ANNEX I

RURAL WATER RESOURCE DEVELOPMENT IN TOGO: MARITIME & SAVANES REGIONS

June 1978

USAID (693 - 0210) FY 79

HYDROGEOLOGY AND DRILLING METHODS

SPECIFICATIONS AND ESTIMATED COST

Prepared by: George C. Taylor, Jr., Hydrogeologist

Robert D. Hilty, Hydrogeologist

Michael V. Glaze, Drilling Technologist

TABLE OF CONTENTS

ILLUSTRATIONS

Page

FIGURES

TABLES

PLATES
(in pocket)

Plate I. Geologic map of Togo

II. General map of Togo

III. Savanes Region map
Dapaong Circonscription
Sansanne - Mango Circonscription

IV. Topographic maps (maps available)
Sansanne - Mango 3a
Sansanne - Mango 2b
Sansanne - Mango 3b
Sansanne - Mango 4c
Sansanne - Mango 4d

V. Map showing the number and location of FED Wells (1978)

APPENDIX

Appendix I. Dapaong Circonscription schools

II. List of Villages that need water
Hydraulic Services - Sokodé
Rural Animation - Dapaong
Hydraulic Services - Lomé
FED - 3: no wells planned

III. List of GOT drilling equipment

IV. Moyno pump brochure

Rural Water Supply Development

Availability of Water Supply : As contrasted with the general regional east-west banding of climatic zones that prevails in West Africa, much of Togo as well as neighbouring areas in southeastern Ghana and much of Benin lie in a zone of climatic anomaly. Rain-shadow effects created by the Atacorian Hills apparently generate this anomaly. Consequently, in the Coastal Plain of Togo and extending inland as far north as Akaba (lat. 8° north) the Sudan savanna type of climate prevails with annual rainfall ranging from less than 900 to about 1,100 mm. Farther north rainfall increases to as much as 1,400 to 1,600 mm on the Atacorian Hills of western and north-central Togo and then decreases gradually to about 1,100 mm in the Savannes Region of the extreme north. Also as a result of this anomaly, rainfall and streamflow tend to be highly variable from year to year and local water shortages are chronic. Rainfall in the Dapaong area and in the middle Oti River basin (Mango - Sansanne area) is generally concentrated in the months between April and October. November through March is the dry season. In the south of Togo the rainy season is a month or so longer, even though the total annual rainfall is less than in the north. Also in the south there is usually one dry month, August, in the middle of the rainy season. (B)

Because of rainfall distribution most of the larger streams in Togo that head south of the Atacorian Hills are flashy with high discharges in the rainy season and very low base flows in the dry season. The most important of these streams are the Sio, Lili and Haho Rivers. The flow of the Sio inland from Lome is at times less than 0.3 m^3/sec during the dry season. The Mono River whose tributaries head in the high rainfall belt of the Atacorian Hills has important base flows even during the dry season. The Oti River, whose middle and upper tributaries rise in the Atacorian Hills of northern Togo and Benin, also has important dry season flows (B)

Because of the seasonal variability of water supply, the Government of Togo has been making strong efforts during the past 15 years, with the help of foreign donors, to ameliorate water shortages in rural areas through construction of modern open wells and also some drilled wells and for the larger urban conglomerations through building of dams and reservoirs, treatment plants and water distribution systems. Nevertheless, and in spite of these efforts, more than 50 percent of the rural population continues to depend on water supply obtained from unprotected springs, unlined traditional wells, defectively constructed modern wells and contaminated natural water holes.

With some exceptions, however, due to unfavorable geologic conditions or deep water levels, ground water can be obtained from wells in quantity adequate for village supply in 80 to 85 percent of the national territory of Togo. Where ground water is not available or too costly to develop, alternative surface-water sources can generally be found and developed. If sanitary quality of rural water supply is to be taken as a valid social goal, however, adequate measures must be taken to protect wells or surface-water sources against pollution and to insure continuing maintenance of water points and pumps. In the absence of maintenance programs to assure continuing sanitary quality, investments in water-delivery systems are of doubtful merit.

Hydrologic setting: Togo contains within its national territory three general groups of rocks, each of which presents particular problems with respect to ground-water development and management. The oldest of these groups are the Precambrian crystalline rocks which directly underlie about 75 percent of Togo, chiefly the Plateau, Centrale and Kara Regions but also the northernmost part of the Savanes Region and the northern edge of the Maritime Region. Somewhat younger are the consolidated Paleozoic sedimentary rocks of the Oti sedimentary basin in the Savannes Region underlying about 15 percent of the national territory. Youngest is the Coastal Plain lying entirely within the Maritime Region and underlain by unconsolidated and semiconsolidated sediments ranging from Cretaceous to late Tertiary age. The Coastal Plain covers approximately 10 percent of Togo. (B)

Among the three groups of rocks in Togo mentioned above, the crystalline rocks of the Precambrian terrain present the most difficult technical problems with respect to extraction of potable water supplies for rural requirements. The methods which must be adopted, in the search for and recovery of ground water in these terrains are often costly with substantial risk of failure or only qualified success in obtaining even minimal supplies. Nevertheless, there is no alternative source of ground water in 75 percent of Togo. The Precambrian terrain includes Dahomeyan migmatized gneiss and mica schists; ancient gneissic granite shield rocks of the Dapaong and Palime areas; and younger quartzites, phyllites and slates of the Buem, Atacorian and Kante systems which form mountainous ridges with intervening valleys trending north - northeast through the western and north-central part of Togo.

The most readily available ground water and presently the most extensively developed for rural water supply in the Precambrian terrains is that which occurs in the surficial mantle of weathered rock together with an underlying fractured zone.

In some lowlands and plains of Togo the weathered mantle attains thicknesses of as much as 40 m or more, but on higher ground near rocky outcrops or in hilly areas the mantle may be only a few meters thick. On the Dapaong and Palimé granites, granite gneisses and mica schists the weathered mantle may attain thickness of up to 40m; on the Dahomeyan migmatites it averages about 10m thick; and on the rocks of the Buem, Atacorian and Kante systems it is commonly less than 2m thick. The weathered mantle from the surface down generally has the following characteristics :

(a) Laterite carapace or duricrust. Thickness 0-10m. Seldom permanently water-bearing. Traditional unlined open wells can sometimes yield up to 30 m^3/h, while the carapace is temporarily saturated during the dry season.

(b) Clayey alterites, commonly Kaolinitic and up to 10m thick. Running or soupy saturated clays may cause problems in sinking the concrete curbings of modern open wells. Yields to wells can range from nothing to a few hundred liters per day.

(c) Friable sandy zone a few meters thick with cemented mineral aggregate in granites and gneisses. Yields to wells can range from a few hundred liters per hour to a few m^3/hr.

(d) Fractured zone as much as 50 to 100m thick, in places less or even more. Yields can range from about 0.5 to 10 m^3/hr.

Most open dug wells do not, and in some cases cannot, penetrate much into zone (d). On the other hand, small diameter tubwells drilled by the percussion and rotary methods can penetrate into zone (d) to intercept water in deeper fracture systems. These two methods may become ineffective and uneconomic, however, if the rock becomes too hard. Penetration of hard rocks to depths of 100m

or more can be accomplished with ease by the down-the-hole air hammer drilling method. In the granites and granite gneisses of the Precambrian terrains of Togo the thickness and permeability of zone (c) conditions the yields of open dug wells. The schists may be productive to open wells in zone (b), but zone (c) is usually absent. Zone (d), however, is usually productive to drilled wells in schists. Phyllites are commonly quite non-productive in all zones but fortunately they are not widespread. Quartzites do not weather significantly, but they are usually productive to drilled wells in zone (d).

Many open wells of both traditional and modern design have been put down throughout Togo to serve rural water-supply needs. The wells which tap water in the weathered mantle of the Precambrian terrain range from about 5 to 40 m deep and average about 15 m. The yields obtainable from such wells are generally no more than about 10m^3/day, and many fail completely. The water levels in wells commonly fluctuate widely in the Precambrian terrain, rising in the places to less than 5 m below the land surface during the rainy season and then declining to as much as 15m or more below land surface in the dry season. Because of these large fluctuations, most open wells must be deepened two or three times before a stable supply through the dry season can be assured.

Ground-water occurrence in the Precambrian terrain whereas homogeneous on a regional scale, is much less so on a local or well-site scale. Consequently, there is always a risk of failure or only qualified success in sinking any well in the Precambrian terrain. On the average about 5 percent of all wells put down find no water, about 10 to 15 percent provide very meager supplies, and 80 to 85 percent can be adequate to provide enough water or more for a small village supply. The risk of failure through poor well siting can of course be reduced by appropriate study of local fracture systems using well-established geologic criteria.

The range and average yields and well depths in the common rocks of the Precambrian terrain of Togo are as follows :

Rock Type	Well yield (m^3/hr)			Well depth (m)	
	Range	Aver-age	Excep-tional	Range	Aver-age
Schist	0 - 20	4	30	25-80	40
Quartzite	0 - 5	3	15	25-80	40
Granite and granite gneiss:					
Zones(a) and (c)	0 - 5	0.2	10	5-40	15
Zone (d)	0-10	4	20	30-80	40

Because of the uncertainty of water supplies from open wells and beginning with the UNDP ground-water survey of Togo in the mid-1960s, increasing efforts have been made to tap deeper fracture systems in the Precambrian rocks with drilled wells (tubewells). Whereas a certain percent (perhaps 10 to 15 percent) of such drilled wells can be considered failures, most succeed in tapping larger and more permanent water supplies than those obtainable from open wells. At Dapaong, for example, four drilled wells were put down in about 1965 to depths of 19 to 58 m in granite gneiss. The yields obtained ranged from 3.5 to 15 m^3/hr. There was also enough yield obtained among the four wells to supply 20 m^3/hr or 480 m^3/day at Dapaong. (B) (These wells still (1978) provide a substantial part of the municipal water supply of Dapaong). The chemical quality of the water is quite good with only 160 to 310 mg/l of total dissolved solids. At Bassar, however, shallow drilled wells put down to depths of 10 to 22 m in Buem quartzites obtained every low yields ranging from 0.4 to 12 m^3/day. (It is possible that larger yields could have been obtained by deeper drilling) (B). Three wells drilled 17 to 4.5m deep at Kante in schists and phyllites produced yields ranging from 7 to 12 m^3/h, but the average yield to be expected from a drilled well of this depth

in this area is about 1.5 m^3/h. Among nine wells drilled in 1965 to depths of 15 to 45m in the Atacorian schists near Sokode four (45 percent) were total failures. Yields in the remaining five wells ranged from 0.3 to 5.0 m^3/h. Most ground water in the schists was found in the fractures of zone (d), and not in the overlying weathered mantle which is 1.5 to 15 m thick in this area.(B) Dahomeyan migmatized gueisses at Lama Kara produced yields ranging from 1.8 to 7.2 m^3/h in three drilled wells, 20,46 and 70 m deep. At Notse the Dahomeyan migmatites yielded 3.0 and 4.0 m^3/h to two drilled wells 52 and 70 m deep (B).

The consolidated Paleozoic sedimentary rocks of the Oti sedimentary basin underlie about 15 percent of Togo in the Savannes Region. Because of their consolidation most ground water in the Paleozoic rocks circulates through secondary fractures and along bedding planes other than through the interstices of the rock grains. The sandstones generally form the most productive aquifere, but the interbeded limestones shales and siltstones are also locally productive. Many existing open wells in the Savanes Region tap shallow ground water in Paleozoic rocks at depths ranging from 5 to 30 m. The yields obtained from such wells range from about 2 to 5 m^3/day, but many go dry in the dry season. The depth to water ranges from about 10 to 20 m in the dry season to as little as 2 m in the wet season. Relatively few tubewells have been drilled in the Paleozoic rocks of the Savannes Region, but the expectable yields and dependability of the supply are likely to be considerably greater than those from existing shallow wells. At Boumbouaka, for example, two exploratory wells drilled to depths 50 to 37 m in fractured argillaceous sandstone produced yields of 7.0 and 0.3 m^3/h, respectively. It is estimated that 50 to 100 m^3/day could be obtained from individual deeper drilled wells in this area(B) The expectable yields that could be obtained from drilled wells in the Paleozoic rocks of the Savanes Region are given in the following table :

Rock type	Well yield (m^3/h)			Well depth (m)	
	Range	Aver-age	Exeep-tional	Range	Aver-age
Sandstone	1-5	3	40	10-100	50
Shale and/or Siltstone	0-5	1	10	5-70	50
Limestone	0-20	10	75	15-100	50

The Coastal Plain of the Maritime Region of Togo is underlain by a wedge of unconsolidated and semiconsolidated sediments. These thicken rapidly seaward (southward) from a feather edge against Precambrian crystalline rocks on the north to more than 600 m along the coast. The Coastal Plain sequence in ascending order includes the following (I) :

1. The Upper Cretaceous (Maestrichtian), which attains a thickness of about 200 m is largely sand or soft friable sandstone overlain by interbedded coal, clay and marl.

2. The Paleocene (Montian and Thanetian), about 45 to 50 m thick, consists of fossiliferous sandy limestone and some sand.

3. The Eocene (Ypresian) includes interbedded marls, nummulitic limestones and a phosphatic facies of Eocene (Lutetian)age.

4. The Continental Terminal (Miocene to Pliocene age) includes interbedded fluvial and lacustrine deposits of clay, sand and gravel which blanket older sediments of the Coastal Plain. The Continental Terminal is less than 10 m thick near the inland edge of the Coastal Plain but thickens to about 100 m along the coast.

5. The coastal plain is dissected by the valleys of the Sio, Lili and Haho Rivers and a pronounced strike lowland, the "Depression de la Lama". These valleys are in places filled by Holocene alluvial

deposits of silt and clay as much as 30 to 50 m thick. The valleys and the lowland divide the Coastal Plain into six interfluvial "plateaux".

6. A sandy barrier beach 5 to 6 m above sea level between Lome and Aneho, which blocks the drainage of seaward flowing streams and forms Lakes Togo and Aneho.

Three important water-bearing zones have been recognized in the Coastal Plain, (C) The uppermost, and perhaps the most productive, of these are sand and sand and gravel aquifers in the Continental Terminal which occur at depths of 20 to 30 m in the north increasing to 60 to 80 m in the south. In the vicinity of Lakes Togo and Aneho the water in these aquifers is brackish or salty. Deeper aquifers occur in sand and limestone of the basal Paleocene. A still deeper aquifer also occurs in sand and friable sandstone of the Upper Cretaceous.

Open wells in the Coastal Plain tap the uppermost aquifer at depths ranging from less than 15 m near the coast to as much as 70m in the Tabligbo area. Owing to dissection of the Coastal Plain by stream valleys the ground-water levels beneath the plateaux are remarkably deep - for example 30 to 60 m in the Tabligbo and Tsevie areas and 10 to 30 m in the Vogan and Attitogon areas. Because of deep water levels and the labor involved in lifting water by hand lines and buckets for domestic water supply, open wells are used as a water source of second or third choice. Cistern supplies and nearby streams or marigots are preferred water sources during the rainy season and open wells are used chiefly during the dry season(C).

At present there are reported to be about 30 production tubewells in the Coastal Plain which are equipped with power pumps and engines. (D) Most of these tubewells tap water in aquifers of the Continental Terminal but some are screened in aquifers of the Paleocene and Upper Cretaceous. The tubewells range from about 40 to 250 m deep. The yields obtained from individual tubewells equipped with

power pumps and engines are reported to range from as little as 2 m^3/h to as much as 180 m^3/h. Most of the tubewells, however, are pumped at rates of 10 to 30 m^3/h. The static water levels in these tubewells appear to be comparable with those found in the open wells. (C)

In addition to operating tubewells, there are reported to be a considerable number (perhaps as many as 200) of idle, small-diameter, completed and screened tubewells now capped with steel plates. These tubewells were put down chiefly for observation in connection with studies of the hydraulic characteristics of aquifers. (D) Many of these tubewells could now be fitted with hand pumps to provide sanitary water supply for nearby villages.

Past projects in water-resources development : A considerable number of water-resources studies and development projects have been undertaken and completed in Togo with international and bilateral donor assistance during the past 15 years. The studies have produced a large volume of useful information essential for the systematic development and management of the country's water resources. Also a considerable number of surface-water and ground-water development projects have been undertaken and completed for town and small city (15,000 - 30,000 persons) water supplies. Foreign donor assistance for construction of both open and drilled wells has been provided in several parts of Togo. The more important of these programs are as follows :

Studies:

(1) ORSTOM (French, Office de la Recherche Scientifique et Technique Outre Mer) in cooperation with the Togo Service du Genie Rural and Ministere de Travaux Publics. ORSTOM supports a country-wide stream-gaging network and makes pre-feasibility hydrologic studies in all the important river basins in the country.

(2) ASCENA in cooperation with the Togo Direction Generale de Meteorologie. ASCENA supports a country-wide network of weather stations and a continuing program of meteorologic observations and data collection.

(3) Italoconsult/UNDP (Study for the provision of water for Lome, Tsevie, Aneho, Tabligbo and Ahepe, 1969). (A)

(4) UN/UNDP/ITALOCONSULT in cooperation with the Togo Direction des Mines et de la Geologie. UN/UNDP Project TOG 4 (Survey of Ground Water Resources, Togo, 1967). (B) Activities in this project during 1964-68 were concentrated in the Precambrian crystalline and Paleozoic sedimentary rock terrains. Altogether 23 percussion drilled test wells were drilled in these terrains. In addition four test wells were put down in the Coastal Plain.

(5) Swedish bilateral technical assistance during 1968-71. Project concentrated in Coastal Plain. Ten exploratory wells were put down by percussion drill in the western part of the Coastal Plain and one in Precambrian crystalline rocks at Avetonou. Seven pumping tests were made of which three were in tubewells 10 to 15 km north of Lome. The depths of the exploratory wells, 90 to 130 m deep, indicated potential yields of 30 to 60 m^3/h.

(6) British bilateral development assistance during 1972-73 in cooperation with the Ministere de Travaux Publics. Project concentrated in the Tabligbo area of the Coastal Plain. Nine production tubewells were drilled by Balakhany, Ltd., Lagos. The tubewells were all equipped with Monolift helical type pumps manufactured by Monyo Pumps, Ltd., U.K. These pumps are belt-driven by Lister diesel motors.

(7) UN/UNDP in cooperation with the Togo Direction des Mines et de la Geologie. UN/UNDP Project TOG/70/511 (Ground-water Exploration in the Coastal Zone, Togo, 1975).(C) This project, carried out during 1971-75, concentrated on the Coastal Plain to

determine the thickness and areal extent of the aquifer systems and the potential threat of salt-water encroachment. In addition test drilling was carried out by the percussion method at 10 selected villages in the Precambrian crystalline terrain. Two drilling rigs were provided by UN/UNDP for the project - one Speed Star 71 percussion rig mounted on a Dodge truck and one WABCO 1250 rotary rig mounted on a Ford truck. Altogether 43 test wells were put down during the project. Eleven test wells were drilled to depths of 40 to 90 m and screened in the Continental Terminal; 20 test wells were drilled to depths of 90 to 250 m (average 150m) to test deeper aquifers in the Paleocene and Upper Cretaceous; and eleven test holes were drilled in Precambrian cystalline rocks. The maximum depth reached was 303 m in the Coastal Plain at Aveta east of Lome with the WABCO 1250 rig. The rotary drilled wells were started with 13-5/8 inch or 8-5/8 inch casing and finished with 6-inch. Johnson wire-wrap and Nold PVC screens were placed opposite the aquifers tested.

(8) CIDA (Canadian International Development Agency) in cooperation with the Direction des Mines et de la Geologie (DMG). (Feasibility study for a project to provide water to the city of Lome and nine other villages in the Coastal Plain) (D). Carried out during 1974-76 the work included hydrogeologic studies, test drilling, pumping tests and a preliminary development plan for well fields with pipe lines to supply the city of Lome. The work was carried out with a Failing Walker-Neer (FWN-40) combination rig, which is truck mounted, and a Bucyrus-Erie truck mounted percussion rig. This equipment was turned over to the DMG at the end of the project. Also as part of this project eight(8) production tubewells were constructed at or near Sanguera, Noepe/Akepe, Amedenta, Legbassito, Mission Tove, Kpogame Nouveau, Abobo and Lebe. The tubewells range from 43 to 250 m deep with yields ranging from 2 to 27 m^3/h. All were completed with 10 to 8-inch surface casings and with Johnson-type stainless steel wire-wrap screens set opposite water-bearing sands. Each of the tubewells is equipped with a Berkeley vertical shaft turbine pump

coupled with a right-angle gear drive to a Lister diesel engine. Each of the tubewells serves populations of 3,000 to 7,000 persons with from one to three ground-level concrete tanks from which water is drawn by users from 10 to 40 faucets. A pompiste is in charge of each tubewell and is responsible for operating the pump, the routine lubrication of the pump and engine, and the procurement of fuel. Responsibility for the operation and maintenance of the pumps was recently transferred from the DMG to the Service (Hydraulique) (SH). No charges for water, fuel or pump maintenance are recovered from the users. (D)

(9) Federal Republic of Germany in cooperation with the Direction de Mines et de la Geologie. (Ground-water exploration project in the Tabligbo region). (G)

(10) Direction des Mines et de la Geologie carries on a continuing program of exploratory drilling for ground water and hydrogeologic studies; and also a country-wide survey of existing water points.

(11) Service de Genie Rural (country-wide survey of dams and tanks.)

Development Projects:

(1) Fond Europeen de Developpement (FED) in cooperation with the Service or Subdivision Hydraulique. FED has financed the construction of some 500 open wells for village water supply in the course of three loan agreements. During the third agreement, work was initiated in 1974 and completed in May 1978. Initially it was planned to put down 250 open wells at a cost of 400 million CFAs, but actually only 120 open wells without pumps were completed at this cost. The gross cost per well was thus 3.33 million CFAs which at 230 CFAs per US$ would be about $14,493 per well. The wells were of the standard West African modern design, 1.8 m in diameter at the surface with a 0.8 m

raised curbing (margelle) and concrete apron around the margelle. The average depth of the wells is reported to be about 28 m, so the average cost per meter would be about $518. The wells are scattered throughout the Savannes, Kara, Centrale and Plateau Regions.(H)

(2) Under the direction of the Regie Nationale des Eaux du Togo (RNET) work is now underway on the construction of a dam on the Kara River at Koumea. This reservoir with an ancillary water treatment plant and distribution system will eventually provide piped water to the cities of Lama Kara, Niamtougou, Pagouda and Ketao as well as neighboring villages. The work is now being carried out by a French construction company, SOCEA. A dam and reservoir for the municipal water supply of Notse has also been completed by the same company. Also two elevated water towers have been completed. A water-treatment and filtration plant and the distribution system are presently under construction.(F)

(3) The German National Development Bank (KVV) also loan funded construction of a municipal water supply for the city of Sokode. Completed in 1971 capital works include a dam and reservoir, a water treatment plant, a 32 km adduction pipe line, a settling basin, and a water tower and distribution system in town. The system services 49 public taps and 150 private connections in the city (pop. 30,000) and 8 villages (pop.5,000 total) along the adduction one. The system is currently being managed by the RNET. (G)

Presently active and proposed rural water development projects by other donors:

There are at present (June 1978) five projects, proposed for implementation by other donors, that are related to the proposed USAID Rural Water Supply and Sanitation Project in the Savanes Region. The West African Development Bank (BOAD) has prepared a project proposal for a "Village Water Supply Programme" requesting the Government of Denmark to provide financing for construction and materials for 150 modern open wells located throughout the 56,600 km^2 of Togo's national territory. The total cost of the project is estimated at 300 million CFAs which at 230 CFAs per dollar would be $1.3 million. The gross cost per well for 150 wells would then be 2.0 million CFAs or $8,695 per well or for the average well 26 m deep, or $334 per linear meter. Each well will have a metal ladder; one margelle 0.20m thick and 0.8m high above the natural land surface; one concrete surface apron; and no pump or cattle-watering facilities. The well curbing will be emplaced either with reinforced concrete poured in place or prefabricated concrete rings 1.4m interior diameter at the land surface. In the weathered zone perforated 1.0m ID concrete rings, backed with a gravel filter pack, will be placed and a perforated concrete slab will be placed in the bottom of the well. In hard rock sections no curbing will be placed. The number and regional distribution of the wells will be as follows :

Region	Average Depth(m)	Number	Total(m)
Maritime	40	25	1,000
Plateaux	17	40	680
Centrale	20	30	1,600
Kara and Savanes	30	55	1,650
		150	3,930

Overall average depth is 26 m. (K)

The Fonds Europeen de Developpement (FED) is currently financing a rural development project in an area of about 3,000 hectares in the Kara Region. The project is under the direction of the Kara Regional OPRV (SORAD) of the Ministere de l'Equipment Rurale. Some 20 modern open wells were constructed for 200 families in the first phase (Feb. 1974 - May 1977) of the project reportedly at a cost of 3.5 million CFAs or 175,000 CFAs per well. The wells averaging about 15m deep yield very little water and some go dry in the dry season. A second phase of the project during which 1,000 new families will be resettled is now underway. Thirty new wells will be constructed in this phase (1977-81) of the project.(H)

In February 1978 a Fourth agreement between FED and the Government of Togo was approved that provides for the construction of 290 drilled wells. The project will last 5 years. Bids for 280 hand pumps, to be mounted on these wells, will be let in July 1978. Two of the wells will be equipped experimentally with solar pumps. Sixty (60) wells in the Maritime Province will be drilled departmentally by the DMG using its available percussion and rotary drilling rigs. The rest of the wells (230) will be drilled by a contractor using a down-the-hole air hammer rig. The company winning the bids for pumps will also be required to provide pump maintenance training at village level and post-sales service. Twelve (12) Togolese hydrogeologists, pump technicians and well drillers are to be trained by the BRGM in France as part of the project. The Service Hydraulique (SH) would have overall responsibility for pump maintenance and repair and would set up pump and well maintenance units in each region. All new equipment would be provided to the project and would be sold at cost to a Water Development Corporation at the end of the project. Some 400 million CFAs have been set up for the project, which for 290 wells would come to a gross projected cost of 1.38 million CFAs per well plus hand pump or at 230 CFAs per dollar would be $6,000 per well plus hand pump.(H)

The approximate number of wells to be constructed in each of Togo's economic regions is as follows :

Region	No. of wells
Maritime	60
Plateau	110
Centrale	75
Kara	20
Savanes	25
	290

The UNDP as financing agency and the UN as executing agency signed an agreement on March 9, 1978 with the Government of Togo ~~xx~~ implementing project UNDP/TOGO/75/008/A/01/01 "Strategie d'Amenagement des Eaux du Togo", First Phase. The project has a 3-year duration beginning in May 1978. The Ministere des Mines, de l'Energie et des Ressources Hydrauliques is the counterpart agency. The Togolese contribution is 120.1 million CFAs (in kind) and the UNDP contribution $US 1,502,683. There are four principal project components.

(1) Complement (or extend) hydrogeologic research in a 15,000 km^2 area of the Plateaux Region by test drilling (using a down-the-hole air hammer rig), photogeology and geophysics. Productive wells would be equipped with hand pumps for provision of water to neighboring villages. (No mention is made of the total number of wells to be drilled but one down-the-hole air hammer rig is provided for in the budget).

(2) Collection of all available hydrologic data for creation of a "data bank" and use of the information to publish an "Atlas of the Water Resources and their Utilization in Togo". This atlas will present information in the form of maps with an explanatory text on the meteorologic, hydrologic and hydrogeologic characteristcs of Togo.

(3) Assistance to the government for the material equipping and development of a "National Commission on Hydraulic Works".

(4) Training of Togolese personnel in well drilling, hydrogeology and the planning and utilization of water resources.(J)

Under joint financing by the International Development Association (of the World Bank group), the FAC (French bilateral aid), and the Government of Togo a 5-year project for Rural Development in the Maritime Region was implemented in July 1976 and will continue until ~~June~~ June 1981. The total funding provided under the project is 3,422 million CFAs. In original project planning provision was made for construction of 20 drilled wells with hand pumps for village water supply. As of the present time (June 1978) no wells have been constructed and it is anticipated that perhaps only 4 or 5 will actually be constructed owing to high unit costs.(K)

Agencies concerned with rural water-supply development : Although some 184 million CFAs per year of Togo's national budget are currently allocated to rural water-supply development, it is not clear how, where and what agencies spend these funds. Responsibility for rural water-supply development is currently fragmented in several agencies among which are :

1. The Hydraulic Service of the Ministry of Mines, Energy and Water Resources (Service or Subdivision Hydraulique).

2. The Sanitation Service of the Ministry of Public Health (Service d'Assainissment).

3. The Rural Engineering Service of the Ministry of Rural Equipment (Genie Rural).

4. The Rural Animation Service of the Ministry of Rural Development (Animation Rurale).

5. The Social Affairs Service of the Ministry of Public Health (Affaires Sociales).

6. The five regional development offices (ORPVs, formerly SORADs) of the Ministry of Rural Development.

7. The Togolese National Red Cross (Croix Rouge Togolaise).

There are also a number of church and private projects for well construction such as the Evangelical Church project in the Plateaux Region, the Catholic Church project in the Savanes Region, and an OXFAM project that was previously carried out in the Centrale and Kara Regions.

Coordination among all the various agencies concerned with rural water-supply development is virtually non-existent. A National Water Commission nominally exists, but this interdepartmental body has yet to convene its first meeting. There is little question that an active

National Water Commission is badly needed to formulate policy and coordinate all the disparate water-resources development activities presently in progress in Togo.

Among the agencies mentioned above, the principal agency involved in the construction of new wells and the maintenance of existing wells for rural water supply is the Service Hydrauliques. The SH operates in two divisions, a southern one headquartered at Lome and a northern one at Sokode. The SH now puts down about 30 open wells per year departmentally and contracts out other well-construction activities to private companies. The SH was the Togolese agency responsible for the Togolese administration of the recently completed third FED well construction project carried out by an Italian contractor. The SH has completed departmentally about 150 open wells during the past 10 years. The SH well construction program is highly mechanized with extensive use of mechanical derricks, air compressors, jack hammers, explosives and sinking pumps. The SH employs the standard design for the modern open well used throughout Francophone West Africa. In the Precambrian and Paleozoic terrains the SH reports that its open wells generally range from about 15 to 25 m deep with average yields about 0.15 m^3/hr. ~~[illegible]~~ but some yield as much as 3.0 m^3/hr. In the Coastal Plain the SH reports its open wells must be sunk in some places to depths of 50 to 70 m to obtain water sufficient for a village supply. Construction of modern open wells to such depths becomes an extremely costly and time consuming operation. Consequently, the SH believes that intermediate diameter (8-10 inches) drilled wells yielding a nominal 20 to 30 m^3/h and equipped with power pumps may be the most appropriate solution to the rural water supply problem in the Coastal Plain. The water from such a tubewell would be pumped to a central water tower for distribution by pipelines to water points in clusters of villages. The rural population density in the Coastal Plain is much higher than in the Precambrian and Paleozoic terrains of the interior.(E)

The Service de Genie Rural concentrates chiefly on construction of small dams and reservoirs in rural areas and also employs some mechanical equipment in its construction activities.

The Service d'Animation Rurale has an extensive program of village self-help supported in part by donations of food from the World Food Program. In self-help projects food is given to those villagers who work on construction of wells, cisterns, earth dams, latrines, schools, roads, social centers, dispensaries, market places, butcheries, etc. As of the end of 1977 Animation Rurale had directed construction of some 386 open wells averaging about 17 m deep, some 76 cisterns with an average capacity of about 75 m^3 and 40 earth tanks averaging about 9,500 m^3 capacity - all supported in part by the World Food Program.

The Direction de Mines et de la Geologie (DMG) is the chief agency concerned with hydrogeological investigations and research as well as exploratory drilling for ground water. The DMG served as the chief counterpart agency for UN/UNDP and Federal Republic of Germany financed groundwater investigations and most recently, CIDA. The DMG has in its custody most of the departmentally controlled water-well drilling equipment in Togo. The equipment, all inherited from past technical assistance projects, includes the following :

1 - WABCO 1250 rotary drilling rig mounted on a Ford truck. Inherited from UN/UNDP.

1 - Failing Walker - Neer (FWN-40) combination rig capable of drilling to 1,000 m. Truck mounted. Inherited from CIDA.

1 - Bucyrus Erie percussion drilling rig. Truck mounted. Inherited from CIDA.

1 - Speed Star 71 mounted on a Dodge truck. Inherited from UN/UNDP. The DMG uses its equipment mostly for exploratory drilling and also for production drilling on contract to other government agencies. (D). Most of the DMGs drilling operations have been concentrated in the Coastal Plain.

In past years the Peace Corps (PC) has been active in construction of both large-diameter modern open wells and also small diameter hand drilled wells for rural water supply. PC well construction programs in Togo are currently inactive owing to excessive confusion and overlap among government agencies concerned with rural-water supply development activities. The PC directed a hand-operated percussion well-drilling program in the Atakpame-Akposso region from 1972 until 1977 under the sponsorship of the Eglise Evangelique, the United Church Board for World Ministries, the OXFAM, the AFVP and others. More than 100 wells were drilled and hand pumps installed. Each recipient village was required to contribute cash and labor amounting to about one-third the total cost of the well and pumps. The wells were started with a hole 5 inches in diameter in which a 4-inch casing was placed, if caving ground was encountered during drilling. This casing was removed and reused when a permanent 2-inch galvanized drop pipe casing with a stainless steel drive point was placed in the well for final hand-pump installation. Yields of 0.5 to 1.0 m^3/hr were obtained by pump test before a well was considered satisfactory for routine hand-pump operation. Sanitary protection was provided by a square concrete apron poured around each well collar. The wells put down by this method range from 10 to 25 m deep with an average of about 15m. The yields obtained from the wells are reported to be generally satisfactory. Also the Eglise Evangelique set up a maintenance service and repair shop at Atakpame for the hand pumps including servicing trucks, spare parts and trained hand-pump mechanics. Operating costs have proved to be quite high owing to frequent breakdowns and/repairs required for both Bodin Majestic and Abi pumps used on the wells. (F)

Elsewhere in Togo the Peace Corps has been involved since the late 1960s in construction of open hand dug wells most of which are curbed with concrete rings 1.0 to 1.5 m in diameter and as much as 60 m deep. The villagers normally provide labor, sand and gravel and sometimes a cash contribution. The Peace Corps provides cement, reinforcing steel, molds for the curbing and tools. Of the gross cost of a well, villagers

have generally provided about 50 percent. Although no accurate figures are available it is estimated that the Peace Corps has put down more than 1,000 modern open wells in Togo since the late 1960s. (F)

The chief private water-well drilling contractor operating in Togo is SASIF, a French company based in Abidjan, whichpresently enjoys a virtual monopoly in the country. There are, however, reported to be one or two smaller competing companies. SASIF, which has been active in Togo since the mid-1950s, employs both rotary and percussion rigs in its drilling operations and is reported to have recently purchased a down-the-hole air hammer rig. (E)

Constraints and Alternatives in Rural Water-Supply Development

The chief constraints to effective rural water-supply development and management in Togo are administrative and organizational rather than technical. The present fragmentation of responsibility for the rural water-supply program among several government agencies and the lack of coordination or cooperation among these agencies mitigates against the continuing viability of upgraded and sanitarily protected village water-supply systems. The key component to the success of such systems is a well-trained, adequately-financed well and pump maintenance organization which receives continuing administrative and political support at national, regional and local levels. In the absence of such continuing support any organization, however well structured initially, rapidly becomes ineffective.

From a technical point of view there is little question that a drilled well with a hand pump is superior to an open well as a source of water supply in the rural environment. The drilled well provides a sanitarily protected supply of relatively stable year-round yield. The drilled well is also more cost effective in terms of investment, maintenance, and of volume of water produced per well. The only major problem is that of the hand pump required for extraction of water from a drilled well and the continuing need for maintenance and occasional repair of the pump. There is considerable awareness of the advantages of drilled wells for village water supply in the upper echelon of the government. As yet, however, there is little evidence of a will to dedicate the national resources necessary to make a well and pump maintenance program operate effectively at the village level.

Although protected wells with hand pumps are probably the most feasible and satisfactory sources of village water supply in most of Togo, there may be other alternatives for developing village supplies. There are reported to be a number of perennial springs scattered through the hilly tracts of the Plateaux, Centrale and Kara Regions. By covering the spring heads with closed collection boxes or captations of concrete or masonry, potable water could be delivered by gravity pipeline to storage tanks and village fountains on lower ground. Before a spring captation program is undertaken, however, it would first be necessary to carry out a national inventory of springs to ascertain their elevation, flow, suitability for captation, and length of pipelines necessary to deliver water to one or more target villages.

Cisterns are used rather commonly through most of Togo to collect rain water from corrugated metal roof tops. Rain water is also collected in earthen jars from the thatched roofs of village huts. Most cisterns are set below ground level so that it is necessary to dip water from them by unsanitary hand lines and buckets. Many of the cisterns of the more prosperous citizens are equipped with cistern pumps to raise water to small roof-top tanks so that running water can be provided for indoor showers and flush toilets. By raising the base of the cistern to perhaps 80 cm above ground level the water could be drawn off by hand faucets rather than by dipping. Better sanitary protection could also be assured by more effective covers, although many existing ones are partly protected by corrugated metal roofs. Greater quantities

of water could be collected from larger surfaces, notably the roof tops of government buildings, warehouses and other large structures. Potential for greater used of cisterns also exists in areas of high rainfall, but where yields from wells are inadequate or of poor chemical quality. If cistern construction projects are undertaken on any substantial scale, prior evaluation and study would be desirable to determine the most effective design in terms of volume of water stored and possible alternatives in design and materials.

Another alternative is rainfall harvesting particularly from the uncultivated rocky knobs, scarps and hillocks of central and northern Togo. By protecting these areas against human and animal trespass runoff of fair sanitary quality could be collected behind pitch rock dikes on hill slope contours and led through settling basins into one or more covered storage tanks around the base of a hill or scarp. These tanks could be periodically chlorinated to assure the sanitary quality of the supply and water could be drawn off from hand faucets in the base of the tank. The tanks could be constructed of rock masonry or other locally available material and lined with neat cement for impermeablization.

In flatter terrain, protected areas could be surfaced with rock slabs and mortar with gentle slopes of one degree or so inward to a central circular or rectangular sump. The sump would be filled with clean sand in which a series of interconnected earthen jars had been buried. The rainwater running off the slab and mortar surface would filter through the sand and seep into the earthern jars. Water could

be drawn off as needed by a simple hand pitcher pump passed through an aperture in the central collecting jar.

Still another alternative is the "sand dam", which is extensively used in East Africa as a source of village water supply and which also could be utilized in Togo. In granite and gneiss terrains such as those of central and northern Togo larger ephemeral streams may carry considerable underflow during the dry season in the sandy fill of the stream bed. By constructing low cutoff dams across such streams, coarse sand is collected behind the dam. The dam, first anchored on bedrock, is raised over a period of 4 or 5 years in successive courses of rock and mortar or concrete about one meter high. By building the dam in stages only the coarse bedload sand of the stream accumulates behind the dam. The accumulated sand then becomes an artificial aquifer from which filtered water can be drawn off by gravity through pipes laid in the concrete or masonry dam. More than 200 such sand dams have been successfully constructed and utilized in Kenya.

Dams and reservoirs to collect and store stream flow for gravity or pumped distribution are already planned or in operation for several larger urban centers and neighboring villages in Togo. Such supplies require treatment before distribution, if sanitary quality is to be assured. Also treatment and distribution facilities have to be maintained if they are to operate effectively. The project design team, in considering this alternative in the Rual Water Supply and Sanitation Project in the Savanes Region, concluded that this alterna-

tive would not be feasible or cost effective for dispersed village water supplies in this region. The alternative might be feasible for large agglomerations of villages in more densely settled areas of the country.

Proposed USAID Rural Water Supply Development Program in Togo

The purpose of the proposed rural water supply development program is to provide an adequate quantity and quality of water for human consumption. At the present time, very few sources provide water throughout the entire year and the quality is less than desirable. However, this does not mean that suitable water supplies are not available for development. In the past, the type of well designs and construction techniques utilized to develop the groundwater available have contributed to both a limited quantity of water and the contamination of the groundwater system.

We have inspected existing wells within the project atea and explored the possibility of improving or changing the design of the large-diameter wells to provide a sanitary water supply without any success. The problem is that the means of withdrawing the water is with a bucket and contamination is constantly introduced into the well. In addition, the wells are hand-dug and the depth of the well is generally determined by the distance below the ground surface or the difficulty to penetrate the formation. Some wide-diameter wells have been constructed in recent years which are an improvement over the "traditional" wells, however, the quality and quantity of water obtained from these wells is still less than that needed by the people. Obviously, the construction of wide-diameter wells requires a low level of technology which appears to be the basis for their favor, but the ~~cost~~ COST of these wells is approximately two times that of

a drilled well equipped with a pump. Proponents of the wide-diameter wells state that the extra cost can be justified because these wells do not have the maintenance problems that are associated with any type of "pump" program. Still, we have observed that considerable time and money must be spent to clean and deepen the wide-diameter wells which are generally not capable of providing water during the dry season. In conclusion, we have decided not to encourage or perpetuate the construction of wide-diameter wells which can only be justified through irresponsible programs of development, but to introduce new technology integrated with a well planned training program to insure the success of the proposed water resource development project.

The proposed project contains the following elements:

1. Reconditioning of existing traditional wells (200 $\pm$ wells)
2. Drilling and construction of new wells (300 $\pm$ wells)
3. Pump assembly, installation and maintenance
4. Location and construction of excreta disposal facilities.

Training programs are to be a major portion of each of thse inputs and will include instruction for not only personnel from the regional office, but for the people at each site to be developed.

1. Reconditioning of Existing Traditional Wells

There are several alternative methods or approaches to reconditioning a traditional well (open, wide-diameter). First reconditioning is generally only considered if the side walls have collapsed but more frequently because the well does not yield water during the dry season. Therefore, most of the reconditioning consists of deepening the well to provide water for a longer period throughout the year. At the present time, the cost to construct a traditional type well to a depth of 20 meters is approximately $10,500 or $500/meter and the cost and time required to complete the work increases with depth. Obviously, it is readily apparent that considerable money and energy is expended to provide both an inadequate quantity and quality of water.

We are proposing that the traditional well be reconditioned or improved by drilling a 4 to 6 inch diameter hole with a cable-tool, rig placed and grouted within the borehole to the ground surface to isolate the contaminated water found in the existing well from the water made available from the borehole. The open well will be capped with a steel reinforced concrete cover designed to permit access to the alrge diameter well and a hand pump installed on the cased borehole. An effective pump paintenance and training program should insure continued operation of the pump in order to provide potable water for the people throughout the year. Should the pump fail, water can probably still be withdrawn through the access port in the well cover.

2. Drilling and Construction of New Wells

Several 4-inch wells are to be constructed at the approximately 83 area school. Each of these wells will be equipped with a hand pump and the operation and maintenance will become part of the students' daily experience, which may be transferred to other members of ther families or villagers

The 6 to 8 inch boreholes will be drilled to a maximum depth of 100 meters using a mud rotary rig. The exact depth is not specified because of the local variations in the hydraulic characteristics of the geologic formations. The minimum acceptable quantity to be made available from each well is approximately 1 m^3/hr which shall be determined by the technical personnel in charge of the project. Because the proposed rate of withdrawal from each well is between 1 to 2 m^3/hr, elaborate aquifer tests are not required for the project, however, adequate testing should be conducted to provide the information needed to quantitatively evaluate the aquifer potential at each location.

3. Pump Assembly, Installation and Maintenance:

The success or failure of the project is dependent on the type of pump and the effectiveness of the maintenance program. We have learned through our discussions with both regional and local people that hand pumps are not an acceptable means of providing water to the rural people. Of course,

the basis for these statements rests on the fact that neither adequate training in pump maintenance nor a sufficient parts supply has been provided in the past. We have evaluated several types of pumps and feel that the MOYNO Pump would be the most durable and easy to maintain because of its simple design. This pump will cost more than other pumps initially, however, the cost and frequency of maintenance should be minimal so that over the life of the pump, the total cost should be less.

The initial training phase will consist of assembly of the pumps that are to be installed at the 500 well sites. We anticipate some lag time prior to receiving all of the drilling equipment and this portion of the project can be implemented during that period. The remainder of the training will consist of the actual installation of the pumps at each site followed by a preventative maintenance program and assistance in the repair of any pump that may malfunction.

4. Location and Construction of Excreta Disposal Facilities

We are concerned in regard to the location and type of construction of the excreta disposal facilities or latrines. If these facilities are constructed without a knowledge of the local geologic conditions, contamination of the water supply could result. For this reason, we feel that the location and type of construction, prefereably steel reinforced concrete for the pit should

be determined by the hydrogeologist after the borehole is drilled and the geologic conditions evaluated. In addition, the concrete pit should be an integral part of the concrete pad at the surface, otherwise both surface and ground water will enter and fill the latrine.

METHODOLOGY

I. WELL DRILLING AND WELL CONSTRUCTION

CABLE - TOOL

Cable-tool or percussion drilling equipment was selected for reconditioning the traditional or open wells. Although this method will require more time per hole compared to conventional rotary drilling, the equipment is better suited because of low operational costs for placing boreholes in both the sedimentary and crystalline (granite) rocks located within the Dapong Circumscription.

The wells will be placed along the inside perimeter of the large diameter wells and should be constructed during the dry season to minimize the cross-contamination between the old and new well. This can be accomplished by initially seating a larger surface casing into the unweathered rocks and later seating and grouting the permanent casing at a lower level.

MUD ROTARY

Hydraulic or mud rotary drilling equipment was selected for drilling the small diameter (4-inch) wells in the sedimentary rocks located southeast of the Village of Dapong. This method enables boreholes to be drilled both at a low operating and maintenance cost and at a rate adequate to complete the proposed 300 wells, within the five years of the project.

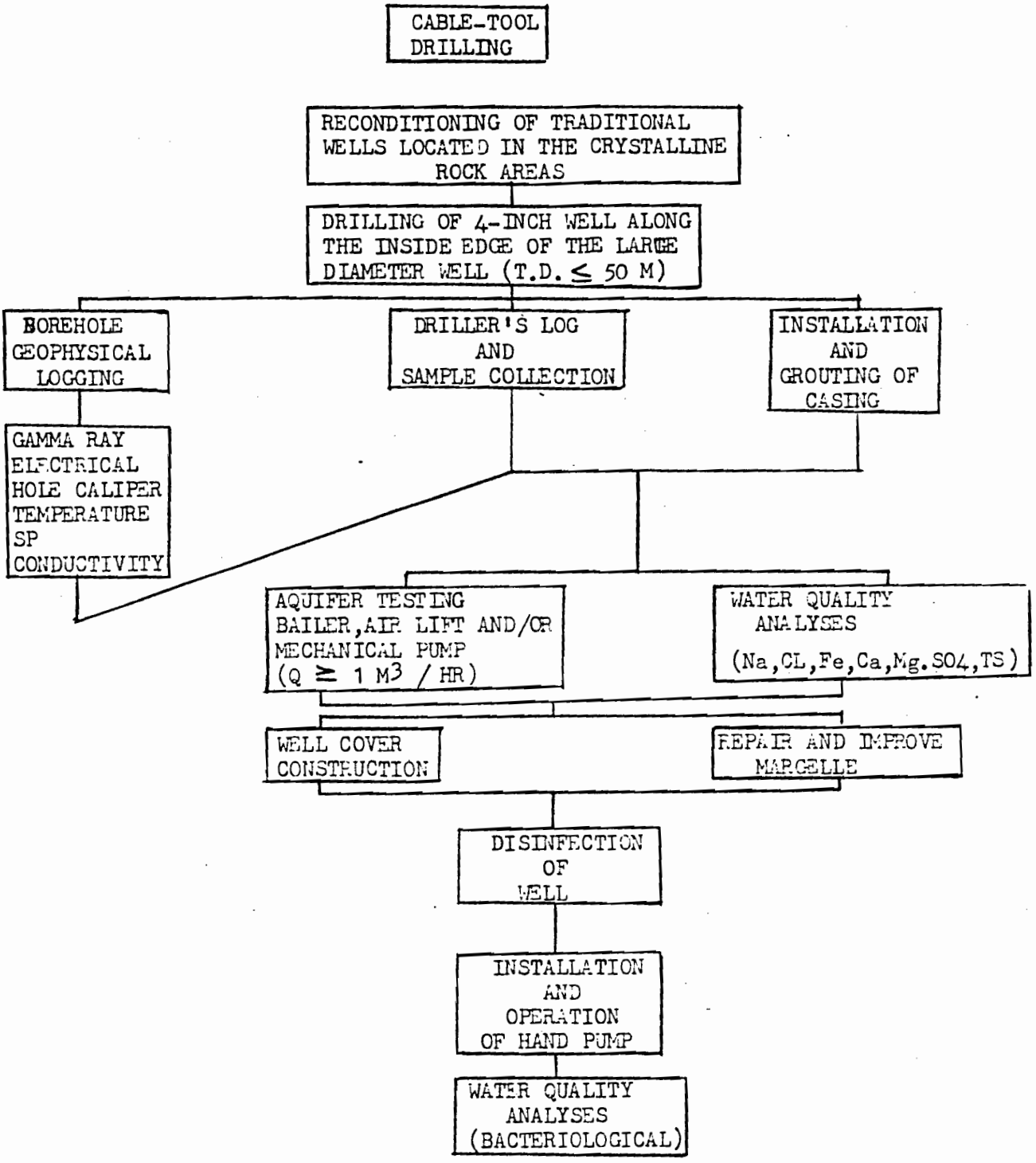
All of the boreholes drilled will be geophysical logged to assist in the determination of the source and quality of the groundwater. In addition, water samples will be collected and analysed prior to the design and completion of the well. Should either the quantity or quality of the water be unsatisfactory, the well will be plugged and abandoned.

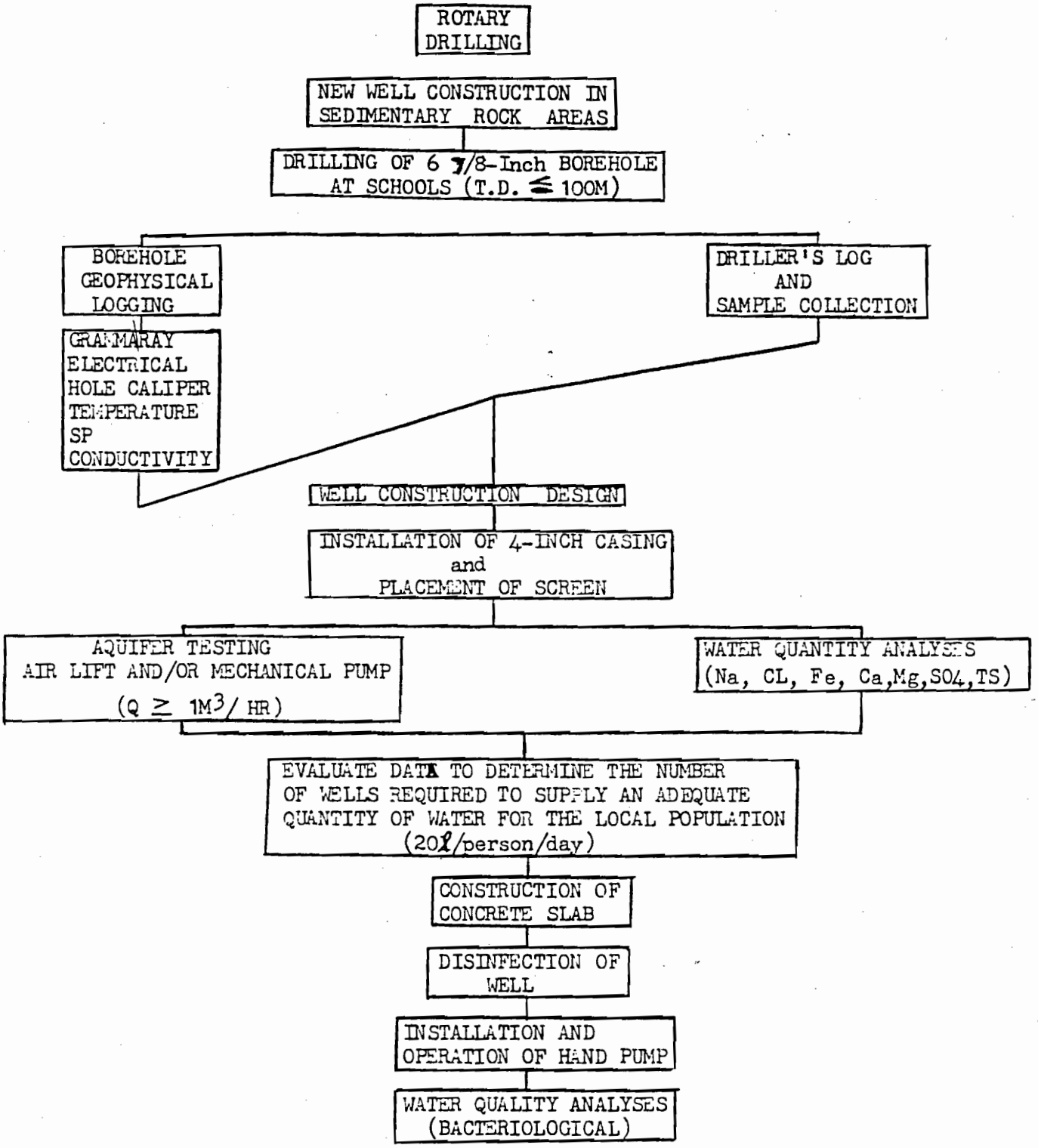
In the boreholes that are capable of producing a good quality and quantity of water, the well construction will consist essentially of screening and gravel packing the water bearing zone and cement or bentonite grouting the 4-inch casing. The well design will vary from site to site e.g. open hole vs. screened, gravel-packed vs. no gravel-pack, and should be determined by the hydrogeologist in-charge-of the project.

II. BOREHOLE GEOPHYSICAL LOGGING

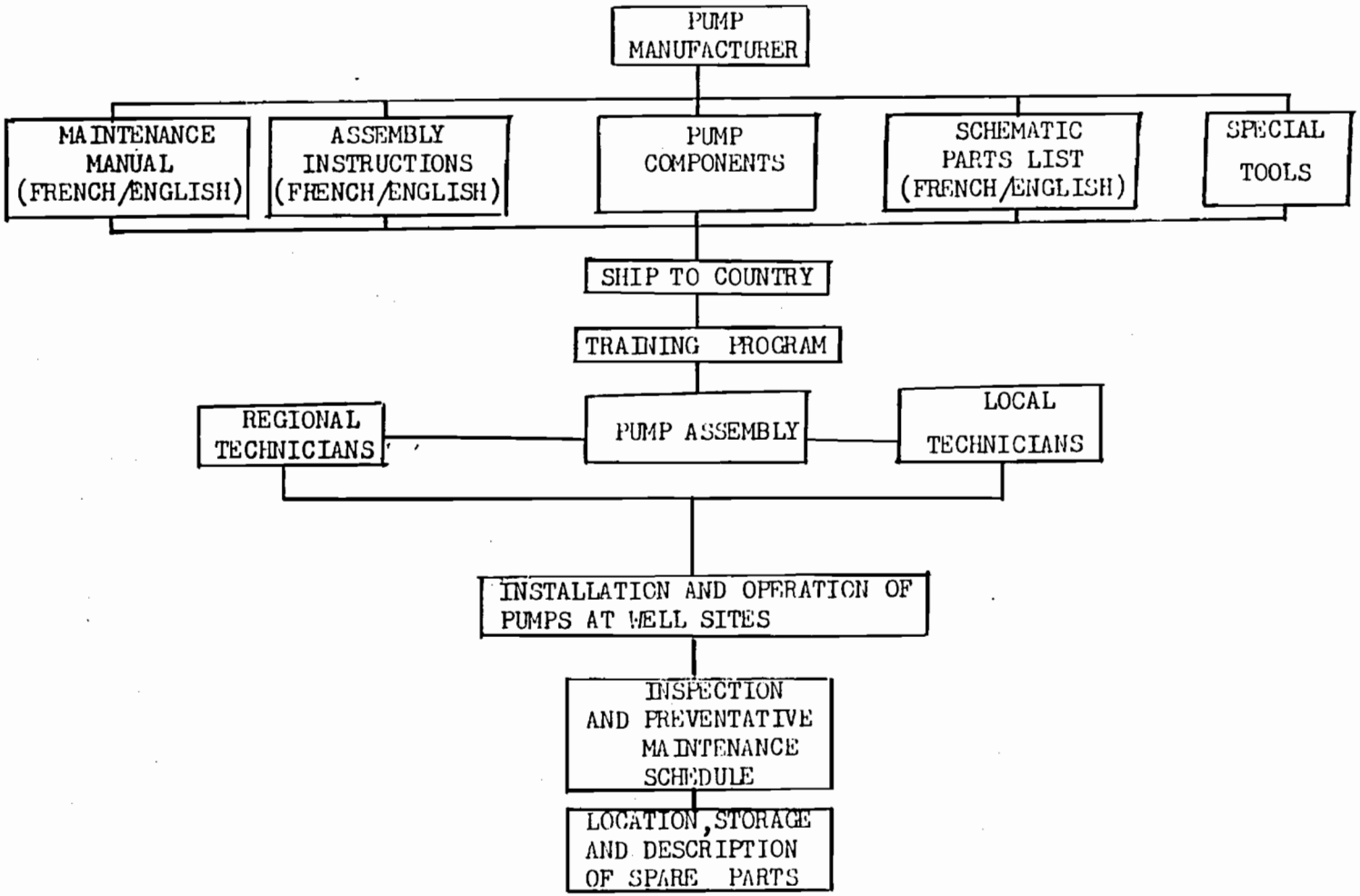
Geophysical logging of all of the boreholes will provide a consistant means of describing the subsurface lithologies needed to evaluate the aquifer potential and to design the well construction at each site. The type of equipment required should be capable of measuring electrical resistivity (0.25, 2.5 normal and single point), gamma ray, spontaneous potential, hole caliper, temperature and fluid conductivity. In addition, the logger should also be a dual pen self-recording unit with a level-wind cable reel capable of traveling at a

minimum rate of 20 feet per minute. The interpretation of the geophysical logs will be the responsibility of the hydrogeologist.


CABLE-TOOL DRILLING
RECONDITIONING OF TRADITIONAL WELLS LOCATED IN THE CRYSTALLINE ROCK AREAS
DRILLING OF 4-INCH WELL ALONG THE INSIDE EDGE OF THE LARGE DIAMETER WELL (T.D. ≤ 50 M)
BOREHOLE GEOPHYSICAL LOGGING
DRILLER'S LOG AND SAMPLE COLLECTION
INSTALLATION AND GROUTING OF CASING
GAMMA RAY
ELECTRICAL
HOLE CALIPER
TEMPERATURE
SP
CONDUCTIVITY
AQUIFER TESTING
BAILER, AIR LIFT AND/OR MECHANICAL PUMP
(Q ≥ 1 M3 / HR)
WATER QUALITY ANALYSES
(Na, CL, Fe, Ca, Mg. SO4, TS)
WELL COVER CONSTRUCTION
REPAIR AND IMPROVE MARGELLE
DISINFECTION OF WELL
INSTALLATION AND OPERATION OF HAND PUMP
WATER QUALITY ANALYSES (BACTERIOLOGICAL)


ROTARY DRILLING
NEW WELL CONSTRUCTION IN SEDIMENTARY ROCK AREAS
DRILLING OF 6 7/8-Inch BOREHOLE AT SCHOOLS (T.D. ≤ 100M)
BOREHOLE GEOPHYSICAL LOGGING
GRAMMARAY
ELECTRICAL
HOLE CALIPER
TEMPERATURE
SP
CONDUCTIVITY
DRILLER'S LOG AND SAMPLE COLLECTION
WELL CONSTRUCTION DESIGN
INSTALLATION OF 4-INCH CASING and PLACEMENT OF SCREEN
AQUIFER TESTING
AIR LIFT AND/OR MECHANICAL PUMP
(Q ≥ 1M3/ HR)
WATER QUANTITY ANALYSES
(Na, CL, Fe, Ca,Mg,SO4,TS)
EVALUATE DATA TO DETERMINE THE NUMBER OF WELLS REQUIRED TO SUPPLY AN ADEQUATE QUANTITY OF WATER FOR THE LOCAL POPULATION
(20ℓ/person/day)
CONSTRUCTION OF CONCRETE SLAB
DISINFECTION OF WELL
INSTALLATION AND OPERATION OF HAND PUMP
WATER QUALITY ANALYSES
(BACTERIOLOGICAL)

PUMP ASSEMBLY, INSTALLATION AND MAINTENANCE PROGRAM



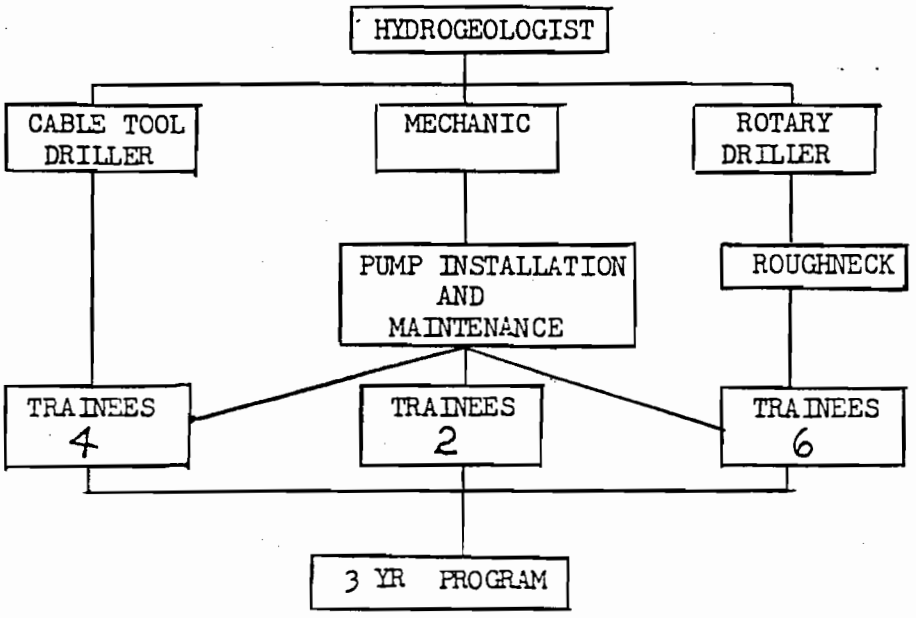
Training Program

The main objective of the initial phase of the proposed project is to train nationals to both drill and construct wells and to install and maintain manual pumps. Because the emphasis is placed on this aspect of the project, it becomes apparent that the effectiveness of the training will determine the success or failure of the project. For this reason, periodic quantitative evaluation of the participants shall be included as part of the program. If it is determined that certain portions of the training program are weak or ineffective, appropriate changes should be made early in the project.

The training program as presented in the following outline should prepare the trainees to perform all of tasks after the 3-year period. Throughout the program, the individual trainees will be given additional responsibilities and experiences to both challenge and test their new skills.

Upon completion of the initial training, the trainees will be capable of performing all of the work, including the utilization of basic hydrogeology to select additional well sites to be developed during the last 2-years of the project and to evaluate the data collected for proper well design and construction. Although preventative maintenance is included in the program, the last 6-months of the project should place special emphasis on maintaining an inventory of spare parts and the procedures for obtaining parts that may be needed in the future.

TRAINING PROGRAM



QUANTITATIVE EVALUATION
2 YRS - 3 YRS - 4½ YRS

TRAINING PROGRAM OUTLINE

I. Drilling

A. Cable-tool

1. Operation and maintenance of equipment.

a. Preventative maintenance program

(1) Lubrication

(2) Periodic inspection

(3) Requisition or ordering of parts

b. Fabrication and/or repair of parts

c. Replacement of parts

d. Dressing and replacement of bits

2. Drilling of borehole

a. Driller's log

(1) Penetration rate

(2) Lithologic descriptions

(3) Collection of samples

b. Tool retrieval

c. Techniques used in various geologic environments

B. Mud rotary

1. Operation and maintenance of equipment

a. Preventative maintenance program

(1) Lubrication

(2) Periodic inspection

(3) Requisition or ordering of parts

b. Fabrication and/or repair of parts

c. Replacement of parts

2. Drilling of borehole

a. Driller's log

(1) Penetration rate

(2) Mud losses

(3) Pressure (down-the-hole)

(4) Lithologic descriptions

(5) Collection of samples

b. Tool retrieval

c. Techniques used in various geologic environments.

II. Well Construction

A. Design

1. Screened

2. Gravel-pack

3. Open hole

B. Installation of various well types

C. Cement and/or bentonite grouting

D. Disinfection

III. Borehole geophysical logging
   A. Operation and maintenance of equipment.
   B. Interpretation of the various logs.

IV. Water quality
   A. Partial chemical analyses

V. Aquifer evaluation
   A. Conduct simple aquifer tests
   B. Analysis and evaluation of the data

VI. Pumps
   A. Assembly
   B. Preventative maintenance
   C. Installation
   D. Operation
   E. Replacement and repair of parts
   F. Stocking and ordering of parts

Personnel to be trained

I. Rotary Drilling Rig (2 crews)

2 Driller - 5 years of experience
Heavy equipment mechanic - 10 yrs of experience
Heavy equipment operator - 10 yrs of experience

2 Driller - 2 years of experience
Heavy equipment mechanic - 5 years of experience
Heavy equipment operator - 5 years of experience

2 Driller - 1 yr. of experience
Heavy equipment mechanic - 2 yrs. of experience
Heavy equipment operator - 2 yrs. of experience

II. Cable-Tool Rig (2 crews)

2 Driller - 5 years of experience
Heavy equipment mechanic - 10 yrs of experience
Heavy equipment operator - 10 yrs of experience

2 Driller - 1 yr of experience
Heavy equipment mechanic - 2 yrs of experience
Heavy equipment operator - 2 yrs of experience

III. Drilling Equipment Maintenance

2 Truck mechanics - 10 yrs of experience.
Heavy equipment mechanics - 10 yrs. of experience

2 Truck mechanics - 5 yrs of experience
Heavy equipment mechanics - 5 yrs of experience.

IV. Pump Maintenance and Repair

2 Mechanics - 5 yrs. experience
2 Mechanics - 2 yrs. experience

EQUIPMENT AND COST EVALUATION

Scope

The proposed project encompasses two (2) regions within the country of Togo; namely the Savanes and Maritime. In the Savanes Region, an estimated 300 wells are scheduled to be drilled and 200 existing dug wells are to be refurbished. Priorities with respect to well locations will be given to schools, dispensaries and villages having high density population, respectfully. Within the Savanes Region, the drilling conditions are variable. For example, north of the village of Dapaong, the rocks are primarily crystalline and south of the village the rocks are interbedded quartzite sandstones and shales. For these reasons, two (2) types of drilling equipment have been proposed for the project.

In the Maritime Region, several drilling rigs are under the operation and control of the GOT - Division of Mines and Geology. At the present time, only one of these rigs is operable because of the lack of financial support to maintain and operate this equipment. We are proposing that the necessary parts and technical assistance be provided to refurbish the existing equipment so that their trained personnel may continue to utilize it within the Maritime Region.

Methods of Drilling

Two methods of drilling are recommended in the Savannes Region. The first, is a cable-tool percussion method and the proposed use for this method would be in refurbishing existing dug wells. The second, is a straight mud rotary method and the proposed use for this method would be in the construction of new tubewells. Due to the physical characteristics of the crystalline rocks north of Dapaong, it is recommended that only cable-tool percussion drilling be instituted there, and only for refurbishing existing dug wells. The rotary drilling portion should be confined to the sedimentary rock areas. It is not recommended to use rotary drilling to refurbish existing dug wells due to the nature of rotary drilling operation.

Equipment Type -- Description and Cost

Many types of drilling equipment are available on today's market. Selection of the correct type for the job depends on several factors.

1. Type of drilling conditions
2. Depth and size diameter of hole
3. Initial cost and repair cost
4. Ease of maintenance

The following type of equipment that is suggested was selected on the basis of the above factors. Also these particular types have a good performance record all over the world and have been used successfully in West Africa.

Cable - Tool

For a cable tool drilling program, a suggested listing of rig type with ancillary type equipment and tools with related estimated cost is as follows:

15 TONS 1 - Bucyrus - Erie 20-W Drill with Waukesha Diesel Engine mounted on 2½ ton single exle 4-sp drive International Harvestor diesel truck with 4" drill tools, spare bits, mandrels, rope socket, stem, chain bar tightener, drilling jars, bailers and fishing tools, as well as necessary hand tools. $75,000.00

7 TONS 1 - International Harvestor 7-Ton Diesel Truck with twin axles; 13 speed drive equipped with 1200 gallon water tank. Tank to be equipped with vacuum, interchangeable suction hoses with strainers and gasoine transfer pump. ... $35,000.00 Also to have 12-Ton Ramsey PTO winch mounted to front.

2 TONS 1 - ACME Drill Bit Forge equipped with firebrick, 220 V. blower, necessary hand tools such as gauges, 12 lb. sledges, tempil sticks, gloves, 4" ring gauges, ½ Ton chainfall ... ... $ 3,500.00

1 TON 1 - Miller D-5 Portable 200 amp continous diesel-drive welder; 220 V. outlet equipped with 30 ft. welding cables, necessary welding equipment has welding hoods (2); spare glass for eye shade, gloves, etc. 200 lbs. No. 7013 .5/32" diameter welding rod. ... ... $ 6,900.00

-- TONS 1 - Airco Oxygen/Acetylene cutting outfit equipped necessary tips for heating, brazing and cutting, 30 ft. hoses, tip cleaners and hose adaptors for fitting metric threaded oxy/acy. tanks and additional items such as check valves goggles, strikers. Tank gauges to be calibrated in both psi and Kg/cm^2. Also gauges are to be equipped with two stage regulators. ... ... $ 700.00

3 TONS 1 - 3/4 Ton-4spd 4 wheel drive GMC diesel pick-up equipped with 50 gal. fuel tank on bed and transfer pump... $12,000.00 Also to have 3 Ton Ramsey PTO which mounted to front.

Equipment Subtotal $591,100.00

Construction Materials and Supplies

Well Casing

Estimated 200 Refurbished wells - Average depth 50 meters (164')

Pipe required - 4" I.D., wall thickness - .250 inch, BLACK, threaded and coupled API thread. 32,800 ft.

180 TONS	32,800 feet of pipe at $5.00/ft.	$164,000.00
4 TONS	Drive Shoes 200 wells at $60.00/shoe. ...	$ 12,000.00
	Well Screens 200; 4 ft., 4" diameter, .012" slot Johnson Stainless Steel Screens with fittings, telescoping	$ 57,000.00
34 TONS	Moyno Pumps 200 initial; Assume 25% failure rate/year (50/yr.) X 5 yr. = 250 additional pumps = 450 pumps at $500.00/pump.	$225,000.00
	Construction Materials and Supplies Subtotal ...	$458,000.00

Operational Costs

13 TONS	Drill Bits 50 - Acme Alloy Bits; Assorted star and regular pattern for drilling 4 6" diameter hole, 4 ft. length	$ 45,000.00
2 TONS	T.B.A.; Tires, Batteries, Accessory Spare Parts for light vehicle(s) and other ancillary equipment. 40% of equipment cost	$236,440.00
	Fuel; See attached sheet A**	$280,987.00
	Operational Cost Subtotal	$562,427.00

Shipping Costs and Insurance

Equipment cost -- $591,100.00 (40%) = ...	$236,440.00
Construction materials and supplies cost ...	$183,200.00
Bit cost - $45,000.00 (40%)	$ 18,000.00
T.B.A. cost - $236,440.00 (40%)	$ 94,576.00
Shipping Cost and Insurance Subtotal	$532,216.00

Personnel Costs

Job Description	Cost/year	Total Cost
Master Driller	$75,000.00	$375,000.00
Driller's Helper	$40,000.00	$200,000.00
Personnel Cost Subtotal	... ...	$575,000.00
(CABLE - TOOL) Total Cost	... ...	$2,718,743.00

Mud Rotary

For a rotary drilling program a suggested listing of rig type with ancillary type equipment and tools with respective estimated costs is given as follows:

30 TONS	1 - Failing 1250 mud rotary mounted on 2050 IHC with interlock equipped with 5x6 Gardner-Denver mud pump; 400' - 2 7/8" IF drill pipe 20' lengths; necessary subs for swivel and end rod as well as additional parts for rig truck, portable mud pit to be included	$ 97,000.00
	Rig to be equipped with Miller 180 amp "Rough-neck" welder and necessary tools and equipment ...	$ 3,000.00
	... ...	$100,000.00

7 TONS 1 - IHC 2050 diesel with interlock; equipped with 1200 gallon water tank. Tank to be equipped with vacuum, gasoline transfer pump and interchangeable suction hoses with trainers. Truck to have 12-Ton Ramsey PTO winch mounted to front. ... ... $ 35,000.00

20 TONS 1 - D5A Caterpillar Bulldozer; equipped with Model 55 D5DD winch. Bulldozer to be equipped with normal width tracks. ... ... $ 75,000.00

12 TONS 1 - IMCO Tri-Axle Lowboy; with IHC 2050 diesel tractor cab. ... ... $ 55,000.00

9 TONS 1 - Cyclone F - 40 pump hoist mounted on IHC 2050 diesel truck. ... ... $ 40,000.00

1 - Airco Oxygen/Acetylene Cutting Outfit; equipped with necessary tips for heating, cutting and brazing; 30 ft. hoses, tip cleaners and hose adapters for fitting metric threaded oxy/acy. tanks. Additional items such as check valves, eye goggles, strikers to be included. Regulators are to be two-staged mud gauges to be calibrated in both psi and kg/cm^2. ... ... $ 700.00

12 TONS 4 - 3/4 -- Ton 4-wheel drive GMC diesel pickup with 50 gallon fuel tank mounted in the bed (for 3 of 4 trucks) and equipped with transfer pumps. 3-Ton Ramsey winch; electric drive mounted to front (for all 4 trucks) ... ... $ 48,000.00

20 TONS 1 - Field Porta-Kamp; equipped for 5 personnel. Base radio station included with 3 field radios. $177,000.00

-- TONS 1 - Johnson-Keck type Electric logging Unit; equipped with Resistivity (o.25, 2.5) S.P., Gamma, and Salinity Logging capabilities. ... ... $ 35,000.00

Equipment Subtotal $565,700.00

Construction Materials and Supplies

23 TONS Drilling Mud, Quik-Gel; figure 3 bags/hole, 3 (300) = 900 bags ($5.00/bag). ... ... $ 4,500.00

3 TONS Barafos, Mud Cleanning Agent; figure 1 bag/hole at $50.00/bag. ... ... $ 15,000.00

542 TONS	Well Casing; average 100 meters/well, 100 meters (300) = 30,000 meters = 98,400 ft. divided by 21 = 4686 joints. 4686 joints of pipe (21') = 98,406" ($5.00/ft.) = 4" - Black Iron; .250 inch wall thickness; T & C API threads.	$492,030.00
6 TONS	Rotary Drill Shoes; 300 ($60.00/shoe)	$ 18,000.00
9 TONS	Well Screens; 300, 4 ft. length, 4" diameter, .012 slot Johnson Stainless Stell Screens with fittings, non-telescoping.	$ 85,500.00
51 TONS	Moyno Pumps; 300 initial, Assume 25% failure rate/year (75/yr.) 5 years = 375 pumps. 675 pumps ($500.00/ pump).	$337,500.00
	Construction Materials and Supplies Subtotal ...	$952,530.00

Operational Costs

12 TONS	Drill Bits; G 7/8" diameter, Assume 1.5 bits/hole in sedimentary rock, 300 (1.5) = 450 (436.36 avg/bit.	$196,362.00

2 TONS	T.B.A.; Tires, Batteries, Accessory Spare Parts for light vehicles and other ancillary equipment, 40% of equipment cost.	$226,280.00
	Fuel; See attached sheet A **	$1,181,104.00
	Operational Costs Subtotal	$1,678,746.00

Shipping Costs and Insurance

Equipment cost - $565,700 (40%)	$226,280.00
Construction materials and supplies cost ...	$135,000.00
Bit cost - $196,362.00 (40%)	$ 78,544.00
T.B.A. cost - $226,280.00 (40%)	$ 90,512.00
Shipping Cost and Insurance Subtotal	$530,336.00

Personnel Costs

Job Description	Cost/year	Total Cost
Hydrogeologist	$100,000.00	$500,000.00
Mechanical Superintendent	$ 75,000.00	$375,000.00
Master Driller	$ 75,000.00	$375,000.00
Driller's Helper	$ 40,000.00	$200,000.00

Pump Installation Foreman	$ 60,000.00	$300,000.00
Personnel Costs Subtotal	...	... $1,750,000.00
(ROTARY) Total Cost	...	... $5,477,312.00

SHEET A

EQUIPMENT DESCRIPTION	ESTIMATED HOURS OF OPERATION/DAY	ESTIMATED * FUEL CONSUMPTION/HOUR (in gals.)	ESTIMATED FUEL CONSUMPTION/ DAY (in gals.)
5 - 4 wheel drive Jeep	4	5	100** (20 gal/day/vehicle)
B E - 20W *	16	5	80**
I H C Water Truck* (Percussion)	6	7	42**
Miller D - 5*	4	4	16**
Failing 1250	16	7	112
I H C Water Truck (Rotary)	8	7	56
C A T D - 5	2 c. 10 hr/wk	6	12
Tractor with Lowboy	2 c. 10 hr/wk	6	12
Caterpillar - Camp Gen. 330 G.T.	20	7	140
F - 40 Pump Hoist Rig	16	5	80

650 gal/day

* All fuel estimates based on diesel
650 gal/day x 6 days = 3,900 gal/work week, or 202,800 gal/work year
At 5 year estimated project length = 1,014,000 gallons = $1,462,091.00
Note: 80 CFA/liter = 302.80 CFA/gal.; or U.S. $ = $1.44/gal. Use 210 CFA/$1.00 Exchange rate

** Cable Tool Only $280,987.00
Rotary Only $1,181,104.00

Proposed Sanitary Dug Well Construction

A construction method for sanitizing existing dug wells is proposed herin. This method would permit access to the well for drawing even if the pump malfunctions.

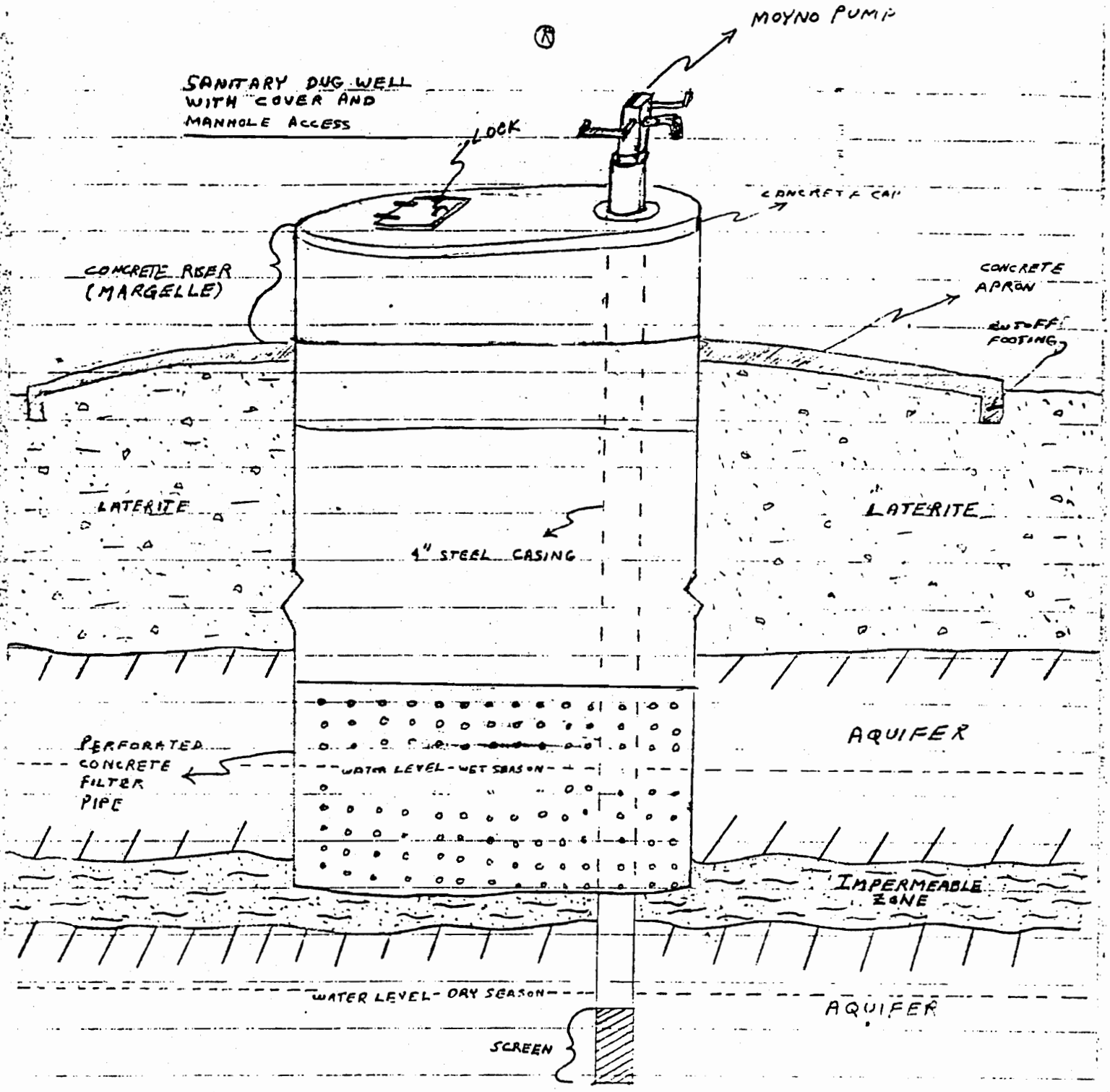
Dug wells currently have basic inherent problems with:

1. Existing dug wells open to surface contamination;
2. Most traditional wells are dug just to the water table and when seasonal fluctuations occur during the dry season the wells go dry.

The method proposed consists of drilling deeper, within the existing dug well, by using the cable tool drilling machine. Upon completion of the drilling, casing would be set into the aquifer (See Diagram 1). The drilled well would then be disinfected with chlorine in conjunction with the dug well. Finally, the dug well would be capped with a circular concrete cap and a Moyno pump installed in the drilled well.

DIAGRAM OF PROPOSED CONSTRUCTION FOR MODIFYING AND SANITIZING EXISTING DUG WELLS *

(DIAGRAM 1)



* NOT TO SCALE

Current Comparative Well Costs

A.) DUG WELLS

To offer a basis for comparison with respect to the proposed project, current as well as prior well cost information was gathered for both dug (puits) and drilled (forage) wells.

Considering the dug (puits) well type first it is apparent (see Table I) that there is a marked variance in costs not only between contractors but also for dug wells in the same area. The causes for this variance are attributed to several factors:

1. Type of construction material used
2. Type of rock in which well is constructed (?)
3. Size of well-diameter and depth of well
4. Type of equipment used in construction (dynamite, air hammer, dewatering pump)
5. Labor costs
6. Transportation/mobilization costs

The average reported cost of a conventional modern dug well in Togo ranges between $300 - $800 per lineal meter with a diameter of approximately 1.0 meter and a 30 meter depth. Careful consideration of the above factors must be given before relating dug well costs from one area to another.

Dug wells utilizing the conventional construction method (poured concrete -walls) with diameter of 1.8 meters and depths of up to 40 meters are being constructed in the Maritime Region. These wells differ from other dug wells in that lateral galleries are drilled at the base of the well. These galleries provide a more efficient means of capturing water. Reportedly only in the Maritime Region are wells of this type constructed. This is believed to be due to the nature of the aquifer i.e. unconsolidated sands and gravels vs. crystalline or sedimentary rocks. A government agency is constructing those wells but no cost figures are available.

Cost figures for the concrete retaining rings (1.5 m diameter) were obtained from the Secretariat Particulier of Animation Rurale in Dapaong. They range from 35,000 to 85,000 CFA. The difference in cost is reflected in the use of steel reinforcing rod in the more expensive rings.

Filter pack material in the Dapaong area is being utilized. It consists of a mixture of cables, 150-200 mm in diameter, and charcoal. The desirability for using this type of filter pack is low. This is due to the fact that any Fines found in the aquifer or that were generated from construction of the well will migrate into the well upon pumping. This in turn will cause eventual clogging of the ring perforation, filling in of the well, and increased wearing of pump parts. It also is essentially distasteful and promotes unsanitary conditions in the well. No cost figures were available for the firter pack material and

not all wells utilize this type of filter pack. Only in the Dapaong area was charcoal observed being mixed with gravel and cables to produce the filter pack. All other wells that were inventoried utilized curshed stone about 50 mm in diameter. Dug wells in Central and Southern Togo utilized crushed gravel.

A relationship could not be found between the digging/drilling a dug well per meter or total cost and the cost of the concrete retaining rings and filter pack materials.

TABLE I -- DUG WELL COSTS - TOGO

CONTRACTOR	WELL TYPE	DIAMETER	AVG. DEPTH	COST PER LINEAL METER	LOCATION
Service Hydraulique	Dug with concrete retaining rings	2 - 2.5m	25 m.	$413.00/m	Throughout Togo
Peace Corps	Ditto	1 - 1.5m	25 m.	$165.00/m	Ditto
Unknown	Ditto	0.8 - 1.0m	20 m.	$800.00/m	Ditto
Peace Corps	Dug Well Hand Drilled	Small diameter Exact diameter Unknown	15 m. 15-25 m.	$430.00/m $231.00/m	Atakpame-Akposso Area
FED - Fond European de Development	Dug with concrete retaining rings	1 - 1.5m	25 m.	$230.00/m 52,000 CFA/m	Dapaong Area
B.D.P.A. - Bureau pour le Development de la Production Agricole	Ditto	1.0m	10 m.	$ 90.00/m 20,000 CFA/m	Dapaong Area
Service Hydraulique	Poured Concrete	1.8m	30 m.	$380.00/m 83,333 CFA/m	Sokode Area

B.) DRILLED WELLS

Reported costs for small diameter (4-5") drilled wells in Togo are approximately $24.00/lineal meter with an average depth of 50 meters.

The Division of Mines and Geology are currently drilling 8" diameter wells with an average depth of 60 meters for approximately 7,000,000 CFA, per well. This is approximately $507.00/lineal meter using the 230 CFA to $1.00 conversion rate. This price is inclusive of casing, screen, grout, aquifer test, and filter pack.

Pump Types and Evaluation

Several Hand Pump Types were considered for use on the proposed wells to be drilled and refurbished. Types considered were the following:

1. AID/BATTELE PUMPS
2. DEMPSTER PUMP
3. MOYNO PUMP

The AID Pump is currently being used in several developing countries throughout the world. In Nicaraugua and Costa Rica the AID Pump has not performed well in comparison to the Dempster and other hand pumps.[1]

Costa Rica

Of the 15 AID Pumps installed in Costa Rica during 1977, 6 were out of service within 9 months of operation or 43% failure rate. Of those 15 AID pumps installed, 2 pumps were out of service repeatedly.

Nicaraugua

Of the 16 AID Pumps installed in Nicaraugua during 1977, 10 were out of service within the first 9 months of operation. This is a 63% failure rate. Of those 16 AID Pumps installed, 3 pumps were out of service repeatedly.

Costa Rica

Of the 8 Dempster Pumps installed in Costa Rica during 1977, all 8 were still functioning properly after 9 months of operation.

Nicaraugua

Of the 8 Dempster Pumps installed in Nicaraugua during 1977, all 8 were still functioning properly after the 9 months of operation.

Statistical data was available on the Moyno pump with respect to its cost and maintenance/service performance and is contained at the end of this section.

Noted failures in the AID Pump were due to the following causes:

1. Broken pump handles
2. Excessive wearing of the leather cups
3. Breakage of the pump caps

All of the failures can be attributed to poor quality control with respect to casting and machining and to a lesser degree to engineering design.

The Dempster Pump is similar in operation to the AID/BATELLE Pump in that it has a single action, reciprocating positive displacement type pump. Wear points of both pumps are similar with respect to (1) fulcrum point between the handle and pump housing, (2) connection between handle and piston rod and (3) wearing of the leathers in the cylinder. Evidence from the performance record of both the AID/Battelle Pump and the Dempster Pump indicates that the manufacturer of the latter has better control of parts quality and better operational design.

The Moyno Pump offers a different operational design. Basically the Moyno Pump, like the AID/Battelle Pump and Dempster Pump, operates on the positive displacement principle. However, where the Moyno Pump differs is as follows:

1. No valves, gaskets or leathers in the pump end;
2. Columm of water is supported on bearings vs. in a piston pump where the weight of water is offset by force on the pump handle;
3. Can be easily adapted to alternate sources of power, e.g. bicycle, windmill, internal combustion engine, electric or animal power;
4. Will effectively pump solids without risk of damage.

Conclusions

Although the Moyno Pump is the most expensive of all three pumps considered, it possesses the most desirable characteristics of a pump, namely, low maintenance, long performance and ease of installation and operation.

		Approx. Costs
MOYNO	-	$500.00
DEMPSTER	-	$257.00
AID/BATTELLE	-	$100.00

[1] Data taken from the "second progress report on the utilization/evaluation of an AID Hand-Operated Water Pump" prepared by USAID by Potts, Moh, Wipple and Craft, Office of International Programs Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia;, January, 1972.

TOGO -- Technical Personnel

A.	Hydrogeologist (1) (5-years)	Minimum of 10 years of education and experience in quantitative evaluation of hydrogeologic conditions; regional and site specific. Recent responsibilities (minimum 5 years) to include borehole geophysical logging and interpretation, drilling techniques and operation of equipment, well design and construction, aquifer testing and evaluation, and personnel training and project management. Fluent French speaking and international work experience; preferably in Africa.
B.	Drillers (2) (3-years)	Minimum of 10 years of experience in the operation and maintenance of both cable-tool and mud rotary drilling equipment in consolidated rocks. Construction and development of open-hole, screened and gravel-pack wells. Experience and/or desire to train qualified nationals to perform the work required to complete the water resource development project. Fluent French desirable and international work experience; preferably in Africa.
C.	Mechanical Superintendent (1) (5-years)	Minimum of 10 years of experience in maintaining heavy construction equipment; preferably well drilling rigs and diesel engines. Experience and/or desire to train qualified nationals to perform all of the maintenance for a well drilling operation. Fluent French speaking and international work experience; preferably in Africa.
D.	Driller's helper/welder (1) (3-years)	Minimum of 5 years of experience in the operation and maintenance of both cable-tool and mud rotary drilling equipment. Desire to work with and train qualified nationals to perform the work required to complete the water resource development project. Fluent French desirable and international work experience; preferably in Africa.

Summary and Recommendations

In the Maritime Region Canadian International Development Agency (C.I.D.A.) with the Division of Mines and Geology were currently involved in an extensive well drilling program. The Division of Mines and Geology are operating the program presently, with Togolese drillers, using a Bucyrus - Erie GOL and a Koehring Speedstar 71, both cable tool drilling machines. Additionally, they also have a Failing 1250 and a Failing Walker - Neer 40 for doing rotary drilling. However, both rotary machines are inoperable at this time due to the lack of spare parts. This problem is not limited to just their drilling equipment but is evident throughout their entire operation. It is felt that supplying new equipment for drilling in this region would not be in the best interests of an AID program. However, an equipment repair training and maintenance program with supplied parts could accomplish a two-fold purpose:

1. Possible integration with Savanes Region Program(s) in terms of establishing mutual self-interest groups;
2. Training of Togo Nationals in an existing program.

The road network in the Savanes Region is all gravel based and the system of bridges are all low load limit capacity with respect to drilling equipment. In addition, these bridges also possess minimal crossing clearance. For crossing local streams or low areas, a ford will have to be constructed. If one already exists, it most likely will have to be improved upon to accomodate

heavy equipment. This is primarily true for the area south of Dapaong in the sedimentary rock where the rotary drilling operation is proposed. In the crystalline rock north of Dapaong, no difficulty is anticipated in negotiating the low areas. Reason being, there is little, if any, soil cover to give many equipment moving problems in regard to the existence of soft ground conditions.

No primary or secondary roads exist in the Region at the present time. Road conditions, east and west of the main north-south road from Dapaong to Mango, are marginal. During the wet season (June 1 - October 30), mobilization may prove difficult to impossible in many of the areas. A shutdown period during the worst portion of this period may prove necessary while equipment is serviced and/or overhauled.

The drilling program is expected to start slowly at first with teaching Nationals how to operate machinery and equipment safely and efficiently. As their level of proficiency develops, the rate of progress will also increase as a direct result.

Standardization of engine type, preferably Caterpillar, in all the equipment, would be advisable for the sake of cost and interchangeable parts. There is

a Caterpillar dealer in Lomé and contact was made with him. He expressed interest in providing parts and service for the project's needs.

The aspect of initiating a pump manufacturing installation is not considered as being feasible at this time.

1. No natural resources are available locally, in counrty, to produce the raw product (iron ore) for supplying a foundry's needs.
2. In-country technology is marginal with respect to setting up and operating a foundry and related machine shop.
3. Prospects of developing a market large enough to warrant consideration of such a facility are also dim.

Local people share a mutual disturst of pumps from prior bad experiences, either personal or related by others.

Presently, it is felt that a pilot program, using the Moyno pump, would prove beneficial from two standpoints.

1. It would show the performance reliability of the pump to the local people.
2. It would permit a training program to be started for installation and maintenance of future pumps.

As reliance is fostered in the pump and its performance, the possibility of establishing an assembly plant with supplied parts should be given consideration.

Moyno Pump

Personal Communication 7/21/78
Mr. Barclay -- Moyno Rep.
Springfield, Ohio, U.S.A.

Price: $473.00 (shallow) 0 - 150 ft.

$493.00 (deep) 0 - 300 ft.

Weight: 150 lbs. (rotor, stator, head and rods)

Delivery: 4 months initial shipment

300/month thereafter

Lubrication: High-temperature grease

Performance: Laboratory tests - 24 hrs. operation

3 yrs. equivalent

No problems or wear

Ghana - C.I.D.A. Project

10 Units

2 months operation

No problems

Discharge rates: 1. Manual - 3.2 to 4.3 gpm at 60 rpm

2. Alternative power - discharge rate vs. rpm: linear function

Monolift Pump (U.K. Mfg.)

The Monolift pump was described in a recent OXFAM report as a more modern pump which can operate for long periods of time without maintenance.[1] The hand-driven pump works on a different principle than most other pumps, in that, it has a helical metal rotor turning inside a fixed sleeve within the well shaft. Operations of the unit consists of turning the crank handle which in turn turns the rotor and discharges the water. The gearing is very simple, totally enclosed and self-lubricating so as to minimize maintenance. The main objection to the Mono pump has been the initial cost which at that time was estimated to be six to eight times the cost of a simpler pump such as the Dempster (1978 -- $268.00/unit). It was still felt that the very low maintenance costs of the Mono pump fully justified its high initial capital cost. Areas where Monolift pumps have been installed are:

1. UNICEF/OXFAM - Sudan, Africa - number of pumps unknown;
2. RIVERS STATE - Nigeria, Africa - number of pumps 1,200 +.

The Rivers State authorities had tested other pumps but found that without exception the Monolift hand-pump was the only unit that withstood the

---

[1] Hand Pump Maintenance, 1977, Pacey, Arnold. Intermediate Technology Publication, Ltd. (OXFAM), 9 King Street, London WCZE 8 HN, U.K.

ardous duties required in villages where little maintenance was possible. In addition, the UNICEF New Delhi office believes that the Mono pump is one of very few types which could withstand the Indian village conditions without maintenance for any length of time.

It is interesting to note that a U.S. manufacturer has recently started to produce and market the Moyno hand pump for rural water systems, using the same design (rotor and stator) to lift the water as utilized in the Mono pump. The Moyno pump (U.S.), however, is being marketed at a cost of $493 per unit for the deep well model which is less than two times the cost of the sampler pumps (Dempster) discussed earlier which should encourage its use on more water development projects.

References:

(A) ITALOCONSULT/UN/UNDP, 1969, Situation actuelle de la position en eau de Lome, Tsevie, Anecho, Tabligbo et Akepe et previsions futures.

(B) UN/UNDP/ITALOCONSULT, 1967, Survey of ground-water resources, Togo with tables, maps, diagrams.

(C) UN/UNDP, 1975, Prospection des eaux souterraines dans la zone cotiere, Togo, United Nations, N.Y.

(D) Verbal communications, Direction des Mines et de la Geologie

(E) Verbal communications, Service Hydrauliques

(F) Verbal communications, Peace Corps, Lome

(G) Verbal communications, Embassy, Federal Republic of Germany, Lome.

(H) Verbal communications, FED, Lome.

(I) Slansky, M., Vue d'ensemble sur le bassin sedimentaire cotiere du Dahomey - Togo; Bull Soc. Geol. France (6), 8, pp. 555-580.

(J) Verbal communications, UNDP, Lome.

(K) Verbal communications, West African Development Bank, Lome.

APPENDIX

Sokodé

LISTE DES PUITS F.E.D. REALISES
DANS LA CIRCONSCRIPTION DE DAPAON

NS = Niveau Statique
Qi = Débit instantané

N°	NOMS	PROFONDEUR (m)	NS (m)	Qi m3/h	OBSERVATION
47	TIMBOU N° 2	16,35	3,65	5,3	
38	BIEGOU	19,80	2,00	0,5	
96	DOUKPERGOU	19,95	8,50	0,04	
35	SONSOURI	13,00	5,20	2,6	
53	SISSIAKE	10,10	5,40	8	Sec par la suite
34	SOGOU	22,50	9,00	0,06	
21	TANTOGA	16,10	3,10	3,10	
27	NAMONDJOGA	12,75	2,75	8	
93	PANABAGOU - (POUBOGOU)	25,45	2,50	0,04	
49	JAMPIGOU	20,45	5,00	0,4	
39	BOGOU	16,40	2,00	0,3	
41	NANO	22,25	-	sec	
48	NADJOU	20,65	7	0,3	
20	TOULOUN KARGA	16,25	5	3,3	
1	PONIO	16,20	5,70	5,6	
26	MARGBANGOU	14,37	1,60	4,50	
13	YAGOU	20,80	6	0,50	
94	DASSOUDI	13,75	2	0,6	
16	DJANIDJAGA	18,50	7,40	3,6	
11	OGARO	15,90	5	0,5	
10	NATIAM BONGA	15,50	3	7,6	
95	TAMPIABME	15,50	4	1,8	
4	YABDOUARE	16,85	5	2,00	
3	KOUNDJOUARE N° 1	14,90	4	6,9	
2	TAMBATODENI	13,30	3	3,5	
6	NIALI	15,75	2,50	0,15	
7	BAGARE	15,90	4,50	0,66	
8	MANDOURI	17,90	6	0,8	
3	KOUNDJOUARE N° 2	20,30	5,50	0,05	
9	DONGA	17,70	13	0,12	
5	DJOIDOU N° 1	15,70	5	0,08	
5	DJOIDOU N° 2	16,50	6	0,05	
40	KOUKOLONE	15,50	5,50	1,00	
42	BOUGOU SUD	15,75	5	0,45	
43	NASSIEGOU	13,65	3,30	1,20	
54	MOGOU	19,20	8	0,27	
52	FIEGOU	19,20	13,50	0,02	
15	FIOMANGA	18,85	8,70	0,04	
12	NATONGPARGOU	17	8,50	0,3	
97	TCHOUMOURI	4,85	-	-	Sec.

FED Nos.

Data furnished by Sanitary Engineer from Dapaong

CIRCONSCRIPTION ADMINISTRATIVE DE DAPAONG

Villages dotés d'une école du 1er degré

I ECOLES OFFICIELLES

N°	Nom de villages dotés d'Ecoles	FED well plédged	FED #	Pop (78)	Effectif de chaque Ecole	Needs
1	Badigou				129	
2	Babona				117	
3	Bagnam				132	
4	Bagon				39	
5	Biagou				100	
6	Bidjenga		24		254	
7	Boadé				109	
8	Bodjopale				637	
9	Borgou	D	19	750	187	2
10	Bongou				74	
11	Boumong C.G.				366	
12	Cinkassé		1	1420	211	2
13	Dapango A				434	
14	Dapango B				278	
15	Dapango C				384	
16	Djassoute				70	
17	Djangou				263	
18	Dokpolou				-	
19	Fobenga				110	
20	Garo	I	2	-	-	
21	Galle				-	
22	Kombonloaga				577	
23	Koni				106	
24	Korbongou A			3000	341	pumping station
25	Korbongou B				331	
26	Koumbogou				-	
27	Koundjouaré				184	
28	Kurientré				124	
29	Loanga				81	
30	Loko				39	
31	Lokpano				96	
32	Mandouri	O	17	1700	210	3
33	Margba				90	
34	Moumouane				160	
35	Nadjou				-	
36	Nadoungou				37	

38		Nagbangou B			40
39	1	Naki-Tindi-Laré EST 22	1300	1	269
40		Naki-Tindi OUEST			293
41		Namoudjoga			235
42		Nandjak			123
43		Nandjoga			116
44		Nanergou			285
45		Nano X			376
46		Nanoum			28
47		Nataré X			81
48		Natoumbagou			122
49		Natou-kporgou			-
50		Nayéga			147
51		Ninkpourma			267
52	1	Ogaro 10 X			-
53		Oubiagou			-
54		Oubitanligou			93
55		Panabagou			81
56		Pancéré			31
57		Pana	23		215
58	1	Papri X 16	2300	4	231
59		Pligou A			273
60		Pligou B			59
61		Poissongui			66
62		Pogno			188
63		Sanfatouti			190
64		Siboltoti			173
65	1	Tamatougou 19	1500	2	98
66		Tambango			170
67	1	Tandjoaté 13X	2000	4	405
68	1	Tami 6 X	650	0	142
69		Talotré			-
70		Tantigou A			178
71		Tantigou B			-
72		Tantoga X			97
73		Tampièlèm			106
74		Timoré			38
75		Tidjoaté			-
76	0	Timbou 4 X	1980	3	371
77		Tonte x			-
78		Toulon			-

79	Toulouga	73
80	Wagante x	70
81	Warkambou	73
82	Worjou	333
83	Yenyame X	40

o Bidjouga 24 1000 2

o Fiegow 32 1200 3

REGION DES SAVANES

CIRCONSCRIPTION ADMINISTRATIVE DE DAPAONG

REPUBLIQUE TOGOLAISE

Travail-Liberté-Patrie

Liste des localités qui sont dans la nécessité absolue d'avoir des puits

1°- Boadé
2°- Warkambou
3°- Naki-Ouest
4°- Lotogou
5°- Tami
6°- Doukpergou
7°- Lokpano
8°- Loko
9°- Kantindi
10°- Pana
11°- Bagou
12°- Goundoga
13°- Safobé, dans le canton de Timbou
14°- Cinkansé
15°- Nandoga

DAPAONG, LE 16 JUIN 1978

LE CHEF DE CIRCONSCRIPTION,

Adja NABROULABA.-

/T)EGION DES SAVANES

CIRCONSCRIPTION ADMINISTRATIVE DE DAPAONG

REPUBLIQUE TOGOLAISE
Travail-Liberté-Patrie

Liste des localités qui sont dans la nécessité absolue d'avoir des puits

1°- Boudé
2°- Warkambou
3°- Nuki-Ouest
4°- Lotogou
5°- Temi
6°- Doukpergou
7°- Lokpana
8°- Loko
9°- Kantindi
10°- Pana
11°- Pagou
12°- Goundoga
13°- Sufobé, dans la région de Tindou
14°- Cinkassé
15°- Nandoga

Dapaong le 16 JUIN 1967

Le Chef de Circonscription Administrative de Dapaong

LISTE DES PUITS F.E.D. REALISES

DANS . CIRCONSCRIPTION DE DAPAON

NS = Niveau Statique

Qi = Débit instantané

N°	NOMS	PROFONDEUR (m)	NS (m)	Qi m3/h	OBSERVATION
47	TIMBOU N° 2	16,35	3,65	5,3	
38	BIEGOU	19,80	2,00	0,5	
96	DOUKPERGOU	19,95	8,50	0,04	
35	SONSOURI	13,00	5,20	2,6	
33	SISSIAKE	10,10	5,40	8	Sec par la suite
34	SOGOU	22,50	9,00	0,06	
21	TANTOGA	16,10	3,10	3,10	
27	NAMONDJOGA	12,75	2,75	8	
93	PANABAGOU	25,45	2,50	0,04	
49	JAMPIGOU	20,45	5,00	0,4	
39	BOGOU	16,40	2,00	0,3	
41	NANO	22,25	-	sec	
48	NADJOU	20,65	7	0,3	
20	TOULOUN KARGA	16,25	5	3,3	
1	PONIO	16,20	5,70	5,6	
26	MARGBANGOU	14,37	1,60	4,50	
13	YAGOU	20,80	6	0,50	
94	DASSOUDI	13,75	2	0,6	
16	DJANIDJAGA	18,50	7,40	3,6	
11	OGARO	15,90	5	0,5	
10	NATIAM BONGA	15,50	3	7,6	
95	TAMPIABME	15,50	4	1,8	
4	YABDOUARE	16,85	5	2,00	
3	KOUNDJOUARE N° 1	14,90	4	6,9	
2	TAMBATODENI	13,30	3	3,5	
6	NIALI	15,75	2,50	0,15	
7	BAGARE	15,90	4,50	0,66	
8	MANDOURI	17,90	6	0,8	
3	KOUNDJOUARE N° 2	20,30	5,50	0,05	
9	DONGA	17,70	13	0,12	
5	DJOIDOU N° 1	15,70	5	0,08	
5	DJOIDOU N° 2	16,50	6	0,05	
40	KOUKOLONE	15,50	5,50	1,00	
42	BOUGOU	15,75	5	0,45	
43	NASSIEGOU	13,65	3,30	1,20	
54	MOGOU	19,20	8	0,27	
52	FIEGOU	19,20	13,50	0,02	
15	FIOMANGA	18,85	8,70	0,04	
12	NATONGPARGOU	17	8,50	0,3	
97	TCHOUMOURI	4,85	-	-	Sec.

(LOUKE)

LISTE DES PUITS DE LA REGION DES SAVANES .

	NAMONGOU ←	NAMOUDJOGA	YABOUARE
30	KONBONLOGA ←	SISSIAKE	NIALI
91	TANDJOUARE ←	TANTOGA 21	BAGARE
	PLIGA ←	BIEGOU	MANSOURA
	TIMBOU O	DOUGOU	12 NATONGPARGOU
45	TABI ←	SOUGOU 34	TAMPIALEME
51	SAVARIDOUARA ←	JAMPIEOU	DASSOUTI
18	KOURIENTRE ←	PANA-BIEGOU 93	DONGA
32	PANATIEROU ← (23 kintik)	KOUNDJOUARE N°1	DJOIDOU N°1.
37	BATE BOGOU ←	" N°2	" N°3
	NASITINDI-LARE ←	TAMBATODENI	KOUAKOLONE

	TIAMANGA	MANDJONKARGOU
	DIABOURI	PADORI
	NAKITONE	NALI
	DJABOU	TAKPAMMA
	KOUNTOURI	

1 - RENDEZ A LA SOUS DE DAPANGO

2 - SI TU SUIS ABSENT, ALLEZ A LA CIRCONSCRIPTION ET DEMANDEZ LE CHAUFFEUR "PIERRE" QUI A SERVI AVEC NOUS ET CONNAIT TOUS LES PUITS -

...IONS	CIRCONS - CRIPTIONS	NOMBRE DE CENTRES DE PEUPLEMENT	POPULATION ANNEE 1970	Taux d'accroisst %	Population ANNEE 1975	Puits ...TES	Forages ...ux de Fo...
...NES	DAPAON	412	150 501	9	368. 410	33	16
	NANGO	159	58 .276	3, 0	73. 822	10	4
	KANTE	42	42 025	3, 2	50. 017	5	2
KARA	NIAMTOUGOU	53	52. 553	2, 7	67 037	9	3
	PAGOUDA	40	44 681	2, 3	53 592	2	5
	LAMA-KARA	101	90 241	4, 3	141 185	10	4
	ANE [illegible]	63	109 615				
	[illegible]ME	85	37 910				
	TA[illegible]BO	30	71. 803				
	TCHE	232	162 .725	2, 3	250 .153	0	10
	YOGAN	34	131 849	-	-	0	-

SONEZ

LOCATION : SAVANES

	VILLAGE	POPULATION		SOURCE OF WATER		
NO.	NAME	1977	1985	DUG WELL	BOREHOLE	OTHER
1	SINKANSE	1500	1715	Traditional FED. Well-1965	* Well W/Pump in Upper Volta	Puisards
4	TIMBOU	2000	2500	FED. Well-1967	-	Puisards, Dam, SRO
14	KORBONGOU	3000	3600	FED. Well Num. Traditional	-	Puisards Ponded Water, SRO
17	MANDOURI	1700	2000	FED Well (22M3)		Puisards Ponded Water, SRO
18	BOUGOU	700	850	-	-	Stream Puisards
23	PANATIEROU	960	1200	FED Well	-	Puisards, Ponded Water
24	BIDJANGA	1030	1250	FED Well (2)Traditional	-	Puisards, Ponded Water
26	BOGOU	980	1200	FED Well (2)Traditional	-	Puisards, Ponded Water
31	TONTONDI	440	535	-	-	River (2km)
32	FIEGOU	1100	1350	FED Well(Dry)	-	River Puisards
34	DJEBOURI	1700	2000	FED Well(Dry) Traditional	-	DAM (3KM)
LOCATION : MARITIME						
1	TOGODO	550	675	-	-	Puisards
6	GBOTO-VODOUGBE	500	600	1939 Traditional	-	River (3KM) Puisards
17	LONVO	375	460	-	-	River, Puisards
18	KOVE	270	350	-	-	River, Puisards
29	AGNROU	700	850	-	-	River(3KM) Puisards

HYDRAULIQUE VILLAGEOISE AU TOGO, MISSION D'EVALUATION (MAI à OCTOBRE 1977), ANNEXE 16

MINISTÈRE DES MINES DE L'ENERGIE ET DES RESSOURCES HYDRAULIQUES

BRGM 77AGE022

55

JUNE 7

	WATER REQUIREMENTS	ADDITIONAL WELLS REQUIRED	FED PRIORITY
1	105 M^3	2	3
4	100 M^3	3	3
14	350 M^3	PUMPING EQUIPMENT	3
17	42 M^3	3	3
18	18 M^3	2	3
23	25 M^3	2	3
24	25 M^3	2	2
26	25 M^3	2	3
31	15 M^3	1	3
32	30 M^3	3	2
34	30 M^3	3	2
1	19 M^3	1	2
6	23 M^3	1	1
17	12 M^3	1	1
18	12 M^3	1	1
29	18 M^3	2	1 HIGHEST

SERV. , DES MINES ET DE LA GEOLOGIE
Section Hydrogéologie (BNRM)

PIECES MECANIQUES DE RECHANGE A COMMANDER

① BERNARD MOTEUR Type 71 Diesel

Palier de vilebrequin	6	
Vilebrequin	2	
Piston	3	
Coussinet de bielle	6	jeux
Jeu de segments	6	"
Pochette de joints	1	

② PIECES DU MOTEUR DE SONDEUSE FWN-4D
SERIE 53

Detroit Diesel Allison
Division of General Motors Corporation
DETROIT MICHIGAN 48228

Moteur en V. Nombre de cylindres 6
La marque du moteur: MACK Detroit Diesel
Engines Série 53.

(Alternateur: Delco Remy. Série 20 DN. Type 255
G.M/ (Model 1117783. Serial 3M. 13
(12 volts GRD 62 Amps (3 au total)

Tige culbuteur	48
Pochette de joints révision	2
Disjoncteur: Delco Remy 9000590 - 12 volts	...4

③ POMPE A BOUE POUR WABCO

Drilling Equipment Division
Westinghouse Air Brake Company
EMID AKCAHOM U.S.A.
Model FM-45
Serial 70467

Tige de pompe	4	
Mud valve assembly	30	
Joint caoutchouc cravon Kinner sur tige de pompe	2	paquets
Ressorts	30	

④ PIECES DE RECHANGE POUR LA SONDEUSE WABCO

Moteur Caterpillar 1160
Serial N° 96B 9055
2 tables de rotation
Jeu complet de segments pour 2 moteurs

Filtre à moteur (huile à moteur)	16	
Disque d'embrayage	8	
Courroie ventilateur	8	
Alternateur 12 volts	2	
Disjoncteur 12 "	4	Delco Remy Réf. 1119-507
Alternateur 15 "	4	55 A D20 F HA-NEG

⑤ PIECES DE RECHANGE POUR MOTEUR CHRYSTER
NISSAN DIESEL

Model CN 375 ND Model 4D 334
Serial N° 316320

Piston	6	
Jeu de coussinets de bielle	9	jeux

Pochettes de joints	2
Jeu de segments	9 jeux
Filtre à huile	1 paquet
" combustible	1 "
Demarreur	1 "
Alternateur	2
Induit de demarreur	2
Charbon	12
Courroie ventilateur	6
Chemise	3
Injecteur	6

(6) PIECES DE RECHANGE POUR GROUPE ELECTROGENE DIESEL - MARQUE ONAN (2 moteurs à réviser)

Model and spec. n° 12-ODJC - 30E/8523 AA
Serial n° 0974859625

Vilebrequin	2
Jeu complet de segments pour 4 moteurs	
" " coussinets de bielle pour 4 moteurs	
" " de paliers pour 4 moteurs	
Pochettes de joints pour 4 moteurs	
Pompe d'alimentation	4
Injecteur	12
Demarreur	2 Induit de demarreur 4
Charbon de demarreur	12
Induit de dynamo	2
Charbon de dynamo	24
Arrêt d'huile carter avant	4
" " " arrière	4
Filtre à huile	1 paquet
" "combustible	1 "
Piston	8

(7) PIECES DE RECHANGE POUR GROUPE SOUDURE ONAN
(3 Moteurs à réviser)

Modèle Type ccKA S/21036
Serial N° 0374773220

Vilebrequin	6
Jeu complet de segments pour	6 moteurs
" de coussinets de bielle pour	6 moteurs
Pochettes de joints pour	6 moteurs
Pot d'échappement pour	6 "
Arrêt d'huile carter avant	6 "
" " " arrière	6 "
Vis-platinées	6 "
Bougies d'allumage	4 paquets
Bobine d'allumage	4 "
Demarreur	2 "
Induit de demarreur	1
Charbon de demarreur	12
Bague " "	10
Induit de dynamo	3
Charbon de dynamo	12
Pistons	12
Condensateur	4

N.B. Jeu complet de paliers pour 6 moteurs.

.../.

(8) COMMANDE DE PIECES DE RECHANGE DE LA SONDEUSE BUCYRUS 60-L N° 234.926

1 Courroie d'entraînement
2 Cables de curage (Sand line)
2 Chaîne de soupape
2 " de verin.

(9) COMMANDE DE SONDES POUR MESURE DES PLANS D'EAU

3 sondes Rossignole de 100 m

Adresse: Sondes Rossignol. Précis Electromécanique
59. MARCHEZIENNES

(10) PIECES POUR INTERNATIONAL A GRUE

International 1160 (Fleed Star 2050 A)
N° du moteur 1160
N° de série 95 B33439
Date of engine manufacture - 5/74
- 1 mécanisme complet d'embrayage
- 2 plateaux "

(12) COMMANDE DES PILES
Trousse chimique

1) - HACH BATTERY N° 1087-53 - 4 ½ VOLTS
MFG for HACH CHEMICAL COMPANY
CAT N° 1087-53 for direct replacement of this Battery
PACK OR. OPTIONAL
HACH -CHEMICAL COMPANY P.O. BOX 907/AMES.
10WA-50010/515/232-2533

2) PILE MALLORY - M 1605 - 9 VOLTS
Transitor BATTERY - MADE IN BRITAIN

3) PILE VARTA - TROCKENBATTERIE
CLAY BATTERY VARTA 72 - 22,5 VIES 15F 20
MADE IN GERMANY

4) EVEREADY LIGHTING-BATTERY N° 5105 NEDA-915 6 VOLTS
UNION CARBIDE CORPORATION
NEW-YORK. N.Y. 10017
MADE IN U.S.A.

TSVP →

(13)

1. "Mudmaster" Slush Pump Piston Failing	Rod Taper	Piston size	Number of assembly	Quantity
4½" x 5" L-100	G-D-1	4½"	F-917 C	50

2. "Mudmaster" Hardened Slush LINERS				
Size and Make of Pump	Liner size	Liner Part		12
4½" x 5" L-100	4½"	L-101		

3. Lubricator Packing glands for Slush Pump Piston Rods					
Size & Make of Pump	Glands	Nut	Packing ring	Assembly	
4½" x 5½ L-100	864-FA	869-F	XG-D-60-H2	F-1032-A	200

4. "Mudmaster" Hardened Slush Valves			
Size and Make of Pump Failing	Valve assembly Part Number	Valve seat Part Number	
4½" x 5" L-100	898-F	FF-39-H	200

SPARE PARTS FOR "MUDMASTER" SLUSH PUMP PISTON :

Modèle : FM-45
N° de série: 70467.

Rural Water Resource Development in Togo

Financial Analysis

Prepared by: Diann H. Painter

A N N E X

FINANCIAL ANALYSIS

T A B L E S

EXCHANGE RATE : 230 CFAF -- $US 1.

FINANCIAL ANNEX

NOTES :

A. Adversary salaries calculated to include an annual increase of 5% - Tables 1-6.

B. Inflation compounded at 10% per annum over 5 years for AID figures - Tables 1-6.

C. Shipping and Insurance, Spare Parts and Fuel costs divided as follows - (Tables 1-10) :

	FY 79	FY 80	FY 81	FY 82	FY 83
USAID	100%	75%	50%	25%	0
TOGO	0	25%	50%	75%	0

D. Shipping costs and Insurance figured at 60% of values of pumps and 40% of values of all other items - (Tables 1-10).

E. Lab Technician Training is for 1 year in Abidjan - (Table 5)

F. Inflation compounded at 15% per annum over 5 years for Togo Contributions - (Tables 7-10)

G. Contingency for Salaries based on past trends of a 15% increase in 1974, 1975 and 1977. Salaries are regulated - (Tables 7-10).

H. Equipment cost explanations are found in the Hydrogeological Annex.

I. Some items under $10,000 are imported and do not appear in Table 16 because they cannot be obtained in Togo.

TABLE I.

ANNUAL FINANCIAL PLAN - ALL PROGRAMS - AID ($US 000)

	FY 79	FY 80	FY 81	FY 82	FY 83	Total	
Capital Equipment							
Rotary Rig	530	52	--	--	--	582	
Cable Tool Rig	--	--	136	--	--	136	
Pumps	165	--	100	--	--	265	
Sanitation	95	40	--	--	--	135	
Administration	30	--	--	--	--	30	
	820	92	236	--	--	1148	
Personnel							
Rotary Rig	255	308	325	341	312	1541	
Cable Tool Rig	--	--	127	133	139	399	
Pumps	60	--	--	--	--	60	56*
Sanitation	40	42	44	46	48	220	336*
Administration	45	48	51	54	57	255	
	400	398	547	574	556	2475	
Construction Material							
Rotary Rig	602	--	--	--	--	602	
Cable Tool Rig	--	--	290	--	--	290	
Pumps	--	--	--	--	--	--	
Sanitation	32	47	47	47	47	220	
Administration	--	--	--	--	--	--	
Operations							
Rotary Rig	463	227	155	100	220	1165	
Cable Tool Rig	--	--	205	75	--	280	
Pumps	590	15	410	20	--	1035	
Sanitation	106	80	55	30	5	276	
Administration	--	--	--	--	--	--	
	1159	322	825	225	225	2756	
Total	3013	859	1945	846	828	7491	
Inflation	--	97	398	262	355	1112	
GRAND TOTAL	3013	956	2,343	1,108	1,183	8,603	

TABLE 2

ANNUAL FINANCIAL PLAN - ROTARY RIG PROGRAM, AID
(US$ 000)

	FY 79	FY 80	FY 81	FY 82	FY 83	Total
Capital Equipment						
Rotary Rig	100	-	-	-	-	100
1 Truck for Rig	35	-	-	-	-	35
4 Trucks	36	12	-	-	-	48
1 Caterpillar Bulldozer	75	-	-	-	-	75
1 Tractor with Low Boy	55	-	-	-	-	55
Base Radio and Radios	7	-	-	-	-	7
Airco Oxy/Acy	1	-	-	-	-	1
Pump Rig	-	40	-	-	-	40
Geophysical Equipment	35	-	-	-	-	35
Drilling Mud	3	-	-	-	-	3
Bits	13	-	-	-	-	13
Porta Kamp	170	-	-	-	-	170
	530	52	-	-	-	582
Personnel						
Hydrogeologist	100	105	111	117	123	556
Mechanical Superintendent	80	84	89	93	98	444
Master Driller	75	79	83	87	91	415
Driller's Helper	-	40	42	44	-	126
	255	308	325	341	312	1,541
Construction Material						
Pipe	492	-	-	-	-	492
Drive Shoes	20	-	-	-	-	20
Screen & Screen Fittings	90	-	-	-	-	90
	602	-	-	-	-	602
Operations						
Spare Parts	15	10	15	15	120	175
Fuel and Lubricants	220	165	110	55	-	550
Shipping and Insurance	225	50	30	30	100	435
Training Program Supplies	3	2	-	-	-	5
	463	227	155	100	220	1,165
	1,850	587	480	441	532	3,890
Inflation	-	59	101	146	245	551
	1,850	646	581	587	777	4,441

TABLE 3

ANNUAL FINANCIAL PLAN - CABLE RIG PROGRAM - AID
(US $ 000)

	FY 79	FY 80	FY 81	FY 82	FY 83	Total
Capital Equipment						
Drill Rig & Accessories			75			75
Water Truck			35			35
Drill Bit Forage			5			5
Welder			8			8
Ceetting Outfit			1			1
Pick-up Truck			12			12
			136	-	-	136
Personnel						
Master Driller			83	87	91	261
Driller's Helper/Welder			44	46	48	138
			127	133	139	399
Construction Material						
Pipe			165			165
Drive Shoes			15			15
Screen & Scren Fittings			60			60
Cover forms and cement			50			50
			290	-	-	290
Operations						
Spare Parts			20	10	-	30
Fuel			125	65	-	190
Shipping and Insurance			60			60
			205	75	-	280
			758	208	139	1105
			159	69	64	292
			917	277	203	1397

TABLE 4

ANNUAL FINANCIAL PLAN - PUMP PROGRAM - AID.

(US $ 000)

	FY 79	FY 80	FY 81	FY 82	FY 83	Total	Othe
Capital Equipment							
500 Pumps	150	-	100	-	-	250	
1 Light Vehicle	12	-	-	-	-	12	
3 Motorcycles	3	-	-	-	-	3	
	165	-	100	-	-	265	
Personnel							
Pump Installation/ Maintenance Training	60					60	
1 Peace Corps							56
	60					60	56
Operations							
Spare Parts	300		200			500	
Repair & Maintenance	20	15	30	20	-	85	
Shipping & Insurance	270	-	180			450	
	590	15	410	20	-	1035	
	815	15	510	20	-	1360	56
Inflation	-	17	107	7	-	131	
	815	32	617	27	-	1491	56

TABLE 5

ANNUAL FINANCIAL PLAN - SANITATION PROGRAM - AID
(US $000)

	FY 79	FY 80	FY 81	FY 82	FY 83	Total	Othe
Capital Equipment							
3 Flat-bed Tractors	21					21	
4 Light Vehicles	48					48	
6 Motorcycles	6					6	
Training Equipment	20					20	
Laboratory Equipment		40				40	
	95	40				135	
Personnel							
Public Health Specialist	40	42	44	46	48	220	
6 Peace Corps							336
	40	42	44	46	48	220	336
Construction Materials							
Cement Roofing, Reinforcing rod, etc.	21	21	21	21	21	105	
Latrine Platform Materials	10	25	25	25	25	110	
Hant Tools	1	1	1	1	1	5	
	32	47	47	47	47	220	
Operations							
Fuel	60	45	30	15	-	150	
Parts and Maintenance	35	30	20	10	-	95	
Laboratory Supplies	-	4	4	4	4	16	
Technician Training	10					10	
Training Supplies	1	1	1	1	1	5	
	106	80	55	30	5	276	336
	273	209	146	123	100	851	
Inflation	-	21	31	40	46	138	
	273	230	177	163	146	989	336

TABLE 6

ANNUAL FINANCIAL PLAN - PROJECT ADMINISTRATION - AID.
(US $000)

	FY 79	FY 80	FY 81	FY 82	FY 83	Total
Equipment						
Office	30					30
	30					30
Personnel						
Administrative Assistant	15	16	17	18	19	85
Project Accountant	30	32	34	36	38	170
	45	48	51	54	57	255
Operations						
Office Supplies	10	10	10	10	10	50
Fuel	10	8	5	3	-	26
	20	18	15	13	10	76
	95	66	66	67	67	361
Inflation	-	7	14	22	31	74
	95	73	80	89	98	435

TABLE 7

ANNUAL FINANCIAL PLAN - SUMMARY ALL PROGRAMS - TOGO
(US $ 000)

	FY 79	FY 80	FY 81	FY 82	FY 83	Total
Equipment						
Administration	25	-	-	-	-	25
	25	-	-	-	-	25
Personnel						
Rotary Rig	31	31	31	31	31	155
Cable Tool Rig	-	-	15	15	15	45
Pumps	21	21	21	21	21	105
Sanitation	25	28	28	28	28	137
Administration	14	14	14	14	14	70
	91	94	109	109	109	512
Office Space/Warehouse						
Pumps	50	-	-	-	-	50
Sanitation	-	25	-	-	-	25
Administration						
	50	25	-	-	-	75
Operations						
Rotary Rig	100	167	233	300	375	1175
Cable Tool Rig	-	-	26	91	150	267
Pumps	-	5	10	20	40	75
Sanitation	2	31	56	81	101	271
Administration	8	11	13	16	18	66
	110	214	338	508	684	1854
	276	333	447	617	793	2466
Inflation	-	50	143	320	587	1100
Contingency	-	14	15	15	15	59
GRAND TOTAL	276	397	605	952	1395	3625

TABLE 8

ANNUAL FINANCIAL PLAN - TOGO ($US 000)

	FY 79	FY 80	FY 81	FY 82	FY 83	Total
Rotary Rig Program						
Personnel						
Drill Operators	18	18	18	18	18	90
Maintenance Men	8	8	8	8	8	40
Drivers	5	5	5	5	5	25
	31	31	31	31	31	155
Operations						
Spare Parts	-	5	15	40	55	115
Fuel	-	55	110	165	220	550
Shipping & Insurance	-	5	30	20	25	80
Training Supplies	-	2	3	-	-	5
Garage Maintenance Support	100	100	75	75	75	425
	100	167	233	300	375	1175
Total	131	198	264	331	406	1330
Inflation	-	30	84	172	300	586
Contingency for Salaries	-	5	5	5	5	20
Total	131	233	353	508	711	1936

	FY 79	FY 80	FY 81	FY 82	FY 83	Total
Cable Tool Rig Program						
Personnel						
Percussion Rig Operators	-	-	12	12	12	36
Drivers	-	-	3	3	3	9
			15	15	15	45
Operations						
Fuel	-	-	-	65	125	190
Training Supplies	-	-	1	1	-	2
Garage Maintenance Support	-	-	25	25	25	75
	-	-	26	91	150	267
	-	-	41	106	165	312
Inflation	-	-	13	55	122	190
Contingency for Salaries	-	-	2	2	2	6
Total	-	-	56	163	289	508

TABLE 9

TOGO: ANNUAL FINANCIAL PLAN - TOGO ($US 000)

PUMP PROGRAM	FY79	FY80	FY81	FY82	FY83	TOTAL
Personnel						
Pump Maintenance/ Repair Center Admin.	4	4	4	4	4	20
Pump Mechanics (3)	6	6	6	6	6	30
Pump Maintenance Supervisor	5	5	5	5	5	25
Parts Man	3	3	3	3	3	15
Accountant	2	2	2	2	2	10
Driver	1	1	1	1	1	5
-- Subtotal --	21	21	21	21	21	105
Office/Warehouse	50					50
Operations						
Maintenance	--	5	10	20	40	75
-- Subtotal --	71	26	31	41	61	230
-- Inflation --	--	4	10	21	45	80
-- Contingencies for Salaries --	--	3	3	3	3	12
-- Total ---	71	33	44	65	109	322

TABLE 9 (continued)

TOGO: ANNUAL FINANCIAL PLAN - TOGO ($US 000)

SANITATION PROGRAM	FY79	FY80	FY81	FY82	FY83	TOTAL
Personnel						
Supervisor/ Latrine Program	5	5	5	5	5	25
Water Control Lab Technician	--	3	3	3	3	12
Public Health Education (3)	6	6	6	6	6	30
Mason (2)	4	4	4	4	4	20
Carpenter (2)	4	4	4	4	4	20
Steel Worker (2)	4	4	4	4	4	20
Laborer (2)	2	2	2	2	2	10
-- Subtotal --	25	28	28	28	28	137
Operations						
Fuel	--	15	30	45	60	150
Parts & Maintenance	--	10	20	30	35	95
Lab Supplies & Maintenance	--	4	4	4	4	16
Printing	2	2	2	2	2	10
-- Subtotal --	2	31	56	81	101	271
Lab Space	--	25	--	--	--	25
-- Subtotal --	27	84	84	109	129	433
Inflation	--	13	27	57	95	192
Contingency for Salaries	--	4	4	4	4	16
--- Total ---	27	101	115	170	228	641

TABLE 10

ANNUAL FINANCIAL PLAN ($US 000)

ADMINISTRATION	FY79	FY80	FY81	FY82	FY83	TOTAL
Equipment						
Office	15	--	--	--	--	15
Vehicle	10	--	--	--	--	10
-- Subtotal --	25	--	--	--	--	25
Personnel						
Project Director	9	9	9	9	9	45
Secretaries (3)	4	4	4	4	4	20
Driver (1)	1	1	1	1	1	5
-- Subtotal --	14	14	14	14	14	70
Office Space						
Operations						
Office Supplies	5	5	5	5	5	25
Fuel	--	3	5	8	10	26
Maintenance of Equipment	3	3	3	3	3	15
-- Subtotal --	8	11	13	16	18	66
-- Subtotal --	47	25	27	30	32	161
Inflation	--	4	9	17	24	54
Contingency for Salaries	--	2	2	2	2	8
--- Total ---	47	31	38	49	58	223

TABLE 11

ADVISORY SERVICES SCHEDULE AID

Type of Advisor	Number of Working Months					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
(A) Long Term:						
Hydrogeologist	12	12	12	12	12	60
Mechanical Superintendent	12	12	12	12	12	60
Master Driller I (rotary)	12	12	12	--	--	36
Tablemen (rotary)	6	12	12	6	--	36
Master Driller II (cable)	6	12	12	6	--	36
Drilling Assistant/ Welder (cable)	6	12	12	6	--	36
Driller's Helper	--	12	12	12	--	36
Public Health Specialist	12	12	12	--	--	36
(B) Peace Corps Volunteers:						
Public Health I	12	12	12	--	--	36
Public Health II	12	12	12	--	--	36
Public Health III	12	12	12	12	12	60
Latrine Program IV	12	12	12	--	--	36
Latrine Program V	12	12	12	--	--	36
Latrine Program VI	12	12	12	12	12	60
Pump Program I						
Pump Program II						
(C) Third Country Nationals:						
Accountant	12	12	12	12	12	60
Administrative Assistant	12	12	12	12	12	60
(D) Short Term:						
Pump Installation & Maintenance Trainer	6	--	--	--	--	6
Well Restoration Engineer	4	--	--	--	--	4
Grand Total						50 yrs. 10 mos.

TABLE 12

TOGOLESE PERSONNEL: ESTIMATES OF
ANNUAL AND TOTAL PROJECT COMPENSATIONS*

JOB CATEGORY	# of years	# of men/ years	Annual Compensation in $US	Total Compensation over project period
Well Construction Program				
1. Hydraulic Project Service Technician	5	1	7,900	39,500
2. Rotary Rig Operator	5	6	3,000	90,000
3. Percussion Rig Operator	5	4	3,000	60,000
4. Drill Maintenance Man	5	3	2,500	37,500
5. Drill Maintenance Laborer	5	2	1,200	12,000
6. Pump Center Administrator	5	1	4,000	20,000
7. Pump Center Maintenance Supervisor	5	2	2,500	25,000
8. Pump Mechanic I	5	2	2,000	20,000
9. Pump Mechanic II	5	2	1,400	9,800
10. Pump Parts Man	5	1	1,500	7,500
11. Supervisor-Well Restoration	5	1	3,000	15,000
12. Mason	5	2	1,600	11,200
13. Iron Worker	5	2	1,500	15,000
14. Laborer	5	4	1,200	24,000
15. Pump Accountant	5	1	1,700	8,500
Subtotal				395,000

TABLE 12 (continued)

TOGOLESE PERSONNEL: ESTIMATES OF
ANNUAL AND TOTAL PROJECT COMPENSATIONS*

JOB CATEGORY	# of years	# of men/ years	Annual Compensation in $US	Total Compensation over project period
Sanitation Program				
1. Supervisor - Latrine Program	5	1	5,000	25,000
2. Water Control Lab Technician	5	1	3,000	15,000
3. Public Health Educator	5	3	2,000	30,000
4. Supervisor - Construction Program	5	1	1,700	8,500
5. Mason	5	9	1,600	72,000
6. Carpenter	5	5	1,200	30,000
7. Iron Worker	5	3	1,500	12,000
8. Laborer	5	6	1,000	30,000
Subtotal				222,500
Project Administration				
1. Project Director	5	1	8,300	41,500
2. Secretary	5	3	1,200	18,000
3. Driver	5	12	1,100	66,000
Subtotal				125,500
Total				743,000

*Based on salaries of employees of the Direction de l'hydraulique et de l'Energie.

TABLE 13

ALTERNATIVE PROJECT SCHEDULES

Plan A*

	FY79	FY80	FY81	FY82	FY83	Total
I. Rotary Program Number of Wells Drilled/yr.	25	25	50	100	100	300
II. Cable Tool Program Number of Wells Drlled/yr.	40	40	40	40	40	120
III. Sanitation Number of School Latrines	30	30	30	30	30	150
Number of Private Latrines	350	1000	1000	1000	1000	4350

*Assumes that Both Rigs Will Be Purchased & Begin Operations in 1979

Plan B*

	FY79	FY80	FY81	FY82	FY83	Total
I. Rotary Program Number of Wells Drilled/yr.	25	25	50	100	100	300
II. Cable Tool Program Number of Wells Drilled/yr.	--	--	40	40	40	120
III. Sanitation Number of School Latrines	30	30	30	30	30	150
Number of Private Latrines	350	1000	1000	1000	1000	4350

*Assumes That Rotary Rig Becomes Operational In 1979, And Cable Tool Rig Becomes Operational In 1981.

TABLE 14

ROTARY RIG SUMMARY TABLE

Rotary Rig -- Per Meter, Per Well and Per Capita Cost of Program

	5 years
USAID -- Capital equipment, personnel, maintenance, operations	4,441
GOT -- Capital equipment, personnel, maintenance, operations	1,936
USAID-GOT -- Administration prorated	164
Subtotal	6,541
USAID -- Pump	821
GOT -- Pump	188
USAID-GOT -- Pump Administrations	82
Total :	7,632,000

Average depth of well - 60 meters
# of wells to be drilled - 300

# of meters drilled = 300 X 60 = 18,000m
20% Failure .8

14,400

With Pump

$ per meter = $7,632/14,400m = $532/m

$ per well = $7,632/300 = $25,440

Without Pump

$ per meter = $6,541/14,400 = $454/m

$ per well = $6541/14,400 = $21,803

if well operated 6 hours per day and capacity is $1m^3/m.$ or 1000 l/h
and acceptable rate of consumption is 20 l/person
can accommodate 300 people per well or 90,000 people,
or 41.5% of population of Savanes ---

Cost per capita --
with pump $84.8
without pump $72.0

TABLE 15

CABLE RIG - SUMMARY TABLE

Cable Rig -- Per Meter, Per Well and Per Capita Costs of Program

	5 years
USAID - Capital equipment, personnel, maintenance, operation	1,397
GOT - Capital equipment, personnel, maintenance, operation	508
USAID - GOT Administrative costs	164
Subtotal	2,069
USAID Pump	405
GOT Pump	134
USAID - GOT Pump Administration	82
Total	2,690

Average drilling depth 20m

	200 wells		120 wells	
# meters drilled	200X20	4,000m	120X20	2,400m
	20% failure	.8	20% failure	.8
		3,200m		1,920m
$/meter with pump	2,690/3,200	$840.6	2,690/1,920	$1,401.0
without pump	2,069/3,200	$646.5	2,069/1,920	$1,077.6
$/well with pump		$13,450		$22,416.7
without pump		$10,345		$17,241.7

Assumptions: well is operated 6 hrs/day
capacity 1,000 l/hr.
consumption 20 l/person
300 people/well

200 well can accomodate 60,000 people
120 wells can accomodate 36,000 people

Cost per capita --	200 wells	120 wells
with pump	$44.8	$74.7
without pump	$34.5	$57.5

TABLE 16

FOREIGN EXCHANGE COSTS - AID
PURCHASER IN LOCAL CURRENCY ($US 000)

	FY79	FY80	FY81	FY82	FY83	Total
Fuel-Rotary Rig	220	165	110	55	---	550
Fuel-Cable Tool	---	---	125	65	---	190
Motorcycles-Pumps	3	---	---	---	---	3
Repair and Maintenance Pumps	20	15	30	20	---	85
Motorcycles-Sanitation	6	---	---	---	---	6
Fuel - Sanitation	60	45	30	15	---	150
Training Supplies Sanitation	1	1	1	1	1	5
Lab Supplies Sanitation	---	4	4	4	4	16
Office Equipment	15	---	---	---	---	15
Office Supplies	10	10	10	10	10	50
Fuel - Administration	10	8	5	3	---	26
Total	345	248	315	173	15	1,096

WELL DRILLING ANNEX

TOGO REPORT

Michael V. Glaze

Michael V. Glaze

TOGO REPORT

EQUIPMENT AND COST EVALUATION

Scope

Initially, the proposed project encompasses two areas in the country of Togo; namely the Savanes Region and the Maritime Region.

In the Savanes Region, an estimated 300 wells are scheduled to be drilled and 200 existing dug wells to be refurbished. Priorities with respect to well locations, within these two regions, are to be given to schools, dispensaries, and villages of high density population, respectively.

A self-help type program is proposed in the Maritime Region where existing well drilling equipment is under control of the Division of Mines and Geology.

Drilling conditions within the Savanes Region differ as far as geographical locale. North of the town of Dapaoun there is primarily crystalline rock. Beginning at Dapaoun and southward there are interbedded sedimentary quartzitic sandstones and shales.

Methods of Drilling

Two methods of drilling are recommended in the Savanes Region. The first, is a cable-tool percussion method and the proposed use for this method would be in refurbishing existing dug wells. The second, is a straight mud rotary method and the proposed use for this method would be in construction of new tube-wells.

Due to the hydrogeologic nature of the crystalline rock, north of Dapaoun, it is recommended that only cable-tool percussion drilling be instituted there, and only for refurbishing existing dug wells. The rotary drilling portion should be confined to the sedimentary rock areas. It is not recommended to use rotary drilling to refurbish existing dug wells due to the nature of how the rotary drilling process operates.

Equipment Type--Description and Cost

Many types of drilling equipment are available on today's markets. Selection of the correct type for the job depends on several factors:

1. Type of drilling conditions
2. Depth and size diameter of hole
3. Initial cost and repair cost
4. Ease of maintenance

The following type of equipment that is suggested was selected on the basis of the above factors. Also these particular types have a good performance record all over the world and have been used successfully in West Africa.

Cable-Tool

For a cable tool drilling program a suggested listing of rig type with ancillary type equipment and tools with related estimated cost is as follows:

15 TONS 1--Bucyrus--Erie 20-W drill with Waukesha Diesel Engine mounted on 2½ ton single axle 4-sp drive International Harvestor diesel truck with 4" drill tools, spare bits, mandrels, rope socket, stem, chain bar tightener, drilling jars, bailers and fishing tools, as well as necessary hand tools . . . $75,000.00

7 TONS 1--International Harvestor 7-ton Diesel Truck with twin axles; 13 speed drive equipped with 1200 gallon water tank. Tank to be qquipped with vacuum, interchangeable suction hoses with strainers and gasoline transfer pump. $35,000.00
Also to have 12-ton Ramsey PTO winch mounted to front.

2 TONS 1--ACME Drill Bit forge equipped with firebrick, 220V. blower, necessary hand tools such as gauges, 12 lb. sledges, tempil sticks, gloves, 4" ring gauges, ½ ton chainfall $3,500.00

1 TON 1--Miller D-5 Portable 200 amp continuous diesel-drive welder; 220V outlet equipped with 30 ft. welding cables, necessary welding equipment has welding hoods (2); spare glass for eye shade, gloves, etc. 200 lbs #7013 5/32" dia welding rod. $6,900.00

OK — TONS 1- Airco Oxygen/Acetylene cutting outfit equipped necessary tips for heating, brazing and cutting, 30 ft. hoses, tip cleaners and hose adaptors for fitting metric threaded oxy/acy. Tanks and additional items such as check valves goggles, strikers. Tank gauges to be claibrated in both psi& kg/cm^2. Also gauges are to be equipped with two stage regulators.. . . . . .$700.00

O.K. 3 TONS 1-3/4 Ton-4sp 4 wheel drive GMC diesel pick-up equipped with 50 gal fuel tank on bed and transfer pump. ~~$12,000.00~~ 15 N.E. Also to have 3 Ton Ramsey PTO winch mounted to front.

Equipment Subtotal. $591,100.00

CONSTRUCTION MATERIALS AND SUPPLIES

Well Casing

Estimated 200 Refurbished wells-Average depth 50 meters (164')

Pipe required-4" I.D., wall thickness- .250 inch, BLACK, Threaded and coupled API thread 32,800 ft.

180 tons 32,800 ft. ($5.00/ft.). $169,000.00

Drive Shoes

4 tons 200 wells ($60.00/shoe) $12,000.00

Well Screens

200; 4 ft. 4" diameter, .012" slot Johnson stainless steel screens with fittings; telescoping $57,000.00

51 tons

Moyno Pumps

200 initial; assume 25% failure rate/year (50/year) X 5 years= 250 additional pumps

34 tons 450 pumps ($500.00)= $225,000.00

Construction Materials and Supplies Subtotal. . $458,000.00

Operational Costs

Drill Bits--13 ton

50-Acme Alloy Bits; assorted star and regular-pattern for drilling 4"-6" diameter hole; 4' length. . . .$45,000.00

T.B.A.--2 tons

Tires, batteries, assessory spare parts for light vehicles and other ancillary equipment 40% of equipment cost . . . $236,440.00

fuel-see attached sheet A** $280,987.00

Operational Costs Subtotal. $562,427.00

Shipping Costs and Insurance

Equipment cost-$591,100.00 (40%)= $236,440.00

Construction Materials and Supplies Cost-$458,000.00 (40%)= $183,200.00

Bit cost-$45,000.00 (40%)= $ 18,000.00

T.B.A. cost-$236,440.00 (40%)= $ 94,576.00

Shipping Costs & Insurance Subtotal. . . $532,216.00

Personnel Costs

Job Description	cost/year	Total Cost
Master Driller	$75,000.00	$375,000.00
Driller's Helper	$40,000.00	$200,000.00

Personnel Costs Subtotal $575,000.00

For a rotary drilling program a suggested listing of rig type with ancillary type equipment and tools with respective estimated costs is given as follows:

O.K 30 TONS 1-Failing 1250 mud rotary mounted on 2050 IHC with interlock equipped with 5 x 6 Gardner-Denver mud pump; 400'--2 7/8" IF drill pipe 20' lengths; necessary subs for swivel and end rod as well as additional parts for rig truck, portable mud pit to be included.

. . . . . $ 97,000.00

Rig to be equipped with Miller ~~180~~ 300 amp "Roughneck" welder and necessary tools and equipment ~~3,000.00~~ 4,500.00

. . . . . $100,000.00

O.K. 7 TON 1-IHC 2050 diesel with interlock; equipped with 1200 gallon water tank. Tank to be equipped with vacuum, gasoline transfer pump and interchangeable suction hoses with strainers. Truck to have 12-ton Ramsey P.T.O. winch mounted to front. . . . . $ 35,000.00

will need 20 TON 1-D5A Caterpillar Bulldozer equipped with model 55 D5 DD winch. Bulldozer to be equipped with normal width tracks. . . . . $ 75,000.00

will need 12 TON 1-IMCO Tri-axle lowboy with IHC 2050 diesel tractor cab

. . . . . $ 55,000.00

will need 9 TON 1-Cyclone F-40 pump hoist mounted on IHC 2050 diesel truck

. . . . . $40,000.00

O.K 1-Airco oxygen/acetylene cutting outfit equipped with necessary tips for heating, cutting and brazing; 30 ft. hoses, tip cleaners and hose adapters for fitting metric threaded oxy/acy. tanks. Additional items such as check valves, eye goggles, striker to be included. Regulators are to be two-staged and gauges to be calibrated in both psi and ky/cm^2 . . . . . $ 700.00

1 flat-bed truck 5-ton 4/4 diesel - - -30,000

12 TON 4-3/4 ton 4-wheel drive G.M.C. diesel pickup with 50-gallon fuel tank mounted in bed (for 3 of 4 trucks) and equipped with transfer pumps. 3-ton Ramsey winch; electric drive mounted to front (on all 4 trucks) presumably 2 small trailers $48,000.00

?? 20 TON 1-Field porta-kamp equipped for 5 personnel. Base radio station included with 3 field radios $177,000.00

1-Johnson-Keck type electric logging unit equipped with resistivity 16"/64", SP, Gamma, and Salinity logging capabilities

Equipment costs Subtotal $565,700.00

Construction Material and Supplies

23 TON Drilling Mud, Quik-Gel; figure 3 bags/hole. 3 (300)=900 ($5.00/bag)= $4,500.00

3 TON Barafos, Mud Cleaning Agent; figure 1 bag/hole @ $50.00/bag= $15,000.00

542 TON Well Casing, average 100 meters/well 100 meters (300)=30,000 meters=98,400 ft. ÷ 21 = 4686 joints 4686 joints of pipe (21') = 98,406' ($5.00/ft) 4"-black iron; .250 inch wall thickness; T. & C.; A.P.I. thread $492,030.00

6 TON Rotary Drill Shoes; 300 ($60.00/shoe)= $18,000.00

9 TON Well Screens; 300; 4 ft. length, 4" diameter, 1012 slot Johnson stainless steel screens with fittings non-telescoping $85,500.00

51 Ton Moyno Pumps; 300 initial; assume 25% failure rate/year 75/yr(5 years)= 375 pumps;300 + 375 =675 ($500.00/pump)= $337,500.00

drop pipe + drive shaft with coupling @ 2.00/ft. avg 75 ft per well = 150 per well 45,000

Operational Costs

12 TON — Drill Bits; 6 7/8" diameter. assume 1.5 bits/hole in sedimentary rock 300 (1.5) = 450 (436.36 avg/bit)= $196,362.00

2 TON — T.B.A.; tires, batteries, accessory spare parts for light vehicles and other anoillary equipment. 40% of equipment cost $226,280.00 ?

Fuel; see attached sheet A $1,181,104.00

Operational Costs Subtotal. . . $1,678,746.00

Shipping Costs and Insurance

Equipment- $565,700.00 (40%) $226,280.00

Construction Materials and Supplies-$337,500.00 (40%) $135,000.00

Bits-$196,362.00 (40%) $78,544.00

T.B.A.-$226,280.00 (40%) $90,512.00

Shipping Costs & Insurance Subtotal $530,336.00

Personnel Costs

Job description	Cost/yr.	Total cost-
Hydrogeologist	100,000.00	500,000.00
Mechanical Superintendent	75,000.00	375,000.00
Master Driller	75,000.00	375.000.00
Driller's Helper	40,000.00	200,000.00
Pump Installation Foreman	60,000.00	300,000.00

Personal Costs Subtotal. . . $1,750,000.00

120

EQUIPMENT DESCRIPTION	ESTIMATED HOURS OF OPERATION/DAY	ESTIMATED* FUEL CONSUMPTION/HOUR (in gals.)	ESTIMATED FUEL CONSUMPTION/DAY
5 - 4 wheel drive jeep**	4	5	100** (20 gals./day/vehicle)
B E - 20W**	16	5	80**
I H C Water Truck** (Percussion)	6	7	42**
Miller D - 5**	4	4	16**
Failing 1250	16	7	112
I H C Water Truck (Rotary)	8	7	56
C A T D -5	2 c. 10 hr/wk	6	12
Tractor with Lowboy	2 c. 10 hr/wk	6	12
Caterpillar Camp Gen. 3306T.	20	7	140
F - 40 Pump Hoist Rig	16	5	80

* All fuel estimates based on diesel

650 gallons/day x 6 days = 3900 gals/work week, or 202800 gals/work year

At 5 year estimated project length = 1,014,000 gallons

Note: 80 CFA/liter=302.80CFA/gal.
or U.S. $ = $1.44/gal.
Use 210 CFA/$1.00 exchange rate

** Cable Tool only - $280,987.00
Rotary only - $1,181,104.00

Proposed Sanitary Dug Well Construction

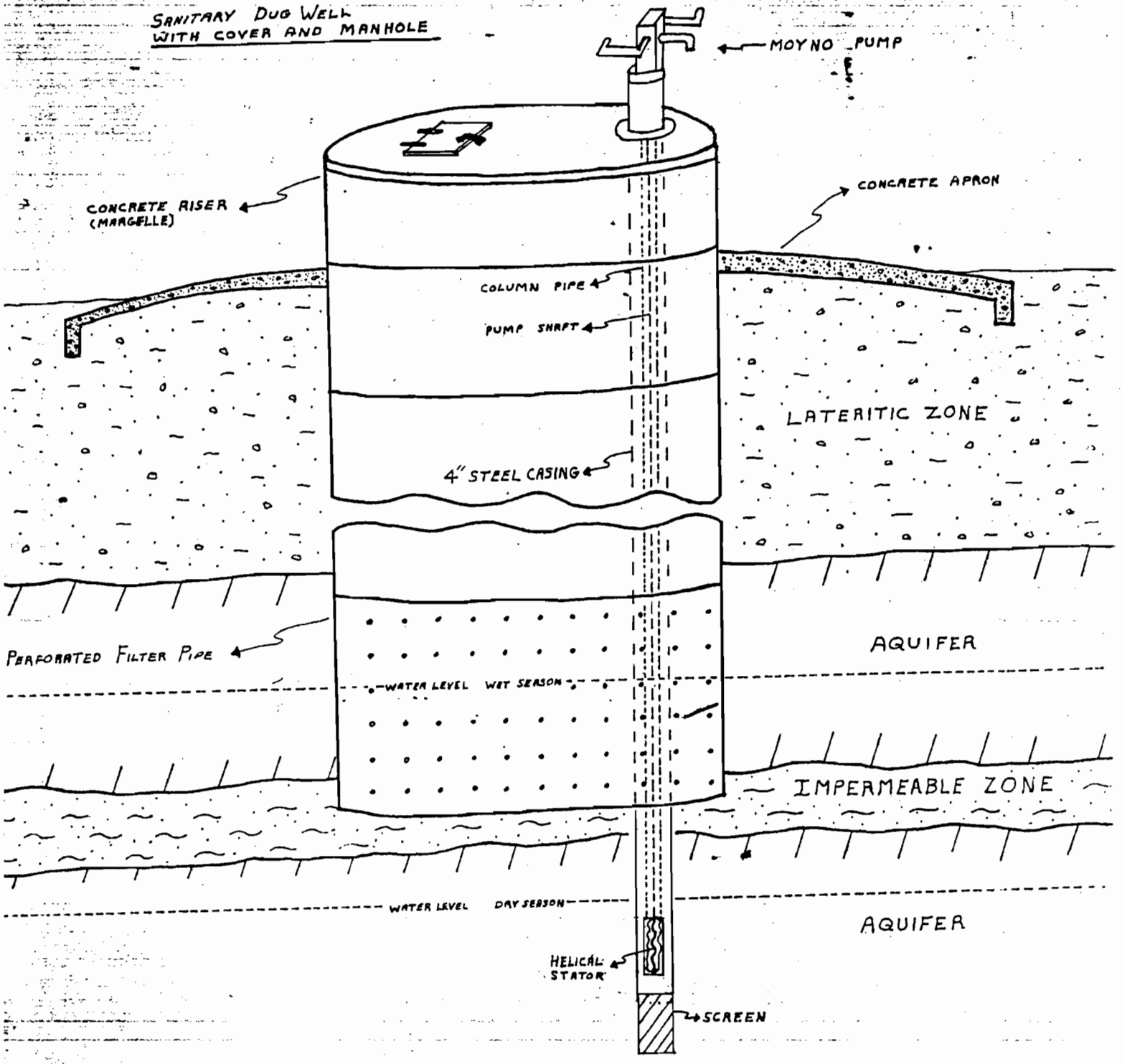
A construction method for sanitizing existing dug wells is proposed herein. This method would permit access to the well for drawing water even if the pump malfunctions.

Dug wells currently have basic inherent problems with:

1. Existing dug wells are open to surface contamination
2. Most traditional wells are dug just to the water table and when seasonal fluctuations occur, during the dry season, the well goes dry.

The method proposed consists of drilling deeper, within the existing dug well , by using the cable tool drilling machine. Upon completion of the drilling, casing would be set into the aquifer (see diagram 1). The drilled well would then be disinfected with chlorine in conjunction with the dug well. Finally, the dug well would be capped with a circular concrete cap and a Moyno pump installed in the drilled well.

PROPOSED CONSTRUCTION FOR MODIFYING AND SANITIZING EXISTING DUG WELLS



Summary and Recommendations

In the Maritime Region Canadian International Development Agency (C.I.D.A.) with the Division of Mines and Geology were currently involved in a extensive well drilling program. The Division of Mines and Geology are operating the program presently, with Togolese drillers, using a Bucyrus-Erie 601 and a Koehring Speed star 71,both cable tool drilling machines. Additionally, they also have a Failing 1250 and a Failing Walker-Neer 40 for doing rotary drilling. However, both rotary machines are inoperable at this time due to lack of spare parts. This problem is not limited to just their drilling equipment but is evident throughout their entire operation. It is felt that supplying new equipment for drilling in this region would not be in the best interests of an AID program. However, an equipment repair training and maintenance program with supplied parts could accomplish a two-fold purpose:

A) Possible integration with Savanes Region Program(s) in terms of establishing mutual self-interest groups.

B) Training of Togo Nationals in an existing program.

The road network in the Savanes Region is all gravel based and the system of bridges are all low load limit capacity with respect to drilling equipment. In addition, these bridges also possess minimal crossing clearance. For crossing local streams or low areas, a ford will have to be constucted. If one already exists, it most likely will have to be improved upon to accommodate heavy equipment. This is primarily true for the area south of Dapaoun in the sedimentary rock where the rotary drilling oper-

ation is proposed. In the crystalline rock north of Dapaoun, no difficulty is anticipated in negotiating the low areas. Reason being, there is little, if any, soil cover to give many equipment moving problems as far as soft ground conditions.

No primary or secondary roads exist in the region presently. Road conditions, east and west of the main north-south road from Dapaoun to Mango, are marginal. During the wet season (June 1-October 30), mobilization may prove difficult to impossible in many areas. A shut down period during the worst portion of this period may prove necessary while equipment is serviced and overhauled.

The drilling program is expected to start slowly at first with teaching nationals how to operate machinery and equipment safely and efficiently. As their level of proficiency develops, the rate of progress will also increase as a direct result.

Standardization of engine type, preferably Caterpillar, in all the equipment, would be advisable for sake of cost and interchangeable parts. There is a Caterpillar dealer in Lome and contact was made with him. He expressed interest in providing parts and service for the proposed project's needs.

The aspect of initiating a pump manufacturing installation is not considered as being feasible at this time. (1) No natural resources are available locally, in country, to produce the raw product (iron ore) for supplying a foundry's needs. (2) In country technology is marginal with respect to setting up and operating a foundry and related machine shop. (3) Prospects of developing a market large enough to warrant consideration of such a facility are also dim. Local people share a mutual distrust of pumps from prior had experiences, either personal or related by others.

Presently, it is felt that a pilot program, using the Moyno pump, would prove beneficial from two standpoints. (1) It would show the performance reliability of the pump to the local people. (2) It would permit a training program to be started for installation and maintenance of future pumps. As reliance is fostered in the pump and it's performance, the possibility of establishing an assembly plant with supplied parts should be given consideration.

Current Comparative Well Costs

A) DUG WELLS

To offer a basis for comparison with respect to the proposed project, current as well as prior well cost information was gathered for both dug (puits) and drilled (forage) wells.

Considering the dug (puits) well type first, it is apparent (see Table I) that there is a marked variance in costs not only between contractors but also for dug wells in the same area. The causes for this variance are attributed to several factors:

1. Type of construction material used
2. Type of rock in which well is constructed
3. Size of well-diameter and depth of well
4. Type of equipment used in construction (dynamite, air hammer. dewatering pump)
5. Labor costs
6. Transportation/Mobilization costs

The average reported cost of a conventional modern dug well in Togo ranges between $300-800 dollars per lineal meter with a diameter of approximately 1.0 meter and a 30 meter depth. Careful consideration of the above factors must be given though, before relating dug well costs from one area to another.

TABLE I - DUG WELL COSTS - Togo

CONTRACTOR	WELL TYPE	DIAMETER	AVERAGE DEPTH	COST PER LINEAL METER	LOCATION
Service Hydraulique	Dug with Concrete retaining rings	2 - 2.5m	25 m.	$413.00/m	Throughout Togo
Peace Corps	Ditto	1 - 1.5m	25 m.	$165.00/m.	Ditto
Unknown	Ditto	0.8 - 1.0m	20 m.	$800.00/m	Ditto
Peace Corps	Dug Well Hand Drilled	Small diameter Exact diameter Unknown	15 m 15-25m	$430.00/m $ 31.00/m	ATAKPAME-AKPOSSO AREA
F.E.D. Fond Europeen de Developpement	Dug with concrete retaining rings	1-1.5 m	25 m.	$230.00/m 52,000 CFA/m	Dapaong Area
B.D.P.A. Bureau pour le Developpement de la Production Agricole	Ditto	1.0 m	10 m.	$90.00/m 20,000 CFA/m	Dapaong Area
Service Hydraulique	Poured Concrete	1.8 m	30 m	$370.00/m 83,333 CFA/m	SOKODE Area.

Dug wells utilizing the conventional construction method (poured concrete walls) with diameter of 1.8 meters and depths of up to 40 meters are being constructed in the Maritime region. These wells differ from other dug wells in that lateral galleries are drilled at the base of the well. These galleries provide a more efficient means of capturing water. Reportedly only in the Maritime region are wells of tis type constructed. This is believed to be due to the nature of the aquifer; for example, unconsolidated sands and gravels versus crystalline or sedimentary rocks. A government agency is constructing those wells but no cost figures are available.

Cost figures for the concrete retaining rings (1.5 m diameter were obtained from the Secretariat Particulier of Animation Rurale in Dapaoun. They range from 35,000 to 85,000 CFA. The difference in cost is reflected in the use of steel reinforcing rod in the more expensive rings.

Filter pack material in the Dapaoun area is being utilized. It consists of a mixture of cobbles, 150-200mm in diameter, and charcoal. The desirability for using this type of filter pack is low. Primarily due to the fact that any fines found in the aquifer or that were generated from construction of the well will migrate into the well upon pumping, as a result of the coarseness of the filter pack. This in turn will cause eventual clogging of the ring perforations, filling in of the well, and increased wearing of pump parts. It also is esthetically distasteful and promotes unsanitary conditions in the well. No cost figures were available for the filter pack material.

Only in the Dapaoun area was charcoal observed being mixed with gravel and cobbles to produce filter pack. All other wells

that were inventoried utilized crushed stone about 50 mm in diameter. The dug wells observed in Central and Southern Togo utilized crushed gravel.

A relationship could not be found between the digging/drilling of a dug well per meter or total cost and the cost of the concrete retaining rings and filter pack material.

B) DRILLED WELLS

Reported costs for small diameter (4-5") drilled wells in Togo are running approximately $24.00/lineal meter with an average depth of 50 meters.

The Division of Mines and Geology are currently drilling 8" diameter wells with an average depth of 60 meters for approximately 7,000,000.00 CFA., per well. This is approximately $528.00/lineal meter using the 221 CFA to $1.00 conversion rate. This price is inclusive of casing, screen, grout, aquifer test and filter pack.

PUMP TYPES AND EVALUATION

Several Hand Pump Types were considered for use on the proposed wells to be drilled and refurbished. Types considered were the following:

1. AID/BATTELE PUMPS
2. DEMPSTER PUMP
3. MOYNO PUMP

The AID Pump is currently being used in several developing countries throughout the world. In Nicaraugua and Costra Rica the AID Pump has not performed well in comparison to the Dempster and other hand pumps.[1]

COSTA RICA

Out of 15 AID pumps installed in Costa Rica during 1977, 6 were

out of service within 9 months of operation or 43% failure rate. Of those 15 AID pumps installed, 2 pumps were out of service repeatedly.

NICARAGUA

Out of 16 AID pumps installed in Nicaraugua during 1977, 10 were out of service within the first 9 months of operation. This is a 63% failure rate. Of those 16 AID pumps installed, 3 pumps were out of service repeatedly. The Dempster pump is also currently being used in the same countries as the AID pump.

COSTA RICA

Out of 8 Dempster pumps installed in Costa Rica during 1977, all 8 were still functioning properly after the 9 months of operation.

NICARAGUA

Out of 8 Dempster pumps installed in Nicaraugua during 1977, all 8 were still functioning properly after the 9 months of operation.

Statistical data was available on the Moyno pump with respect to it's cost and maintenance/service performance as follows:

MOYNO PUMP[2]

Price:	$473.00 (shallow) 0-150 ft. $493.00 (deep) 0-300 ft.
Weight:	150# (rotor, stator, head and rods)
Delivery:	4 mos. initial shipment 300/mo. thereafter
Lubrication:	High-temperature grease
Performance:	Laboratory tests-24 hrs. operation (3 years equivalent) no problems or wear Ghana -CIDA Project 10 units (2 mos. operation) no problems

MOYNO PUMP (cont.)

Discharge rates:

(1) - Manual-3.2 to 4.3 gpm @ 60 opm
(2) Alternative power-discharge rate vs. rpm is linear functio

Noted failures in the AID Pump were due to following causes:

(1) Broken pump handles
(2) Excessive wearing of the leather cups
(3) Breakage of the Pump Caps

All of the failures can be attributed to poor quality control with respect to casting and machining and to a lesser degree to engineering design.

The Dempster pump like the AID/BATTELLE Pump is similar in operation, that being a single action, reciprocating positive displacement type pump.

Wear points of both pumps are similar with respect to (1) fulcrum point between the handle and pump housing, (2) connection between handle and piston rod, (3) wearing of the leathers in the cylinder.

Evidence from the performance record of both the AID/BATTELLE Pump and the Dempster Pump indicates that the manufacturer of the latter has better control of parts quality and better operational design.

The MOYNO Pump offers a different operational design. Basically the MOYNO Pump, like the AID/BATTELLE Pump and DEMPSTER Pump, operates on the positive displacement principle. However, where the MOYNO Pump differs is as follows:

(1) No valves, gaskets, or leathers in the pump end

(2) Column of water is supported on bearings versus in a piston pump where the weight of water is offset by force on the pump handle.

(3) Can be easily adapted to alternate sources of power, e.g. bicycle, windmill, internal-combustion engine, electric or animal power.

(4) Will effectively pump solids without risk of damage.

Conclusions:

Although the MOYNO Pump is the most expensive of all three, pumps considered, it possesses the most desirable characteristics of a pump, namely, low maintenance, long performance and ease of installation and operation.

Approximate Costs

MOYNO	-	$500.00
DEMPSTER	-	$257.00
AID/BATTELLE	-	$100.00

---

[1]Data taken from the "second progress report on the utilization evaluation of an AID Hand-Operated water Pump" prepared by USAID by Potts, Moh, Wipple and Craft, Office of International Programs Engineering Experiment Station Georgia Institute of Technology, Atlanta, Georgia, January, 1972.

[2]Personal Communication 7/21/78 with Mr. Barclay -Moyno Rep. Springfield, Ohio U.S.A.

SOCIAL SOUNDNESS ANALYSIS
FOR
A RURAL WATER SUPPLY AND
SANITATION PROJECT,
TOGO

By
FRED WALDEN,
ANTHROPOLOGIST

Togo - June, 1978

SOCIAL SOUNDNESS ANALYSIS

By: Fred Walden, Anthropologist

Socio-Cultural Feasibility *

Introductory Description

Dapaong Circonscription is the northern most administrative region in Togo. Composed of 31 cantons, the total population for the Circonscription in 1970 was 183,140. The following statistics on Dapaong Circonscription were taken from Recensement General de la Population (Mars-Avril, 1970), Volume 2, published in August, 1975:

TABLE ONE

POPULATION BY REGION

Region	Total Population
Maritime	715,726
Plateau	483,016
Central	308,315
Kara	217,787
Savannah	243,436
Dapaong: 183,140, Mango: 60,296	
Total Population of Togo	1,998,280

Looking at Table One we see that the Savannah Region is the second least populated region in Togo. Dapaong Circonscription is three times more

* As this project is being designed to be implemented in the Dapaong Circonscription of the Savannah Region, this analysis will concentrate on this area and not on Togo as a whole. The information herein is based on an examination of existing publications, interviews with people in Lome and Dapaong and on site visits to villages in the Dapaong region. A list of publications and people consulted can be found at the end of the annex.

populated than Mango Circonscription. This is due to the existence of two game reserves in the region as well as to the problem of Onchocerciasis (River Blindness) in the Oti River Valley from where people have withdrawn.

TABLE TWO

AGE DISTRIBUTION OF THE POPULATION OF DAPAONG CIRCONSCRIPTION

Age	Males	Females	Total
1 - 14 Yrs.	47,778	43,188	90,966
15- 24 "	12,159	14,716	26,875
25- 44 "	18,425	24,287	42,712
45- 59 "	7,746	6,110	13,856
60 + "	4,714	4,017	8,731
Total	90,822	92,318	183,140
Percentage	49.6%	50.4%	

From Table Two it can be seen that the male to female ratio is about 50-50. About 50% of the population is under fourteen years of age which is similar to the age pyramid of the country as a whole.

TABLE THREE

POPULATION DISTRIBUTION ACCORDING TO VILLAGE SIZE

Villages with Population	Total
Less than 300	188
300 - 500	122
500 - 1000	75
1000 - 2000	25
2000 - 3000	1
3000 - 4000	0
More than 4000	1
Total	412

Total: 183,140 Population Density - 37.3 p/km^2

The data in Table Three shows how dispersed the rural population is. About half the population live in communities of less than 300 persons while over three-fourths live in villages of less than 500 persons. The dispersed nature of living arrangements has been one of the major problems in trying to bring progressive change to the region. The concept of a "village" is a relatively new idea for a region where people are not geographically linked in close proximity but are socially linked by kinship.

TABLE FOUR

RELIGIOUS AFFILIATION OF THE TWO MAJOR ETHNIC GROUPS

	Christian	Muslim	Traditional
Moba	3,707	854	76,938
Gourma	2,135	2,084	69,822

The following ethnic groups inhabit this region. The Moba and Gourma live on the laterite mesas and granite hills north of the Oti River, the Oti plain belongs to the Tchokossi, N'Gaugan and Dye. The Lamba occupy the intermediate zone north-west of the Defale Mountains. The Moba at 81,904 and the Gourma at 74,234 are the dominant groups making up a majority of the population of the region. The vast majority of the population is rural sedentery subsistence farmers. The population is 93.6% illiterate - one of the highest illiteracy rates for the whole of Togo. The population has overwhelmingly remained with their traditional religious beliefs (Table Four). However, there has been increased activity on the part of the Catholic and Protestant missions in the area.

Historical Background - Pre-Colonial

The Moba and the Gourma migrated in successive waves from the north. The Gourma launched many attacks south conquering the Moba and making them vassals and serfs. This push south from Fada n'Gourma was the result of political conflicts and to escape vindictive chiefs. They created a powerful kingdom west of the Oti River at Kantindi. From this stronghold the Chief of Kantindi

From this stronghold the Chief of Kantindi lead continous raids on caravans selling captured people as slaves to the south. The area was controlled by several large clans which increased their interconnections through exogemous clan marriage by bride exchange. The fortress - like appearance of present day residences in the area probably date from this active period for wars and migrations.

Colonial

The Germans followed by the French engaged in an active campaign of rural pacification which left the region under the control of the colonial administrations. However, little was done to interfere with the existing social and political organizations. The colonialists were satisfied with indirect rule in the region. They controlled the man who ruled. The Latter could rule as he wished as long as it did not interfere with the colonialists plans. When need for manpower in the south grew, northerners were forcibly relocated to the south.

Post-Colonial

Since the colonial period the Savannah Region has been relatively ignored. The colonial administrations concentrated their projects in the south drawing on the north for manpower. The south benefited from this prolonged exposure through the development of better communication systems, construction of educational and health facilities and access to positions within the administrative framework. After independence this trend continued until the present

government came to power. This government has been trying to improve the infrastructure of the northern regions by improving the highway system, building schools, (there were 83 primary schools in Dapaong in 1970) and medical facilities (there were 27 dispensaries in 1974) locating new industries in the north and introducing new agricultural techniques and products. However, Dapaong Circonscription is still regarded as a hardship post by most Togolese civil servants. The government has found it difficult to find qualified personnel to work in the Savannah Region. Many people in the administrative cadre in the north do not speak the local languages.

Social Organization of the Moba-Gourma Peoples

After a long period of inter-relations the Moba and Gourma can be considered as sharing the same socio-cultural organization. They speak dialects of the same laguage, Para-Gourma, which belongs to the Voltaique language grouping (Bertho 1952).

The Moba-Gourma peoples are organized by clans based on blood ties. Members of a clan recognize a common ancestor (usually mythical) share the same food taboos and animal totems. Clan members are spread out over a large area but they come together once a year for the Tingba-dyal festival to reaffirm their blood ties. Below clans people are organized into lineages which are groupings of extended families related to a common real ancestor. These people may live in proximity. Although ties are based on the male line they also recognize decent from a common female ancestor. This group referred to as Nataan unites the members of a family and members of a lineage. Below the

lineage comes the extended family which inhabits the same compound or Soukala. The head of the Soukala is the eldest male. His primay role is that of provider. All harvests belong to him. He owns the granaries and he supervises the distribution of food to the people in the compound. His second role is that of protector and as such he is the family priest. He is responsible for sacrifices to the ancestors to ask for aid and protection for the entire family. He is also the arbiter for family quarrels and it is his right to give girls in marriage. Lastly he has the important role as educator to the children. He teaches them clan and family history and ancestral sacrifices. By doing this he is regarded as passing the soul of the family on to the children.

Kinship and Marriage

The Moba-Gourma peoples are patrilineal (recognize blood ties through the male line) and patrilocal (male marries and lives in or near father's compound). They practice exogamous marriage at the clan level. (Marry someone only from another clan.) The most common form of marriage in the past has been bride exchange in which two families from different clans exchange girls for marriage. This involved no bride-price or payments but established important ties between the two families and the two clans. Marriage is regarded not as a marriage of two people but as a marriage of two families and thus of two clans. As contact with westernizing influences increases this method of marriage is becoming less popular especially with those young people who have a school education.

Although the Moba-Gourma stress the importance of the male line (inheritance being from father to sons) as mentioned above they recognize descent from the female line also. The kinship system reflects the logic of exogamous marriage. All relatives of the grandparent generation are considered grandfathers and grandmothers. All relatives of the parent generation aside from actual parents are known as aunts and uncles. Their children are called brothers and sisters. And as it is forbidden to marry one's brother or sister one must marry outside the clan.

Marriage is regarded as the most important task of life. Man is on the earth to marry and produce children. Men marry at a later age than women (women between 14-15 years old - if she is more than 18 and has not yet married she becomes suspect). Marriage is the consecration of maturity on the young man. Only married men are considered adult and can take part in religious ceremonies. The goal of marriage is procreation with male children favoured over females. It is believed that a woman who gives her husband children has made a man of him, has created a line of descent and has cemented ties between their two families and clans. Celibacy is considered not normal. Sterility is the worst malediction to strike a family; only women are regarded as being sterile. A sterile woman can be totally ostracised by the community. Fertility is the most important sign of divine benediction. It is a sign of harmony between the living and the dead. A family with lots of children is considered a happy family and is more respected than that of a rich man's. Fertility insures eternal life as life continues through one's descendants.

Food Production and Consumption

The major crops grown in the Dapaong area are millet, corn, sorghum, peanuts, dry beans, cassava, fonio, yams, sweet potatoes and rice. Millet is the most important crop as it is the basic food staple all year round. It is stored in granaries to be taken out as needed and ground by hand into a flour. This is mixed with hot water to make a paste which is eaten with sauces made from vegetables and what meat or fish they may be able to afford. The following tables taken from Froelich et al (1963 : 128-129) give a summary of the seasonal food production and consumption for the Moba. (See page 10)

Division of Labor

In the past there was a strict division of labor according to one's sex. It was said that a woman never touches a hoe as it is the masculine tool par excellence. Today these beliefs are changing. As more women cultivate their own fields they have become involved in all aspects of the planting cycle. However, the following basic division continues to exist. It is the man's job to clean and prepare the fields. Then the women sow the seeds. Men are responsible for weeding the field during the growing period. The women are responsible for harvesting and carrying produce to the granaries which are built by the men. Then the cycle begins again with the men cleaning the field and burning it.

Children help in all phases of these activities. Usually, they are divided according to the sex roles of their parents. Although one can occasionally see young girls helping the men and boys. Children begin working from 10-12 years of age especially the boys who begin by weeding the fields.

Calendar of Food Production

S = Sow H = Harvest

Crops Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov.	Dec
Yams	S	S	S	S			H	H	H	H	H	H
S/Potato							S		H	H	H	H
Cassava	H	H	H	H	S	S						H
Sorghum				S	S	S					H	H
Rice						S	S	S		H	H	H
Maize				S	S		H	H				
Fonio				S			H	H	H			
Beans						S	S	S	H	H	H	
Fast Millet				S	S		H	H				
Slow Millet				S							H	H

Calendar of Food Consumption

Crops Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Yams									----	----	----	
Millet	----	----	----	----	----	----	----	----	----	----	----	----
Petit Mil	----											----
Maize	----	----										----
Fonio										----	----	
Peanuts	----	----	----	----	----	----	----	----	----	----	----	----
Sweet Pota.	----											
Beans	----	----	----	----	----	----	----	----	----	----	----	----

Markets in the region are rotating, held every three days with only three major market centers in the whole Savannah region, Dassong being the most important, where market day is every Wednesday. The women transport their produce to market in three ways:

1. Cars and trucks on major roads.
2. By carrying produce on the head sometimes great distances (30 km).
3. By mule or horse (This is very rare and usually a man uses this method not a woman).

However, these people are only peripherally involved in the market economy. Less than 20% of their produce is sold. They sell only what they feel they can in order to have money to purchase those necessities not found locally (discussed below). Women are in charge of the money which is given them by their husbands. In order to have their own money women cultivate fields lent to them by their husbands. They cannot own lands but they have the right to all the harvest from that land.

Women's Source and Use of Money

Women sell the following in order to get money: Millet, Tchouk'bou, néré (local fruit), okra, tomatoes, peanuts, dry beans, spinach, firewood and charcoal which they have made. They do not make an effort for the wood and the charcoal as for the other products. They take the products to market where they are bought usually by other individuals. However, some businessmen buy peanuts, millet and néré to resell elsewhere. There is usually hunger at the end of the dry season. People eat what is left from the

graneries (millet or corn) if there is any left. Plus they eat some vegetables from their gardens. Those who have money buy millet in the market.

Women spend their money on their own clothes, clothes for their children and condiments for the sauces (salt, piment, tomatoe paste and small dried fish). They also buy meat for the household. However, the husband also spends money to buy meat (chicken, goat, sheep, beef, etc.). On special occasions (marriages, funerals, religious ceremonies) they will kill an animal in the household. Families usually eat 2-3 times a day in times of plenty, but only once a day in the famine season for those without a plentiful store.

Traditional Religion and Values

The Mobe-Lourma people believe that Man has a vital force within himself which can interact with those forces in nature. It is possible for man to capture the forces of nature and use them for his own benefit. Thus the diviner who foretells the future accurately is thought to have captured the force of water.

They believe in a supreme being (Yendu) who created man. He brings all fortune and misfortune on men. The people do not communicate directly with Yendu but through intermediaries - ancestors and lesser spirits. They believe it is Yendu who makes it rain and makes it stop. Their sacrifices to the ancestors and the spirits are only paths the Yendu

There are three categories of spirits:

1. Spirits of the earth - believed to be the least malevolent and bothersome to man.
2. Spirits of the airs - thought to be the most evil. They are known for attacking children. They were created by Yendu from dead men and they travel at night.
3. Spirits of the waters - they guard the ponds and are especially active during the rainy season. Although considered not as evil as those above, they are still feared. There are two kinds of Water Spirits - those created by Yendu and those from drowned men. The latter live in the water and have the power to draw the living into the water to drown them.

Each clan has its spirit protector ancestor to whom sacrifices are made annually after the harvest. Each family head in turn makes sacrifices to diverse spirits and ancestors to protect the inhabitants of the Soukala. In addition sacrifices are made to insure a good crop, a fertile woman and good rains. Homage is later rendered to the ancestors thanking them for having done the things requested above.

The connection between the living and the dead is very strong. After death it is believed that good spirits will care for the living while bad spirits will harass the living. To insure immortality sacrifices are made to the dead so that he or she can find his/her family again. The Mobs-Gourma believe in reincarnation so that each new child born is thought to be an ancestor returned to earth. The relationship between the living and the dead is also

reflected in their concept of past and present. They regard the past as something which is not behind but under foot, never ceasing, which climbs back to us and is thus the present. The future on the other hand is some vague unknown which only Yendu knows.

The Moba-Gourma peoples believe that there is no natural death. There is some cause behind every death which goes beyond the physical to the metaphysical. In order to determine the cause of death a specialist is consulted - a diviner who is expert in looking into the other world. They recognize three kinds of death:

1. Those who in their lives had considerable influence (wise ones, elders, chiefs, doctors, healers);
2. Deaths in the family (parents, friends, extended kin and initiation comrades);
3. Marginal deaths - those not integrated into the family of ancestors (includes those who die a violent death - they can never be integrated into the clan of ancestors - they are totally rejected and forgotten.

Death in the first two categories can be either good or evil according to the ideas of the living. The living aid the dead in reintegrating themselves with the family through funeral ceremonies and sacrifices. When these are not performed or neglected the spirits of the ancestors search to do evil.

Aside from the priests of the earth and the diviners who are considered to be in contact with the spirit world for the benefit of the living, there is the healer (Nogdan in Gourma) who is an expert in herbal medicines. He is

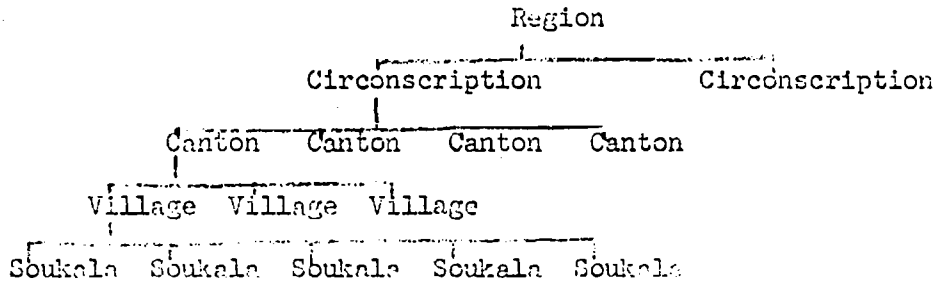
consulted for illnesses and wounds. In addition he gives people objects to protect them from bad sorcery and the evil eye. He also gets his knowledge from a special relationship with certain spirits.

In Moba-Gorma thought, there exists one other person who is a specialist in dealing with the spirit world. However unlike the priests, diviners and healers this person seeks to do harm to the living. This is the witch or sorciere - the eater of souls. The witch is always an old woman who lives alone in the mountains or hills chased from her village after it was determined she was a witch. The people believe that she travels about at night, able to leave her body and sneak up unawares on people. It is the main reason these people have a fear of the night.

Political Organization

In the past the village was governed by the Priest of the Earth and his councelors. They were responsible for performing all religious ceremonies necessary for continued good relations with ancestors and spirits, participation in these rituals act as a form of social control. It is also maintained through gerontocratic relationships - elders having the final word on all matters. This is counterbalanced by the influence of public opinion. One's opinions, advice and ideas are listened to only so long as you remain a respected member of that community. If you act to bring community disdain down on your head you will have lost any social influence you once might have had.

Although the priest of the earth was the religious head of the village he has in the present evolved into a chief in the modern political sense. He has added an administrative role to his existing religious role. Above him is the Chef de Canton which groups several villages together for administrative purposes. This chief in turn is responsible to the Chef de Circonscription who is the central government's regional representative. Below is a diagram of this pyramidal authority structure:



As stated earlier villages are a relatively new concept of organization imposed upon these people by the exigencies of the modern political order. Scattered Soukala are inaccessible and difficult to supply with governmental resources. To be recognized by the powers that be, an agglomeration of compounds must be formed. Thus there is a move toward a greater concentration of individuals in a smaller area along relatively accessible roads. Looking again at Table Three (p. 3) one can see that small villages with scattered population are still the rule. The availability and quantity of potable water will have tremendous impact on the continued growth of these villages. When water is plentiful, of good quality and available all year round, the community will grow. Conversely, where water is scarce, of poor quality, and available only seasonally, communities will stagnate or be reduced in size.

In order to establish an effective well and pump maintenance capability at the village level assignment of appropriate tasks must be made. Who is to be responsible for keeping the well clean and free from debris ? Who will be responsible for servicing pumps on a day to day basis so that they will stay in good working order ? These decisions must be made by the local authorities in conjunction with project personnel input. Most often it will be the chief and/or a council ~~which~~ who will assign one or more persons to these tasks. As some training is foreseen for pump maintenance, the persons chosen must exhibit some mechanical capabilities and a desire to take on this responsibility (a knowledge of French may not be necessary). Whether or not there is a question of salary must be determined at the local level depending on the exigencies of the situation.

There is less of a problem with addressing oneself to the right authorities in regards to the latrine construction program. The authorities at schools and dispensaries will make these decisions while the head of individual households will be in charge of any private latrine construction.

Women's Committees

A new feature of Moba-Gourma society has been the relatively recent creation of Women's Committees. Theoretically each village has such a committee as well as each canton. There is a president for each committee who is chosen by all the women when they meet together. The criteria for becoming president are good reputation, dynamic personality and progressive thinking. Meetings are held twice a month usually at the chief's house. Although these meetings are not obligatory most women will come to the meetings if they hear about it in time. Quarrels between women are resolved at these meetings. The improvement

of the women's position is discussed. They especially spend much time discussing how to care for their children. The women who attend and participate in these meetings are considered more evolué or progressive than those who refuse to come or do not participate although they may be present. The former show a great desire to receive advice from experts outside the community and change traditional ways of doing things.

The effectiveness of these committees in presenting new ideas depends upon two factors. First, the degree to which the men in the village support the committee's activities and do not feel threatened. If a chief or a community of elders decide that the women have over-stepped their position, support will be withdrawn and the committee may cease to exist. Secondly, the degree of progressiveness that the women exhibit will determine whether or not a given committee can be effective in changing existing attitudes and prejudices. A committee without dynamic representatives will deteriorate into a social club.

The women's committee is an important channel of information for dissemination of health education. State agents or other trained personnel (Peace Corps Volunteers) could meet with this committee to discuss problems of family health, child-raising, nutrition and precautions necessary to avoid contamination with water-borne diseases. It may also be possible to give some basic health education training to one or more members of this committee so that they in turn could act as educators for the rest of the female community. These decisions must again come from the local level involving the committee members and project personnel.

Water Gathering Activities and Excreta Disposal

Women and children are the principal drawers of water. Using buckets of inner tube, plastic or metal attached to hand-woven or nylon cords they draw water from wells that in some cases are great distances from their homes. (It is not unheard of for women to walk ten kilometers and back to fetch water). Ponds, streams and dams are other sources frequently with water available only seasonally. Some women dig holes in the sandy bottom of dry river beds in order to capture the sub-surface moisture.

They bring the water back to the house in clay jars or in large metal pans (25 liters capacity). Arriving at the house they put the water in large clay jars and cover it. Bathing and washing clothes is done near the well, river, or dam. In the dry season when water is scarce there is less washing and bathing.

Early in the morning the first thing the women do is sweep out the Soukala. Then they fetch water. More water is used in the morning so they make about four to five trips. In the evening they go to fetch water for the evening meal between 4-5 PM. It usually takes about 2-3 trips in the evening. They have very few rain catchment systems. From those rooms with zinc-corrugated roofing they catch the run-off but usually without a gutter system. There are no cisterns. Consequently, rain water collection is marginally practiced. How much time is spent fetching water ? That is difficult to calculate. It depends on the distance to the water, the number of trips necessary to acquire enough water for the household needs. One can safely say that it is a time consuming activity for a great many women in the Dapaong area.

Women prefer well water rather than water from other sources because they regard the latter water as dirty. Dirty water can be one or a combination of the following :

1. Water with visible worms in it
2. Muddy water
3. Water having run over areas where one has defecated
4. Stagnant water (used to bathe in however)
5. Rain water ponds - considered too dirty for any use at all
6. Clear water with strange taste or odor - will not be used at all

The sixth category could be a problem if, as a result of the water purification program in the project, chemicals are introduced into existing wells. The people may refuse to consume the purified water. Before such a step is taken there should be adequate education of the population on the purpose and benefits of purification. The people should be allowed to taste the purified water and should see the agents drink the water also. A microscope demonstration could be particularly useful as it has been successfully employed by the Canadians in the Ivory Coast. They took a microscope to the villages, prepared two slides - one with the normal village water and one with purified water. When the villagers saw the microbes swimming around in the one and not in the other they were convinced.

Most women when asked about their attitudes towards having closed wells with hand pumps were rather hesitant to answer. Those having past experience with hand-pumps were quite adamant against their use because of the maintenance problems. Pumps broke down after less than three months' use. Other women were concerned because of limited access to the water. Whereas in an open well several women could thrown their buckets in at the same time, with pump use each must wait her turn. Some women on the other hand were ~~amenable~~ receptive to trying hand-pumps as they saw it as a less expenditure of energy than drawing water from a deep open well. Yet, here again they were concerned for the maintenance of the pump.

However, the one thing that all the women were very hesitant to do was to contribute financially towards the maintenance of the pump and/or the well. Some women said they could give five or ten francs a month but others refused. Asking them to make a financial contribution is feasible only if all who benefit participate. If there are hold-outs then ill-feeling develop and so all contributions will cease. There have been past instances where people were asked to pay for the water as they drew it from pumped wells. They abandoned the use of the well for water from other sources rather than pay. The possibility of village financial contribution towards well and pump maintenance must be addressed on a village by village basis and implemented where possible.

Latrines

There are generally no latrines in the Soukala. The people regard fecal matter as dirty and something to be removed from the home as far as possible.

They go into the bush and defecate on the ground. They do not dig a hole or cover the fecal matter. They do not go to the same place each time because it is regarded as dirty. They use their left hands to wipe themselves using leaves, corn cobs, sticks and pebbles. Sometimes they will defecate in their fields. Those who are sick will go just outside the Soukala to defecate and cover it with dirt. Those too sick to leave the compound will defecate on the ground inside and children will clean it up and throw it in the bush. Certain of these beliefs may give rise to problems in the latrine construction program. The notion of dirtiness connected with fecal matter may hinder people from using latrines. Again it is a question of an adequate educational program designed to teach the villagers the benefits of privy use and maintenance especially for those who are sick.

A second problem arises from their use of corn cobs, sticks and pebbles as toilet paper. If these items are thrown into the privy it will fill up much sooner than anticipated. Perhaps cheap toilet paper could be made available or they could be educated away from the use of pebbles. The corncobs and sticks could be burnt after use.

A third problem arises from the male fear of menstrual blood which would preclude the use of the privy by both males and females. Within a Soukala there would have to be a privy for each sex. Whether or not they would have to be physically separate can only be determined from local beliefs. In one village the women said that one latrine with two holes in it

with a wall dividing the two would be an adequate separation. However, women and men from other villages may not agree with this response. Privies constructed at schools would have to be divided into male/female sides.

Allocation of Time

The wet season is the time of most active labor. Both the men and the women are engaged in preparing and planting the crops for that year. The women are further occupied with their own fields (for those who have such fields). In addition it is the women's responsibility to provide food and water to those working in the fields and to their families in the evening. During this season the women have little time for other activities. Fetching water from some distance becomes an added burden during the wet season.

During the dry season people have more free time. The harvesting of crops is scattered over time involving less intensive labor. It is during this period that women become involved in activities [illegible] around the Soukala. They make the millet beer, néré flour and karité butter to sell. Some make charcoal or gather firewood also to sell. However, the dry season also means scarcity of water. The women will expend more time fetching water during this period as it is probably farther away than during the wet season.

Providing people with a safe accessible water supply that lasts year round would reduce the amount of time women and children spend drawing water. How they would allocate this free time becomes of major importance in terms of providing people with an opportunity to improve their living standards.

When faced with the possibility of more time to do other things women responded with the following priorities :

1. Spend more time in the fields
2. Teach their children home-making activities (i.e. sewing, mending, sandal-making, pottery-making)
3. Learn new home-making activities (especially interested in knitting).

The women would take advantage of this extra time first to increase their own field production capacity. This would mean added income for the women. The second and third priorities apply more to the dry season when the women would have more time to spend in the compound. The existing women's committees are the logical point for attempting to establish artisanal activities. However, additional research should be undertaken in order to determine (1) the kinds of handicraft production which would be feasible in terms of local availability of raw materials and (2) those artisanal activities which would not conflict with existing division of labor customs. For example, among the Moba-Gourma, pottery-making is a woman's activity while basket-making is a man's. Any attempt to set up a woman's basket weaving group could meet with disaster.

Motivation and Obstacles

Climatological conditions in recent years have rendered it easy to establish the motivation of those who would benefit from a well digging project. Water has become the scarce resource for most of the population.

Women as the principal carriers and users of water would be the most motivated to providing them with readily accessible water sites. They want water. They want water not only to be able to continue their nourishing role to the family but also to free them from the sometimes day long search for water in the dry season. They realize that this wasted time spent searching for the precious gift of life could well be spent on more productive activities.

However, their strong desire for a permanent water supply generally overrides their concerns for the purity of the water. What they desire is more water available all year around as soon as they can get it. Most women are less concerned with whether or not the quality of the water so supplied would meet the safety standards of some outside agency. As described above, women do discern certain water quality standards. When given the choice they usually will choose that water which they feel is cleaner. Generally women regard well water as being cleaner and safer than water from other sources, i.e. ponds, rivers, dams or rain ponds. There are exceptions. During the rainy season streams which come alive and are nearer to the compounds may be a preferred source of water over well water. Also, due to certain mineral content of some soils, well water can take on a milky appearance or have a slight salty taste. The women may use this water only as long as they have no other choice. But if renewed streams are near the compounds they may abandon the well water for these rain fed sources. Covering wells and installing hand pumps could run counter to a good many women's desires for a readily accessible water supply. By doing this you have effectively limited the number of women and children who could draw

water at the same time from anopen well. They may be forced to use it in the dry season. However, as soon as the rivers provide them with another water source many abandon the use of the pump-mounted well for what they see as a more accessible source of water. The women rarely take into account the health hazards of such actions.

The installation of latrines whether at dispensaries, schools or private compounds also raises problems of motivation. The majority of the population regard fecal matter as dirty and something which should be removed as far as possible from living areas. Defecation is something done apart, alone, and in relative privacy. To bring this activity nearer to other human activities raises basic conflicts in traditional belief systems that may be difficult to resolve.

Latrine construction in primary schools would offer the most likely success and acceptance. Most children are more accessible to learning and adopting to new customs. They have as a role model their teachers and schools directors who in using latrines present the pupils with an acceptable example of the importance of using latrines. Hopefully what these children learn about latrine use would be brought back to their compounds. Thus they would act as educating agents, sensitizing their families to the benefits and importance of latrine use.

Latrines for medical facilities also raises problems related to cultural beliefs. Some people believe that if they use the same site to defecate that a sick person has used that they could fall sick themselves.

Consequently, some hospital or medical facility staff would refuse to use on-site privies. Separate facilities may have to be built for the patients and staff. Or those concerned should be taught the importance of latrine use for everyone -- patient and staff.

The most difficult area of finding adequate motivation is in latrine construction for private compounds. Due to the beliefs mentioned above people do not like to defecate near where they live. Secondly, many people feel that latrines take up room that could be used to grow more crops. Most people do not see the benefits of fecal matter disposal vis-a-vis the health of their family. Others insist that their pigs would loose a source of foods if privies were constructed. All in all a successfull latrine program rests on adequate education at the village level to show people the importance of maintaining an effective disposal system in order to keep those water sources available free from contamination and thus improve the health of the community.

There are those villages where they have had frequent contact with state agents, Peace Corps volunteers (or other such voluntary agencies), or educated locals returned to the villages, where the level of understanding of basic preventive health care is greater than in those villages where such contact has been minimal. In the former villagers, motivation is high for latrine construction. What is lacking is the financial resources to purchase the necessary materials to build privies, and the necessary basic technical skills to carry it out.

It is an important goal of this project to attempt to mobilize local village participation in all those aspects which are feasible. The more involvement the more likely that the villages will take an active interest in maintaining the wells and pumps as well as improving their quality of life. Where motivation is outstanding active participation of the greatest number of villages is a necessity.

MINIMUM PARTICIPATOR PROFILE

There are several minimum participators in this project because of the span of activities to be carried out during its implementation. The first minimum participator is the female rural resident of the Togolese Circonscription of Dapaong. She is illiterate and is involved in the experiences of subsistence level farming. She is limited not only by this environment but also by the fact that she will spend a good deal of time at least part of the year looking for water. She is basically a housewife but maybe involved in farming and/or trading. Her main concern is to give birth to and raise children for her husband's family. She is most likely an adherent of traditional religious beliefs and customs which tend to impede the development of changes in lifestyle.

These women are very concerned for the well-being of their children. They wish to provide them with a safe and healthy environment in which they can develop to adulthood. Some women who have tried to implement the information they have learned have noticed positive changes in the overall health of their family. They will be most receptive to participating in a water supply program which emphasizes the need for water quality control.

Those women who cling to traditional ways, living in isolated communities with little contact with outside forces will tend to be interested in an increased water supply but not in the basic health rules necessary to maintain the water pure. An extensive educational program will be necessary to reach these people. The program must be carried out over an extended time, not limited to just a few visits. It must work through those sections of the community which have the legitimate authority and respect of the community as a whole -- i.e. chiefs, councelors, and women's committees. The people chosen to act as agents of change must be both males and females. The females must be women and not young ladies, so that they can communicate effectively with the female population who are mothers. Both should speak the local language (hopefully even be of the same ethnic group), be willing to participate in village life (which means staying over night in the village) and be able to command the villager's respect. Such contact should be about twice a month for a period of from two to five years in order to insure continued adherence to changes in health and related practices.

The second minimum participator is the rural male Togolese farmer living in the Dapaong Circonscription. He is most often illiterate but may have a rudimentary knowledge of French. He is basically a subsistence farmer whose goal is to provide his family with the necessities of life and protect them from life's pitfalls. He also adheres to traditional religious beliefs and customs which tend to impede social change. He is concerned for the health of his family, especially his sons as they will carry on his name and that of the family. As head of household he is responsible for providing everyone with enough food to exist and for maintin

maintaining harmony within the compound.

Those men who have had contact with outside agents similar to the ones mentioned above are aware of the importance of providing appropriate excreta disposal systems. In order to implement a successful latrine program for a village community, outside agents must address themselves to those elements of the society which are progressive, dynamic and command the villagers' respect, i.e. chiefs, village councils, elders, educated residents (teachers, nurses, mid-wives, etc.) and youth groups. These villagers who have had previous contact with forces of social change related to the matter of fecal matter disposal are quite eager to participate in a latrine construction program. Again those men living in isolated communities, practically untouched by outside influences, will not see the necessity of building latrines. Here again an extensive program in health education emphasizing the importance of appropriate excreta disposal will be necessary in order to effectively bring about a change in ideas.

The third profile of the minimum participator is that of the village students and their teachers in Dapaong Circonscription of Northern Togo. Anywhere from 5 to 16 years of age with a predominant male enrollment (usually less than one-third are female) these students are for the most part farmers' children. They have lived most of their lives in the immediate rural environment with few contacts with outside forces of change. They have grown up working for their families in the fields.

The greatest influences on their lives at the moment are their peers and their school teachers. The teachers are in a position of great importance vis-a-vis changing existing beliefs and values. The classroom becomes a major stage for developing new ideas and changing old ones. A well digging, latrine construction, and health education program associated with schools would provide an excellent opportunity to reach the next generation of community residents. What the children learn in school may be disseminated to their homes -- providing another source of changing existing customs and beliefs.

Teachers are most often males between the ages of 18 and 30 who have a basic high school education with additional short training as teachers. They may not necessarily be from the same region where they are teaching. If this is so then they do not usually speak the local language and for the most part are anxious to be transferred to positions near their regions. They also do not see teaching as a permanent occupation but just a stepping-stone to something better. Consequently for a good number of them motivation is low. They could be more of an impedence than an aid in reaching the pupils.

The last profile for minimum participator includes the staff and patients of local rural medical facilities. First, the patients who come to be treated at these facilities do so because they hope that the knowledge of the staff will be efficacious -- that they will be cured of whatever ails them. Their presence alone indicates a degree of readiness to accept the staff advice and directives. Therefore the

potential is there to use this situation as another channel of information dissemination on health related matters. These patients are the same people described above - rural sedentary subsistence farmers - male and female who believe or at least hope that they will be given adequate treatment. They are ready to listen to the proscribings of the medical staff. Whether or not they follow through on what they are told depends on several factors: Past experience at treatment; past experience of others; financial capability; and whether or not the proscription conflicts with traditional beliefs and methods of treatment. There are some people who will consult a traditional healer (guerisseur) at the same time as consulting the medical staff. Others may consult the healer before or after seeing the modern medical authorities depending on the results obtained from those visits. It is important to underline the fact that the patients' presence at the medical center indicates a willingness to try something new to improve their condition.

The staff is usually quite small for the rural medical centers. There can be a nurse (infermier), a medic (infermier-adjoint),and/or a midwife (sage-femme) as well as aids, custodians or helpers. The technical staff have a high school education with at least two years additional training in their specialized fields. The non-technical staff may not even have finished a high school education. Generally they are most occupied with curative medicine devoting very little time to preventive or health education. The technical staff may also be from different regions than their position. Consequently they also may not speak the local language and must use the non-technical staff who are most often locals as interpreters.

The medical center personnel are again in such a position as being important agents of change. What little health education that many rural villagers receive comes from visits to these medical facilities whether it be dispensaries, maternities or hospitals. Thus the incorporation of these personnel into the program of well and latrine construction and health education becomes extremely important in providing another channel of information exchange to the rural villagers.

Constraints

Throughout this analysis I have mentioned from time to time various obstacles which may act to impede project implementation. Herein lies a summary of these constraints :

1. Scattered nature of living arrangements - the traditional soukala compound is dispersed over large areas making it difficult to install wells to benefit the greatest number of people. In addition, this type of living arrangement renders it hard to organize groups of people to work for a common goal and to deliver services to people dispersed over a large area.

2. The level of awareness of the villagers - the degree to which the local population is cognizant of basic health practices will influence their participation in the project. Where villagers stubbornly cling to traditional beliefs and attitudes, channels of communication are blocked. Consequently, attitudes about excreta disposal and water quality control determine the acceptance of pump-fitted wells and pit-privies.

3. The degree of village leadership capability - those villages where dynamic and progressive authority figures both male and female are lacking will tend to impede the mobilization of the local population to participate in the project.

Communication Strategies

Although radio, and television to a much lesser extent, offer a means of mass communication, the number of rural households in northern Togo which would be influenced would be minimal. Perhaps it could be effective at the school level. However, face-to-face interaction is the most effective form of communication for this population at the present time.

This can be accomplished through the use of government itinerant agents who, speaking the local language, would visit the villages involved in the project to put the problems of water quality control and excreta disposal in the cultural context of the local population. Visual aid materials (posters, slides, films, microscopes, etc.) could be used to further advantage to show the villagers the importance of improved water quality and the benefits of latrines.

Not only would villagers be exposed to such information from itinerant agents but also from visits to local medical facilities where agents would also give lectures on basic health education, family health, and nutrition.

Finally, schools would be another site where information could be disseminated. Both teachers and itinerant agents could be used to instill in the younger generation new ideas on health which then could be another channel of communication back to the village.

Spread Effects : The Diffusion of Innovation

Although the project title, "Rural Water Supply and Sanitation" is dichotomous, the program philosophy is to tie these two aspects together, At about the same time as wells are being rehabilitated or drilled, latrine construction accompanied with health education should be in progress in the same locality. The project is designed to touch about 350 villages in the northern region of Togo, including about 100 schools and dispensaries with a total population of 120,000 as the primary beneficiary of the water supply program. The target group covers all age ranges and both sexes but with an emphasis on the younger population and women.

The school age children will learn about latrine construction and health education in schools. Village women will learn about proper water use and excreta disposal and basic health education in the village and at medical facilities. Village men will learn techniques of well construction, pumps installation and maintenance, latrine construction and basic health education in the village and possibly at dispensaries. Consequently the whole family will benefit from improved family health due to better sanitation, with water quality and control of disease. The spread effect will be limited by the availability of equipment, technical expertise and material. It is planned that the government of Togo will carry out on the project after USAID's withdrawal.

The aspects of the project which are innovations - closed wells with pumps, latrines and health education - all have a chance at diffusion. However, the rate of diffusion is dependant on the rate of success of each aspect of the project. Much hinges on the maintenance section of the program. Pumps which breakdown and remain disabled for some time will tend to discourage the diffusion of the idea of hand-pumps for wells. As long as there exists an effective on-going maintenance program which can continue after the program conclusion hand-pump installation can be a viable innovation for diffusion.

Leadership/Authority

There are several groups in Togo whose leadership will be important for the success of this project. On the national level the Bureau d'Assainessement in the Ministry of Health and the Service Hydraulique in the Ministry of Mines are the two most crucial offices in regards to health education, latrine construction and well drilling and maintenance. Both have expressed strong desires and interests in promoting such a project. The problem remains in effectively coordinating activities so that the various aspects of the program will be carried out in a logical framework.

At the regional level adequate infrustructure exists through which the project may be implemented. There is an on-going sanitary program working in schools and dispensaries involving health education and latrine construction centered in the town of Dapaong. The health education personnel from the project will be able to work with this regional Bureau d'Assainessment to coordinate thwir activities in the development of a health

education-latrine construction program linked to the well construction program .

Although the appropriate cadre are present in Dapaong to coordinate the well construction program it will be necessary to establish a regional center for training of personnel for well and pump maintenance. The establishment of an effective maintenance program at the regional level is of primary importance to insure the continued success of the project.

The regional level leadership plays the important role of backstopping and material assistance to the villages in terms of equipment maintenance, health education and supply of material. They will act as coordinators for the various aspects of the project and be the line of communication to the national level.

In addition to the Togolese input at the national and regional levels, the leadership role at the local or village level will be as or even more important for the successful implementation of the project. The authority figures will vary from place to place but will most often be from the legitimate political structure - village chief, council of elders, religious leader, women's committee president, health committee, etc. It will be important for the project representatives working at the village level (contract personnel, governmental agents, Peace Corps Volunteers) to recognize these leaders as well as other potential authority figures and work closely together with them for the mutual goal of supplying an adequate safe water supply and generally improving the health and life in the village.

Patterns of Migration

Seasonal migration from the Dapaong Circonscription in a phenemenon which has been developing since before independence. Young men for the most part go to other regions of Togo (the Plateau Region and Lomé) and to Ghana (the coffee-cocoa producting areas) where they can make relatively quick money. They work as laborers or tenant farmers and return to their villages. They may return after one season or they may stay for several years but eventually most will return home. Returned migrants are another potential source of leadership and diffusors of innovations as they have been exposed to new experiences which tend to make them question existing social values and customs. The recent drought has put added pressure on the number of people the land can support such that increased levels of migration have resulted.* The immediate effects of providing new year-round water supplies should act to decrease this out migration.

Social Consequences and Benefit Incidence

A major drawback to the spread of the project benefits beyond initial target areas lies in its prerequisites for technical and trained personnel to drill, install, and maintain water sources. While these examples provided by project successes may stimulate demand for similar systems in other needy areas, fullfillment of those needs will require further development of technical and institutional capabilities. However, the technical and institutional experiences gained from the work in the initial program areas

*For a detailed study of the migration patterns of the Moba, one should be able to consult a new study now in progress under the direction of Guy Pontie, Sociologist at the Bureau des Sciences Humaines, O.R.S.T.O.M., Lomé.

should assist in taking on the problems of other, similar geological and hydrological settings.

It is envisioned that once work reaches a conclusion in the Dapaong Circonscription, the project will shift to the Mango Circonscription, second of the two Circonscriptions forming the Savannah Region. Before continuing the program in this area further sociological inquiries must be undertaken to assure the readiness of the population, to judge the socio-economic impact of bringing the project to that area and to provide the technical personnel with the socio-cultural material necessary to insure a successful implantation and running of the project.

The social consequences of the implementation of this project can be seen to affect the quality of life, the health, and the mobility of those concerned. The amount of income of rural households is not likely to be directly affected by this intervention, but the general quality of life, at household and community levels, is likely to improve.

Moving water sources from ponds, streams, dams and rain-water cisterns which harbor guinea worm, schistosomiosis and other such parasites to wells with hand pumps may be expected to reduct the incidence of gastro-intestinal and other diseases. Greater quantities of water for washing clothing and for bathing may reduce the incidence of skin diseases, especially for women and children. Where there is a reduction of water-

borne diseases due to better protected and adequate water supplies, communicable diseases and their potential carriers from the project area may also be reduced. Consequently transmission of these diseases from the program area to other regions, both urban and rural, may also be expected to be reduced. Knowledge of, and concern with health care related to water-borne diseases will result from associated efforts at health education. Children as well as adults may not only become more healthy, but more aware of water as related to health, as the program continues.

Providing greater quantity and quality of water to areas suffering from short water supply may also reduce the rate of seasonal and long term migration to cities and other cash-crop production areas. Consequently, investments in the productive potential of the local area are likely to increase. However considerations must be made as to the ecological ration of population to land support potential - to the fragile nature of the soil and its tendencies to exhaust such potential. Any programs involving mass relocation of communities (as foreseen for the Oti River Valley) must be studied in depth to discover the socio-ecological impact of such displacements.

The implementation of this project is unlikely to cause serious shifts in activities associated with specific roles. Water carrying and the bulk of water use will remain the responsibility of women and children. This project may perhaps make water drawing a more pleasant and convenient activity without radically changing their patterns in the village. The

program will not detract from the quality of women's social lives but should reduce the amount of labor required for this basic female activity, as well as other water related female activities - i.e. - washing clothes, utensils, cooking and bathing. Providing women with a safe, accessible and perennial water supply nearer to their households will provide them with more free time to engage in more productive activities. Consequently the quality of life and the productive potential for women may increase.

Finally, the project anticipates development of community participation in water supply and sanitation systems. This may provide a focus for community action in a context which has obvious benefits for all. Leadership which manifests itself in connection with this program at the village level may enhance the community's ability to articulate demands for development to local government and state agents.

Bibliography

Agency for International Development, Office of Housing.
1977. Republic of Togo, Shelter Sector Assessment. Washington D.C., September, 1977. (Mimeo).

Agency for International Development.
1977. Project Paper. Togo. Togo Family Health. Project No. 693-0212, Washington, D.C. (Mimeo).

Bertho, R.P.
1952 Rares et Langues du Bas Dahomey et du Bas Togo. Notes Africaines.

Cornevin, Robert.
1968 Histoire du Togo. Paris.

Frobenius, Leo.
1967 Les Moba, Documents Ethno-sociologiques du Cerk. Servie C. ffas. 3, September 1967.

Froelich, Jean-Claude, Alexandre, Pierre and Cornevin, Robert.
1963 Les Populatilns du Nord-Togo. Paris.

Konu, Emmanuel.
1967 La Population Togolese. Institute National de la Recherche Scientifique, Lomé. (Mimeo).

n.d. Accroissement Demographique et Progrès Socio-Economique en Togo. Lomé. (Mimeo).

Othily, Arthur, Sossah, Innocent and Kenkou, Georges.
1974 Etude Sociologique dans la Region de la Kara. Entreprise dans la cadre de la preparation de project. FAO/PNUD TOG 74/001 "Nord Togo". O.R.S.T.O.M. Centre Lomé. (Mimeo).

Tchably, Modest.
n.d. Approaches de la Mentalité Moba. Serie de Cours donnés a Bombouaka, October 1969 - March 1970. Notes de Cours. (Mimeo).

Togo, Republic of, Ministere du Plan. Direction de la Statistique.
n.d. Recensement General de la Population du Togo. (Mars-Avril 1970). Resultats Provisoires. (Mimeo).

1974 Recensement General de la Population. (Mars-Avril 1970). Volume I: Methodologie et premiers resultats. (Mimeo). June, 1974.

1975 Recensement General de la Population. (Mars-Avril 1970). Volume II: Resultats Detaillés par Circonscription. (Mimeo). Aôut, 1975.

Warford, Jerry and Sanders, Bob.
1976 Village Water Supply in Developing Countries. John Hopkins University Press, Baltimore.

White, Gilbert and White, Ann U.
1972 Drawers of Water. University of Chicago Press.

Persons Contacted

Washington, D.C.

Curt Anderson, A.I.D., Health, Sanitation and Nutrition.
Victor Waymen, A.I.D., Civil Sanitary and Health Engineering
Bernard Laine, State Dept., Togo-Benin Desk
Mary Elmendorf, World Bank
Robert McAllister, Peace Corps-Action, Africa Section
Richard Brush, Peace Corps-Action

Abidjan, Ivory Coast

Dan Aronson, R.E.D.S.O., Sociologist
Jon Eriksen, R.E.D.S.O., Agronomist
Ann Mackie, R.E.D.S.O., Health Sanitation
Larry Bond, R.E.D.S.O., Project Supervisor
Les Maupin, R.E.D.S.O., Hydrologist
Ray Van Rolte, R.E.D.S.O., Acting Director
Michel Le Grand, Canadian Embassy, Will-drilling Expert

Lomé, Togo

Ambassador Ronald D. Palmer
Sally R. Sharp, A.I.D. Office
Karl Beck, Peace Corps Director
Kelly Morris, Assistant Peace Corps Director
John Reddy, Director, Afro-American Labor Center
Guy Pontie, Sociologist, O.R.S.T.O.M., Sciences Humaines
Mde. Awussi, Librarian, C.N.R.S. (Center National de la Recherche Scientitique)
M. Agbojon, Ministere du Plan
M. Neonene, Directeur du Bureau de l'Assainesment
M. Johnson, Service d'Assainessement

Dapaong Circonscription

Adja Nabroulaba, Chef de Circonscription, Dapaong
M. Kambia, Directeur de l'Organisation Regionale de Production Vivrier, Dapaong
M. Gabla, Directeur de la Genie Rurale, Dapaong
M. Baly, Directeur de l'Animation Rurale, Dapaong
Chief and Villagers of Timbou
Chief and Villagers of Nanergou
Villagers of Tabi
Mme. Sankareaja, Affaires Sociales, Formation des Femmes et Alphabetization, Dapaong
M.J. Kludze, Chef du Bureau de l'Assainessement, Dapaong
Pupils and Teachers in Public School of Korbongou
Chief, Elders and Women in Nakitindi

RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION

REPUBLIC OF TOGO - JULY, 1978

By:* Edward P. Michalewicz, Dr. P.H., R.S.

I. INTRODUCTION

For many years in the more industrialized countries man has been concerned about the effect of the environment on his health and well-being. He has learned to control some of the elements which contribute to the effects of his environment on himself. He has learned the basic requirements for personal hygiene and has an understanding of the causes of the more common diseases which may beset him. He knows that the water which he obtains so easily from a number of faucets in his home will be safe to use. When he flushes the toilet his bodily wastes are carried away - where he does not know nor care. The garbage disposal takes care of most of his garbage, the rest is carried away by the trash man.

In many rural areas of the developing world however man is not fortunate. Safe water is not readily available, in fact his wife and children may have to spend many hours in carrying for miles on their heads or backs the meager quantities of dirty water available to them for cooking, bathing, drinking and for laundry.

The nearest corn field is used for defecating and urinating. In northern Togo small rocks are used after defecating, as paper and leaves are scarce.

---

* Edited for use as an annex to the Togo PP for Rural Water Supply and Sanitation.

What little garbage there is, is thrown in a heap outside the compound, sometimes is even buried. When it rains the fecal matter is washed into the places where the women obtain their daily supply of water and the disease causing agents are brought back to the home to carry on their deadly work. Flies, and rodents add to the problem. The result is a variety of water-borne, water-related diseases which take their toll of the rural family. The problem is aggravated by the multitude of worms and intestinal parisites which abound in tropical areas and which consume up to 50% of the scarce food that the poor family is able to raise or afford.

Hence the concern of AID and other bilateral and international donors as well as the national governments themselves about doing something to help the rural poor help themselves to better their living conditions through better agricultural methods, better housing in a more sanitary environment.

A. Relationship of Water to Health:

In addition to the basic need for clean water for man's physiological processes, water plays other important roles. Many diseases are water-borne or water-related. Parasitic organisms which live on or within other living organisms are contamination of water and will attack man if they have access to him. Some use the water as an acceptable environment for survival while others require it to complete their life cycle. Others use it as a mode of transmission to reach and enter man. Man can be attacked directly or through the use of water living intermediate hosts.

Water is the primary mode of transmission of cholera, leptospirosis, typhoid fever, schistosomiasis and hepatitis. The causative organisms of bacillary dystentery, paratyphoid fever and amoebiasis are water-borne and enter man through the mouth. Thus, water acts as a habitat as well as a vehicle of conveyance.

Chemical contaminantes are also found in water supply sources. Water's chemical constituents like arsenic, cadmiuin, lead, selenium and nitrate at certain levels of concentrations can produce serious adverse effects on man. Excess fluoride produces mottling of teeth while optimum levels reduce dental caries. Excess sodium in water consumed by one having diseases of the heart, kidney and liver can be fatal.

Clean water of sufficient quantity is necessary to maintain hygienic conditions. Clean water for bathing, washing of foods and clothing is also important to man's health. Water is necessary to keep the body clean. It is also important in controling parasites and fungi responsible for many skin diseases. Without adequate potable water conveniently available, water-borne and water-related diseases will continue to be among the leading causes of morbidity and mortality, particularly among the children, in the rural areas in developing countries.

<u>However a potable water supply is not enough</u>. WHO states that "studies show that improvement of water supplies alone, without concomitant provision for sanitary excreta disposal is much less effective". Actually to assure full

health benefits a water supply program should be accompanied by a sanitary excreta disposal program, a continuing health education component and full community participation in all phases of the programs.

If one or more of these elements is missing the expected health benefits will not result or will be seriously diminished. Yet many of the projects being carried out with bilateral and international assistance provide only for water supply with no provision for sanitary excreta disposal, health education nor for the community participation needed to guarantee the continuing success of the water supply programs. The present project contains all of the above mentioned components in an endeavour to obtain the full health benefits which are the objective of the project.

B. Purpose of this Annex

Other sections of the PP and of the Annexes address the various aspects of the water supply problem in Togo and recommend alternative solutions to that problem. This annex includes a brief reference to actual health conditions in the area covered by the project (to the extent statistics are available) and covers the phases of the project related to health education, sanitary excreta disposal and community participation.

In synthesis the present PP includes provision for the following elements in the Savanes Region :

1. Training of well drillers, mechanics, pump installation and maintenance people for work at the circonscription, district and village levels, also training for health educators, sanitarians, latrine construction crews.

2. Construction of new drilled-wells and restoration of existing wide diameter wells, including the capping of the restored wells leaving manholes for access to the well in case the pump fails, plus the installation of hand pumps on both the wide-diameter and the drilled wells.

3. Establishing a laboratory with trained personnel to monitor the quality of the water being provided by the various sources in the Savanes Region.

4. The stimulation and motivation of the villagers in the project area to understand the reasons for the facilities which the project will help them to install and to maintain those facilities to obtain maximum benefit from them.

5. Assisting the villagers to install sanitary latrines in their own compounds, and for the schools and dispensaries where they exist. The theme throughout the project is to involve the beneficiaries from the project in all aspects of the project from early planning at the village level, through the construction phase and then in the all important continuing maintenance of the facilities provided by the project.

This Annex covers the last three categories of staff training mentioned in Item 1, above plus Items 3, 4 and 5.

II. DEMOGRAPHIC PROFILE

A. For the Republic of Togo

The pertinent data on location, area, population distribution and number of tribes is contained in other Annexes and so is not treated here.

The 1976 health statistics[1] show a birth rate of 18.4 per 1000 population, a fetal death rate of 40/per 1000 live births and an infant death rate of approximately 60 per 1000 live births. The maternal death rate was 1.3 per 1000 live births. The birth rate is low as only hospitals and dispensaries report births. Births in the home, common practice in West Africa, are not reported.

The available data on morbidity and mortality in Togo for 1976 are listed in Table I.

---

(1) Statistiques Sanitairé : Anne 1976, Direction General de la Sante Publique, Division de l'Epidemiology, Service National de la Statistique Sanitairé, avril 1978.

TABLE I

MORBIDITY AND MORTALITY REPORT FOR TOGO IN 1976(2)

Disease	Cases	Deaths
Bacilliary dysentery	1,884	9
Amebiasis	7,349	56
Dysentery	137,130	1
Whooping Cough	5,196	3
Poliomyelitis	33	2
Chickenpox	7,986	-
Smallpox	26,018	75
Malaria	274,459	24
Onchocerciasis(River Blindness)	8,707	-
Schistosomiasis (Bilharziasis)	5,749	-
Trypanosomiasis (African Sleeping Sickness)	4	2
Yaws (Pian)	4,866	-
Filariasis	285	-
Ancylostomiasis	15,202	-
Intestinal worms	8,903	-
Flu and pneumonia	17,682	4

(2) Statistical Sanitaire : Anne 1976, Direction General de la Sante Publique, Division de l'Epidemiology, Service National de la Statistique Sanitairé, avril, 1976, P.13.

B. For the Savanes Region

As this project is being designed to reach the rural people in the Savanes Region of the country with emphasis on the Dapaong Circonscription the following information is given for that area. A number of villages in this area were visited to obtain on-the-spot information from the people, about their customs, habits and beliefs about diseases and hygiene, also to observe living conditions. Numerous publications and documents were reviewed.

Rural villages vary in size from a few people to nearly 10,000. Population distribution (Table II) based on the 1970 census for the Savanes Region show a total of 240,000 inhabitants with 181,000 living in the Dapaong circonscription and 59,000 in the Mango circonscription (3,4). Nearly 94 percent of the population in the Region is illiterate. One trained doctor is available for each 90,000 people. Twenty-seven dispensaries are located in the Region.

Tables II and III give a comparison of the first 10 causes of morbidity in the Sanitary Subdivision of Dapaong in 1974 with the data for the country as a whole.

Appendix A and B contain data for 1974 for the Sanitary Subdivision of Dapaong and for the Republic of Togo of the medical consultations registered according to age and sex for the most frequently observed diseases, Table IV was extracted from annual reports for 1975, 1976 and 1977 of the Children's Hospital operated by the Augustine order in Dapaong.

TABLE IV

MORBIDITY REPORTED IN CHILDREN AGE 0 - 14 AT HOSPITAL D'ENFANTS

DAPAONG, TOGO

Diseases	1975		1976		1977	
	No.	% of Tot.	No.	% of Tot.	No.	% of Tot.
Chickenpox	70		19		18	
Measles	1,160	1.4	1,459	1.2	1,132	1.0
Malaria	3,569	4.3	3,525	2.9	4,907	4.4
Diarrhea & Dysentaries	3,794	4.6	4,245	3.5	4,257	3.8
Bilharziasis (Schistosomiasis)	30		39		26	
Onchocerciasis	5		--		--	
Elephatiasis	29		75		5	
Malnutrition	907	1.1	984	0.8	1,202	1.1
Coughs	2,734	3.3	3,047	2.6	3,666	3.3
Amebiasis	6,136	7.4	6,130	5.1	7,611	6.8
Trichomoniasis	668	0.8	776	0.7	808	0.7
Filariasis	5		6		1	
Total Consultations	83,152		119,240		110,031	

III. ORGANIZATION

A. National Level

Various agencies of the Republic of Togo have responsibilities pertaining to water and rural sanitation programs. Involved are Ministries of Health, Education, Plans, Rural Development, Hydraulics, which primarily provide support and technical services to the regional and circonscription levels for rural water supply and sanitation programs. Overall responsibility for coordinating the activities of all programs rests with the Ministry of Planning. The hierachal organizational structure of authority is diagramed below:

Republic of Togo

Ministry Ministry Ministry

Regions Regions

Conscription Conscription

Canton Canton

Village Village Village

The Ministry of Health at Lomé has within its agency a Division of Environmental Health. The Division is adminstered by a sanitary engineer. Sanitarians, technicians and assistants are assigned responsibility for handling excreta disposal, water supply, housing, vector control, hygiene, industrial hygiene, quality control and health education from the national level. Consultants in Sanitary engineering and sanitation from the World Health Organization are also available to the division.

The Department of Sanitation has five regional offices. Each is administered by a sanitary engineer. Regional and subdivision level personnel are responsible to the chief sanitary engineer in Lome. The organization structure of the Division of Environmental Health is found in Appendix C.

B. Savanes Region

The Savanes Region has a sanitary engineer in change of the environmental health unit. The organization is as follows:

Regional Engineer

Sanitarians (5)

Sanitary Inspectors (1)

In addition to the sanitary engineer there are five sanitarians and one sanitary inspector responsible for health education and sanitation. Health

education is carried out through the schools, villages and dispensaries. The department carries out programs for the construction of latrines, the inspection of grocery stores, restaurants, butchershops, and abattoirs. A program requiring all food service employees ot obtain "health cards" is also handled by the department. A physical examination is required at least every six months and may be obtained at the hospital. A small service chage is made by the hospital for the examination.

The department of environmental health is also responsible for location of wells and the sanitary quality of the water produced. No laboratory is available in the area at present for testing water quality. A minimal amount of money has been committed for starting a laboratory that will be used to monitor environmental health activities.

The environmental sanitation department at Dapaong works very closely with the hospital and its satellites. A physician in charge of the regional hospital and dispensaries is responsible for the health services provided in the region. Nurses function in the hospitals and in the dispensaries where they have itinerant workers to help them. These itinerants work with villagers at health centers. The itinerants do the health education which is primarily directed toward their patients. The sanitarians provide sanitation training to nurses and itinerants and work with villagers. The close relationship that exists between preventative medicine and curative medicine is encouraged and should continue to be cultivated.

The fact that there is an active on-going environmental sanitation program well organized in the Dapaong Region makes it feasible to consider the expanded program required for the present project. The addition of two more latrine construction crews and of two health educators all under the direction of a Latrine Program Supervisor, with adequate training for all the personnel involved in the program will strengthen the present organization and not place an undue burden on it.

The organizational structure for public health activities is as shown below:

Regional Hospital
(Doctor)

Dispensary (Nurse) | Dispensary (Nurse) | Dispensary (Nurse)

Health Center (Itinerants) | Health Center (Itinerants)

IV. DAPAONG CIRCONSRIPTION ENVIRONMENTAL HEALTH PROGRAM

Although a number of programs are in operation in the Department of Environmental Health, only the latrine (pit privy), health education and water quality programs were investigated and will be commented on here.*

---

* A report of the Department of Environmental Health is found in Appendix D.

A. Excreta Disposal Program

The present excreta disposal program is Dapaong is based on a project started by the Ministry of Health in 1966 in the Maritime Region. This five year project met with limited success and has resulted in the construction of 120 six-hole latrines for schools in Togo. The Dapaong Circonscription is constructing latrines at schools, dispensaries and for some communities using knowledge and techniques developed in the original project. Financing for materials and personnel comes from department funds.

Present Program

Four geographic areas of Togo with different dialects, customes and beliefs were chosen by the health department in which to undertake the pilot latrine program. It is directed toward construction of latrines for schools. Communities were contacted and agreed to participate. Teachers and missionaries were invited to cooperate in helping stimulate community participation and to encourage construction of latrines for compounds.

In the Dapaong area under this program five public latrines have been constructed and eleven are under construction. In addition, some 115 private latrines built by indivieuals are located in Dapaong proper.

The Health Department in Dapaong constructs the latrines providing some materials and manpower. UNICEF and other doners contribute to some extent. For example, the World Food Program provides food for workers at the site. The community, teachers and students help dig the pit, mix the concrete,

make the cement blocks or adobe, etc. Sand for concrete is provided by the community and provision is made to haul it, if it has financial resources. In some cases the health department 1/2 ton pickup truck is used as the transport vehicle. The roof and doors are generally of corrugated metal furnished by the health agency.

A latrine construction crew is employed by the Department of Environmental Health in Dapaong. The crew obtains its technical advice on construction, location, etc. from the sanitary engineer and sanitarians. The construction crew includes: 5 masons, 3 carpenters, 1 iron worker and 2 laborers.

The crew is taken to the work site each Monday, with the Department's vehicle, and returned on Friday. When necessary, the vehicle is used to haul aggregate on the return trips. The villagers provide housing for the crew or they sleep at the site.

The department uses a standard plan in the construction of latrines. School and public latrines are six-hole "squat" type. In some cases three holes are used for men and three for women. Separate toilets are provided for men and women if the population warrants.

The pits are at least 4 meters deep, and some up to 6 meters. Cement block is used for the walls lining the pit and then plastered with cement. The vault is basicly water tight. A beam at the top of the wall is reinforced

with steel and extends beyond either side of the pit. This is to prevent the protective building from falling in the pit in the event the pit wall should crumble. In one place this happened, and a child was killed. The squat platform slabs are made of reinforced concrete, each hole made separately. The walls of the protective building are generally made of adobe brick plastered with cement to prevent deterioration. A roof of corrugated metal and metal doors are then installed.

Latrines for private use are one-hole (sometimes separate holes are required for males and females) and have basicly the same design (Appendix C).

The costs of a six-hole latrine is approximately $600 for materials only. The major cost is cement which is approximately $88.00 per ton. Labor costs for complete construction are nearly $400. However, mush of the labor is volunteered and some materials donated. The cost of constructing a concrete one hole slab is about $8 to $10. Detailed costs are noted in Appendix C.

The major latrine design shortcoming is that the pits are constructed too deep. A number have collapded due to soil and moisture conditions. A tremendous pressure is exerted on the walls because of the depth causing failure of many pits. The 4 to 5 meter depth is also of public health concern as leakage of pit contents may contaminate a nearby ground water bearing strata with pathogenic organisms.

Because of the shortcomings of the present latrine design, one of the first phases in the proposed ~~spring~~ latrine program will be an investigation of the type of latrine which will be most acceptable to the prospective users and then the development of a design which will result in a structure which will stand up in the area where it is to be used. The investigation will consider school latrines and also latrines for use in family compounds. The improved designs will probably result in higher costs and this has been taken into consideration in estimating the cost of the latrine program.

The rainy season influences to a considerable extent the timing of the construction of latrines. In the Dapaong area, the rainy season begins about June 1st. and lasts for six months making it very difficult to dig pits and construct wells. During this period, the health agency conducts studies, plans future construction projects and concentrates on other programs.

B. Health Education

Numerous agencies of the Republic of Togo have varied responsibilities with respect to public health education. The national, regional and local levels of government work primarily through the public health system and the educational system. Some health education on personal cleanliness and nutrition is taught at the elementary and secondary schools by classroom teachers. The health department has prime responsibility for health education of the people. Doctors, nurses, sanitarians, dispensary workers, sanitary engineers, midwives, itinerants and health workers are all responsible. This is done

through a one-to-one relationship between health workers and those with whom they are working.

The Department of Health uses its sanitarians to provide health education. The sanitarians instruct school teachers and provide them with information that they may use in the classroom and as reference materials. They also work with nurses and itinerants to instruct them and consult on sanitation practices.

Meetings are held in communities to inform adults of public health, particularly prevention of diseases through use of proper sanitary measures, and to promote community health programs. The building of school and public latrines and private latrines is accomplished through community participation. Information on protecting foods, water-supplies, the need for proper nutrition, personal hygiene, etc. are presented by employees of the sanitation department.

Emphasis on education methodology and public health principles should be stressed to all health workers. This would be done through basic training, retraining and upgrading of various levels to address and meet health needs.

A need also exists for health education materials for teachers, students and to convey information to the adult population on various aspects of health. Much of the information is conveyed verbally through one-to-one or one-to-group contacts. Little visual aid material is available. The radio could

also be used directed toward a specific target population, to inform the population of health issues in their native tongue. Various methods of information dissemination should be used to achieve maximum results.

The Peace Corps (PC) has one health education volunteer working in the Maritime Region on a concentrated effort to provide thirteen vilages with health education. A national counterpart is being trained in the program. Prevention is stressed leaving curative medicine to other health professionals. Pre-natal classes are held in the villages as are presentations on nutrition, food preparation, quality and storage. Teachers are instructed on health principles and the P.C. volunteer is used as a resource person. Some classes are taught by the volunteer directly to school children. Posters and educational material are being developed but is limited due to constraints of time, finances and accessibility to necessary resources.

The Peace Corps Volunteer uses the following teaching manuals:

Moyens, Cours. Education Sanitairé. Ministere de l'Education National, Lomé, Togo. 1974.

Gadagbe, Dr. E. Z.. Conseils de Sante a la Famille Africaine. Ministere de la Sante Publique et de Affaires Socials, Republique Togolaise, 1973.

Corwin, Mary Lee. Health Education: A Study Unit of Fecal-Borne Diseases and Parasites. Peace Corps/Philippines. March 1977.

Other health education materials are being developed by the PCV applying public health principles to local situations and customs. . .

C. Water Quality

Most water used by people in rural areas is obtained from rivers, stagnant ponds and pools. However some is obtained from open wells. The city of Dapaong has 601 private wells and 22 public wells. Nearly all are dug wells open at the top for drawing water. Curbing up to one meter above the ground is found on 517 wells. Some are lined only a short distance below ground level permitting surface water contamination of the well. Of the total number of wells, 413 go dry periodically. 210 wells can be considered as producing year round (see Appendix D). All water is drawn from the open wells in rubber tubes or metal buckets using ropes or straps. This method introduces filth into the well. Material thrown into the well contributes to the contamination of the water. Poor construction and inappropriate locations of those wells allows infiltration of additional pollutants.

The objective of any water supply project is to provide the users with potable water which is safe to use and free of disease organisms and injurious chemicals.

. . . A water quality control laboratory is necessary to check the chemical and bacteriological quality of the water. Such testing should be done as soon as a source is located and before the source can be approved for use, then the water supply system should be checked as the facility is placed in operation. It should be tested whenever repairs are made to the installation as well as periodically.

As there is no water quality control laboratory in the Dapaong area, such a laboratory is being considered for that area. About $3,500 per year is being budgeted. It is planned that the present project will provide funds to develop a multipurpose laboratory which will meet the needs of the Environmental health office and those of the hospital as well. The laboratory will be under the responsibility of the Regional Sanitary Engineer.

V. PROBLEMS IN SANITATION - FIELD OBSERVATIONS AND INTERVIEWS

A. Water Supply

The water supplies observed in rural areas of Dapaong being used for human consumption, washing of clothes, cooking and bathing are generally inadequate and usually contaminated. The water sources may be streams, springs and wells, usually large diameter hand-dug by the people, also machine dug under some government program. The depth of wells varies from a few meters to 50 meters. Water in the wells also varies in depth depending on the season. Many hand dug wells are shallow and dry up during the dry season but may fill to ground level during the wet season.

Most private wells were dug to depths where water was reached or rock prevented further digging. Most were not lined and had no protection. Where concrete lining was provided it was inferior and did not prevent surface water contamination from leaking into the well.

None of the wells had pumps and only a few were found to have some type of wooden or metal covering. In many cases sticks, leaves and grass were floating on the water surface in the wells.

The location of private wells was chosen primarily for convenience. They were generally close to the living quarters and livesock was generally found near the well where they were watered. Clothes were washed near the well and on a number of occasions bathing was observed nearby. Some wells were placed in areas where gulleys had formed and it appeared that heavy rains would flood into the wells. Because of poor construction and protection contamination of the wells is inevitable.

Community wells were also examined. The wells served a number of families (Soukala), the village or a couple of villages. Most of these wells were lined and had masonry curbing extending some 24 feet above the ground. A majority of community wells were installed under a program sponsored by the European Development Fund (FED). These wells were properly constructed and located in suitable areas but were not covered. No pumps were provided and the villagers used ropes and buckets to obtain water. Some of these wells did not produce water during the dry season and less suitable sources had to be used, often at considerable distance from the village.

Women and children are the principal drawers of water. Water is drawn from the open wells with buckets made of inner-tubes, closed at one end, plastic or metal containers attached to woven rope or nylon cords. The buckets and rope are lowered into the well, filled and returned. The rope drops on the ground and is stepped on by the drawer of water and others at the well site. Livestock droppings are common around the well area. Contamination of the cords and buckets through direct contact on the ground surface is inevitable.

The drawn water is put into containers of varied material and size and placed on the head to be transported to home. In some cases this is a considerable distance.

Ponds, streams and man-made reservoirs are other sources of water. These may be the only available sources during the dry season or are used to supplement water obtained from wells. Baths are taken and cloths are washed in the water and dryed on bushes or the grass. Children swim in the water and a considerable amount of social activity takes place around such water sources. It was observed that humans were urinating into the water and on the banks. They were also using the bush to defecate. ~~This~~ Runoff from these areas enters the water and is another source of contamination.

Cisterns are used in some areas to collect water for domestic use. They are more common in the Maritime Region. Cisterns are less common in the Savanes Region, although rain water is caught and used to some extent in some villages. This water is subject to contamination in its collection and storage.

Open cisterns are frquently used and small quantities of water are kept in large earthen jars or metal containers. Most containers and cisterns were found to contain mosquito larva, insects and debris. This water is used for all domestic purposes. Only a limited number of cisterns could be considered properly constructed to prevent continued contamination of the stored water. ~~while in storage~~. None of the water was chemically treated before use.

Water being used was in some cases clear while in other cases milky white in color. Women prefer well water but use other water for various reasons. Dirty water is considered as having one or a combination of the following characteristics:

1. Strange taste
2. Offensive odor
3. Stagnant
4. Visible aequatic life
5. Rain water ponds
6. Muddy water
7. Water that has run over areas where one has defecated.

Water with chemicals added for purification would be acceptable for use, according to the women, if they were informed and understood that the chemicals are added to make the water safe for drinking. The lack of protecting sources of water, obtaining it from approved sources, and protecting it from contamination during transport and in some storage is due to a general lack of education and in particular to a lack of knowledge in basic health and sanitation practices.

B. Excreta Disposal

Human excrement is found almost anyplace in the rural areas. People relieve themselves when and where it is necessary and convenient. One commonly sees people urinating on walls, fences, along roads, on sidewalks and in the

bush. Certain areas are more commonly used around homes and soukalas. Although privacy is important, its importance depends on the place and situation.

Private latrines are not common. Some have been constructed and are generally pits three meters deep with logs and dirt on top for the platform. Concrete is not used for the pit walls nor is the platform hole covered. Protertive shelters are constructed of sticks, bamboo or adobe, which is sometimes pd plastered with cement. and In some places no walls are provided. The roof may be of straw or corrugated metal. Occasionally doors are provided but often they were hanging by one hinge or off completely. In most instances the private latrines were found clean.

Latrines were also found near some schools and dispensaries. School latrines were relatively clean as teachers take responsibility to see that they are kept clean. Where a fee is collected for use of a latrine, paper was provided and the latrine was kept relatively clean. However, it was noted in a number of cases that people were not willing to pay and were relieving themselves just outside the public latrines.

The health department has a regulation which requires school and public latrines to be located at least 15 meters from a well. This distance is minimal and depends on soil conditions and topography. The lack of personnel prevents a strict enforcement of the rule for pirvate latrines.

School latrines were located some distance from the school, sometimes as much as 50 or 60 meters. Thexreason given was odors - although odors were

minimal near the latrines examined. Probably the latrines were located at these distances because it was the area most frequently used by the children before the latrine was built and thus a natural place to construct a latrine.

Latrine-pit depths varied from 2 meters to 6 meters. Most pits were excessively depp. Reasons for this were "that they would fill up with waste material quickly if shallower". Some pits were at depths which undoubtedly reached ground water levels. Such depths must be discouraged as it may result in contamination of the ground water strata. Excessive depths of latrine pits results in high earth pressure on the lower portion of the latrine lining and a number of cases were observed where the walls had been pushed in by this pressure resulting in the collapse of the entire latrine structure. School pits were dug by children and teachers with help from the community in some places. Public latrine pits were dug with hired help paid for by the community or dug with volunteer help.

Latrines constructed for schools and dispensaries were of cement block vaults and walls of adobe plastered with cemnt or of concrete block. The roof was generally constructed of corrugated metal as were the doors. Sticks, bamboo, grass and straw were used in some cases for the walls of the protective building but more commonly for private latrines. The platforms were of concrete, particularly for the multiple hole latrines. Walls around the school latrine area were sometimes constructed for privacy, In one case broken bottles were placed on the top of the wall and the entrance to the area was locked because of extensive village use and vandalism. Public use

of privies without any responsibility for their maintenance resulted in a limited life of the facility because it soon become too filthy to use.

In some areas men and women use separate latrines. The men are not willing to use the same facilities used by women and children. A latrine construction program must consider separate facilities for the sexes and privacy to gain acceptance by the users.

In the Savanes Region, paper, leaves, corn cobs, sticks, stones and water are used to clean oneself after defecation. Local custom and religious beliefs influence these practices. Stones are not used in the sourthern part of Togo where paper is more readily available. In most areas, used wiping materials are not discarded into the pit but are put in the corner and allowed to dry. The reason given is that it fills the pit in a very short time. It was reported that most pits were deep and constructed within the past few years. None looked particularly full, however, it could not be ascertained if the filling was due to materials deposited or due to surface water, ground water or soil entering the pits. More detailed studies are needed as reported construction dates did not correlate with visual observations of filling of pits.

When asked if the homeowner did anything to reduce odors in the latrines various replies were given. Some said they poured gasoline into the pit periodically and then lit it; others added ashes. Anorther said he added two liters of boiling water once each month. Some added lime and then did not use the latrines for a month or two.

Sokode

Yao, Amefia, Chef Regional de la Service Hydralique, Central Region

Tagbligbo Circonscription

Kilim Bini, Chef de Circonscription
Villagers of Aoute Kondji
Villagers of Kika Kondji
School Director of Gboto Vodougba
Chief and School Director of Ahepe
Chief, Elders, and Women of Koni Kondji
Mlle. Akpene Kudalo, Lycee Student, Lomé

Tsevie Circonscription

Chief and Villagers of Badja

Nuatja Circonscription

Ron Harvey, Administrative Director, Experimental Agricultural Project

Kpaline Circonscription

Bill Taylor, Peace Corps Volunteer, Construction (Kpaline)
Rick Wagner, Peace Corps Voluntcer, Construction (Vogan)
M. Yaeger, Peace Corps Volunteer, Construction (Lomé)

Aneho Circonscription

Aidy Goldberg, Peace Corps Volunteer, Health Education ~~Interviewer~~
Infermier, local village near Aneho