing irrigation system (see Annex III), supervised the installation and operation of pilot sprinkler and trickle irrigation systems, and submitted monthly reports on project activities.

The evaluation team had the following comments on this teams' work:

Soils: The survey and map were clear and well presented. However, minimal discussion of fertility testing and data is included.

Crops: This survey appears unrealistic. The most prevelant crops being irrigated at present, sweet potatoes, peanuts, and manioc, are not mentioned and the report does not indicate that present cropping systems have been analyzed and data interpreted. Nor have any "optimal production technologies" been determined as requested in the project paper.

Irrigation: The analysis of the existing surface irrigation system has been useful, but additional information and analysis is required. Specifically, comparisons between traditional methods and the proposed alternatives (sprinkler and trickle systems) in terms of, inter alia, irrigation efficiency, water consumption, operating and maintenance costs, and management will be necessary to evaluate properly which system to employ under various cropping regimes. Given the high evapotranspiration and water infiltration rates at Tarrafal, water conservation should be an important criterion in the evaluation of all irrigation systems. As it is,

little specific agricultural data is available on the existing system.

CID has experienced some difficulty in identifying and scheduling the agricultural economist, a specialty required to determine the costs of production and market values of cropping systems. No conclusions have yet been reached on irrigation techniques and economics. The evaluation team also notes that the MRD named counterparts for the CID agricultural specialists in 1979 (Oswaldo Cruz, Carlos Silva and Mario Lima). However, no fieldwork or follow-up by these counterparts was evident during or after the specialists' visits, although CID has not mentioned this in their reports.

There is a consensus among both the CID consultants and evaluation team that the present system of irrigation appears well-managed, very cooperative, highly efficient, and easily replicated.

II. MANAGEMENT OF PROJECT INPUTS

A. GENERAL MANAGEMENT

1. Host Country Administration and Management

The Tarrafal Water Resources Project was placed under the direct responsibility of Engineer Horacio Soares, who was charged with the function of Director General of Conservation and Exploitation of Natural Resources (DG/CARN) of the Ministry of Rural Development. Soares has since been named Director General of MRD's Agrarian Research Center, but has retained his function as GOCV coordinator of the Tarrafal project.

A national technician, Francisco Barbosa, was chosen for the coordination and execution of all field work. Barbosa receives instructions from the persons responsible for the various technical areas, namely Engineer Horacio Soares, Dr. Alberto Mota Gomes, and Engineer Jose Vera-Cruz.

There was a CID contract coordinator who would visit Cape Verde on the average of two or three times a year to arrange for technical assistance and training. The visits of the coordinator were always programmed not only as to time but also as to its objectives. There would be meetings (to determine work programs) and field visits that involved not only the previously mentioned persons but also other personnel of the Ministry. At the end of these visits there would be a conclusion concerning the work to be carried out by one party or another. The instructions were then transmitted to the coordinator of the field works and human and material resources were provided for the execution of the activities (topographic surveys at various levels, description of future locations for the construction of dikes, etc.). In these meetings, a representative of the local USAID office always participated. Thereafter, the coordination of the

specific activities was committed to each one of the responsible MRD officials cited.

Subsequent personnel changes included the departure for the United States of Engineer Vera-Cruz, who was replaced by Engineer Maria de Lourdes Monteiro. Also, Engineer Antonio Sabino arrived from Santo Antao to assist in the field work in Soil and Water Conservation. Organizational charts of the Ministry of Rural Development and of Tarrafal project management are included.

2. USAID Management

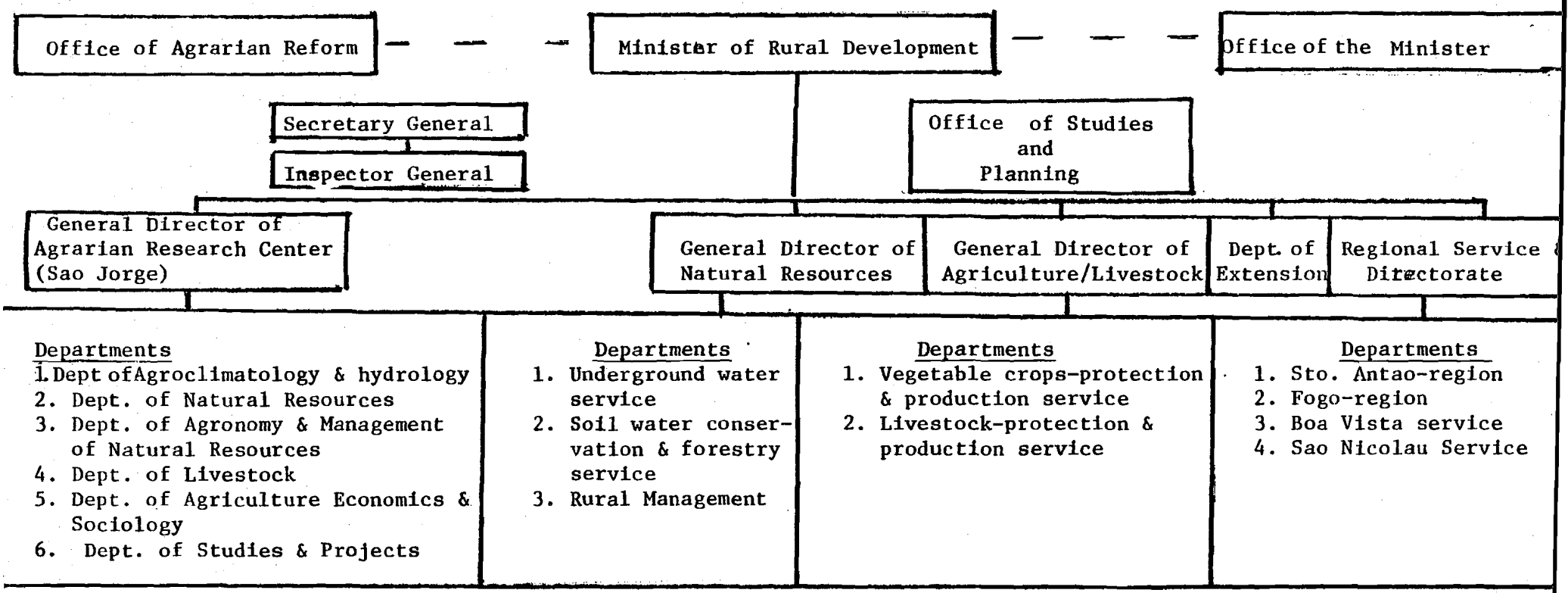
At the time of project design in 1976, there was no AID staff in Cape Verde. Agency affairs were handled by a Country Development Officer who is responsible for both Cape Verde and Guinea-Bissau. The CDO is located in Guinea-Bissau and commutes to Cape Verde as business dictates. A full time Food and Agriculture Officer came on board in 1977 and managed the project for two years. On his departure in January 1980, an International Development Intern (IDI) (later Agricultural Projects Manager) was posted and has been managing all USAID agricultural projects to this date. Major project administrative ingredients are procurement, monitoring the technical assistance contract and coordinating training activities. Procurement delays, implementation problems, an expanding USAID program and difficulties in filling staff positions, particularly the engineering slot, created unusually heavy workloads.

3. Project Expenditures

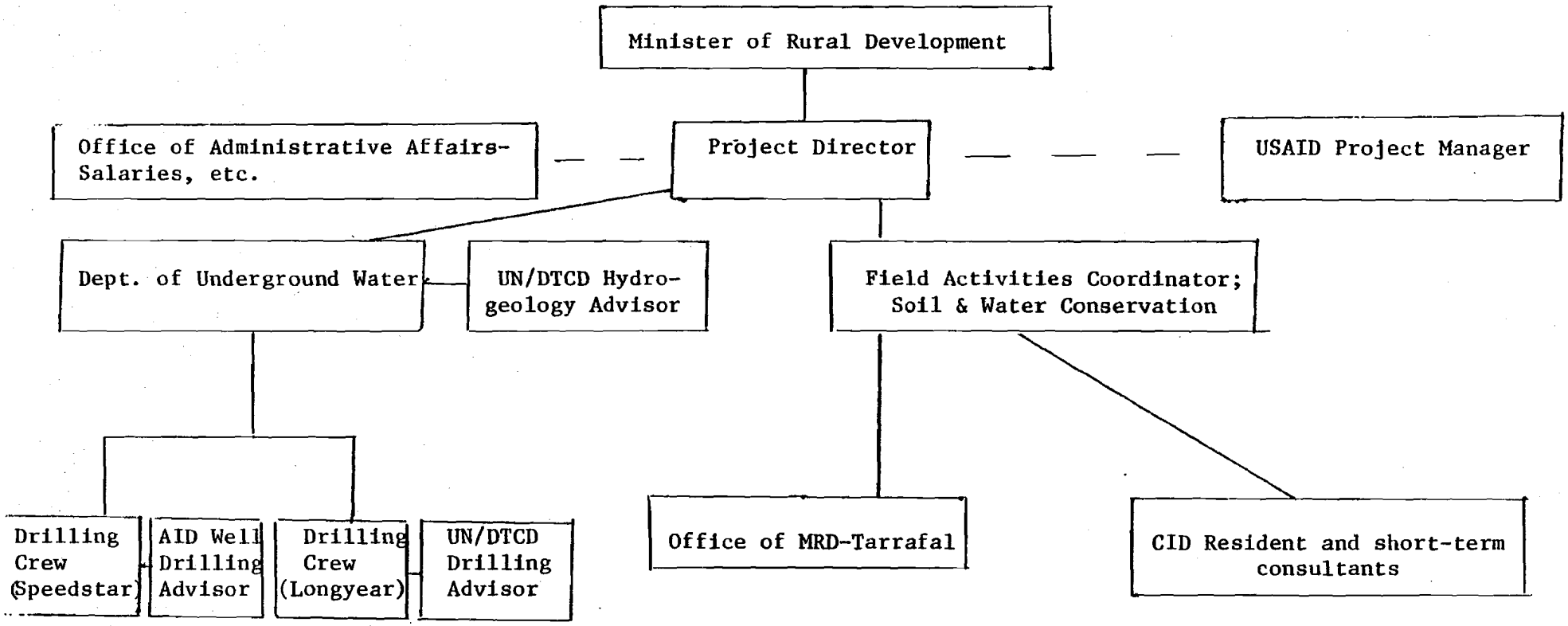
The Tarrafal Water Resources Project (Irrigation Investigations and Training) Grant Agreement between the GOCV and USAID was signed March 29, 1977 for $1.9 million. Two amendments, one on May 23, 1978 ($1,000,000)

and the other on September 30, 1980 ($100,000) resulted in a project total of $3.0 million. These revisions were for additional commodities and technical assistance (well driller). Commodities are the largest budget item, being about 76 percent of the total, followed by technical services and training. The estimated GOCV contribution is $697,000 for land cost ($591,000), permanent staff time ($41,000) and training ($65,000).

ORGANIZATIONAL CHART OF MINISTRY OF RURAL DEVELOPMENT



ORGANIZATIONAL CHART - TARRAFAL PROJECT AS OF 11/81



Budget Summary (Project Grant Agreement as amended, September 1980)

AID Financial Inputs	Previous Amount	Amended Amount	New Total
Equipment & Commodities	2,305,000	50,000	2,355,000
Technical Assistance	302,000	50,000	352,000
Training	100,000		100,000
Other Costs	193,000		193,000
Total	$2,900,000	$100,000	$3,000,000

Financial Situation (As of September 1, 1981)

Total Grant to Date				$3,000,000
Less: Cumulative expenditures and sub-obligations:				
Drilling equipment and tools		$ 1,432,702	48%	
Technical assistance:				
-CID	$435,313			
-Well drilling advisor	59,390			
-Other	9,596			
Total Technical Assistance		504,299	17%	
Shipping, insurance, packing		418,363	14%	
Vehicles and parts		276,805	9%	
Participant training		214,200	7%	
Heavy earthmoving equipment		122,605	4%	
Explosives		15,252	0.6%	
Soils lab		6,000	0.3%	
Fuel expenses		3,454	0.1%	
			100%	(2,933,680)
TOTAL FUNDS AVAILABLE FOR SUB-OBLIGATION				$ 6,320

Budget Summary - GOCV

PL-480 Proceeds

	CV Escudos	
GOCV Input 78/79	11,069,153.00	
79/80	10,186,639.00	
80/81	12,653,743.00	
TOTAL Escudos (3 years)	33,909,535.00	
TOTAL Dollars (3 years with average exchange rate of $1 U.S. = 45 Cape Verdean Escudos)		$753,545.00

B. COMMODITIES

A total of $2,355,000 was expended on equipment and material to implement the project. This represents 76 percent of the total project cost of $3,000,000. The project paper contained a detailed list of equipment which was generally adherred to. The following comments are based on information obtained during the evaluation and from reports.

1. Well Drilling Equipment

A relatively sophisticated rotary percussion rig (Koehring Speedstar) was procurred. It is versatile but requires substantial capability on the part of the drilling crew if it is to be utilized effectively. The project design team recommended that a factory representative be provided for a total of five months of training and advice.

The drilling rig was initially used prior to the arrival of Mike Montgomery, the factory representative. The result was that $12,000 worth of drilling tools were lost in the first attempted major borehole. The cause appears to have been insufficient circulation of air resulting in a buildup of cuttings, thereby trapping the bit. After Montgomery's arrival, no further major problems were encountered during his stay. Montgomery provided a total of about 135 days of technical assistance including travel time.

After his departure the drilling program began again to be plagued with problems, the most serious of which was the tower toppling due to activation of the wrong hydraulic control.

The MRD and AID agreed in April 1980 to provide an advisor to assist in the drilling program. After a long search by AID/W, Lynn Brumbaugh arrived in February 1981 and has remained until November 1981.

The drilling rig was capable of providing for the goals of the well drilling program. There does not appear to be anything intrinsically defective concerning the drilling rig from a technical point of view. However, from a human viewpoint, it is apparent that a less expensive and simpler rotary rig may have been more appropriate.

Remaining commodities to support the drilling program include screen, casing, bits, trucks, drilling accessories, test pumps and well monitoring equipment. The present well drilling advisor claims that the tri-cone bits are not needed and that he has performed the drilling with percussion hammer bits. Approximately $140,000 were expended on tri-cone bits and they should be returned for credit towards future drilling commodity requirements.

The test pumps have only recently (summer 1981) been available. Testing of wells should have occurred earlier, however, the unavailability of these test pumps does not seem to be the reason. The MRD uses a specialized crew for test pumping wells which is equipped already with pumps. They tested four wells earlier this year.

The drill bit selection was not well coordinated to casing requirements. Bits generally are too small and therefore produce a borehole size too small for optimum pump testing. Brumbaugh is presently preparing a list of spare parts and additional materials which will be specific to the needs of this project.

2. Boring Equipment

A Longyear boring machine with air compressors was furnished for dam site foundation investigations and gallery explorations. It has performed satisfactorily.

3. Gallery Construction Commodities

Material has been ordered for gallery construction although the feasibility of galleries has not been demonstrated. If possible, any unfilled orders should be cancelled.

4. Terrace and Dike Construction

The dikes and terraces are constructed using manual labor. The D-6 Caterpillar and Massey Ferguson tractor have not been necessary for this activity. The inventory of hand tools (picks and crowbars) is adequate.

5. Irrigation Equipment

CID provided equipment for irrigation experiments at Tarrafal. Ignoring the issue of whether these experiments are useful, it appears that the equipment is appropriate.

6. Procurement Problems

a. Most of the commodities were procured via PIO/C's with AAPC, Inc. as the authorized agent. AAPC's reporting on procurement status has been inadequate for AID/Praia to keep informed on how procurement was proceeding and how much unexpended funding remained in the PIO/C. For example, between January 1979 and July 1980, no report was received on the status of a $2 million PIO/C, and then only in response to a direct request. AID/Praia staff had assumed that all requested items had been purchased and all funds expended. In fact, AAPC advised us that many items had never been purchased (supposedly on instructions from the Cape Verde desk in AID/W), and that an unexpended balance of over $400,000 remained. Among the unpurchased items were important pieces of equipment such as test pumps and accessories, and well monitoring instruments. AID/Praia has now established a commodity control system in which each step of the

procurement process is recorded, and any omissions or delays in the process can be immediately identified. For its part, AAPC has promised improved reporting, but this is not yet evident.

b. Slowness in obtaining spare parts for the Speedstar drill rig has resulted in prolonged "down time". The current practice for ordering parts is as follows: Tarrafal personnel identify needed part and catalog number and inform AID/Praia; AID/Praia cables AID/W (SER/COM); SER/COM contacts AAPC; AAPC issues purchase order to Koehring Co. Speedstar Division; Koehring Co. air freights part, which changes planes at New York, Lisbon, and Sal before reaching Praia. Once here, the part sits in the airport until all necessary paperwork is done, fees paid, etc. Even if things go fairly smoothly, it takes a minimum of two months to complete the process. To help reduce this time, AID/Praia has asked SER/COM to investigate the possibilities of establishing a line of credit with Koehring Co., so that when a part was needed, AID/Praia could telephone or cable directly to Koehring. No word has yet been received from SER/COM on this subject.

C. PARTICIPANT TRAINING

The project paper proposed 13 person-years of both short- and long-term training. To assist the GOCV in planning for the expansion of irrigated lands and optimal conservation and irrigation techniques, the areas of study considered necessary were hydrogeology, hydrology, soils science, hydraulic, irrigation, soil conservation and agricultural engineering, and project planning and analysis. The contract negotiated with the CID somewhat narrowed and reduced training to 11-1/2 person-years in hydrogeology, hydrology, soil conservation/science, agricultural engineering, hydraulics and irrigation engineering, and project management. A contract amendment later included long-term dam construction training and short-term training in irrigation and well drilling. Two weeks of on-site training was also mentioned in this amendment.

To date, CID has provided the following training:

Long-term*: (B.S.)	Irrigation	1 person-years
	Agronomy	1 "
	Soil Science	1 "
	Agricultural mechanization	1 "
Short-term:	Irrigation	1-1/2 "
	Dam construction	2 "
	Irrigation	1/2 "
	Soil conservation	1/2 "
	TOTAL	8-1/2 person years

*All long-term degree training was shifted to the Sahel Manpower Development Training program.

In addition, CID's technical consultants also organized three short training programs while on site visits:

September 1978:	Basics of Hydrology	10 person-weeks
June 1979:	Basic Hydrology & Soil Conservation	30 person-weeks
August 1981:	Hydrology, Irrigation & Soil Conservation	20 person-weeks
TOTAL		60 person-weeks

The university training program was complicated by the lack of candidates qualified for post-graduate training in highly technical fields. Therefore, long-term training required five years per person instead of two (and was shifted to the SMDP program after the first year to conserve funding). The short-term training required, in most cases, well over six months. Language was also a problem. GOCV staffing requirements and qualification requirements limited the number of candidates, yet this constraint was well overlooked in the project design. The change to training in dam construction is not justified in project documents and is contrary to project priorities. However, a contract amendment specifying such training was signed as late as January 1981.

The evaluation team was surprised that there has been no overseas training in hydrogeology, hydrology or project management, without doubt the most critical and problematic areas in this project.

Since the long-term trainees have not yet returned, the team could not assess their training. The team did, however, discuss the program with both short-term and on-site participants. In their view, CID did not make the necessary effort to place all short-term trainees in appropriate and effective programs. In the case in point, the trainee had to take six months of English language courses, and then was placed in a standard M.Sc. program whi ously not be able to finish.

Only one course in a language other than English was offered. The participant did not receive the "intensive" irrigation training forseen in the project paper.

The on-site training provided by the CID consultants also had mixed results. On-site training can provide field technicians with useful analytical tools and field training is implied in any technical assistant's scope of work. Yet, the evaluation team questions the effectiveness of CID's senior technical consultants as teachers in a class of field staff. According to participants, several of the teachers were difficult to understand and coursework was often technically over their heads. The courses were too hurried and there was no follow-up to the instruction. No tests of problems were given to gauge the course's effectiveness, nor short refresher courses on following site visits. No audio-visual techniques were employed.

The evaluation team commends CID's attempt to train mid-level field technicians, but the team believes that this CID program could also have been much more effective had more thought and planning been given to the pedological aspects of these training sessions.

Quantitatively, CID's training program has or will result in eight technical cadres with university studies, and twenty-eight technicians with very basic soil conservation and water management skills. This falls short of the contracturally-specified quantity of training to be given (11-1/2 person-years) as well as the number of technical fields listed in the project paper and contract. At a cost of nearly $100,000 (travel excluded), the evaluation team does not believe that the GOCV got its money's worth.

The evaluation team still sees a need for university-level training in hydrogeology, hydrology and project analysis and management. This training should be specific and practical and in the participants' first or second language, like the several-month long special Francophone program in project management given at the University of Pittsburgh. An attempt should be made to identify particularly relevant programs; perhaps institutions in Puerto Rico or Hawaii offer courses in the hydrogeology of volcanic formations. The USDA and Department of the Interior might be another source of this training. Short, specific and comprehensible programs would give the "intensive", high-level training needed while minimizing the loss of valuable technical staff time to the GOCV.

As the project develops, training will also be necessary for GOCV field technicians. Well drilling, diesel and electric pumping, pipefitting, tractor operation, farm management, and basic forestry are specialties in which short, "hands-on" training will be necessary. Effort should be made to identify Lusophone training opportunities in these fields (for example, a USAID project in Sao Tome is sponsoring a 3-month course in farm tractor operation, and one in Bissau is financing a short-term pumping technical assistant).

A final note concerns GOCV placement of returning participants. At present, none of the three returned trainees are assigned to the Tarrafal project. This training was specifically planned for and financed by the project and is a vital ingredient to project success. The evaluation team is well aware of the multiple staffing needs of the GOCV's many development activities. However, further USAID-financing of any training should be predicated on GOCV guarantees of the participants' assignment to the project.

D. TECHNICAL ASSISTANCE

1. Contractor Performance - Well Drilling Advisor

A PSC contract was made with Lynn Brumbaugh to provide well drilling technical assistance from February 1981 to approximately December 1981. This decision was made in April 1980 after the GOCV continued to have difficulty in using the Speedstar drilling rig.

Interviews with Brumbaugh, the drilling crew and others indicate that he provided good technical guidance in the day-to-day operation of the drilling rig. During his tenure there were no major malfunctions or accidents involving the rig. Further, he introduced stabilizers to ensure straight boreholes; steel caps on casings to stop vandalism and provide easy access; and drilling foam which minimized the problem of cuttings removal from the borehole.

Brumbaugh seemed to have a communication problem with Alberto Mota Gomes, who is responsible for the well drilling and exploration program. They do not fluently speak a common language. An additional problem appears to be related to confused and shifting lines of authority. Directions to Brumbaugh should have been confirmed in writing to minimize confusion.

While the project evaluation was in process, two events occurred which indicated problems in the rendering of technical assistance. One was the bilateral decision to withdraw, effective immediately, the well drilling advisor. The other was the statement of preference for a more experienced resident coordinator for the CID contract which had no immediate effect on project operations.

The team investigated these events as fully as was possible without arriving at firm conclusions. The factors worth mentioning in the two cases are the following:

a. There were problems in relationships with Cape Verdean counterparts in both cases. The problems tended to be at higher levels in the MRD bureaucracy. In neither case was there a one on one counterpart relationship, but rather an outside advisor attempting to relate to an organizational structure.

b. The United Nations has advisors on board whose services outdate those of the present Tarrafal project incumbents and whose advisory role covers all of Cape Verde, as opposed to one project. These UN/DTCD advisors advise on hydrogeology and well drilling. The AID and UN technical services have not been well coordinated and it is the responsibility of the GOCV to provide such coordination. The MRD, in the well drilling area, has sometimes used advisors in a decision-making or executive capacity. The word interference came up repeatedly in interviews concerning working relationships.

c. The problems were of fairly long-standing. The MRD administrative structure made it difficult to pinpoint responsibilities for resolving

such problems. In any case, the problems were not resolved satisfactorily or promptly.

d. The MRD seems determined to run its own program as far as well drilling is concerned. It will likely rely heavily on the UN/DTCD advisor. If it is relatively successful in future well drilling efforts, this will testify to the success of the U.S. advisory input. On the other hand, if relatively unsuccessful, this will indicate that possibly more help is/ was needed.

e. The MRD is anxious to have more technical assistance in other areas up until now handled under the CID contract. The Mission should make continuous efforts to recognize these needs and respond to them, making sure, however, that a certain level of coordination with related technical undertakings is maintained at all times. This will help assure that technical services have a high order of relevance, are well-received and productively utilized.

2. Contractor Performance - CID

The project purpose is to "provide the GOCV with the equipment, technical assistance and training required for carrying out investigations and training regarding a proposed 600 hectare expansion in land under irrigation in the Tarrafal region." It is clear that the project is to be implemented by the GOCV and therefore the technical assistance contractor role is passive, responding to requests for assistance. The contractor statement of work reflects the above implementation strategy.

An evaluation of contractor performance should be made keeping in mind the contractor's role and responsibilities as described in the

contract "statement of work". The following will evaluate the contractor using the contract as the basis.

a. Project Management and Support

The CID project coordinators have been J. Alfaro (April 1978 - June 1980) and K. Stutler (July 1980 - present). The initial project completion date of November 30, 1980 has been extended to December 31, 1981. The justification is primarily delays in equipment procurement and not providing a sufficient level of technical assistance to meet the project purpose.

The first project coordinator was not able to be the "primary mover" that the contract described. It is apparent that his modus operandi of having occassional technical assistance consultants accompanying him on trips was not effective. It would have been more effective to use a team approach so that the consultants could interchange opinions and recommendations.

A team probably would have caused the GOCV to be more responsive to their recommendations. As it was, the recommendations are contained in separate trip reports. In fairness to CID, it is also apparent that although the GOCV accepted the consultant's recommendations, the GOCV did not have the capacity to carry out the recommended data gathering. This is a basic fault of the project design. Too much was assumed concerning the GOCV's capabilities. Further, the GOCV did not designate counterparts to work with and carry out the consultants recommendations.

The technical assistance momentum was restored by the new project coordinator, K. Stutler and by the designation of an in-country coordinator, Phillip Coolidge. Coolidge arrived in Tarrafal during February 1981. Unfortunately, the capability of the GOCV to carry out the recommendations of the consultants did not improve. Technical assistance of a consultive

nature was not effective. It would have been better to require the contractor to be responsible for gathering data that was not currently being gathered by the GOCV.

Delays in commodity procurement do not appear to be related to CID performance. Problems are delivery and less than timely, efficient procurement by the authorized agent. (See Section II.B for procurement problems.)

CID was also to prepare and update a "Time and Progress Chart" every 90 days. The only chart available in the project file is dated 30 December, 1980. If it has been updated, no copy is available in the AID file. Although CID may be reluctant to remind all parties every 90 days that the project is not meeting the schedule, it is a useful project management tool (even if to remind all parties of poor progress).

The project coordinator was also responsible for preparing an interim project evaluation. This report is poorly written, of limited usefulness and contains superfluous information (repetition of contract statement of work).

b. Quality of CID Technical Assistance

CID provided technical assistance to the GOCV as required based on consultation with GOCV project representatives. The intent of the contract was that it was to be flexible, responsive to needs and therefore the contract personnel selections are tentative. The following summarizes the results from the technical assistance section.

(1) Wells and Galleries - Logan provided high quality guidance to the GOCV. Lack of progress in this area is not related to CID performance.

(2) Dam Feasibility - CID provided geotechnical assistance through Dr. Keifer. The information available during his consultative visit was not sufficient to make final conclusions on geotechnical dam feasibility. CID was to provide hydrology and sedimentation assistance for the purpose of analyzing runoff and sediment data. Because the GOCV has not collected the data, CID has not provided this assistance.

(3) Soil Conservation - CID technical assistance was effective resulting in substantial progress in erosion control structure construction. Further, CID consultants gathered information on soils and developed soils maps for the project area.

c. Role of Contract Coordinator

A major issue in evaluating the CID contract has been the project coordinator role. The GOCV, with hindsight, clearly would have preferred a fairly senior coordinator located permanently in Cape Verde, who could advise the several departments of the MRD on a variety of general technical matters and arrange for specialized experts to come in on TDY where called for. Such an experienced on-the-spot person could really coordinate the diverse activities being undertaken on the Tarrafal project.

But instead of a coordinator, the contract provided an absentee leader who was too far removed to coordinate. Later he was complemented by a resident in-country coordinator to improve field level coordination and advise on irrigation engineering.

3. Contract Supervision

In order to be fair to the contractors involved in this project, one would have to consider certain deficiencies in USAID's supervisory arrangements, such as the following:

a. The CID contract coordination arrangement, ill-advised as it was, was approved by USAID.

b. The problems of contract performance were of long-standing and were not dealt with promptly or conclusively.

c. USAID's contract supervisors displayed certain weaknesses due to personnel turnover and under-staffing (a vacant engineering position for two years).

III. FUTURE PROJECTIONS

A. EXTENSION OF PHASE I

Due to the current lack of data on water resources, the evaluation team feels that a decision on whether or not to proceed with a Phase II of the project would be premature. Instead, it recommends that Phase I be extended one year to December 31, 1982.

While the team found shortcomings in several areas of project implementation, it does not feel that terminating the project at this point would provide a realistic solution to the problems. Rather, attempts should be made to institute the necessary changes to accelerate the rate of progress in achieving project goals. During the course of this evaluation, it has been made clear that improvements in MRD's supervision and management of the project are essential to success. MRD has responded with a revised organizational chart (Annex VII) for more coordinated project management, and assurance that regulations would be issued to clarify implementation responsibilities. MRD has also begun the assignment of additional personnel to Tarrafal to ease the burden on the Project Manager. Similarly, modifications on the part of AID and CID are also necessary if implementation is to improve.

An additional year of Phase I implementation will allow time for (1) development of improved MRD managerial and administrative capability before embarking on a major new Phase of the project; (2) the completion and coordination of the various studies necessary to determine whether and how to proceed with agricultural development in Tarrafal; and (3) the realization of some important tangible benefits from the project, namely the provision of improved domestic water supplies for the area population and of more water for irrigation.

Current project funding appears to be sufficient to cover AID's anticipated inputs at least until June 1982. The amount of additional funding required for the remainder of the extension period has not yet been defined. Discussion will continue with MRD and CID representatives to quantify the value of additional AID assistance for CY 1982.

B. 1982 WORK PLAN

During the proposed one-year extension, the following activities are foreseen (action agent in all cases is MRD with technical assistance from CID, except where AID/Praia action is specifically noted):

1. Soil conservation: The labor-intensive works program funded through PL-480 proceeds will continue. Greater attention will be given to upper watershed areas using techniques successfully demonstrated in the pilot watershed. An evaluation system for the quantification of the impact of the soil and water conservation works will be established.

2. Well drilling and testing:

a. MRD will reorganize its arrangements for drilling supervision to provide for more coordinated implementation of the program. This will include organization of a pump testing unit (both equipment and personnel) and establishment of a program for the regular monitoring of water level and quality for selected wells. Purpose and strategy of the drilling program and well design will be reconsidered and agreed upon by representatives of MRD, CID and AID.

b. AID will try to set up a line of credit with Koehring Co. to allow for quick procurement of spare parts and/or technical services when needed. An attempt will also be made to return or sell some of the drilling accessories ordered with the rig but now considered

3. Utilization of completed wells:

a. Plans will be finalized for the utilization of water from the Ribeira Grande wells. These plans will include:

(1) adequate protection of wells

(2) installation of pumps

(3) establishment of a monitoring system

(4) organization of a maintenance and operations plan, including cost analysis

(5) final decision on size and route of the pipes in the conveyance system

(6) arrangements for the division of water between domestic and irrigation use.

b. When above plans are completed, implementation of them will begin.

c. Plans will be elaborated for the conduction and distribution of water from the other completed wells to irrigable zones, focusing on Chao Bom.

4. Irrigated Agriculture:

a. A baseline survey of existing irrigation systems on Santiago Island will be undertaken.

b. Plans will be made for the development of agricultural production in the Colonato area, using water to become available as a result of the actions listed in Section c above. Planning will include attention to:

(1) land distribution

(2) organization of farmers

(3) water management

(4) provision of technical assistance and inputs to farmers

(5) establishment of a research area

(6) crop selection

(7) establishment of an appropriate farm records system.

5. Dams:

a. A site will be selected and plans drawn up for the construction of a small pilot dam. Construction will not begin until after the next rainy season, i.e. November 1982. AID will procure any necessary imported materials, e.g. cement, asphalt. All necessary equipment is believed to be available within MRD.

b. A program will be established for regular monitoring of runoff in riverbeds following rainfall.

6. Galleries: Of the three major potential sources of water in Tarrafal, the evaluation team has given lowest priority to galleries, following wells and dams. Exploration in this area will continue only if resources (supervisory personnel, drilling equipment, transportation) permit.

7. Completion of Phase I studies: CID will complete its various studies on Tarrafal agricultural development (including soils, crops, dams, hydrogeology, agricultural economics, farm management, et.al.) and present them in a final coordinated report. In addition to CID's work, studies in the following areas may be useful:

a. Domestic water needs and strategies for fulfilling those needs. An AID-funded W.A.S.H. contractor can assist with this work.

b. Additional socio-economic data on area residents. MRD's Rural Sociology Division can supervise the gathering of this data.

C. AID INPUTS

AID's assistance to the project during the proposed extension period can be summarized as follows:

1. Technical assistance provided through the CID contract in the following areas:

Hydrogeology
Farm management and project administration
Irrigation engineering
Agricultural economics
Agronomy
Soil conservation
Small dam construction.

2. Commodities: spare parts for drill rigs and AID-purchased vehicles, cement, and certain irrigation supplies.

3. Training:

a. On-the-job training in technical disciplines listed in Part A. above.

b. Possible short-term training in project management.

c. Assistance to MRD in developing training plans for Colonato farmers.

D. GOCV INPUTS

GOCV inputs would be technical and administrative personnel, land, certain commodities (inter alia, production pumps, plastic pipe for water conveyance, fuel) warehouse and workshop space, and repair and maintenance facilities for equipment and vehicles.

ANNEX I

EVALUATION TEAM SCHEDULE

Nov. 1	G. Anders arrived Praia (W. Slotten arrived earlier)
Nov. 2	M. Gould arrived Praia
Nov. 3	A.M. Group meeting with team members and GOCV officials.
	P.M. Discuss evaluation scope of work and made work assignments.
Nov. 4	Work at USAID and MRD; study available reports.
Nov. 5	Evaluation team departs for Tarrafal area; visits potential dam sites and soil conservation sites.
Nov. 6	Team visits Colonato, Achada Grande, Achada Boi and Ribeira Prata.
Nov. 7	Team meeting at MRD office in Tarrafa.
Nov. 8	Visit Longyear drilling site. Return to Praia.
Nov. 9	Evaluation team meeting and group discussions.
Nov. 10	Begin drafting reports.
Nov. 11	Evaluation team meets with USAID and GOCV officials.
Nov. 12	Evaluation team meets with USAID and GOCV officials to discuss findings. G. Anders departs.
Nov. 13	Team meeting to review drafts.
Nov. 14	A.M. Team meeting
Nov. 15	Sunday
Nov. 16	Team meeting to review drafts.
Nov. 17	Dimond and Slotten visit Tarrafal project site.
Nov. 18, 19	Finalize draft report.
Nov. 20	Final review of draft report with GOCV & USAID officials.

ANNEX II

REPORTS

Trip Reports

Robert Hill	Nov. 22, 1978
R.W. Hill & R.K. Stutler	Sept. 23, 1978
R. Kern Stutler	Aug. 29-Sept. 25, 1978
A. Alvin Bishop	Nov. 26-Dec. 15, 1978
Jose F. Alfaro	Nov. 26-Dec. 16, 1978
Jose F. Alfaro	Jan. 29, 1979
Jose F. Alfaro & Howard B. Peterson	Feb. 20-March 9, 1979
Jose F. Alfaro & Joao Queiroz	June 7-29, 1979
Jose F. Alfaro	May-June 29, 1979
Fred M Tileston	Nov. 9, 1979
R. Kern Stutler	July 29/Aug. 19, 1980
Mike Gould	July 31-Aug. 16, 1980
R. Kern Stutler	Dec. 23, 1980
R. Kern Stutler	July 20, 1981
R. Kern Stutler	Sept. 15, 1981

Special Reports

Conservation Plan for Tarrafal Experimental Watershed, Santiago, Cape Verde
R. Kern Stutler — June, 1979

Water Resources of the Tarrafal Area, Santiago, Cape Verde
John Logan — Aug. 16, 1979

Evaluation, Tarrafal Water Resources, Cape Verde, Nov. 1979
Evaluation Team:
Horacio Soares
Hugh Smith
Merril Asay
Fred M. Tileston
H.B. Peterson

Soils Report for Santiago Island
A.R. Southard, J.S. Queiroz — Jan. 1980

Interim Guide to Soils Utilization and Cropping Alternatives
R. Kern Stutler, Howard B. Peterson
and Alvin R. Southard Feb. 1981

Bulletin d'Analyse: Salinity, Conductivity
Christian Mannaerts April, 1981

Tarrafal Water Sources Project, Cape Verde Islands
John Logan July 29, 1981

The Search for Water at Tarrafal
John Logan July 29, 1981

Consultation Visit - Tarrafal Water Resources Project
Theresa Ware, Behavioral Scientist Oct. 22-29, 1981

Other Reports/Progress, Monthly, etc.

Quarterly Report, CID	Oct., 1980
Quarterly Report, CID, Utah State University	Dec. 31, 1980
Preliminary Analysis of Dam Sites, Dr. Keifer	1981
Memorandum, Patrick Byrne	March, 1981
Monthly Progress Report, Phil Coolidge	June 2, 1981
Memorandum, Phil Coolidge	June, 1981
Survey, Jack Livingston, Paul Brown	1981
Quarterly Report, CID	July 15, 1981
Memorandum, Pat Byrne	July 12, 1981
Progress Report, D. Lynn Brumbaugh	July 1981
Monthly Report, Phil Coolidge	Sept. 14, 1981
Progress Report, D. Lynn Brumbaugh	Aug. 1981
Progress Report, D. Lynn Brumbaugh	Sept.-Oct., 1981
Monthly Report, Phil Coolidge	Nov. 3, 1981

ANNOTATED BIBLIOGRAPHY OF TECHNICAL REPORTS*

Soils Report, A.R. Southard and J.S. Queiroz, Jan. 1980.

Reports the results of a limited soil survey. Although brief and terse, it does provide useful information appropriate to the present needs of the project.

Water Resources of the Tarrafal Area, J. Logan, Aguust 1979.

Provides a good description of geology of the project area and applies this knowledge to the exploration of groundwater. Using existing information and assumptions, estimates of groundwater quantity and quality are made. Recommendations for continuing the groundwater study are made.

The Search for Water at Tarrafal, J. Logan, July 1981.

Followup to the August 1979 report by Logan and gives a review of current status. Recent information is analyzed and good direction is provided for future studies.

Conservation Plan for Tarrafal Experimental Watershed, R.K. Stutler, June 1979.

This brief document provides recommendations on soil conservation measures.

Preliminary Analysis of Dam Sites, Keifer, 1980.

Report provides some interpretation of boring results and recommends pressure testing of the bore holes at the tentative dam sites. An initial examination of dam design alternatives is made. Report is preliminary and therefore inadequate for finalizing geotechnical dam feasibility.

Interim Guide to Soils Utilization and Cropping Alternatives, R.K. Stutler, H.B. Peterson and A.R. Southard, February 1981.

Preliminary recommendations concerning crops. Report does not take into account specific local conditions and practices.

Trip Reports (Only those containing technical assistance results)

Hill, R.W., September 1978.

Contains recommendations to the GOCV on meteorological and hydrological data gathering.

Alfaro, J.F., December 1978

Recommends GOCV gather data on wells, water use, irrigation practices, meteorology and sediment; and prepare topographic maps.

*Trip reports which are essentially technical reports are also listed.

Bishop, A.A., Dec. 1978.

Recommends GOCV gather data on crops, irrigation methods and water resources.

Alfaro, J.F. and H.B. Peterson, March 1979.

Provides some general agricultural guidance concerning wind, soil fertility, irrigation and crop selection.

Tileston, F.M., Nov. 1979.

Contains an evaluation of the water resources investigations and soil conservation progress.

ANNEX III

EXISTING IRRIGATION

The System at the Colonato in Chao Bom
(From Coolidge, March 5, 1981)

The water supply comes from three sources:

a. a spring (gallery) at Ribeira Prata which used to give 80 cmph (cubic meters per hour) but which has dropped to 20 cmph and apparently is not considered reliable;

b. a well at Ribeira Prata giving 35 cmph;

c. a well at the mouth of Ribeira Grande giving 25 cmph. This connects to the Ribeira Prata aqueduct somewhere near the farm. These last two wells are run at different times of day, so that the flowrate varies depending on which pumps are turned on.

Before the water reaches Colonato, the people at Chao Bom lift out a certain amount from the aqueduct for their own use. This decreases the daytime flow perceptibly.

At Colonato, the water can be diverted to a small tank. From there:

a. it can be pumped up the hill to refill the reservoir for Tarrafal. This is usually done in the early morning and is about the same amount each day. If there are more soldiers at the base, the amount increases.

b. it can be pumped to a small tank to give household water to Colonato;

c. it can overflow to Tank 1 for use by parcelholders.

If the water is not diverted as described above, it flows into Colonato where it can be used to fill Tanks 2 or 3, or goes directly to the parcels. The state has a right to 3 days of water, and the other 4 days go to parcel holders (renters). Each parcel holder gets 3 hours of water per week.

For 4 months a parcel receives water in the day, and then 4 months at night. The latter is preferred since there is a higher flowrate. To compensate for variations in flow during the day or during the night, each week the time for receiving water is rotated by 3 hours. Parcel holders can store their 3-hour water ration in the tanks if they wish and the hydraulic system permits. This allows them to take night rations and use them in the day. Also, the elevation of the canal is high, and water from the tank is closer to the level of their plots; the tank is used as a drop structure.

If four parcel holders (4 x 3 hours = 12 hours) fill the tank, then they measure the total depth of water in hands ("palmas") and each takes one fourth of the depth. This amount may vary from night to night, depending on the inflow. Thus allotments are sometimes measured by time, and sometimes by volume (depth in the tank).

There is no charge for water, but the cost of renting 1 ha. of land is 8000 escudos (U.S. $180) per year.

ANNEX IV

SOIL CONSERVATION WORKS (FROM GOCV PROJECT REPORTS)

1979

Topographic surveys:

-Dam sites and flood zones at Cincho 1 and 2, Garca 1, 2, 3, and 4, and Ribeira Grande. (1:500 and 1:2500)

-Experimental watershed at Monte Covado (1:2500)

Conservation works:

-Dike construction in Ribeira Fontao, Cincho, Guindao and Grande. 96 dikes totaling 7204 m^3 of rockwork.

-Terracing walls at Monte Covado

-Acacia plantings in basins. 3000 saplings in Cincho

-Miscellaneous dike repair

1980

Conservation works:

-Dike construction at Mau Passo, Guindao, Fontao, Ribeira Prata and Cincho. Total of 73 dikes for 10754 m^3 of rockwork

-Terrace walls. Total 3500m

-Bench terraces. Total length 4200m

-Acacia trees in Monte Covado, Achada Grande and Colonato. Total of 23290 saplings

1981

Conservation works

-Dike construction at Fontao, Cincho, Garca, Ribeira Grande and Ribeira Prata. Total of 6 dikes

-Dike Repair
Total of 5 dikes in Ribeira Grande

-50,380 trees planted

-Dikes repaired - 5

-Drilling of 10 production wells and 2 exploratory wells

-Test pumping in one well

-Wells protection, 3 wells in Ribeira Grande

-Office construction - MRD Office in Tarrafal

ANNEX V

RECOMMENDATIONS FROM HYDROGEOLOGY REPORT BY J. LOGAN, JULY 1981

Recommendations

My recommendations are numerous. Most of them were discussed with project personnel prior to my departure. However, some important information received on my very last day has led to revisions to the draft list of recommendations that was earlier distributed. The major change is found in recommendation "E-3" below which has been completely rewritten.

A. Access to wells

1. Obtain oxy-acetylene metal-cutting equipment for the Speedstar crew.

2. Remove the masonry caps from all wells, wherever installed. Let Lynn Brumbaugh and the crew make and install secure, metal caps that will provide rapid access into the wells and at the same time will be vandal-proof.

B. Measurements of depth to water

1. Immediately upon completion of "A", recommence the program of measuring water levels.

2. Make monthly measurements for one entire water year and then assess the program with the object of reducing the frequency of observations.

3. To assist this activity, determine the elevation of the measuring point and of the natural ground level at each well. Also locate each well in plan with sufficient care that its location becomes known with an error of 20 m or less.

4. Maps of the elevation of the ground-water surface should be prepared and maintained on an up-to-date basis. Maintenance is important because each new data point may lead to changes in our knowledge of ground-water configuration and that configuration may largely control any use of ground-water for irrigation.

C. Well Siting

1. As previously agreed, all new drillings and their locations should be mutually agreed upon by Barbosa, Brumbaugh, Coolidge and Mota Gomes. At least until Step "G" below, all drillings should be made in direct support of the Tarrafal Project (including Longyear holes).

2. The same group of persons should also consult at the termination of drilling, to decide whether or not a given boring is indeed completed before the rig leaves the site.

3. A water-level recorder might be installed at any well. Security of the recorder should be considered in all sitings.

D. Longyear Drilling

1. The Casa Choca boring must be deepened in order to determine whether water was encountered or not.

2. Drilling at the Monte Palha site should be stopped immediately and the rig should be moved to either one of the following sites (the second being preferred):

a. Above Casa Choca on the new road to Santa Catarina within 100 m of east-coordinate 08;

b. Directly east of that point, about 10 m above the thalweg of Rba. Guindao (the height being needed for flood protection) if an access road can be constructed.

3. Drilling at this revised location must reach water.

4. Upon completion of these two borings, a third site must be selected. It should be chosen with great care in order that a maximum of information be obtained with a minimum of drilling.

5. The recommendations of "A" and "B" above apply to all Longyear borings.

E. Speedstar Drilling

1. The new Grundfoss pump should be given to the Speedstar crew so that a provisional pumping test may be performed before the rig leaves the drill site. The completion of such a test will provide the information needed for a rational decision as to the well's completion.

2. Upon the completion of the redrill of SST-3 (now just to begin), drill a new hole about halfway between SST-3 and SST-18. Should its water level be at about sea-level elevation:

a. do not equip the well with large-diameter casing. Instead, install a 1- or 2-inch measuring tube, backfill and add to the observation program.

b. forget about irrigating Achada Tomaz with ground-water.

Should the static level in this well be substantially above sea-level, test the production and then redrill and test SST-18 at the new site agreed upon among Brumbaugh, Mota Gomes and myself.

3. Following "E-2", concentrate drilling along and near Ribeira Grande, exploring upstream and southeasterly from SST-8 in order to define the shape and the location of the ground-water ridge that appears to be associated with the ribeira. Locations of exploratory sites will be largely controlled by access and must be determined by the "committee." I do urge that one well be drilled within the ribeira close to SST-2 and SST-19 in order to

determine the transverse gradient of water level.

4. SST-4 needs redrilling and testing. Similarly for SST-14, but at lower priority.

5. A number of wells drilled in the past await redrilling to a larger diameter in order that casing may be installed and that pump testing can be conducted. In order that this situation may be avoided in the future, Alberto de Mota Gomes and I agree on the following two actions and we urge that they be made effective immediately:

a. all wells designed for production be drilled with an 11-3/4" bit or larger.

b. all wells designed as piezometers be drilled with 8" bits.

6. The "target" of 50 exploratory wells should be reduced substantially.

F. Pump Testing

1. To improve the accuracy of water-level measurements, a measuring tube should be used at all tests: a temporary pipe of 1" or 1.5" diameter will serve. If drawdown is about 1 m or less, try to measure water levels with a precision of 2 mm. This will be very difficult (and perhaps impossible) to do but success - if achieved - will merit the effort.

2. The step tests will be greatly improved if four steps are used for 100 minutes of pumping each, followed by 100 minutes of recovery measurements.

3. During either step or 24-hour testing, no more than 10 measurements of water level are needed for each log-cycle of time. The following schedule (in minutes) is widely used around the world: 1, 1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 10, 12, 15, 20, 25, 30, 40, 50, 60, 70, 80, 100, 120, 150, 200, 300, 400, 500, 600, 700, 800, 1000, 1200, 1400. Recovery measurements should use the same schedule.

4. Additionally, conductivity and temperature (to 0.1°) should be measured at the end of each step and at each hour during a 24-hour test. Additional samples should be collected for chemical analyses.

5. The pump testing crew must - repeat must follow the drill rig closely in time! Pump testing should begin within a few days after the rig leaves a site. Information must be made available without delay because "Phase II" of the Tarrafal Project is to be designed at an early date.

6. Give careful consideration to any possible method of pump testing that will result in discharges substantially larger than the 28-32 m^3/hr achieved to date. Using the "rule of thumb" that 1 lt/sec is needed for 1 hectare, a production of 30 m^3/hr will irrigate only 8 ha! Much higher pumping rates will be needed if irrigation from ground-water is to succeed at Tarrafal.

G. Assessment

1. Upon completion of the items under "E" above (including the appropriate pump testing), the then available data should be carefully assessed, with future activities being determined and assigned priorities.

2. A concentrated effort will be needed in order to conduct the assessment at an early date, else "Phase II" may suffer.

H. Miscellaneous

1. Galleries: Upon completion of "D" above, the possibility of gallery construction should be assessed. If such a source of water appears to be interesting, Alberto de Mota Gomes could be sent to Tenerife on an inspection trip, contacting geologists at the Universidad de Sta. Cruz de Tenerife, officials of the Ministerio de Obras Publicas at Sta. Cruz and local "gallery masters." Please note that I am neither an optimist nor

a pessimist about galleries at this stage of the game: more information is needed before anyone can form an opinion on the utility of galleries as a source of water.

2. Water-level recorders: The two recorders should be placed in service with Phil Coolidge being in charge of this operation. One should be used at any pumping test for which an observation well is available.

3. Windmills: Windmills offer great promise for the pumping of modest supplies of water, such as may be needed for a village. Rather than performing lengthy meteorological testing, let us install a windmill and determine its success or failure from actual experience.

4. Well protection in Rba. Grande: I fear that the new masonry walls around ST-3, ST-4 and SST-8 may be too low to provide adequate protection against floods. Rather than raising the walls, serious consideration should be given to raising the wells themselves, particularly if turbine pumps are to be installed. Coolidge has some good ideas on this subject.

ANNEX VI

BASELINE INFORMATION OUTLINE

Scope: Island of Santiago.

Purpose: To provide basis for planning and decision-making.

Authorization: GOCV/MRD and USAID.

Personnel: MRD/CID, with USAID advice.

Time Period: December 1 - February 28.

Stage 1a

Determine needs for information by interviewing decision-makers in MRD, USAID, other donors, etc. Also, obtain leads on what information may already be available. 1 - 15 December.

Stage 1b

Produce strategy paper outlining rationale for baseline study, analysis of data needs, inventory of existing relevant data sources, listing of gaps to be filled, results of literature search (Cape Verde data only), and plan for implementation. 16 - 31 December.

Stage 1c

Develop data collection guides, field test guides, plan itinerary, notify persons where necessary. January.

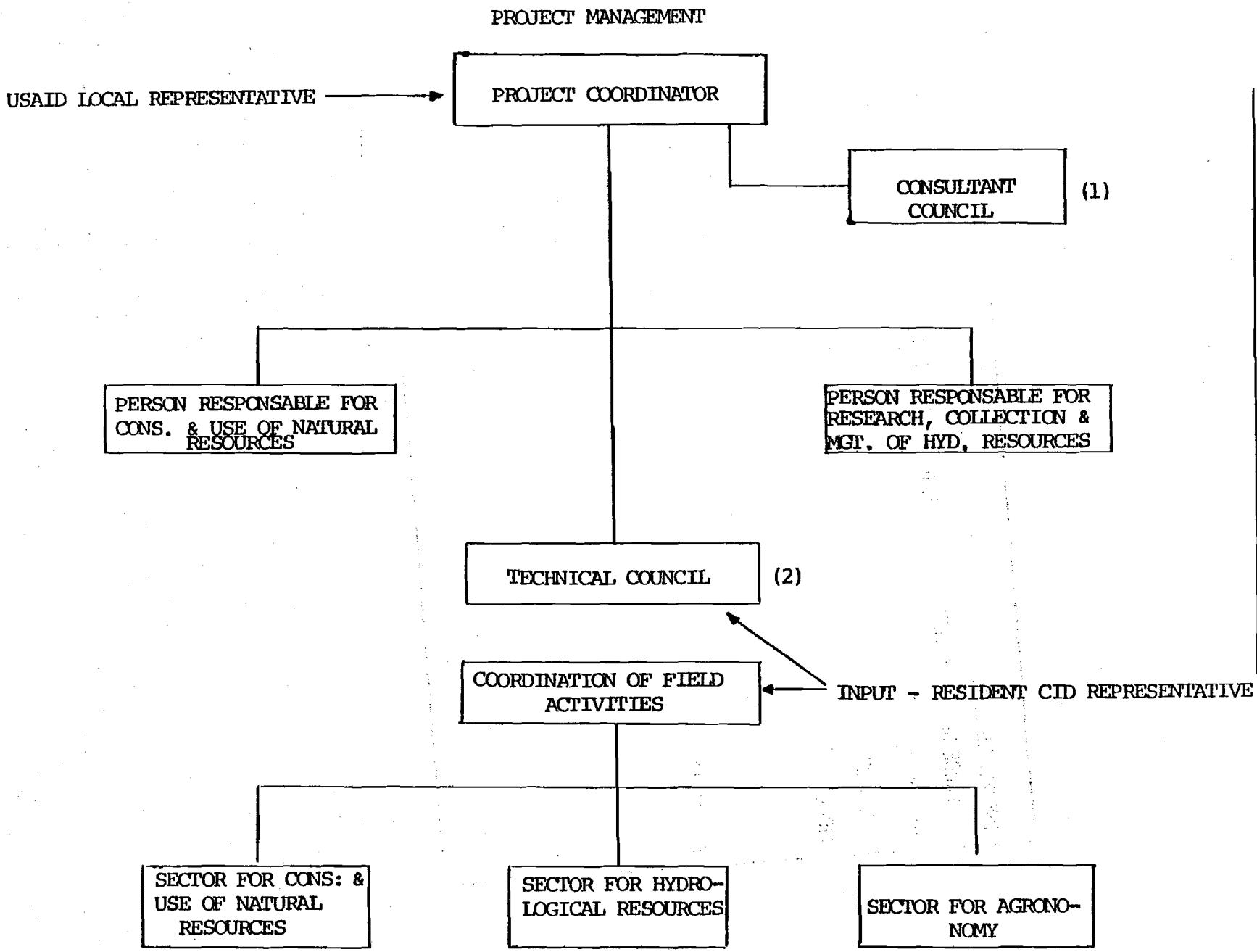
Stage 2

Collect data.

Stage 3

Analyze data, prepare tables, write up report, discuss implications for future project activities in the area of irrigated agriculture. February.

PROPOSED ORGANIZATIONAL CHART FOR TARRAFAL PROJECT MANAGEMENT



(1) BI-ANNUAL MEETINGS

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